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not specifically cited, deal with the follow-up medical surveys which became annual. The observations have been published without restriction or qualification.

Geography of the Proving Ground and Background
of the "Bravo" test of March 1, 1954

The Marshall Islands are a group of atolls which mark off the southern boundary of the North Pacific Basin, lying about 10^{o} north latitude roughly halfway between the Hawaiian Islands on the east and the Marianna Islands on the west. The only inhabited places between the Marshalls and the Aleutians north of the fiftieth latitude are Wake Island about 500 miles due north and Midway Island about 2700 miles north-northeast. This open area to the north and west of the Marshalls was a major consideration in the selection of Eniwetok and Bikini Atolls, lying about 200 miles apart on an east-west line at the westernmost end of the Marshall chain, for the testing of new generations of nuclear weapons (1).

The Marshallese who inhabited Bikini and Eniwetok were transported, after proper negotiations and settlements, to newly-built villages on other atolls or islands before the technical buildup began for the first test in July 1946 (1). The reference cited describes among other things the environmental surveys under AEC sponsorship that preceded and followed these tests.

The first two tests in the Marshalls were conducted without incident at Bikini Atoll (4). The next nine were at Eniwetok, three in 1948, four in 1951, and two in 1952. The eighth in this series, the first experimental thermonuclear device, probably approached the megaton range. The cloud top penetrated into the stratosphere and created appreciable amounts of fallout. As planned, the fallout from this detonation was carried away by a wind blowing from the east-northeast. Some of the radioactive debris fell into the lagoon, and on the narrow band of

uninhabited islands, and in the ocean beyond (1). No people were involved although plants and sea life and the detonation area exhibited radioactivity. Also, as more fully appreciated later, the radioactivity injected into the stratosphere would be subject to worldwide distribution.

The Bravo Test, March 1, 1954

Bikini Atoll was selected for the next four tests beginning with the Bravo test of March 1, 1954. Four additional tests at Bikini followed by a sixth test on Eniwetok lagoon completed the "Castle" series of that year; these latter five were uneventful. Bravo, however, was the first test of a high-yield fission-fusion device designed to be in the multi-megaton range; also, it was expected to produce fallout similar to that of the thermonuclear test of 1952 and ample precautions were taken. The task force was careful to follow the standard injunction of detonating only when the meteorological conditions would ensure that the close-in fallout would be carried out over the uninhabited ocean. To reinforce that end, a precautionary no-entry zone was established for ships and aircraft extending about 335 miles east to west and 150 miles north to south around the Eniwetok-Bikini Atolls.

On March 1, 1954, the meteorological conditions were judged to be suitable to conduct the detonation. The explosion attained an estimated 15 megatons and yielded unusual amounts of radionuclides and fission products adherent to or dissolved in the coralline rock melted up from the surface of the island. Much of this debris was injected into the stratosphere for the cloud topped out at about 100,000 feet. Some of the expected close-in fallout

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Rad-safe aircraft in the meanwhile had detected and charted the anomalous plume so that ships moved out of its path and after a time were decontaminated.

Exposure of the Marshallese to Fallout

The Marshallese on Ailinginae*, Rongelap and Utirik, being unaware of the nature of fallout, did nothing to protect themselves or wash off the particulates, except as they changed to swim or use the lagoon. The fallout was gritty, whitish and varied from a dust to small flakes. Indeed the oil used on their hair and their clothing helped retain the fallout and the records note the difficulties encountered in decontaminating the skin and hair (1,2). Itching and burning sensations of the skin and eyelids were the first signs of the skin lesions that were to follow. Some of the people lost their hair in patchy patterns beginning about the third week after exposure. During the first few days some experienced transient nausea, vomiting, diarrhea, loss of appetite and tiredness.

As indicated on Table I, the people on Rongelap and Ailinginae were evacuated after the detonation and transported by sea and air to Kwajalein Atoll where first-class hospital facilities, medical specialists and clinical laboratories were available. Apparently the Marshallese had not been exposed to identical amounts of fallout for they exhibited a wide range of intensity of the clinical signs relative to that expected from a radiation exposure of 175 Roentgens. In general, however, the characteristic patterns of depression of the bone marrow with reductions in circulating blood platelets and white blood cells were observed in the Rongelapese as were the slow, gradual recoveries of the circulating cellular elements to their normal levels. During the phase of low-blood counts, minor infections were observed which responded well to antibiotics.

The 18 people on Ailinginae were Rongelapese who chanced to have gone to Ailinginae Atoll to fish in that lagoon. They were classed with and treated as Rongelapese but having a lower exposure.

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among Utirik people while they were on Kwajalein were slight, transient reductions of blood platelets, lymphocytes, and neutrophils. These were found only in some persons and disappeared promptly (2). Their clinical symptomatology was negative excepting the upper respiratory infections and gastroenteritis common to all personnel on Kwajalein at that time. After two months' observation and treatment on Kwajalein, the Utirik people were returned to their home atoll. An extensive radiological and environmental survey, which served as a prototype for similar subsequent observations, had found the foods, water supplies, and terrain of Utirik acceptable for habitation.

Surveys of Rongelap and Ailinginae indicated the radiation levels were unacceptably high, so the Rongelapese were resettled in a newly-constructed village on Ejit Island of Majuro Atoll about July 1, 1954 (1). While they recuperated and prospered on Ejit, they were not happy because Ejit was not "their land." Their repeated requests to return to Rongelap resulted in a series of resurveys and when the radiation doses from the decaying fallout had

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was centrally involved in these operations both as to medical and environmental effects and radiological safety (1). When the Marshallese returned to a more or less civilian status, the Division undertook to carry on the series of medical surveys and continue the environmental surveillance of the test area. Dr. Robert A. Conard, who had been a member of the survey teams for the second (1956) and third (1957) examinations post-exposure, was chosen to organize and lead the annual surveys. Each year since then, he has led a team of medical specialists to the Islands to examine the exposed people plus unexposed comparison populations of Marshallese.

As a Senior Staff Member of the Medical Department of Brookhaven National Laboratory, Dr. Conard is in a specially favorable position to obtain the nation's best medical collaborations and laboratory's support. For example, when urine samples collected from the Rongelapese before and after returning to Rongelap Atoll suggested that the people might be acquiring increased but still low-body burdens of certain radionuclides from the residual fallout in the soil, a whole-body counter was transported to the Islands to maintain surveillance over these biophysical parameters. It was found that the body burdens of certain radionuclides were higher than those of people in the United States, but they still were far below the guidelines established by the Federal Radiation Council, now EPA.

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United States. One or more outstanding thyroid specialists have accompanied the team each year since 1964. During the years 1964 to 1971, additional cases of thyroid disease developed in the exposed population ranging from hypothyroidism with deficient growth to nodularity of the gland to malignant adenocarcinoma. The majority of people affected had been under 10 years of age at the time of exposure. Prompt surgical treatment and/or daily thyroid hormone therapy brought the situation under control. The observations have been widely published and accepted by medical authorities. A summary of the incidence of thyroid disease in the exposed populations following the March 1971 survey is enclosed.

The Marshallese on Utirik who received low exposures (less than 15 Roentgens) have been visited by Dr. Conard and the teams at three to four-year intervals. It has been reported that the Utirik people are of two minds about this schedule: On the one hand they feel neglected, particularly by comparison to the Rongelapese; on the other they are happy not to be examined and have blood drawn.

Non-Medical Problems which Relate to the Medical Surveys

Possibly the most troublesome problem originates from a legal complaint styled Abia et al. v. United States, Trial Division, High Court Trust Territory of the Pacific Islands. This was received by the High Commissioner in Guam with the request that he effect service upon the United States. In essence it sought a sum of $8,500,000 for property damage, radiation sickness, burns, physical and

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health status of those exposed to fallout radiations and certain others who serve as a control population. In order to accomplish the survey on an island or atoll, it was found useful for reasons of good public relations to set up a "sickcall," i.e., outpatient clinics, for the people in general. This is done with the knowledge and active cooperation of the Health Department of the Trust Territories.

The physicians in the Health Department on the other hand are responsible for the day-to-day general medical care of about 100,000 people who live in small groups on islands or atolls scattered over an area of the Pacific equal to that of the United States. Considering the logistic problems and the dearth of physicians willing to practice under these conditions, the Health Department performs its duties very creditably. The Survey Team is concerned only with diagnosis and evaluation unless a very serious condition is found or an acute disease is developing. Definitive treatment is kept at a minimum by the Survey Team since that is properly the responsibility of the attending physicians of the Medical Department of the Trust Territories.

Misconceptions about The Lucky Dragon

The Marshallese and others seem to have a mistaken understanding about the compensation given the 23 Japanese fishermen aboard the Lucky Dragon that was in an area about 85 miles east of Bikini as the Bravo test detonated (1, 3). The boat appears to have been close to the center of the fallout pattern for the men and the surfaces of the boat received a covering of fallout material. Although the men began to suspect what the material might be, they knew nothing of decontamination procedures and were exposed for 14 days during the voyage back to Japan. Within two days after docking, news of their exposure became an international concern. The men were soon diagnosed as suffering from radiation sickness and hospitalized. One man died six months later (Sept. 23, 1954) of a complicating infectious hepatitis while the remainder were discharged on May 10, 1955. The radiation doses to the men could not be computed.

When it was found that fish in the hold of the Lucky Dragon were also contaminated and that fish being sold on the markets in Japanese cities were contaminated with radioactivity, the Pacific Ocean fishing industry was severely affected. The Japanese were especially affected as much of the protein in their diet comes from the sea. Although the Bravo detonation probably contributed most of the radioactivity detected at that time, it came to be recognized that other tests may have contributed fission productions and radionuclides that were reaching people via the sea-plankton-fish-man sequence.

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At present Dr. Conard is in the Marshall Islands with a medical team for the annual survey. This year the team is being joined by two Japanese physicians. Upon completion of the survey we will be pleased to provide additional information.

TABLE I

A SUMMARY OF THE NUMBERS OF MARSHALLESE AND U. S. SERVICEMEN ON THE ATOLLS EAST OF BIKINI WHO WERE EXPOSED TO FALLOUT FROM THE TEST "BRAVO" ON MARCH 1, 1954 (2)

Number of People in Group	Time of Commencement of Fallout Hrs.	Time of Evacuation Hrs.	Est. Total r Air Dose Roentgens
1. Rongelap - 64	H +4-6	H +50 (16 people)	175
		H +51 (48 people)	
2. Ailinginae*- 18	H +4-6	H +58	69
3. Rongerik - 28 U. S. Servicemen	H +6.8	H +28.5 (8 men)	78
		H +34 (20 men)	
4. Utirik - 157	H +22	Started H +55 Completed H +78	14

* The people in the Ailinginae group were Rongelapese who happened to be fishing on Ailinginae at the time of exposure.

THE CURRENT STATUS OF THYROID DISEASE AMONG THE MARSHALLESE EXPOSED TO FALLOUT FROM THE BRAVO TEST, MARCH 1, 1954

(The following data are taken from an informal report by Dr. Conard dated 4/20/71)

The current status may be updated as follows:

I. Young Rongelapese exposed to fallout March 1, 1954, when they were 1 to 8 years of age. (Estimated dose: 175 rads external gamma plus 600 to 1400 rem internal irradiation.)

Total - 19

1. Currently normal by clinical and biochemical tests. (There may be a slight unevenness of the gland in one patient.) 2 (11%)

2. Currently hypothyroid with minimal nodularity. Responding satisfactorily to oral thyroid hormone therapy. 3 (16%)

3. Have undergone surgery in the U. S. prior to 1969 because of nodular thyroid disease; histologic diagnosis of adenomatous goiter and Huerthle cell tumor. Responding satisfactorily to oral thyroid hormone therapy with one exception: This patient shows some enlargement of the remnant of thyroid left from a partial thyroidectomy in 1964; as she has not followed her post-operative thyroid hormone regimen, there is question as to whether she should have further surgery. 11 (58%)

4. Young people operated on for thyroid disease during August 1969 and recovered. Diagnoses: Primary benign adenomatous goiter in two and papillary adenoma of serious grade malignancy in one. 3 (16%)

(None of six Ailinginae children exposed to an estimated external dose of 69 rads have shown thyroid dysfunction.)

II. Surviving adult Rongelapese exposed to fallout. (Estimated dose: 175 rads external plus 160 rem internal irradiation.)

Total - 34

1. Papillary carcinoma removed surgically at age 41. No recurrence. Taking oral thyroid hormone therapy. 1

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dose: 69 rads external gamma irradiation.)

Total - 8

1. Adenomatous goiter removed at age 45; recovered and was on thyroid therapy. Died of influenza in 1968.

IV. Surviving adult Utirik people exposed to fallout. (Estimated dose: 14 rads external gamma plus 15 rem internal irradiation.)

Total - 120

1. One person developed a nodular thyroid gland and underwent surgery in 1969. As the tissue resembled a follicular adenoma in frozen section, a total thyroidectomy was performed; histologic sections confirmed the diagnosis and upgraded the degree of malignancy. She has recovered satisfactorily.

2. One person with slight enlargement of one lobe of the thyroid to be treated conservatively and observed.

One case of nodular thyroid has been found in a non-exposed Rongelap woman living on Ebeye. Thyroid surgery has been recommended for this patient at Majuro Hospital. No other instances of thyroid abnormalities have been found in the control populations living on Utirik, Majuro or Ebeye.

It appears that the exposed populations have stabilized so far as the thyroid reactions are concerned.

[redacted] test and the subsequent events are in the public domain. Those references are placed first.

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