PRNC081

PRNC ~ 81

(Rev. gan. 1967)

PUERTO RICO NUCLEAR CENTER

ABSTRACTS OF PROGRAMS SUPPORTED

BY THE AEC DIVISIONS OF;

Nuclear Education and Training

Physical Research

Biology and Medicine

Isotopes Development

7/7 CrmaTiD 4Y UNIVERSITY OF PUERTO RICO UNDER CONTRACT

NO, AT (40-11.1892 FOR U.S. ATOMIC ENERGY. COMMINSION.

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Solid State Physics Program. au

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DIVISION OF TSOTOFES DEVELOPMENT

Radiation Preservation of Tropical Poots,

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Clinical Applications bivision

Sergio Tritarry, M, Ds, Chief Scientist II, lead; Aldo BE. Lanaro,

M, Dey Associate Scieniist IT; Pedro Juan Santiago, M.'D., Associate

Scientist I (Fart=Tine).

PURPOSE

?The tain purpose of the progran of thie Division ie teaching and

training of latin Anerican physicians in the diagnostic and therapeutic uses of radioisotopes in hunans.

cue sous

Sources Avaiiabi:

1. Basie Course Clinical Applications of Radioicctopee. This course consists of forcal lectures, denenstraticns, periods of dis cussion and laboratory work. Tts cain purpose is to enphasize training in the use of clinical radioisotope techniques.

2. Orientation Course Clinical Applications of Radioisotoves for Megical Regidentge ?This Te'a non credit goosster couse Tor Netieal Residents designed for orientation omy in the modical uses of radio Asotopes.

3+ Course in a Medical Secialty. ?hie is a course emphasizing ?the application of nuclear techniques ina special field of Medicine. A twonweck couree in the field of Pediatrics vill be offered following

?the Basic Course in Clinical Applications of Hadioisctopes in February ?and June 1967.

4, Qraining in Clinical Rogearch. ?his course stresses research aspects ini Clinical wedicine, ani is designed to provide research faci~ Lilies to trainees interested in clinical radioisotope research work.

Special activities to inereace the muuber of prospective caniidates for ?the training courses have included several trips to south America by Dr. lanaro during which he has visited hospitals, univereities and other institutions and participated in scientific neetings.

---Page Break---

Many prospective trainees would coe to Puerto Rico provided maintenance expences could be provided.

Glinical Research:

?To complenent the training progran, research projects are active in the areas indicated

Fa

2

Thyroid disorders

Cancer detection

Gaetrointestinal absorption

Problems of clinical radiation

Liver and kidney disorders

---Page Break---

Radiotherapy and Cancer Division

oTrP

Wietor A, Varcis}, I, D. Chief Scientist TL, Head; Joss XN. Toad,

4H, Ds, Chief Scientist 1; Jeanne Ubivas, li. De, Chie scientist Ip

Antonie Bosch, Hi. D., Chier Scientist 1 Marfa? P, de Lozano, Me Sey

Research Associate 13 Zenaida Frias, ii, §., ledieal Research Statistician.

PROS

The vain purpose of thie Division is to train yhysieiane and allied Personnel in all agocte of the apolication of nuclear energy to cancer. ?A second purpose is to develoy and carry cut @ research program to improve oar knevledge in tho cancer end rediation Ticlda.

CURRENT smATUS

?This Division offers twe vregrams in Raciotherany Training: (2) Radiotnerany Restoncy Prosran. he objective of this program is to prepare qualifies radiation therapiste, Thie te an approved progran that fulfills the requirenente of the Anerican Boar of Rdiology. Thysicians vith « year's internshin or equivalent clinical experience are accepted for this training. The teta! training perica lasts three years, tut trainees are required te take an addizional fourth year of supervised practice (preceptorship) before aduiasicn to ?the specislty examinations. Trainees acquire a solid background in clinieal cancer through slpervieed worl: with new, folloy-up, and hospitalized cancer yatients. They earn to diagnose the disease, determine the extent ci the sane, choose the appropriate treatment, and plan and coniuct radiological therapy. Radiation therapy experience 4s acquired by workings with rcentgontherayy machines of various veltagee

and teletherapy units, which include cobalt and cesium, and with the wpplication of radlcactive waterial suck as radiu, ctrontiun, cobalt, and tridiun.

Trainces alco beccne familiar with non-radsolegical cancer treatnent methods, such ac aingery and chenotierany. Tn addition, they learn of cancer control activities in Fuerte Rico; this includes ?the opem tion of a Contral Cancer Rogistzy, tunor elinie work, cancer detection, ani public ani professional education in cancer.

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(2) Specie? shor Roiothersuy Trainin: Course,

Seciad prograne are wwevare! Ec Ube heeds oF the persons Perticipants cay engage in u regearch project ant vay particinate

in all teaching activstics of the Tadictheropy and Cancer Division;

?ut are nob given vetient ressonaibility.

Ap aiditicnsl trsining activity is eftereé fer Fourth
Year Medical Stulentc. Selected candidates receive cne senth of
Intensive in-service training, where they are exposed to cancer ond
radiotherazy clinical. probleas.

Experienced radiotheranisis fro Latin Averica are hired
as visiting staff. This yersite then to becoue ocquainted with the
work of this Divieicn um! te carsy out research projects.

?To complenent the training precrans, © muber of research projects are active in this Division. These include: (2) Iaveeti-gation of the Role of Surgical Serilization in the btiolagy of Cancer of the Uterine Corvi:r; (2) study of Procticnation of Weekly Radiation Doses in Cancor Pationts Under Radiotherapy: (3) Careinewa of the Uterine Cervix: Aceociated with Pregnancy: (1) Doterainationof Optinal Tmor-Dose in Radiation Therapy cf Concer of the Erophagu: (5) Controlled stuly cr the sylit-Dose Technique in Rediotherapy of Cancer; (6) stuay of Chreviosene Changes in Tatsente Undergoing Radiation Therayy for Cancer; (7) Exfoliative Cytolocy az ¢ Tool for Determining Prognosis in Cssce with Cerviea) Coreincoa subitted

to Irradiation; (8) durzical Adjuvant Breast Project; (9) study of the Tneidenee of Leulenia in Fatients vith Cervical Cancer Treated with Radiation; (19) Clinica) Doce-Tae-Practicns tion Relationshine.

hie Division is collaborating in varicus research

projects coniuctet by cther Divicicns of FRNC; thees are, study or

thyroid funetion in vatiente with peovlacia, tunur loealizetion

studies, gastrointestinal abgorntion studies, norsel and neoplastic

tisme ?cell-cycle stulics, nice L.D.-50 studies, ete,

---Page Break---

Agricultural Bio-Sciences Division

say

Robert A. Luss, Ph, Dey Chicr Sofentict, tuo: Jost A. Ferrer

tonge, Mh. Ds, Chler Sicn.iet; Francie K. 8" KoO, Fhe D., Aggociate

Scientist 11; Devic W. Valker, Th. D., Acgocicte Scientist 11;

Gureekant WN, Dechrande, Th. D., Associate scientist 1 José Cuevas,

Hy S., Research Acsceitte I.

PIRIOS:

To train ctulents at the graduate ant the post-graduate level

for reeearch in agricutture or biclogy, erhasizing mileor techniquee.

To cerry on continuing basic research ywograne which ore concerned

with problene in trovical agriculture that can be uniquely studied by

nuclesr techniquee.

satus

Education ami Training

Bight ctudente currently sre vorking tovand al. & degrees in

biology snd agriculture-~degrees which Will be avardea by the

University of Puerte Rico unc comletion of course york sm

?oxperinentel thesis. In the last five years, several ctulente

hhave contimed cn fer doctoral training in U. 5. universitie:

In the last year rive rersons hove dons ~ovt-graiunte research
in the Divseion, supserted threugh rellovahine tem IABh, GINS,
Kg, ant the Peace Core, There trainees creme? res 1 to 15 ronthe
st Fane taking cources ani/or participating in research srojectes
?ey then return to their hore countay to develop seiontitie
projeste there (eug-) in Toiven, Crugunyy Gustonsie). An alditiona
THEA Fellow 1s in proz-cet.

Division ster? arn currently offering graduate level courses at
?the University, uhere they held ?appointsonts, Thie
acadenic year Courses in Nuclear Techniques in Acricultire, Muclear
Techniques in Biclegical Research, and in Cytogenseics (both conpuses)
are being presented.

Division start aeabere hove served ae Seienlific Advisors with the
?ABO Exhibit "Atenoe en Accién? in El salvador oni Glotenala in 1965
and in Coste Rica ani Micuragus in 1956. Ro-visitelion of yrevieue
Exhibit ites permite contimied contact an) coonerstion with Central
?Anerican scientiste.

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IL, Research

A. Radicbotany of somarcane

Jo increase the cecncsic return ros cwarcane (Puerto Rice's
oct important cron), tho imluetion of pleut sutante with high eueroee
content ie being aitéaptev. Initial exserinenta to determine the radio~
sensitivity of ceede ond buds to thermal neutrone produced in tho PRKC
negawatt reactor have been ecapleved. dubsequently, theveands of ceeds
and vegetative buds uve been irradiated, yervinete, and planted in

the Field. Nags cheaical sercening ror Sugar content in the Individual
plants produced in being carried out via autcmsted anelytical techniques.
Visible mutations sich se vider etister leaves indicate thot other favor
able characteristics vay Ve Inluced. Suerior mutants vill be prozs-
gated ond evaluated in the University Agviculiurel Ex-eriment Station?
program of eron breeding and invroverents

A similar oregras concerned with the inducticn of resistance

in sugarcane to tho "cesie virus Clesace is uvienay. early 3

?thousand vlants have been grom fron irradialoc eco and these are

in preceee oF sone screoning by srtirieial ingectirn sith the virus,

B. Radiotsotove studi

in suparcane

Imertant problexe of beth imediste and long-range application, have been stutied in sugarcane through the use o. radioisolopes. Several field and groonheuse cxzerinents which doo? with acronente practice were camletes thie year. Fer examle, the elvect or e0il Factors (pil, density, moisture content) on the nutrient uptake and utilization or phomintes, sulfates, and trace cleaents har been @etermined. Also, che enfunceuent ox reliur abecrstion of uhosphatee by wetting agente vac measured; resulte will be of wae in the aerial spray application of Jertitizers to sugarcane, on increasingly more comin sractice.

The enzymatic legradalion of auevore in the aigercane plant by invertase hes been the sibject or bicchosical Investigaticn. Factors which control invertase wermaticn have been deternines by measuring ?the incorzoration cr eciod carbon-l!i labeled snino acide into the protein fraction of sugarcane neristen tiesie, Contacters auch a2 ?pagnesiur. ion have been roan? cesential ror thie incormcration; the protein roruition is ceneidarably reduced by preeence of aulthydryl ?compourts.

©. Radiation preservation sanices

Several exotic tropical iruits hove considerable sarket potential if their ripening could be delayes te permit shivaent.

To evaluate the process of rodiation oreservolion, a seriee oF experiments vere donc, Involving 20 varivt ics of mangoes Srradinted to different dcaes at? three Gisferent etogee o: ripening and stored

---Page Break---

at posteirradiation tenoeratures of 50 and 70°P, Fron these studies it wag found thet 250 Kr. doses of gamma radiation extend the shelf-Life at 50°F by ayproxinately twenty daye Tor certain varieties oF mangoes. Sich results hold pronise for the radiation preservation of thie frait.

Biochenical studies of softening of mangoes during and folloving irradiation also have been carried out dy measuring the extent of

depolymerization of the pectic constituent in irradiated Pruit,

Sortening was fount due both te radiation induced depolymerization of

pectic acids ani to the considerable polygalacturanase activity in

?the mango.

D. Other projects

Within ite structure, the Agricultural Bio-Sciences Diviaion

currently houses three Projects supported through contracts with the

USWC: Radiation Sterilization cf the Sugarcane Borer, Radiation

Preservation of Tropical Foods, and Resonance in Radiation Brvects.

While these projects are reported elsewhere, it should be pointed out

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

tum, rely for their senior investigators on Division personnel.

---Page Break---

Radioisotope Applications Division

SUF

Ay Marry Stunt, Hi. D., Chiei Seientist 11, tieads Alec Gréatecn,

Bi Dey asocelate Gientist! 11 (Fovtefine); José P. 2. Castrtliéa,

stats, The ney Aeseatate

T (urtefice); Simpeon, Th. D., Agsociate scientist

3; Gerardo cline Vass, lie Sy Reeeareh Auoschate TEs Resa Sontana

ae Tirade, 4 8., Research Segoetats T.

PROS,

The main chjective ox Use oregran 1s the

taining to sclentigts in the ayplicution of sulsoseotozes and ionizing radiation to the physical cclenees te provide tecknical competence for their future verk, A secon objective is the offering of introductory training to eelunticte, irremective of their Tiel Of interest, in radioisotoves ani icniting radiation as u Lackgroune for af conmlonentery vrevoraticn For their serticipation in other prograns ef PRIC.

cunRERT orATUS

Courses with University credit

1, Madiochentsiry Cuuree (Cheuistry M5 =! erelit hours). A one sesester course oiZepet ence a year For sdvarce! undergraduate and graduste giwlente, Three eae-hour lectures and one sour-hour Inboretory pericd ver wee!,. A -proxinate envellsent. i to 6.

2. ttuclear Techniques in Biological esearch (Biology 372 = & credit pours). A cno-soveatzr course ci¥ere! une 2 year Yor advanced uniergraduate otulente. ?hree ono-low lectiwrea cm? one howr-hour laboratory yeriol ver week, Amrexitiate enrolluent:

Wo 6.

3, Particiyation in Graduate on® Undergradvate Research Courses.

Research trainin; in che Yielis of photo ant radicehonieal reactions fond in the application of rodlolsotones te cheascal etucies 12 orvered to students sursain; the HD. om: B. 3, deumees at the University of Puerts Rico, Roch) steal carries out an individual researeh sroject in accor? with the credite for whieh he registera in Cheaictry 599 end Chonistry 397-300.

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Sweeis? Trainin:

1. Basie Cours in fadjokactove Techniquas = Your=wees course now boing offered ivur cr five tire o year. le have had y tetai

of 272 sarticipante (6 (ns) including G) Letin Amerisane,

The present rate ci certichuunle in eproxtestely 39 er yaar. (This course vas incornorute? in the eursiculus of the graduate pregrane of Biocheoictry ont jiivroblole y at the U, P. Re aehool of Uedieine a Biochenietry ant hutrivion redit hours).

2. Rudielogics? Thysten = A sreciol course offered te Hy De Residents in Tadiology when reque ste?

ORGAITC GrBMISTRY PROCRAE

PURPOSE:

The muzpose ox the snoyren ie te wovide advenecd chendeat treining in organic chentetry With special eupnasia on ity miclear espects, The nrojecte cover e relatively ville range af subjects Anonler to ofrer 9 broad experience to ell nenbore cf the ZEOu, and the uifrusion of the varied aspects ef argunie cheatstry 1s pronotel by grow seminars and ¢iscuesions.

?CURREET STARS

the research topics inciude the use of $-35 in exchange reactions, the use of tritium, Cl-30 am! Cel% Yor the delerainationef reaction mechanisns, Ue synthests boren coupeunda cf potential use in neutron sctivation therary, ani the gama raliolysic of dimethyl sulvoziue.

the stuly cf the guise rediolyeie oF dfwethvi sxbvoride te oF
recent origin, but correlative atusies ccncernet with the phyefeal
properties of this substance have been in procresa for sone tine,
The boren project in currently Inactive because o; tho departure
of the recearch assistant vio wer involved in thie work.

PHOTOCMEATSTIY AND RADIATION CHLSMY. PROGRAI

PURPOSE

The purpose of the vroyras i to provide atvanced chentes)
training in photecheni siry and radiation chenietey, with special,
enphasio cn the relations en distinctions boween theae. Also
Includes are orojects ylvine Uraininy in the use or quantum chesteaL
ealewlations for evaluation of the eerinontal results.

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CORRE suATUS

?The edvanced chenical training in thie area involves active

participation in the experinental and theeretical projects detailed

under "Matrix Isolation Studies of Products of Gamma Radiolysis of

Heterocyclic Molecules", as vell ae participation in group seainare.

---Page Break---

Nuclear Science and Technology Division

SUF

ven Hl. Uheclex, DB. Sox, Thy Di, Cihfer Scieutiel I, Mead (Parte

Tine); Hidie Oréiz,?Ta. D.,?Chicr Seiontist 1 (Al honores); Rev. Ignacio

Contarel2, Mh. D., Associate sciontict IT (Fert-Tine); Julio A. Gonzate,

Ph. D., Associate Scientist IT (Port-Tine): Florencio Vazquez Nartines,

Ph. Dl, Associate Geiontist II (Fart-Tine); Ruvere E. Lee, ie Soo,

Research Associate 111; J. Eliein Trabal, D. S., Reecorch Azsociace T.

sore

?he Division wovides treininy und roserch facilities in fields
of cheaietry ani plyvies related le nuclear selenee for stulente in
the E. S. degree prograxs of the Doparinents of Chesistry, Mystics and
Muclear Engineering o: the University of Puerto Rico at Heyaguez.

?he Division alco eifers research facilities far vorkers at the
pres and post-doctorel icvel und the eiaif menbers carry ou: infevendent
research.

cuRREET soVIUS

BDUCATION AND TRAINING

Seven graduate etucents ere carrying wut research For their Me

degree in chewistry ana one in physics in the Division. Kesbers of the Division are currently teachin; times courses in the Deaartnente of Choststry ani Fhysice uf the University or Mierto Keo at Kayacues, in meclear physics an! chemistry, redicchtaistry, and sola etate phystes.

fir, Ruyert A. Lee ig completing bis thesis york for @ Pi. D. dn radiation chemistry cron the Univeresty of Alberts,

COENTSIRY PROGRAL

?The Tunvlanental seelionicam of the gadielyeie oF hydrogen chloride ant hydrogen tranide is bein vtudied, ueine beth vanma radiation ani figsion recoil variiclez. This stuly is sart 0

?the conversion ct Tission eneryy inte electrics! ene involving radiolysis of © lyurngen hadi

provide feed waterisl vor = tuel cold.

ore

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Studies ere ates boing carvio? cut on radiation dniueed reactions

of organic conpounte in eolntion, and on the weeheriss oF theraal

Pearrangeronte usin: iaotones

A program of yegvarch in hot~aten chesictry Le now supported ty

the Divicion o> Research o: the ABC. ?lo other research groupe are Financed by grants rac the Tational Institutes of Health; one oa the Qmthests or Thiactercids (3 asstetante) and the other on the Radiclysis of Peptides (2 assiatante)

PIYSICS PROGRA

Radiation darage 1 ie investigated by reans of hysteresis ant aielect ?an! of veaeurevents of egnacity and conductivity, the effect of tauerature ehanges to + 10-3'C in

?the region of the Curie temersture hae been studied. The coapcunde stuliet Inclule triglyeine «iiate, en? alkali ihviregen selenites.

Work 1s bein: initiated en the formation of coler centers in nagnesiiu oxide ant alkali holides, ani on field ealscion Fron highty clean surfaces.

Related studicc, in conjunction with the Mysice Department,

University or Puerto Rico ot Yayaruez (ilk J. Gemborg and F, Cruz-Videl)

are concerned vith the efficiency of colér center Torvaticn in alkali

halides asa function «? the energy of incident mcncehraustie ?rays

near the K absorntion oiige of the indice.

ole

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Nuciear Engineering Division

BL. Dey Chie? sebensist T, Heats Aviva Be

Sientist Ty Peiliip 1. Osborne, Ph. De,

Kennet Soierstron, i. 8. Rogeareh Asccciate

II]; Carloe Wheeler, 3. S., Research Agsseiate II: Erich Hénden

Veray, He 8. Rasearch Arecctate

PURPOSE

?he sain purpose o: the Division progres ie to teach, train and

do reovarc in the asic sciences snd engineerin; contributing ve development er the usc of nuclear energy. University cf Merto Rico students in the proprax mist be enrollet ver graduate atwties and be accented in nrogran leading toward one of the Meter of Science Gegrees in engineering, urually nuclear engincoring. ?Stulents feu other sniversitiee in the United states or in L:tin America may be accepted for particination in research fcr completion oF theale requiresents. PRIC participates In the CRLIIG Graduate Fe-lawehiy Progran for upport of U, 5. citizens doin: thesis research,

?There are nev 15 stulente working tovard tl, & cecresn in Maclear Engineering.

In addition to the orimiry purgose, the Divieien alco provides special non-degree treining vrograne tor technictane ami ror engineers and scientist.

CURRENT STATUS

he mrinary effort ic on the educations? nrogran 4m fuclear Engineering carrivd out in cooperation with the Depariuent of thelear Engineering of the College ef Engineering. Courses being ?taught are:

Core Courses:

1, Blonents of fuclea Rypincorsnys. (181 Be 695) Four credit hours, Four lectures sor wok, Characteristics or the ateale fuclets, ?Tadioactive decay. Interaction of radtaticn ont netter. Baste neutrenice,

2, Reactor Theory (tu Fy 621) Three credit hour. Three lectures per week. Feutron belanco equiticn, Dirfision theerys Stoving dow theory. Bare honcgenecus reactor. Retlectod reactor. Heterogenecus reactor. Tine depenient reactor. Terturbation theory. Transport thecry.

1.

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3. Mathenatics of Motor Soience 1 (Iki BG 675) Tree eredit

er veek. A acre advanced? study co some

75076." Complex variables, partial

differential equations, special functions, transfer ealenlus.

4, Miclear Yoacuresent,

ereait ear ?e-hour Taboratories each week.

Prerequisite: Fays list. ice of overation ani thorough

feniliarization used in? the azplication of specialized techniques

such ag: coineidence ant anticoineidence coust=n, pulse analysis,

neutron cpectronetry, cama ray spectrometry, ete.

5. Advanced Reactor Troory (tu Rg 622) Taree credit hours,
Three lectures per week. Prerequisite: ki Eg Ocl. Advanced transport theery. Reactor Kinetics. Hoterenenceue reactor theory. Prereaui= sites. th Bg 675, tia Ez G95, Ta Ee Gl. Cerequiaite: i Bg 676.

6. Mathemtics of Modern Science II (Math 676) Three credit
hours, Three lectures Fer veck. h-nore advance! study ot? some topice covered in tath. l75-476. Sturn Licuville systems, calew of variations, intecrsi, cquntions, tensers, Tinite differences.

7. Reastor Laboratory (thx Bg 625) Iwo credit eure, Two three= hour ?Laboratories cach week. Prerequisite: la Eq 621, Laboratory problene involving the suclear veactors

8, Graduate Soninar (Hi Eg 616) One eredit hour Iwo houre per welt. Report's and discussione on special topics tn Ihiclear Selence and Engincoring.

9. Muclear Reactor Technotoxy (itu Bg 602) Four credit hours. ?Tree lectures and cne three-hour laboratory denonstration period each veek. Prerequisite: thu Bg 605 an] mu Sg 621, Steary-state fand transient thermal conduction in fuel elenents; thermal convection in heatvexchangor deaign; liquid metal aystene; breeding enl conver= sion; an introtuction to the econenice of reactor operatin; reactor engineering decign problews.

10, Theste (su Ez 699) One to eix credit hours. One to et research? periods cach veek. Research in the field of Muclear Engineering and presentation of 8 thesis.

Supplewentary Cores:

1, Muclear feactor Hetolurey (tu Bg 612) tree creait hore.
Iwo lectures and one three-hour laboratory each week. Corequisite:
Ma Bg 601.

An introduction to elencntaxy physical metelluray of the princtpel reactor aterials sich as alusinus, eireoniu, uranium ail high temperature alloys; mechanical nrozerties; fabrication of nuclear fuels; radiation danage to resctor ccuponente,

---Page Break---

2, Introtuction te Kuclear Brwineeriy: (im Be 952) Taree credit hours: ?This course is cfvered fer advance! untergraduate and none fucloar engineering sraduote students. Three lectures each week. Ficeion ami chain reactions, elenente of reactor Gesisn, utiliza tion of miclear energy vor never uml radiotion problews,

Research

?The staf of tho Nuclear Engineering Division and menbera of other PRIC Divisione are carrying out research through projects designe] Tor student varticipaticn, These inclwle.

1, Method of reactor

Xenon peak.

matdevn minimizing tbo after ekutdoun

2, Heamirenent of te transfer function on the L-77 homogeneous

reactor by the rolulation Lechniques

3. Stuly of the variation cx the neutven characterd cries occur

Ang during the reacter cporation duc to the changer in

Lsctopic componition or the core.

A, Bfvecte of irradiation on the re

plexiglass.

?ture characteristice of

3. Detersination of nase lov rates in nines by use of the

nuclear Doppler effect.

6. Determination of netel to uetel diffusion ecezticiente by diffusicn of radicactive muclet.

Ts The effect of metear irradiation on the enissivicy of graphite.

8, Determination or the heat-transrer coer¥icient Tor free convection or air tetveen ?late-tyve fuel elenents.

Honechronativetion of reactor beamport neutrons by maltiyle critical angle reatter.

De

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Reactor Division

SDF

Héctor Darceld, M. S., Chief Scientiet I, Heads Richard Brom Campos, M. S., Associate Scientict I, Reactor Sivervisors Ernesto Guerra, B. £.?8., Reactor aivervisor: Six Reactor Operator

PURPOSE,

The main objective of this Division {a the operation, maintenance, land protection of the tvo FRC reactors: an 1-77 homogeneous reactor and an A. N. F. pool-type research reactor currently operating at

2 one-negawatt power level. ?The Division starf aleo operates and maintains pneumatic tubes, hot cells, a gamma irradiation room, fuel elenent irrediators, a gama pool, ahd all equipuent necessary for the operation of these facilities ani participates in the training

of reactor operators and supervisors.

smarus

The Reactor Division supports all other divisions and programs associated with the Tuerto Rico Muclear Center.

In the pool-type resesrch reactor, two six-inch beam tubes are being utilized by the neutron diffraction program for two neutron spectrometers. A shielded room has been built aroun? another six-inch beam tube Yor ruture experiments in biology ani medicine.

A borated water shutter has been built for this beam tube, A neutron moncehronator, based on critical angle reflection techniques, is Being built to be installed ina fourth bena tube. ?The fifth beam tube is scheduled for the experinents by Lee on riesion

Product radiolysis of hydrogen halides.

Presently, tho one mogavatt research reactor ie operated on ?a sixteen-hours-a-day basis, at a continous yover of one megawatt, Studies are in progress for an increase of pover to two megawatts and an increase in operation tine to twenty-four heure, five daye a week. Ultinate plans are to increase the pover level to five megawatts continuous with puleing capability with peak pover of two ?thousand megawatts.

The I-77 reactor is used for teaching ond experiments suitable for a water boiler honogeneous type of cource. An oecillator Tor dynamic experinente is being built.

Be

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the demm: Yor jie dLeTerant neces ev cperation of the yeol
roictor, neindy, contimine, soady state, MLL porer cov researchers,
versus variable Phu, chun Ge ef vomisaration ane Interns stent

operation required Sr ony trainin, uresvone moved ide Pavision te
or the cenztruction of unother reeeter to be
pr end om the wool. Thic Lar yevar reactor Se

to be buile ani yar into opcrudien by teaiers of the Divielom.
This reactor vill be cveraiec on an er-orr teris with the nrinacy
wurneae to provide @ Mealble suel}ity where miclear engineering
fant other graduate students my sorfor labarstery exerinente
ani research projects relates to Division wet.

?he Divieton

ani suyervisore, ant

Acinote: tn the treiain: ey vesctor oeratere

is wor'h Polated to resetor

Divicion haz tained two reactor

tions at the Coleapie mucker

gave opereter training te the BOIS clartup team, The training

ef providing pructfeal evyoriones ia reactor startup

Ti also articlyetes in uo trainin: oF tuelve

ina toneveck sumnor couree, In addition,

srovlene oF DOME ciudenes stulyin; for the vegree in

ticlear Ensineering of the University of frerte Rieu at bayaguee,

Were supervise! by verecuncl of the "acter Mivision.

In the Tiel! of technical nels te other organtzetions, resbers
of this Division have been in lose contact vith the Columbia
reactor. The director ex the Divicien ica pemer of the BOWS
Sifety Comiitee, uni uiso vavtieisated ino study grow meeting
in Caracas, crganized by tho International Auumic Energy Agency+

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---Page Break---

Health Physics Division

od

Peter Paraskevoudakis, Ph. D., Asscciate Scientist IT, Acting

leads Pedro Cruz, Ii. S., Research Aescciate II; Heidi Pabon, i. Sy Associate in leaith thystes, and five Health Riyeice Asoistonte.

SCORE

?The Division has tvo general responsibilities: (1) services assceiated with radiation and industrial safety, and (2) training ?and education,

cunnent sparus

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

1, Personnel Venitoring - This 1p the nost extensive program. Dose assesment mainly by vay of sensitive film Se provided to ?the Nuclear Center, Bonus Fever Plant and the Cancer liogpital at Rio Piedras. During fiscal your 1966 more than 13,000 film packets were processed.

2, Area Nonitoring ~ Thic progran is Limited to PRNC controlled areas and provides inzornation on operation of the difverent Facilities of the installation in their relation to the use of radioactive material,

3. Environmental Survefliance - This srogren involves the

collection ani snalysie of enviromental samzles auch ag soily water and vegetation beyond the area of the PRIC aite,

4s, igste Digpossl ~ the Wealth Thyeice Division has the respon sibility for managenent an! contrel of radioactive wastes generated by FRUC.

5. Radioactive and Non-fadicactive llazardous Material Handling = The Division carries out routine inepections ani checks to engure safe bandling of thie tye of uaterial. Part of the progran includes Anloctrination of the personnel using ihe waterial in proper eafety procedures.

6. General Iaboratory Safety - this progran is in essence an extension of the previous one. Eurhasis Se given to the supervision

?we

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of eyerations not covered under iter 9 auch o¢ combiance with rire, electrical constructin calec, etc. Pertorie inspections an Indcctrinstion of pergonaei fora an dntegral perl of thie prograi.

In addition to these procraus Health Physice ic in charge of supervising an? dirocting Hecontanination operations.

The Division operates two facilities, one for the calibration of radiation monitoring equizwent and the other Yer 2 muclear accident dosinetry conter based un a dorineter ayster orizinildy deveroped by Thirst

In the orca or training ani eduention the sta?y portteipates in the teaching an? Lraining ov students ond tary weavers in the principles ant practice of radiation safety. Miig ineludee acwlenic courses, se:inars and thesis researeh. In coozeration with the University o1 Puerto Rico, the Divisi¢n offers a curricule leading to an is S. ulegree in siealth Fhyeies. This iz an approved program Yor the Atouic Enorgy Crmmigeion Svecial Pellarehip in Health: Physics. A graduate course in Healt Taysice 1 offered, Yor stulents not apecializin. in this flels, with acalente

credit granted through the Biclocy Departuent of the University

of Puerto Rico in iinyaguos. The Dévirion alco carries cut research bo supnert investigations in other divisicne amt programe.

A recent develoment i9 the smevicion of doainetry standunle Zor researchers threuchou: PRIC. Using knewn techniques and Geveloping new ones, ac nooted, Health thysies provides enerey apf dogo information for all neutron and gama rey radiation facilities such as the reactor beas tubee, pneumatic tubes, thermal colin, pool area, the neutron ani the gar irradiation occ, the eobait-6o sources, ani cther major sources ae they are introduced.

?0.

---Page Break---

Medical Sciences and Radiobiology Division

STAFF

Jorge M. Chiribogs, 1. D., Assistant Director for Sctentirie

Prograns, Acting ties; Royiro Martinez Silva, M. D., Associate

Scientist 1; Julio 1. Colin, Ph. D., Associate Sientist (Ad honoren);

José Hoel Correa, u."D., Astociate Sientist (Ad honoren); Ivelisee

Rodrf:uez de Oquendo, 11, 5., Research Azgcoiate I: Ana Sylvia Guesade

de Rodricuez, H. S., Research Associate (Ad honorew); Couredo Asenjo,

Mh. D., Chie? Scientist (Ad honoren)); José A. del Castillo, Ph. Dis

Chief Scientist (Ad honoren): Luis Otero Villaderbs, Th. Ds,

Associate Scientist.

PURPOSE

1, To tonch and coniuct research at difverent levels within the

?held or Radiation Belogy.

2. To establich projects which have a bearing on the problens

of Tropical Medicine (Field and Laboratory Studies on the Efrects

of Raciation on Host-Paracite Relationshine),

3. To maintain a tisme culture

for taining ond reecarcls,

jcility to serve as a mediun

cuRRENT sa\TuS

?Training - A four week course in Mesue Culture and Radiotsctopic Techniques at Cellular ent Subcellular Lavel wae offered froe Octoder 17 to Novenber 10, 1965. The Course ie Cesimned to give euphasic to the basic osyects of tissue culture mich as the applications of this technique to virology, radicbiclogy, etc. Micro-autoradiographic techniques, chreaosonie preparations, labeling

and iguid seintilletion counting of mucleic acids at's cellular level, and other techniques are includes.

Research - Work is bein; done on various research projects. The following will be a brief reainé of the more inportant ones:

1, Wo cel. Lincs derived ros o Danish chondrosarcona are under? study with eveciai interest in karyotypes and metabolic functions. Tt is hoved that the redicbiolo;ical effects in vivo ani in vitro can be connared.

---Page Break---

2, Diploid Inman colle are under culture and the effects of

radiation on the aging vrocese are being studied.

3. A group unter the direction of Dr. del Castitio is trying

to maintain living mcle celle of Ascaris in the tiesue culture

sedis

4. the effect of radiation on the host-parasite relationships

in stent arthropod borne viruses has been started utilieing tissue

culture and host aniuele.

6, The Schistosomiasis studies conducted in this Division are

renorted ina soparate abstract.

---Page Break---

Participation of the Puerto Kico Muclear Center in the USAEC Atoms,

in Action Exhibit in Latin America

STAFF

Fausto J. tiufoz Ribaleneira, 5, Ch. B, Research: Associate IZ,

Progran Director Bugenia P. de Audres, Mninistratave assistant:

PRIC scientisic staff participates as needed.

PURPOSE:

PRUC has been assigned ressonsibility for conducting a prograa of scientific researc: as part o1 the USARC Atcas in setion Exhibit. Researen yrojects are selected on the basis of uoesible econonie interess, the present status of scientitic developuent in tue host countries, siuslarity of projects to current PRNC research, and avelladility of PRNC?stai! to serve as consultants. A subsequent {ollow-uj and evaluation of the experi-mental results is carried out by tue PRIC acienticts who participate in the Baavit.

CuRREND STATUS

The Atoms in Action Bxhibit has now visived four Central Agerican countries. In February and March 1365 the Exhibit visited San Salvador, EL Salvador, and in August and Se,touber 1905 the Bxnibit wae held in Guatenala City, Guatemala. ?In February and farch 1956 the Exhibit was in San José, Costa Rica snd in October and Hovenber 1X6 the Exhibit Was in Managua,? Mearagua,

Selvadorean researchore used cana radiation to determine the mor tality sterilization dosages for Leuco,tera coffecla, an invect yest in coffee, and Heliothis zex, a cotton and corn yest. Preliminary reculee on radiation preservation o: shriay ani cantelou:e welons were satiefac-tory. Genetic studies in seane have sacwn in the firet crop a total weight increase of 25 ger cont and an rice a stifver strav las been ovtained. Guana radiation also inroved coffee flavor and taste, Four graduate students of the University carried out thesis research with exhibit equiyment.

In Guatemala entonolosy stulses vere focuss2? on Tonasvinsu postica,

citronella and levon yrass plantation insect pest. In genetice, the

sexinun survival dose for corn wae detersined. Exeriwents to vevermine ation efiect on coffee flavor and taste, beer, and essential ofle

---Page Break---

were perforsed. Researchers fron the Central Arerican Institute ior Industry (ICAIT1) carried out investigations on canned pineapple sterilization by ganna radiation and investijators of tae Hutritional Institute for Central anerice and Panana (ICAP) used Incayarina to study the degradation of vejetable ;rovein unier gana radiation, Twelve hundred under~ graduate stulents voluntarily attended © special program yreyared ty the PRC personnel, an? cir graduate stuients of the University of San Carlos yerformed thesis research under tne guidauce of PRNC lecturiay acientiste Salvadorean researchers case to Guatansla to continue genetic studies on beans ond rice and entonolo.icel studies on lieligthis sea. PRIC personnel Played an inyortant role in the donation of the Jana irradiation Tacility

9f the exnivit Crom the Regional Office tor Central anerica and Panama abfairs (ROCAP, U.S. Departuent of State), to ICAITT.

?The research activities in Costa Rics dealt primarily with agricul tural problens with additions! topics in the :hysieal selences. Radio-active tracers were utilized to study organic cnemical reactions.

Projects carried out inclwied work oa fish, potato, ant coffee pre servation vy radiation, been softesins by radiation, radiation effects on corn, rice, and vean ceou viability, effects of gana radiation on tthe hysteresis cycle of trighycine sulfate crystals, szfects of formic acid concentration on the Fricke dosimetry syztas, ratiation chemistry of titanium sulfate sclutions in sulfuric acid, and other chemical studies.

In Kicaragus research projects have been started in food preser-
vation using bananss, dean softening, sorghun 3eed viability ani sorgtun
wenetics. Experiments are alco being carried out in neutron dynamics:

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Solid State Physics Program

STUDY OF RADIAPTON DAMAGE IN ORGANIC CRYSTALS
USING ELECTRICAL CONDUCTIVITY

STAFF

?Amador Cobas, Fh. D., Associate Director; Shavel 2vi Weisz, Ph, D.,
Chief Scientist, Alfredo J. Torruelle, Ph. D., Ascociate Scientist (Ad
honorea); George M. Simpeon, Ph. D., Associate Scientist; Jesis M-
TMharrats, Ph. D., Associate Scientist (4d honoren); Janes A, Mair,

Ph. D., Associate Seientist I.

PURPOSE

?The effects of radiation on orgcnic crystals is the prinary inter-

est in this project. Tt is ielt that such studies on well defined
crystalline structures can provide a Tira foundation for a later study
of more conplex materiels, including those of direct biological interest.
Anthracene has been chosen as the initial material for study because
?this substance bas been studied more than any other organic material.

(CURRENT STATUS

?The danage induced by radiation is studied by measuring the changes
in the electricel and optical properties before and after irradiation,
The measuresents at present are perforsed on anthracene ingle crystals

?The electrical properties are studied by measuring the steady state
and transient current voltage characteristics. By applying an injecting
electrode to the crystals (either highly absorved light or iodine ina
Sodium-iodide solution) the current through the anthracene is space charge
Limited. From the transient and steady state behavior of the space charge
Limited current (SCiC) - voltage characteristics carrier traneport and
trapping properties, such as mobility, trap density, trap deyth, trapping
Lifetine, and capture cross section can be deduced. In this lab it was
found thet the measurenent of the SCLC through anthracene is a very 2en-
sitive tool for the detection of dasage induced by radiation.

Our results indicate that by irradiating anthracene crystals with gemma or a-rays, hole traps are introduced in the crystals. The presence Of these traps was detected using steady state space charge limited current techniques using a NaI-I solution as the hole injecting electrode.

= ah

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the changes in the steady state syace charge Linited current voltage characteristics for a ervstal defore and efter irradiation the density of the introduced traps vas eelculsted, The dencity <f these was found te vary linearly with the avsorbed raliation doce. The Litetine of the injected tree carriers was measured usitu; the transient space charge Limited current technique and the results inuicate that the eapture cross section of these tras for hole trappinz 42 apyrexinately of olecular size

The current voltaye charactarictics of irradiated anthracene crystals were conared with the currant voltaye characteristics of crystals grovn fron irradiated anthracene power and very little difference was found. This result iniieates thet the delects introduced

by irradiation are molecular rather than crystalline,

In order to try to get a vetter understanding of the nechensn
involved in the space charge Lisites currents in insulators, vhich We
luse ac the detection nethod in our investisation of radiation damage

in anthracene crystals, s thorough theoretical stuly of injection of
carriers into ineulators hiss been done. Solutions for the tine depen-
dence of the current have been ootained for the case where the reservoir
Of the free carriers at the injecting electrode is tine devenient. In
his analysis the transient space charge limited current, where the
farrier density at the reservoir is infinite and constant in Ue, be-
cones @ special cae of the problen.

The optics properties are studied by measuring the radiation
Andueed changes in absorption spectrum, in instantaneous fluorescences,
land in delayed fluorescence. Thr delayed flucreccence is neasured in
Scintillstion grade anthracene crystals. They are exposed to radiation

oses fron 102 to 108 R, The excitation is by a high intensity red flash ?The triplet excitons are produced by direct absorption in the triplet band and the singlet excitons are produce by two choton absorption

fand by triplet-triplet annihilation. The teuporal resjone of the blue enissicn is continuously monitored both lurin; and subsequent to the excitation. Garsa radiation creates centers in the crystal that quench the singlets ani the triplets. The centers are yeranagnetic and reduce ?the 1ifetine of the triplets, however, they do not affect the Dimolecular triglet interaction rate conitant. The density of the triplet quenching centers intuced by one roentgen corres.onds to the density of the hole ?eraps measured by the s.c.1.0. uethoa. By ealevlating the density of the singlet quenching centers using the value of the bimolecular einglet interaction rate constant obtained from photoconductive neasurenents, it is, Found that this density is larger by three orders of magnitude than the Gensity of the triplet quenching centers. Heasurenents are in progrese to determine the bincleculer singlet interaction rate constant by optical nethods. ?These ceasurenents will pereit determining tae yield by which free carriers are jroduced in the singlet-singlet annib{lation process.

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By use of multiple techniques on individual single crystal of anthracene cao be used as a yide range dosimeter, triylet-trislet

annihi 6 Limited current

"6 quenching in the range 109 to

i) and absorption sectroscapy above 107R,

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Neutron Diffraction Program

STAPe

Mortiner I. Kay, Ph. D., Chief Scientist I, Principal Investigator;

Seymour F. Kaplan, Ph. D., Associate Scientist 11; overt Kleinberg,

Bh. Dey Associate Scientist IT; Ismael Almodévar, Ph. D., Associate

Scientist 11 (part-tine),

PURPOSE

?The Neutron Diffraction Progras is concerned with ideal and inverfect

arrangenents of stonic nuclear and angnetic spin systens in solide. 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 chemical properties.

curren starus

In collaboration with Dr. K. Okada, who returned to Japan in August after a two-year stay at PRC, the hydrogen positions in copper formate tetrahydrate have been determined at roon temperature and sone electrical, Beasurcnents made on the compound in the vicinity of the phase trancition at -W0°C, ?Since antiferroelectricity vas discovered, future york will consist of determining atomic positions in the presence of an electric field with the objective of denonstrating the atomistic basis for the electrical properties.

Manganous formate dihydrate has been studied and the hydrogen positions determined. A comparison of the disordered tetranydrate with the dihydrate structure shows clearly the reason for the greater stability of the Latter.

Dr. D. T, Cromer spent a year at, PRNC on leave fron Los Alamos Scientific Laboratory. While he was here, data was collected on the three types of alums A*B*3(804)2. 1240." The cenbination of PANG neutron data with ASL a-ray data has Lead fo'a complete elucidation of the 3) 3, chd

y slum structures. The role of #1 cation size, hydrogen bonding, and disorder

fon the structure has been elucidated. Interesting non-harnonie thermal notions have been noted.

Neutron diffraction data vas conbined with x-ray diffraction date taken by Okeya and Stenple at IBM to produce a refined structure of a-tartaric acid,

---Page Break---

Data ha veen teen or Hall,(520,)2 (roum cexperature) ami Tai at (130°C) to stucy the serzoeidatri? trans.tions cf interest to tu solid? state Jnysiciscs in waya.se2,

The agretic ctructure deterunstions of CaCl, an. HiCl; Hexahydrates have been co: ted vy Dr. 3, Kiciaber, at the U.S. Hevel Research Laboratory. Otner transition seta alte will be exaninad in the future. Vor'. on the structure ef wolten SnCh, hy neutron Gictraction usins isotovic re Lace.cat ox the Sn to ely severate terns

an the vaitial aiscravubion function 23 veing carried out ty Er. Hovard b. Ritter, Dr. iitter is Research Proiessor of Chenistyy at stan University

in Oxfora, Ohio and is currently syeniiay one year us an Cac Ridge Research

Participant in thie Frocras,

---Page Break---

Hot~tom Chemistry Frogram

SIF

Oven H, Wheeler, D. Se., Ph. D. Chief Scientist 1, Principel

Investigator, Caruen'L. Gonzdlez, i.8., Research Associate 1.

score

?The sechanisa of the formation of radioactive yroducts in the neutvon activation of orgeno-uetallic compoune® containing carbon ynetal oonds is being investigated. Studies include vors with short half-life isotopes.

CCURREWT STATUS

Studies have been conyleted on triphenylyhosphone and its oxide ?and on tetra.nerylphosphoniur: chloride, and also on daphery) sulfide, sulfoxide end sulfone. Other vork on Cobaltocene and nickelocene has been completed and several publications are veing prepared.

Research in progress covers studies on siuilar compounds of ne cury, thalliw, iodine, selenius, bismuth and tin. The effect of radical scavengers is teing studied,

A gas-chrooat
vapor phase studies.

graphic counting system is being constructed for

---Page Break---

Terrestrial Ecology Frogrem, fart 1

?The Rain Forest

STAFF

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

cari P. Jordan, Ph. D., Ascociate Soientiet I; George Drewry, th A.

Associate Scientist 1) and visitins investigators,

PURPOSE

(1) Fo study effects of jonma irradiation fram 10,000 Cartes

Cesiun on the Rain Forest systen st Bl verde.

(2)_ To study sone wineral cycles of the vain-forest in relation

to fall-out, atomic excavation, and plant nutrition,

(3). To characterize the circuits and wetavolic energy pulses of a

complex terrestrial ecclogical systen 0 ae to understand the consequence

of irradiation and fallout a

curren starus

A, Radiation Effects Studies

The Rain Forest Project at £i Verde involves irradiation of « plot of lover montane forest with gama radiation fron a 10,000 Caries Cesium source. After 15 nonths of pre-irradiation studies and preparations at ?the radiation and concrol areas, irradiation began January 1), 1965. The main site was irradiated for 3 nont.a, tie innermost sones raceiving one aillion R. Post irradiation weasureacnte are in progress showing effects of radiation according to dosage received, according to species, and according to various categories of ecological and cytological structure and function. Data energing provide some factual basie for predicting effects of radiation on rainforests and tue rates of regeneration of the Living systen,

B, Recovery and Succession Studie

?Tne radiation center is now in an active process of recovery from the effects of te ganna radiation. Studies are in progrees to docunent the invasion of tie area by nev plants and to observe tue recovery of old danaged plants. Tye radiation center has been subdivided into a grid of fone meter squares wiic 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 intervols and the information gained will se usec to construct

@ series of maps viich wll show a continuous record of the changes which

occur during the recovery stass. Another u-thed of decwsentation of the

Fecovery process invulves photographic corpariccas of ths irradiated area

With other areas in ths lores: whiel nave oven damaged, Observations of

this type indicat: thas cle clwactor of ~ccovovy in tle irradiated ares

As no different frca th "in ccoas Of tay forsct wich lieve had catastrephic

damage from cutting or hard

G. Mineral cyelo:

Quantit-tivs voder?t ands

aysteng is cscentic? t> under native of

the soils, and tk> ways such ryaters may orceees cadioactivity entering

in relation to AL. reletud activate

will be the prins:

project.

1. Radiommelite Eviance Jn the edt

thet 2 substantia) proportion cf Hér.on srodust . four? in plent communities

4s in the fora of curfa fimacion on Jeawes and that only @ minor
Part of thess isotopes ?ver exter thy net-iolie).thways of ths plants.
Vevertheless, such observation: st }1 Vere: as tis extenatve curtace root
Gevelogment, and root ivvasion of orc nie Litter ona lous sugests that
this forest might Ne weil adaycr¢ to the conservation of minerals by
maintaining then in rearcnabli* closed cycles. This view 12 reinforced

by prelininary observations 0." coils vhich indicate lov levele of fission
Products while the decaying Litter at the 90.1 surface contains a large
amount of radioactive ieotopes. én experiment in progress vas decigned

to test whether fall-cut isotopes were recycled fron the forest floor

throygh roots into understory lente. In this exyerinent 13Cs, Stn,

and 85sr were sprayed in cazrier free aqueous solution directly on the
forest floor. Tha r. suits efter ono yoar Amdicate that most of the
original radioactivity remained where it was first placed end euch of

the original organic iitter was ctill highly radioactive. The rate of
uptake of the isotopes by tho undsvatory trees vas slasst undetectably slow.

2. Efiect of ccm Trradiation on Fision Product: Retention by

Forest Trees

Samples were Cekon before and afte the irradiction from forest,

trees in the irradiated control centers. Heasurenent of Ce-137 and

Wna54 in these seaples by gamua-ray spectronetry indicated no detectable

effect of irradiation on th> leaching of these elements in the forest

system by rain water.

=m

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3. Heutron Irradiation Studies

?Therual neutron irradiations of soils frou various points in

Puerto Rico and froa Panama have weer carried out, The wost pronsnent, isotopes which canbe observed in these soils regardless of origin are: 59re, Nose, ehiia, Sein, ani 15380, Samples of plant ash are also being prepared for stuly by thermsi neutron arradiation,

Plans have been completed and equipment constructed for an atteapt to carry cut fst neutron activation ctudies of soils and plants utilising a special nuclear reaction which may generate fast (Uitiev) neutrons in the presence of thermal neutrons.

4, atural Radionctivity in the Enviroment

Prelisinary surveys of soil specimens from various Locations in Puerto Rico have reveslod certain sites of unucually high levele of radium daughters. ?There cites which contain a actor of S mors natural radioactivity than the Bl Verde site nay be of considerable value in future studies of the Dehavior o: radioisotopes of the Uranius decay series in natural enviroments.

A sugyested prelininary use for these sites 12 to study the

possibility of radon trunspiration by plant by extanining wood fro
the trees of these locations for equilibriu: mixtures of lead-210
and poleniii-210.

5. Radiolsctope Persistence in the Rain Forest

?The radionuclides Mice, 52r-95m, 5!in, and 137ce vere

observed to have extrencly high persistence in the trovieal forest at

El Verde. Yeagurenents nade on sauzples collected fron the forest on a
monthly basis indicated that the rate of renoval of the above mucLides from
?the forest systen was controlled prissrily by the physical halr Life of the
muclide and that a biological half Life could aot be experinencally defined.
Such measurewents vere made at a tine uhen the input of nuclides into

the forest vas neglicibly sali. They vere interrupted oy the arrival

of fresh nuclear debris betveen 11 and 24 days after the Chinese atmos
pheric weapons test of Nay 1965. The sanyling progran 18 contanuing.

D. Circuits ani Hetaboticn

A special PRIC proposal uss prepared outlining an electrical analog ?cuit that wight be prepared if authorized and budgeted. The ayaten on the peasive principle allove for flows in 35 coupartwente for whieh there are data available to cet storage constants and rates, This svsten is uunder construction at the University of North Carolina ay Howard T. Odum who is a consultant to the project.

-B-

---Page Break---

?The giant cylinder exverimont war used to provide vater budget ?and carbon netaboliza data on the rain forest. ?The water budget,

?late vas of particular interest for predictions of the fate of tritiun in 2 tropical forest since this isotope is likely te be produced in Large quantities iy nuclear exeuvations. Atteapte are being nade to use the giant cylinder to study an annual cycle of metabolisa and water use in the forest.

---Page Break---

icrine Biology Program

STAFF

Frank G. Loman, Ph, D., Chief Scientist 11, Progran Director;
Donald K, Phelps, Ph. D., Chief Scientist 1; Robert ¥. Ting, Ph. Diy
Associate Scientist i; Joun H. Wartin, Ph, D., assoclate Scientist I
and Rail MeClin, i. S., Research Associate T.

PURPOSE,

?The Marine Diclogy Program at the Puerto Rico shuelear Center was started in January 1962 and is cospoced of six major research projects: land supporting areas of researen ail of which are interrelated into an Integrated research activity.

?The program vas designed to provide neasurewents of the Matribu-ion and movenent of trace eleuonts in restricted but complet ecological land biogeochenical systems, Tne research includes Investigation of the Lithosphere and the marine blo-and hyérospheres. Specifically, the Gistributions and novenents of selected trace elenents are being folloved

fron the rociss, minerals ond coils of three river water sheds into the river waters, Orgenions and sediments, thence into the marine water at Gepths and distances off chore, throuch the sarine bioeshere and inte the marine sedinents.

CURRENT STATUS

In order to obtain inforsation on the interactions of the marine biosphere and hydrosphere, neasurenents are being wade to determine the influences of violosical yroductivity, biological hali-Lives af trace elenents, food webs, characteristics Of trophic levels, and physical and chemical oceanograshic factors won the distrivution of trace elenents in the marine waters off shore fron the west coast o: Puerto Rico, The effects of shysical and chemical oceanographic conistione upon ?the distribution of organteus are being studied, with special euphasis on observations cf the offects of varying amounts of mineral-rich silt upon the distribution patterns of marine organisns.

The research projects include: (1) Measurenents of Biological Productivity, (2) Analysis for selected trace elenents, (3) Measure nents of concentration factors of selected organiens for given Fadio= Asotopes, (i) Heasurenente of radioactivity and radiotsotopes now

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present in the carine organisas, waters ani cedinents off the west coast or Puerto Rico, (5) Backsround seasuresents in physical and chemical cceanograpty, and (6) Distribution of rare earths in the Alasco Systen.

Supporting ereas of research include investiyations of the effects of interactions of river and sea vater uoon the precipitation of trace chevents 1m estuarine euvironiente, chenical ant physical characteristics Of marine sedinents deporite freu three rivere which drain woter sheds containing limestone, serpentine or rocks of voleanae originy the characteristics of variability in trace elenent content of populations of organiens frou a given enviroment, and ue developuent of methods for analysing trace elenents in a varicty of sample types.

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Estuarine and Warine Ecology Study - Specific Activity Approach

STAFF

Frank G. Lowen, Ph. D., Chie? Scuentist I1, Progran Director;
Donald J. P. Swift, Pu. D., Associste Scientist i; Rail MeClin, H.S.,
Research Associate I; Henry Besselievre, Research Ascocsate Id; plu
technical start,

PURPOSE,

The program is part of a feasibility study for a sea-level dethnian
Sanat in Central Anerica under the wanagenent of Battelle Memorial
Institute and is designed to develo? and carry out investijations of
stable elenent distribution: throughout the marine ant estuarine
enviroments in the Darien area of Panana including the Gulf of Panama
fand the waters off the continental ahelf in the Caribbean Sea fron

Punta Mosquito, Fanon to Barranquille, Colonbia. ?The degree of potential
hazard to man through contenination of thoce environments ty radionuclides
ray then be predicted fron thece data.

CURRENT STATUS

?This progran is an extension of the Marine Biology Program at PRIC which is supported by the Environmental Sciences Branch of the USAEC Division of Biology ang Medicine. A unique feature of the progran is the ?specific activity" approuch-- a procedure of swipling and anelysic Which holds oromise of cuccessiii application to marine contanination problens. This wethod Is based upon two preuises

1, That the distribution patterne of biologicully-evailable steble elenents in the organisns and their environnent may te used to predict approximately the distribution vatterns of introduced radioisotopes of the sane elezente,

2. That if the specific activities (C1 of radiotsotope/eran of correavonding stable elewent or carrier elenent) in the estuarine or warine environment ere maintained below the allowable specific activities for radioisotopes in the human body, then no indivi-dual can obtain greater than the allowable anount of radioactivity fron foot derived ron these sources.

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On the basis of the prelininary assescnont of potentially eritical Tadionuclides a field collection prouran has been developed and two Fesearch vessels with an ei fit nan operating crew and seven scientific investigators viii be sent (o Panens in Yecrusry 1-57. The feld tears will renain in the Ponana ares for three wonthe makin the cellections which will include soils, river waters, sedineate and organisas, marine water and sedinents, and marine orcanians including molluscs, plankton, Seston, crustacea, ind fish. at the end of the first taree-conth survey, which will be conducted during the "ary" seacon, the research vescel "Shinada" wil1 return to Tuerto Rice. In August the collections for the ?rainy? season vill be wade in Fanana. ?The ?Shinada? and the creve Will return to the site ot that vine.

Stable elenent analysis for 10 elenente vill be done on approximately 41250 samples in the tiayaguez Laboratory. The distribution patterns of the stable elewents for which corresyondin; potentially dangerous radioisotopes lay occur, will be determined. Frou these data the expected specific activities in hunan food itous may be calculated and conpared with those published in radiolegicsi safety udes and regulations.

3H.

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Schistosomiasis Project

BFFECT OF IRRADIATION ON HOST-PARASITE RELATIONSHIP

IM SCHTSTOSOMA HARSONT

STAEP

Jorge Chiriboga, M. D., Assistant Director for Scientific Progran:

Acting Prograa Director; Julio I. Colén, Ph. D., Associate Scientist

(Ad honoren); Raniro Wartinez Silva, H.?D., Associate Scientist.

score

Schistosomiasis is a worldvide parasitic disease with a complex life cycle for which there is not yet a known method of control. This project attempts to use all methods available through atoaie energy to learn the basic mechanians of the individual phases of the life cycle with the ulti-mate objective of finding a way to break the cycle, The principal aspects of this progran may be divided into two: effects on the relationship

between mice and Schistosoaa mansoni, and effects on the relationship between snails and Schistosoma uansoni. One of the goals in the first part is to develop an effective vaccine vith the mice vhich could later

be used for man and one of the goals of the second part is to effect @ ?mutation in the snail host that would lead to a generation of snails Jamune to the parasite,

current snaTus

A method of assessing the degree of infection which is based on the umber of S. mansoni ova vhich can be recovered from the feces of infected ice, using standardized observation procedures has been denonstrated.

?The optimun amount of radiation for cerearial expocure, to induce the Greatest degree of resistance to challenge, bas seen determined with this laethod. An analycis of these results show that the degree of variability is very high. A new method for determination of this garaseter utilizing Whole body radiation of the mouse is now under study. Preliminary reaults indicate that this method can be used for the following:

a. determination of the optimal nuber of cereariae for immunization
b. determination of a different schedule for immunization.

Preliminary studies to determine the LD-50 of the snail ustratorbis

bratus, show that the value is in the range of 10,000-100,000K-

SSE TS Sate Con aeare co ee ee ae

develorment of snail enbryos, to perfect the LD-50 determination, and

to attenpt to produce snail mutants,

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?Sugarcane Sorer F rogram:

Induced Sterility for Population Control of

?the Sugarcane Borer (Diatraes

seccharalis) in Puerto Fico

STAFF

David U. Walker, Ph. D., Associate Scientist II, Principal Invectizator.

PURPOSE,

This progran vac vegun in 1963 to deterine the potential for contre

by radiation sterilization of the sugarcane borer (Diseree: sacchari!)

(Fa.), Cranbidae, Lepidoptera), and to ctudy the DYonauIGe ST tHE species a5 it Telates to a uass-release prouren,

jon doses cuitable for sterilization of the sugarcane borer have been determined. Advlts are steri2iced at 35 Kilorad doses without affecting their Life-syan, oviposition rate, or sating behavior. Tamiature stages are such nore radiosensitive, with 9 Kilorad causing over 90% lethality,

Factors involved in the mass-rearing of the Puerto Rican strain of this species have teen studied, Thece include the following:

L, Artificial diet: vigorous adults of high fertility esn ve produced fon a diet containin, carrot sowier, Liguid corn stalk eytract, corn stalk fiber, ascorbic acid, svar, casein, sodius benzoate and methyl parahytrory~ benzoate. Survival on this diet 15 eiehty per cent or higher, and adequate unbers are being produced to conduct tmall-ecale Tield teete. Assuring fifty yer cent survival, foot cost 12

per adult.

2, Opbiuun rearing comlitions: Light, teuperature, and humidity are controlled during laboratory rearing. Under these conditions eix dayo 18 Fequired for egg maturation, thirty cays Tor larval develoment, and sever to eight cays for pupation.? Alulte sroduced from this diet live longer and Produce more viuble eggs than ecaparable individuals grown on eugarcane

land other host plants. Eggs are collected éaily and are placed en the food imediately tefore hatching. Pupse are reuove! {roa the food as they form. Sex is detercined in the puyal stase. Adults are collected as they enerce from the pupal case.

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3. Maviny conditions jiasing taxeo yl

lumen) and is imvisted by teuserature reduetion and Lint decrease.

Males are ettracted to fenales by a se: attractant and by the epecific ving beat frequency. iiaied seuales bogan laying fertile egso witain one hou after natin. Fea oviosition occurs on the second and fourth daye after fsating. Three hundrei fifty ese are luid yer resale (average) ari uncer ormal conditions eys hatch ic one hundred ver cent frce fertilized Seales except durins the joriot tes Deceuber to larch.

sce an the dark (ese than 1

A arse steld cage hay been constructed to semit determination of pooulation decline under i1olc conditions using corn as the fost plant. Gorn olanted in the cage has been infested by a now mmber ov normal: adults collected fron rature, Toyulation overtlooding by irvadiated males and/or fenales has bee: done to measure yorulution reduction. Larval Dopulationsure neasured by direct visual observation of Larval tunnels

in stalks, and adult nae population is determined by trapving at night Guring nuytial Light.

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Kesonance in (adiation Frogram

STAFF

Henry J. Gouvers, Fh. D., Devuty Director and Robert A. Lage, Ph. D.,
Chief Scientist (part tise), Prineayak Investigazore, Francis KS. Keo,
Fh. Dy: Florencio Vizquer, ih, D.; and Peter Paraskevoudakic, Th. D.,
Astociate Scienticte (ail part time).

PURPOSE

Jo answer the question "What are sone of the unique efvecta of ienizins radiation on matter?" ?To unis ond, the project hee etudied x-radistion effects in tie 5 to 20 Key enersy fange yon biological aysteuc. This ererey region is of considerable importance since it contains the K-absorption edges of the constituent atons of most Living systens.

STATUS

Evaluation continues of the hypothecis that radiation danage in wwolecule can be a function of the zite at vhich the shoten iz initially absorbed, Tt is postulated that absorption of an x-ray photon in the

K shell of an atom wit produce a highly lonized atem and that the fag state of ionization will lead to najer disruption ot the molecule at the site of photon absor>tion:

Using nonochroustic x-rays, biological aolecul:s were irradiated at energies above and below the Keabsorption ease of selected target atons. Danage was Judged on the basis of effect observed yer unit enersy abscroed, OF per photon absorted, in the nolecular aystom. Experiments in the enersy range 6.l to 0.3 Kev hive shown increased inactivation of the actalloenayne catalase at or near the Keabsorytion edge of iron (7.11 Kev), which is, located et the active site of this enayme. In another biolo?ical cysten, chromosones in onion root tap cells treated with 5 bronedeoryuridine have exhibited an increase in vreataces caused by aonochroatic x-rays at Jhoton energies equal to or slishtly greater than the Keabsorption adge of bromine (23.46 Kev). In contrast, tere is no such effect an cello sontaimins no

sided BUDE. Hence. in these two Janortant tyzes of molecule--enzyme and hucleic acid~» it has ven shom that the efficiency o1 damage rroduction ig @ sensitive Mumction of the yhoton eneriy. The significance of this finding in more complex viological systeas (bacjerial cells, HeLa celle) As at recent being ex Lored.

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Current project activity has been directed to several biological systens in an attept to find optinnl eystens for denonstrating the Resonance phenomenon. At this point, the effect hae been shovn in both the metalloenzyme catalase and BUDR-labeled chrososones. Efforts now will be directed to developing sechanisns of the effect based on nore quantitative studies. Initially this will involve biochenical studie: on structural changes in the catalase molecule irradiated at or near

?the Keabsorption edge of iron.

Supplementing the irradiation studies of biological molecules is the development of special equipment vhich peraits absolute veasurenent of

the very low photon fluxes generated in our highly monochromated (7 50 ev) xeray beans. In addition, design and construction of high intensity field emission type x-ray sources have been carried out and the effect of various Paraneters (vacuum, cathode material, applied voltage, and cathode-snode spacing) on electron enission has been tested.

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MATRIX ISOLATION SUDTES OF PRODUCTS
OF GAMA RADIOLYSIS OF HETEROCYCLIC MOLECULES

STAFF

Alec Grimison, Ph. D., Acccciate scientist; George Sinpoon, Ph. Da,
Aseociate Scientist, liariel M. lair, Mi, D., Associate Scientizt,
and W Research Aeaistante,

Poros

?This vrogram 4s concerned with the effects or game radiolysis on simple heterocyclic molecules, which can be considered as acdels for more complex eubstances of biological izportance. Unstable species formed in this gama radiolysis are trapped by carrying, cut irradiations in solid aatrices at 77°K, and are studied unier ?hese conditions to elucidate their structure.

?CURRENT stATUS

Optical devars have been designed and tested for the exanination of optical spectra at liquid nitrogen tenperatures. Current projects include the investigation of color centers formed by gamma irredis~ ?thon of heterocyclic solutes in methyltetrahydrofuran ant carbon tetrachloride matrices. These tro colvents have been chosen to enhance radico) enion end radical cation Formation, respectively. Goot agreenent has been obtained on the Literature values ror the efficiency of production or color centers in the pure sclvente. aystens hich have proved sarticularly interesting are purine

and syrozine in methyltetrahydrofuran, and uyrrole tn carbon tetrachloride. This last cysten 1s currently being investigated also by photochemical irradiation of rigid eclutions.

?Theoretical worie includes the prediction of the us v. ant

Electron Spin Resonance spectra of likely radical secies,

using Molecular Orbital and Volence Band Techniques. A eet of!

valence bend calculations on triplet states of simple heterocyclic

Compounds is being done in collaboration with Dr. Zauli at the

Instituto di Chimica Fisica, University of Bologna.

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Kadiation Preservation of Tropical Foods

STAPF

Horace D. Graham, Pu. D., and Robert A. Luse, Ph. D., Chief Scientists

(Gart tine), Principal Investijatore, Sureekant fy Dea, pande, Po. D.

Associate Scientist I (Part tine).

PURPOSE

To determine te feasibility of radiation preservation of bananas

fang mangoes, through exanination of two aspects of tie general preble

1, Determination of those factors of yre-irradiation condition, radiation dose, and yost-irradiation treateent widen delay ripening and Raxinize tue suelt life of tie food roduct, Have qualitative or semi quantitative criteris of riyening, such as Softening, cuanges in color, spotting, and taste are utilized, Tuese are aupjlenented by measurencrit of tiose ?characters associated vit.. ripening, erg. stares te suger conversion and yuly acidity.

2, Measurenent by appropriate biochemical ascay of changes in various uutritional factors teat accompany radiation pasteurization. Tois part is anenable to quantitative assay of vitauin levels and now tuey are affected by radiation dose and treatment.

rar

Bananas ot tue variety Monte Griste and mngoes of the varieties Native, Hafu, Seedling 110) and Hative-ayajuevano nave been irradiated Yo determine \f relatively Lov dosea 5! ganna irradiation can be used

for tue preservation of tuese tropical fruits. Najor eapiasis 18 placed fon the influence of irradiation on tue retardation of ripening in these fruits and on tie levels of nutritionally important bioc nical components such as ascorbic acia, earatencids, sugars, starch and on titratable acidity. Studies also are made of tle effect of muna irradiation on tue depolymerization of sone of tie pectic constituents of mangoes.

Bananas of known idstory and 90-120 days old at the tia? of cutting have been irradiated at 10, 20, 30, 40, and 50 kilorads and then, along

with non-irradiated samples (controls), stored at 60°F, 75°F, and 60°F.

Evory swvin days eaanter am witharamn ant amivze? fer the somponents

ened above. At 65°F, using bananas 96-10b days, no retardacion of

Tipening has been noticed, On the contrary, sone stimilation was evident, but ?the pattem was erratic. At 50 kilorads, intense blackening of tne fraits

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occurred; hence #11 subsequent work was Minited to KO kilorad;
Retardation of ripening occurred at 75° and at 70-0 kilorads,
but there was no consistent relationship between the radiation
ose and the extent of retardation. At this temperature and at
an irradiation dose of 40 kilorads, there vas Little or no effect
fon the levels of sugar carctenoide but the titratable acidity
inereaged and ascorbic acié decreased by about 29f. At GO'F
retardation of ripening vas more pronounced, but the Yruite ripened
much Taster than at 75°F.

Mature or almost ripe mangoes have been irradiated at 50, 100,
150 and 200 kilorade an? stored at 50°F; non-irradiated controls
were also included. Biochemical analyses were done oh represen=
tative samples as described above for benanae, All fruits stored

at SO'P kent well. ?The irradiated rruite remained green for 30 days. Fruite of the ?Native? variety irradiated at 150 kilorads or above showed severe blackening of the pulp. his blackening progressed from the seed outwards and was not noticed in the other varieties. Durning or blackening of the dkin occurred in all varieties when irradiated at 150 and 200 kilorads. The wide natural variations fro fruit to rruit and from batch to batch hinder waking any valic conclusions as to the effect of irradiation on the Dicehemical couponents aseayed.

Fectic constituents of mangoes of the variety Sindareaha irradiated ?at 500, 1,000, 1,500 and 2,000 kilorads have hom © consistent Gecrease in the molecular weights of their highly methylated water soluble pectinic acid fractions with increasing rediation dose. tiow-ever, increase in radiation dose did not cause a severe degradation Of the lov methoxyl pectins or the protopectine extracted fron these fruits. Fractionation of pectins fron control fruits with molecular sieve chronatography indicated the occurrence of at least tvo major fractions of distinct molecular sive. Tt vas inferred that the radiation-depolymerized pectins constitute sub-fractiona of these major fractions. Study Of their wolecular weight distribution patterns therefore is contemplated, in order to determine the

relationship between pectin depolymerization and rruit softening.

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