

ANNUAL REPORT OF THE LABORATORY OF RADIATION BIOLOGY  
UNIVERSITY OF WASHINGTON  
JULY 1, 1959 - JUNE 30, 1960

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Director

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The Laboratory of Radiation Biology (formerly the Applied Fisheries Laboratory) has completed its seventeenth year of active contract research with the U. S. Atomic Energy Commission and its predecessors. The international moratorium on the testing of atomic devices during the past year has provided an opportunity for the Laboratory to evaluate the vast amount of data that has accumulated and to direct efforts into other areas of interest in the field of radiation biology.

The work of the Laboratory is coordinated into a unit effort, but for ease in reporting and summarizing the operations are reported individually.

A. Fallout Studies at the Eniwetok Test Site

Supervisors: Frank G. Lowman and Ralph F. Palumbo

A continuous effort has been made to evaluate the biological impact of the series of devices tested during Operation Hardtack in 1958.

Radiochemical separations and gamma spectrometric analyses were made on a sample of fallout from one device detonated

during the Hardtack test series. Rhodium-102 was detected in the sample and the identity of the isotope was confirmed by several radiochemical techniques and by gamma energy determinations. The amount of the isotope was related to the levels of fission products in the sample.

Radiochemical separations were made on samples of sea water and bottom material collected in the target area of a nuclear device detonated inside of Eniwetok lagoon. The sea water was divided into particulate and soluble fractions. Samples of bottom material were treated with eighteen different eluents over a pH range of 1 to 13 and the amounts of cobalt-60, zirconium-95, ruthenium-106, cerium-144, and stable calcium removed by the different eluents were determined.

Samples of plankton and water collected during the Rehoboth, Collett, and Silverstein surveys were subjected to radiochemical and gamma spectrum analyses. The Rehoboth data have been published and the Collett-Silverstein paper is almost completed.

The radioisotope content in the organs of the clams Tridacna and Hippopus was related to the amounts of stable elements in the same samples. The effects of stable element content on uptake of individual radioisotopes were studied by this method.

A survey paper on the marine biological investigations at the Eniwetok Test Site was prepared for presentation at the Monaco

meeting of the International Atomic Agency, November 16-21, 1959, and was incorporated into the proceedings of that meeting.

Analyses of plant, fish and invertebrate samples selected at several islands some distance from the Eniwetok Test Site from 1954-1958 were completed during the fiscal year 1959-1960. The results of these analyses are being published as one of the UWFL reports.

A study involving the recovery of land plants which were exposed to chronic doses of radiation at the Eniwetok Test Site during 1954-55 has also been completed and is being published under the title, "The growth and radioactivity of the land plants at Eniwetok Atoll, 1954-55."

B. Rongelap Radiation Ecology Program

Supervisor: Edward E. Held

The period July to August, 1959 was devoted to a continuation of radiochemical and chemical and physical analyses of samples collected on previous field trips, as well as to the preparation for the field trip of September 1959.

The field trip included observations and collections at twenty islands, and the measurement of gamma and beta-gamma dose rates at thirteen of these islands. The major collection

and study sites were Rongelap and Kabelle Islands. Soils and vegetation were resampled at previously established plots and new plots were sampled to better delineate soil types. A vegetation map of the northern half of Rongelap Island was completed; also data needed for completion of soil maps of Rongelap and Kabelle Islands were obtained in cooperation with the Trust Territory Agriculturalist. Newly planted coconut groves were treated with different combinations of chemical fertilizers. Invertebrates were collected at most of the islands visited. Reef fish were observed and collected primarily at Rongelap and Kabelle Islands, with the emphasis placed on goatfish and organisms upon which they were observed to be feeding. Plankton was collected by continuous pumping at the surface between eighty-nine stations in the lagoon. Twenty-four-hour collections of plankton were made at three depths at three of the stations. Bottom cores were successfully recovered at seventy-four stations. At Kabelle Island the transition from lagoon shore to island soil was studied, with particular attention to the formation of beach pavement and the rooting zones of plants. Twenty-four-hour rations were obtained from nine adult males at Rongelap Island.

Mr. Robert Lee, University of Hawaii, accompanied the group for the purpose of making productivity measurements of sea water

using the C<sup>14</sup> technique.

Dr. I. E. Wallen, U. S. Atomic Energy Commission, Division of Biology and Medicine, spent one week with the group at Rongelap.

Personnel from the Eniwetok Field Office, (U. S. Atomic Energy Commission) accompanied the group for the purpose of making gamma dose rate measurements.

The period from October 1, 1959 to June 1960 was spent in the preparation and analysis of samples and data collected on the September field trip.

Soils. Sieving, determination of exchangeable bases, gross-beta counting, classification and mapping, preparation of samples representative of the six major soil types for radiochemical analysis.

Plants. Preparation of plant samples by drying, grinding, gross-beta counting, radiochemical analysis of edible plants, Cs<sup>137</sup> and potassium determinations of selected samples from fertilizer plots and different soil types, completion of vegetation map of northern half of Rongelap Island.

Bottom Samples. Determination of composition of cores by one-inch increments, gross-beta counting of total material and fine particle size fractions, gamma spectrometric examination

of selected samples.

Plankton Samples. Qualitative gamma spectrometric examination of the total plankton collected from each of three nets of different mesh, counting of individual samples at the  $\text{Co}^{57}$ ,  $\text{Ce}^{144}$ - $\text{Pr}^{144}$  photopeaks, determination of composition of plankton by sorting of major groups.

Invertebrates. Dissection and preparation of samples, gross-beta counting, gamma spectrometric examination of selected samples, radiochemical analyses of selected samples.

Fish. Analysis for  $\text{Zn}^{65}$  content of various organs and tissues of goatfish from a single school in relation to size classes, determination of stable zinc content of samples of goatfish and organisms on which they were feeding.

Birds and Rats. Samples prepared for radiochemical analysis, but actual analyses remain to be initiated.

The period from July 1, 1960 to June 30, 1961 will be devoted to a continuation and completion of the above studies, with the addition of (1) chemical and radiochemical analysis of samples from the pot culture experiment completed at Eniwetok; (2) pot culture experiment in the new greenhouse of the Department of Botany, using Rongelap soil; emphasis is being placed on  $\text{Cs}^{137}$ ,

K relationships; (3) a field trip to Rongelap Atoll is projected for March 1961. The primary objectives are (a) to collect soil and plant samples from previously established fertilizer plots, (b) to record growth measurements on previously marked trees and shrubs, (c) to collect edible fruit samples, (d) to collect Birgus (coconut crab) for radiostrontium analysis; (4) preparation for a field trip to Rongelap Atoll projected for August 1961. This will be of similar scope to the September 1959 field trip and will require a vessel capable of operating in the lagoon and supporting the scientific party for approximately three weeks.

Members of the field party were:

Senior members

Edward Held, party leader,	Laboratory of Radiation Biology
Kelshaw Bonham,	Laboratory of Radiation Biology
Stanley Gessel	College of Forestry
Ole Mathisen	Fisheries Research Institute
Richard Walker	Department of Botany

Junior members

William Anikouchine	Department of Oceanography
Mark Behan	Department of Botany
Timothy Joyner	College of Fisheries
Reid Kenady	College of Forestry
James Kimmel	Department of Botany, Ohio State University
Conrad Mahnken	Department of Oceanography

C. Fern Lake Trace Mineral Metabolism Laboratory

Supervisors: Paul R. Olson, for the Laboratory of  
Radiation Biology

John R. Donaldson, for the State of  
Washington Department of Game

The cooperative study at Fern Lake (Washington), with the State of Washington Department of Game providing the physical environment and research participation in fisheries management, the University of Washington the supervision of the program and graduate students for research work, and the U. S. Atomic Energy Commission financial support, continues to be an outstanding area in our over-all program.

During the past year the major effort was directed toward an evaluation of the watershed and its basic productive capacity. Graduate students in the College of Forestry continue their work on the water budget of the watershed, the movement of nutrients through the soils, and the uptake of trace minerals by the flora.

The total production of fish in Fern Lake has been determined by measuring the number and weight of fish that migrated from the lake and by treating the lake with rotenone, then collecting all of the remaining fish that had not migrated.

During the coming year the studies of the role of trace minerals in the Fern Lake watershed will be intensified by using

selected isotopes of elements of biological interest and following their movement in the fauna and flora.

D. Alaska Harbor Program--Project Chariot

Supervisor: Allyn H. Seymour

One project of the U. S. Atomic Energy Commission's Plowshare Program for the peacetime use of atomic energy is known as the Chariot Project. This project calls for the underground detonation of nuclear devices near Cape Thompson on the Arctic coast in northwest Alaska for the purpose of making a surface excavation. A name commonly given to this operation is the "Alaska Harbor Project," although there are no plans for developing the excavation into a harbor. In fact the detonation of the devices has not been approved; however, in the spring of 1959 the Division of Biology and Medicine of the AEC was granted approval to initiate an ecological program from which the biological cost of the experiment could be evaluated in the event approval is granted.

The Laboratory of Radiation Biology was asked by the Division of Biology and Medicine to assist by planning the marine part of the program, other than for marine mammals. The principal objectives of this project were to determine the circulation of

the ocean water, to compile a list of organisms and to determine the present level of radioactivity. The oceanography program became the responsibility of the University of Washington's Department of Oceanography; the collection of specimens was largely the responsibility of the North Pacific Exploratory Fishing and Gear Research Branch of the Fish and Wildlife Service; and the identification of samples and evaluation of radioactivity was the responsibility of the Laboratory of Radiation Biology. Specialists from the U. S. Fish and Wildlife Service, Juneau, and from the College of Fisheries and the Fisheries Research Institute, University of Washington, were hired for the identification of the fishes and the invertebrates and to conduct salmon surveys.

During August 1959 collections and surveys were made in the field. The work last summer was the most intensive study that has been undertaken in this region and is especially important because of its contribution to the present scant amount of information about the area. The fish population was small but the invertebrate collection was large both in respect to number of individuals and to number of species. The identification of the fishes is essentially complete. The work on the invertebrates is continuing. Radioactivity in marine

organisms from fallout radioisotopes was either not present or scarcely detectable. The naturally occurring radioisotopes,  $K^{40}$  and  $Ra^{226}$ , were present. (In the land plants and animals some fallout radioisotopes were detectable). Three progress reports for 1959-1960 have been submitted to the Committee for Environmental Sciences, Project Chariot, of the Division of Biology and Medicine.

As the collections of fish and invertebrates are deemed adequate further pretest collections are not planned. However, identification of the invertebrates from the 1959 collection will continue during the fiscal year of 1960-1961.

Stream surveys for salmon will be conducted during July and August, 1960, since the runs in 1959 are unrelated to those in 1960. Salmon runs are not large in the immediate vicinity of the Chariot site, but because of the importance of the salmon fishery elsewhere in Alaska an effort is being made to obtain as much information as possible.

Reports of this year's work also will be made to the Committee for Environmental Sciences, Project Chariot.

E. Analytical Research Activities

Supervisor: D. Chakravarti

Research investigations dealing with potassium as an index of naturally occurring radioactivity in tuna muscle, potassium and cesium-137 in coconut crab muscle and analyses of trace elements in fish tissues were published.

The analytical work primarily involved determinations of strontium-90 and stable calcium in plants, fish, and invertebrates as well as in samples from the test site and off the test site. Samples from the western Pacific as well as from the Chariot Site in Alaska were also analyzed for strontium-90 content. Part of the time was invested in development, modification and verification of certain analytical methods, especially with respect to trace elements (transition elements).

The tentative analytical research plan for the coming year will include determinations of macro- and microelements as well as of various radionuclides, especially strontium-90 and chromium-51, in samples from the test site in the Marshall Islands, from Japan, western Pacific areas, the Chariot Site, and the Oregon-Washington coast. The types of samples will include plankton, coconut, copra, Scaevola leaves, Messerschmidia, rat bones, bird bones, clam shells, and bottom samples. Radioactivity

in Rongelap goatfish will be studied with respect to transition elements and related radionuclides. Chemical and radiochemical analyses of samples of a 24-hour ration of the Rongelapese will also be investigated.

Analytical method development, modification and verification will include a rapid turbidimetric method for potassium, selective precipitation of sodium from sea water, rapid processing methods for water samples and further verification of ion-exchange and colorimetric tests for transition elements.

#### F. X-radiation Studies

Supervisor: K. Bonham

Penetrating radiation from an external source continues to be one of our best research tools. The facilities at the Laboratory of Radiation Biology are used by staff members and graduate students in the Laboratory to further their research.

The Laboratory has provided X-ray facilities to other research workers as follows.

During the fiscal year July 1, 1959 through June 30, 1960, the Picker Deep Therapy X-ray machine was used by departments (other than the Laboratory of Radiation Biology) as listed in the table.

<u>Department</u>	<u>Personnel</u>	<u>Organism</u>	<u>Use</u> <u>Hours</u>	<u>Times</u>
Medicine	Motulsky and Mezistrano	mice	36	10
Pathology	Prehn, Ott, Syrotuck, and Emery	mice	28	34
Surgery	Young and Carson	mice	11	7
Physiology	Carlson and Bustad	mice	8	8
Medicine	Finch and Glickman	rats	10	10
Genetics	Stadler	Neurospora	1	2

A new Victoreen Condenser r-meter, Model 570, was purchased to replace the original meter obtained in 1943. The four old chambers are being used with the new meter.

G. Summer Institute in Radiation Biology

In-Service Institute in Radiation Biology

Supervisor: Arthur D. Welander

During the summer of 1959 two Institutes in Radiation Biology, one for twenty college teachers and one for twenty high school teachers, were initiated. This course in radiation biology was designed for science teachers and was sponsored by the National Science Foundation, the Atomic Energy Commission and the University of Washington. From all reports by participants and others involved in evaluating the course, the venture was a success.

A similar course was supported during the summer of 1960. In addition, an In-Service Institute in Radiation Biology is

being planned for evening class attendance by teachers and graduate students during the academic year 1960-61. In this latter course, demonstrations will have to be substituted for laboratory participation because of an unfortunate lack of laboratory space for the preparation of radioactive samples and counting of radioactivity.

Each course is made up of four parts which are presented sequentially, as follows: (1) the relationship of physics to radiation biology; (2) the relationship of chemistry to radiation biology; (3) the biological effects of radiation; and (4) the use of radioisotopes in biological studies. The course is taught by a number of specialists from the Laboratory of Radiation Biology, the Hanford Laboratories Operation, and the University of Washington. Thus the teaching load is distributed as widely as possible so as not to interfere excessively with research commitments.

H. New Programs

1. Exposure of Salmon Eggs and Larvae to Low-Level Irradiation

Supervisor: Lauren R. Donaldson

During the fall months 150,000 salmon eggs and their larvae will be exposed to low levels of irradiation from fixed sources. The plan is to expose the embryo during the entire developmental period to  $0.5 \pm r$  per day. After rearing to migratory size the fish will be marked for release to the sea. A like number of "control" fish will also be released.

The impact of the radiation experience will be evaluated on all aspects of the salmon's life, including their reproductive capacity and the survival of their progeny.

2. Distribution of Radioactive Materials in the Pacific Ocean from the Hanford Atomic Products Operation

Supervisor: Allyn H. Seymour

A cooperative effort between the Department of Oceanography and the Laboratory of Radiation Biology is proposed to evaluate the distribution of the waters of the Columbia River in the Pacific Ocean and the radioactivity they transport.

I. Pressing Problems

The most urgent need of the Laboratory is for space on the campus to house our operations. During the past ten years the space available to our operations in the Fisheries Center has remained constant while the scope of our operations has increased fivefold.

We need:

1. More office space
2. More laboratory space for research
3. Classroom and laboratory space for graduate teaching
4. Office and laboratory space for visiting post-doctoral research workers

J. Budget

Financial support for the Laboratory of Radiation Biology is provided by the U. S. Atomic Energy Commission, the National Science Foundation and the State of Washington Department of Game.

The funds available during 1959-1960 and the proposed budgets for 1960-1961 are divided into the following categories.

A. Laboratory of Radiation Biology basic program

(Budget No. 60-2401 for 1959-1960)

(Budget No. 60-2411 for 1960-1961)

	<u>F.Y. 1960</u>	<u>F.Y. 1961</u>
(1) Salaries	\$153,750	\$158,400
(2) Travel	25,800	23,200
(3) Equipment	25,650	36,800
(4) Supplies and expense	12,600	21,600
(5) Overhead	<u>40,000</u>	<u>40,000</u>
	\$257,800	\$280,000
(6) Overhead, additional request*	<u>---</u>	<u>7,500</u>
	\$257,800	\$287,500

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\*Dean McCarthy's letter to Mr. Kenneth Englund, May 12, 1960

B. Fern Lake Research  
(Budget No. 60-5276)

	<u>F.Y. 1960</u>	<u>F.Y. 1961</u>
(1) Salaries	\$ 15,000	\$ 20,570
(2) Travel	800	930
(3) Equipment	3,400	1,000
(4) Supplies and expense	3,000	700
(5) Overhead	<u>1,800</u>	<u>1,800</u>
	\$ 24,000	\$ 25,000
(6) Overhead, additional request*	<u>---</u>	<u>56</u>
	\$ 24,000	\$ 25,056

C. Summer Institute of Radiation Biology\*\*  
(Budget No. 60-5281)

	<u>F.Y. 1960</u>
(1) Support for participants	\$ 41,000
(2) Operational costs	
(a) Salaries for staff	13,300
(b) Supplies and equipment	6,360
(c) Indirect costs	<u>2,949</u>
	\$ 63,609

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\* Dean McCarthy's letter to Mr. Kenneth Englund, May 12, 1960  
\*\* Budget for 1961 in preparation

D. In-Service Institute for graduate student training, 1961  
(Budget No. 60-2410)

(1) Support for participants	\$ 1,200
(2) Operational costs	3,661
(3) Instructional costs	5,500
(4) Indirect costs	<u>1,374</u>
	\$ 11,735

E. Funds for the Department of Oceanography for the Chariot Program (Operation Flowshare) are provided by the U. S. Atomic Energy Commission by transfer from Contract No. AT(45-1)540 to Budget No. 60-2402

For Fiscal Year 1960 the support for Marine Ecology amounted to \$100,000

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TOTAL CONTRACT FUNDS FOR FISCAL YEAR 1960 \$445,409

Personnel of the Laboratory of Radiation Biology

Academic

Lauren R. Donaldson	Director
Kelshaw Bonham	Research Assistant Professor
Diptiman Chakravarti	Research Assistant Professor
Edward E. Held	Research Associate Professor
Timothy Joyner	Research Associate
Frank G. Lowman	Research Associate Professor
Paul R. Olson	Fisheries Biologist
Ralph F. Palumbo	Research Assistant Professor
Allyn H. Seymour	Associate Director
Dorothy J. South	Assistant Radiation Chemist
Arthur D. Welander	Research Professor

Non-Academic

Irma J. Appleman	Laboratory Technician
Margaret A. Breen	Clerk-Typist
Joan F. Catoni	Secretary
Marion L. Chase	Editor
Roy J. Daniels	Hatchery Caretaker
Joanne A. Frank	Clerk-Typist
Sharon R. Long	Clerk-Typist

Personnel (continued)

Non-Academic (continued)

Marguerite E. McAlpin	Laboratory Assistant
Maxine M. Pautzke	Clerk
Lura Mae Savage	Laboratory Helper
Donald R. Weeks	Electronics Technician

Temporary -- Student

William A. Anikouchine	Graduate Student
Mark J. Behan	Graduate Student
Ronald Eisler	Graduate Student
Ian E. Ellis	Student Helper
Richard G. Embom	Laboratory Technician
Joseph W. Greenough, Jr.	Graduate Student
Theodore C. Hoffman	Graduate Student
Reid M. Kenady	Graduate Student
James D. Kimmel	Assistant Radiation Chemist
Devidas Y. Kode	Student Helper
Philip R. Loe	Graduate Student
Paul L. Lund	Student Helper
Conrad V.W. Mahnken	Student Helper
John B. McDonald	Graduate Student
Noel B. McGary	Student Helper

Personnel (continued)

Temporary -- Student (continued)

Richard E. Miller	Graduate Student
Norman H. Miner	Graduate Student
Daphne K. Morris	Student Helper
Walter T. Pereyra	Assistant Fisheries Biologist
Peter J. Peterson	Student Helper
Gunnar Rollefson	Student Helper
Paul F. Selle	Research Assistant
Raymond C. Simon	Assistant Fisheries Biologist
Carl Y. Wong	Student Helper

Temporary -- Academic

Ole A. Mathisen Fisheries Research Institute	Research Associate Professor
Howard D. Smith Fisheries Research Institute	Fisheries Biologist
Albert K. Sparks College of Fisheries	Associate Professor
Richard B. Walker Department of Botany	Associate Professor
Norman J. Willimovsky U.S. Fish and Wildlife Service	Research Associate Professor
Remzi Geldiay Turkey	Visiting Professor
Sven Sømme Norway	Visiting Professor