

PRNC211

SELECTED INFORMATION

PUERTO RICO NUCLEAR CENTER

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** Incomplete. Tabulated February 8, 1970 by the Information and Recreation Services Division

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?Thesis Research in Progress

February 1970

Medical Sciences and Radiobiology Division

1, Guatborto ¥. Borrero (Puesto

(of Sinbis Virus Wild Type.

- USA), ?The effect of ionizing radiation on the latency

?Tropical Agro-Sciences Division

1. Isabel Bolla (Colombia), Effects of gamma rays on isozyme patterns of malate and glucose
G- phosphate dehydrogenases in soybean seedlings

2 Carmen tiers Santini (Puerto Rico-USA), Combined mutagenic effect of soft xxays and
lucleoside analogues in histidine operon of Recherichia coli strain C.

8. Carmen Elena Cintrén (Puerto Rico-USA), The Effect of Temperature ofthe Mitotic Cyele
in Vicia fade,

4. Aida Roca de Mari (Puerto Rico-USA), Bffect of Gamma Radiation on the Peroxidase Effect
Isoenzymes of Glycine Max (Soybean)

Oscar Aragon (Niceragua), Complimentary Effects of Tonising Radiation and the Lipoxidase
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?Nuclear Science Division

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Manuel Lunas (Chile), Radiolysis of organic compounds in aqueous solution.

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B, Lyons (USA), Radiation protection studies by ESR.

(Panais), Recoil Reactions of tritium in liquid organic acid.

4. José Sequeira Sevilla (Dominican Republic), Radiolysis of organic nitrogen compounds.

Physics

1. Genaro Coronet (Paraguay), Critical behavior of the specific heat anomaly in ferroelectric TGS,

2 Carlos Basore. (Puerto Rico-USA), High frequency behavior of ferroelectric Rochelle Salt,

3. Luis ©. Hemandes (Colombia), ESR epectra from ferroelcttics,

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Physical Sciences Division

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Julio Alberto Mainarci (Argentina), Annealing of singlet quenching centers induced by
?gamma redistion in anthracene crystals.

Leon Percira (Colombia), Determination of free-hole trapped electron interaction rate
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Lisandro Vargaz Zapata (Colombia), Study of radistion induced electron traps in
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4. Femndlo Goeneo Very (Ontrbia), The Dauie Injections in Arcane Gye,

Chimistry

1. Bisa Géinoz Audrines (Puerto Rico-USA), The relationship between quenching in liquid scintillation counting and chemical structure, (She uses «Cas nf emitter)

2, Hilda Aledo (Puerto Rico-USA), The relationship between quenching in liquid scintillation counting and chemical structure (She uses ^{90}Co .as an internal conversion electrons emitter)

8 Sonia Vizquez (Puerto Rico-USA), Metalic complexes of heterodihydroanthracenes.

4. Agnes Costa (Puerto Rico-USA), Tritium recoil labeling of lithium organi salts:
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5. Rafael Pereira (Colombia), Tritium recoil lab

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6. Juanita Freer Calderón (Costa Rica), A rearrangement in the chromic acid oxidation of
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1. Rafael Aleaté (Puerto Rico-USA), Measurement of Reactor Shutdown Reactivities by the
?Asymmetric Source Method

2, Antonio Castro (Puerto Rico-USA), Study of Gas Production in Irradiated Barytes-Boron
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4, Fernando B. Pli (Puerto Rico-USA), Effect of Gamma Radiation on Organic Materials in
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1, dorge Pérea Rivera (Puerto Rico, USA), Possibilities ofthe Rxistence of HRP(Horseradish Peroxidase) Molecule in a Patilly Damaged Condition.

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Tropical, Avro-Sciences Divieion

This division offers courses in agriculture? research and biology at UPR

Rfo Picdras and Mayaguez. In 1969, five graduate students were doing these re-
search under the staff's supervision,

PRNC's special training--pertiouarly in food irradistion--has attracted
stutents and sefentists fron Thalland, Mexico and Guatenals,

The long-range research goal is to help improve @let conditions in trops-
cal areas, such as the Caribbean and South America. A mutation breeding stucy
of the soybean ains to obtain strains of high yield and protein content which

adapt well to the tropics. Food irradiation studies are directed at prolonging the shelf-life of such distant and market staples as the papaya, mango and plantain. A sugarcane borer program explores methods to eliminate this pest from cane fields by mass releases of insects which have been sterilized by radiation (the present concentration is on inherited sterility effects). In studies of Feonance radiation effect, target atom irradiation used in combination with other principles has been tested for possible control of mutation induction in higher plants (as of Late 1969, results appeared to be affirmative).

Future plans include fertility studies in highly leached soils and the relation to crop production; Livestock feeding and heat tolerance; low radiation dose effect on crop production; nitrogen fixation of leaf epiphytes of coffee, citrus, banana, plantain, guava, and pineapple plants.

On an international basis, planned programs include broadening cooperation with ICATTI of Guatemala, extending to food preservation other than fruits, insect control in hide cattle, and to organize programs in several areas with Guatemala's National Institute of Nuclear Studies, Soils studies and mutation breeding in the vast Llanos areas of Colombia are planned, in cooperation with Colombian scientists and the government.

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Clinical Radionuclide Applications Division

Located in PaHO's Rio Piedras installation, this division trains physicians and allied health personnel in the diagnostic and therapeutic uses of radioisotopes.

During the past year, two types of courses were offered: a training course for Medical Technologists, with 13 students; a Clinical Applications Course, with 7 students. This training drew students from a broad geographic area,

Clinics) research focuses upon the use of radioisotopes to study thyroid disorders, such as the application of minimum doses of I-131 to control hyperthyroid states, and the study of the effect of external irradiation on thyroid function. Work is also being carried out in the study of liver disorders, renal blood flow, tumor localization, and on the detection of pulmonary emboli.

Future plans call for the introduction of more advanced techniques to the study of clinical problems. New areas for teaching and research under consideration are: the more intensive use of short-lived radioisotopes with high speed scanners and scintillation gamma cameras; the use of new radiopharmaceuticals that may be locally produced by PHNC's Chemistry Division; the use of radioactive tracers to study pulmonary function and circulation; the search for improved diagnostic and therapeutic procedures which may result in better understanding of disease and management of the patient.

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Health and Safety Division

This division has a triple role at PRN: it provides educational and research programs; it provides the services needed to safely operate the Nuclear Center, such as monitoring personnel and the area, calibrating equipment, waste disposal, and handling of radioactive materials,

An 8, degree program is conducted in conjunction with the University of Puerto Rico School of Medicine. This program, in its second year, has six students, including one each from Colombia, Mexico and Israel. An eight-week course in Radiotherapy Dosimetry for 15 physicians from Latin

America is now being organized, under the sponsorship of the ZARA.

Research efforts center upon maximizing information on dose ratio in Scintigraphic and Radiographic procedures, Basic studies in image formation, Information transmission and assessment, and Imaging performance are being initiated. In addition to a recent paper on exposure slit modulation transfer

functions, theoretical studies on the effects of screen phosphorescence on the temporal modulation transfer function, and the modulation transfer function of scanning apertures are near completion. It is hoped to establish a coherent optics laboratory facility to study image manipulation in Fourier space, and signature analysis as a diagnostic tool for screening procedure.

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Medical Sciences and Radiobiology Division

This division offers training and research in fundamental nuclear energy aspects of biology, radiation biology, biochemistry, molecular biology, virology and medicine.

Research is directed in large part toward biological problems encountered in tropical areas such as Puerto Rico and most of Latin America,

The Division has cooperative programs with different working groups in Latin America: with the Brazilian Group on Schistosomiasis of Belo Horizonte;

and with the Veterinary Institute for Tropical and High Altitude Research, in Peru, especially in research on parasitic diseases. A cooperative program with the Biological Section of the Argentine Atomic Energy Commission #4# being considered.

Much of the research has centered on the effect of internal and external radiation in the host-parasite relationship in viruses, and in human and animal parasite

A schistosomiasis project has studied the immunological mechanisms and biological control of this disease, which is considered the number one health problem in many areas of the world, and remains a serious problem in Puerto Rico.

A new project studies *Fasciola hepatica*, a cattle liver disease which affects the wool industry and meat and milk production in much of Latin America

A virus project studies the effect of irradiation on virus infections.

Efforts in this project are directed to find the mechanisms of the host-parasite relationship, and in doing so to answer fundamental questions in virology, usually dealing with the latency of viruses, especially arboviruses, transmitted in the tropic:

?The trypanosomiasis project deals with the effect of irradiation on host-parasite relationships at the cell and animal level. This parasite infects approximately 7 million persons from the U.S. southward to Argentina. No preventive or curative agents are known. A new type of tissue culture cell line derived from a murine chondrosarcoma, more sensitive to the infection than any other tested, was developed at PRIC's laboratory in FY's 1968 and 1969. This cell permits the cultivation of the parasite starting from one organism, and is also an ideal method for quantitative work,

Future plans include: more integration with the Puerto Rico Medical Center and Medical School, and with the Graduate Program of the University of Puerto Rico; participation in the planning of a multinational center for parasitic diseases in Latin America; raising the level of microbiological research, using electron microscopy, and biophysics) and molecular techniques.

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?Nuclear Engineering Division

?This division teaches graduate courses at UPR, Mayaguez, and conducts research in nuclear engineering. The staff also directs thesis research of nuclear engineering students from the UPR and from other universities in the U.S. and Latin America. The division also offers short courses for scientists, engineers, and technicians, and for staff members engaged in individual research.

?At Mayaguez, the UPR (in cooperation with PRNC's Nuclear Engineering Division) offers the Master of Science Degree in Nuclear Engineering. ?The UPR faculty for this field is comprised largely of PRNC staff members; the director of the UPR department heads the TRC division as well.

In the past three years, 11 students have received their M.S. degrees, 6 others are working on their thesis, and 7 new students are engaged in course work.

Research is being conducted in the areas of reactor kinetics, Plowshare, pollution control, activation analysis techniques, and material irradiation.

Future plans call for the more intimate integration of computers in the Program. Within two years it is hoped that a time-sharing computer terminal will be situated in the Division offices. Plans also call for a six week

Plovahare Institute to be offered for professors from Latin American universities, possibly in February 1971.

A plowshare-type research project within the Nuclear Engineering Division is a study of in situ leaching by nuclear devices. Studies have been focused on the hydrometallurgical aspects of chalcopyrite (CuFeS_2) in relation to underground mining. Chalcopyrite is one of the most abundant copper ores, but is also considered the most insoluble copper sulfide. Studies include the search for new leaching agents that may produce copper solubilization via long-term leaching time is applied. Recent research has uncovered a possible cheap, readily available solvent for chalcopyrite.

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Nuclear Science Division

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This division supports the graduate level programs at the UPK's Chemistry and Physics Department in Yaguajay, It provides personnel to teach graduate courses and thesis research opportunities for M.S. degree students. Research

facilities at the pre- and post-doctorate levels are available.

There are (late 1969) eleven graduate students from the Physics, Chemistry and Electrical Engineering Departments carrying out research under the supervision of MLI's staff. Five former M.S. students are doing Ph.D. studies at schools on the U.S. mainland (U. of California, Santa Barbara, J. of Pennsylvania, Carnegie Tech, MIT, Harvard). Some former students who now held academic and directive posts at various Latin American universities (Bogotá, Panamá,

El Salvador, and in Ponce, Puerto Rico) have begun research projects along the lines of research performed at PANC, and keep in close contact with the Center.

Research--The Electron Spin Resonance Spectrometer was set up in March 1969. Since then, data has been collected on γ -irradiated single crystals of solid potassium, lithium and cesium trihydrogen selenites. Work is also being done on radiation chemistry of aqueous solutions of organic sulphur compounds in order to determine the importance of sulphur as a radiation protective agent. Another scientist is investigating the mechanism of radiolysis of peptides in aqueous solutions. And another scientist's interests lie in the critical behavior of ferro and antiferromagnetics. Guest researchers include one from the United States and 2 from Latin America.

Two separate research programs are in the area of Nuclear Science. The Neutron Diffraction Program is generally concerned with ideal and imperfect arrangements of atomic nuclei and magnetic spin systems in solids. The scope of the project includes: the magnetic structures of inorganic salts, and the

determination of the role of hydrogen in structures of importance in solid state physics and chemistry.

The Hot Atom Chemistry program investigates the products formed when an atom covalently bound to carbon undergoes nuclear recoil. The recoiling elements have included the transition metals and heavy metals, as well as non-metallic atoms. The carbon compounds employed have been phenyl derivatives, malonates and metal carbonyls. The purpose of these studies is to determine the mechanism of high energy reactions in organic compounds through a study of the products formed under different activation conditions. The possibility of directly preparing compounds and of obtaining radioisotopes of high specific activity by recoil methods is also being investigated. Joint research programs are planned with Mexico, Venezuela and Colombia.

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Physical Sciences Division

The long-range objective of this division is to offer advanced training opportunities for Puerto Rican and Latin American trainees, primarily through participation in research projects which involve the use of high energy radiation and radioisotopes. Since this program is geared to regional needs, it includes an introductory training course in the use of radioisotopes, and PRIC's

scientific personnel participate strongly in the academic activities, via joint appointments, of the natural science departments at the UFR campus in Rio Piedras.

Education activities range from a four-week non-credit training course in the use of techniques of radioisotope applications, to research training at the Center's Laboratories. In recent years, there has been a significant increase in the number of research participants, as well as in the ratio of persons who actually use radioisotopes in their professional work, following their training at UFR.

Research is being carried out on: (1) Stereochemical effects in the gamma radiolysis of cis- and trans-1,2-dimethylcyclohexane; (2) radiation-induced addition of thiophenols to indene; (3) tritium recoil labeling of Lithium Polymethylacrylate; (4) product isolation studies of the gamma radiolysis of heterocyclic nucleosides; (5) radiation damage in organic crystals; (6) oxidation of α -olefins; (7) Influence of chemical structures on quenching in Liquid scintillation counting; (8) calculation of C^{13} chemical shifts, and (9) molecular orbital calculations on lactone-lactin tautomers, and on aminophenols and aminothiophenols.

Other research groups are also involved in physical science studies.

The Solid State Physics Projects studies radiation damage on anthracene,

phenanthrene and other organic crystals. It is felt that such studies on well-defined crystalline structures can provide a firm foundation for a later study of more complex materials, including those of direct biological interest.

Present research works concern: (1) electron spin resonance (ESR) measurements in anthracene, 9,10-dicyanoanthracene and deuterated anthracene; (2) the quenching of the triplet quenching radiation damage in anthracene; and (3) photoenhanced space charge limited currents.

Four students are engaged in thesis research at the laboratory during FY 1969, compared with 2 in FY 1968.

The Radiation Chemistry Project aims at trapping and subsequently characterizing the species formed by gamma-radiolysis of heterocyclic molecules

which are of possible biological importance. Direct observation of labile intermediates formed following absorption of high-energy radiation is emphasized.

This is made possible by using the matrix isolation technique, in which the molecule is irradiated in some form of rigid matrix, usually at low temperature.

Current research topics are (1) absorption spectra of radiolytic intermediates at TPR; (2) thermoluminescence following radiolysis at 11°K; (3) thermoluminescence and ESR signals following radiolysis at room temperatures; (4) photo-

ionization in rigid glasses at 77K, and (5) self-consistent field calculations on heterocyclic radicals and radical ions. A new project on energy transfer processes with emphasis on steric effects is planned. It is planned to appoint the following scientific staff by Latin American post-doctoral fellows within the next few

years,

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Batioscology Division

?The Radioecology Diviaion eduinisters two major research projects:

(1) the Terresteini Heolozy Prost in the BI Yunque Ralu Zorest, east of Ban Joan; end (2) the Marine Biology Progran, ron PRNC Kaysguex.

Terrestrial Eeolozy

This progran, now in its eoveath your, was designed to study the radicacology of a tropical rain forest, by Anstalling a Cesiua-137 source in the area, and

king extensive follov-up studios. Wo einilar stuty las been carried out in

?any tropical area of the world. The first four years vere devoted to investi

galing the effects of ganna raliation on the forest's ecosystem. Beginning in

1966, emphasis was shifted to the economic objective: the assessment of fallout radionuclides. This objective has since been modified to include the cycling of both radioactive and stable isotopes in the area. The cycling studies were further divided into four categories: (1) fallout radionuclides; (2) tracer experiments; (3) stable element analyses; and (4) water balance measurements. Since 1956, the movements of $Ce-134$, $Sr-85$, $Hn-54$ and $Zn-65$ in plants, animals and soil water have been studied and reported. Experimental work on the movement of tritium in plants and soils has been successfully studied. Current research includes studies on insect ecology, movement of selected isotopes through the animal food web, element input via rainfall, and its subsequent distribution in the forest, recovery in the irradiated area, movement and distributions of previously applied isotopes in the soil, plants and animals. Future work will be directed towards the systematic study of the movement of selected radioisotopes in both the biotic and abiotic components of the forest. Increased emphasis will be placed on the physical and chemical properties of forest soils, and the movement of macro and trace elements via soil water to the stream.

A new field study station is planned for the Commonwealth Forest Reserve in Western Puerto Rico. This will deal with trace element movements in a tropical forest, and will be integrated with the Marine Biology Division's current

Jovian river and valley studies.

Marine Biology

Marine Biology scientific studies trace element movements from a land mass into sea water, marine organisms, and bottom sediments, and investigate the cycling of those elements into the food webs and in the open sea environment.

This program is important because it directs itself to problems of marine contamination from nuclear-powered ships, nuclear power sources for marine and space applications, waste disposal, and Polaris-type projects.

A feasibility study was completed two years ago for the Interim of Panama, sea-level canal. Current research studies basic mechanisms which the canal studies program revealed to be essential in future work. These include precipitation and coprecipitation reactions in the areas of mixing river water (with suspended sediment) and marine waters, coprecipitation of radionuclides by stable material in fallout from excavations with nuclear explosives, and other relevant data. A new research vessel is expected to be in operation by late FY 1971 or early FY 1972, which will increase the efficiency of field work and

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Murine Diedery (Rudloceedogy Div.) Contd.

provide sea-going capability for future surveys and special research problems.

During the past year, throe new Juvestigators Joined tho staff: one on a

Bureau of Commercial Fisheries Training foliovehip, to investigate phycieaL

fani chemical mecharisns in the Arasco Hiver} another tron Oregon State University,

to investigate the distribution patterns of carrier-free nuclides in solution

fant on bottor ant suspended cediueents in mixtures of vhole river and sea water}

and a third, fron Ouk Ridge Laboratory, to study mangrove forests.

In general, the emphasis of work in the Marine Biology program is directed toward immediate needs of the ABC in peaceful uses of nuclear explosives and in power reactor development. In FY 1972, plans call for « new study of radiation effects upon tropical reefs, or mangrove groves. A feasibility study is now being prepared for this program.

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Radiation and Cancer Division

This division trains physicians and allied personnel in all aspects of the application of nuclear energy to the treatment of cancer. A residency program approved by the American Board of Radiology, prepares qualified radiotherapists. The program functions at the Tertio Loco Hospital Center, primarily at the

T. Ginzler-KartSnez Oncologic Hospital (adjacent to FRI, Rio Pieares).

Cancer research centers on the use of radiation in treating the disease.

The extensive facilities and patient load of the hospital (which treats medically andigent patients) are used for clinical studies related to the evolution of treatment results with different therapeutic methods, and to time-dose fractionation relationships in radiation therapy. Laboratory studies include work with cell cultures and irradiated animal tumors. Epidemiological studies on various forms of cancer of notable incidence in Puerto Rico are also conducted.

At present three doctors (two from Puerto Rico and one from Colombia) are being trained by the division. There are six clinical research projects underway, and the division also collaborates on four nation-wide cancer research Projects.

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The Reactor Division

The primary purpose of this Division is to operate and maintain:

- (2) one 367 pool-type research reactors
- (2) 916i, aqueous-homogeneous 1-77 reactors
- (3) « Co-60 gaseous irradiation facilities
- (4) 9 an reactor, and
- (5) high speed hot cells.

The pool-type research reactor is to be converted to « 246) thermal, constant power reactor with a pulsing capability of 2000 during 1970.

The division also supports FMC's education program, offering courses for reactor operators, and reactor supervisors.

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ANIC has engaged in joint project with Puerto Rico's Dept. of Health:

Department to survey X-ray equipment in Puerto Rico and evaluate average

Bonstedt's radiation dose in order to recommend how doses may be limited

Without diminishing the diagnostic value of the procedure. It was found that

direct lead shielding can eliminate such potentially harmful dosage to

abdominal X-ray alignment, and recommendations have been made that shielding

should be required by law.

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