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anthracene crystals. Lisandro Vargas Zapata (Colombia), Study of radiation-induced electron traps in anthracene crystals. 4. Femando Goeneo Very (Ontario), The Daurie Injections in Arcane Gye, Chemistry. 1. Bisa Géinoz Audrines (Puerto Rico-USA), The relationship between quenching in liquid scintillation counting and chemical structure (She uses 137Cs as an emitter). 2. Hilda Aledo (Puerto Rico-USA), The relationship between quenching in liquid scintillation counting and chemical structure (She uses 90Co as an internal conversion electrons emitter). 8. Sonia Vizquez (Puerto Rico-USA), Metallic complexes of heterodihydroanthracenes. 4. Agnes Costa (Puerto Rico-USA), Tritium recoil labeling of lithium organic salts: radiochemical yield and molecular distribution of the labeling. 5. Rafael Pereira (Colombia), Tritium recoil lab retention vs. inverter. 6. Juanita Freer Calderón (Costa Rica), A rearrangement in the chromic acid oxidation of arylothiophenes. [Nuclear Engineering Division]. 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 Concrete as a Function of Temperature. 8. Braulio Mejías (Puerto Rico-USA), Instrumental Methods in Neutron Activation Analysis. 4. Fernando B. Pli (Puerto Rico-USA), Effect of Gamma Radiation on Organic Materials in Aqueous Solution. ---Page Break--- Health Physics Division. Health Physics 41, Efigenio Rivers (Puerto Rico-USA), Measurement of Neutron Spectrum of the PRNC IMW Reactor. Radiobiology 1, Jorge Pérez Rivera (Puerto Rico, USA), Possibilities of the Existence of HRP (Horseradish Peroxidase) Molecule in a Partially Damaged Condition. ---Page Break--- “wion oo‘ore't _(6D6r ‘OF eT wep Tie aT coon r 00000" L " P ontyg wr edoa Sie 00°00" . ma |W = souag aeajo0Ny speed U4 908g SIN coon SS evone't | oosrcs omer er 1s wemawemaan | auemy | Sanenpenmyommoe | oo'oot

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Training—particularly in food irradiation—has attracted students and scientists from Thailand, Mexico, and Guatemala. The long-range research goal is to help improve living conditions in

tropical areas, such as the Caribbean and South America. A mutation breeding study of the soybean aims 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 food 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 resonance 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 their 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. Soil 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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The Clinical Radiotherapeutics Applications Division Located in PAHO's Río Piedras installation, this division trains physicians and allied medical personnel in the diagnostic and therapeutic uses of radiotherapy in humans. 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 radionuclides 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 gases 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. ---Page Break--- Health and Safety Division This division has a triple role at PRN: it provides educational and research programs; and 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. A 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 procedures. ---Page Break--- +18 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 Biomedical Section of the Argentine Atomic Energy Commission is 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 parasites. 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 that 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, most common in the tropics.

trypanosomiasis project deals with the effect of irradiation and host-parasite relationships at the cell and animal level. This parasite infects an estimated 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 so far 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 biomedical research, using electron microscopy, biophysics, and molecular techniques. ---Page Break--- 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 UFR 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 PRIC's Nuclear Engineering Division) offers the Master of Science Degree in Nuclear Engineering. The UFR faculty for this field is comprised largely of PRIC staff members; the director of the UPR department heads the TRC division as well. In the past three years, 11 students have received their B.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 Plowshare 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 mining 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 when long-term leaching time is applied. Recent research has uncovered a possible cheap, readily available solvent for chalcopyrite. ---Page Break--- -15. Nuclear Science Division This division supports the graduate level programs at the UPK's Chemistry and Physics Departments in Mayagüez. 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 (as of late 1969) eleven graduate students from the Physics, Chemistry, and Electrical Engineering Departments carrying out research under the supervision of M.S. staff. Five former M.S. students are doing Ph.D. studies at schools on the U.S. mainland (U. of California, Santa Barbara, U. of Pennsylvania, Carnegie Tech, MIT, Harvard). Some former students who now hold academic and administrative posts at various Latin American universities (Bogotá, Panama, 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 y-irradiated single crystals of sodium, potassium, lithium, and cesium tri-hydrogen selenites. Work is also being done on

radiation chentstay 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 antiferroelectrics. Guest researchers include one from the United States and two 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 stoichiometric 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 metals have included the transition metals and heavy metals, as well as non-metallic atoms. The carbon compounds explored have been pheny derivatives, molybdenum complexes 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. ---Page Break--- “16. 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 techniques of radiol isotope 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 radiol isotopes in their professional work, following their training at FIC. 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 Polyacrylate; (4) petrix isolation studies of the gamma radiolysis of heterocyclic molecules; (5) radiation damage in organic crystals; (6) oxidation of allylbenzenes; (7) Influence of chemical structures on quenching in Liquid scintillation counting; (8) calculation of chemical shifts, and (9) molecular orbital calculations on lactone-lactam tautomers and on aminophenols and aminothiophenols. Two research groups are also involved in physical science studies. The Solid State Physics Project 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 C14H10 and deuterated anthracene C14D10; (2) the connecting 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 1970, compared with 2 in FY 1969. 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 temperatures. Current research topics are (1) absorption spectra of radiolytic intermediates at TPR; (2) thermoluminescence following radiolysis at 11°K; (3) thermoluminescence and EPR signals following radiolysis at room temperatures; (4) photoionization in rigid glasses at 77K; and (5) self-consistent field calculations on heterocyclic radicals and radical forms. A new project on energy transfer processes with emphasis on steric effects is planned. It is planned to augment the scientific staff by recruiting American post-doctoral fellows within the next few years. ---Page Break --- same Radioecology Division ‘The Radioecology Division administers two major research projects: (1) the Terrestrial Ecology Project in the El Yunque Rain Forest, east of San Juan; and (2) the Marine Biology Program, run from PRNC Kayaguex. Terrestrial Ecology This program, now in its seventh year, was designed to study the radiocology of a tropical rain forest, by installing a Cesium-137 source in the area, and making extensive follow-up studies. No similar study has been carried out in any tropical area of the world. The first four years were devoted to investigating the effects of gamma radiation on the forest's ecosystem. Beginning in 1966, emphasis was shifted to the second objective: the measurement of fallout nuclides. 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 measurements; (2) tracer experiments; (3) stable element analyses; and (4) water balance measurements. Since 1956, the movements of Ce-134, Sr-85, Mn-54, and Zn-65 in plants, animals, and soil water have been studied and reported. Experimental work on the

Movement of ‘tritium in plant 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 from 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 ongoing river and valley studies. Marine Biology

activities study trace element movements from a land mass into seawater, marine organisms, and benthic sediments, and investigates 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 plowshare-type projects. A feasibility study was completed two years ago for an Isthmus 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 sediments) and marine waters, coprecipitation of radionuclides by stable material in fallout-free 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 ---Page Break--- o18- Murine Diedery (Rudloceedogy Div.) Contd. provide sea-going capability for future surveys and special research problems. During the past year, three new investigators joined the staff: one on a Bureau of Commercial Fisheries Training fellowship, to investigate physical and chemical mechanisms in the Arasco River; another from Oregon State University, to investigate the distribution patterns of carrier-free nuclides in solution found on bottom and suspended sediments in mixtures of whole river and sea water; and a third, from Oak 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 a new study of radiation effects upon tropical reefs or mangrove groves. A feasibility study is now being prepared for this program. ---Page Break--- -19- Radiotherapy 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 Terto Ico Medical Center, primarily at the T. Gonzalez-KartSnez Oncologic Hospital (adjacent to FRI, Rio Piedras). Cancer research centers on the use of radiation in treating the disease. The extensive facilities and patient load of the hospital (which treats medically indigent 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 nationwide cancer research projects. ---Page Break--- =20- The Reactor Division The primary purpose of the division is to operate and maintain: (1) one 367 pool-type research reactor (2) 916i, aqueous-homogeneous 1-77 reactors (3) Co-60 gamma radiation facilities (4) one reactor, and (5) high-level hot cells. The pool-type research reactor is to be converted to a 246 thermal, constant power reactor with a pulsing capability of 2000 during 1970. The division also supports FMC's educational programs, offering courses for reactor operators and reactor supervisors. ---Page Break--- ANIC has engaged in a joint project with Puerto Rico's Department to survey X-ray equipment in Puerto Rico and evaluate average background radiation doses in order to recommend how doses may be minimized without diminishing the diagnostic value of the procedure. It was found that adequate lead shielding can eliminate much potentially harmful dosage from abdominal X-ray diagnostics, and recommendations have been made that shielding should be required by law. ---Page Break--- ---Page Break---