SCIENCE FOR PEACE

Two Reports

THE ANNUAL GENERAL MEETING

THE PUBLIC CONFERENCE ON THE LONG-TERM EFFECTS OF NUCLEAR EXPLOSIONS

Holborn Assembly Hall, London, WC1

Saturday 26th March 1955

OUR PURPOSE

Science for Peace *was started in 1952 by some of the British scientists who were disturbed by increasing emphasis upon the destructive applications of science. They sought through this movement to express their views collectively. Its name was chosen with deliberation; for without real peace a distorted application of science seems unavoidable. Furthermore, the assumption that lies behind the scientific approach to all problems, natural or social, is that they can be solved by reason and without an appeal to violence.*

In this era of the hydrogen bomb, the outlook of Science for Peace *is increasingly shared by other scientists and by the public at large, both in Britain and abroad. Nevertheless, official policy is now tending to make the use of thermonuclear weapons almost inevitable. We know that the effects of these weapons would be unprecedentedly cruel: their little known long-term effects may be a threat to the human race. We feel it to be urgent for those who understand what is at stake to speak out confidently, that the extent of the danger may be realised and atomic war averted.* Science for Peace *exists to promote the use of science solely for peaceful construction and human welfare.*

A statement signed by *S. M. Manton, Dorothy Needham, J. D. Bernal, F. Le Gros Clark, F. G. Gregory, Joseph Needham, A. C. Offord, N. W. Pirie, R. L. M. Synge and J. H. C. Whitehead.*

16 ULSTER PLACE · MARYLEBONE ROAD · LONDON, NW1

SCIENCE FOR PEACE

THE NATIONAL COMMITTEE

MEMBERSHIP

All scientists, engineers, technologists and technical assistants are welcomed as Members of *Science for Peace*—Annual Subscription, £1. The secretaries of organisations, librarians, and others who wish to receive our publications, but not to become full voting members, are invited to join as Associate Members—Annual Subscription, 10s. Student Members pay only 5s. annually. Subscriptions are due on joining and thereafter in January of each year.

Correspondence, remittances and materials for the Bulletin should be addressed to the Secretary, Science for Peace, 16 Ulster Place, London, N.W.1.

MESSAGES FROM ABROAD

Professor Albert Einstein, NL — *The Alternatives*

The alternative before us is peace secured through a supra-national organisation or total destruction. This everybody knows today. But it still needs some courage to act accordingly; for such is the nature of man that the interests of today influence him more strongly than even the most horrifying aspects of tomorrow.

Professor F. Joliot-Curie, NL — *The Growing Awareness*

I have followed the activities of *Science for Peace* since its foundation, and I am very happy to assure you of my support. The very title of your organisation shows the line of action which must be pursued by every scientist conscious of his responsibilities and concerned with the future of humanity.

You have chosen as the subject of your conference a group of problems which urgently require consideration by scientists in all countries; for, throughout the world, men are asking themselves anxiously what can be done about the terrible perils presented by atomic and thermonuclear weapons to all mankind.

It is necessary, first of all, to know the dangers to which mankind is exposed. Then we must show that these perils can be removed; that no inexorable fate draws men towards destruction and death; and that, given the will, peaceful solutions can be found for all these problems. You are met to consider these grave problems, as scientists have already done in some countries and as they will soon be doing in others.

This collective awareness will become very important in the development of public opinion during the coming months. You are no doubt aware that in many countries there is a growing desire to see the organisation of an international scientific conference which would expose the dangers of the misuse of science; and I have no doubt that your conference will provide an important step towards the convening of such a meeting.

I wish you every success in your efforts and deliberations.

Professor Max Born, FRS — *Attitudes Must Change*

I send you my best wishes for a very successful conference. I am deeply worried about the nuclear armament race and try, in collaboration with other scientists, to inform the public of the dangers. I do not think the abolition and control of these horrible weapons are practical suggestions. Only a general change of attitude, which refutes war as a means of political settlement, can lead to salvation.

I have all sympathy for your endeavours.

[*Professor Bohr felt that he had nothing to add to the 'general views' expressed in his* Open Letter to the United Nations (*J. H. Schultz, Copenhagen*) *of 9th June, 1950. Therefore, we have felt it would be useful to extract from the* Letter *the following passages which seem to summarise his general opinions.*]

'The ideal of an open world, with common knowledge about social conditions and technical enterprises, including military preparations, in every country, might seem a far remote possibility in the prevailing world situation. Still, not only will such relationship between nations obviously be required for genuine co-operation on the progress of civilisation, but even a common declaration of adherence to such a course would create a most favourable background for concerted efforts to promote universal security. Moreover, it appears to me that the countries which have pioneered in the new technical development might, due to their possibilities of offering valuable information, be in a special position to take the initiative by a direct proposal of full mutual openness.

The situation calls for the most unprejudiced attitude towards all questions of international relations. Indeed, proper appreciation of the duties and responsibilities implied in world citizenship is in our time more necessary than ever before. On the one hand, the progress of science and technology has tied the fate of all nations inseparably together; on the other hand, it is on most different cultural backgrounds that vigorous endeavours for national self-assertion and social development are being made in various parts of the globe.

An open world, where each nation can assert itself solely by the extent to which it can contribute to the common culture and is able to help others with experience and resources, must be the goal to be put above everything else.'

The National Committee of Science for Peace is deeply grateful to Francis Aprahamian *and* Brian Hayes *for the notes on which the following Reports are based; and to all the principal speakers for revising the abbreviated versions of their remarks.*

THE ANNUAL GENERAL MEETING

The President, *Professor F. G. Gregory,* welcomed those present. He noted the large attendance with particular pleasure, as he believed that our function is now very much more important than it was three years ago. There has been a considerable change in the 'climate of opinion' and our aims are now widely accepted. He thought that someone of high position should state what *Science for Peace* is trying to achieve. He realised that no major political party will venture to make our views a part of its campaign, but he felt that if one of the parties did do so it would gain considerably. For the public everywhere is urgently interested in the consequences of scientific research and in the opinions of scientists who are deeply concerned about the use made of scientific discoveries.

The President was aware that *Science for Peace* should respond to public interest and pressure by increasing its efforts to give leadership and provide information, but he was also aware that progress is limited by membership and resources. Therefore, he hoped that many new and active members would join *Science for Peace* during the coming year. He felt that our pamphlets, especially *Atoms for Peace—Not War,* were tokens of what we could achieve.

Professor Gregory then vacated the Chair, which was taken by *Mr. N. W. Pirie,* the Chairman of the National Committee. Mr. Pirie said his first duty was to ask for nominations to the Standing Orders Committee, and Messrs. R. Innes and J. Pace were nominated and elected. The Standing Orders Committee recommended that there should be twenty members of the National Committee, with power to co-opt and to elect its own officers. This recommendation being approved, Mr. Innes described the procedure for nominations to the National Committee. The names of the members of the new Committee are printed on the inner front cover of this report.

Our International Activities

Dr. A. H. Gordon reported on the international aspects of our activities, which had become even more important recently in view of the increased threat of H-bombs and the decision to re-arm Germany. He felt that there were hopeful signs of improved international relations between scientists, and of increasing awareness of the scientist's responsibilities. In the United States the American Federation of Scientists had called on their government to investigate the long-term effects of H-bombs through the United Nations. In the U.S.S.R. Professor Pontecorvo, who seemed to have 'disappeared,' gave a press conference in which he emphasised the peaceful objectives of his work.

Some of our particular activities, Dr. Gordon continued, were:

1. A circular letter to various learned societies asking their views on restrictions on international travel by scientists. There were thirteen replies, of which four were favourable to our effort to remove these restrictions, and two were partly favourable.

2. The sustained work done by the National Committee, in collaboration with the National Council of Civil Liberties, to prevent the deportation of Dr. Cort and to help him in gaining a hearing. The campaign is not yet ended; the N.C.C.L., for example, intends to discuss the matter at their next conference.

3. We have promised support for the organisation of a medical commission to go to Japan to investigate radiation hazards. In this connexion, Dr. Gordon referred to Professor Waddington's article in the American *Nation*.

The Secretary's Report

The Honorary Secretary, *Dr. S. M. Hilton,* stressed the feeling of the meeting that the H-bomb gives a new point to the existence of *Science for Peace* and a new urgency to its work. He could not put it better than Professor Einstein had done in his message to our conference today.

Dr. Hilton did not interpret Professor Einstein's statement in a pessimistic sense. He observed that our point of view was being increasingly expressed by distinguished scientists who are not associated with us; and drew attention particularly to Professor Haddow's constructive letter in *The Times* last year, Bertrand Russell's very impressive broadcast speech in December, 1954, and Professor Rotblat's forthright answers to questions on the biological effects of radiations after 'the 9 o'clock news' last night. He appreciated, too, the splendid efforts of our colleagues in the medical profession and recalled Dr. Albert Schweitzer's urgent appeal to scientists to accept their human responsibilities. In London itself we were all grateful to Dr. Barnett Stross, M.P., for his energetic rôle in the growing campaign against the H-bomb.

Many religious leaders were also on our side. The Pope himself stated in October that 'if a war of atomic, bacteriological and chemical weapons involves such an extension of evil that it completely escapes control, then its use, even in defence, must be rejected as immoral. In a case like this . . . there can be no question of "defence" against injustice and necessary "safeguarding" of lawful possessions. It is a case of pure and simple annihilation of all human life within the range of war-like action. No reason can be adduced to allow this.'

Nevertheless, we should remember that officially we are committed to the use of these weapons—as early as October last year Field Marshal Montgomery stated that SHAPE was basing its policy on using atomic and thermonuclear weapons, some of which are regarded almost as

'conventional.' In other words, the threat of total war is being used, as the Nazis used it, in the conduct of national affairs.

In view of this persisting danger it is regrettable, Dr. Hilton continued, that *Science for Peace* is still a comparatively small organisation. But we are growing in size and effectiveness, though it is difficult to estimate how far our influence extends. We are quite well known in academic circles (the Secretary of the Royal Society recently asked for information about us), but we have not yet made any impact in industry. It is sometimes thought that some of our efforts are wasted, but this is not really so. It is true that our press statements seldom appear in the leading papers, but they help to influence opinion even if only to remind editorial departments that official war-policies are not supported by many scientists. This is important, as the programmes of all governments are dependent on the goodwill of scientists.

Our pamphlets, as Professor Gregory said, have been our chief activity; and Dr. Hilton thought that the meeting would like to know that a large number of them, especially Mrs. Jessie Street's *The Control of Atomic Energy,* had gone to individuals and libraries in the United States and India. Moreover, we had good contacts in Europe, particularly France, Germany, Italy and the Scandinavian countries; and individual members of the National Committee have established cordial personal relations with scientists in the U.S.S.R., China, Poland and Czechoslovakia, who had sent us their greetings and good wishes.

We participated in many successful meetings and conferences during the year, notably in a meeting held jointly with the *Medical Association for the Prevention of War* on the threat of the H-bomb and the conference recently sponsored by *Teachers for Peace;* we supported the petition of the National Campaign Committee against the H-bomb; we have kept in touch with the *Comics Campaign Council;* and we have provided speakers for several public meetings—a service we hope to extend. In addition we have worked closely with other professional organisations for peace. There is now a Joint Committee of the Arts and Sciences, which was revived largely as a result of discussions initiated by us. The Social and Concert arranged by this Committee were both very successful. We did not succeed in getting the necessary support for a joint journal, for which we submitted a scheme; but this effort has left some of the professional bodies for peace, and several members of the others, with the feeling that such a journal is becoming necessary.

Referring to plans for future activities, Dr. Hilton said we had been asked to send a representative to the World Peace Council's conference in June in Helsinki; and the Committee felt that, if the meeting approved, we should be represented, as the H-bomb is on the agenda. *Teachers for Peace* wished to join us in sharing the cost, and it is possible that other organisations may also help.

Dr. Hilton felt that we should participate still more in the activities of other organisations, both internationally and at home. But our first task is to systematise and expand our own organisation. Our

Bulletin should appear regularly, which we hope it will soon do; and it should be supplemented by a letter to our members every other month giving and asking for information. Other interested persons and groups should also receive our publications and communications. Several Labour Members of Parliament, for instance, have asked for a report of today's meeting, and we shall certainly comply with their request. Many scientists have also written to us as a result of the publicity for this afternoon's conference—and some have given active support by joining us. Others are in sympathy with our aims, but are evidently still disinclined to be fully associated with us as members. Perhaps they will feel we are at least deserving of financial support.

Moreover, it is probable that there is a large number of individuals and organisations who want to know about our activities without being committed to active membership, and we have had complaints from interested students that they find the membership fee prohibitive. Therefore, we have established two new categories of membership—Associate Members at 10s. a year and Student Members at 5s. a year—which cover all non-voting rights, including the receipt of publications. We hope that these facilities, combined with a more vigorous response on our part to increasing awareness, will enable us to build *Science for Peace* into an organisation with still greater authority and influence. With your support we believe we shall grow and respond as opportunity and urgency require.

The Treasurer's Report

The Honorary Treasurer, *Miss Edith Parfitt,* said that the financial position could be called satisfactory, since we were at least solvent: we had £36 12s. 5d. in the bank. We received £91 17s. 8d. during the year in subscriptions and donations; and she hoped that administrative reorganisation, and the proposed News Letter to members, would increase this amount during the coming year.

Our meetings had been successful, but not financially. We spent £37 2s. 6d. on meetings, including the last Annual Conference, from which we only realised £31 6s. 5d.; but, perhaps, this position would also improve with better organisation. Meanwhile, we could feel that our meetings had been well worth the small deficit of £5 16s. 1d.

Receipts from the sale of literature were small (£6 13s. 10d.), as our latest pamphlet only came out a day or two ago. They brought our total income up to £129 17s. 11d., our total expenditure for the year, including £42 for printing and £48 16s. 5d. for administrative expenses, being £154 3s. 5d. The loss was covered by a balance of £63 17s. 11d. brought forward from the previous year. Miss Parfitt felt that regular payment of subscriptions, increased membership, and greater activity—of which there were already encouraging signs—would enable her to report much more income and useful expenditure at the next Annual General Meeting.

THE EFFECTS OF NUCLEAR EXPLOSIONS

The Chairman of the Public Conference on the long-term effects of nuclear explosions, *Dr. P. W. Brian,* welcomed the large gathering and read messages of good will (those from abroad precede these Reports) from several distinguished scientists who were unable to attend. He then introduced the four principal speakers: Professor P. A. Sheppard, Professor of Meteorology in the University of London (Imperial College); Dr. J. H. Fremlin, Lecturer in Physics, Birmingham University; Dr. Anthony Ryle, a medical practitioner closely associated with many medical organisations, including the *Medical Association for the Prevention of War,* concerned with social welfare; and Dr. E. H. S. Burhop, Reader in Physics in the University of London (University College).

Nuclear Explosions and the Weather

Professor P. A. Sheppard opened the discussion on this subject. He began by warning the meeting against the unscientific statements which have been made 'to prove a point,' and said that he would try to be careful not to go too far in the opposite direction. He would confine himself to stating what we can learn from the existing observations. His conclusions would be speculative but, he hoped, reasonably founded. Unfortunately, he could not show his slides on the explosion of an A-bomb at Bikini, but he said that at the end of the sequence there was no visible evidence that an explosion had occurred.

There have been several H-bomb explosions since November, 1952, so it is reasonable to consider if there has been any climatic response. The investigation must be considered against the background of deciding whether one change in a number of fluctuations has any special man-made cause. We know we had a very bad summer last year, but it was not exceptional: in fact, 6/84 summers in England and Wales and 25/84 in Scotland have been wetter. It was a cool summer as well as a wet one, but 2/53 have been cooler. The weather in Western Europe was mainly very cool and wet, but was within normal bounds. On the other hand, the U.S.A. and U.S.S.R. had weather which was mainly dry and very warm. India and Japan had wet summers. Thus, it would appear that the weather was rather extreme but by no means exceptional. A special man-made cause need not therefore be invoked, though this possibility could not be ruled out. Again, an examination of global flow patterns gave no indication of anything occurring which had not happened before.

From the point of view of effect on the weather it is interesting to study the aftermath of unusually large volcanic eruptions. The

energy released from the eruptions of Krakatoa in 1883, Pelee in 1902 and Katmai in 1912 was greater than that from an H-bomb, but no definite changes of weather were produced. It can only be said that after two of these eruptions there was perhaps a downward trend of temperature and an upward trend after the third.

The amount of energy released by an H-bomb is approximately 10^{16} calories more or less instantaneously. The energy from a thunderstorm covering an area of 10 sq. km. is approximately 10^{15} calories, but it is spread over half an hour or so. The energy released by the precipitation from a warm-front rain belt is about 10^{18} calories, spread over about three hours. Thus, there are many cases of energy releases of the order of H-bomb magnitude. An H-bomb would need to trigger other reactions in order to make a noticeable difference. The atmosphere is in fact often naturally unstable but, when conditions are right for these reactions, there are many natural triggers available.

Disturbances grow in the atmosphere until the instability present is relieved. The dissipation of the energy of these disturbances is so continuous and active that the atmosphere, so to speak, forgets what it was doing a week before: that is to say it probably needs a constant forcing pattern in order to acquire a pattern of behaviour such as we get in a rainy season.

Large volcanic and H-bomb explosions give rise to dust in the stratosphere which persists there, while that in the troposphere is washed out by rain. This persistent dust depletes solar radiation by scattering it back to space and the effect might be as much as 5 per cent, but it must be noted that variation in the amount of cloud exerts much stronger control on the amount of radiation than this back scatter. If the sunshine were less powerful the temperature would be lowered initially, but that would lower the activity of the atmosphere and cloud would probably be less. Professor Sheppard hazarded a guess that the temperature would go down by 2-3 degrees F.

It has been suggested that the particles from the bomb might provide freezing nuclei, which would promote cloud instability and increase rainfall; but so little clear-cut success has been obtained with attempts to increase rainfall on a significant scale by seeding clouds that this seems unlikely. The production of ions by radiation from the bomb also appears to have little climatic significance, as condensation on such ions would require a state of high super-saturation which appears never to be attained.

Professor Sheppard concluded by saying it was unlikely that H-bomb tests during the past three years had produced any major effect on the weather, but it was possible that minor effects had occurred. He insisted, however, that the absence of certain knowledge indicated that great caution is necessary, both in assessing possible effects and in adding to the number of experimental H-bomb explosions.

Radioactive Rain

Dr. J. H. Fremlin described his work on radioactive rain. His starting point was that shortly after the explosion of an A-bomb or an H-bomb a heavy rainstorm occurs in the area surrounding the explosion. This rain carries a significant amount of radioactivity. The danger from radioactive rain was realised from the beginning, though it was thought, at first, that this would only be a local effect. Then people began to doubt this, first on theoretical grounds, and then from practical experience.

The Eastman Kodak Company in Rochester, New York, found that some of their photographic plates were being fogged as a result of the radioactivity of the black paper in which they were wrapped. It was eventually established that the straw from which the paper was made was radioactive, though it had grown many miles from the most probable source of contamination. The plants had concentrated the radioactive material during the processes of growth.

Dr. Fremlin proposed to concentrate on the long-distance effects of nuclear explosions as he had been testing them himself. There is no doubt that there are such effects, but the amount of radiation received in Britain is very small *at present*.

His method was to test rainwater or snow collected near his home. He deliberately avoided carrying out any work at his laboratory, as there is a large cyclotron there. He lives about a mile away from the laboratory. He admitted that it would have been desirable to carry out a number of controls before the first bomb was experimentally exploded, but no one had thought of measuring natural radioactivity before the first explosion. Suggestions that a check should be made on the output from the factory furnaces and chimneys for radioactivity are not very useful, even during a period when no explosions have taken place, as results would vary from day to day.

On the question of natural radioactivity, the main naturally occurring radioactive elements have a very long half-life period.[1] It is possible that short life decay products might be produced, but there are not many of these. Further, the half-life period is either too long or too short to give results of the order he found. In fact the materials collected do not possess a half-life consistent with naturally occurring elements.

It is most effective to take observations over a long period. He began his observations when the explosion of the first American H-bomb was reported, that is to say 2-3 days after it had been dropped, but before any radioactive material could possibly have reached here.

He collected samples of rainwater, evaporated them down, and measured the beta particle radiation. The collecting vessel was a zinc bath with a collecting area of about 2 sq. ft. The figure obtained was about 40 disintegrations per minute per litre of water, this measure-

[1] The time in which a radioactive element decays to half its original activity value.

ment having been corrected for various factors, such as absorption. There was not much rain at that time and he could not collect a sizeable amount of rain for about a month. The number of disintegrations had then gone up to 120 and in the following week a value of 140 was obtained (there is no significant difference between these two figures). By June the figure was down to 10-20 disintegrations.

This radioactive material had a half-life of six weeks; there is no natural material which could simulate this half-life. Moreover, he was confident that precautions taken at Harwell and similar places would prevent contamination from these sources. It is probable that the material collected was a mixture of elements.

When collecting snow the area covered by the sample varied in size and was often larger than the collecting area of the zinc bath. It is possible that results expressed per unit area are more significant than those expressed per litre.

Unfortunately, the control for his counts after the Nevada explosion, which he had left in a saucepan until he had time to boil it down, was thrown away by an over-enthusiastic cleaner. He then cut the middle out of a 'snowman' made by his children. This sample gave a result of 100 disintegrations per minute per litre. He was able to repeat the test as snow fell almost every night for the next few days. The results obtained were: March 6/7, 120; 7/8, 360; 8/9, 200. There was no more snow until the night of March 18/19 when the count was 200-250. For a sample collected on 22/24 the count was 70.

The apparent half-life of the material collected was three weeks plus or minus a week. The material was probably rare earths, such as lanthanum, although this is not proven. As a further check he took an alpha particle count to test for thorium, a naturally occurring element, and its decay products. This gave four disintegrations per minute per litre. Therefore the element was not derived from thorium. No measurements were made of gamma radiation.

Human blood contains potassium, and is at least five times as radioactive as the rainwater he was dealing with; but this does not allow for concentration of radioactive materials by plants and then by animals eating the plants. So that the amounts mentioned, although small, are not negligible. This is an important point. Radioactive rain in Britain is nowhere near the danger point; nevertheless he felt that the amount of radioactivity should be kept low.

American scientists have given a figure of 0.1 Roentgen units per head of population in the U.S. as the total amount of radiation received from all the tests carried out so far. Even if this figure is correct, the effect on the large American population, from a long-term genetic point of view, would be the same as 500 Roentgen units (the median lethal dose) on 40,000 Japanese at Hiroshima—and few survivors could have had so large a dose.

Biological Effects of Nuclear Explosions

Dr. A. Ryle began by saying that he did not claim to be an expert in radiation medicine, but he would try to present the main points available from published data, especially from recent papers by Japanese authorities. It is well known, he continued, that a high dose of radiation is fatal. Different tissues, of course, have different degrees of sensitivity to radiation, those in which cell-division is most frequent (for example, skin, gonads and blood-forming elements) being most sensitive. Long-term effects of small doses include the production of neoplastic (cancer forming) changes and harmful alterations of genetic patterns. Thus, doses which are not immediately fatal can be eventually lethal. It should be remembered that the effect of radiation is cumulative. A small frequent exposure gives the same effect as a large single dose.

In war, the population may be subjected to radiation in two ways: by direct radiation from the bomb; and by radiation from remnants of the bomb, or from material having induced radioactivity as a result of the explosion. The danger resulting from this second category is much greater from the H-bomb than from the A-bomb. In Hiroshima 80 percent of the deaths occurred within two weeks of the explosion. The majority of the remaining deaths took place within eight weeks, largely through destruction of the blood-forming cells.

Among those who survived, however, there have been many examples of delayed response to injury. Radiation sickness, for example, has occurred a considerable time after the explosion. In one case a three-year-old child who probably ingested radioactive material at Hiroshima became ill at the age of eleven. Other facts are that 9.8 per cent of the 869 persons who survived being within 1,000 metres of the explosion had developed cataracts by 1950. The number of people who developed leukæmia in Hiroshima between 1948-52 was four times the national average for the same years—a late effect of the initial radiation injury.

With regard to the effects of the Hiroshima explosion on growth rates, it has been found that the younger children suffered most, the maximum effect being on children *in utero* at the time of the explosion. Among the infants of eleven pregnant mothers, who survived being within 1,200 metres of the centre of the explosion, only two developed head sizes within the normal range.

The results of an H-bomb explosion would be similar to those mentioned above but on a much greater scale. An important new feature to be considered in this connexion is the vastly increased danger from the fall-out of radiation dust. Radioactive ash from the H-bomb explosion at Bikini on 3rd March, 1954, fell on a Japanese fishing boat 80 miles away. The boat was still strongly radioactive when it was examined on 17th March. Heavy gamma radiation was present, although the boat had been washed and the short life elements would have been mostly spent. The dust on the boat contained a calcium

compound from coral, and barium, strontium and rare earth elements were also found. The investigators wore masks which were found to be radioactive after a short period aboard the boat.

All members of the crew showed symptoms of radioactive sickness. Their skin lesions largely reflected the clothes they were wearing when the ash fell. It was estimated that they must have received a dose of 400 Roentgen units, which is only a little below the lethal level. The usual effects were observed and several men suffered from jaundice. One of these men died recently and a statement from the United States claimed that the cause of death was infective jaundice and not radiation sickness; but the fact is that the autopsy confirmed radiation damage as the cause of death.

The Japanese reports also dealt with the contamination of fish caught in the area. It was suggested that the fish had eaten radioactive plankton. Fish caught some four months after the explosion still showed radioactivity. Large areas of the fishing grounds were accordingly closed, yet one percent of the fish landed had to be rejected.

Examination of rainwater gave very high counts of radioactivity. One metereological station depended on rainwater for drinking purposes and those who drank it suffered from depressed white cell counts. It follows that sufficiently radioactive rain fell on the mainland of Japan to produce symptoms in those drinking pure rainwater.

There is a risk of cancer production because of the long half-life of barium and strontium. These elements are concentrated in the bones. In addition the breathing of radioactive dust containing these elements can produce a high concentration of radioactive material in the lungs. Dr. Ryle said that he had asked Dr. Honda, the Japanese pathologist, a number of questions on this point. She replied that they had only recently started measuring the radioactivity at the roots of the lungs of those patients who had died from other causes, but who had been in Hiroshima at the time of the explosion. It was probable that there would be a delay of ten to twenty years in the development of lung cancers of this origin.

The genetic effects of radiation were not known, but calculations indicated much cause for alarm, since small increases in exposure to radioactivity can increase the mutation rate. The annual radiation exposure, resulting from test explosions, of the American population has been estimated at 0.1 Roentgen units, which doubles the natural exposure and could increase the mutation rate by 10 percent. Indeed, any increase is dangerous, and talk of a threshold level is misleading. Therefore, it is the duty of informed persons to do their utmost to break through the press silence on these issues. The future of mankind depends on making known the possibilities as well as the actual facts.

Discussion

Professor J. B. S. Haldane said there were two kinds of genetic damage. One is the effect on children through damage of the chromo-

some structure, which goes up as the square of the dose. The other is that of recessive mutations, which need to be mated to show. The results of such matings reach their maximum in the fifth generation.

We do not know how many of these mutations would give rise to premature deaths and deaths of embryos, or how many may cause sterility, i.e., no births to provide the calculated number of deaths. For each two mutations one death would occur sometime in the children. We do not know the radio-sensitivity of human beings. The experiments being carried out on mice will not give the answer to this question. Experiments on human tissue will be more useful, when we have mastered the technique for doing them.

Professor P. A. Sheppard said, in reply to a question, that the ultra-violet rays from the sun were blanketed by the upper atmosphere, while those from the bomb were not. There might be some effects, but he could not say that there was any effect; and, in any case, the principal radiation from the bomb was in the visible region.

Dr. R. Firth questioned the statement that ions were not responsible for condensation in the atmosphere. He asked whether large amounts of ions could have an effect.

Professor Sheppard replied that he stood by his previous statement. However, it was possible that there was an indirect effect because of the ions' ability, possibly, to convert cloud droplets into ice.

Professor J. D. Bernal said that his interest lay not in how the bomb affected the weather but how the weather affected the bomb. The weather must have an effect on fall-out. In clear weather, such as that encountered by the Japanese fishing-boat, the fall-out was as dry dust. He also asked what would be the effect of European conditions on distribution of the fall-out.

Professor Sheppard said that a rainstorm in the area of the bomb sometimes occurred. There is little information on large-scale effects on fall-out. There might be significant differences in different latitudes and different weather situations, and there would probably be bigger variations in middle latitudes than in low latitudes. The fall-out at given distances, however, would probably not change by more than an order of magnitude.

Mr. Daw asked whether there was a minimum dose of radiation necessary to produce genetic effects. If so, what was the danger due to natural radiation?

Dr. A. Ryle said that natural radiation did have an effect. Any increase in radiation exposure increases the rate of mutation. He invited Professor Haldane's opinion on this point.

Professor Haldane said it was not known what proportion of mutations were due to natural radiation. It was difficult to suppose that less than a quarter of the mutations were due to natural radiation, and equally difficult to know the effect of doubling the radiation received. In this connexion experiments on mice might prove useful. Dr. Ryle had said that all mutations were unfavourable, but it is possible for a mutation to occur so that the organism was better adapted to an

abnormal environment. It is true, though, that the more complicated the organism, the less chance there is of a favourable mutation.

A questioner commented that artificial radiation was taken in from particles and could therefore be concentrated. He asked whether this could also happen with naturally occurring radioactive elements.

Dr. Ryle replied that the lungs received both large and small particles; and went on to say that the products of the H-bomb (strontium, barium and iodine) were stored in the body. Naturally occurring radioactive material also tends to be absorbed and concentrated.

The Problem of Abolition and Control

Dr. E. H. S. Burhop said he proposed to give an outline of the steps that have been taken to get agreement on the abolition and control of nuclear-fission weapons. The negotiations could be divided into three phases.

The first was from 1946 to 1949. All the proposals made were governed by the fact that the United States had the monopoly of atomic weapons.

The second was from 1949-1953. It was characterised by the fact that the monopoly had been broken, but the United States still had a substantial lead in technique and stock-piling.

The third was from mid-1953 to the present time. Now a position of equality or approaching equality has been reached between the U.S. and U.S.S.R. Before this phase began physicists had stated that the U.S.S.R. could not be approaching equality with the U.S., because there had been no mention of Russian use of the synchro-cyclotron. We now have technical information on Russian experiments in the acceleration of high energy particles and mesons, and it seems that the Russian synchro-cyclotron is the largest in the world.

These factors of relative development have influenced the course of negotiations in the past and will continue to do so in the present.

The difference in the views of the U.S.S.R. and the Western powers was on the question of whether the banning or controlling of nuclear weapons should be the determining first stage. America and Britain placed emphasis primarily on control, the U.S.S.R. on abolition. Some of the major points of difference between the U.S.S.R. and the West were then outlined by the speaker.

The first was the question of timing. The U.S.S.R. believed that the ban on the use and manufacture of nuclear weapons should come right at the beginning of the institution of a control scheme. The Western governments, on the other hand, visualised such a ban, if it came at all, as coming at the end of a complicated set of stages, during which control would be exercised over a gradually increasing part of the manufacture of nuclear weapons.

The second was the question of inspection. The U.S. and U.K. proposed that the inspection schemes should include the right of the

control commission to search and enter at any time, which carries with it the right to make unscheduled flights over the territory of any country. The U.S.S.R. was somewhat vague on this question initially, but in June, 1947, a detailed inspection procedure was put forward.

The third was the question of ownership. The U.S. believed that all atomic energy plants should be under the ownership of the U.N. Atomic Energy Control Commission, except for small research reactors. Russia objected, and still objects, to U.N. ownership. Dr. Burhop believed that ownership was not essential to effective control. In the present situation, when both the U.S. and U.S.S.R. have large stock-piles of weapons, it is the control of these stock-piles that is of primary importance. Therefore, the question of ownership has lost much of its importance.

The fourth was the question of the veto. The U.S.S.R. believed that the ordinary work-a-day activities of the Commission should be carried out by majority vote; but questions involving sanctions against countries which had broken the terms of the agreements should be referred to the Security Council. Such questions would thereby be subject to the unanimity rule, that is to say the veto. The position of the Western powers was that the decisions on sanctions should also be governed by majority vote.

For some time after 1946 only minor changes in position occurred, but one or two important steps were taken. In 1948 the U.S.S.R. changed its position on timing. It agreed that the banning of the use and manufacture of bombs, and the destruction of existing stocks, should coincide with the application of a control scheme.

In 1952 the U.S.S.R. agreed to a system of continuous inspection. Previously they had insisted on periodic inspection with prior notice.

Before 1951, in the monopoly period, the U.S. and U.K. had insisted that the question of atomic weapons be discussed separately from that of conventional weapons. This insistence was now dropped.

The U.N. Disarmament Commission has been discussing these questions since 1952. On 11th June, 1954, the Anglo-French plan was put forward for reduction of conventional arms and the banning and control of atomic weapons. It was proposed that disarmament should be carried out in two stages. In the first stage half the agreed reduction of conventional arms should be carried out. The second stage should begin after the Control Commission reported the completion of the first reduction; and at this point the manufacture of nuclear weapons should cease. Existing stocks of nuclear weapons should be destroyed when the agreed reduction of conventional arms was finally completed.

Mr. Vishinsky put forward similar proposals in September, 1954. The first stage was the same, but with the proviso that it should last 6-12 months. The Soviet plan required that the cessation of production and dismantling of existing stocks should both start at the commencement of the second stage, which should also last 6-12 months.

The question of ownership is still not clear as neither side has mentioned it recently.

In earlier discussions the U.S.S.R. had insisted on all powers reducing their arms by a certain ratio. In September, 1954, only agreed levels were mentioned, but there is no indication of either side having changed its position on this point.

[This position was modified shortly after Dr. Burhop's address. In April the Soviet Union suggested definite quota levels, which agree closely with those previously suggested by the United States, for each of the major powers.]

The present series of discussions were occurring as a result of a unanimous vote of the U.N. General Assembly. There was a lessening of tension due to the success of the Geneva Conference, but tensions have again increased because of the Formosan situation and West German re-armament.

It should be realised that, whatever the control plan adopted, absolute control is impossible; but it is still possible to get workable control, especially by checking production records. The question of control cannot be separated from the political situation. The reduction of political tensions would ease the prospects of agreements, and when the bombs are banned, and workable control established, a new political climate would begin.

The situation is urgent. There is not only the ever-present threat that mass-destruction bombs may be used, but we have heard this afternoon that the tests of the last three years have created new dangers which must be controlled. The most optimistic view is that at best the results of the tests are not known to be harmless. Therefore, it would be a step in the direction of control—and agreement on control is the most urgent problem at present—if an agreement on the control of tests could be reached. We should all realise that every advance in international agreements about nuclear energy helps to safeguard the future of mankind, while every day's delay increases the dangers and difficulties. The problem *must* be solved before it gets out of hand.

Discussion

Mr. N. W. Pirie asked the speaker to say something about the recent statement by Sir Anthony Eden in the House of Commons to the effect that control of tests was no longer useful, because tests could be made without any actual explosion of the bomb.

Dr. Burhop agreed that some tests could be carried out without explosions. It was always possible to continue experiments aimed at modifications in mechanism and design, but a stage was reached when a full scale test became necessary. Therefore, the ban on test explosions would tend to freeze development at its present level.

Dr. A. H. Gordon asked how tests were made to determine that a nuclear fission bomb had been exploded. He had read that the R.A.F. had been making secret flights in this connexion.

Dr. Burhop replied that aircraft made flights and took samples of the air, which were then checked for the products of an explosion.

By this method it was discovered that the U.S.S.R. was using lithium deuteride, and not tritium, in its H-bomb. The tritium was produced from the deuteride in the explosion itself.

Mrs. K. Fielding-Clark asked if new bombs had been made, such as the cobalt bomb and even more terrifying weapons of destruction.

Dr. Fremlin replied that the cobalt was used to sheath the bomb. Any substance could be used as a sheath. The 'best' material was uranium, because each item gave several radioactive items on breakdown, including both long and short half-life elements.

Dr. Burhop said, in answer to a question about the 'shortness of life' of stored bombs, that an H-bomb containing tritium would have a 'short life'; but the point about lithium deuteride bombs is that tritium is generated at the moment of explosion. Therefore, they can be stored easily and for long periods.

Mr. J. Burkovitch remarked that the prospect of incomplete control worried many people. Could this point be discussed further?

Dr. Burhop replied that this was the kernel of the problem. It is not possible to get complete control, but it is possible, even under present political conditions, to get a high level of control. It should be remembered that the difficulties would increase with time, for several countries may possess nuclear weapons in the near future. The establishment of reasonable control now would more or less eliminate this prospect. It would also help to promote a political climate in which complete control would be eventually achieved, because the stimuli for making nuclear weapons, under restrictive conditions, would be lacking.

Dr. Fremlin said it was necessary for all countries taking part in a control scheme to declare their stocks of materials. Minor secrecies and small leakages would not be important, because it would take some time to dismantle existing stocks; and he agreed with Dr. Burhop that when this was done there would be a better atmosphere.

Some people worried about the possibility of, say, Russia concealing bombs. They should consider how fast both Russia and America can make bombs if their total production capacity was geared to their manufacture. If either country did hide any bombs, the risk of total production by the other would be incurred. In short, there was too great a risk in hiding an effective number of bombs and too little advantage in hiding a few. The risks being run while there were no control agreements were far greater than those due to flaws in the security of control arrangements.

At this point there was a good deal of general discussion about human motives and aggressive instincts. In this connexion, some speakers felt there was an urgent need for searching scientific investigations, as well as the establishment of adequate machinery for international law and order. It was proposed that *Science for Peace* should elect a deputation to wait on the responsible Ministers of the Government; send circulars to scientists urging them to withdraw from work directly concerned with preparations for war; and strongly support

measures for world government. There were no replies from the platform.

Professor J. D. Bernal reverted to the question of abolition and control. The working out of technical methods of control presumes, he said, a real intention to get control and to avoid using nuclear weapons. Perhaps Sir Winston Churchill is right when he suggests that the sheer horror of the weapons will in the final event deter, but this is not something we can rely on. Possibly the knowledge of genetic damage will also have some effect, but it has not done so yet.

The truth is that there exists a very definite intention in some quarters to use these weapons. The pretence of using them only for retaliation has been dropped, and military commanders are boasting of their incorporation in normal military establishments. Therefore, there are people who will always find reasons for saying that control is not possible. It follows that the answer to the problem of abolition of atomic weapons lies not in devising more ingenious methods of control, but in beginning to establish control. This will not be done as long as there is the intention to use nuclear weapons, but when that intention is dropped, control will be easy. The people know this. They know that the 'grand deterrent' wanted by Churchill and Eisenhower is not what they want themseves; and for this reason they are resisting certain official policies. In fact, a split in the Labour Party was only just avoided on this issue. The danger of such a split has shown that there is consciousness of the strength of popular feeling against use of the bombs.

Science for Peace must guide, and be guided by, this enormous popular feeling. We must communicate the knowledge we have. Our actions must be based on the strength of public opinion. Primarily, this means more pressure on the Government. This pressure is already under way, and we must do more to strengthen it.

A remarkable feature of the situation, Professor Bernal continued, is the extreme reluctance of the Governments of Britain and the United States to state that they will not use the bomb first. Apparently they are too scrupulous to make a statement they may not keep. But such a statement would have an enormous psychological effect; in fact, it would prevent the use of the bomb.

In advance of any detailed control, a statement of principle is necessary. We must get such a statement formulated and officially accepted. We must recognise that there is much support for unilateral renunciation of the bomb. Our duty as scientists is to get across to the people the facts about nuclear weapons and what an H-bomb war will do to mankind today and for many generations to come. In this task we must seek the assistance of other organisations and our colleagues in other professions, especially doctors, teacher, writers and artists. The work that is being done on the after effects of the A-bombs on Hiroshima and Nagasaki, and the tragedy of the Japanese fishermen under H-bomb fall-out, has given us much to say. And we must not forget the consequences of the tests to the Pacific Islanders supposedly

under the 'protection' of the U.N. Their fate has not been considered in official reports of the explosions, nor is it sufficiently recognised that no nation has the right to use the territories of other peoples for such experiments.

It is our duty to study the facts about the effects of nuclear weapons and to use every means at our disposal to communicate them. We must make the public continuously aware of the effect of what people are rightly calling the Horror Bombs and of developments in connexion with them. There are still many who do not know that if one H-bomb is dropped half the people within 7,000 square miles will be killed; and that the remainder will suffer a degree of disfigurement and disease of which the Hiroshima and Nagasaki victims offer us only a faint example.

These are some of our tasks. They need to be enlarged—and this is very important—by spreading the facts about the peaceful uses of atomic energy. We must co-operate fully with the will of the people to end the misuse of science.

Dr. P. W. Brian said that Professor Bernal had saved him the trouble of summing up. There may have been a feeling when our conference began that some of the talk about dangers of the tests was exaggerated. A certain amount of exaggeration is inevitable, for a very real fear of the consequences naturally produces a tendency tc exaggerate. But we have also heard facts, alarming and terrible facts, which put exaggerations in their proper perspective. An outstanding fact is that there is a great deal we do not know which we should know; but which we will not know while vast sums of money are spent on the development of weapons and relatively insignificant sums on research that should be its proper corollary, leave alone research within a co-ordinated plan for human betterment.

This is the challenge which scientists must continue to meet. We must press, as so many of our speakers have insisted, for the abolition of nuclear weapons and a workable machinery of control; and we must demand more opportunities for fundamental enquiries. We must satisfy the public hunger for more knowledge at this critical stage of human history—and we must do all we can to put ourselves in a position to supply positive knowledge on the basis of thoroughly scientific analysis and research.

Science for Peace exists because its members recognise these duties. It is to be hoped that all scientists who realise their responsibilities—and there can be very few who don't—will join us, or at least support us, in carrying out our tasks as fully as we should.

The Chairman then mentioned the pamphlets on sale in the hall and referred intending members or donors to the officials they should see. Finally, he thanked the speakers, as well as all those present, for their participation in what he felt was a most successful conference. He did not declare the meeting closed but merely adjourned. He felt that many of those present would like to look more closely at the Exhibition prepared by *Science for Peace* and *Artists for Peace;* and

later they would doubtless join the social gathering at the nearby hostelry which the Secretary had mentioned. There were so many experts who knew how to get there that he would not presume to offer any guidance.

After again thanking the meeting, Dr. Brian vacated the Chair

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PEACE MUST NOT BE WAR IN MASQUERADE

This is our aim. We know that we must work for it more vigorously during the critical months to come. We must increase our services in every direction. We must enlarge and improve our *Bulletin,* publish more pamphlets, organise more meetings, co-operate wherever we are needed.

The first of these intentions will be evident, we hope, in our next *Bulletin.* Our plans for it include a memorial article on the late Professor Einstein, a critical review of present knowledge and opinion on radiation hazards, a discussion of the scientist's responsibilities, a report on science at the Helsinki Conference, and several pages of notes, news and reviews.

In short, we are determined to give more, but to give we must also get. We need ideas, criticisms, materials for the *Bulletin,* offers of working assistance. And, of course, we need more members, more friends who will make our efforts known to their friends, and more contributions to our slender financial resources.

Our tasks are urgent and vitally important
Your support will help us to fulfil them

SCIENCE FOR PEACE
16 ULSTER PLACE · LONDON, NW1