PRNC098

PRNC - 99

PUERTO RICO NUCLEAR CENTER

PROGRAM ABSTRACTS

May 1967

Speotal Teaue for

Radlation Research Sootety Nesting

May 7-11, 1967

San Juan, Puerto Réeo

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PRNC - 98

PUERTS RICO NUCLEAR CENTER

PROGRAM ABSTRACTS

May 1967

«7 OPAATEO BY UNIVERSITY OF PUBLTO RICO UNDER CONTRACT NO. At (40-1)-1899 FOR UL 5. ATOMIC EMIRGY COMMISSION

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FOREWORD

?The urgent acceleration of econoaic develoment of the countries of latin Merica requires the most effective application of all relevant technologies, anong which those involving miclear energy mst rank high. Further, the groving concern of the United States with the probleas of ?the tropics tends to increase the densnds upon the existing scientific research centers which are tropically located.

Here in the tropical environment of Puerto Rico, many of the funda~ mental problens of development found in Latin Anerican countries are Deing attacked most vigorously. Puerto Rico now has one of the highest retes of econonie grovth in tho vorld. Tho achiovenents in public health during the past tonty years have been dramatic. Although many of the solutions may not be fully applicable to other countries, Puerto Rico is ?a comunity in vhich the fundamental requirenents of successful Latin

?American economic developuent nay be explored.

Te Puerto Rico Muclear Center is university-ageociated institution devoted to the application of miclear energy both to problems of the tropics and to the fulfillment of the educations] needs of scientists of Latin Anerica in the miclear field. The escentiul thesis 1s that fruttful econeate development takes place upon a foundation of good technology and the latter is an educational responsibility. The ticlear Center 4s therefore directed to enlarging the competence of young scientists

land engineers who wilt becoae the future leaders in the educational systens of their countries.

?The program presented in these abstracts reflects the fundamental objectives of the Center in graduate education and in the research related to its mission and to its location. The Center's educational progran is sponsored by the US ABC Division of Nuclear Bfucation and Training. Research prograns are sponsored by the US ABC Divisions of Biology and Medicine, Physical Research, Isotopes Development, and Technical Information. In addition cone research is sponcored by

?the Interoceanic Canal Comission.

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TABLE OF CUNTENTS:

RBBRE Fou

DIVISION OF PHYSICAL RESEARCH

Solid State Physics Progr

Neutron Diffraction Progra

Hot Atca Cheaistry Progras

Bee

DIVISION OF BIOLOGY AND MEDICINE

?Terrestrial Ecology Prograu I: The Rain Forest,

Project - :

Marine Blology Program +...

Estuarine and Marine Ecology Study - Specific

Activity Approach .«

Schistosomissis Project =

Sugarcane Borer Progra

Besonanee in Radiation Progra

Radiation Cheaistry and Photocheaistry Program «+.+.+

DIVISION OF ISOTOPES DEVELOPMENT

Radiation Preservation of Tropical Foods «++e+ss+++

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Briel Histry of dhe i verw nics Nuciear Sener

At the 1956 Panana meeting of the Organtzation of Auericon States President Fisenhower urged action by the Os to moten the beneficial uses of miclear energy. The needs and potentials of Latin Anerican countries vere studied by Admiral Paul Foster, then Deputy General Manager of the Unite States Atcuic Energy Coanission. This study found great need for technical training in a latin anerican franc work to make available the latest xnowledge and technology in the field. As a Feeult JAdnirel Foster recomendea to the US ABC the ?creation of a Tuclear Center in Puerto Rico to be managed by the University of Puerto Rico. The recmnendation was approved by the Conmiseion and by the Department or State.

Joint planning studies vere initiatea by the University of Puerto

Rico and the US ABC for the proposed hiclear Center. ?The responsibility for implenenting ond adninistersng the contract for the new Center was assigned to the Oak Ridge Operstions Office whose Operations Manager, Hr, Sam Sapirie, negotinted vith the University the contrect which gave mubstance ant direction to the original concept.

[As part of the forward planning, the Tenth Oak Ridge Regional Sys posiua war held at the University of Puerto Rico in Jamary 1957. In fan address to the Symposium, Chairman Levis L. Gtreuss of the Atenic Energy Commission sai2: "The broadened program will provide the University of Pierts Rico vith unique training ond research Meilitie

And because these facilities will be truly outstanding-<the aost up-fo-date in concept and design--and becauce the instruction wil! be in Spanish, the University of Puerto Rico may well becene a training center to many countries of the horisphore. T can tell you that we Will cooperate entiusiagtically in the expansion,

In January 1957, Chancellor Jnine Benftee appointed an At oc Con mittee of the University fucuity to explore the development of graduate work in the natural seiences ot tha University of Puerto Rico, with particular reference co possible developments in the field of mclear energy. This Comittee recommended to Chancellor Benitez the establish- ment of graduate studies and research at the University and that the proposed muclear reactor be located in Mayaguez.

Representatives of the US ABC and the University of Puerto Rico signed contract AT-(40-1)-1833 to operate the Nuclear Center on Gctober 2, 1957. The University agreed to operate the facilities land program on a cost-reinbursable backs tut without fee.

Dr. Charles F, Bonilla froa Columbia University served as Director of the Buerto Rico Thiclear Center for two years beginning October 19573 Dr. José L. Garefa de Quevedo was appointed Head of Research and Head of

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the Reactor Divisions Dr. awador Cobss wis ap

Seotopes Divieions ?in DF. Fret Soltors was mee Woad of the Buclea Science and Technology Division. free Ostober 1959 until June 1560 Dr, José L. Gaels de Quevedo served us Acting Director. On Juiy ly 1960, Dr. Jotn C. Bugher, was appointee Director of PHC. Dr. Bughor served on loan roa the fockefeiier Foundstion ot the request of UPN Chancellor Benfter. In October if, Dr Henry J. Gomberg, sho had served us Director of the Phoonix sisiori) Projest at the University of Michigan, wie appointed Deputy Director.

inted Head of the Ridlow

On Jaly A, 1958, grounsbresking vormonies for the Reustor Bailding of PREC vere hold in ?ayaguer vith Dr. illlton Eisenhower acting as official representative of the U. 3, dovornsent. On August 23, 1960, the PHNC Research Reactor, ° 1 meguvatt /WiP pool-type unit, was dedicated,

In April, 1959, an 8000 curée Cobsit~60 Therapy Unit was installed fat the Cancer Hospitel where it resaincd antil transfer to the Bio-Medical Biiiding In early 163. Tn April 1962, the Tirst section of the PHIC Big-ilediea) Mullding located in the now Puerto Rico Hedicel Center at Rio Pisdras sms occupiad. In Januiry 1963 the nev Dr. T. Gonadle: lareines On-ologle Hospitl ns enugureted. This hospital As adjacent to the P:IC Blosiledical MuiLiing ?ind the PRIC Radiotherapy

Division serves ois ns tho Radiotherapy Nepartnent of the Hospital. This enabled al) PIC neaical divisions to be united for the first tine.

In 1963, the Hharine Biology Progrom sequired fron the U.S. Amy a 200 ton dicesel vergal rename? "Shiai". Mais yosce! Mas proved to be excellently adapted to the requirenonts Sr the oceanegoing opemtions Of PRC. Tn 1966 2 second vessel, "Tho Horry Ark", was acquired in anticipstion of adiitiona! marine biologic survey work. The PRIS Marine Blology group wis selected to do sctuarine ani marine ecolo~ gical studies in Fenane during 1967 in conjunction with current trans~ Sethmus canal statics.

In 1963, 2 lange tract of innd in the iuguitlo Experimental Forest

woe made avalluble uy the U, &. Torestry Service to PRIC ae the site of & Terrestrial Beology Progrin. In 1965, » 10,000 curle vesiua-137 Source was placed #9 that a portion of lover aontane rain forest ws exposed to guna trralistion for 99 duys. Extensive posteirradiation studies contine in this aren.

In Hlovenber 1966, Dr. Joka C, Bugher retired fron the Rockefeller Foundation and is Director of PAIC, Under nis direction the PRIC educa ?ional program wis noved former into the cridyate and post-gratuate Levels, together sith « continually expanting research program enpha-sizing nany provlens best spproachod in a trepioi? snvironaent.

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In Novenber 1966, Dr. Henry J. Goaberg was appointed Director of PRIC by University of Puerto Rico President Beniter and the appointaent yas confimed by the Council of Higher Biucation. At this tine, Dr. Amador Cobas, who had served as Associate Director for the San Juan-R{o Piedras operations of PRIC since September 1959, wis appointed Deputy Director

for all operations. Dr. Victor A. Marcial, Head of the Radiotherapy and Cancer Division since its establisient in July 1958, was appointed Associate Director for Medical Programs. Dr. Oven H, Wheeler, Head of

?the Division of Miclear Science and Technology since 1962, was appointed Associate Director for Mayaguez operations.

?The total staff of the Miclear Center at the end of its first year of operation (FY 1958) numbered li3, At present (FY 1967) there are ?approxinately three hundred persons ouployed at PANC. The Center? ?educational progran is sponsored by the US ASC Division of Iiclear Baueation and Training. Research prograns are sponsored by the US

ABC Divisions of Biology and Medicine, Physical Research, and Isotopes Development. Additional research is sponsored by the Interoceanic Canal Couns seion

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Clinical Applications bivision

SOF

Sergio Irizarry, M. De, Chief solentist IT, Head; Aldo E. Lanaro,

mM. Dey Associate seientsct 11; Pedro Juan Santiago, M.'D., Associate

Setentist I (Part=Tine).

PROS

?he sain purpose of the program of this Division is teaching and

training of Latin American physicians in the diagnostic and therapeutic

uses of radioisotopes in husans.

come svATUS

Courses Available:

1. Basic Course Chinical Apolications of Radioisotope, This

course conetts GF isreat Teste, denonstrations, periods cf dice

Gussion and laboratory vork, Tte asin purpose is to enphasize training

in the use of clinical radioisotope techniques.

2, Orlentatica Course Clinical funLications of Radiotestenes for

Medical Regidents. hia Te a non credit senester course ror Nedical

Residents designed for orientetion only in the medical uses of radic~

isotopes.

3. Couree in a Medical Srecialty. This ic a course emphasizing ?the application of miclear techniques in a special field of Medicine. A twerweck course in the field of Pediatrics vill be offered folloving the Basie Course in Clinical Applications ef Fadioicotopes in February ?and June 1967.

4, Training in Clinical Research, This course stresses research aspects in Clinica! Nedicine, and ie designed to provide research fack~ USties to trainees interested in clinical radios gotope research work.

Special activities to increase the musher of prospective candidates for the training courses have included several trips to South America by Dr. Lanaro during which he has vieited hospitale, universities and other institutions and participated in scientific mectings.

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Many prospective trainees would cone to Puerto Rico provided maintenance expenses could be provided.

Glinical Research:

To couplenent the training progran, research projects are active

in the areas indicated:

1

2

3

?Thyroid dtsorders

Concer detection

Gastrointestinal absorption

Problens of clinical radiation

Liver and kidney d.gorders

2

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Radiotherapy and Cancer Division

oO

Victor A. Marcial, ti, D. Chie? Sclentict If, Head; José H. Tend,

MH, Di, Chief Siientict 1; Joanno Ubifse, 1. De, Chor seientiet Ts

Antonio Bosch, Ii. D., Chie? Scientist I} Maria?? de Lozano, Me Sy

Regcarch Associate T; 2enaida Frias, i, S., ledi¢al Nesearch Statistician.

PIRPOS,

?The main ourpose of thie Division ie to train physicians and allied

personnel in all aspects of the application of muclear energy to cancer.

?A second purpose ie to develo and carry cut a research progras to

improve cur knowledge in the cancer and radiation Tield;

connent staus

Thie Division offere tre programs in Radiotherary Treining:

(2) Radictherany Recidency Progran, The objective of this

progran ie to prenare qualities radiation therapiste, Thie 1a an

approved progran that fulfille the requirenente of the Anerican Boar

of Radiology. Physicians with a year's Internship or equivalent clinical

experience are accepted Tor this training. the total training pericd

lasts three years, but trainees are required to take an additions)
fourth year of supervised practice (preceptcrshtp) before adnizaicn to
?the specialty examinations. Trainees acquire a solid background in
clinical cancer threugh suerviced werk with nev, follev~up, and
hospitalized cancer yatients. They learn to diagnose the disease,
Acternine the extent ci the sue, choose the appropriate treatment,

and plan and conluct radiological therapy. Radiation therapy experience
is acquired by working vith rcentgentheragy machines of varicus volteges
and teletherazy units, which include ecbalt and cesiun, and with the
application of radicactive material sucn as radius, strontium, cobalt,
and iridiue.

Trainees sizo becone faniliar with non-radiclogical cancer
treatzent methods, much as surgery and chenctherany. In addition,
?they learn of cancer contre! activities in Puerto Rico; thie inclwtee
?the opam tion of a Central Cancer Regictry, turor clinie work, eancer
@etection, ani public and professional educaticn in cancer.

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(2) Special Short Term Radsotherapy Training Course. Special programs are prepared according to the needs of the person. Perticipants ey engage in @ research project and may participete in all. teaching Sctivities of the fadiotherapy and Cancer Division; but are not given patient responsibility.

?An additional training activity 4s offered for Fourth Year Medical Students. Selected candidates receive one month of intensive in-service training, vbere they are exposed to cancer and radiotherapy clinical robles

Bxperiences radiotherapists fron latin America are hired as visiting staff, ?This pereits then to becone acquainted with the work of this Division end to carry out research projects

?To complenent the training prograas, a munber of research projects are active in this Division. ?These include: (1) Investigation of the Role of Surgical Sterilization in the Etiology of Cancer of the Uterine Cervix; (2). Study of Fractionation of Weekly Radiation Doses in Cancer Patients Under Radiotherapy; (3) Carcinons of the Uterine Cervix Ass0~ ciated with Pregnancy; (ls) Deterainations of Optimal Tunor-Dose in Radi- ation Therapy of Cancer of the Esophagus; (5) Controlled Study of the

Split-Dose Technique in Radiotherapy of Cancer; (6) Study of Chronocone Changes in Patiento Undergoing Radiation Therapy for Cancers (7) Bxfolia~ tive Cytology as a tool for Determining Prognosis in Cases with cervical Carcinana Sumitted to Irradiation; (6) Surgical Adjuvant Breast Project; (G) Study of the Incidence of Leukemia in Patients with Cervical Cancer ?Treated with Radiations (10) Clinical Dose-Tine-Fractionstion Relation-ships.

?This Division 4s collaborating in various research projects conducted by other Divisione of PRIC; these are: study of thyroid function in patients with neoplasia, tinor localization studies, gastrointestinal absorption Studies, noraal and neoplastic tissue cell-cycle studies, mice L.D.-50 studies, etc.

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Agricultural BioSciences Division

SsuuF

Robert A. Iuso, Ph. Di, Chic? Scientist, Head; Joo? A, Ferrer Monge, Th. De, Chier? Ssienvicts Francie K. 8." Koo, Ph. D., Associate Selentist IT; Dovid W. Walker, Fh. D., Associate Sientist TI; Swreekant HW. Deshrante, Ph. D., Agsoclate Scientist 1; José Cuevas, M, S., Research Aesociate I.

PURPOSE,

?To train stulents at the graduate and the post-graduate level
for research in agriculture or biology, emphasizing micleer techniques.

?T carry on continuing basic research programe which ore concerned
with problens in tronical agriculture that can be uniquely studied by
nuclesr techniques.

stmaTUS

I. Bdueation and Training

Bight etudente currently are working tovard M. 8 degrees in
biology and agriculture--degreee hich will be awarded by the
University of Puerto Rico upon completion of course vork and
?experimental thesis. In the last five yeare, several ctuiente
have continued on for doctoral training in U. 8. universities.

In the last year Five persons have done vost~eraduate research
In the Division, supported through fellowships from IABA, ORINS,
OAS, and the Peace Carpe. These trainees spend from 1 to 15 monthe

fat PRIC taking courses and/or participating in research projects. They then return to their hone country to develop eeientitic projects there (e.g., in Taivan, Uruguay, Guateraia). An edditional IAEA Fellow is in prospect.

Division star? are currently offering graduate level courses at the University, where they hold ad honcren appointsents, This academic year Courses in Nuclear Techniques in Agriculture, Iuclear Techniques in Biological Research, ani in Cytogenetics (both campuses) are being presented.

Division staff menbere have served ac Scientific Advisors with the Abc Exhibit "Atonos en Accién? in E) Silvedor and Gustenala in 1955 ?and in Coste Rica and Nicarams in 1966. Recvisitetion of previous Exhibit sites permite continued contact ant ccoperation with Central ?American scientists.

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IT. Research

Radicbotany of sumrcane

?To increase the econcaic return frac sugarcane (Puerto Rico's ?most important cron), the induction of plent mtants with high sucrose content i¢ being attempted. Initial experiments to determine the radio-sensitivity of ceeds and buds to thermal neutrons produced in the PRIC tegavatt reactor have been completed. Subsequently, thousands of seeds ?and vegetative bude have been irradiated, germinated, and planted in the Field. Mage chesical screening for sugar content in the individual plants produced is being carried cut vie automated analytical techniques. Visible mitations such oe wider ctizfer leaves indicate that other favor-able characteristics may be inluced. Swericr mutants will be propa~ Gated ani evaluated in the Univeraity Agricultural Experiment Station? program of ercp breeding and inorovenent.

A sintlar program concerned with the induction of resistance im sugarcane to the norsic virus disease ie underway. early @ thousand plants have been gromn fron irradiated seed and these are in process of mae screening by artificial infection with the virus.

B, Radlotectone studies in susarcane

Inportant problene of both immediate and long-range application have been studied in aigareane through the uso of radioisotopes.

Several field and greenhouse exrerinents which deal with agroncmic practice were coupleted this year. For exanple, the effect of soil factors (pH deneity, moisture content) on the nutrient uptake and utilization of phombates, sulfates, and trace elesents has been determined. Also, the enhancenent of Foliar absorption of phosphates by wetting agente vas measured; results will be of use in the aerial spray application of Tertilizers to sugarcane, en increasingly nore camon practice.

?the enzymatic degradation of sucrose in the sugercane plant by invertase hae been the mibject of biochesical imestigation. Factors which control invertase rormation have beon determined by meseuring ?the incorporation or added carbon-1l labeled anino acids into the protein fraction of sugarcane neristen tissue. Co-factors uch ae ?nagnesium ien have been found cgsantial Ter thie incorporation; the protein formtion is coneiderably reduced by presence of sulfhydryl ?compound

C. Radiation preservation mangoe:

Several exotic tropical suite hove considerable market, potential if their ripening could be delayed to permit shipment.

?To evaluate the process of radiation preservation, a series oF

experinents ere done, involving 20 varieties of mangoes irradiated fo different doses st? three different eteges of ripening and stored

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at posteirradiation temperatures of 50 and 70°F, Frou these studies At wae found that 250 Kr. doses of gama radiation extend the shelf-Lige at 50°F by approximately twenty days for certain varieties of mangoes. Such reaults hold promise for the radiation preservation of this fruit.

Bicchenical studies of cortening of mangoes during and folloving Arradiation algo have been carried out by meamuring the extent of depolymerization of the pectic constituents in irradiated fruit. Softening was found due both to radiation induced depolymerization of pectic acids and to the considerable polygalecturansse activity in the mango.

D. Other projecte

Within ite structure, the Agricultural Bio-Sciences Division currently houses three Projects supported through contracts with the UGEC: Radiation sterilization of the Sugarcane Borer, Radiation

Preservation of Tropical Foods, and Resonance in Radiation Brvecte.

Maile these projects are rezorted elsevhere, it chould be pointed out

?that these are an integral part of the Division's program and, in

turn, rely for their senior investigatore on Division personnel.

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Radioisotope Applications Division

STAFF

R. Uorry serent, Fh. Diy Chiet Scientist TT, Head; Alec Grimi son,

Fh. Di, Acocciate Gentist II (FurteTine); José P, A. Castrilaén,

Ph. Diy Aggoeiate Scicntict 1; trict if, Mair, Mh. D., Associate

Scientist 1 (hart-Tne); George Siupoon, Pa. Dap Acgociste Bientict

T Gerardo Molina Voc, M.S, Research Associate IT; Rosa Sintena

Ge Trado, H. 8., Research Associate I.

PURPOSE

?The main objective of the progray 1s the offering of sufficient training to seienticte in the application of radioisotopes and fonizing radiation to the physical sciences to provide technical competence Tor their future Work, A second objective Lo the offering of introductory training to selentists, irrespective of their Tields Of interest, in radicisotoves and ionizing radiation as a background or a¢ comlenentary vreporaticn Tor their participation in other prograne of FRIC.

CURRENT: STATUS

Courses with University

sit

1. Radiochent stry Course (Chewistry 465 ~ li credit hours). A one scuester course oivere! once a year for sdvanced undergraduate ani graduate stullente, Three one-hour lectures and one four-hour Jaboratory perict ser veel. Avproxinate enrollment: & to 6.

2, tuclear Techniques in Biological Research (Biology 372 ~ credit hours). A one-seneator course crfered once a year Tor Sdvanced undevgraduate etulents. Three one-iicur lectures and one hour-heur laboratory pericd rer week. Approxiuate enrollment, Wee 6.

3. Participation in Gradate ont Undergraduate Research Courses. Research training in the flel:2 ef photo ani radicchenical reactions and in the epplication of vadicieotones to chenical ctudies {2 offered fo students sureuing the i. 5. opi B.S. degrees ot the University oF Puerto Rico. Each student carries cut an individual resesreh project in accord with the exedite ver which he regieters in Chentatry 599) and Chemistry 397-390.

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Special Training Coures

1. Basic Course in Radioisotope Techniques - Pour-week course nov being offered four or five tines a year. We have had a totel

Of 272 participants (36 ssecions) including 69 Latin Anericans.

She present rate of participants is ayproximately 30 per year. | (This Zourbe was incorporated in the curriculum of the graduate programs of Biocheaietry end Nicrobiolocy at the U. P. R. School of Medicine ac Bicchenistry and Mutrition 0, 2 credit hours).

2, Radiologicel Physics - A special course offered to M. Dy Residents in Radiology when requested.

?ORGANIC CHEMISTRY PROGRAIL

AROS

the purpose of the prograa is to provide advanced chemical training in organic cheaistry vith special exphasis on its nuclet aspects. The projects cover @ relatively wide range of subjects {morder to offer a broad experience to ell uenbers of the group, ?and the éiffusion of the varied aspects of organic chemistry is promoted by group eominars ani discussions.

CURRENT STATUS

?he research topics include the use of S39 in exchange reactions, ?the use of tritiun, C1-36 and C-14 for the determination of reaction mechanisss, the aynthesie of boron conpounds of potential use in houtron ectivation therapy, and the cama radiolysis of dimethyl sulfoxide.

?me stuty of the caum radiolysis of dimethyl sulfoxide is of, recent origin, but correlative etidies concerned with the physical Groperties of this sibstance have been in progress for sone tine. The boron project is currently inactive because of the departure Of the research assistant who was involved in this vork.

?PHOTOCHEMISTRY AMD RADIATION CHEITSTRY PROGRAM

PURPOSE

?The purpose of the progras is to provide advanced chemical training in photechenistry ond radiation chesistry, with speci) euphasis on the relations and distinctions between these. Also {nluded are projecte givine training in the use of quantum chenieal calculations for evaluation of the experimental resulta.

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CURKENT STATUS

the advanced chemical training in this area involves active

participation in the experimental and theoretical projects detailed

Under "Matrix Toolstion Studies of Products of Gama Radiolysie of

Heterocyelie Molecules", as well ae participation in group seminars.

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uclear Science and Technology Division

STAFF

Oven H. Wheeler, D. Se.) Ph. D., Accociste Director, Head (Port

Time); Eddie Ortiz, fh. D., Chic? Scientist I (Part-Time); Rev. Ignacio

Gontarell, Ph. D., Associate Sclontict 17 (Part-Time); Julio A. Gonzalo,

Ph. D., Associate Scientist 11 (Part-Tine); Florencio Vézquer Nartinez,

Ph. D., Associate Scientist II (Purt-ine)} Rupert A. Lee, M. Se.

Research Associate TIT; J. Blisin Trabal, B. S., Research Associate 1.

SCORE

?The Division provides training and research facilities in fields of chenistry and physics related to nuclear science for students in the M. 8. degree prograns of the Departments of Chemistry, Physics, snd Wuclesr Engineering of the University of Puerto Rico at Mayaguez.

The Division algo offers research facilities for workers at the re- and post~doctorate level and the start menbers carry out inde- pendent research.

CURRENT STATIS

EDUCATION AND TRAINING

Seven graduate students are carrying out research for their Ml. S. degree in chenistry, one in physics, and one in miclear engineering 4A the Division. Menbers of the Division currently teaching three courses in the Departments of Chemistry and Physics of the University of Rierto Rico at Mayaguez, in miclear physice and chenistry, radiochesistry, aed solid state physics. Fart of thio work 4s carried out in collaboration

with the Neutron Diffraction Program.

Mr. Rupert A. Lee is completing his thesis work for a Ph. D. in radiation cheuistry Tron the University of Alberts

CHEMISTRY PROGRAN.

The fundamental mechanisa of the radiolysis of hydrogen chloride and hydrogen bronide is being studied, using both gamma radiation and fission recoil particles. This study i2 part of a concept for the conversion of fission energy into electric] energy, via © cycle involy= ing radiolysis of a hydrogen halide by fission fragnents to provide feed material for @ fuel ceil

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?Studies are also being carried cut on radiation induced reactions of organic conpounts in solution, and on the mechanian of thermal rearrangenents using Lectopea.

A program of regearch in hot-atom cheaistry is now supported by the Division of Research of the ABC. wo other regearch groups are Financed by grants from the Netional Institutes of Health; one on

?the Synthesis oF Thiasteroids (3 assistante) and the other on the Radiclysis of Peptides (2 aseietanta)

PHYSICS PROGRAM

Radiation damage in ferroelectrice is being investigated by means of hysteresis and dielectric stuiies, and of meagurenents of cgpacity nd conductivity. ?the effect of temperature enanges to + 10-3°C in ?the region of the Curie temperature hes been studied. ?The compounds studied include triglycine sulfate, and alkali trihyirogen selenite,

Work is being initiated on the formation of color centers in magnesium oxide ant alkali halides, and on field eniseion from highly clean surfaces.

Related studies, in conjunction with the Physics Departnent, University of Puerto Rico at Mayaguez (H. J. Gouberg and B, Cruz-Vidal) ?are concerned with the efficiency of color center formation in alkali halides as a function of the energy of incident monochromatic x-rays near the K absorntion eige of the halide.

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Nuclear Engineering Division

SUFP

Donald S. Sasscer, Th. Ds, Chief Scientist I, Head; Avive E Gileadi, Ph. D., Chief Scientist 1; Pillip W. Osborne, Ph. D., Chie? Scientist? 1; Kenneth Scderstros, M. §. Research Associate III; Carlos Wheeler, B. S., Rescarch Associate 11; Erick Ménde Weray, M. &. Research Associate 1,

PURPOSE

The vain purpose of the Division program is to teach, train and do research in the basic sciences and engineering contrituting to Gevelopment of the use of nuclear energy. University of Ruerto Rico students in the progran mist be enrolled for graduate stuiies and be accepted in a progran leading tovard one of the Master of Science degrees in engineering, uoually nuclear engineering. Students tron other universities in the United states or in latin Anerica nay be accepted for participation in research for completion of thesis reguirenents. PRNC participates in the ORINS Graduate Fellowship Program for support of U. &. citizens doing theeis research,

There are nov 15 students working tovard M. S. degrees in Nuclear Engineering.

Im addizion to the primary purpose, the Division aleo provides special non-degree training prograns for technicians and for engineer and scientists.

CURRENT STATUS

?he primary effort te on the educational program in Muclear Ingineering carried out in cooperation with the Departnent of Wuclear Engineering of the College of Engineering. Courses being ?taught are:

Core Courses:

1, Hlenonts of Muclear Engincering. (1x Be 605) Four credit hours. Four lecturce ner weeks Characteristics or the stosie nucleus, Tadioactive decay. Interaction of radiation and matter, Taste neutreniee.

2, Reactor Theory (liu Fg 621) Three credit hours, ?Three lectures per week. Heutron balance equation. Diffueion theory. Sloving don theory. Bare honcgeneots reactcr. Reflected reactor Heterogeneous reactor. Tine dependent reactor. Perturbation

?theory. Transport theory.

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3. Mathenatics of Nodern golence I (Mh BG 675) ?hree credit hours. Three lectures per week. A more advance? study of owe topies covered in Nath 475-N/75." Complex variables, partial Gifferential equations, special functions, tranefor calculu:

h, Miclear Neamurenente and Instrusontation (tu PG 603) Three ereait tigurs. One Tccture anf ?vo three-hour laboratories each week. Prerequisite: Tiys 455, Characteristics of operation and therough foniliarization used in the epplication of specialized techniques jauch ae: coincidence ani anticoineiéence counting pulee analysis, heutron epectronetry, gemma ray spectronetry, ete.

5. Advanced Reactor Theory (tiu Bg 622) Three credit hour

?tree lectures per week. irersquictte: Ta Bg 621. Advanced transport theory. Reactor Kinetics. Heterogenecus resctor theory. Prerequisites, No Eg 675, Mo Be 605, Tu Bg 621. Corequisite: Nu Eg 676.

6. Mathouatics of Modern Soicnca IT (Wath 675) Three credit houre, Three lectures bev veok, f more advanced study of some topics covered in Nath. 75-H76, Stars Liouville eystens, calculus of variations, integral equations, tensors, finite differences.

7. Reactor laboratory (tt Fe 625) ?Wo credit hours. wo three hour ?laboratories each Veek. Prerequisite: Th Eg 621, Laboratory problene involving the nuclear reactor.

8, Graduate geninar (Io By 616) One credit hour. Wo hours

per week. Feports and discussions on special topics in Nuclear Soience and Engineering.

9. Muclear Reactor Technology (thu Eg 602) Four credit hours, ?Three iectures and one three-hour laboratory demonstration period each week. Prerequisite: i Bg 605 and liu Bg 621. Steady-ctate ?and transient thermal conduction in fvel elenente; thermal convection fn beatwexchanger design; liquid mets) systens; breeding and conver-?ston; an introduction t0 the econonice of reactor operation; reactor engineering design probienc.

10, ?Thesis (tia Es 699) One to six credit hours. One to six research periods each week. Resourch in the fielé of Nuclear Engineering and precontation of « thesis.

Supplenentary Courses:

1. Muclear Reactor Netellurgy (tis Bg 612) Shree credit hours, two lectures and one threc-hour laboratory each week. Corequisite: Ma Eg 601.

[An introduction to elenentery physical wetallurgy of the principal Feactor materials such a6 alimiria, zirconiun, uraniun, and bigh Yemerature alicys: nechanical properties; fabrication of nuclear fuels; radiation danage to reactor couponents.

ae

---Page Break---

2, Introduction to Nuclear Engineering (Iti Bg 551) Three credit hour, ?Tits course {n offered for advanced untergracuate and nome nuclear engineering graduate students, Taree lectures each week. Fission ani chain reactions, elements of reactor design, utiliza: tion of nuclear energy for paver and radiation probles.

Research

The staff of the Nuclear Engineering Division and menbers of other PRNC Divisions are carrying cut research through projecte designed for student participation, These include

1, Method of reactor shutdown minimizing the after shutdown Xenon peak.

Measurenent of the transfer function on the L-77 henogeneaus reactor by the modulation technique,

Study of the variation of the neutron characteristics eccur= ing during the reactor operation due to the changes in isotopic composition of the core.

4, Bffecte of irradiation on the fracture characteristics of plexiglas

Determination of mass flow xates in pipes by use of the ?muclear Doppler efvect.

6. Determination of metal to metal diffusion coofficients by

aiffusion of radtoactive miclei.

7. Me effect cf nuclear irradiation on the emissivity of

graphite,

8, Determination or the heat-transfer coeiTicient for free

convection of air beteen plate-tyze fuel elenenta.

9. Monochrenstization of reactor beamport neutrons by

multiple critical angle scatter.

---Page Break---

Reactor Division

SOF

Héctor arcelé, tis 5, Chie? Sedentist I, Head; Richard Bram

Caupos, H. S., Accocinte Scientist I, Reactor Sivervieors Eneato

Guerra, B. E.'B., Reactor Ainerviser? Six Reactor (perators.

PURPOSE

the vain cbjective or this Division is the overation, maintenance,

end srotection of the tvo TRUC reactors: an L-77 homoyeneous reactor

and an A. X. F, peal-type regenreh nencter currently operating at

8 one-negawatt never level. The Diviion staff algo operates and uaintaine meuratic tubes, hot celle, 2 gama irradietion room, 2uel element irradiaters, a gama rool, and sll equizsent necessary for the operaticn of these facilities an) participates in the training Of reactor operatere ani supervisere.

?tor Division supports ell other divisions ant programs associated with the Muerto Rico fuclear Center.

In the pool-type reseerch reactor, wo six-inch Deas tubes are being utilized by the neutron Ciffraction sroyran Ter two neutron Spectrometers. A shielie? ror has been built aroun another six-inch bean tube ror Quture exporizente in bsolecy and eedicine.

A borated vater shutter haz been built for thie beast tubes A neutron moncehronator, base) cn critical angle reflection techaiques, is being built to be inctelie? in a fourth bean tube. ?The 4th bean tube te scheduled Tor the experiments by Lee on fiseion

profuct radiclyeie or hydvoren halides,

Presently, the che segewatt research reactor ie operated on
a cixteen-houre-a~day basis, at a contimous power of one megawatt.
Studlee are in progress Zor an increase of power to wo wegewatts
and an increase in operation tine to twenty-rour houre, five days
& week, Ultinte plans are to Increase the pover level to rive
egawatte continacrs with pulein: capebility vith peak paver of two
?thousand megivacts.

Te 1-77 reactor {s used for teaching om! experinents suitable
Yor 9 water boiler honagenecus tyne of source. An ose{llatar Yor
@ynamic experinente ig being built.

---Page Break---

?Me docand for two different nodes cf operation of the pool reactor, namely, continuous, steady state, ull pover Yor researchers, veraus variable flux, changes of configuration ant intermittent operation required Tor any training pregrane wovea this Division to present a proposil for the conctruction of another reactor to be installed at the other ent of the pool. This lov pover reactor ie

to be built ant put into operation by menbers of the Division.

?This reactor will be operated on an on-off bacie with the primary purpose to provide a flexible facility where nuclear engineering

?and other graduate students nay perfora laboratory experinents

and research projects related to Division work.

?he Division participates in the training of reactor operators and supervisors, ant supervises thesis vork related to reactor physics. Among others, the Reactor Divieion has trained two reactor supervisors fron Colonbia, whe are nov in charge of reactor opera~ ?tions at the Colonbia nuclear research reactor. The Division

gave operator training to the BOWS startup team. ?The training consisted of providing practical experience in reactor startup

?and shutdovn, Tt also participated in the training of twelve

ROWS reactor operators ina ten-week sumer course, In addition,

?two thesis nroblems of BOWS students studying for the degree in

Miclear Engineering at the University of Puerto Rico at Mayaguez,

were supervised by personnel of the Reactor Division.

In the field of technical help to other organizations, mesbers

of this Division have been in close contact with the Colbia

reactor. The director of the Divieion ie a menber of the BONUS

Safety Comittee, and alco participated in a stuly group necting

in Caracas, organized by the International Atenic Eneray Agency.

?re

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Health Physics Di

SIF

Peter Paraskevoudakis, Ph. D., Associate Scientist TI, Acting

esas Pedro Cruz, M. §., Research Associate TT; Heidi Fabén, iH. S.,

Aeeoeiate in Health Physics. and five Health Thysics Assistant

?SOF

?The Division has tvo general responsibilities: (1) services associated with radiation and industrial eafety, ani (2) treining ?apd education.

CURRENT STATUS

In the area of services, Health Physics conducts the following programs:

1. Peroonnel Monitoring - This ie the sost extensive program. Dose assesment mainly by vay of sensitive film is provided to ?the Miclear Center, Bonus Fower Plant and the Cancer Hospital at Rfo Piedras. During fiscal year 1966 more than 13,000 film packete were processed.

2, Avea Monitoring ~ This program is Limited to FRNC controlled areas and providee information on operation of the different

facilities of the installation in their relation to the use of

radicactive catertal.

3, Buvironmental Survetlance - This program involves the

collection and analysis of enviromental samples such as soil,

Water ant vegetation beyond the area of the PRIC cite,

4, Waste Disposal - the Hoalth Physics Division has the respon

sibility for managenent and control of radioactive wastes generated

?by PRC.

5, Radioactive and ton-Radioactive fiazardous Material Handling ~

?me Division carries out routine inepectione and checks to ensure

safe handling of thie tye of material. Part of the progran includes

Indoctrination of the personnel using the material in proyer earety

procedures.

6. General laboratory Safety - This program is in essence an

extension of the previous one, Enphagis is given to the supervision

a8.

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of operations nct covered under iten 9 auch as compliance with Tire,

Glectrical construction codes, etc. Pericdie inspections and

{ndectrination of personnel Form an integral pert of this progran.

In addition to these procrans lleaith Prysice Le in charge of

supervising and directing decontanination operations.

the Division cremate to ZuciLities, one Ter the calibration

of radiation nenitering equizment and the other for 2 miclear

Scciient dosinetry center based on a dosimeter aysten originally

Geveloped by Hurst.

in the area of training and education the staff participates

in the teaching ond training of students ani staff nenbers in the

principles anf practice of Tadiation cafety, Tair ineluies

Realenie couress, seninare ané thesis recearch. In cooperation

Attn the Univerelty or Ruerto Rico, the Division offers « curriculum

Jeading to ants § degree in Health Mysics, This is an approved

program fer the Atonie Energy Comission Syecial Fellovehip in

Inalth Physics. A graduate ccurse in liealth Paysice is offered,

for students not specializing in this field, vith acadenic

Credit granted through the Biclogy Depertuent of the University

ce Puerto Rico in Heyaquez. The Divicion also carries out research fo cupport investigations in other divisions and programe.

A recent development is the provision of dosinetry standards for researchers throughout FRI, Ucing mcm techniques and Gevelopine nev ones, as needed, Health Physics provides energy fant dose Information for al) neutron and genmsa ray radiation facilities such as the reactor beam tubee, pneusstte tubety {hermal column, pocl aren, the neutron ani the gomn irradiation Foons, the eedsle-5O sources, anc other major sources ao thoy fare introduced.

?19.

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Medical Sciences and Radiobiology Division

oorF

Jorge lt, Chiriboga, 1. D., Ascietant Director for Sefentitic Progra, Acting leet; figiro tiartinas Siva, HM. D., Assoetate Bientist 1 Julio T. Colin, A. D., Associate Sientist (kt honoren);

Joo8 fice} Correa, Vi. D., Aetociate Stentiet (Ad henoren); Tvelisse Rodrfcuez de Oquendo, II. S, Tosearch Aggociate I; na Sylvia Cuessda de Rodrigues, 11. S., Research Assceiste (Mo nonoren); Conrado Asenjo, Fh. De, Chief Selentist (hd honovea); Joos A. del Castillo, Pas Dey Chiet Sctentist. (Ad honorea): Lule Otero Willaderbé, Fa. Dey Associate Sientizt.

PROS

1, To toach ond conduct research at different levels within the Field or Radiation Biclegy.

2, To establish projects viich have @ bearing on the problens of Tropic] Medicine (Fiel2 and laberatary Studies on the Efvecte Of Radiation on liogt~Porazite Relationships).

3. To maintain a tisque culture raciLity to corve as a mediun for training and research.

CURRENT STATUS

Training - A Your veek course in Tesue Culture and Radioi ectopic Techniques at Cellular ond Sibcellular Level vag offered from Cctoler 17 to Noveuber 10, 195. The Course is deained to give enphasis to the basic ersects of tismuc culture such as the applications of this technique to virology, radiobiclogy, ete. Micro-auteradiograshie techniques, chrevosenic yreyarations, labeling

and Miguid seintiiletion counting of mucleie acids at e cellule: level, and other techniques are included.

Research = Worl: is being Jone op various research projects. ?Me Tolloving vill be a brie? reawé of the nore smportant ones:

1, Mo cell. Lines derived froa 9 Denich chonirosarcoma are under study with eecial interest in karyotypes and metabolic functions. Tt Le hoyed that the radicbiolojical effects in vivo fand in vitre can be cosrare:

---Page Break---

2, Diploid man cells are under culture and the effecte of radiation on the aging process are being studied.

3. A group under the direction of Dr. dol Castillo is trying to vaintain Living mecle cells of Ascaris in the tisme culture media.

4, ?he efvect of radiation on the host-parasite relationships in latent arthropod Lorne viruses has been started utilizing tissue eunture and host. eninal:

6. the Shistoscaiasts studies conducted in this Division are reported ina separate abstract.

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Participation of the Puerto Rico Nuclear Center in the USAEC Atoms in Action Exhibit in Latin America

STAFF

Fausto J. Mufioz Ribedeneira, B. Ch. E, Research Associate II, Program Director; Bugenia P. de Rarirez, Administrative Assistant; PRIC scientific staff participates as needed.

PURPOSE

PRIC has been assigned responsibility for conducting « program of scientific researc as part of the USABC Atos in Action Exhibit. Research projects are selected on the basis of possible econoaic interest, the present status of scientific developuent in the host countries, similerity of projects to current PRIC research, and availability of PRIC staff to Serve a8 consultants. A subsequent follow-up and evaluation of the experimental results is carried cut ty the PRNC scientists who participate in ?the Exhibit.

CURRENT STATUS

?The Atoms in Action Exhibit has now visited four Central Averican countries. In February and March 1965 the Bxhibit visited San Salvador, EL Salvador, and in August and September 1965 the Exnibit was held in Guatenala City, Guatemala. In February and March 1966 the Exhibit was in Ban José, Costa Rica and in October and Novenber 1966 the Exhibit was in Managua, Mearagua.

Salvadorean researchers used gauna radiation to determine the nor~ tality sterilization dosages for Leucoytera coffeela, an insect pest in coffee, and Heliothis zea, a cotton and corn pest. Preliminary results on radiation preservation of shrimp and cantelouge melons were satisfac- tory. Genetic studies in beans have shown in the first crop a total weight increase of 25 per cent and in rice a stiffer straw has been obtaines. Game radiation also improved coffee flavor and taste. Four graduate ctudente of the University carried out thesis research with exhibit equipaent.

In Guatenala entovology stuiies were focussed on Toraspinas postica, fa citronella and leson grass plantation insect yest. In genetics, the maximum survival dose for corn vas deterained, Experinents to determine radiation effect on coffee flavor and taste, beer, and eseential oils

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were perforsed. Researchers fron the Central Anerican Institute for Tndustry (ICAITI) carried out inveetigations on canned pineapple sterilt-gation by gama radiation and investigators of the Nutritional Institute for Centyel America and Panane (INCAP) used Incayarina to study the degra. dation of vegetable protein under ganna radiation, Twelve hundred under~ Graduate etudente voluntarily attended a special progran prepared by the FRNC personnel, and six greduate students of the University of Sen Carlos performed thesis research under the guidance of PRNC lecturing scientists. Balvaderean researchers cane to Guatemala to continue genetic studies on dears end rice and entomological studies on Heliothis zea. PRI personnel played an inyortent role in the donation of the ganna irradiation facility Of the exhibit from the Regional Office for Central fwerica and Panana Affaire (ROCAP, U, 8. Department of State), to ICAITI.

?The research activities in Coste Rica dealt prinarily with agricul-tural problens with additional topics in the physicel sciences. Radio-active tracers were utilized to study organic chemical reactions.

Projects carried out inclwied work on fish, potato, and coffee pre-servation by radletion; tean softening by radiation, redistion effects

on corn, rice, ani bean seed viability, effects of gamma radiation oa the hysteresis cyeie of triglycine sulfate crystals, effects of formic facia concentration on the Fricke dosinetry systen, radiation cheuistry of Citaniun sulfate solutions in eulfuric acid, and other chemical studies

In Nicaragua research projects have been started in food preser-

vation using bananas, been softening, sorghun seed viabilSty and sorghum Jenetics. Experiments are algo being carried out in neutron dynasics.

---Page Break---

Solid State Physics Program

STUDY OF RADIAFTON DAMAGE I ORGANIC CRYSTALS

?USING ELECTRICAL CONDUCELVITY

STAFF

?Amador Cobas, Ph. D., Associate Director; Shuvel Zvi Weiez, Ph. D., Chief Scientist, Alfredo J. Torruella, Ph. D., Associate Scientist (Ad honorea); George M. Simpson, Ph. D., Associate Scientist; Jesis M. Tharrats, Ph. D., Associate Scientist (Ad honoren); Janes A. Muir,

Ph. D., Associate Scientist I.

PURPOSE

?Te effects of radiation on organic crystals is the primary inter~
eot in thie project. It ie felt that such studies on well defined
crystalline structures can provide a firm foundation for a leter study
of nore conplex materials, including those of direct biological interest.
Anthracene has been chosen as the initial material for study because
this substance has been studied more than any other organic material.

CURRENT STATUS

?The danage induced by radiation ie studied by measuring the changes
in the electrical and optical properties before and after irradiation.
?The measurenents at present are performed on anthracene single crystals.

Te electrical properties are studied by measuring the steady state
and transient current voltage characteristics. By avglying an injecting
electrode to the crystals (either highly absorbed Light or iodine in a
Sodiua-iodide solution) the current through the anthracene is space charge
Linited. From the transient and steady state behavior of the space charge
Limited current (SCLC) - voltage characteristics carrier transport and

?trapping properties, such as nobility, trap density, trap deyth, trapping Lifetine, and capture cross section can be deduced.? In this lab it was found that the neasurenent of the SCLC through anthracene is a very sen sitive tool for the detection of danage induced by radiation.

ur results indicate that by irradiating anthracene exystals with gonna or x-rays, hole traps are introduced in the crystals. The presence Of these traps was detected using steady state space charge limited Current techniques using @ Nal-Ip solution as the hole injecting electrode.

= abe

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From the changes in the steady state space charge linited current voltage characteristics for a crystal before and after irradiation the density of fhe introduced trays wee calculated. The density of these was found to vary Lineariy with the eveorbea radiction dose. he litetine of the Injected free carriers ?ras necsured using the transient syace charge Limited current technique and the results indicate that the capture

cross section of tiese rage for hole trapping se approximately of sole-
cular sige.

?The current voltaye characteristics of irradiated anthracene
exystale vere conpared with the current voltaye characteristics of
crystals grovn fron irrediated anthracene power and very Little dif-
ference was found. This result indicates that the desects introduced
by irradsation are molecular rather than cxystelline.

In order to try to get a better understanding of the mechanism
involved in the space charge Limited currents in insulators, vhich ve
luse aa the detection method in cur investigation of radiation dassge

in anthracene crystals, » thorough theoretical study of injection of
Carriers into insulators has been Cone. Solutions for the tine depen-
dence of the current have been obtained fer the case vhere the reservoir
of the free carriers at the injecting electrode is tine dependent. In
this analysis the transient space charge limited current, here the
carrier density at the reeervoir is infinite and constant in tine, be-
?cones a special case of the problen.

?The opticai proverties are studied by measuring the radiation induced changes in absorption spectrum, in instantaneous fluorescences, and in delayed fluorescence. The delayed fluorescence is measured in Scintillation grade anthracene cryetels. They are exyosed to radiation doses fron 102 to 109'R, ?The excitation ic by a bigh intensity red flash. ?The triglet excitons are produced by direct absorption in the triplet band and the singlet excitons are produced ty two yhoton absorption

fand by triplet-triylet annihilation. The temporal resyonse of the slue Cniselon is continuow2y uonitorea both during and subsequent to the excitation, Gana radiation creates centers in the crystal that quench ?the singlets ana the triplets. The centers are yorenagnetic and reduce ?the lifetine of the triplets, hovever, toey do not affect the bimolecular triplet interaction rate constant. The density of the triplet quenching Centers induced by one Toentgea corres.onds to the density of the hole Grape measured by the e.c.1.c, sethol. By calculating the density of the Singlet quenching centers using the value of the bisolecular singlet inter-action rate constant obtained Tron yhotoconductive measurements, it 15 found that this density is larger by three orders of magnitude than the Gencity of the triplet quenching centers. Measurenents are in progress {to deternine the binolecular singlet interaction rate constant by

dptical wethods, These neacureente will permit determining the yield

by which free carriers are 2roduced in the cinglet-singlet annihilation

process.

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By we of multiple techniques an individual single crystal of

anthracene can be used as a yide range dosineter; triplet-triplet

fanninilation in the ragge 10° to 104R, space-charge Limited current

nthe range 103 to 106R, fluorescence quenching in the range 109 to

MR, and absorption spectroscopy above 107%.

---Page Break---

Neutron Diffraction Program

STAFF

Mortiner I. Kay, Ph. D., Chief Scientist 1, Principal Investigator; Seymour F. Kaglan, Ph. D., Associste Scientist 11; Rovert Kleinberg, Ph. D., Associate Scientist II; Isaael Almodévar, Ph. D., Associate Scientist 11 (part-time).

PURPOSE

?The Neutron Diffraction Progran is concerned with ideal and imperfect arrangenents of atonic nuclear and agnetic spin systens in solids. Of particular interest to the program are magnetic structures of inorganic salts and the determination of the role of hydrogen in structures having Amportant physical and chenical properties,

CURRENT STATUS

In collaboration with Dr. K. Okada, who returned to Japan in August after a two-year stay at PRC, the hydrogen positions in copper fornate tetrahyarate have been determined at room temperature and sone electricel meacurenents made on the compound in the vicinity of the phase transition fat -l0°C. Since antiferrcelectricity vas discovered, future vork vill Consist of determining atonie positions in the presence of an electric field with the objective of demonstrating the atomistic basis for the electrical properties.

Manganous formate dihydrate has been studied and the hydrogen positions determined, A comparison of the Aicordered tetrahydrate with the dihydrate structure shows clearly the reason for the greater stability of the latter.

Dr. D. T, Cromer spent @ year at PRIC on leave from Los Alamos Scientific Laboratory. While he was here, date was collected on the thre

types of alums A°B"3(S04)p.12H,0. The combination of PRIC neutron data

with IASL x-ray data hae lead fo a complete elucidation of the a, 8, ani Yvelun structures, ?The role of +1 eation size, hydrogen bonding, and disorder on the structure has been elucidated. Interesting non-harnonic thereal

?uotions have been noted.

Meutron diffraction date was combined with x-ray diffraction data ?taken by Okaya and Stemple at TBM to produce a refined structure of actartaric acia.

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Deta has been tsicen on Hak,(Se0;)2 (room teeperature) and Hal at (150°C) to study the terroeléctrié transitions of interest to the solid state physicists in hayaguer.

The nagnetic structure deteruinations of CoCly and MiCly Hexahyarates have been coupleted using data collected by Dr. #.?Kleinberg-at the U.S. Naval Research Leboratory. Other transition metal salts will be exanined in the future, Vor on the structure of solten SnCh, by neutron Aitfraction using isotopic re,laceuent of the Sn to hel separate teras

fn the radial distribution function 3s being carried out by Dr. Howard L. Ritter. Dr. Ritter is Research Provessor of Chemistry at liiani University in Gxford, Ohio and is currently spending one year as an Oak Ridge Recearch Participant in this Progran.

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Hoi-Atom Chemistry Program

STAFF

?Owen H. Wheeler, D. Sc., Ph. Ds, Associate Director, Principal Investigator; Marfa inisa MoClin, M,'S., Research Associate; and 43 Assistants.

SCOPE

?The mechanisn of the formation of radioactive products in the

neutron activation of organo~metallie compounds containing carbon-nnetal tonds is being investigated. Studies include work with short balf-Life isotope:

CURRENT STATUS

?Stusies have been completed on triphenylphosphine and its oxide

and on tetraphonylphosphonium chloride, and also in diphenyl sulfide, sulfoxide and sulfone. Other work on cdbaltocene and nickelocene hss: been completed and several publications are being prepared.

Research in progress covers studies on similar compounds of mer= cury, thallium, fodine, selenium, Dismith and tin. The effect of radical scavengers is being studied.

?A gas-chromatographic counting systen 1s being constructed for vapor phase studies.

---Page Break---

Terrestrial Ecology Program, Fart 1

The Rain Forest

STAFF

Jerry R. Kline, Ph.D., Chief Scientist I, Principal Investigator;

carl F. Jordan, Ph.'D., Associate Scientist I} George Drewry, M. A.,

Associate Scientist I; and visiting investigators.

PURPOSE

(2) To stuay eftects of genma irradiation from 10,000 Curies

Ceciun on the Rain Forest systen at El Verde.

(2) To study sone mineral cycles of the rain-forest in relation

to fall-out, atonic excavation, and plant nutrition.

(3), To characterize the circuits and metabolic energy pulses of a

couplex terrestrial ecological aysten eo as to understand the consequence

of irradiation and fallout storage.

?CURRENT STATUS

A. Radiation Effects Stuaies

?The Rain Forest Project at £1 Verde involves irradiation of a plot

of lover montane forest with gamma radiation fron a 10,000 Curies Cestun

source. After 15 nonths of pre-irradiation studies and preparations at

?the radiation and control areas, irradiation began January 19, 1965. The

fuain tite was irradiated for 3 montis, tue innermost. zones receiving one

million R, Post irradiation measurenents are in progress shoving effects

Of radiation according to dosage received, according to species, and according to various categories of ecologies) and cytological structure and function. Data exerging provide sone factual basis for predicting effects of radiation on rainforests and tue rates of regeneration of the Living systen.

B. Recovery and Succession Studies

?The radiation center is now in an active process of recovery from the effects of tie gama radiation. Studies are in progress to document the Invasion of the area by nev plants and to observe the recovery of old damaged plants. Toe radiation center has been subdivided into a grid of fone meter squares whic! are being studied individually for the occurrence

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of new plants and their rates of grovth. Such studies will be repeated at regular intervals and the snforsation gained will be used to construct

f series of aaps which Will show a continuous record of the changes which Qceur during the recovery stage. Another method of docunentation of the Tecovery process involves photographic comparisons of the irradiated area with otfer areas in the forest which have been danaged. Observations of This type indicate that the character of recovery in the irradiated area {ano different. from thet in areas of the forest vhich have had catastrophic Ganage fron cutting or herbicides.

Cc. Mineral cycles

Qquantitetive understanding of the mineral cireuite through tropical systene Js essential to underetanding of the nature of such machinery, the soils, and the ways such systems may process radioactivity entering in relation to AEC related sctivities. Understanding mineral cycling Uhl be the pripery objectives of nev ceasurements in the rain forest project.

1. Radionuclide Balance in the Rein Forest

?The experience of investigators in the temperate zones indicates that a suvstantial proportion of fission products found in plant coumuniti Tein the fom of surfece contamination on leaves and that only ¢ minor part of these isotopes ever enter the vetabolic pathways of the plants. Jeverthelese, such observations at El Verde as the extensive surface root

Revelopnent, and root invasion of organic Litter and logs suggeste thet his forest might be well adapted to the conservation of minerais by fuaintaining then An reasonably closed cycles. This view is reinforced by prelininasy observations of soils vhich indicate low levels of fission Prouucte while the decaying Litter at the soil surface contains @ large Frount of radioactive isotopes, An experivent in progress vas designed fo test whether fall-out isovozes were recycled from the forest floor Eheoygh reste into understory plants. In this experiment 134¢s, Yn, RY Wir were epreyed in carrier free aqueous aolutson directly?on the forest floor. The results afver one year indicate that nost of the Scluinal radioactivity remained where it vas first placed and much of fhe original organic Litter wae still highly radioactive. The rate of TBtane ef the isotopes by the understory trees was aluost undetectably slow.

2. Effect of Gamma Irradiation on Fission Product Retention by Forest Trees

Samples were taken before and after the irradiation from forest trees in the irradiated contro) centers. Measurevent of Cs-137 and Mesh in these seaples by gamia-ray spectronetry indicated no detectable Btfect of irradiation on the leaching of these elements in the forest tysten by rain water.

sae

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Neutron Irradiation studies

?Thermal neutron irradiations of sols fron various points in Puerto Rico and fron Panama have beer carried cut. The most prominent isotopes which cen be observed in these soils regardless of origin are: 59pe, Hose, na, 5m, ant 1936n, Senples of plent ash are also being prepared for study by thernal neutron irradiation.

Plans have boon completed and equipuent constructed for an attempt to carry out fast neutron activation studies of soils and ants utilizing @ special nuclear reaction which may generate fast {siev) neutrons in the presence of thermal neutrons.

4, Natural Radioactivity in the Environment

Preliminary surveys of soil specimens tron various locations in Puerto Rico have revealed certain sites of unusually high levels of radiun daughters. These sites which contain a factor of 6 more natural radioactivity than the El Verde cite nay be of considerable value in future studies of the behavior of radioisotopes of the Uraniun decay series in natural enviroments.

A suggested preliminary use for these sites is to study the possibility of radon transpiration by plant by exanining wood fron the trees of these locations for equilibrius mixtures of lead-210 ?and polontun-210.

5. Radioisotope Persistence in the Rain Forest

The radionuclides Mice, 9521-950, Sltin, and 137ce were

observed to have extrenely high persistence in the tropical forest at

El Verde, Meaguresents made on saxples collected fron the forest on a monthly basie indicated that the rate of resoval of the above nuclides fro the forest systen was controlled prisarily by the physical half life of the nnuclide and that a biological half Life could not be experimentally defined. Such measurenente were made at a time when the input of nuclides into

?the forest was negligibly snall. They were interrupted by the arrival

of fregh nuclear debris between 12 and 24 days after the Chinese atmos: Dherie weapons test of May 1965. The sampling program is continuing.

D. Chrouits and Netebolien

A syecdal PRIC proposal ves prepared outlining an electrical analog circuit that mignt be preyared if authorized and budgeted. ?The systen on ?the passive principle allove for flows in 36 compartments for which there are data available to cet storage constants and rates. This systen is Under construction at the University of North Carolina by Howard 7. dus who 1s a consultant to the project.

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?The giant cylinder experiment was used to provide water budget ?and carbon metabolisa data on the rain forest. ?The water budget data vas of particular interest for predictions of the fate of tritiun in a tropical forest since this isotope is Likely to be produced in Large quantities by nuclear excavations. Attempts are being nade to use the giant cylinder to study an annual cycle of metabolism and water use in the forest.

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Morine Biology Program

StF

Frank G. Lowan, #h. D., Chief Scientist 71, Program Director;
Donald K, Phelps, Ph. D., Chief Scientist I; Robert Y. Ting, Ph. D.»
Associate Scientist I; ?hn H. Martin, Ph. D., Associate Scientist Ts
and Rail McClin, M. 5., Reeecrch Associate T.

PURPOSE.

?The Marine Biology Progran at the Pierto Rico Nuclear Center was started in Januery 1962 and is composed of nix major research projects and supporting areas of research ell of wateh ere interrelated into an integrated research activity.

?The progran vas designad to provide ueasnzoronts of the distribu tion and movenent of tract elemaris in restricted but complete ecological

land biogeochemical eysters. The reiiearch includes investigation of the Lithosphere and the rarine hio-an* iyerospheres. Specifically, the distributions and novesents of uolectod trace elenente are being followed fron the rocks, ainavals on4 coils of three river water sheds into the river waters, Organisus and vedinants, thence into the marine water at depths and dlevancee off slore, through ths marine biosphere and into ?the marine sediments.

CURRENT STATUS

In order to obtain Snforsation on the interostionr of the marine biogphere and hydronghere, measurancnte cre being ade to determine the influences of biological productivity, biclogizel half-lives of trace elenents, food webs, characticvier o: trophic levels, ana physical fand chemical oceanographic fastore upon the distribution of trace elenents in the marine watere off shore fvom the west coast of Puerto Rico, The effects of physical cna chemical oceanographic conditions upon ?the distribution of srgan'ovs re being stutied, with special expbasie on obeervetions of th: effects of vorying axounte of mineral rich silt upon the distribution rattexns of evvine crganisns.

swre.sats of Biological

clenonts, (3) Measure-

anisas for given radio

(ih) Measurenente of raciouctivity end reafoteotepes now

The research projects incluie

Productivity, (2) Analysis for col:

ments of concentration factors Uf sclect.

Lsotopes

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present in the marine organians, vaters and sediments off the west coast of Puerto Rico, (5) Background measuresents in physical and chemical oceanography, and (6) Distribution of rare earths in the Afisco Systen.

Supporting areas of research include investigations of the effects of interactions of river and sea vater upon the precipitation of trace elewents in estuarine enviroments, chenical and physical characteristics of marine sediments deposited fron three rivers which drain water sheds containing limestone, serpentine or rocks of volcanic origin, the characteristics of variability in trace elenent content of populations of organiss froa a given environment, and the development of methods for analyzing trace elesents in a variety of sample types.

---Page Break---

Estuarine and Marine Ecology Study - Specific Activity Approach

STAFF

Frank G. Lowman, Ph. D., Chief Sctentist IZ, Progran Director;
Donald J. P. Swift, Mh. D., Associate Scientist 1; Rail MeClin, MH...
Reearch Associate I; Henry Beeselievre, Recearch Associate III; plus
technical staff.

PURPOSE

?the progran is part of e feasibility study for @ searlevel isthnian
canal in Centval Anerica under the managenent of Battelle Memorial
Yastitute and 4s designed to develop and carry out investigations of
Stable elenent distributions throughout the marine and estuarine
Gnvirensents in the Darien area of Panana including the Gulf of Panama
fand the waters off the continental shelf in the Caribbean Sea fron

Punta Mosquito, Pananta to Barranquilla, Colonbis, ?The degree of potential
hazard to tan through contanination of these environments by radionuclides
nay then be predicted from these data.

?CURRENT STATUS

?This progran is an extension of the Marine Biology Program st PRIC
which is supported by the Environmental Sciences Branch of the USAEC
Division of Biology and Medicine. A unique feature of the progran is
the "sgecifie activity? approach-- a procedure of sampling and analysis
which holds prosiee of successful application to marine contanination

problens. ?This method is based upon two premise:

1. That the distribution patterns of biologically-available stable elesents in the organiens and their environnent may te used to predict approximately the distribution patterns of introduced Fadioieotopes of the sane elenents.

2. That Af the specific activities (Ci of radiotsotope/gran of Corresponding stable elenent of carrier elenent) in the estuarine Gr earine environsent are maintained below the allovable specific Activities for radioieotopes in the husen body, then no indivi~ Gaal can obtain grester than the allowable anount of radioactivity fron food derived fron these sources.

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On the basis of the prelininary assesonent of potentially critical radionuclides a field collection progran has been developed and two research vessels with an eizht can operating crew and seven scientific investigators will be sent to Panana in February 1957. ?The field team will remain in the Panama area for three uonthe making the collections which will include soils, river waters, sediments and organisns, marine water and sediments, and marine organisns including melluses, plankton,

Seston, crustacea, and fish. At the end of the firet three-sonth survey, which will de conducted during the "ary" eeacon, the research vessel "Shimada" will return to Puerto Rico. In August the collections for the ?rainy? season will be made in Panana. The "Shinada" and the crews will return to the site at that tine,

Stable elenent anslysis for 10 elesents vill be done on approximately 1250 samples in the Mayaguez laboratory. The distribution patterns of the stable elenents for which corresponding potentially dangerous radioisotopes way occur, will be determined. From these data the expected specific activities in hunan food ites may be calculated and compared with those Published in radiological safety guides and regulation:

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Schistosomiasis Project

EFFECT OF IRRADIATION OW HOST-PARASITE RELATIONSHIP IN SCHIBTOSOMA MANSORT

Starr

Jorge Chirtboga, M. D., Assistant Director for Scientific Prograns,
Acting Progran Director} Julio T. Colén, Ph. D., Associate Scientist
(Aa nonoren); Ramiro Martinez Silva, M.'D., Assdcsate Scientist.

Schistosomiasis is parasitic disease that occurs in Puerto Rico and
in many other areas of the world. Its hosts are sone mammals including
Jan and some snails. It is calctlated that at least one fnndred million
people suffer from it. o valid control of thie ai is available

fand the situation is s0 hopeless that in the opinion of an authority dn
this field ?unless sone means of control is discovered, the increase of
the disease caused by the new Aswan Dan in Feypt will mllify any econo-
mic benefits the Dam may yield,"

The Rierto Rico Nuclear Center is conducting research on Schistosomiasis
using radioactive isotopes end other miclear energy methods. The goal 4a to
obtain & better understanding of the mechanien regulating the host-parasite
relationship that eventually will load to the control of Schistosomiasis.
Studies et PRC approach the problem fren three different aspect: First,

radiation effects on the host-Schistogaza wansoni relation; Second, radiation effect on the snail-Schistoscma mansoni relation; Third, radioleotope applications for better understanding of the Schistosax natural history,

?The possibility of using irradiated cercariae of Schistosoma as a vaccine to protect against the disease is unter study. Experimental resulte ?show @ degree of protection in sone animals.

Experiments using irradiation to make a strain of snails resistant to the penetration and development of the parasite that can also compete with the normal snails in the field are also being conducted.

The biology of the parasite and the snaile is not well know in the actual endenic areas. For this reason, experiments are conducted with Asotopes to study the habits of the snails and the parasite in collaboration with the United States Public liealth Service in order to learn how to break the Life cycle.

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Sugarcane Borer Frogram

Induced Sterility for Population Control of the Sugarcene Borer (Diatraes secharalis) in Puerto Rico

STAFF

Devid W. Walker, Ph. D., Associate Scientist IT, Principal Investigator.

PURPOSE

ae progran wee begun tn 1963 to deterniog the potential for contol dy radiation sterilization of the sugarcane borer (Diatraea saccharalis. (fab.), Crambidae, Lepidoptera), and to study the bionouice of this species as it Felates to 4 mss-release progr

Stas

Ganma radiation doses suitable for sterilization of the sugarcane borer have been determined. Adults are sterilized at 35 Kilorad doses without affecting their life-span, oviposition rate, or mating behavior. Imature stages are mich more radiosensitive, with 9'Kilorad causing over 90% lethality.

Factors involved in the mass-rearing of the Rierto Rico strain of this species have been studied. These include the following:

1, Artificial diet: Vigorous adults of high fertility can be produced

on s diet containing carrot powler, liguia corn stalk extract, corn stalk fiber, ascorbic acid, agar, casein, sodium benzoate ana mettiyi parahydroxy-denzoate. Survival On this diet 13 eighty percent or higher, and adequate munbers are being produced to conduct small-scale field tests. Assuming fifty percent survival, food cost is approximately one-fifth of a cent

per adult.

2. Optimum rearing conditions: Light, temperature, and unidity are controlled during laboratory rearing. Under these conditions six days are required for egg maturation, thirty days for larval developaent, and seven to eight days for pupation.? Adulte produced frou this diet Live longer ?and produce nore viable eggs then comparable individuals grown on sigar-cane and other host plants. Eggs are collected daily and are placed on ?the food immediately after hatching. Pupse are reaoved fron the food as they form, Sex iz determined in the pupal stage. Adulte are collected ag they euerge fron the pupal case,

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3. Mating conditions: Mating takes place in the dark (ees then 1 lunen)?and is initiated by temperature reduction and Light decrease.

Males are attracted to fensles by a sex attractant and ty the specific wing beat frequency. Nated fenales begin laying fertile eggs within one hour

after mating, Peak ovivosition occurs on the second and fourth days after ating, Turee hundred fifty eggs are laid yer fenale (average) and under normal conditions egg hatch is one hundred per cent from fertilized fenales except during the period fron Deceuber to March.

?A large field cage has been constructed to vermit determination of population decline under Tield conditions using corn as the host plant. Corn planted in the cage has been infested by a known number of normal adults collected from nature. Population overflooding by irradiated males and/or fenales bas been done to measure population reduction. Larval populationsare measured by direct visual observation of larval tunnels

An stalks, and adult nale population is determined by trapping at might during nuptial flight.

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Resonance in Radiation Program

STAFF

Henry J. Gonberg, Ph. D., Deputy Director and Robert A. Luse, Ph. D., Chief Scientist (part?tine), Principal Investigators; Frencis K-8. Koo, Ph. D.5 Florencio Vazquez, Ph. D.; and Peter Paraskevoudakis, Pa. Di, Associate Scientists (all part tine).

PURPOSE

To answer the question "What are sone of the unique effects of ionizing Fadiation on matter?" To this end, the project has studied x-radiation effects in the 5 to 2 Kev eneray range upon biological eysteas. Thi energy region is of considerable importance since it contains the K-absorption edges of the constituent atoas of most living systens.

staTUs

Evaluation continues of the hypothesis that radiation dauage ina hnolecule can be a function of the site at which the photon is initielly absorbed. It is postulated that absorption of an x-ray photon in the

XK shell of an atom will produce a highly ionized atom and that the high state of ionization vill lead to major disruption of the molecule at the site of photon absorytion.

Using nonochrouatic x-rays, Diological aclecules vere irradiated at energies above and below the K-adsorption edge of selected target atoas. Danage vas Judged on the basis of effect cbserved yer unit enerey abeorved, cor per photon absorbed, in the molecular system, Eayeriaenes ie the eneray range 6.4 to 8.3 Kev have shown increased inactivation of the metelloensyoe entalase ot or near the K-absorption edge of iron (7.11 Kev), which 19 Tocated at the active site of this ensyme. In another biclogical syaten,

chromosomes in onion root tip cells treated with 9 broaodeoxyuridine ?have ?emhibited an increase in breakages caused by sonochrosatie x-rays at photon energies equal to or slightly greater than the Keabsorption edge of browine GSrEe kes}. van concrnst, theve as no much effect an pelta Somearaine ne aged BUDR.? Hence, in these two iaportant types of molecule--entyae, and Iucleie acia-- {thas been show that the efficiency of danage preauction 4 a sensitive function of the rhoton energy. The significance of this Finding. in more cowplex Biological eystens (oacgerial celle, Hela cells)

in at present being explored,

ome

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Current project activity has been directed to several biological systens in an atteayt to find optinal systeas for desonstrating the Reconance phenomenon. At this point, the effect has been shown in voth the netalloensyne cavalase and BUDR-labelea chronosones. Efforts now jail be directed to developing nechanions of the effect based on more Guantitative studies, Initially this will involve biochemical studies

On structural changes in the catalase molecule irradiated at or near

?the Keabsorption edge of iron.

Supplenenting the irradiation studies of biological molecules is the

developsent of special equipment which permits absolute measurenent of

the very Low photon fluxes generated in our highly monochromated (* 50 ev)

jeray beans. ?In addition, design and construction of high intensity field

Guission type x-ray sources have been carried out and the effect of various

Daraneters (vacuim, cathode material, applied voltage, and cathode-anode

spacing) on electron emission has been tested.

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Radiation Chemistry and Fhotochemistry Frogram

MATRIX LSOLATION STUDIES OF PRODUCTS

(OF GAMMA RADIOLYSIS OF HETEROCYCLIC MOLECULES

uA

Alec Griaison, Ph. Diy Agsceiete Solentist; George Stmpedn, Fhe Dey

Acecciate Sciontiet, Haricl H. Ihr, Th. De, Associate Scientist,

ani Research Aesistants.

PURTOSE

?hie oregran is concerned with the erfects or gone radiolysis
on sinple heverecyctic wolecales, woich can be contiuered as aolele
fer wore comlex substances of Biological teportance. Unstable
species formed in this gam radiolycis are trapned by carrying
Gat irradisticns in colit matrices at 77K, and are studied uner
?these conditions to elucidate their structure.

?CURRENT STATUS

optical dewars have been designed and tested for the examination
of optics! spectre at Liquid nltregen temperatures. Current projects
{netuie the invectigation o: color centers formed by gene irradia
ton of heterocyclic colites in wethyltetrahydrofuran and carbon
tetrachloride matrices. Thee tvo cclvente have been chosen to
enhance radical anion an¢ redical cation formation, respectively.
foot sgreenent has been obtained on the Literstare values Tor the
Grficiency of preduction o1 color centers in the pare solvents.
?stens which have proved particularly interesting are murine

ani syresine in methy)tetrahyerofuran, and zyrrole in carvon
tetrachloride, Tie lect aysten 12 currently being investigated
?aleo by photecherical irradiation of rigid solutions.

?theoretical work ineludes the prediction of the us v. and

Biectren Sin Besonence ancctre cf Likely radical svectee,

Being Helecular Orbitel end Volence Band Techniques. A sot of

valence bend coleulations on trinlet statee of simple heterceyclic

Coapounie 1% being dene in collsboration with Dr. Zauli et the

Gnstituto di Chinica Fisica, University of Bologna.

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Radiation Preservation of Tropical Foods

STAFF

Horace D. Graham, Ph. D., and Robert A. Iuse, Ph. D., Chief Scientists

(Part tine), Principal Investigators; Sureckant N. Desupande, Pr. D.,

Associate Scientist I (Part tine).

PURPOSE

To determine tie feasibility of radiation preservation of bananas
?and wangoee, through examination of two aspects of tie general problem:

L, Determination of those factors of pre-irradiation condition,
radiation dose, and post-irradiation treatuent which delay ripening and
axinize the sielf Life of tue food product. Hore qualitative or semi-
Quantitative criteria of ripening, such as softening, changes in color,
Spotting, and tacte are utilized, Tuese are supplenented by measurenent
of those characters associated witu ripening, e.g. starch to suger
conversion and pulp acidity.

2, Meagurenent by appropriate biochemical assay of changes in
various nutritional factors that accoapary radiation pasteurization.
?hie part ie anenable to quantitative assay of vitamin levels and now
?they are affected by radiation dose and treatment.

STATUS

Bananas of the variety Monte Cristo and mangoes of the varieties
Native, Hafu, Seedi uuezano nave been irradiated
SEER HEY Pec acd ay tev. doaee ot Gooee rvaatation can be used
for the preservation of tuese tropical fruits. Major enpiasis is placed

fon the influence of irradiation en the retardation of ripening in the: fruits and on the levels of nutritionally important bicciemical ?components such role ackd, carotenoids, sugars, starch and on titratable acidity. Stadies also are made of tue effect of ganna irradiation on the depolymerization of sone of the pectic constituents of sangoes

Bananas of known history and 90-120 days old at the tine of cutting have been irradiated at 10, 20, 30, 40, and 50 Kkilorads and then, along with non-irradiated samples (contréls), stored at 60°F, 75°F, and 60°F. Every seven days gageies are vithdram and analyzed for the Components named above. At 66°F, using bananas 6-104 days, no retardation of ripening nas been noticed, On the contrary, sone stimulation vas evident, but the pattern wae erratic. At 50 kilorads, intense blackening of tne fruits

=m.

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?cccurred; hence all subsequent work vas Limited to 40 kilorads,

fetardation of ripening cecurred at 75° an at 20-10 kilorade,

But there was no consistent relaticnship between the radiation

Bote and the extent of retardation. At this teuperature and ot

tn irrediation dove of 40 kilorada, there wae Little or no effect

on the levele of cugar corctencids but the titrateble acidity

Gmcreased and ascorbic acid decreased ty about 25%. At 80°F

retardation of ripening was more pronounced, but the fruits ripened

tach faster than at 75°F.

Mature or eluost ripe mangoes have been irradiated at 50) 100,

150 and 200 kilorade ant stored at 50°F; non-irradiated controls

Were aleo included, Biochemical analyses were done cn represen

Xative simples as described above for banana. All fruits stored

At SOF kent well. The irradiated rruite renained green for 30 days.

Fruite of the "Native" variety irradiated at 250 kilorads or above

thoved severe blackening of the pulp, This blackening progressed

from the seed outvarde and was not noticed in the other varieti

Burning or blackening of the skin occurred in all varieties when Hrradiated at 150 and 200 kilorads. The wide natural variations from fruit to fruit end froa batch to batch hinier waking any valid Conclucions as to the effect of irradiation on the biochemical componente assayed.

Fectic constituents of mangoes of the variety Sundareshe irradiated ?at 500, 1,000, 1,500 and 2,000 kilorade have chom s consistent Gecreave in the molecular weighte of their highly uethylated vater soluble pectinic acid fractions with increasing rediation dose. How~ ever, increase in radiation dose did not cause a severe degradation Gf the lov methoxyl pectine or the protopectins extracted from these fruits. Fractionation of pectin frou control fruits with molecular Sieve chronatography indicated the occurrence of at least two major Fractions of distinct molecular glze. It vas inferred thet the radiation-depolynerized pectine constitute sub-fractions of these Sajor fractions. Study of their uolecular weight distribution Jatterns therefore is contemplated, in order to determine the Felationchiy between pectin depolyterization ani iruit softening.

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