Experiment in Annihilation

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To celebrate the 88th birthday of its author today, we're republishing the first-ever comprehensive non-classified paper on the hydrogen bomb and problems with its early testing. It was translated into French by Jean-Paul Sartre and published in his journal "Les Temps Modernes" and the opening lines were once read in the US Congress without attribution. The author wrote under the pseudonym Jules Laurents out of fear of McCarthyism and I'm proud to be able to tell you that he is in fact Harold Shapiro, my father – happy birthday, Dad!

The author circa 1954.

EXPERIMENT IN ANNIHILATION

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MARCH 1, 1954, the same day that shots were ringing on the floor of the House of Representatives, another "shot", unheralded but of sweeping significance, was fired in the

Marshall Islands. On that day an American AEC task group detonated a hydrogen bomb of monstrous size. In its widest implications that bomb has not yet ceased to reverberate. A long chain of incidents, ranging from the curious to the tragic, has made it clear that "peacetime" nuclear explosions present a substantial threat to our well-being. Storm signals from earlier atomic tests such as fogged photographic film and radioactive rain have given way to the storm — which has already resulted in the radioactive poisoning of several hundred people. The March 1 explosion also blasted the lid of secrecy from the AEC's thermonuclear adventures, giving the public its first real look behind the "uranium curtain"; thus it is now known that the AEC touched off three prior hydrogen explosions, the third of which (November, 1952) gave more than five times as great an energy release as predicted by its creators.

I. Chronicle of Events

The March 1 bomb was expected to explode with a force of four to six megatons (a megaton denotes the energy released by exploding one million tons of TNT) but developed instead about fourteen, according to Joseph and Stewart Alsop, New York Herald Tribune, April 7, 1954. It left scientific measuring instruments unable to record its full effects. Sound waves from the blast were detected in London, and an American astronomer said the flash could have been seen from Mars. Rep. Holifeld of the JCAE (Joint Committee on Atomic Energy) described it as "so far beyond what was expected you might say it was out of control". Defense Secretary Wilson called it "unbelievable", and President Eisenhower admitted it "surprised and astonished" the scientists. Rep. Van Zandt of the JCAE stated that the "explosion had left an area of total destruction about twelve miles in diameter, with light damage extending in a circle with a diameter of forty miles". The AEC called it a "routine atomic test". As with the November, 1952 H-bomb, the first inkling the public had that something extraordinary had occurred was through "leaks". Intent on maintaining secrecy, the AEC ordered all task force personnel to refrain from divulging any information about the tests. Such an order was not given on Kwajalein, however, 176 miles from Bikini, it being assumed apparently that at this distance details of the explosion could not be perceived. Yet a marine corporal stationed there wrote to his mother:

"I was walking back to the barracks . . . just as it was getting daylight, when all of a sudden the sky lighted up a bright orange. . . . About ten or fifteen minutes later . . . we heard very loud rumbling that sounded like thunder. Then the whole barracks began shaking as if there had been an earthquake. This was followed by a very high wind."

In a second letter he reported: "There were two destroyers here to-day bearing natives of one of the Marshall Islands that was within seventy-five miles of the blast. They were suffering from various burns and radioactivity".

Directly thereafter the AEC issued the following statement:

"During the course of a routine atomic test in the Marshall Islands, twenty-eight U.S. personnel and 236 residents were transported from neighboring atolls to Kwajalein Island according to plans as a precautionary measure. The individuals were unexpectedly exposed to some radiation. There were no burns. All were reported well. After the completion of the atomic tests, they will be returned to their homes."

The AEC never acknowledged the statement of the corporal, nor his assertion that some victims were suffering from burns. (We shall see that the AEC statement is false.) When the announcement was made some observers were puzzled over how, after the victims were "unexpectedly" exposed to radiation, they were evacuated "according to plans as a precautionary measure". Time magazine introduced additional cause for apprehension by reporting that American casualties from the March 1 explosion were exposed to radiation "ten times greater than scientists deem safe".

On March 13 (2) a grave new consequence of the "routine atomic test" was reported. The Japanese fishing trawler Fukuryu Maru docked in Yaezu, Japan, with its twenty-three crew members showing symptoms of acute radiation exposure. They told how on March 1 they were some eighty to ninety miles from Bikini, when at 4 a.m. they fancied they saw the sun rising prematurely "in a strange manner". Six or seven minutes later they heard a roar, and two hours later they were showered with a white ash, which continued to fall for several hours. The ash was, of course, fall-out from the explosion, consisting mainly of irradiated coral dust. Only after they had become quite ill did they suspect that they had been rained with shi no hai (ashes of death) and head for port. They had on board 40 tons of freshly caught tuna and shark, which, according to a New York Times dispatch, exhibited radioactivity "sufficient to be fatal to any person who remained for eight hours within thirty yards of the fish". Two of them were in worse condition than the rest, having eaten some of the fish. The crewmen were hospitalized, the sampan was ordered burned at sea and sunk, the fish buried; but not before several thousand pounds of the contaminated fish had been unloaded and shipped to market. A "hot fish" panic ensued in Japan, and police, in a frantic effort to track it all down, ordered a thousand tons of other fish destroyed, with which it had got mixed. Fish prices dropped to half overnight, and Tokyo's numerous sushi houses (sushi — a popular fish dish) reported business at a standstill. It should not be necessary to give all details — it is sufficient to recall the Japanese experience with atomic bombs, coupled with the fact that fish is the mainstay of the Japanese diet (a million pounds a day of tuna alone are consumed in Japan) to appreciate the extent of the panic. The people's fears were not entirely groundless. Life, March 29, in an article First Casualties of the H-Bomb reported "Six families from the town of Saganihara reported stomach pains, numbness and diarrhea after

eating raw tuna and gray mullet". An INS dispatch from Tokyo, March 23, reported "Physical examinations were ordered to-day for fifty-one Osaka residents with mild blood disorders which officials feared may have come from eating radioactive fish caught in the mid-Pacific after America's recent hydrogen test blast". As late as May 17 a UP dispatch from Formosa reported: "Fishery authorities in Formosa urgently requested Geiger counters from the U.S. to-day after a Chinese family in Keelung was hospitalized with what doctors thought might be radioactive poisoning [after eating a seafish]." (It is, of course, impossible to say whether the March 1 bomb or a later one would be responsible for such a case.) In view of the fact that a score of other Japanese fishing boats have since returned with radioactive cargoes, and considering the delay with which radiation-induced disorders often manifest themselves, further incidents of this type are not excluded.

Soon after the mishap, Dr. John Morton, head of the Atomic Bomb Casualty Commission (ABCC) at Hiroshima, reported concerning the twenty-three fishermen, "they will recover completely within a month". Apparently his years of studying Hiroshima victims had not proved instructive, for by 23rd March five of the fishermen were reported in serious condition, and all of the men are still (July) hospitalized. Morton and his staff were received uncharitably by the victims and their Japanese doctors, for reasons expressed by the leading Tokyo newspaper Asahi: "The ABCC is an organ to conduct research but not to treat patients. Dr. John Morton and his staff should treat the patients this time not only to make a fine report to America but to give the patients assurances they are not guinea pigs". It also urged the U.S. to reveal to Japanese physicians the materials used in the blast (this would facilitate identification of the isotopes in the ash, which knowledge would be valuable in treatment) but admitted: "Presumably the U.S. does not want to disclose military secrets". Indeed not; in fact, Rep. Sterling Cole created much hard feeling when he suggested the Japanese trawler might have been spying on the tests! When the Japanese scientists had completed their analysis of the ash, they were dismayed to find that it contained not-negligible amounts of strontium 90, a long-lived isotope particularly dangerous to absorb into the body.

About 25th March it was reported that the U.S. Navy tanker Patapsco, operating with the H - bomb task group, had received "light but not dangerous contamination by radioactive fall-out".

March 27th two more "atom-dusted" sampans came into port and were quarantined. One (the Myojin Maru) had been operating about 780 miles from the test site 1st March, and the other (the Koei Maru) 200 miles away. Japanese newspapers reported that both vessels registered Geiger counter readings above the danger point, although "only one crewman was more than slightly affected". Japanese health officials were undecided whether to destroy the catch of the Myojin; they destroyed the entire 80,000 pound tuna catch of the

Koei. And a UP dispatch of 3rd April reported that a fourth fishing boat had come back radioactive from the 1st March explosion and been quarantined.

There were numerous other ramifications, of varying degrees of gravity, from the 1st March explosion. Americans experienced snowfalls in Montana and Wyoming exhibiting radiation equal to 200 times the normal background. Prof. Henry Kraybill of the Yale University Physics Department revealed that Yale's most sensitive Geiger counter was incapacitated on 7th March by an increased number of radioactive particles in the air. However, on the whole, few such particles were observed in the U.S. Newsweek, 29th March, wrote:

"The subject isn't discussed openly around the AEC but scientists are worried about the whereabouts of the radioactive 'mushroom cloud' generated by the March 1st H -bomb explosion. . . . Within a few days after all previous tests, laboratories around the U.S. have reported detecting traces of radiation in the atmosphere. So for no traces have been spotted from the March 1 bomb, which shot its mushroom an unprecedented 20 miles into the air."

The same publication, 5th April, published another provocative remark:

"U.S. atomic scientists, still puzzling over the unexpected fury of the March 1st H-bomb blast . . . .are now wondering whether the bomb set off a small chain reaction that ignited hydrogen in the atmosphere and surrounding sea. Most [reject the possibility of a globe - girdling chain reaction] but the theory is being reconsidered."

Many other Americans apparently were "puzzling" over the 1st March blast. As early as 19th March Rep. Cole, head of the JCAE, reported that a Congressional investigation would be pushed to determine (in the words of an AP dispatch) "whether avoidable errors were made during the monstrous hydrogen blast in the Pacific March 1st", and that his committee had begun questioning AEC officials in closed sessions. Rep. Van Zandt, of the JCAE, according to a UP dispatch of 18th March,

"criticised officials . . . for failure to set up adequate safeguards against injury to American, native, and Japanese personnel in the area. He said the government should have set as out of bounds a 'hazard area' about twice as large as that actually prescribed…'It was poor planning' Mr. Van Zandt said. 'In my opinion somebody is guilty of a blunder in failing to apply the necessary precautions. It is my intention as a member of the Joint Atomic Committee to find out who was responsible'."

Dr. David L. Hill, Chairman of the Federation of American Scientists, a Los Alamos physicist, commented that the failure to predict the exact size of the 1st March explosion was to have been expected in a rapidly moving development program. Against this turbulent background, the AEC detonated an even larger H-bomb 26th March.

The 26th March bomb was intended to have been dropped by parachute from a B-36 superbomber, but for reasons of caution this plan was abandoned. This was probably for the best since the bomb, expected to develop three megatons, exploded instead with about seventeen (according to the Alsops). And Newsweek later reported (12th April) that "Air Force officials refuse to talk about it, but a giant B-36 superbomber observing the March 26th H-bomb explosion was flipped completely over by the blast". The AEC had taken many new precautions, such as extending the "restricted zone" to an area 450 miles wide, covering several hundred thousand square miles. It had searched the area carefully, to make sure no ships were there. Nevertheless two Japanese fishing boats came into port 8th April with cargoes of radioactive tuna. On one of the boats, the Kaifuku Maru, health officials found it necessary to destroy "about one-third of the thirty-five tons of tuna . . . when it recorded more than 100 [Geiger counter] impulses a minute. About 45 minute is considered the maximum for human safety". (UP dispatch, 8th April.) Curiously, the other ship, the Shoho Maru, had only six radioactive fish out of a thirty-ton catch, giving counts of 60 to 1,300 impulses a minute. An INS dispatch of 10th April clarifies this situation, telling that these six had "eaten atom-radiated small fish". The Shoho had been 400 miles south of Bikini. As time went by other radioactive ships were remarked, including one that had been "dusted" at a distance of 2,200 miles; a Geiger counter held to the head of a crewman from this vessel, the Misaki Maru, clicked 200 times a minute.

U.S. News and World Report of 9th April, 1954, in an article entitled Has the H-Bomb Gone Wild? , reflected the prevailing sentiment when it commented: "The guarded secrets of [the] H-Bomb now are coming out. The facts, when pieced together, indicate that the tested model is a far cry from the H-bomb ordered by President Truman in 1950". By the end of March a vast clamor had risen around the H-bomb, to which even the AEC could not remain entirely oblivious. Indeed, Lewis Strauss, Chairman, held a special press conference on 31st March at which he assured the public that there was nothing to worry about, that the victims with radiation burns were "well and happy", etc., and emphasized that we were rapidly approaching the millennium of atomic energy for peacetime use. With this assurance, the AEC detonated three more bombs. News of them reached the public unofficially, e.g. through reports of radioactive rain by Japanese scientists and accounts by American airline passengers of a "midnight sunrise" in the Marshall Islands. An AP dispatch of 14th May said: "Evidence indicates [an] explosion of April 6, another about May 1 and a final shot within recent days". It seems likely that a great 40 megaton blast originally scheduled for around 22nd April did not take place.

Incidents of similar character to those arising from the previous blasts continued to be reported. A cross-section of news items follows:

Tokyo, April 19 (AP) – "Two Japanese scientists to-day said new radioactive rain showers fell on Japan Saturday and yesterday . . . the showers started 40,000 feet up and fell from the stratosphere . . . . Meanwhile health officials at the giant Tsukiji Japanese Fish Market condemned 3,000 pounds of tuna from a mid-Pacific catch brought here to-day. The fish showed signs of harmful radioactivity."

Tokyo, April 30 (AP) –"Another Japanese tuna boat has been found radioactive and some of its catch has been condemned . . . . The ship is the 100-ton Koyu Maru. Kyodo [News Agency] said it was operating about 500 miles southeast of Bikini March 26 when the U.S. touched off its second hydrogen blast."

Lander, Wyo., May 14 (AP) — "Uranium hunters in this central Wyoming area are blaming atomic dust for a sudden jump in activity on the dials of their Geiger and scintillation counters. Even tests on Lander's main street showed radioactivity five to six times the normal reading."

Kamaishi, Japan, May 23 (UP) – "Health department officials said to-day the fifth crewman of a Japanese ship that arrived at this northern port yesterday showed signs of radiation burns. The [Jintsuguwa Maru] left Macatea Island south of Australia, April 17 . . . and supposedly skirted the zone around the Bikini-Eniwetok atomic proving grounds . . . ."

Sydney, Australia, May 24 (Reuters) — "Radioactive rain fell on Sydney Sunday, it was reported to-day . . . D. E. Davies [manager of a concern manufacturing Geiger Counters] said, 'We were subjected to some sort of radioactive rain as a result of a hydrogen bomb test in the Pacific'."

San Diego, Calif., May 28 (UP) – "The escort carrier USS Bairoko arrived here to-day from the Pacific hydrogen bomb tests, but the Navy kept its 'secret' label on everything concerning its recent operations. Reports were heard, both here and in Washington, that the Bairoko received a mild dusting with radioactive particles . . . . [Reporters and photographers were not] allowed to visit the ship."

New York Herald Tribune, May 28, under the heading Radioactive Rain Worries Tokyo printed a dispatch, “Rain so radioactive it might be dangerous to anyone drinking it fell on Tokyo to-day . . . . It was the latest and most serious of a number of such showers. Samples . . . gave a Geiger counter reading of 10,000 [clicks per minute], potentially dangerous if drunk.”

Calcutta, May 30 (Reuters) – “The Indian Nuclear Physics Institute here reported to-day that radioactive rain fell over Calcutta on April 29 . . . . A Reuters dispatch from Calcutta June 1, said: ‘Radioactivity in atmospheric dust and rain over the Bay of Bengal soon after the Pacific hydrogen bomb explosion April 6 was seven to eight times normal, it was disclosed here to-day [by Dr. S. Kuk Mitra, head of the department of physics at Calcutta University]’.”

Tokyo, June 4 (AP) – “Five crew members of a Japanese freighter that passed within 1,200 miles of the United States hydrogen bomb tests in the Pacific were reported suffering from radiation sickness to-day . . . .”

Tokyo, June 10 (AP) – “A Japanese radioactivity test ship detected strong signs of contamination last night 500 miles south of the U.S. H-bomb test area at Bikini, Kyodo news agency reported to-day. Radioactivity was found in the fish, rain and seawater tested by the Shunkotsu Maru. Japanese officials yesterday ordered destroyed as radioactive 8 tons of an 82,000 pound catch from the waters near Truk Island in the Caroline Islands.”

Tokyo, June 10 (INS) – “Seven Japanese were reported under treatment for radioactivity to-day because they drank rain water from clouds which passed through the U.S. Bikini H-bomb testing area. Japanese coast guard officials said that three lighthouse attendants and four members of their families are recovering, but will be hospitalized for some Time.”

Tokyo, June 12 (AP) – “A Japanese scientific research ship reported to-day that measurable radioactivity has been found in the sea water within 100 miles of Bikini Atoll where the U.S. conducted test H-bomb explosions in March and April [and May – JL]…. The amount of radioactivity was small but noticeable as the research vessel sailed to within 67 miles of Bikini . . . . Meanwhile, radioactive jittery Japan learned to-day that some scientists have found wild birds were mildly radioactive in Japan this year. A scientist said he found traces of radioactive ash, presumably from U.S. H-bomb tests, in the internal organs of the birds.”

Because of the fact that whole islands, in the form of radioactive dust, are now drifting in the

upper atmosphere, and much additional radioactive matters is now being assiduously concentrated by sea organisms; in view of the presence of long-lived isotopes in the ash (we have already mentioned strontium 90; consider also that the atoll of Rongelap in the Marshalls must remain evacuated for at least a year, according to the AEC); and in view of the long delay (often years) which precedes the chronic effects of radiation injury, it may be stated with certainty that we have not heard the last of this series of hydrogen tests. Even the incidents we have quoted probably give an inadequate picture of what has already been reported – because the heavy censorship of the AEC has been augmented by a conspiracy of silence on the part of the press. For example, the New York Times, which has seen fit to give many days of front page coverage to an Egyptian funeral ship, has consistently buried the news dispatch on radiation injury in its hinter regions, insofar as it has deemed these dispatches fit to print at all.

2. The AEC Explains — A Study in Appearances and Realities

The American government has issued only one public statement dealing with the effects of hydrogen explosions! This took the form of a press conference held by Strauss, 31st March, where he read a prepared statement and answered several questions from reporters. Evidently the AEC plans to let its case rest with this press conference and does not intend to amend or augment the statements of Strauss. And it is not through lack of sensitivity to public concern that further enlightenment has not been forthcoming; for instance, one citizen who wrote to President Eisenhower expressing alarm over the hydrogen tests received a two-page personal letter from Morse Salisbury, director of the AEC's Information Service, answering objections point by point on the basis of material in the Strauss press conference. A mimeographed copy of the latter was enclosed. And an interview with some Marshallese natives by an AP staff writer published 9th June bore the explanation: "The following story was delayed by censorship in the Defense Department, the AEC and the State Department . . . minor deletions were made in the original copy".

We have already seen several instances where the AEC was less than candid with the public. This trend reaches a summit with the Strauss report, which is no more than a fairy tale designed to allay public apprehension (Strauss calls it "misapprehension") over the disaster at Bikini – and pave the way for further "experiments".

The tone of the Strauss statement is itself significant; there is no humility, no regret, no apology – not even a crocodile tear is shed in the interests of propaganda for the Marshallese, Japanese or American victims. To shed such a tear would be to acknowledge that something had gone wrong. But more important, the hydrogen explosions are primarily acts of intimidation – and one does not follow up an act of intimidation with an apology. The Admiral begins with some "historical background", telling how "there is good reason to believe that they [the Russians] had begun work on this weapon substantially before we did" but happily "enormous potential has been added to our military posture by what we have

learned" from the recent tests, etc.

"Now as to this specific test series. The first shot has been variously described as 'devastating', 'out of control', and with other exaggerated and mistaken characterizations. I would not wish to minimize it. It was a very large blast, but at no time was the testing out of control. The misapprehension seems to have arisen due to two facts. First, that the yield was about double that of the calculated estimate – a margin of error not incompatible with a totally new weapon (the range of guesses on the first A-bomb covered a relatively far wider spectrum). Second, because of the results of the fall-out."

We shall not engage in semantic quibbling as to whether it is "mistaken" to call "devastating" a bomb which "left an area of total destruction about twelve miles in diameter" (Rep. Van Zandt) and gouged a deep crater in the ocean floor; similarly, we need not quibble over whether Rep. Holifeld "exaggerated" when he said the bomb was "out of control"; but the Admiral might have given us facts. He might have admitted that the blast jarred Kwajalein, 170 miles away, and created a very high wind there, or that on Rongelap atoll, over 120 miles distant, there was "wind so strong some people fell down" (according to an AP report), or that two British Planes watching one blast were lost and a giant American B-36 was flipped completely over by the shock wave. Could he not at least have told us what Newsweek has told us 29th March, that the bomb "shot its mushroom an unprecedented twenty miles into the air" and that this cloud was still at large in the stratosphere? Or would such facts give the "mistaken" idea that the testing was "out of control"? One point must be added about the word "control". In response to a reporter who asked, "Is it possible that a hydrogen explosion or series of them could get out of control?", Strauss said, "I am informed by the scientists that that is impossible". Now the expression "out of control" is used by the physicists in this connection to mean setting off a chain reaction that would envelop the entire earth. Thus to know that an explosion is not "out of control" in this technical sense is small comfort, and, in particular, does not imply that it is in any real sense in control. As for blowing up the entire earth, the majority of scientists believe this is impossible; it may be said with certainty that they will never have to admit they were wrong.

Let us examine the "two facts" responsible for public "misapprehension". First, that "the yield was about double that of the calculated estimate". By "yield" Strauss means apparently the number of megatons. But then, what of press reports that the 1st March explosion developed fourteen megatons, whereas the "calculated estimate" was four to six? Or that the 26th March bomb developed seventeen megatons as against an anticipated three? These ratios are more nearly three to one and six to one than "double". And one Pentagon official who witnessed the 1st March test, according to Newsweek 5th April, "insists that all published estimates of the H-bomb's force have been too conservative" and claimed that

the tested bomb gave about a twenty-eight megaton explosion. Actually, the whole concept of measuring the "yield" in megatons is misleading. As Edward Teller wrote in the Bulletin of the Atomic Scientists, February, 1947: "It is hardly possible to compare the effect of an atomic bomb with the effect of a certain tonnage of TNT [for] atomic bombs also destroy by flash burns and by causing radiation disease". In reality it makes sense to speak of a "yield" only in ecological terms, in terms of damage to man and his environment. Measured in these units Strauss's statement about a "yield double the calculated estimate" takes on the meaning, "We expected to cause only 150 cases of radiation sickness but caused instead 300; we calculated on making one atoll uninhabitable for six months but the yield was two atolls for a year", and so on.

Let us note that the hydrogen bomb is not a "totally new weapon" in the same sense as the first A-bomb; indeed, three thermonuclear explosions had been conducted by the AEC prior to 1st March, 1954, and in every case the energy release exceeded predictions, the last (November, 1952) by a ratio of more than five to one. Were not these ample warning of the uncertainty involved? A more accurate phrase to describe the circumstances would be "a margin of error not incompatible with a totally new concept of morality".

Now Strauss's second "fact" causing "misapprehension" — "the result of the fall-out". He explains correctly that when a nuclear explosion occurs near the ground, material from beneath the center of the explosion is sucked up into the air, the lighter particles and fission products being borne away by the wind, eventually to settle out. (Detailed information of this sort is available in the AEC's 1950 manual The Effects of Atomic Weapons). Forecasting correctly the direction of the winds at altitudes within the range of interest is all-important, and hence:

"Before the shot takes place, there is a careful survey of the winds at all elevations up to many thousands of feet . . . . Contrary to general belief, winds do not blow in only one direction at a given time and place. At various heights above the earth, winds are found to be blowing frequently in opposite directions and at greatly varying speeds . . . . The meteorologists attempt to forecast the wind directions for the optimum conditions and the Task Force Commander thereupon decides on the basis of the weather report when the test shall be made. The Weather forecast is necessarily long-range because a warning area must be searched for shipping and the search . . . requires a day or more to complete. [My emphasis – JL]."

We thus see that successful prediction of the fall-out pattern depends directly on successful long-range prediction of the winds, and this as high as the top of the mushroom cloud. Strauss indicates that the winds are quite tricky, but his account must be augmented for a

clearer understanding. In the Compendium of Meteorology (Boston 1951) Namias and Clapp of the U.S. Weather Bureau write:

"The state of our knowledge . . . of the general circulation [of air masses] is still quite inadequate. Our deficiencies lie particularly in the absence of a long period of record of upper-air data over large areas of the Northern Hemisphere and most of the Southern Hemisphere. Not much can be done for many years to remedy the 'long period' part of this deficiency."

In the same volume A. Grimes points out that "the properties of tropical air are quite well known up to four or five km., but observations are too few above five km. for reliable conclusions to be drawn". One of the principal causes of consternation in high-altitude wind prediction is the existence of "jet streams". First discovered during World War II, these narrow filaments of air travel as fast as 300 miles an hour at heights of between six and eight miles. In the Scientific American, October, 1952, Namias gives an account of these "strange winds" and their "violent and unpredictable behavior". He points out that:

"Neither [of the two existing theories of jet streams] is complete enough for detailed weather prediction . . . many large areas of the Pacific are still meteorological no-man's-lands . . . what causes their often striking behavior from one month to the corresponding month of the following year are questions that remain unanswered."

Thus fortified we pursue Strauss's account:

"For the day of shot number one the meteorologists had predicted a wind condition which should have carried the fall-out to the north of the group of small atolls lying to the east of Bikini . . . . The shot was fired. The Wind failed to follow the predictions [!] but shifted south of that line and the little islands [atolls –JL] of Rongelap, Rongerik, and Uterik were in the path of the fall-out . . . . The twenty-three crew members on the ship, twenty-eight American personnel manning weather stations on the little islands, and the 236 natives on these islands were therefore within the area of the fall-out."

It is clear that if the atmosphere a mere seven or eight miles up is "a meteorological no-man's-land", and the bomb "shot its mushroom an unprecedented twenty miles into the air", it is inherently impossible to predict with any certainty the fall-out pattern. Incidentally, we see now the meaninglessness of many comments which have been made concerning the

fall-out, such as Rep. Van Zandt's attribution of the disaster to "unpredictable wind shifts at high altitudes". Furthermore, even the more tractable lower altitude winds become problematical – owing to the force of the explosion itself. We recall the powerful winds that swept Kwajalein and Rongelap, and a New York Times report from an American observer that the bomb "set off a local wind storm that might have upset weather forecasts that had been correct earlier". Thus Strauss's "two facts", the size of the explosion and the fall-out, are seen to be one: A chaotic fall-out pattern is in the very nature of such a large explosion (3). The fall-out problem is, of course, also greatly magnified in the case of a large explosion because there is so much more debris to fall out. Thus "freak accidents" followed like clockwork after each of the great hydrogen explosions, and will continue to follow any low-altitude blasts of similar magnitude which may take place in the future.

Strauss touches obliquely on the central question of the right by which an American task force can declare "off limits" to the rest of the world a huge area of the Pacific Ocean.

"The 'warning area' is an area surrounding the proving grounds within which it is determined that a hazard to shipping or aviation exists. We have established many such areas as have other governments. . . . Including our continental warning areas, we have established a total of 447 such warning and/or danger areas. This particular warning area was first established in 1947. [A-bomb tests were held at Bikini in the summer of 1946 — JL.] The United Nations were advised and appropriate notices were carried then and subsequently in marine and aviation navigational manuals."

What "other governments", Admiral, have ever closed off to all sea and air craft half-a-million square miles of international waters, and this for a period of several months? Included in the 26th March "warning area" were some of the best Japanese fishing grounds and much of the Marshall Islands. Not even the high-handed gang in the Kremlin has set any precedent for such an action. And the argument that "We have done similar things in the past" is slender justification. Even if we grant the (completely untenable) assumption that America has acquired some "unwritten" right, on the basis of historical precedent, to set up proving grounds in international waters, we are confronted here with an entirely new situation — as with most other aspects of the hydrogen bomb question a quantitative change has become qualitative. As Dr. Lee Du Bridge, President of the California Institute of Technology, wrote in 1946 in protest of the first Bikini tests: "One can do target practice with a gun (even a I6-inch gun) in his 'backyard'. But brandishing atomic weapons is in a different class." Especially so when the effects, in varying degree, are felt from Calcutta to Wyoming; and large areas are not only denied to others but more or less permanently mutilated.

Concerning the mutilation of the areas, Strauss says:

“Each of these two atolls [Bikini and Eniwetok] is a large necklace of coral reef surrounding a lagoon two to three hundreds of square miles in area, and at various points on the reef like beads on a string appear a multitude of little islands, some a few score acres in extent — others no more than sandspits. It is these small, uninhabited, treeless sand bars which are used for the experiments. . . . The impression that an entire atoll or even large islands have been destroyed in these tests is erroneous. It would be more accurate to say large sandspit or reef.”

The “baby bomb” of 1952 had already “annihilated an island of the Marshalls group” half a mile long. But leaving aside question of out – right annihilation of islands (a preposterous standard of damage) and considering instead their spoliation much more can be said. As early as the 1946 Bikini tests Dr. David Bradley, a radiological monitor with the first task force, remarked that:

“The main island of Bikini . . . has been pretty well ravaged in the preparations for these tests [by the erection of installations] . . . and even discounting the possibility of lingering radioactivity it is doubtful if this island could support them (the dispossessed Bikini natives] again for a generation.” (No Place to Hide, Boston, 1948.)

He points out similar depredations of Kwajalein and many smaller islands, adding: “In the lavish expense account for Operation Crossroads, the spoilage of these jeweled islets will not even be mentioned, but no one who visited them could ever forget it”. But all this is piddling compared with the damage wrought by the H-bomb. Let us consider merely the effects of thermal radiation. We recall first some information about A-bombs, quoting from the AEC’s The Effects of Atomic Weapons (EAW):

“It may be concluded that exposure to thermal radiation from a nominal atomic bomb, on a fairly clear day, would lead to more or less serious skin burns within a radius of about 10,000 feet from ground zero (p. 200) . . . . Thermal radiation burns were recorded at a distance of as far as 13,000 feet at Nagasaki (p.202) . . . . Fabrics, telephone poles, trees, and wooden posts, up to a radius of 9,500 feet from ground zero at Hiroshima and up to 11,000 feet in Nagasaki, if not destroyed by the general conflagration, were charred and blackened (p. 207) . . . . The top of a wood pole, about 6,700 feet from ground zero, was reported as being ignited by the thermal radiation (p. 214).”

It is thus seen that the heat wave alone from a twenty kiloton A-bomb would cause severe injury to animal life out to more than two miles, and severe damage to trees and foliage (including starting fires) out to more than a mile from the blast. Now from equation (6.39.4)

of EAW (p. 195) we can calculate what will be the corresponding distances for H-bombs. Assuming a very clear day, we get about eighteen miles and fourteen miles respectively (4) for a twenty megaton bomb. Since the atolls are roughly circular, we see from their areas, as given by Strauss, that the furthest distance between any two points in a typical atoll is of this order. Thus it appears that a twenty megaton H-bomb detonated anywhere in, say, Bikini atoll would sear all living creatures on the islands (5), killing most, and reducing to charred ruins the majority of trees and foliage. The Marshall Islanders had best forget about ever returning to Bikini – or Eniwetok, which was dealt the coup de grace in 1952. The fact that "uninhabited, treeless sandbars" are used as the site of detonation obviously would not affect these considerations. Let us give one example of the kind of fauna that once inhabited Bikini (aside, of course, from the human habitants) – the sea birds, valued not only for their beauty but for the phosphate deposits with which they enrich the soil of the islands. Here is Dr. Bradley's description of Cherry Island (the Americanized name for one of the twenty-six islands in the Bikini group):

"Cherry proved to be a rookery; birds rose in screaming protest all about us and the trees were burdened with their nests. Terns they were — black noddy terns and dainty little fairy terns, pure white and almost translucent against the sky."

These are the forgotten casualties of the H-bomb, together with coconut palms and coral reefs and parrot fish and giant lobsters and so many other exotic denizens of the South Seas (6). It is a supreme irony that these should be sacrificed in the name of "science".

We move next to Strauss's account of the condition of the victims.

"The Task Force Commander promptly evacuated all the people from these islands [in the path of the fall-out]. They were taken to Kwajalein where we maintained a naval establishment, and there placed under continuous and competent medical supervision. I visited them there last week. Since that time, it has been determined that our weather personnel could be returned to duty but are still being kept on Kwajalein for the benefit of further observation. [They were since transferred to Tripler Army Hospital in Hawaii (7) — JL.] None of the twenty-eight weather personnel have burns. [Note that the original March announcement said flatly "there were no burns" — JL.] The 236 natives also appeared to me to be well and happy. . . . To-day, a full month after the event, the medical staff of Kwajalein have advised us that they anticipate no illness, barring of course disease which might be hereafter contracted [!]."

The Marshallese petition to the UN said the natives were suffering from "lowering of blood count, burns, nausea, and the falling off of hair from the head". A later report by AP staff writer Waugh, published in the New York World-Telegram and Sun, 9th June, after official censorship, said: "Of the eighty-two Rongelapers, about forty-five suffered radiation burns . .

. one man still has a bad burn on the back of his right ear, three months after the explosion". How in this condition the natives appeared well (and happy!) to Strauss, it is difficult to imagine. So jubilant are they, indeed, that they refer to themselves as "the poisoned people". Undergoing frequent deportation is in itself not conducive to the highest standards of well- being.

The AFC's March statement that "after the completion of the atomic tests, they will be returned to their homes" is also flatly contradicted by Waugh's article — the Rongelap natives will remain on Majuro atoll for at least a year!

There are deeper undertones of deception in Strauss's statement which derive from the fact, well known to Strauss and his advisors, that many effects of ionizing radiation are delayed – even for years. What is commonly called "radiation sickness", or "acute radiation syndrome" is due to exposure of the order of several hundred roentgens. (See Supplement.) Its typical symptoms (loss of hair, general malaise, fever, pallor, diarrhea, emaciation, sore throat, blood spots under the skin) usually occur by the third week, and if the patient survives three or four months he will generally recover – for the time being. The AEC tries to create the impression that "radiation sickness" is the only hazard of radiation, and that recovery from it means complete recovery. We shall see how small an amount of radiation can ultimately produce disabling and lethal effects, indeed an amount far too small to produce the syndrome or any detectible early symptoms at all. In general, the chronic biological effects of radiation are even now very poorly understood; the AEC at its installations permits to an individual a maximum exposure (8) of only 0.3r (roentgens) per week (this may be compared with the fact that the Japanese and Marshallese victims must have been exposed to at least 100r in order to develop the clinical picture of "radiation sickness")

Furthermore, radiation effects are particularly insidious and inescapable when the active material lodges in the body; and isotopes such as radioactive strontium or (unfissioned) plutonium which lodge in the bones and emit negligible gamma radiation are extremely difficult to detect, except by the effects which they eventually produce. Since the Rongelap natives drank water from their well into which the radioactive ash had fallen, and a number of Japanese ate contaminated fish, it is clear that these considerations are not excluded in their case. Even one one-millionth of a gram of plutonium in the body will often kill the host – with bone cancer or aplastic anemia – the latent period being at least several years. (9) Among the many recorded cases of chronic radium poisoning (and plutonium is as poisonous on a gram-for-gram basis as radium) it is not uncommon to find death caused by one-tenth this mass of radium in the body, and latent periods of ten and twenty years. Strontium, barium and zirconium fission products are of comparable toxicity, and in the case of a close-to-ground hydrogen burst there are usually a dozen radioactive isotopes unleashed in fair quantities, which can produce chronic death if several thousandths of a gram enter the body

(e.g. phosphorus 32, sulfur 35).

One finds an ever-increasing number of delayed effects among Japanese A-bomb victims. For example, an AP dispatch of 21st June, 1954, cites the first recorded instance of a cancer developing on the site of a scar from a radiation burn – nine years after the injury. The 1953 publication Atomic Bomb Injuries by Dr. Nobuo Kusano reports thousands of cases of leukemia among the victims, many times the pre-war incidence. A number of cases of malformed miscarried, feeble-minded or stillborn offspring of mothers irradiated at Nagasaki during pregnancy were recently reported and analyzed by three Los Angeles doctors, according to an AP dispatch of 30th April. Over 200 cases of eye cataract (opacity of the lens or lens capsule) have been observed among the victims. And Dr. John Bugher reported in Nucleonics September, 1952, other delayed effects ranging from "detectable abnormalities" because of spontaneous mutation to impaired growth of young boys, malformed teeth, and increased incidence of dental caries. Dr. H. J. Curtis in Biological and Medical Physics II (New York, 1951) remarks: "Many months after the acute symptoms had passed some [Japanese] patients reported extreme weakness, and this symptom is still persisting in many of these people. If we can reason from the experiment on mice . . . we would conclude that these persons will remain weak and lethargic the rest of their lives". And the biologist H. J. Muller has predicted that genetic deaths in the A-bombed areas will, in the course of time, claim as many victims as the bombings themselves.

One does not have to go further in demonstrating the insidiousness of radiation injury than the experiences of X-ray and cyclotron workers. H. C. March (Am. J. Med. Sci. 220, 1950) showed that the incidence of leukemia in radiologists over a twenty-year period was nine times as great as for non-radiological physicians. Over fifteen radiation-induced cataracts have been discovered in American cyclotron workers. And compare the "well and happy" assertion of Strauss with the following remarks of Dr. G. Failla of the College of Physicians and Surgeons of Columbia University:

"A striking characteristic of the biological effects of ionizing radiation is the lone delay that occurs between the exposure to radiation and the manifestation of the effects . . . sometimes complications occur much later in a tissue that has recovered almost completely . . . it is very important to bear in mind that death may be the final outcome of even an apparently mild local skin injury. [In the case of the radiologists] the important point is that the daily dose was too low to produce readily noticeable skin changes within, let us say, the first two years. . . . Nevertheless obvious skin changes did occur later . . . fifteen or twenty years later one of these growths, or one of a more recent origin and less annoying may develop into a cancer. If this is of the squamous cell type it will eventually spread – metastasize – to some vital organ and the patient will die. . . . The incidence of leukemia in radiologists has been found to be significantly higher than in other physicians . . . there are

numerous cases in which the individual appeared to be normally healthy and active until the leukemic process started in late life." (Taken from Industrial and Safety Problems of Nuclear Technology, Harper and Bros., 1950; emphasis added – J.L.)

In view of all these facts no further comment is needed on Strauss's double- talk about "barring of course disease which may be hereafter contracted". And in all this we have not yet gone into the genetic damage — a particularly grave consideration in the case of the Marshallese because virtually the entire population of certain atolls has been exposed.

And what of the twenty-three fishermen? Strauss tells how they happened to be exposed:

"Despite such notices there are many incidents where accidents or near accidents have resulted from inadvertent trespass in such warning area. The very size of them [!] makes it impossible to fence or police them. . . . A Japanese fishing trawler, the Fortunate Dragon, appears to have been missed by the search but . . . it must have been well within the danger area."

Note that here he says "danger area" rather than "warning area" – for it has been well established that the trawler was outside of the "warning area". In this sense the statement is correct – by definition. Obviously anything which is endangered must be reckoned "within the danger area" – and since the Misaki Maru 2,200 miles away received dangerous fall-out, some idea of the size of the "danger area" can be obtained.

Of the condition of the fishermen, Strauss says:

"The situation with respect to the twenty-three Japanese fishermen is less certain [!] due to the fact that our people have not yet been permitted to make a proper clinical examination. [However] the reports which have recently come through to us indicate that the blood count of these men is comparable to that of our weather station personnel. Skin lesions observed are thought to be due to the chemical activity of the converted material in the coral rather than to radioactivity, since these lesions are said to be already healing. The men are under continual observation by Japanese physicians, and we are represented in Japan by Dr. Morton of the ABCC [who said 'they will recover completely in a month' – J.L.] and Mr. Eisenbud of the AEC [who aroused great resentment in Japan when he ordered routine Geiger counter tests of fish bound for Japanese tables, but very complete and careful examination of American-bound tuna. – J.L.].

The fishermen received very severe dosages of radiation, both beta and gamma, because

the ash fell on them only several hours after the explosion, at which time many short-lived and therefore intense radioactive emitters would still be present in quantity. Even the analysis of the ash several weeks later by Japanese scientists, which revealed deadly isotopes, would not tell the whole story. For instance, we may mention 14.8-hour sodium 24. As EAW point out, the coral at Bikini is “saturated with sodium” from the sea water. Ordinary sodium is known to capture neutrons readily and become sodium 24 (EAW, p. 255) which decays to magnesium by emitting strong beta and gamma radiation. Because several hundred pounds of neutrons are liberated in a hydrogen explosion, large amounts of sodium 24 are formed, and from this source alone the coral ash falling on the fishermen must have been quite “hot”. Many similar elements could be mentioned encompassing both fission products and neutron-induced radioactivity: the fission products alone from a small A-bomb have an activity of six billion curies an hour after the explosion, and 133 million curies (10) a day after (EAW, p.251).

In the absence of reliable information, which would require at least an interview with the fishermen and complete medical records, one cannot state with certainty what is the present condition of these men (11), but certain illusions can be dispelled. Some circulation has been given to a rumor that the men merely got a “strong sunburn”. Actually they were at least eighty miles from the explosion and hence not within range to be affected by ultra-violet or other thermal radiation. The damage to the skin has all the earmarks of severe beta-ray burns. To see this, let us recall published accounts of the men’s symptoms. An INS dispatch of 27th March quotes an official Japanese report as saying: “Seven or eight days after the accident the crew began to feel painful irritations from what looked like burns on the neck, faces [and] ears . . . .” Again, an AP report of 25th March quotes Yamamoto, a victim: “After four days nearly everyone turned black and felt itchy. Our hands and faces swelled up, blistering like a burn. . . .The exposed parts worsened and itchiness was unbearable”. These may he compared with a classical case of beta burns, as described by Hempelmann and Hoffman in Annual Review of Nuclear Science III, Stanford, 1953, involving four persons who accidentally picked up “hot” fragments at the 1948 Eniwetok tests:

“An Important practical fact emerging from them these accidents is the itching and burning of the skin noted during the exposure. One of the persons changed his rubber gloves several times because he believed they contained some irritating chemical. The symptoms . . . were referable almost entirely to the hands. They consisted of swelling of the fingers, beginning several hours after exposure, and blistering starting after one week and reaching a peak four weeks after the exposure”.

The Effects of Atomic Weapons (EAW), p. 357 says:

“The reactions following contact with beta-emitters . . . may vary from temporary redness to complete destruction of the skin, depending on the doses absorbed. Even mild doses may result in delayed degenerative changes of the skin. When the hands have been exposed to large amounts of beta radiation, they become swollen within a few days and this is followed by reddening [in very severe cases, blackening – J.L.] of the skin. . . . Subsequently, large blisters form, become confluent, and finally turn into a slough. . . .”

The similarity is unmistakable; the four at Eniwetok received only hand burns, and after an extended series of skin grafts they “recovered” — except that “the most seriously injured finger is stiff and atrophied” and “some [other fingers] are slightly atrophied or slightly stiff”. Some of the more unpleasant possibilities which could beset the fishermen are implicit in what we have already said regarding the Marshallese victims. Yet because the seriousness of their condition has been glossed over in some quarters without factual justification being given — and also because there is a lesson here for all of us — let us go more deeply into the matter.

Here are some further excerpts from the paper of Dr. H. J. Curtis of the Columbia University College of Physicians and Surgeons (op cit.):

“. . . if a drop of solution containing a very small amount of a radioactive isotope were to splatter on a hand . . . one spot on the skin would receive a very appreciable dose of beta rays. This might lead to a small radiation burn which in turn might eventually lead to a skin cancer at that spot. . . .”

Hematologic changes proved to be a very poor index of the degree of radiation damage. Even in the animals receiving very high single doses of a penetrating radiation from which they recovered, the blood picture would very soon return to normal and remain so until the death of the animal. [Compere Strauss’s remark concerning blood count. — J.L.]

“Animals surviving the acute phases of the beta-ray damage often died of secondary infection from the skin ulcers. Of the remainder that died prematurely, almost all of them died of skin tumor. In some series of rats the skin tumor incidence was practically zero in the controls and 100 per cent in the experimentals. Practically every type of skin tumor ever described was found, and there were as many as 100 separate loci on some rats . . . if one assumes that man is as sensitive to tumor induction by radiation as the most sensitive rodents, then the induction of neoplasms in persons working with radiation is a very real possibility. . . .

“At about thirty days [in the subacute reaction to beta-rays] small layers of the superficial layers of the skin start to slough [forming ulcers]. . . . Usually these ulcers heal fairly rapidly [‘skin lesions are said to be already healing’ – Strauss]. This healed skin appears somewhat dry and thickened but otherwise quite normal. . . . However months later sloughing commonly occurs again leaving large deep ulcers. These late ulcers are very slow to heal . . . . There are many more deaths proportionately in the subacute period among the animals receiving beta-rays than among those receiving penetrating radiation . . . . Several months after irradiations an opacity of the eyes developed in all rats and mice receiving large doses of beta rays [this may correspond to several years in the life span of man – J.L.]. It is interesting that this occurred quite rapidly, one week the eyes being quite clear and functional and the next milk-white and opaque”. [Note that ash got into the eyes of the fishermen (UP dispatch of 14th April) – J.L.]

Of course, the influence should not be drawn that the development of these morbidities by the Japanese fishermen is inevitable – but the danger is real. The results of animal experiments must be taken seriously because, as Harold Plough points out in Nucleonics, August, 1952, humans are more sensitive to radiation than most other animals. For instance, the median lethal dose (the dose of penetrating radiation that will cause acute death to 50 per cent of young adults exposed) is 650r for mice and only 400r for humans. An INS science writer reported that adolescent mice exposed to radiation from the 1946 Bikini bombs,

“developed tremendous tumours of the pituitary gland in their old age . . . cancers so severe the tiny gland at the base of the brain grew until it filled one-third or one-fourth of the cranial cavity, making a virtual pancake of the brain”

and that Dr. Jacob Furth of the Children’s Cancer Research Center in Boston, “a top cancer specialist” connected with these experiments, pointed out “this effect in mice may not hold true for men” but “that other effects observed in the mouse studies [leukemia, loss of hair color, susceptibility to infections and cataracts] already have found a grim parallel in some of the biological change occurring in surviving men and women at Hiroshima and Nagasaki . . . . Similar effects, the scientist indicated, conceivably could appear in the future in the Japanese fishermen recently showered with [radioactive] ashes”.

So far we have indicated possible damage from the surface (beta) radiation. A whole spectrum of new horrors appears when the total-body (gamma) radiation is considered. It is known that the fishermen exhibited the familiar syndrome associated with an overdose of penetrating radiation. As Rutherford Poats, UP staff writer wrote from Tokyo 14th April: “The fishermen were vomiting and they had diarrhea” when they reached port; also their blood count dropped sharply. To develop these symptoms in less than two weeks strongly

indicates a dose of at least 200-300r (compare EAW, p. 347). For comparison, consider that 400r is normally fatal to 50 per cent of humans. A nearly fatal dose certainly has permanent effects, even though the victim survives. To quote again from Curtis:

"The chronic changes produced by large single doses of a penetrating radiation are very poorly understood. As already described, the animals either become emaciated and die in a state of atrophy before their controls, or else develop some form of neoplasm [tumor – J.L]. Premature greying of the hair in dark haired animals is universal. A few develop opaque eyes just as the animals exposed to beta rays. The preliminary results on the exercise tolerance tests indicate considerable muscular weakness or lethargy, but the mechanism of this deficiency is completely unknown. In the case of the animals dying in atrophy it seems fairly certain that they finally succumbed to some one of the diseases tibility to disease…. [In this generalized atrophy] no definite pathological changes can be detected but the tissues present the same picture as that of tissues from very old animals".

This and much other experimental evidence (also the cited experiences of the A-bomb survivors) indicate that at best, even barring neoplasia, anemia, sterility, atrophied genitalia or other specific disease, the fishermen will suffer emaciation and premature ageing. And what of the fishermen (and scores of other Japanese) who ate contaminated fish? One does not know whether the radiostrontium deposited in their bones is lethal, but it doesn't take much — a few millionths of a gram and lots of time will do it.

From all this we can see why the condition of the fishermen is "less certain". Cavalier pronunciamentos by AEC spokesmen that they have "recovered" will not do — in this case nothing short of certified clinical and histopathological data can be taken seriously. Similarly, a recent statement by Dr. Masao Tsuzuki that the victims "were making satisfactory progress" — announced while said doctor was on a tour of American atomic installations as a guest of Admiral Strauss (New York Times, 28th May) — is suspect. In an Alice-in-Wonderland vocabulary where "well and happy" means "suffering from radiation sickness and burns" (12) and "complete recovery within a month" means "many months of hospitalization", what is "satisfactory progress"? In truth the only information content of this vague expression is that the fishermen are still alive! Every possible step has been taken to keep them alive, (13) including blood transfusions on a lavish scale because of extensive damage to the blood-forming tissues. It is proper that these steps be taken — but at least let the truth be known to the American people, who must soon decide whether they will permit a new "Operation Syndrome" in other people's backyards!

Now back to Strauss. The closest he ever comes to expressing regret is:

“In the matter of indemnifying the Japanese, our Government has informed the Japanese Government that it is prepared to agree to reimbursement for such financial assistance as the Japanese Government and our Embassy in Tokyo, jointly, may find necessary as an interim measure to give to the persons involved for current medical care and family relief, including wages.”

Even these miserable promises have not been kept. At the date of this writing (1st July) payment has not been made to the fishermen or their families, who now experience great hardship. And the indemnification of the Marshall Islanders? Twenty-seven wooden shacks on Majuro atoll (14) — and bigger bombs promised for 1955.

And what of the contaminated fish? Strauss says:

“With respect to the stories concerning widespread contamination of tuna and other fish, the facts do not confirm them. The only contaminated fish discovered were those in the open hold of the Japanese trawler. Commissioner Crawford of the U.S. Food and Drug Administration has advised us: ‘Our inspectors found no instance of radioactivity in any shipments of fish from Pacific waters. [These fish had of course been ‘screened’ before shipment – J.L.] Inspections were undertaken as a purely precautionary measure . . . . There is no occasion here for public apprehension about this type of contamination.’”

Published news items before Strauss’s press conference had already stated that the Myojin Maru and the Koei Maru came into port 27th March exhibiting dangerous radioactivity; and an AP dispatch of 30th March said that Japanese health officials had destroyed the entire 80,000 pound tuna catch of the Koei (and were undecided about the Myojin). How could Strauss seriously stand up before a world eager for “the facts” and say that only aboard the Fukuryu Maru was there contaminated fish? But in the light of hindsight the true magnitude of Strauss’s understatement is first apparent: it should not be necessary here to recapitulate the many news reports we have presented concerning contamination of fish.

Regarding contamination of the sea, Strauss says:

“With respect to the apprehension that fall-out radioactivity would move toward Japan in the Japanese Current, I can state that any radioactivity falling into the test area would become harmless within a few miles after being picked up by these currents which move slowly (less than one mile per hour) and would be completely undetectable within 500 miles

or less."

Let us recall the cited AP dispatch of 5th June that "A Japanese radioactivity test ship detected strong signs of contamination last night 500 miles south of the U.S. H-bomb test area at Bikini", and that fish caught many hundreds of miles from Bikini have been found unsafe to eat. An AP dispatch of 5th July quoted Dr. Hiroshi Yahe, chief of the Japanese radioactivity test group, as saying: "We have found that H-bomb tests seriously affected sea waters, fish and other marine life". Recently the Japanese group completed its study, but its report has not yet been made public. It will be important to note whether this report is subjected to any American censorship. Meanwhile a summary has been released (not available to the author) which is discussed by Lindesay Parrott in the New York Times of 7th July under the heading: Bikini Area Safe, Japanese Report. The report, we are told, "explodes scare stories spread [in Japan] by anti-American elements, some university professors [e.g., Hidiki Yukawa, one of the world's leading physicists – J.L.] and the sensational Tokyo press". For example, "The report is particularly explicit in stating that navigation in the entire test area is safe, though caution should be used in taking seawater aboard for such purposes as washing down decks, cookery, or use of a crew" (emphasis added). On the day that the Pacific Ocean is so poisoned with gamma ray emitters that it is unsafe even to navigate there, the time for discussion will of course be long past — we will all be scrambling for lead vaults. Again,

"A minor danger area was found only [!] in the current setting northward toward Japan, west of Bikini. There more than normal radioactivity was found in plankton and small fish. Tuna, which apparently fed on these lesser forms of sea life, showed signs of radiation around the gills and in the internal organs but little [it takes very little! — J.L.] in the parts of the body usually used for food."

Naturally no sane person would contend that the Pacific Ocean has been transformed into one great radioactive holocaust — but this is not the standard by which the hydrogen explosions must be judged. As we have shown, considerable damage has been done, and no amount of hand-waving by official apologists can alter this fact. And there are long-range factors at play yet to be evaluated. According to EAW p. 251 the fission products from a 20-kiloton A-bomb give 110,000 curies of gamma activity alone, one year after detonation. In the recent hydrogen explosions, beside the fission products and plutonium, great quantities of long-lived isotopes of carbon, sulfur, iron and other elements were formed by neutron action. All these radioactive elements enter the metabolic processes of sea organisms, just like their non-radioactive counterparts. In particular, many elements, despite initial dispersal, become reconcentrated. (See EAW pp.283-4.) Examples of this process can be found in the treatise The Oceans (New York, 1942) by Sverdrup et al: It is pointed out, for instance, that radium is found in one hundred fold greater concentration on the sea bottom

than in sea water because it is collected by certain marine life. Other organisms concentrate strontium in their calcareous skeletons, and so forth. In addition to concentration, the radioactivity can be transported hundreds of miles by migratory fish. We have already cited such a case in connection with the Shoho Maru. The tuna is highly migratory — cases are recorded where a fish missed at Tunis or Spain is caught in Norway (the hook in his mouth permitting identification). Eels of all parts of Europe and Africa cross the ocean and come to the Atlantic shores in autumn. Science News Letter of 13th March, 1954, reported that an albacore, caught and marked in Japan, escaped and swam 4,900 miles across the Pacific where it was recaptured off the California coast 324 days later. Thus it is not unlikely that radioactive fish will turn up in American waters in a year or so. (Radioactive fish have in the past been caught in the rivers near the AEC's Hanford, Washington, atomic plant.) Another long-range process particularly difficult to evaluate is the diminution of the fish population of the Pacific, and the changes in the existing balance of species. One cannot rely on counting corpses to know how many fish have been poisoned — for at the first sign of disability, the radioactive fish loses out in the battle for survival, and is swallowed by a predator.

Strauss next discusses world-wide contamination by fall-out:

"With respect to a story which received some currency last week to the effect that there is danger of a fall-out of radioactive material in the United States, it should he noted that after every test we have had and the Russian tests as well there is a small increase in natural 'background' radiation in some localities within the continental United States, but, currently, it is less than that observed after some of the previous continental and overseas tests, and far below the levels which could be harmful in any way to human beings, animals, or crops. It will decrease rapidly after the tests until the radiation level has returned approximately to the normal background."

Is "200 times normal background" in Montana and Wyoming, as reported by U.S. News and World Report 9th April, a "small increase"? Background radiation five to ten times normal was recorded in many locations throughout the world. "Rain so radioactive it might be dangerous if drunk" fell on Japan – over 2,000 miles from the explosion. Furthermore, the AEC has been known to underestimate even with fall-out from Nevada A-bomb tests. Their 13th Semi-annual Report to Congress in 1953 claimed that "the highest radiation level detected anywhere outside the Nevada proving ground was at a mine located nearby. Here, measurements showed a radiation level which would deliver an estimated dose of 1.75 roentgens during a lifetime". Yet in April, 1953, university scientists in Troy, N.Y., 2,300 miles from the proving grounds, detected "exceptionally high" radioactivity from a rain storm. (Science, 7th May, 1954.) At one "hot spot" on campus, radiation an inch above ground was 120 milliroentgens per hour after two days, enough to furnish the prescribed I.75r "lifetime

dose" in less than a day. And a man and woman from Utah have brought suit against the government for $200,000 for falling out of hair, peeling of skin and fingernails, and recurrent nausea allegedly caused by radioactivity from last spring's Nevada tests (New York Times, 5th May, 1954). If these claims are substantiated — and a similar accident involving cattle from the first A-bomb test makes them plausible — dosages of at least 100r are indicated. In view of these facts, and because radioactive dust may remain in the atmosphere even for years before settling out, Strauss's remarks appear more like a time-honored recipe than an attempt to evaluate the situation at hand.

Strauss ends his statement with a tribute to "the men engaged in this patriotic service" and the heartening prospect that,

"one important result of these hydrogen bomb developments has been the enhancement of our military capability to the point where we should soon be more free to increase our emphasis on the peaceful uses of atomic power at home and abroad. It will be a tremendous satisfaction to those who have participated in this program that it has hastened that day".

Strauss seems unaware that long before atomic energy enriches the life of man (atomic power is promised to us by 1975 at the earliest) — and intensifies the already critical problems of radioactive waste disposal (15) — the health of all of us may be ruined by "experiments". Yet the real irony is that the experiments do not even "hasten that day". They are not simply a temporary unpleasantness which will soon be over with, but will go on indefinitely (as the AEC has assured us) thereby diverting vast resources from "peaceful uses of atomic power". And does the information gained about thermonuclear phenomena contribute to "peaceful uses"? Eminent physicists (see Supplement, §3) have pointed out repeatedly that the thermonuclear reaction has only one possible use. In the words of Otto Hahn, discoverer of nuclear fission:

"The particularly unpleasant thing about the hydrogen bomb is that it will never be possible, as in the case of the fission of uranium, to utilize the nuclear of the hydrogen reactions for peaceful purposes. We can reach the temperature of 20 million degrees or more only for millionths of a second and not for any length of time. A 'controlled reaction' is not possible. The same nuclear reactions which have been going on in the sun for millions of years and which yield the energy forming the basis of our life on this earth, become in the hands of man simply a means of destruction and nothing more." (New Atoms, Elsevier, 1950.)

This concludes our examination of the "official" explanation of the events following the 1st March explosion. The AEC carefully safeguards the personnel at its installations with an array of radiation counters, dosimeters, blood checks, lead vaults, even ten-ton windows.

The U.S. Navy ships at the recent “tests” had special sprinkler systems in readiness to wash overboard any fall-out before it could settle on deck (and these were needed!). Not a microcurie shall escape detection at Oak Ridge. Yet, displaying one of the most remarkable double standards in history, the AEC unleashes many megacuries of dangerous activity on the world and tells us there is not the slightest cause for concern. Victims with appalling syndromes become models of fitness, and beta-ray reddening of the skin becomes the high color of robust health before the magic wand of Admiral Strauss. In view of the record of misrepresentation, can we trust these men to tell us the truth?

It is not alone Strauss, or the AEC, who are responsible. The “testing” of nuclear weapons has long left the realm of a routine military operation; rather it must be considered national policy, with purposes quite divorced from the gathering of information. What the forces are that compel American ruling circles to e age in this H-barbarism will be discussed in the second article; relevant for us here is the observation that the hydrogen explosions are in the deepest essence of America’s current role. They cannot be abandoned without abandoning a good deal more. That is why not only the AEC, but our statesmen, the kept scientists and the respectable press stretch the truth beyond all limit to keep the apprehension of the American people below the level where it will upset the applecart. That is why the Reporter calls the hydrogen bomb “a big bang in the empty reaches of the Pacific” and Sen. Hickenlooper announces, in contradiction to physical theory, that the fusion reaction can be controlled for power. And that is why a new concept of morality is foisted upon us — a morality which permits any horror to be perpetrated, so long as it is accompanied by appropriate incantations about “deterring aggression”.

3. Radiation and the Race

Thus far we have dealt mainly with the short-range effects of the hydrogen explosions, notably the injuries to several hundred Asians by large doses of ionizing radiation from fall-out. We have pointed out that high-level irradiation produces deadly injury. But what about the much lower levels of radiation, which are nevertheless well above normal background radioactivity, spread throughout the whole world by the bombs? When background radioactivity “five to ten times normal” was detected in New York, should that have been reason for concern? According to the New York Times of 19th June,

“The Kings County Medical Society’s public health committee has recommended legislation to restrict atomic and hydrogen bomb experiments. Explosions thousands of miles away endanger New Yorkers, the committee reported yesterday. . . .”

Many similar warnings have been sounded. By way of orientation several such statements

from authoritative sources may be given. A UP dispatch of 2nd April reports:

"The Federation of American Scientists said the 1st March explosion means 'that current tests may be approaching orders of magnitude where close control not only becomes difficult, but effects in fact may become incalculable' . . . it added that the consequences of living things of the radioactivity involved 'can hardly even be estimated from presently available data'."

A UP dispatch of 7th May said:

"A leading California scientist said to-day that the low, but increasing level of

radioactivity may pose a threat to the health of millions of persons. 'During the last ten years, man has deliberately increased the amount of high-energy radiation in the world by an enormous amount' said Dr. Albert W. Bellamy [University of California professor of biophysics]. 'Concurrent with this has been a corresponding increase in the number of persons potentially exposed to these radiations. We have not lived long enough with radiation to know yet just how much long-continued, low level radiation —both internal and external — we can live with without injury. Radiation exposure is extremely insidious. None of the human senses can detect it. The effects of radiation exposure may not show up for weeks, months, or years' [said Bellamy, who is also chief of the State Division of Radiological Services]."

This dispatch also informs us that "Dr. Gordon Fitzgerald, university X-ray expert, said recently careless use of X-rays had lowered the life expectancy of dentists to fifty-six years, about ten less than normal". Since the gamma rays from radioactive substances affect the human body in precisely the same way as X-rays, it is not only dentists who need take notice.

The Manchester Guardian of 4th May reported that "fifteen teachers and research workers in London University" sent a letter to Sir Winston Churchill saying:

"We … feel compelled to write to you in view of the incalculability of the effects of the present series of experiments with hydrogen weapons . . . the distribution of radioactive products from such explosions cannot be accurately predicted, and the serious danger to health which would occur if any quantity to radioactive material should fall in a populated area must not be underestimated."

Alexander Haddow, Director of the Chester Beatty [Cancer] Research Institute in London

wrote to the Times, 30th March:

"It has long been the anticipation of many scientists, increasingly perturbed by the biological implications of the development of atomic weapons, that sooner or later the world would be confronted by the need for a radical decision, involving nothing short of the international prohibition of nuclear explosions, if the gravest results were to be prevented. Your leading article of 26th March [suggests] that the crucial moment is now upon us. Recent events in the Pacific, with their demonstration of the powers of the hydrogen bomb for limitless annihilation, at once bring to an end the notion that the area of danger can have any but relative meaning. If we are entering the realm of the incalculable the likelihood of ultimate disaster grows steadily greater . . . . [The bomb's physical destruction], although vast, is so far limited, and the subtler menace — potentially limitless and cumulative — arises from the liberation of radioactive products, and from their immediate, delayed, and remote effects. Of the first we have had an account from the skipper of the Fukuryu . . . . The second also are now well recognized, from the work of the ABCC, in an increased incidence of leukemia [among A-bomb survivors]. The third are genetical and racial, and it is a measure of the unexpected speed of recent developments that these now bulk rather less in preoccupation in relation to the problems of world survival itself."

We already know the AEC's attitude toward these problems. As U.S. News and World Report, 9th April, expresses it:

"The theory had been widely held among scientists that radioactivity could be gradually raised to dangerous levels by repeated H-bomb explosions. The AEC now is attempting to knock it down, insists that this danger is infinitesimal and nothing to worry about,"

What about the great quantities of carbon 14 generated from atmospheric nitrogen by an H-bomb explosion? This element emits beta particles with a half-life of 5,100 years, and enters the carbon cycle, thereby to mingle with all living things. What is to be the ultimate fate of the megacuries of fission products now in the sea and atmosphere, and also in the waste disposal vaults of the atomic installations? The only agency which can eliminate the blight of strontium 90 and cesium 137 – which nature apparently never intended to be on this earth – is time: centuries for these elements alone. Chlorine 36, potassium 40, and plutonium 239 remain with us, to all practical purposes, for eternity. These are facts of life, and it is difficult to see how the AEC plans to "knock them down". On the other hand, there is a wealth of experimental data underlying the scientists' warnings against increasing the background radiation.

Before the atomic age, human beings received a small quantity of ionizing radiation, mainly

from cosmic rays originating in outer space, and carbon 14 and potassium 40 in the body. The Effects of Atomic Weapons estimates this quantity at about 0.003r per week, or less than 10r in a 60 year life span. This is the radiation level with which the human race has, over geologic time, reached equilibrium. The currently accepted "tolerance dose" is one hundred times this or 0.3r per week. Not many years ago 0.1r per day was considered safe. What is a "safe" dose, from the long-range point of view? Boche, as a consequence of low-level radiation experiments on animals, conjectured a few years ago that an appreciable decrease in the life span of humans may be expected from exposure to 0.1r per day. E. Lorenz, an eminent radiologist, and co-workers have discovered a number of striking results. In one experiment, 0.1r/day induced a rare mammary gland tumor in at least 20 per cent of irradiated female mice, with 0 per cent in the controls. (16) Another strain exposed uniformly to 0.1r/day until natural death showed 60 per cent incidence of ovarian tumor with 12 per cent incidence in the controls. (References in Furth and Upton's article in Annual Reviews of Nuclear Science, Vol. 3, 1953.) As Furth and Upton point out, "the high sensitivity of the ovary to ionizing irradiation has been amply confirmed by recent studies". In fact Lorenz, on the basis of experimental results, has indicated that an increase in the incidence of ovarium tumor in the human female may be expected beginning with an accumulated total-body dose of 100r (which would be got in less than seven years at the 0.3r/week rate). He has suggested that in women, at least, the maximum exposure(be limited to 0.02r/day. And R. M. Siovert of the Caroline Institute in Stockholm has suggested 0.01r/day for men and women alike. The 0.3r/day tolerance level is subject to criticism on other grounds. Thus Brues and Sacher, at the Symposium on Radiobiology at Oberlin College in June, 1950, remarked that:

"Calculations . . . using empirical constants deduced from mouse and dog survival data, indicate that a continuously accumulated tolerance dose might decrease the human life span by ten per cent."

(This, and other material, which we shall quote from the Oberlin Symposium, has been published in Symposium on Radiobiology, John Wiley, 1952). Other data, difficult to evaluate, has accumulated regarding obscure blood changes from chronic exposure. For instance, Ingram and Barnes (AEC Document UR-137, 1950) reported lymphocytes with bilobed nuclei in cyclotron workers and in experimental animals exposed to doses of neutrons considerably below the tolerance values.

What follows from all this? One cannot with certainty make inferences about the effects on human beings from animal experiments. But having lived for only a few years with increased background radiation, we are forced to base ourselves on this data. Obviously, the entire atomic program comes into question on this basis.

We come now to the most subtle, but what is in the last analysis the most important, of the biological effects of ionizing radiation: the effect on genetics. Contrary to some popular belief, this effect does not manifest itself in a proliferation of freaks and monsters. (17) In fact, even when pronounced genetic damage has been effected upon a race, this damage is quite difficult to isolate, although very real suffering is inflicted upon many individuals, and long-range statistics will eventually show clearly the decline of the race. The very subtlety of the process and its extension in time make it a perfect candidate to be ignored by those who, for instance, adopt complete disintegration of an island as a minimum standard of damage. On the other hand, the cumulative and irreversible nature of the process make it imperative that the danger be realized in time. Fortunately, men of the highest scientific competence have given clear warning of this danger.

Mutations occur spontaneously in the genes of the human germ cells, at a rate which is quite constant, and in equilibrium with the existing birth rate. H. J. Muller, a leading biologist and Nobel Prize winner, has calculated (Amer. J. Human Gen. 2, 111 (1950)) that the human race is in such a precise balance with respect to genes which produce defectives, that an increase of even 25 per cent in over-all mutation rate would produce a progressive and inevitable decline of the human population over a long period.

Qualitatively, it is not hard to see why an increase in spontaneous mutation rate will lead to decline. Well over 99 per cent of mutations are harmful. Some mutant genes are so harmful that they are not even compatible with life and will kill the offspring to which they are transmitted. Most mutant genes are only mildly harmful, but

“Each mutation received by an offsring results, on the average, in the genetic death of one descendant . . . no matter how slightly detrimental the effect of the mutant gene may be. This paradoxical result is a consequence of the fact that the less detrimental genes will tend to accumulate so as to hamper ever more individuals, until they make their ‘kill’ and so become eliminated. For this reason the total harm done by a small mutation is in the end as great as that done by a large, fully lethal, mutation. (H. J. Muller, Oberlin Symposium).”

Thus, almost every mutant gene is a “genetic time bomb” which will eventually eliminate itself from the population by causing a “genetic death” (ie., an individual who does not reproduce himself) — possibly many generations in the future.

Most mutant genes are recessive but, as Muller points out (Oberlin Symposium), even a recessive from only one parent produces some very slight deleterious effect, and so behaves in that case like a dominant of much lesser effect.

The connection of all this with radioactivity is that ionizing radiation induces spontaneous gene mutations. This fundamental discovery was made by Muller about twenty years ago. The mutations so induced are precisely of the same kind as those which occur naturally, only the rate is enhanced. A remarkable and most unpleasant fact is that, in the words of Professors L. C. Dunn and T. Dobzhansky, eminent Columbia University zoologists:

"There is no such thing as a 'safe' dose of radiation; the number of mutations induced is simply proportional to the amount of radiation reaching the sex cells, and if a person is exposed daily to small amounts of the rays, these small amounts may add up to very dangerous sums." (Heredity, Race, and Society, New American Library, 1952.)

Dunn and Dobzhansky go on to say:

"We must, then, do all in our power to diminish the number of defective mutant genes being added to the gene pool of human populations. Unfortunately, the progress of modern science and technology has so far accomplished the exact opposite — the rate of origin of harmful mutations is likely to become very much increased. . . . The release of atomic energy, either for constructive or for destructive ends, will expose to mutation-inducing radiations even greater numbers of people. . . . Misuse of atomic energy may result in eventual harm to mankind which is fearful to contemplate . . . defective genes introduced into the human gene pool will be doing their gruesome work in a slow but remorseless way."

Although the full impact of extensive gene damage is not felt until long into the future, even first generation offspring are endangered. H. K. Plough of the AEC's Biology Branch wrote in Nucleonics, August, 1952:

"[This] suggests that the offspring of a man or woman whose germ cells receive a single dose or an accumulated dose of 80r radiation (or possibly as little as 30r) may be expected to show a 100 per cent increase in mutations over the number which will appear anyway. The hazard of even a slight increase in the number of deficient or malformed offspring, which is what an elevation in mutation numbers would entail, constitutes a problem worthy of serious consideration for every individual subjected to radiation exposure of the germ cells.

"We cannot contemplate with equanimity an increment in deficient individuals or in the 'genetic death' of the unborn . . . radiation hazards cannot be neglected for human beings even though they are not immediately apparent to the individual receiving exposure."

If Muller, one of the world's leading experts on radio-mutations, considers a 25 per cent increase in the mutation rate dangerous, and 30 to 80r is a dose that would double the rate, one cannot contemplate with equanimity the smallest unnecessary exposure. A recent editorial in Nucleonics remarked that it is a widely held belief that 8r delivered to the whole population might cause serious genetic damage. S. Wright (J. Cellular Comp. Physiol. 35, Supplement 1, 1950) estimated that as little as three roentgens might double the mutation rate! (18)

To deal comprehensively with the fullest genetic implications of increased radioactivity would carry us beyond the scope of the present article. Muller, in the cited Oberlin Symposium and BAS articles, two long articles in The American Scientist, January, 1950 and July, 1950, and in other publications, has dealt very elaborately with the possibility of decline of the race from this cause. Reading these articles is strongly urged upon all, and must be part of the intellectual equipment of every socially conscious individual in his consideration of atomic questions. Aside from safeguarding our own children and grandchildren, social consciousness requires that we prevent harmful effects which "slight in any one generation, would, as it were, pile up layer on layer", towards a new equilibrium in which the whole biological level of the human race had been lowered; because they are hidden from us by veils of space, time, and circumstance". Given its present course, the human race cannot do otherwise than undergo this gradual and irreversible decline — unless, of course, the shorter-range catastrophes inherent in the hydrogen age efface all of us long before that time.

4. Conclusion

We have now seen that a disaster of considerable proportions took place with the recent hydrogen "experiments": serious injury was inflicted upon hundreds of individuals, obvious harm was done to the environment, and dangerous processes whose end effects cannot yet be predicted have been set in motion. It is to be expected that similar deleterious effects will follow future hydrogen explosions, regardless of what "precautions" are taken, because no "precaution" can keep a neutron from entering a nitrogen nucleus, nor direct a radioactive particle in the stratosphere not to settle in someone's lung. The "danger area" is the earth.

What follows from this? What answer can the American people give to their United Nations delegate, when he says that America must explode hydrogen bombs as long as Russia does? The answer is simplicity itself: America must stop its explosions regardless of what Russia does. The bestialities perpetrated within Soviet borders are many. If one of these happens to be the explosion of hydrogen bombs, to the detriment of all humanity, so much the worse for us all. But to answer this crime against humanity with larger and more frequent

explosions only intensifies the jeopardy of the human race. July 16th, 1954.

(To be continued)

SUPPLEMENT

1. Whence the Bomb?

The decade from 1895 to 1905 saw such fundamental discoveries as natural radioactivity, X-rays and Einstein's special theory of relativity — which among other things propounded the revolutionary thesis that mass and energy are equivalent, being only different manifestations of one and the same fundamental physical entity. Surely the early investigators could not dream of the development that was to unfold in the next half-century from these beginnings. In particular, the equivalence of mass and energy seemed for many years a mathematical fiction; and although Einstein's celebrated equation $E=mc^2$ (where c = velocity of light = three thousand billion cm/sec.) implied that vast quantities of energy are latent in even a small mass (e.g., twenty-five billion killowatt hours in a kilogram), means for liberating this energy were unknown. But knowledge of the atomic nucleus advanced rapidly in the twentieth century, and a particularly brilliant period of new achievements in the 'thirties culminated in 1938 in the discovery of uranium fission by Hahn and others. In this process a uranium nucleus, when bombarded by a heavy uncharged particle called a neutron, captures the neutron and splits into two lighter nuclei, accompanied by the release of several neutrons and the conversion of a small part of the original mass into energy in accordance with the above. This suggested the possibility of producing a chain reaction in a piece of uranium, although to be sure many difficulties had first to be overcome. In any case, the implications for construction of a nuclear bomb were widely recognized, and with the coming of world war further developments were cloaked in military secrecy. The first chain reaction was produced in Chicago in December, 1942. Then in 1945, only seven years after the discovery of fission, and forty years after the abstruse considerations of Dr. Einstein, atomic physics intruded itself shatteringly upon the consciousness of the world when the city of Hiroshima was laid waste by a nuclear explosion.

2. The A-Bomb

This weapon tends to be neglected in current discussion (unreasonably so, for now that the general level of public horror has been raised sufficiently to accommodate the H-bomb, the use of at least A-bombs in future warfare has been virtually assured). A critical mass of fissionable material is the least mass sufficient to sustain a chain reaction, and will explode spontaneously. The A-bomb, in its most primitive form, consists of two subcritical masses of fissionable material (either U-235 or plutonium), whose aggregate mass exceeds the critical.

Critical mass has been estimated by Professor Oliphant at from twenty-two to sixty-six pounds. For detonation, these component parts are brought together rapidly and a stray neutron, certain to be present, initiates a chain reaction. More than two components can of course be used, but the necessity of bringing them together simultaneously with great rapidity limits their number sharply in a practical bomb. Hence the amount of fissionable material used in an A-bomb is inherently limited to several times critical mass, and the explosive power obtainable is correspondingly limited. The Hiroshima bomb had an explosive force equivalent to 20,000 tons of TNT. (The largest bombs of World War II used ten tons of TNT.) Modern A-bombs can be made more powerful, due mainly to more efficient utilization of the fission reaction. Ralph Lapp credits President Eisenhower with having stated that A-bombs twenty-five times as powerful as the Hiroshima bomb are now available. Lapp has also estimated that America now has a stockpile of "thousands of A-bombs" (Reporter, 11th May, 1954).

3. The H-Bomb

The H-bomb operates on a principle quite different from nuclear fission, namely that of thermonuclear fusion. At temperatures of millions of degrees fast moving nuclei of light elements may collide and "fuse" into a single nucleus of a heavier element, a fraction of the aggregate mass being transformed into energy in the process. A typical reaction of this kind is the fusion of a tritium with a deuterium nucleus to form a helium 4 nucleus plus a neutron plus 17.6 million electron volts (MeV) of energy. To raise the light nuclei to the necessary temperature an ordinary A-bomb is used as a detonator. Whereas the A-bomb is limited in power by the above-mentioned criticality considerations, no such limitations apply to the H-bomb. The nature of the fusion reaction (and the ready availability of hydrogen and lithium) make it possible and even relatively inexpensive (as these things go) to construct a bomb of almost arbitrarily great destructive power.

There is another significant difference between the two reactions: the fission reaction can be controlled in speed, thus making it theoretically possible to use the energy release as a source of power. The fusion reaction cannot, and thus its only possible application is building a bomb. Although it is believed that the stars derive their radiant energy from a continuous fusion reaction. This has been claimed by Bethe, Hahn and other leading physicists to be physically impossible on as small as scale as the earth. As R. F. Bacher, Physicist and former member of the AEC, wrote in the Bulletin of the Atomic Scientists (BAS) May, 1950: "There is no possibility that the energy release from this type of reaction can be controlled on the earth … On the earth these self-sustaining thermonuclear reactions will either give an explosion or nothing at all."

It seems difficult to reconcile this with rumors afoot recently of "peace-time applications." Sources from Sen. Hickenlooper to Harold Urey have "hinted" at applications. No details have been forthcoming. It appears that the only possible use of "astrophysical engineering" (Dr. Edward Teller's Phrase), aside from erasing humanity, is the construction of an artificial

star in space at some future time — just what the world is waiting for.

4. Radiological Warfare and the C-Bomb

Soon after the first atomic explosions, it was recognized that the cloud formed could injure life over a large area. Edward Teller wrote in the BAS, February, 1947:

"The radioactivity produced by Bikini bombs was detected within one week within the U.S. . . . The danger arising from the radioactivity [has] become evident by observations which have been made at widely separated places. . . . We have here a method of destruction which we cannot help noticing."

Due notice was taken, but the question arose: how can one augment the radioactivity of the fission products? The answer was found in the neutrons liberated by an atomic explosion. We have stated that neutrons can induce radioactivity in most elements. For instance, a pound of neutrons could, under ideal conditions, generate twenty-four pounds of radioactive sodium 24 or sixty pounds of radioactive cobalt 60 from the ordinary forms of these elements. Thus, one can "rig" an atomic bomb by adding to it quantities of an element which will be activated by the escaping neutrons. The conditions which an element must fulfil to be a candidate for this role are: (1) It must capture neutrons easily. (2) The resulting isotope should have a half-life sufficiently short so that the radiation emitted is quite intense. (3) The half-life should be sufficiently long so that the radioactivity will not he given up before reaching a target. (4) For best results, penetrating (gamma) radiation should be emitted. (5) The element should be fairly abundant.

The elements which best fulfil these conditions are cobalt and zinc. Radiocobalt is especially deadly, giving off intense gamma rays with a half-life of 5.3 years. If cobalt is added to even a medium-sized A-bomb, which generates, say, five pounds of neutrons, one has already a rather troublesome radiological weapon. Added to a twenty megaton H-bomb, one has in a single bomb the means to denude a continent of man and beast. Professor Harrison Brown, nuclear chemist at the California Institute of Technology, said in 1950 that if a cobalt bomb incorporating a ton of deuterium were detonated on a north-south line in the Pacific about a thousand miles west of California,

"the radioactive dust would reach California in about a day, and New York in four or five days, killing most life as it traverses the continent. Similarly the western powers could explode hydrogen-cobalt bombs on a north-south line about the longitude of Prague that would destroy all life within a strip 1,500 miles wide, extending from Leningrad to Odessa and 3,000 miles deep from Prague to the Ural mountains."

Actually, this does not tell the whole story for, in the words of Edward Teller (BAS, February, 1947): “One limitation to such kind of an attack is the effect of these gases on the attacker himself. The radioactive products will eventually drift over his country too”. Thus, the hydrogen-cobalt bomb (or “C-bomb”) is only usable as a universal suicide weapon. The manual of instructions that comes with the cobalt bomb says: “Set it off anywhere”. For this reason the AEC has not yet “tested” a C-bomb. Similarly, America does not rely on the cobalt bomb alone to deter aggression. Dr. Teller has suggested using a shorter-lived element to “rig” an atomic bomb. Zinc is a good candidate; radiozinc has a half-life just under a year. Surely a zinc bomb will be built by the AEC, if for no other reason than to have bombs from A to Z.

Quantitatively, what is the perspective for total annihilation? In 1950, with the advent of the H-bomb, came the dissolution of all moral as well as physical barriers to consideration of the final question: How can we destroy the race? The answer, as we have indicated, was found in the hydrogen-cobalt bomb, and some scientists worked out the arithmetic of annihilation. Professor Leo Szilard of the University of Chicago, a chief architect of the A-bomb, said:

“I have made a calculation in the connection . . . . I have asked myself: How many neutrons or how much heavy hydrogen do we have to detonate to kill everybody on earth by this particular method? I come up with about fifty tons of neutrons as being plenty to kill everybody, which means about five hundred tons of heavy hydrogen [about 400 fair-sized bombs — J.L.] . . . . [The necessary deuterium] could be accumulated over a period of ten years without an appreciable strain on the economy of a country like the U.S.” (BAS, April, 1950).

Dr. James Arnold, in the October, 1950, BAS concurs in the general validity of Szilard’s thesis, and estimates that, given the deuterium, 10,000 tons of cobalt might be sufficient to kill everybody. We may note that the U.S. currently consumes about half this amount annually, that it is currently stockpiling cobalt and, according to the recent Haley Report on national resources, the U.S. is expanding its cobalt stockpile and plans to “consume” 20,000 tons of cobalt annually by 1975. Of course, this fact is not of itself sinister. The chief uses of cobalt are in jet engines, rockets, guided missiles, armor plate, gun barrels, and radar components — and America might devote her cobalt stockpile to these ends, rather than to means of mass destruction. Yet once again, American policy is consistent with the worst of all possible future developments. Similar remarks apply to the other potential mass-killer, zinc: according to the New York Times of 8th April, the government recently announced it plans expansion of its zinc stockpiling program. Currently, American firms use about 60,000 tons a month of this metal, “plenty to kill everybody”.

The reader may now think the entire discussion has become academic; for no one would wish to build a cobalt bomb. Yet the New York Times of 28th March, under the heading Cobalt Bomb Being Developed for Radiation-Nerve (19) and Germ Warfare Studies, writes:

"Military science has or is devising a selective arsenal of weapons that could kill multitudes in a split second, minutes or years . . . . Behind the scenes, in obscure laboratories and proving grounds, scientists are working . . . improving techniques and devices for radiological, gas and germ warfare . . . Over-shadowed by the official announcements and speculation about the hydrogen bomb and the atomic bomb is the so-called 'C-bomb' . . . strategists foresee the possibility that in an all-out war situations might occur where there would be a need for other means (than the H-bomb) of incapacitating enemy troops or war workers or of rendering a big area [the earth — J.L.] uninhabitable for a period . . . . The natural 'fall-out' of radiated material from an atomic cloud, with its short life, would be inadequate. The problem is to keep alive, at a high level, the radioactive contamination. And in the mineral element cobalt military scientists are finding their answer."

Another cheerful form of radiological warfare is simply to spread radioactive products from a pile over an area. Thus, Hanson Baldwin, military analyst for the New York Times, has recently pointed out how fortuitous it is that we are accumulating these deadly wastes, since they can be dropped on people.

5. The First Use of the Bomb

The first A-bomb was successfully tested l6th July, 1945, at Alamogordo, New Mexico; the only two other models then in existence were thereupon whisked across the Pacific Ocean and dropped on Hiroshima (6th August) and Nagasaki (9th August). The way to Hiroshima had been paved with five months of air raids, starting with the great 9th-10th March jellied gasoline attack on Tokyo (alone killing 83,000) during which period 220,000 civilians had been killed and 3,000 houses destroyed (20); a quarter of the urban population, of 8,500,000 people, had been forced to migrate. Thus there was a certain continuity in the attack of 6th August upon the civilian population of a prostrated country. The James Franck report, submitted to the Secretary of War in June, 1945, by a committee of seven scientists and a simultaneous petition to President Truman signed by sixty-Four scientists (all of whom had worked on the bomb) urged, on humanitarian grounds, that it not be used directly. The Franck report (republished in the Bulletin of the Atomic Scientists, 1st May, 1946, with an editorial comment that the report "undoubtedly expressed the opinion of a considerable group of scientists on the project") suggested as an alternative that:

"a demonstration of the new weapon might be made, before the eyes of all the United

Nations on the desert or a barren island . . . . After such a demonstration the weapon might perhaps be used against Japan if the sanction of the United Nations (and public opinion at home) was obtained after a preliminary ultimatum to Japan to surrender. . . . We believe that these considerations make the use of nuclear bombs for an early attack against Japan inadvisable."

Aside from these pleas it was known that the Japanese economy was on the verge of collapse because of the blockade and the air raids, and that Japan had already attempted to negotiate a surrender via the Pope. (21) Against this background, all clap-trap about "saving a million American lives" notwithstanding, the frenzied haste with which the newly completed weapon was employed, especially the repeat performance at Nagasaki, leaves an impression that the American military were only afraid lest the Japanese surrender too soon and thereby preclude employment of the bomb. If this impression seems fantastic, it does not seem so to a great many Japanese, who feel their people were used as guinea pigs—and this should be borne in mind in understanding their reaction to the recent H-bomb tests. At Hiroshima a U-235 bomb was dropped; it annihilated completely 4.4 square miles of the city, killing eighty thousand people, and injuring nearly an equal number. At the Nagasaki experiment a plutonium bomb was tried; a 15 per cent. Greater radius of destruction was achieved, although "only" thirty-five thousands were killed, with an equal number injured. (These are official figures; yet John Bugher of the AEC's Division of Biology and Medicine wrote in Nucleonics, September, 1952, that the fatalities from the two bombs "probably exceeded 200,000" and, as we have pointed out, delayed casualties have continued up to the present day.) These "live" testing grounds have provided the Atomic Bomb Casualty Commission with a wealth of material which its staff of 900 has continued to study diligently over the years, and much of what is known today concerning the effects of atomic weapons is based on "The Japanese Experience".

Let us emphasize that, in this first decision concerning the use of nuclear weapons, the most extreme of all possible alternatives was taken; this, as we shall see, has been true of practically every subsequent decision in the atomic program: always the opposition has been successfully overridden by the most extreme elements.

6. Bikini, 1946

Although the recommendations of the James Franck report were disregarded, the suggested idea of exploding the weapon on a "barren island" did, however, appeal to the military — and less than a year after Nagasaki they embarked on a long series of adventures by "testing" several bombs at Bikini in the Marshall Islands (which had first been rendered "barren" by the simple expedient of uprooting some 160 natives and shipping them to another atoll). These very first Bikini tests, conducted in the summer of 1946 by the U.S. Navy (ostensibly to determine the effects of atomic bombs on ships) produced some reaction which is interesting when viewed from hindsight. There was widespread protest in

the United States against inaugurating the new era of peace on such a note; Senators Hoffman, Lucas and Walsh among others urged on the Senate floor that Truman abandon the tests. Particularly prophetic (and radiating as well a freshness that one no longer sees in the utterances of our scientists) are the words of Dr. Lee Du Bridge, (22) a leading physicist and president of the California Institute of Technology, some of whose remarks in the May 15, 1946, BAS we quote:

[The results] would not make a ripple on the surface of basic nuclear science. The study of nuclear fission will not be advanced one iota by all these figures. The value to pure science will be nil . . . it is said that there are a thousand or so technical people participating. Many no doubt look forward to the trip and to seeing the explosion . . . [but] how the universities need these men now for their overcrowded classrooms and undermanned research staffs! . . . No doubt hundreds of secret reports will be written on the variation with distance from the impact point of the damage done to masts, to gun turrets, to tanks and trucks and radar and rabbits and field kitchens. There will be profound studies of why ship A was sunk and ship B was not. . . . The enormous and intensely radio-active cloud that arises from an atomic explosion is a terrifying thing. It is completely subject to the whims of meteorology. Who could say that a sudden rainstorm could not precipitate dangerous quantities of this material onto one or more of the ships packed with observers? Or might not a cloud of this lethal dust be carried hundreds of miles and deposited on unsuspecting inhabitants? The surface burst will raise a great cloud of water spray and where it be carried? . . . the dangers . . . may be remote — but I know experts who are participating in the tests who are worried about one or more of them . . . And how will the results of the tests be represented to the American people? Regardless of what the results are they will stimulate exaggerated claims and counter-claims. 'The Navy is invulnerable!' 'The Navy is obsolete!' 'Armies are useless!' 'We must have universal military training!' . . . Are international relations to be improved by these tests? Not even the greatest enthusiasts for them have claimed this [that was 1946; to-day, with the complete triumph of the 'peace through terror' ideology the 'enthusiasts' from Eisenhower on down have claimed this — JL] . . . I will say only that at this critical hour they are in poor taste." (All emphasis added.)

It is interesting to see how accurately the main elements of the present H-bomb issue are foreshadowed in these remarks. But of course the tests took place, complete with 42,000 men and half the world's supply of photographic film, and the Army-Navy Joint Chiefs of Staff could report such observations as: "The second bomb threw large masses of highly radioactive water onto the decks and onto the hulls of the vessels. These contaminated ships became radioactive stoves and would have burned all living things aboard them with invisible and painless radiation".

This second bomb was indeed quite a phenomenon; it was detonated beneath the surface of the lagoon, and threw up millions of tons of water to a height of about a mile. Because the fission products and neutrons were all entrapped by the water, the contamination was

severe and the huge fleet of “target ships”, from the venerable Saratoga to the sleek Prinz Eugen had to be deliberately sunk after the test for this reason; and a third test “shot” was cancelled. The AEC wrote in its 1950 publication The Effects of Atomic Weapons that within a week most of the fission products had settled to the bottom of the lagoon, covering an area of over 60 square miles. Dr. David Bradley, in No Place to Hide, had described extensively the nature of the contamination produced. Let us give only a few quotations:

“these ships are fouled up with radioactivity to a degree far greater than anticipated… there is a real hazard from elements present which cannot be detected by the ordinary field methods [mainly plutonium — J.L.] . . . . Of the fish caught on the lagoon side of the reef, all showed considerable radioactivity . . . . What is true of the reef fish will now become increasingly true of the larger migratory fish — the tuna , the jacks, the sharks, and so on — as the latter, the predatory fish, eat more and more of the smaller fish who are sick with the disease of radioactivity [and hence easier to catch]. We know that this process is going on. Almost all seagoing fish recently caught around the atoll of Bikini have been radioactive . . . .”

7. The Later A-Bomb Tests

Similar tests followed through the post-war years both at Eniwetok atoll in the Marshalls and at Yucca Flat, Nevada. These achieved on the whole no great notoriety, and the public learned to accept such activities as a part of daily life — although attention was occasionally focused on such incidents as the breaking of windows in Las Vegas, the falling of radioactive rain and snow in Eastern cities, and the fogging of photographic film. Of course, the Eniwetok tests, like the Bikini, involved the deportation of the native inhabitants and the spoliation of the atoll.

Up to 1st March, 1954, there had been reported in the world some fifty-five atomic explosions together, including four or five in Russia and a few British bombs. The great majority were detonated by the AEC in seven series of tests: Spring 1948(Eniwetok), Winter 1951 (Yucca Flat, Nevada, sixty-five miles from Las Vegas), Spring 1951 (Eniwetok), Fall 1951 (Nevada), Spring 1952 (Nevada), Fall 1952 (Eniwetok) and Spring 1953 (Nevada). The Spring 1951 and Fall 1952 tests included thermonuclear weapons, and at the Spring 1953 tests the first shell bearing an atomic warhead was fired, from a mobile 280 mm. cannon. In addition to detonating weapons some of the tests also served to acquaint troops with the realities and manuœuvres of atomic warfare, and to test bomb effects on buildings, ships, mice, dogs, monkeys, etc. Possible damage to the environment by radioactive contamination had been discussed from time to time, but the danger was not considered great. Yet several incidents of some interest had occurred. Fall-out from the original A-bomb blast at Alamogordo had injured cattle ten to fifteen miles away. This first blast also resulted in the fogging of photographic film in Indiana. Sienko and Cocconi of Cornell University’s

Laboratory of Nuclear Studies, in referring to a beta-emissive speck detected in England in 1952, said: “This kind of speck is probably due to radioactive dust produced by nuclear explosions and carried away by the winds. Undoubtedly many more cases similar to this will be found . . . because radioactive dust is already spread everywhere in the world”. The Canadian Journal of Physics 30 (1952) reported that radioactive fission products from a Nevada explosion in January, 1952, fell on Ottawa two days later and again two weeks later. A French scientific journal (Comptes Rendus hebd. Acad. Sci. 235 (1952)) reported that from December, 1951, to June, 1952, radioactive dust from Nevada explosions had fallen on Paris. In America mild degrees of fall-out and radioactive precipitation were commonplace to the occasional consternation of scientists engaged in low background radiation experiments. At least three cases were reported of precipitation emitting radioactivity approaching dangerous levels; these cases were recorded by independent investigators at Helena, Montana (reported in Nucleonics), Chicago, Ill. (Chemical and Engineering News, 16th June, 1952), and Troy, N.Y. (already mentioned). A typical reaction to these disclosures is that of a Chicago chemist who, in a letter to Chemical and Engineering News, expressed concern over the Chicago rainout. His letter (published 25th August, 1952) goes on to say:

“It appears that the U.S. is being covered intermittently with radioactive dust of dangerously high activity as far as 1,000 miles from the place where the dust is generated. It is also evident that those in positions of responsibility are glossing over these facts with glib assurances that all is well. . . . Let us not be so afraid of a backward enemy that we are willing to poison man, dog, woman and child to get a military advantage.”

The AEC replied to him in the same issue with glib assurances that all was well.

Although our interest covers all nuclear explosions, we have been discussing so far those conducted by the U.S. This is natural, since the great majority of the bombs have been detonated by the U.S. About Russian explosions almost nothing is available, and we are dependent upon microscopic disclosures by American military intelligence for information on this subject (presumably because detailed information might prove valuable to the Russians). We have been told that Russia detonated an H-bomb in August, 1953. The British have held A-bomb tests in the Montebello Islands (off the Australian coast) and at Woomera similar to American tests at Eniwetok. One aspect of the test in the Montebello Islands in the summer of 1952 may be noted here: Although British officials claimed the islands were barren and uninhabited, Australia’s leading ornithologist pointed out that there were over twenty species of birds and several mammals living on the islands, including a pipit and a kangaroo found nowhere else. What has been the fate of these animals is not clear. Churchill, in replying to a query on this subject from an MP assured him that every effort had been made to “inconvenience them as little as possible”. We presume it is picayune to be concerned with the annihilation of wild creatures in an age when humans are slaughtered on an unprecedented scale; yet there was a time when men who called themselves scientists

did not wantonly destroy rare and interesting specimens of nature.

8. Birth of the H-bomb (23)

In September, 1949, President Truman announced that the Russians had exploded an atomic bomb. Allegedly on these grounds, he announced in January, 1950, that he had instructed the AEC to develop the "super bomb". (We may note that years later, after Russia had been credited with exploding an H-bomb, Truman said he was not convinced Russia had even an A-bomb.) To be sure, a great deal of soul-searching preceded the decision of January, 1950. The inner circle of atomic energy officialdom had been divided on the H-bomb program, with the preponderance of opinion against it. The AEC opposed it three to two, and the nine-man General Advisory Committee to the AEC (including eight eminent scientists) opposed it unanimously on a combination of moral, tactical, scientific and financial grounds. The opposition included such distinguished figures as Oppenheimer, Lilienthal and Henry Smyth (author of the famous Smyth Report). But the H-bomb had its champions, notably Lewis Strauss who, in the words of a laudatory editorial in Iron Age "set up a howl for the H-bomb that reverberated around the AEC and to the White House". Strauss received strong support from Secretary of State Acheson, Defense Secretary Johnson and Sen. McMahon. Truman, true to the tradition of his A-bomb decision of 1945 and Bikini decision of 1946 (and to the principle of "the triumph of the extreme elements" which we have enunciated), gave the order to proceed, and the scientists dully embarked on a new "crash program". Ideological justifications were of course invented as needed to allay public malaise and soothe bad consciences. But for all that, the program was generally viewed with trepidation. The Bulletin of the Atomic Scientists published in 1950 some sixteen articles on the H-bomb by leading physicists; and although none of them directly renounced Truman's decision many anxieties were expressed and the destructive possibilities frankly and terrifyingly set forth. Einstein wrote:

"The ghostlike character of this development lies in its apparently compulsory trend. Every step appears as the unavoidable consequence of the preceding one. In the end there beckons more and more clearly general annihilation." Twelve physicists signed a statement requesting of the American government "a solemn declaration that we shall not use the bomb first". In addition to "solemn declarations" other scientists called for "top level disarmament conferences", "outlawing the bomb", "international controls", etc. — proposals which had long ago exhausted themselves, but which nevertheless revealed, in the timid idiom of these men, widespread apprehension. Oppenheimer said: "There is grave danger for us that these decisions have been taken on the basis of facts held secret… the relevant facts could be of little help to an enemy; yet they are indispensable for an understanding of questions of policy". Leo Szilard, referring to the difficulty of predicting the path of radioactive fall-out, said "on this aspect of the question, I would say that we leaped before we thought when we decided to make H-bombs". Here is the lament of Otto Hahn, the German who had discovered fission in 1938 and (like Gentner and von Laue) maintained

a strict silence about atomic bombs during the war years under Hitler:

"Remembering the effect of the atomic bombs on Hiroshima and Nagasaki in August, 1945, or considering the investigations at Bikini in 1946, one would think that mankind had already carried it magnificently far enough with the utilization of atomic energy for destructive purposes and that there would be no desire to add still more powerful ones to these means. Nevertheless this seems to be the case…. Pres. Truman has ordered the development and construction of the 'hydrogen bomb' to be officially begun in order to create a new weapon for keeping the world peace." (New Atoms, 1950.)

A number of scientists who acquiesced to the wisdom of Truman-Strauss gave up their chastity only "with some reluctance". Thus Harold Urey was "very unhappy to conclude that the H-bomb should be developed and built . . . but, with Patrick Henry, I value my liberties more than my life". On the other hand a refreshing singleness of purpose was shown by Dr. Edward Teller who, with his colleague Ernest O. Lawrence (inventor of the cyclotron), was eager to have an H-bomb. In an article Back to the Laboratories, Teller exhorted his fellow physicists to end their "honeymoon with mesons" and join him on the H-bomb project: "We must realize that plans are not yet bombs, and we must realize that democracy will not be saved by ideals alone…. The holiday is over. Hydrogen bombs will not produce themselves". In any case, the project was advanced and the laws of physics were co-operative. The Spring 1951 tests at Eniwetok (Operation Greenhouse) saw the successful detonation of two "crude and cumbersome thermonuclear devices". Both "shots" exceeded expectations. A more streamlined H-bomb was exploded at Eniwetok in November, 1952 (Operation Poison Ivy). During November, 1952, a good many sensational reports of the explosion "leaked" out to the public via letters written home by eyewitnesses and it was generally believed that an H-bomb had been tested. Official confirmation was only given, however, after a furore had been touched off by the effects of the 1st March, 1954, H-bomb. As has recently been revealed, the 1952 "baby" bomb produced a fireball 3.5 miles in diameter, annihilated an island of the Marshalls group, and ripped out of the ocean floor a crater a mile in diameter and 175 feet deep. The radius of total destruction was three miles, with "severe to moderate" damage out to seven miles.

9. Atomic Bomb and the Weather — Speculation?

There has been much speculation about nuclear explosions affecting the weather; this probably originated as early as Hiroshima, which shortly after the A-bombing was inundated by a typhoon killing early visitors to the devastated city. The wave of tornadoes and freak weather that swept America's East coast concurrently with last Spring's Nevada A-tests was bound to stir speculation, for the breaking of weather records in this case translated itself into hundreds of dead, thousands of homeless, and many millions of dollars of damage. Impressive was the coincidence behind the disclosure of an AP dispatch of 10th June, 1953,

that:

“Rep. Ray J. Madden, Democrat of Indiana, had asked that the House Armed Services Committee start a full inquiry into possible atomic effects on the weather.”

The investigation was not held because:

“Key [House] members said to-day they had been assured that atomic tests had not caused the series of tornadoes sweeping the country. . . . ’Atomic scientists told us [said Rep. Leroy Johnson of California] they consulted regularly with top weather observers and said the atomic tests are too small and restricted to have any effect on the weather’.”

One of the more striking chains of incidents followed the largest bomb in the series which was exploded 5th June at an altitude of six to eight miles. 8th June Arcadia, Nebraska, had a tornado killing ten people; 9th June Cleveland, Ohio, had its first tornado in twenty-nine years (killed eight, injured 300) and seven other tornadoes swept Michigan and Ohio on that day (killing 113). 10th June Exeter, N.H., was heavily damaged by storm, and Worcester, Mass., had a disastrous tornado, the worst in seventy-five years, killing eighty-five, injuring 700, and leaving 2,500 homeless; the Worcester tornado was accompanied by an unprecedented barrage of giant hailstones.

Abnormally high radioactivity was present in some of the more freakish precipitation. For instance, the highly radioactive rainfall at Troy, N.Y. mentioned before, accompanied “an unusually violent electrical storm … one of the worst flash storms to hit the area in recent years” and followed by thirty-six hours the detonation of a Nevada A-bomb. The year 1954 has again produced strange weather, sometimes with disastrous consequences, as in the weird flooding of the Danube river which has dispossessed over 70,000 people. The New York Times of 14th July wrote concerning this even that:

“The press continues to suggest that last spring’s hydrogen bomb tests in the Pacific may have been responsible for the floods. The argument is that stratospheric clouds of atomic dust resulting from the explosions possibly reduced the amount of sun’s rays reaching the earth enough to cause the heavy rains.”

Are these speculations in any sense valid? Is there a link between the flooding of the Rio Grande, Lima’s coldest winter in twenty-five years, and freak tidal waves in Lake Michigan? Is there validity in a Japanese scientist’s recent prediction that the world will have colder

weather (because of the obstruction of the sun's rays by the Marshall Islands)? This author does not claim to know. However, because our very lives, and it is no exaggeration to say the future of the human race, are intimately intertwined with the world's climate, these questions deserve the most serious consideration. Any communication on the subject would be welcomed by the author.

Some form of connection between atomic blasts and rainfall seems plausible. For instance, it is well known that ionized air molecules, such as are produced in the wake of a radioactive cloud, serve as nuclei for the condensation of moisture. In measurements reported by the French Meteorological Office, radioactivity curves of rainwater and atmospheric dust over a four month period (November, '51 — February, '52) reached peaks ten days after nuclear explosions, exhibiting in cases activity ten or twenty times normal.

Hubert Garrique, Comptes Rendus de l'Academie des Sciences (1951), purported to show by studying the distribution of condensation nuclei, which he claimed emerged from atomic explosions, that abundant precipitation in France at that time was attributable to these. An amateur meteorologist, J. O. Hutton, has attempted to show by similar considerations a link between the A-bombs and tornadoes of 1953 in the U.S. Published in Astounding Science Fiction magazine, April, 1954, the article does not appear frivolous. His weather data is well-documented, and the article may seriously be recommended to the attention of the readers. (24)

Because of these "condensation nuclei" considerations, connections between A-bombs and the weather cannot be discounted merely by the observation that the energy release of an atomic explosion is far smaller than the kinetic energy of a large air mass. Even aside from this, the blast itself (especially in the case of an H-bomb) is large enough to set off local windstorms, and one cannot content oneself with a routine assertion that so vast a dislocation in nature has not remote effects in space and time. Profound long-range effects are believed to have resulted from discharge of particles into the air by past volcanoes (Cf. Climatic Change, a most interesting book edited by Harlow Shapley, Harvard Univ. Press, 1953, pp. 90-103).

10. General Aspects of Radiation Injury

Alpha, beta, gamma, neutron and X-radiations are the most familiar of the ionizing radiations, so called because they produce ionization of atoms and molecules which they encounter. It is this property which is exploited in the Geiger counters for the detection of radioactivity. It is this same property which is responsible for the damaging effects of radiation on living tissue: the ionization sets in motion chemical reactions (as yet poorly

understood) within the cell. These may result, depending on the type of the cell and the dose, in inhibition of the growth and mitosis of the cell, damage to the chromosomes and genes of the cell (which in the case of a germ cell will also he passed on to all succeeding generations), impairment of the various functions of the cell, or the death of the cell. Because the nature of radiation injury is on the fundamental level of cell metabolism itself, and because different cells and different doses exhibit widely varying effects, it is to be expected that the macroscopic changes produced in the organism by irradiation will cover an enormous spectrum, and this is the case. Many volumes have been written describing observed a biological effects of radiation, ranging from osteogenic sarcoma to graying of the hair. Every kind of tissue, every bodily function, will be impaired by sufficient radiation, administered to the appropriate part of the body. There is, however, great variation in sensitivity; most sensitive are the lymphoid tissues which produce and store white blood cells; also very sensitive are the white blood cells, epithelial tissue, mucous membrane, small bowel, ovary and embryonic cells.

(1) This is the first of two articles dealing with the recent hydrogen explosions, and studies the damage they have wrought upon man and his environment. Historical and scientific background material is presented in the Supplement the end. The second article will go more deeply into the social implications.

(2) All dates without years refer to 1954.

(3) Robert S. Allen wrote in his Inside Washington column:

“The wind was not the cause of this accident. It was due to miscalculations on the size of the explosion and the consequent radioactive fall-out. That covered twice the estimated area.”

(4) This is in agreement with an INS account of 27th March that the 1st March fireball had a radius of complete incendiary destruction of fourteen miles. Looked at differently it suggests that the 1st March blast developed at least twenty megatons, tending to confirm the remark of the cited Pentagon observer that “all published estimates have been too conservative”. A more refined guess could be made on this basis, but one runs the risk of blundering upon “classified information”

(5) In a recently reported experiment with rabbits who merely watched an A-bomb explosion from fifty miles away, steam momentarily generated in the retinal fluid caused “a little localized explosion” in the eye tissues. When the eye is adapted to night vision, this danger is greatest. The damage is similar to the “eclipse burns” that some humans have

experienced. (AP., 23rd June, 1954.)

(6) Such facts do not impress Mason Sears, U.S. delegate to the U.N., who told that body 13th July:

“What has resulted from our tests is that one natural sandspit, uninhabitable for man or beast and without vegetation [this has since become true — JL.], and one man-made sandspit were destroyed — and that is all.” [Amen!]

(7) Robert S. Allen, reported in his Inside Washington column that:

“The exposed sailors and airmen . . . are receiving special medical care, and are under expert observation which will last for months, and possibly years.”

As Allen points out, this is not cause for concern. On the contrary,

“the extensive fall-out is proving a ‘blessing in disguise’. It is affording U.S. authorities the opportunity to conduct medical and other studies of momentous significance. They were made possible through the accidental exposure of twenty-eight men of the Navy and Air Force to . . . [radiation] five times more than any other living Americans have experienced. This opened the way for the studies the scientists had never before been able to undertake on human beings.”

(8) The distinction between “dose” and “exposure” and a few other technical niceties are overlooked in the interests of simplicity.

(9) This quantity of plutonium will deliver to certain “hot spots” in the bones alpha bombardment estimated as biologically equivalent to 5 or 10r per day. A sarcoma induced in such a spot, however tiny, is generally fatal.

(10) For comparison, all the radium ever produced has an activity of several curies.

(11) The London Times, 8th April wrote:

“According to Japanese medical men [who are treating the twenty-three fisher-men] the condition of all twenty-three is still deteriorating. Dr. Nakazumi said that the white corpuscle counts of the patients were still decreasing. Even if their white corpuscle counts improved, said Dr. Nakazumi, they might never be able to do strenuous work again.”

(12) This vocabulary has many practitioners, e.g. Sen. Pastore and Rep. Holifeld of JCAE reported (AP, 19th March) that the Americans and natives were “normal, happy and in the best of spirits”.

(13) Numerous drugs are known to retard death following acute irradiation.

(14) The New York Times, 14th July, wrote:

“The U.S. said to-day [in the U.N.] it was limiting economic aid for inhabitants of the Marshall Islands for fear that they might consider themselves its wards. . . . [Frank Midkiff, American High Commissioner of the islands, said:] ‘The present administration has recognized the rugged character traits [!] that it will be necessary for the Bikinians to acquire in order to adjust themselves to life on Kili [infertile new home of displaced Bikinians — J.L.]. While it is desired to enable them to come through the tests without serious [!] injury, it is not desired to coddle them to be wards or dependants’.”

(15) A one thousand megawatt nuclear power plant would produce in a year one hundred million curies of fission products Cockroft estimates in Nucleonics, January, 1952.

(16) In interpreting this result one must not think that, because a mouse is smaller than man, “the 0.1r is distributed over a smaller region” and that hence the mouse “gets a more concentrated dose”. “A mouse is given an 0.1r (whole body) dose” means that ionizing radiation is administered to the mouse sufficient to release 8.3 ergs of energy to each cubic centimeter of tissue in the body. An 0.1r (whole body) dose to men releases 8.3 ergs to each cubic centimeter in the men’s body. (Similarly, one could speak of a dose of 0.1r to a man’s spleen, etc.) Thus, the tissues of a man receiving a specified dose of (whole body) penetrating radiation are being attacked at the same rate as those of the correspondingly dosed mouse. The total ionization is of course much greater for the larger animal.

(17) Freaks” due to mutations are rare, only “a useful handle in the study of genetics, as Muller says. Most genetic changes

“affect inner physiological properties or features of the body chemistry, and so cannot be detected without special study. Probably most of these changes simply consist in weakening the degree of activity of some chemical process that is occurring normally in the body, thus making it more prone to one or another ill when the body is subjected to difficult conditions of living that a quite normal individual would usually be able to withstand.” (H. J. Muller,

Bulletin of the Atomic Scientists, September, 1947.)

The occurrence of Mongolianism and other teratologies among progeny of Japanese A-bomb victims is due chiefly not to mutation, but to irradiation of embryos in the womb. We might remark that embryonic tissue, like all rapidly proliferating tissue, is extremely sensitive to radiation. Thus, exposure of rats and mice in utero on the ninth day of gestation to as little as 25r has resulted in significant incidence of skeletal abnormalities, microphthalmia, and abnormal growths of epitheloid cells in and around the brain of the offspring. 50r retarded development and produced microphthalmia in a third of the fetuses with brain and spinal cord abnormalities common. (Cf. Rugh's article in Annual Reviews of Nuclear Science, vol. 3, 1953.)

(18) Government agencies and their spokesmen have frequently falsified these genetic dangers. Perhaps the most flagrant example is the Army's Handbook of Atomic Weapons for Medical Officers, which states: "Little is known of the actual effects to be expected in man [In some quarters —J.L.] but it is estimated that about 600r would be required to produce significant mutation rate changes." This does produces death within a month in 100 per cent of humans.

(19) While on this train of thought we quote a different aspect of this article:

"American military scientists now are ready to speak somewhat more freely of never gas, a much more swiftly lethal weapon. The reason is that this gas is not an exclusive American invention, but came originally from the laboratories of Nazi Germany. The Army's Chemical Corps said to-day that there were several forms of so-called nerve gas. They are without color and without smell. 'The inhaled vapor from as few as three drops would prove fatal to a human being in about four minutes', the Corps added. 'More toxic than the previously known chemical warfare agents, the nerve gases are designed to destroy life with sudden ness; their presence is not ordinarily detectable by the senses, and we must rely upon detection devices to identify them.'. . . Another weapon is bacteriological warfare. Like gas, such a weapon is difficult to detect quickly. One of the greatest eventual advantages of 'BW' long under experiment but still not entirely perfected, is that it can he applied under the long range plans of strategic operations. Its effect 'hangs fire', may not be felt for the days or weeks required for the incubation of a disease". A New York Times dispatch of that time entitled Denver Calmed on War Gas Fear told how some Denver residents were nervous about the disclosure that "the Rocky Mountain Arsenal was manufacturing a nerve gas that could wipe out the populations of enemy cities". It gives a further description of how muscles would be paralyzed. "There would be a sensation of great weight upon the chest, pain, then choking and death as the brain's messages commanding the heart to beat were blocked from the heart muscles." After the further remark that "The arsenal produces this weapon twenty-four hours a day, seven days a week", they quote the reassuring ministrations of Lieut. Col. S. J. Effnor, acting commandant of the arsenal, who says: "The

facts about nerve gas do not justify the horror weapon name so often used to describe it". Col. Effnor states that maximum measures to safeguard Denver area residents have been taken and "there is no possibility of any danger to the civilian population in Denver". In addition, "the means for effective defense and treatment have been developed" and an antidote, atropine, is available in quantity. After describing the safety measures in some detail, the article points to the excellent safety record: "No one at the arsenal has suffered more than temporary minor effects from the gas". Some inkling of these temporary minor effects is given by a UP dispatch of 6th May headed 70 at Arsenal Affected by Deadly Nerve Gas. The officials queried "admitted that security regulations had prevented them from telling the whole story of the effects of the gas" [Why, since this was already known to the Germans? — J.L.] but the following was released: "Seventy or more employees . . . here received mild closes of a deadly nerve gas . . . . All recovered without permanent injury within five days . . . . Exposed workers told of wild dreams and nightmares, anxiety and jitters and reckless decisions. 'While they were driving they found themselves taking chances they would not ordinarily take', Col. Werne said."

(20) "Mastermind" of these raids was Gen. Curtis LeMay, now head of the Strategic Air Command (SAC), the elite corps entrusted with "delivery" of the hydrogen bomb. A laudatory article by Ernest Havemann in Life, 14th June, 1954, tells about LeMay and SAC:

"The fire raids, as much as the dropping of the atom bomb, involved grave moral problems. They were planned to destroy industry, but everybody knew that each time LeMay sent his B-29s out a lot of innocent and helpless men, women and babies were also going to be burned up. This fact did not deter LeMay. He is a thoroughgoing professional soldier. To him warfare reduced itself to a simple alternative: kill or be killed. He would not hesitate a moment — indeed he would not consider any moral problem to be involved at all — in unleashing the terrible power that now lies in his hands with the B-36, the B147, the B-52 and the hydrogen bomb."

(21) A good deal of important material on the condition of Japan can be found in Blackett's The Military and Political Consequences of Atomic Energy. We disagree with Blackett's conclusion on the first use of the bomb, however.

(22) Dr. Du Bridge is now a consultant to the military.

(23) These lines were written before the Oppenheimer affair. More detailed information is now available.

(24) Astounding Science Fiction, incidentally, has on occasion printed articles with mature scientific content. A course on radar at the Massachusetts Institute of Technology during the last world used as its text — an article in this magazine