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PUERTO RICO NUCLEAR CENTER

THE RAIN FOREST PROJECT

ANNUAL REPORT FY - 65

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Reports ty Viciti:

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GENERAL ACCOR?

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Flies

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Leaf all, Leaf eles, phenology

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Early report on the cftver of

irmidiation

RETORT? OF PARTICTPA:TS

P, varpiy -- Tee erovth

RT cal Flart soetoled

AL Tage => Scealirg meteboli

Ty vecoreleh =- coeiestey, palm populations

ty Cowley == Saeroecopie fimgt

EE outer == ernsenpic tue!

?itkanp © Aersttel tensity, activity

Sy dohneor == dcvial eonitorine

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"hfe fo the aunisd report for work done on the rain forest projects! 12 Verde, fuert Ries. A year of procirreddation neanvrencnte, conatryetion anf fn stallatior of the source (10,000 Curies}, and prepa- Setione of the aren ented January 15, 1985 with the stare of 90 taye irrodiction, An actount <9 given of fhe mearurencnts ese in thi varsour phsset of Vore vy rosisent sent ani viateing pareietpante, ? Som Eetentifie results ere tnetiset, The annual, pattern of Mologicel process's savslves come properties wet fe tennnvably constant an cone other petterne whieh fave definite seasonal patterns:

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"TITRODUCTION

?This 1s an annul progrece report for the rain forest progran at FL Verde, Puerto Rico vhich hac three objective

L. > determine the effects of gam irradiation fron 10,000 Curtes Of Ceetun on @ plot of lower-nontane rain foreet.

2. To measure cycles of fall-out elements in the rain forest eysten.

3. fo determine the cireuite of energy flow and metabolic processes of the ecosysten in order to understand the phenomena observed.

The project bogan in Yay, 1963, with vartous preparations of the irradiation end control areas such af traile, electric power, maps, towers, Gata cables, polar coordinate narkers, instriment recording Systens, and shelters. Work in the current year his concerned the regular measurement of sone forest indices co as to document pro-irrediation properties. | Faty of these data have not yet been analyzed since the resident staff in the Yact ? nonthe has been largely involved in the logistics of getting the {rradiation source installed and health physics aspects cleared. Minety days of continous irraiiation began January 19, 1965 and contisues as

?this account 1s witten.

In last years proposal ant report, the vork var decerited in mmbered phases, and for contimiity this year's general account of progress is written ith the cane headings. Sone eciontific results follov ineluiing reports written ty vielting participants. Subaitted under separate cover te 8 proposal for work in the coming year. The proposed work involves repetition

of the measures taken before Irraliation plus vork on cycling ani netebolic objectives.

1. Loorsres:

Th the course of the year adaitional preparations vere made of the study area, the El Verde Station, and facilities in Rio Piedras.

Electric Power

Untt Hoverber, 1964, pover vac cupplicd by our paired diesel generators. A power Line contract vas arranged with the Vater Resources Authority, the costs of clearing a mile strip charged to the project. After the station was fevired, power service was change from generators ending 13 nonths of con~ tinuous eervice made possible by continuous trouble chooting ty the resident

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scientist, tir. Drevry. One of these gencrators rensins as a standby for Part of the station circuit, nite pover Lines are now stretched on Grou through the forest study areas. For cone needs involving critica: Voltage levels a gasoline generator station is provided in a shelter near the giant cylinder site. The power lino to the tover is black, and 220 w Lines operating the source are red. Sone of the Lines have been in the fost for 2 years without failure as yet.

Chenega Alta House

Precipitated by the coning of Ii. Rotert Fora Saith, former employe: ?and now ORIHS fellow at the University of Georgia, a special 5 year, no cor?, Lease was taken with the Institute of Tropical Forestry, U. 8, Departnent Agriculture, for one of the concrete Forest houses, located at Cienega Alta about 5 niles further up Houte 166 from Bl Verde Station in a spot of great Deauty on the edge of the Luguillo forest. The house vith around 900 square feet Het propane facilities but no clectrictty other than sone old wiring for generators. With eome finds provided ty ltr. Smith and matching funds fron PRIC, the Water Resource futhority installed a power Line to that howe.

one of our raliation guards (Moisés Parrilla), vho 1s also an electricte:.

Snstalied house wiring, ?This dvelling thus provides housing for the visit!

jovgvan in addition to thet at the El Verde Station.

concrete Platforms

Prior to the moving in of the source Mr. Renin Mieves and 3 crew nenbers vere brought in for seversl weeks. With materials carried in by ?the Youth Camp nen and assictes by our regular staff, concrete foundation were poured for the Cesium Source, the tovers of the giant cylinder, the 15 HP moter and 7 foot fan, anda larger pad 19 feet by 1b feet for Dr. Wetnbren's fiela butlding for mosquito-catching operations between the rive" on the ox trail above the control center, Tals will next be supplied with = power Line fren the EL Verde Station.

Inter-agency Agreenent

After sone delayed negotiations, the inter-ageney sgreenent betveen the Depertnent of Agriculture and the Atonic Energy Comission vas finally sigicd providing the El Verde Station and 160 acres of Rein Forest for the resessch for a 5 year period. This arrangenent puts radiation safety as responsibility of the ABC but provides for apprevals ty the Institute of Tropteal Forestry on matters of construction and forest cutting.

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New Laboratory Ballding at FL Verde

After an appropriation of $20,000 from general plant project funds) preLisinary plano ani cpecifications for a snall laboratory at the El Verde Station were cubaitted, Bazed on this, ABC contract procedures for construc {ion vent Into operation vith final plans by the architectural fim, SogNag. After initial bidding, final negotietions provided a contract with Dot Cor~ poration in Carolina with construction starting in tlovember. the floor plan Te given in Fig. 1, The building should be ready for occupancy by the end of Faiiation.

?The new Isboratory has air conditioning and de-humiaifteation eystens, soue circuits vaieh are voltage regulated, a hood, snl an isotope storage

and dilution roon, The five main rooms are designated for five main functions: electronics, mcroscopic vork, field tracer work, enslytical vork, and proces= Sing vork for handling of botenical and eoil samples. The present instrument Yor renains ae contvol center and office-laboratory of resident scientist.

Station Modifications

A gas refrigerator vas provided for Dr. Weinbren's progres in the house mlidle sectzon, a small refrigerator vas provided for the northvest room, and a hot water heater Was installed for the resident scientist apartment. The visitor's room doubled as laboratories during the year. Further eiditions of wiring, voltage regulators, ani racks vere made to the instrument room which 4s shown in Fig, 2, The electronic bench was equipped Sith an ose!lloscope and cone frequency instruments. The interior of the station vas paint

bridges

Murphy era others constructed a eteel personnel bridge above the Sonadora River on the main trail fion El Verde station to the study area to eliminate accidents crossing the roclss and feolation of personnel due to flash flooding. heroes the two rivers on the ox trail above the uphill control center, steel {reads were cabled to the Yocks to provide fim Tooting in lov and medium river stages there

cron Cable Car

?To provide access to forest croms, Mr. Robert Ford Satth, P. Murphy, br. Joe Binisten, and others stretched a half inch steel cable 600 feet starting with a fabamuco fork 90 feet high in the uphill control center and Gnling near the radiction center. f chorter 3/8 esble vas elso passed in he crown of the loves center. Cable? positions are dram in Fig. 2 of Snith's report below.

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Mechanteally Danaged Control Area

Related to ir, Salth's dissertation problen, a third arca vac laid out for later mechanical dazaze co that succession may be compared with that in

?the irraiisted area, The forest vas opened acchanically so that thé

optical properties at the ground correspond to those in the irradiation area, This arca 16 located on a Tidge downhill to the north ant is marked with con crete post

Mo Pledras Laboratories

?The project room in the bacenent of Institute of Tropical Forestry was tthe center of the grinding, weighing, end processing of forest samples, the metabolic studies on seedlings, and microscopic work.

Following construction of a wall partition, a laboratory in the Biomedical Building with hoot wae acsigned to the project. Ashing, chloropiyll, and counting are nov centered there,

Adninietrative matters, secretarial functions and communication central? Aeation remained in the office at the Blonedieal Puilding here sone new files were added.

Mrs. Ana Josefina Correa developed procedures, reports, files, end office level accounting as Administrative Assistant.

PLATS

Vegetation and Topograpty ape

?he colleboration with the Tropical Terrain Research Detachwent of the U.S. Amy Corps of Pngineers Vstervays Ixperiuent Station under ?ir. Villian Rushing continued during the year by which data and methods are shared due

?to common chjectives in analyzing vegetation. Very important to the project fare three sete of nape in vaich cach tree, major rocke, stumps, loge and halt meter contours in the 30 meter rediue cireie are plotted uy transit. Aecon-penying data on height, diameter, and other aspecte arc tabulated. ?These nape fotal 10 sheets and oan cerve ac the basis for the dosinetry xape, the pricm chemical eeleulations, ete. These mape vill be firet neported through Ar=y publication outlets.

Seedling Dravings

Dr. Janes Duke of the Department of Agriculture in Beltsville, had, made

two trips to Puerto Rico to identify and characterize vegetation in sone herbicite studiee not far from £1 Verde. Common to that project and the EL

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Verdc project vac the need for identification of seedlings. ra. Pegey Dukes Yetanieal dilustrator, was brought dow by PRIC and vr. Alejo Estrada Pinto wet MMciened to help iocate the seedlings in the rain forest area and in other Communities ae well. She reeult te « manuscript with 36 plates, viich has aiready been submitted for publication.

br. Duke has helped menbere of the project with taxononie problens, and ailoved sone of his unpublished reports on vegetation in Puerto Rico to be mimeographed for project use.

?to aia our participants @ Listing of nev ani old nanes 1s included as Saith's nabie 6. Another eid wee the publication of the book guide to trees ty little fant ligdevorth, obtainable from the Superintendent of Documents for $4.25.

?Tree Date on Punch Carte

continating the Lacon with the Tropica? Terrain Research Detachment » ?RNC set up a punch card machine and operator at Stop 7 1/2 to put the date ebiiectea by the Ary group in the sapping study on TBH cards to meet their Sfjectives ae vel as ours. ?These carde have nov been punched according to he format given as Fig. 3. They vent to the ?ayoguee computer center?

for various conputations euch as means, frequencies, basal areas,volunes, etc.

?Tree Trunk Grovth Heasurenents

Feter Murphy continued his etu?y of tree grovth of 5 opectes with the guidance of Dr. edsvorth, There is now a year's recor with some of the Gata sumarized in en appendix ection. When it was suspected that the Catty measurements vere 00 euall duc to tightening of tapes in the first Souths after installation, additional tapec were added to sone of the trees Mith old tapes in order to get a cormection factor.

Fuenological Record

The recon of fruit and flovers has nov covered a year with data indicated in the data section,

Palm Populations

Progress on the study of palm populations 1s given in the report from Dr. Frank ileCormick.

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Lis Tip Grovth,

Pegun ty Mr. tturphy and continued by iir, Smith, Limb tips elong the cor cable were marked with metal clips so that the distance from elip to Granch tip coul be measured before and after trradiation, These trece have no annual linb scars. It vac during this vork that fr. Smith fell injuring back and ankle,

Forest Bioaase

?The vegetation nape by tr. Fushing apt the Tropical Terrain Research detacheent permit prism computations of macs In more detail then was for~

nerly contesplated, This vork is yet to be done.

Roote ant Merorhiza

Dr. Joe Bintsten rade @ working trip to explore relations of the soll ?and roots af reported in his report in the Results Section that fellows.

Fans

Dr. Covley, University of South Carolina, and ltr, Janes 7, Holler cane in the sumer for study of done fungal aspects. Mr. Holler remained making Plate counts ant isolations for his Master's thesis. Dr. Cowley also mate Zeurvey of some higher racroscopic fungi, Their report is included in the selentific results section.

Microbiological Processes

br. Martin Waitessp, Beology Division, Oak Ridge Mational Laboratory, cone In December for sone microbiological explorations ac indicated in the report of his trip.

Aigae

br. Phil Halick! visited for studice of algae, marked 50 stations, and

arranged for the study of palm frond replacerents for computing leaf succes- ston.

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Hosses

Dr, Wilden C, Steere azcisted ty lire. Steere cane fron the New York Botanical Garden for a pre-irradiation stuiy of the mosses as indicated in Iie report thut follove' in the next section.

Leaves on Shrube

Following Yr. Snith's cceident, Mrs. Snith atded ty Jusn Martinez completed sone counts of leaf miner? on unlerstoay vegetation in the Tati ation ares,

ChorophyLt

With leaves collected fron numbered trees by Hr. Murphy, Marta De Arce ant Carmen Laura Fereles made 850 chlorophyll deterainations to characterize Dhotoaynthetic function before irraiiation -or couparicon aftervarte. Sone Sumaxy of these date 1o given in the results section. A minuscript on

echloroptyll vork done in 1957-1958 by Odum, Abbott, Selender, Golley, and Wilson was prepared for publication.

Forest Cross Section

Using the forest cable-car cable ac a transect, lr. Suith made a forest crose section ac inlicated in hie report in the results section,

Seeding Plots

Mr, Saith counted surviving oeedLings 8 year after he carkea quadrats in 1963.

Actinowycetes

Dr. Andrew Naretzki collected sone sampler of leaf litter ant coll for Dr. J. J. Perry, Dept. of Bacteriology, "N.C. State, Faleigh who made some surveys for actinouyectes.

3. WEATIER REcomDS

Solar Radiation Heacurexents

?The Eppley instruments fron U.S, Amy of llatick have been recording for over a year vith a few interruptions. then the hurricane vas forecast to pacs pear San Juan, ac promised, we pulled dovn the main tover and removed

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the top platform. Mr, Drevry made sone calibration checks at thet tine and

Tens tke taulty flaking in one gythelioncter. The full daylight photoueter

fia different tine developed water leek. Poth went back to Sppley Co. for

SCoutiting and recalibration, The photoaeter is back in service and the

Joubie heelephere pyhelionetere continue their recoris, A representative

fron the U. 8. Army at fatick visited the project to observe our use of their

instruments ana other satters.

Forest Optical Density and Sunflecks

one ving of silicon cells has provided a years record of optical density.

tn Novenber, George E. Drewry began recording on three other rings of solar

Geis incliling irredietion and control centers. it. Rushing reports & uc-

Geseful years use of the portable device developed for their plots through

Collaborative effort. A publication note is planned on this instrument.

Rainfall, Wind, Temperature, Humidity

ime pre-trradiation annual record for the main tover above and below

?the canopy 1s mostly conplete for rainfall, ini, temperature, and humidity.

?The Cup auenoneter vos out of Ainction for part of the period, and there was fone drifting in celibration of humidity and bot wire snexoneter records faditional thermistore were alied in Decenber.

?me problene of catching malfunctions, inking, and dating charts vas taxen over ty Bre. Suith on a part tise arrangenent which involves a morning {nstrusent routine. So fer three of the Pustrake and Mustrak euplifiers have nd to go for factory repair, a better service record than expected consider-{ing that sary have been snapping away continuously for 1s ronths: As yet the weather data have not been analyzed.

Digital Systes

?A tion-Linear Systens 20 Channel Digitel Scanner was purchased and tr. BALL Moore and He. George E, Drewry begen wiring the connections for the Gigital voltmeter, the word, and the scanning progran. A progran board vas igo purchased for an Ih! ké tape to cart converter and ie being vired with fhe ala of the IBM Service Bureau, The digital cysten ts to go into operation hen the new laboratory ie ready. Tue systen will give sone data regularly Wouted to corde in addition to the roll charts. irs, Flpidia Rivera began punching teuperature chart date on IBN Caras (Fig. 3).

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5. cyToLocy

De. Francis Koo, at FRIC Hayagucz Leted ar half time on the project acsisted vy lire, E4lth Fobles de Irizarry in the laboratory and ir. Robert Yenator in the field, conpleted meseurenents of muclear volune, made 9 stuiy of Taiiation effect On broxeliads using a radiation souree in ?layeguezy and explored sane aspects of germination ani werictens. To appraise the effect of radiation on the bronelisie, chlorophy}1 extractions vere made and the Bepetrophotonetric meacurenentz done in Mo Pledras ty ilarta De Arce slong With detersinations being wade from the site, Dr. Koo's report ie given in ?the Results Section.

Walking Sticks

Dr, Hitlo Virkkd collstorating from the Bxperinent Station male cytological preparation: of testes of vaiking stick insecte os material permitted, fir. Mill Solline during the curmer collected oninale for hin. Phase microscopic equipment vas ordered to replace equipment he has on ?temporary loen for thie work.

Ferme

br, ¥. Sorsa ani wife, both eytologists, enroute to Finland made cytological collections of the ferns.

6. ANIMAL POPULATTONS

Shade

Des Harold festvole, Lepartment of Biology, UFR continued the popule-?tion study of the large etaile vith acsistance of part tine students paid frou the project et various tines: Joaquin solinart, ?Willian R, Bhajan, Mnilia Hetos, and Zaida /iiranda, ile report is attached.

daphtbSene ond Lizards

?The population etuly of the cogut frog al two dominant spectce of Anolis Lizards vee contimsed by Dr, Fred Turner and lir. Clayton Gist of the Ratiation laboratory at UCLA. Dr. ?Turner cone on vorking tripe and tir. Gist ani fanily moved comm for the year being attuched alministratively to PRIC. Salerice and scientific direction renaine? through UCLA, spectal local expen= eee and travel vere budgeted through the project budget. ir. Gtet returned, hone in Novenber. Dr. Turner visited in December vith Tir. Aovland to put ndero~dosinetere in froge and lizaris. Their report follows in Results.

?They presented come of the data at nectings in Septenber.

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Birds

Dr. Harry Recher made quarterly vorking trips to census the bird populations, plotting pocition mapa, computing densities, recording aspects Bprghenoloey. Kis report is included in results.

Frog Hote

lie, Drowry reports on his annual record of Coqui sound in the Results Bection, He has alo made progress 1a cireuite for recording other popula~ ?thon components.

Insect Diversity on Sticky Peper

ir, Drevry took over the sticky-paper sampling vith the aid of Joaquin Molinari ant Butebio Diaz Pagén. This vork involved computing species diver~ Cities, setting up keys and reference collections for the 500 species, send- {ng spectnens Off for identification, and naking sone tests of eubstrate effect.

Hevbivore Action on Leaves

Aasteted ty Marta De Arce, Feter lurphy ond others continued the Leaf pote study begun ty E. P. Clum,? Sanplee from the leaf fall were placed in fhe Light box and the percent Of holes determined ty reading first with Yeaven only and then with leaf holes obscured with pieces of alumimun fotl, An enmal record io given in the Results Section,

Bromeliad Fauna

br. Rassett Moguire, The University of Texas, provided results on his working trip in the Results Section,

Mosmals, Noequitoes, Virus

?these populations are stuliea under a different project under Dr. Paul: Wetnbren whieh Se funded and administered through the PRIC Bionedicel Division, und submite @ separate report.

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Sof Merozoa

Sone results on thie phace ore given by Dr. Richard Wegert fron

is working trip fron the Institute of Rudistion Ecology of Untversity of

Georgia at Aiken, S. Ce

7. METADOLIC STUDIES

Seedling Stuty of Sh:

¢ ant San Species

Ae bie Haster's Thesis at UFR Ariel Lago completed neacurenents of photosyatherie vereur Light ani clr flor velocity for tye species, whose Bcellinge ere survadapted an? cusceeeionel on} tvo dauinant climax species Vinose seedlings remain for long periode in deep chate and grow vhen the banoyy opens. Sone of these data are given in hic report in the Results Section.

Shade litreresceme

Fourteen plastic daseteators with sceaedsotl an plants renained unettented at the future irradiation afte for a year. The small hose fittings remained openea for gas exchange. Prior to irradiation all were opened, execes water viich hel accumdated ver drained out and the systens atehed according to general quantitice of vegetation. Seven were placed in the irradiation center and seven in the control center.

Diurnal carton-aioxide curves vere previously made after months of acclimation ty renoving the microcoss temporarily to an air-eonattionea Foon and e fluorescent Light providing eimilar conditions of Might intensity Eni temperature to that of acclimation, An exanple is given in the Results Section,

Soil tietaboltes

As chown in lact years progress report the coll metabolion 1s highly seneitive to flow rate during ite neacurenent, hen sone visiting partict~ ents repeated cone meagurenente using cur hotevire anenoneter box previ~ Dasly deseribea, they obtained values ten tinee those ve obtained previously. The principal innovation they added vas foam rubber seal to the soil rather ?than alloving inflow of air under the edge of the box. ?There may have been puction created because infloy holes vere not large ehoygb. Thus further etudy of this mist follow.

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au

chant Cylinder Experinent

?About 50 neters from the Irradiation center, construction of the gient cylinder begen in lete Fail, Six cnall slunimm tovers vere carried into the forest ty Youth Caxp meh an] cet on concrete pads with guys to the tree The toners were connected to each other by cables to form a hexagon 60 feet ?aerose so thet no guys vere needed on the Inside. The forest ot this point je Go fect high. rte) Lugo, Alejo Betrada Pinto, and others gradually raised the erenk-up tpvers, ucing small cables to tie back branches v0 as to eke a Fraccvor for/fyLinder vith epace for a plastic curtain. With aid of « group Of seanstresses fron E1 Verde, 10 ail polyctiylenc vas sewed on a vire ring fend suspended from the hexagonal tover francs by 12 ryion Grav ropes vorking Ghrough pulleys at about 50 feet. The plastic ves readily hauled up as & Curtain to about 40 feet, but beyond that the increasing veight began to cre~ Eke straine reoulting in?ploctie teare, broken strute in the aluutmm towers, fod other problens, ?the plastic vas then cut at ground ievel and a second plastic curtain cewed co that the weight could be distributed fron two hefghts Mithout the necessity of hanging all the weight from one ring.

ith the help of ABC Engineer Hr, Keller, the giant fan and 15 HP gasoline noter ver installed on the concrete pol, Mth the plastic at ko feet, a umole bonb vas cleared tron the cylinder in less than 5 minutes.

The 7 foot fon at present 42 geared for relatively few rps, 200 maximum, and Goes not use the full pover of the engine. The engine exhausts directed into fhe outflow of the fan vere eorried dovuvind vel away ?rom the cylinder and GLa not feed back into the cylinler as determined in a preliminary meacure~ Gent with the infre-rea analyzer. The scheduled radiation date caught up {ith this second priority hace co thet it mst be coupleted after April hen the orea 1s rgain escessible, A paotograph of the cylinder with the Plastic ct chout 25 feet is given as Fig. 4.

?eaneptretion

ULtn one of the Fygredynunie Humidity Systens already butlt into the

.gular weat'=r, recording fron the tover, a second portable system vas tee~

8 ty tire. L. Ortfs 25 a neane for measuring trancpiretion in open flow

gyetens through plant leaf ehanbers. Although more sluggish than the

enalyzez, rncre is eee noise in the revort. \hether ve will be succes

fn sealing this up to the giant eylinder in order to get forest transpiration

remains to be seen.

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5

8, PHOTOGRAPHIC RECORD

vey pictures vere taken during the year and are pert of the general

recori one series vill be published az a pictorial record. Ary picture t<

Gralluble ty auplication for any participant in connection with his special

feporting and publicetion. Vieiting participants contribute copies of pictures

?they take to this pool.

Helicopter Series

continuing collaboration with the Tropical Terrain Research Detachment of the U.S. Corps of Enginecre Vatervays Experiment Station, the Cold Regions Research Laboratory of the U. 5, Amy at Hanover, Sew Saxpohire, and the Department of agriculture herbicide project of the Experinent Station at Mayaguez, a helicopter flight wes chartered every other nonthjand Mr. Dave ?Atwood took pictures with color, infra-red, and camouflage film,

br. Pail Johncon of the Amy group at Hanover is making a study of the opticel aenaity of the ftine and relating it to ground measures such as optical aensity of the forest.

Light Plane Series

Peter Murphy of the FRIC staff obtained hic pilots license and vith the

help of Clayton Glet, Robert Ford Gnith, and others begen teking serial pictures in alternate zonths fron a chartered Light plane.

?Tover Sertes

He. Clayton Gist took @ umber of pictures of the radiation center at various tines fron the top of the instrunent tover whieh overlooks the radiation ares. .

Pipe Series

Me. A. Atvoot and Dr. Johnson continued their in-forest record of pictured fran reproducible positions on Sized pipes.

oak Rage Photographer

A pictorial record of forest activity at the time of source installation was made by E. Uesteott ABC photographer ona viet from Osk Ridge.

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?Aniual Series

A serice of pictures of representative animals vac taken ty Hr. Clayton ost of UCLA,

RD FLOUS

Nomad Gttter Fall

Feter Marpty, AleJo Betrais, and Doroteo Martine: collected leat fal) monthly from the 50 statione set up by Dr. Ulegert. After the leat hole nea: furencite were male, the Litter vee oven dried, Fruits vere separated, tden= tified by Alejo Estrada, and arica separately. See the Reeults Section

Litterbag Decomposition

?The T1014 experinente of Leaf decomposition in fiber-glace bags oct up ty Dr, hegert ant sone later series cet up Peter Hurphy vere continued with age removed for drying and weighing at ' nonth intervele,

110, CRSIUNI SOURCE AD PROTECTTOH#

Nenufacture ai Inctalletion of the Source

A response to the call for bids cane fron 5 fime} the purchase onter for the design and construction of the source vent to the lov bidder, Anerican Raclear Corporation of Osk Rigge, Tenn, for $21,Wh, Fotloving part T of the procedures set up in the purchase order, plane Vere Aram and subjected to eritieten vithin FRIC and then included vith slight nodifiestion in a Hasards Report concerning the entire aspect of source installation, operation, ond matters of Health Fhysics and public safety. ?hen this docunent was approved by the ABC in Oak Ridge, Pert IT of the purchace onter, the actual construc fon, vent into effect, A provided in the onler, inspections of the apparatue were mate in Oak Ridge in Tovenber by Olun, C, 8, Shoup, Joe Lebmharat and

H. Hacker from ABC Operations in Oat Ridge, ant A, Jones, engineer invited frou RIL, A eerier of modifications vere reconncnles ant incorporated at that tines

"me source was ehipped by truck and boat arriving at San Juan Rarbor Dee. 3. After inapectione by FRC Health Physice officer's, Dr. Ferrer ilonge and

Faro Cruz, and the Coast Guart reeponsible for the harbor, the source was oaded on truck and driven vith preceding and folloving veilclee to the end of

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Mu

?the Sonadora Road 600 feet from irradiation center, The helicopter team of GME Riorte Rico Power Authority ms enlisted snd on the following Honday the iBncecplg, weighing one ton, vas picked from the truck by a 90 feet, 1/2 Goch; cteeh cable am witbia 15 minutes war eet dovn on the concrete pad in Ghe forest by precision flying and ground ratio guidance, The blast of the helicopter broke mary linbe in the ralistion center chenging optical proper- ?tee somevhat.

six red wires for power and control were stretched fron EL Verde Station to the sounce site, parsing on separated insulators in the very high reaistion field near the source.

?Aloo foot, 3/' tnch condust was laid over the irregular ground contours and threaded with @ 1/16 inch stainlese steel safety cable that operates an emergency mechanical trip hook.

A two Snch etee) tube tripod vas placed over the source with fect in concrete so as to deflect any falling tree.

ceonge Drewy built an alditional safety provision, a half inch steel cable oop about 15 feet above the source for helicopter snatch of the source. The weitce apparatus although cabled to a 6000 pound concrete pad, is released from {hese theve connections ty mechanical. cable tripe that open when stainless steel {rigger vires are dram as the steel snatch loop is lifted. Thus, should el ?Other devices fail, the source could be vithiram by helicopter and carried

fer acep pool of water of the river for repair operations. Five feet of vater would provide the sane protection as the five inches of lead. Helicopter personnel would be partly shielded ty the plug.

Me, Je Hs Wilde, predident of American Nuclear Corporstion, the manufsc~ turer, cane for i dayo during the final installations making various checks ?ani recoenendations, The chipping cover vas removed, the hoist machinery vas Bolted in its place, ani the verioue cables were attached. Fig. 5 was taken et that tine, The control tox vas installed in the instrument room at the Bi (etde Station 2000 feet fron the eouree along with safety devices. Then Biter fences vere finally completed ani two anendnents to the lazards Report Gere approved by the AEC erea office, an official inspection and radiation Nest vas held January 12. Dr. Roig represented the Director's office, Mr. Pedro Cruz the Health Piysioe Division, and Mr, Keller the AEC Area Office.

?me first up-source test, Jan, 12, vac made satisfactorily and vhile the source was up, Cri, Oitm, and Valieciilo surveyed the fences ant peripheral Souds with Ineuvey actere with the recult given in Pig. 6 and 7. The radia~ {lon levels vere less than those previously given in proposals for the work,

?the down cource nechanien also worked. After raising the source again, seran ond mechanical trip devices vere tried, witl no response.

?the source vas lovered with the Jova mechanism and various inspections nade vhich shoved too much friction in the mechanfeal cable in the conduit fend in the electrical hoist devices end fluid brake.

---Page Break---

After a phone conference with uezicen Huclear Corporation, the mechanical cable was renoved fro conduit to the free air, ;'10 of] was placed in the fluid Greke, and bearing friction vag reduecd. fn electric enti-noisture heater vas Toluced in power ant novel go thet it vas not vaporizing Iwericating fluids. The counter weight on the trip cable vas reduced. A nev authorization memo-randim wae processed, end a second tert var nade January 18, ALL systens

Were Aunctional et thet (inc, hen ease under-fence holes vere sealed, Dr.

Dagher nade 9 personal, inepection, ani final irredietion begen the evening

of Jamray 19. A ceras test made a weel: later shoved systems still functional.

?A partial plan for the couree ie given as Fig. ani the electrical syste
as Fig. 9. the inierosvitel: thet tums the red ?sourve-ovt of box" Lights on
So located on th sie of the vertical tube ani iz actuated as the plug passes.
wo other microswitches are in the moter box on either end of the hotst spool
go that the completion of the tums up or the completion of the turas dovn
Setustee a cuitch, cats off the moter eutonatically, and extinguishes the moter
Light, 2 there te pover failure, a reley is tripped oo that vhen pover 1s
restored, no power passer beyond the control box without active turn of the
power key

Bither pover interruption or turing the scram switch dom, releases the
magnetic eiuteh eo that the 45 pound plug with souree uolls the free running
holst cable fron the drum, the plig reaching the pig in 3 seconds, Bringing
the eource down ty moter operation of the down button takee 14 seconds. ?The
up button brings the source up to ull height in 19 seconds.

Souree Operation

Souree operation is made ty an approved check list to help avoid omission
of important steps. There 1s a metal box that contains the key to the up-
Gource button, A bar on the box, sonetiing Mike the one st Brookkaven ana
Emory, has provieion for mexy locks to be added incluting one ty the official

operator, During periods in wich the source ic down and someone is authorized

fo go within the 160 neter fence, he puts hic lock on that box-bar so that it

Cannot be raieed wrtil he returné and renoves tt,

bp source procedures require verification of written authority, 5 minutes

of sizen, renoval of locks, teat of the tine required for Light change in the

Up procece, relocking of the up button, and locking key in the box.

?The ecran button is available to anyone vho night suspect that someone

unauthorszed was beyon! cur controlled areas. After seranming, the one res-

ponsible operator 16 required to raize 1 again.

?Mat radiation is on nay be detemsined by (a) the radiation recorder in

?the instrunent Foor vhose transducer in 300 feet fron the center, (b) vy using

fa survey neter et the control house (0.1 ar.per hr. vhen up and iess than 0.°1

fxs per brs when dow), by the Ped Lights on the panel board, and vy the audio

Gaackle over the phone from the tover shed ratencter, After the source 1s put

---Page Break---

oun, the power is turned off 4f persons ure to enter the 160 neter circle.

She fespousible operator is the flret person to go in with the duty to check

thet there fe 2 fixe ceat of source with survey meter.

If work is to continue for longer than tvo days, the source plug is also ?unhooked fron the hoist apperature, and the clectric?pover turned on so thet ?the heater {8 operating.

Sarety Fence and Signe

?The provicions for source operation, cafety, and health phystes ere covered tn detail in the Hazards and Safety Report and ite tvo anendaents now spproved. Ae show in Fig. 6 thera is a 160 meter hog fence 8 feet high Gtuples from tree to tree. voles underneath vhere gaps are created by rocks Gnd? ground gaps are doce! vith fence patches. At 23 feet intervals are cigne with the inscription.

Extreme Denger

igh Intensity Radiation

Beyond thie fence Do Not Enter

?Avea, Extrematanente Peligrosa

Tadiacién Intense

No Pase Mao ALLA de Esta VerJo

?These signs are masonite and in red and yellow vaming colors.

At approxinately 500 netare on the downhill side of the mountain toverds people cingie strand of barbvire has been stretched at 3 feet and the cane Yarning sigr placed at 25 fect intervals. here this vire approaches 8 forest tall it changes into fencing wth eigne, In the sector on the north side which ke nearest to the Route 186 Dridge over the Sonadora River where people some~ Hines pienic, the line becones fence for 600 feet. Ae shown in Fig. 6 a gate vas put across the Sonadora Koad with conbination lock.

ouarts

Starting Dec. 4 with the aesictance of the Department of Agriculture and ?the EL Verde Ranger and ltr, Joeué A, Colén of the aininistrative division, 4 quarto vere employed from the village of #1 Verde. The patrol routine set up Givolved an 8 hour shift with watch clock stations at the Ranger Station, the Ei Verde station, the Sonadora gate, and Saith's house. The patrol

has four functions. 1, By patrolling rosd access, keep eurvillance of persons who are in the vieinity to prevent anyone fron going beyond our outer warming [ines Perenthetically, it should be mentioned that one has to do sone rough elinbing ent get maddy ard mesoy to get that far. 2, Guards require any

---Page Break---

persone vorkins at the GL Verde ctetion ox in the zone between the fences to have written pace anl Zils badge. 3. Cuants check the control panel and weten for power failure and other walfsetion, '. Guarde provile a persone el transportation shuttle to £1 Verde village ani the Cienega Alte house.

Radiation Filed

?hen the source ie dom, satin: radiation at the source ie on the toy aide, lnux/ir. ition the souree tr up, radiation at the 169 ueter inner fen ranges 3 to 17 mr/hr depewing on topography. At the $00 meter warning Linc of signe radietion fe 0.1 to O.sar/ur, At the public vost 106 the realings are Lees than 0.02 ux/hr including the pointe of ?Gtrect Line of sight? and the Sonadova Bridge. At the El Verde station ovteile of the concrete buildings the vadiation is 0,12 ur/ar. Qt vhe cad of the mechanical trip cable within the immer fence but behind @ ridge, the radiation te 10 ar/br. A prelininay graph of dosage rate Je given ex ?ig. 7. Onc survey was cate by Mr. P, Cruz and ir. F. Valleeilios another wae siade ty & teas of about thirty neubers of U.S. Department of Agriculture Soll Conservation Service under Mr. WE, WeKinzic as fa field exercise February 23, 1965.

Docinetere

1000 sealed capsules from Con-Rad Company vere placed vithin the irradia tion field by Dr. Fronk HeComick ascisted by W, Tuehing an¢ associates 20 a8 to eho micro-variations as vell as provide a docinetry map. Sone of the 500 microdosimeters viieh are to be rea by Germshausen, Digerton and Grier vere paired with the larger capsules and gone vere placed in a ceries along the cable-car cable, 160 microosinetere vere put in frogs ani lizards, by Tumer fant Rovland, 50'in enalle by Heatvole, end come in rate by Veinbren ard associate

cobalt Survey

Poior to eubmdasion of the latarde Report, Pedro Cruz and the ?icalth

Prysics division brouglts 5 Curie Cobalt source from Neyaguez, placing it ot ?he end of the Sonslora foal. Air aniforest penetration were measured to show that there vere no features of the Bl Verde situstion that might eawse radle~ ?tion to be more penetrating than ai Brookhaven and at Georgia.

Film Badges

Starting with the arrival of the source in the area in December, a filme badge rack vas set up at 1 Verde station an? incorporated in the regular routine at FRC by Mes Heidi Pab6n of Health Miysics. Also maintained were ?temporary filn bedge packs for the various vorkmen of Dot Corporation, visitors, ete.

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Public Relations Intefing

?hs part of the necessary aspects of liealth and Safety, a public infor: ation program hac been contucted, First Dr. Bugher isoued an annowncescot matter PecGroject in the newopopers in 1963, Then vhen the source vas ehtpped weet och Ridge, a neve release there vas picked up end repeated in several Son Tian popera in Yovesber. At the time of source arrival, Yr. rent of the 10 Operations Office took charge of public relations vith several meetings Nett Gere Gian. Mr. E. Stockely Public relations officer fron Oak Ridge cane fo eens helt several consultations evolving a written plan for the public

seimelons announcenent. According to that plan s simple ennouncenent wae

sae ere carly Secenber that appeared in all the papers ani in one 7V outlets

Tens when the fencee ond other preparations vere in readiness, = formal pabite

een eee earing unler AEC contvol and suspieces vas scheduled and organized

Gy a. Rushford on January 6, Talks mee byt, FloydP. Trobt) (Ory

Wassorth, Dr. Anmlor Cobas, and Dr, Hovard T. Odum vere followed by a trip $9

veteeeretta bus to El Vere. ALL attendants valked up the trails, exasined the

Scare, end observed various aspects of the study. ir. Rushford distributed

Felaers with large photographe taken by the ABC photographer from Oak Ridge, and

Tolgviches and coffees ves served. The meeting vas attended by various

Siccentatives of the press, Comorsealth Goverment, the iayor of Ric, Grane

BPon Ge the nearest municipality to the cite, ani representatives of the

wighboring Girle Scout Camp and Youth Camp. "he briefing was followed by

ce eaves th the newepapers that week nt sone feature articles sonewhat Later.

Griptte of ali the explanations ond docunents given the press, one article

Roma tne source pleture and deeeribed tt as @ nev powerful dosineter for

SEG defence surveys in the island. lost pepers aid carry the principal

sEktge that there vas no danger whatever outeide the fences, but, there was,

Miteegous radiation within, There have apparently been no editorial comments

qereettie Alscussions of these announcenents, A radicol university stulent group

Gaeluled « paregraph in a mincogrephed leaflet denouncing the project

2. SYST cHBASTRY

For the noct part radiation effect studies have taken precedent this year over chenieal cycles stuiies, ?This emphasis vill change after completion of err ctr ratietion experiment, the completion of the EL Verde Laboratory, and the arrivel of a staff neuber to increase this vork.

Chemical Composition of a Forest Prism

Mes. George Ann Briscoe spent mich of her tine before leaving for Bogan preparing 9?0 powiered samples of roots, Lisbs, trunl-woods, ant, leaves free rere re 2 epecies. After chemical analysis, one may multiply the vetehte of ?opeaeterdal ty the analyste of that material end sun to get the chenical seh tition of the forest prisns. The detailed tree maps provided by '- fushing's Aray group vill be the beste for thet.

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In collaboration with Dr. J. D. Ovington who had earlier visited snd

?vegan these phases, the samples vent to the Monks Wood Experimental Station, Huntingdon, England for snalyees of principel comon elements by the chentcel ection there.

Sone soil saaples are also being processed through a chemical section of the University of Georgia ty Dr. Joe Ednisteny

Costus ani Manganese Peaks in Gara Spectra

?Taking a personal hand, Dr. Bugher assisted by Ada Livia Rodriguez de Col6n and Yarte Se Arce made 60 ganna epectra of forest materials. In initial explora- {ory aeapurenents strong cesium and manganese peake vere found in all leaf mate- Hiels. ith a year iapeed since the ceseation of main atnospheretc miclear tes Tings the leaves shoved lover beta counte than ve reported in lact years study and the gama epectra vere cimpler.

?fs a test of radiation effect fron the Cesiuz Souree on the ability of the forest to hold in eyele the ceeium and manganese, effort was concentrated on getting neasurenents of the tvo elenente from muibered trees in the radiation {Meld before irradiation, Ash samples vere prepared fron nev sun leaves, old gun leaves, new shade leaves, and old shade leaves of the 6 species being Studied for grovth. ?These meseuremente Vill be repeated on the sane trees after [rradiation, Sone data are given in the Results Section, Conductivity of Forest Fluide

?A conductivity indicator wae set up for renote recording of rain on top ?the tower ant that folling through the forest. The conductivity was exceedingly Variable fren 10 to over 100 micro-shos Tron rain to rain, Often nore ealinity Nar fauna in the electrodes under the forest, possibly due to recycling mitrients Jue prelindnary exploretory meastrenents show that sone micro-habitet differenct fan be found. Por example, the flow along trunks can be compared. Data will have to be corrected for the influence of the mobile hydrogen fon by taking concurrent pHi measurenents.

Resins

sone exploratory testswere made of salt uptake in resin tubes that were placed in the rain guage tubes, ith the enall water flovs involved, the vethod eae not censitive enough to. give good ganna spectra after 2 months. Sone Yeteer funnels vill be required as 19 normelly Snvolved vith thts vork. Dr. Vs Bowen, loots liole Oceanographic Institute visited and was sent one set of [sins for atudy with sooe sensitive counting equipment he is using. Depending be this result ve can plan our rain etuifes in connection vith next years vater ?balance effort.

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12, EBASURS OF TODAL S¥BTH:

No further efforts have been made thir year in syntheses of data into cfreuit etructuree, electrical analogs, eneray diagrass, and measures of ongenization beoaude of the urgent proseurce involved with ctarting Lrredi-lation and for lack of cone key data nov being obtained in other phases as alreaty deceribed.

13. PUPLICANTO:

Authough a muaber of publiestions canc out during the year ty staff fon work done cleevhere, no project vork war published caring the year ant most writing avaits tht poct-irraiiation comparisons.

The post irradietion studics will begin approximately Hay 1, 1965

with the flrct emphacie to be a year of meacurenents duplicating thore of

the pre-irrediation year. lence, many date on the first objectives will

bbe obtained by lay 1966, Recently there has been consierable discussion

Of possible vays of reporting the project in the regular scientific 2iterature. There nov seens to be @ conseneus anong many participants and staff that publication of a group of papers in one volume may be desirable.

Authough the nature of the outlet Jo not yot determined, At may be wise to give everyone adequate notice that manuecripts of a combined volume of papers vill be assenbled in sumer of 1966, vaich ie a little over a year froa nov. A supplenentary volume might follow several years thereafter with reports of the long range effecte of the irradiation and emphases on the mineral cycling studies,

RESULTS

?Anqusl pattern vere meacured ty the various intrunentel records, spot surveys and uonthly samples of the pre-irradisted forest, Although mary of the data are not analyzed for reporting yet, sone properties of the year ean be given in the following parographe and in? cone reports of participants ?that follow. Unquestionably, the F1 Verde forest plot 1s one of the most stable biological syetens on carth, but there vere definite seasons in the activity of particular species of plants ani animale, Pulses of activity occurred In sone processce that were continuove, Saxe reproduction phenoaena were distinctly ceaconal. The tine dimension vas separating functions, simplifying the life of the forest.

tans Fed

The leafzul at the 50 stations set up by Dr. R, Wegert ie reported in Fig. 10. The record confirmed the increased fall in the epring which hhad teen quslitatively observed. ith the exception of Buchenavia end one or tvo other specice, nev? leaves vere fomed before others vere dropped, 0 ?thet the forest war continuourly evergreen as previously reported.

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Prevological Pattern

Sone phenologicel patterns ere given in Murphy's report. Some other aate are given in Fig, 10 and ll. The graph in Fig. 10 shows the reproduction fon 20 palus selected by HeCormick and Murphy and exanined monthly ty various staff. Buterpe ie one of the ost abundant plants and its flovering and fruiting continued through the year but vith a pulse with sumer seedling buen resulting. Zar graphe foliov for sone other species based on notes

Bade each conth by Alejo Estrada Pinto and others. In general the flovering Was recorded for shorter periods than the fruiting wh{eh vas extended through oat the year Zor may epecies, but not all.

Gonna Spectra fron Peltout

?The relatively high levels of fallout-redtoactivity observed in leaves in 1963 declined during 1964-65 as might be expected with diminichea atmospherte testing. A gemma spectrum of leaves from 1963 is compared vith more recent spectra of similar leaf uaterials in Fig. 13. The later spectrun io simpler Since the peaks of shorter lived clenente decline leaving mainly those of Potacolum ho, mangenese 5k, and Cesiux 137. Also shown in Fig. 13 and 14 are Spectra of various forest phaces and specice. Although there are quantitative Qbfferences, spectra for the leaves of various species have about the sane general appearance, and there ie as mich difference between leaves of different fige on the sane tree as between different species. However, the strong peaks in the gana spectra for leaves and leet Litter were not in other components

of the forest such as inorganic soil, roots, boles, Linbs, and lizarde.

Gnnara Spectra fron the Cesium Source

Assisted ty BILL Woore, Dr. J, C. Bugher carried the Goma spectrometer to the ML Vere Station instrament room placing the 2 inch scintillator crystal outside the vindov. ?Tie station is about 1600 feet fron the cesium source, ?nd survey metere show 0.13 mr per hour. ?The spectra vhich were found first With the source doun (shielded) and second with the souree up are given in

Hig. 15. It is interesting to compare the backuround spectrum vith the leaf

spectre of Fig. 13 anc ih, With the source up, one finde that alnost all of

the radiation vhien left the source at about 0.66 MEV had been transformed

?to mich lover energies vith the peak st 0,08 MEV.

Early Report on the Rediation Effects

As this report is being mineographed, some redietion effects are

being observed. he area around the center was examined several tines since

start of irradiation during short interruptions. A zone of dead brow leaves

fe epreading outward az graphed in Fig. 15. Paiches of yellowing leaves may be

@etectea further out as also graphed.

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Fig. MA Phenological records at El Verde st leaf fall stations.

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Fig. 13.

Sanna spectra of

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Fig. la. Gamma specura of forest a , background eubtracted.

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Fig. lab. rest materials at El Verde, Ganma spectra, bach

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Fig, 260 Spread of rad.

effect at Fl Verde a?

Figs 168 Gana spe

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Studies on Five Principal Tree Species

yw

Peter Murphy

?Tree Growth

?The tree grovth stuty involves five of the more common rain forest tree species found in the experizental plots. ?These species are: Dacryoles excelsa, Yani]kara pitida, Croton poecilanthus, Sloanea berteriana, and Gecropia peltata, each representing a different family, Alusinun vernier Grovth tenis have been fitted to 50 specimens of cach species, 1.c. a total fof 250 trees, and are read once aonthly for evidence of sten dianeter grovth; the bands being attached to the bole at approximately 1.5 feet sbove the Grounl.. Youth by month grovth of these trees is graphically represented in Figs 1 (overage growth of 25 trees of cach species at each center).

A note should be made concerning the validity of the first fev months readings, ?It wae suspected that due to the design of the grovth bands, which Guploy a steel spring for achieving tension around the tole, it vould probably {ake & short period of tine for the slack to be renoved fron the band. During this perfod the full amount of tree grovth would not be indicated due to the Hightening of the bend itself. To check this possibility 25 bends were fitted fo trees already having had bands for 10 months. As suspected, a comparison

of the two readings after one month shoved the new tape to 1ag'the older one

ty ae mich os .03 inches diameter change. (See Table 1) Further comparisons vil) have to be nade to determine the period that should be alloved for band adjustment to take place.

Froa Fig. 1 it ts apparent that Dacryodes excelsa is the fastest grover.

?This species shove only a eoall anount of grovih fluctuation throughout the

40 month period, s slight decrease in grovth rate during the sumer mchths. However,

Vantikara nitids reached « peak in growth rate curing these sane sumer months.

The remaining three species grev fairly uniformly through most of the 10 month

erica.

Tt can be seen that in the caze of all five species both experinental

centers showed very eimilar grovth trends. anilkara nitide vas the major

exception ant grovih appeare sLightly sore rapid in the north center.

?Trees used in this study vore Limited to a diameter of 10 cm. or

greater. Specimens in the 20 to U5 cn, dianeter class of Dacryodes excelsa

(the fastest groving species) showed mact rapid growth. ?the largest Iniivi-

duals of thie species ranged up to 65 cm, in diamster. Grovth rates varied

considerably in ll diameter classes.

---Page Break---

Flovering snd Prutting

Once cach month a one cguare meter frase ts get down at marked Location beneath each of the 250 trees ured tn the tree growth study. ALL Flowere ana zvaite, of the oame spre-ce ap the tree beneath vbich the frane te placed, aze counted and rencved. later these gata vill be correlated with observations of Plovering ani fruiting in the esnory.

Hig, 2 shows the evemge muniher of Flowers and traits of each species fount, nonth by noth, at cuch center, ?he velues are baeed on 25 frames for each apectes at each Center, The first mouth should be dieregantea eince 1 representa the first resoval of accamlated flowers and fruite.

42 five specter soy sone degzee 7 fruiting throughout most of the nine nonth period. Flokers have not yet ten recorded for Slosnes bertertana fand only during one uonth for Cecropia yeltate and Dacrycdes exeelea. The flowere, being Light in ueight, probably do not tend to fall directly beneath ?the tree, shere the frune 1s Loceted, as often as do the fruits. Croton poectlanthue however, shoved fairly consistent flovering throughout the entire period, Hoth centers stow very sizilar trenis.

Bree Srovth Card Format - Cext I

ert Tdentifieation (2) - first cart

|_?-soectee ~ letter ote

?tree 30. (conresponde to tag tn fteid)

1p = latter cole

c Fron Center (Meters)

ring (Degrees)

os euerenee he tears teg3t (00.)

FESS Setter soon Area (60?)

i CS iegent to top of Crom (eters)

fo teignt to Zottom of Crow (ites)

Height to Lowest Living Branch (Meters)

?Crom Dinneter (Meters)

? ?Crown Position - Number code

TEE mvers oven rts (gott traitatton

BEd ot ames £8 Seorata pxtata

Aires = Ranker cote

Bol Moisture (Fervent)

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---Page Break---

Gent. Table 1.

mira Month

na Tape New Tape

iret ?Two Months of Mew Tape

01g Tape ew Tape New Tape lag fervor

Species

are required

in tree including

ate through May 65.

repeating each

?month

---Page Break---

hie i ?

Pe orecsted Boe bho! aaj

jive SouWb Linde $_ NORM. Carpe

" Genetutine? Sourn Conte

ESPSR 92R

ry Ind CicumeeRENCe CINEMES PER Mong)

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Dare OF MunsoRErEHT

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sen Fine (Pe-fMoness)

ales Bo se IS We AS he ene al

Meh

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uw

Vegetation Structure of the Lover Vontane Rain forest at EL

Verde, and Preliminary Preperations for ?leasuring the

Eefect of Radiation on the Forest

Robert Ford Smith

ORES Fellow, ?ntv. of Ceorgia

The folloving are the objectives:

1. decerive the phystoguoay of the forest in order (o understand

Ats affinity to other tropieal rain forests; to define the forest

2. ?o deserive the epecies structure and species ecological niches

in the forest as a basis for understanding funetions and long tera succession

3. Yo deecribe the gross radiation effects on the forest,

?The folloviny progress hae been made:

1. Profile draving: A profile draving ie complete, except for details, from zero to 80 meters underneath the cable along tlie SSE line of center II, nich is being irradiated. "he drawing ecale is In = em, ?he draving ic made fron strip five meters wide instead of 7.5m. suggested ty Michards

?fn the ?ropteal Rain Forest. All perennial ferne and spermatoptytee are included except seedlings end saplinge under 1.ln, in height. vlerbs, ferns, epipiytes and lignes are black, understory trece are stippled, trensgresstves fand canopy undividuale are left clear.

?he profile éraving is along a Line with tvo fallen trees vhich allovs Light penetration and thus good epiphyte and herb grovth. The profile vill be redravn after irradiation shoving darage and preliminary regeneration. The vill serve ae the only planned study of the sensitivity of herbs and Lanes.

2. Speciee composition Liste are given in ?ables 1-5. the folloving fare conclusions drew: from the specice Lets and fron sone other data:

?mis forest is such more diverse in trees thon temperate forests though lees diverse than some mainland tropical forests. The total munber of species represented on the lists 1s 200.

over halt of the canopy is composed of only five species. If the

omall speciec Euterpe and Croton of tie palm doatnated areas are eliminated,

then Daeryodes, Sloariea and Naniikare renain as the overvhelming dominante

of the

Four specter make up the overuhelaing preponderance of understory

species (79.1) although the understory species thenselves cospose only about

One-third of the understory grovth. Other epecies in the understory grovth

fare young of canopy species

Lianes are about hel? ee abundant es canory trees. Although epiphytes

fare connon, they are not a uajor component of the forest and are less minerous

?than in soe other tropical forests. Host of the list of eptpiytes Include.

---Page Break---

48

relatively rare ferns (22-37) and orchide (30-13).

ferb level ground coverage 4¢ noticeably lacking in the forest. Some apectes cover rocks only, Aoovt four small planta cover each square ncter,

Dut of there only one ie an herb ?usually the grace [chanting or the fern

he others are tree seedling?. i

3.

Beedlinge ie abost efx renthe

1, vo detemuine the effect of trretiation on etenctip grovth, etx hundred feet of cable vere euepended in the forest crow uetwees the {yo censers as shomm on the acconparying ep. vig lengths have Leen measured on 130 trees. Each tvee lias ten twige sagge4 vith a nusbereé metal band. Toot-{rradtation meazurenente should give a neacire of the effect of radiation on stem tip grovth at various distances. The cable position te dram in Fig. 2.

?table 1.

Species couposition list arranged according to density and in the various

syzusiee of rediation plots at El Verde.

Canopy tree (specien over lem. aiancter breast height).

seal absolute denesty: Relative density below:

0.087 trees/a®

Groton porefiantine roan

Bloance berterian choiey

Tapitkara bide state (A., DC.) Cher.

?gynorya N. nitile (seeee ~ lice.) Dabara

Miconta fetandra (5v.) D, Don

Geeropia peltata L.

Gemcsie keugld Urten

Haye dentegenets (D0.) Sati

ngs fepivolia (c,) Willd

aynona Inga Taurine (Sv.) winia

inociera doninmeneie (Van.) <nobl.

synonym ayepes douinzeasi (Ian.) Krug ? Urban

Alchornes Letifolia Sv.

Richorneopsig portoricensie \rban

Sapfum lauroserasus Deer.

abebuta paliiin ?ers.

synonym 7. heterophylla (DC.) Britton

Eapttate inh) ont.

ak,

Suchenavi

Mieropholis garciniaetolia Pierre

---Page Break---

Seotea Leuecryton (Sv.) Hex.

Calyeoxoatin squamulogus Cogn

Giarea trichilioides 1.

eynonyn G. guara (Jacq.) P, Wilson

Didymopariax moratotont (Aubl.) Deene * Planch

dome vere VIE,

synonym Tiga Inge (L.) Britton

Eugenia stanlit (klacrek,) Krug ~ Urban

Sains Heettone

W rela spleniens (Sv.) 0c.

Guettarda Iaevie Urten

Gasearie eylvectrie Sv.

eae Eee AC

facaria arbores (L. C. Rich) Urban

Gordie suleata DC.

Geotes portoricensis lez.

rotate Ciefen.) er.

ria bicolor (Urban

Fyreonins spicata (Cav.) DC.

Hicue trigonata 7.

?ious eintenteit Ward.

Tetragastrie balganifera (Sw.) Kuntee

YWeonta prasine (Sv.) DC.

Guatteria cariiace (Urban)

saribsea (Urban) Dritton

?@ulavensis (AUbL.) Urban

Fagnolia splendens Urban

Yectandra menbranacea (Sv.) Griseb.

ieLiosma herbertii Polse

Tentietella faselcularis (Sv.) C, Wright

lyrete deflexa (Potx) Dc.

genie jambosa (L.) vitie Species present

aa Boringuena 0, F. Cook but not sampled.

ietirhen Goriscen (Tani,) tirben

Meropnotis

Beilechnted:

syronye ?Lfelandia pe ila (O0.) ees

nia Zubeordata Sw.

Sea pearvertney Laceie

Taenianthus ealicifoliue vars. obovatue iinobl.

aynonye: Urban

Cleyera sivopunctsta (Criseb.) Krug "rban

synonys Eroteus albopunctatun (friseb,) Tritton

Maytenus ponceana Uritton

Tabernaenontana oppocitifolia (Spreug.) Urban Seat.

chia fucate Ker. strean-eide trees

Aodira ineraie (W, Uright) iP. Kk. Tree geen

Uaneifera indice L. only as seedlings or

Calophylinas brasiliense Canb. saplings,

---Page Break---

?Table 2.

understory trees species vhich reproduce under the main canopy ant ao not

usually grow to the canopy.

?otal absolute density: 0.228 treee/x?

Total density tneiuding ati plants frog

Lil tall to 10cm Dit: 0,725 trees/ae Relative density below:

Palicoures, riparia venth,

fee glauca Yah).

Gordian Doringiencie Urban

Tirtelis rugosa Tere.

Fayehoteie bette

iyreta 7

Trichilie paluiaa Sv.

?Tears forsee Claca.) >

this Lanceolatue (Crigeb.) "irban

gynomja L, uoralesii (ortecb.) C. Uright

Cassipourea gulanensis Aubl.

L. pa

12. Guarea rani flora vent

Corocladta glabre (Schultes) Spreng.

Li! Dephopeie philippiana frug Urban

15. Hedesia glaucifiore Mirban

?aynonjm Teacorea glaueiflora (\irban) Dritton

26. Vallenie penauia ('rban) vez.

?gmorim Fetesioider pendulum (Urban) Pritton

XT. Piper treleaseamus ?Fitton 7 Yileon

8. Gera Haveifers (T.) coud.

19. Piper snalago

20, Bitte mrieotdes Grtsen,

Sexyda spinuloss Vent.

22. Piper afuneus

Tex ideroxpoides (Sv.) Grteeb.

Tayehotria saleotens ?rban

Fayehotria patene Sv.

Feychotvia sliginosn Sy.

Drunfelaia portoricensia Krug © ?inten

Hecrenium caygdalinut (Deer.) C, Wright

Hyreia berserie Tc.

Tedyosnun arborescens Sv.

Toccolobie Bi

Githereg ius cautatun L.

Tarpinia panieulate Vert.

?racemose Caubl.) DC. 3li--38 are sxal,

Weonfa sintenisii Cogn, ?freee vhich need

Meoria gutapensis (DE) Cogn open sunlight.

ane ares () ?an B, Smith

36. Hguenetie teeunize Urban

---Page Break---

a

tape 3.

Lanes, woody vines vaich grow into the canopy.

?Total absolute density: 0.133 Lianes/n? Rel. density below:

1. Houree glabra ?teen, 28.45

2, ISLS irene cenott ilo

5. Suncgivie reetitiare © 0

i EiSptenie nuetetie (c.) om BT

5. Bentogetta beesiyantia ieee, ho

? SEariteis (sha) ?vision ,

. ci fornia) ?ritton 2

1 Biuease oimeete Oe us

Tata (o0.) Suntec

6, Saatine siete aa

9: Himoew faa ca, 32

SEES SET a repandum (sce.) chotey

Eettoeeper calimoliey (hens) cng 2.9

iloterec atin (0). ot, i

ie

3

Lr ger 3

Clusia actually epipiytic tut with aereal roots

Rajania cords

fkania fragilie

omble ,

Bpiphytes, epecice without terrestrial attachgent, groving on other plants.

Total absolute density (expressed as plants/n if? the epiphytes were brouglt

vertically to the ground): 0.K72 plante/22

?etchomance copiliacers: 1.

?Perieroniens (88) ?er,

Tephrolepie rivularte (Vanl.) vett

Eghoeisaa Flasctfwe (ree) roore

Folypodius lycopedioides 1.

Hpiderdrs app.

Elephowlocsix iugets voters,

ng.

Felle) tee.

Relative density below

reepeoyes

[lie parasitica Jacq.

---Page Break---

LL, Oleandre artieuete (Sv.)

we Hig gS Herainieri ("ory ? Fee) Hoore

Elephosiossan

13. Tyeopodius 1isdroltus T.

AG. Heurothantis foliate ?riceb,

Ly, EB, ruseifolia (acq.) . Tr.

18, Fhoradendron piperoides? ('!.

19 Gumeenia Tingulate (L.) ten,

20. Gatopsie floribunda (Srongn.) L.P. Smith

21. Tyeopodiue funiforme tory

22. pichonance punctate Poir.

23. 7. erispun 1.

2, Boiypodium polypotioides (1) watt

25. Hlapholosew: pteropus C. Chr. Ind.

26. E spoiun (raulf-) foore

27. E, flaccidua (Feé) loore

-K) rel.

37. Keplentun cuneatun Lan.

38. Jaguinfelia glotosa (Jacq.) Schlechter

BB: Grpthidion cocctanm (saca,) Satise,

Bolyetanye extinctoria Fen).

it) Rosas Sst

Uo, Bpidendrun coryuboeam Lindl.

43. Epiderdrus sp.

Nerds (reproducing ground spectes)

Table 5

Total absolute density: 1.4h herbe/n®

Density including seedlings: 4,16 plante/a?

Totmanthue patiens (Sv.)

Pilea krugit roan

Dryopteris deltoidea (Sv.)

aethrostylidiun samentogun Pliger

?Hisophiia boringueria Maxon

Peperouia esargizelia (Sv.)

Polypodiua duale Taxon

Erythrodes planteginea (L.) Lindt.

Belaginella krugit ?Weren

?Grenosiphon portoriceneie ?rban

Hephogionnn rigidur Chabl,) than

Aithurius doninicense Schott

Baiantus

BBESyosoy repr

we

Relative deneity belov:

oo PEE eo RS

---Page Break---

1h, Anthuriun acaute (Jacg,) Sehott

15. Tegonte decandra Pay.

De

17. Belaginelle portoricensis A.

8) fpteris see (att) Far

19. Exythrodes hirtelius (5u.) Lindl.

2. ?Triphore guringscnete (Linal,) Tritton

21. Hiscoophaerfon persicariaefotius (Dc.) ¢,2. Clarke

22, Fitcairnia anqustifolia (sv.) Reaiute

23. Teliconia bihat

2b, Gonolobus yarlifolie (Schiechter) Fritton

25. Teva.

26. senidentata (Juss.) veda,

21. ?Trichonanes rigidun sv.

26. Danaea nodose (Z) J. 1, Smith

29. D. ellipeica J. £, suith

30. Dryopteris ertusa (Sv.) Urden

31, Dryopteris reticulata (L) Xaule.

32. Potybotraye cervina (L.) Kault.

33. Huipidopteris peitate (Sv.) Schott

3h. Jephwolepte tuserrate (Sv.)

5. ?To determine the effect of irradiation on leaf fall, 179 lov understory. trees vere tagged and the leaves counted on one branch Of each plant. All low ?trees were tagged inside thirty meters in the area being irradiated, Many Palicourea riparis ani lirtella rugosa vere tagged outside thirty metere in the site being irradiated and in the control eite. All tags vear the letter ", Posteirratiation leaf counts will shov leaf fall, ?These data can be ?compared with leaf fall data being collected in the canopy trees.

6, Some soil moisture data vere taken to determine similarity or aiesini-larity of sites. Soll was collected after three days vithout rain, A ?temlency was foind tovart less soll moisture on the ridge eites (centers

I, If, ant TIL) veroue the poorly-drained, palm dorineted areas. Some statistical significance vas established (Fig. 7), Areas of coil sampling are drava in Fig. 2.

---Page Break---

5h

Note to Project Participants: ?his is the List of higher plant species in the

FL Verde stuly areas. ich vork has already been recorded using the code List

in lest year's (1964) report. This nev List corrects error in the earlier table

fand Inelldes nane changes nov being recognized in taxonomic vork such as in the

?papers by Janes Duke and the new book by Little and Vadsvorth.

To avoid confusion on the project we suggest thst the whole latin names

?be used rather than the code (except on the IB cards). Renenber that the 7000

alurinun tags on the trees may have the older name. HTO

maple T

List of Connon Plant Species of El Verde Radiation Site,

Symbol, Latin None, Spanish None, Laportent Synonyms.

Changes mate fron lest year's report ere underlined to ald those making corrections.

Alsophila borin

Anthurtum doninicense

Alchornes latifolia

.quena ~ Palnilla grande

abe

me

mi: Achtotitio

Ap ~ Alchorneopsis portoricensis - Palo de galline, (palo de pollo

Be Racenavin capitate = Grapaainio ot

BL = feteropterie laurifolta (Sanisterta 1.) Bejuco de gonsora (vine!

Be - Hyrsoniza coriaces (3. spicata) Yaricao auarillo (N. colorado)

Ca = Casearia arborea Reto de ratén

Ge = Contfa boringuenefs "Palo de auteco ?)

Goi Casesria bicolor Talantrén o vero de Sapo (Yunquea

Ge - Guatterie carivace (Cenanga e.) Tidn=tide

Cep- Gecropia peltata Yogruno hembra

Gg? Casearia guianensic Talo blanco

Gig- Clusia guntlachit Cupey © Cupettio de altura

Cog= Concclaaia glabra Carasco

Cp ~ Croton poceflanthue Sabinbe

Cpa- Casstpource quianensis (C,alba) otro Teta de turre

Gr = Gyrilin racenifiora Talo colorado

Cs = Casearia sylvestris Palo de cotorro (Palo bianco)

Csq- Celycogoni squamlosum Jusilio © Canasey justiic

- Cordia euleate oral

5) De - Doliocarpus calinotdes BeJuco de agua (vine)

+ Dacryodes excelsa Tabomico

= prypetes glauca Varital (cafefito)

= Didyzopanex morotatoni ?Yagruso macho

= Dryopteris deitotdce Palnilla peaueila

= Daphnopsis philippiane MaJagua de sierra

= Raterpe globose (Frestoca montana) Paina de oferra

7 Tnesoce Sepania (Exogonism Fepandan) Selda conevelda

+ Bigenia stenii! Guayabote

Securidaca virgata (Elsote virgata) BeJuco de afen (vine)

?rigonata (F, oressinervia) Jagucy coloraio

SPERRIRER ISS

---Page Break---

5

Table 7 ~ Cont.

lous laevigata (F, eltrifolie) - Jaguey blanco

Guares trichtiiotace (6. guara) Guaraguao

Gucttaria Iaevie Cacubano

Guarea ranifiora Guareguaslo

Henrietells fascicularis Tipo de casey

HonaLiun recenosun Caracolillo

Hirtelia rugosa Teta de burra

Inora ferrea Palo de clavo

Ig - Ardesia glauciflora (Icacorea g.) Ausubsn

11 2 Sige Tnubiea (ings fast fos ia) ?ona

Ip = Iohnanthue? pallens

Inga vera Giava

Linoctora doningenis (Mayepea 4.) Hueso blanco

Lasiantius lenceolatus (1, moraicsii) Mata de peo

Vingnaiia splendens Laurel eabinén

Nataybs don:ngensis egra lore

Nyreia defloxa Cleneguillo

Micropholis garciniaefolia Caingtillo verde

Neliosna herbertit ?Aguacatillo

Manllkara bidentate (M, nitida) Ausubo

Naregravia rectiflora ?BeJuco de pelna (vine)

Miconia prasiza Canasey Sentsosa

Miconia tetranira Canaeey prieto

GRE Ry

FEREEE

By = Neorudoiphia volubilic Bejuco de violeta (vine)

Nnem-Nectrandre menbransces Laurel prieto

Omosia krugii Palo de matos

Ccotea leveoxylon Laurel geo

Ocotea mocchata Henoca o Tez nosesda

Gcotea portoricensis Iaurel de palooa

Gcotea spathulata tenocaé o Nenocd

Fiper amalago Suiguillo oloroso

Faychotria bertcriana Palo de eachimbo blanco

Pullodendron krebeii BeJuco de calabazén (vine)

Puilodeniron Lingulatun otro B. de calabazén

Palicourea riparia. Cachinto coleraio

Paullinia pinnata Be juco de cabra

Piper trelesseanus Jugutllo apestooo

Rajania cordata Bejuco de gudyaro (vine)

Rourea glabra Bejuco de Juan Caliente (vine)

Soanea berteriana Cacao actille 0 Wetillo

Snilax coriacea Hejuco escanbrén (vine)

Sepiim Lnuroceremus vansantlio ; (ine)

Schlegelia brechyantha (S, portoricensis) BeJuco de trapo (vine:

Tetremcgastris balsamifere? Palo de mea

Oe

aL

Os

op

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Pa

BR

Fe

BL

Pr

tp

Fs

Re

Re

sb

Be

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8

B

= Tubeduie pallida (T. heterophylla) Robe blanco

{ae} TprBeichille galuide, corte (Aitophyius cectdentatts)

+ Urera baccifers Ort

&) Wor lallenta peodule (Petesiotdes peniuda) otro Ausubén

ie a2. = oso je nena

cs Wyreia gpendens (Sv.) DC. Oja menuia

> SGasataatata?Birauta (incy.} Sena faynonya Duggenta hirsuta (Jacq.) Britton

RF. Saith

---Page Break---

Manber of Species

per quadrat (64 square aeters each)

Plants

8

Fig 1

Survival before

atlon--4ll epecies

7° Mine te montha 0

Survival of seedlings in the pre-irrediatton year

Surber of tavlivicua

pdivicual gragh of diveraity. plante over 12 dnches,

---Page Break---

---Page Break---

Figs Ul. Soeciesnaren curve for understory oyestes. tt

frets 10 en high to 7 on Dy anes Petween 3.2 and 30 sete

date inctute 1357 Indivieoade,

Pineter clreless

are Tet

Has $6 Specteewnares curve for saplings only. Uadiation ees

Plants 30 to 1hO en high

---Page Break---

?Aceon in square meters

Fig. 6A. Spectes-area curve for canopy trees. Radiation centers plants 10 ox

BH snd over; 725 individuale considered.

500 11000 1500

?Aven in square meters

ig. 68, Spectes-area curve for lines. Radiation center; individuals whose

ten enters the crow} 230 individuals considered in an area with 156 trees.

---Page Break---

seus,

Radiation

Conver

a)

Contre

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Pele area

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Men

Syanoanb ERROR OF

Rana

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a

Progress Report on Seedling Metabolism

ay

arted Lago

?The pregent report includes results obtaized in the study of two. foct groving plant spectes alapted to cuccescional situations at high ght intensities, Anthocechalue cadambs, an inported tree fron rainforests of Asia, ara Cecropis peltsts, a tree found in openings in the Pain Forest,

A, chdauba is being tested for plantetion planting near the Fl Verde site. Date on clinax spectes are being proccessed,

The seedlings vere studied using a Beclnan Infra-red Coz Analyzer Nogel TR-15A and an open system shomm ia Fig, 1, They vere watered before essurenents and leaf area vas dctersined after the neasurenent. Fesulte ?were expressed in grams of carbon/lea? urea/hour.

Since the seedlings were in plastic begs during measurenents, the flow rate of air vas adjusted to prevent abromal effects such as overheating in plant tissues, The effects of air velocity on the metabolism were studied and reaults are found in Fig. 2 and 3. The rate of flv of 10 liters per minute war selected as the adct suitable for high light intensity neastrenenti

Table 1 has sone temperature measurements taken with flat themieters probes clamped on the eaves and recorled on a Rustrak Reoorter. For the

Cecropta seedling the temperature under bigh Light intensity conditions and 10 liters per minute ie only 1 degree greater then the control plant out of ?the chamber. If the flov lo decreased,the differences are then greater.

Continous tenperature determinations vere made on A, cadasba seedlings, and the results shov a sintlar pattern of tenperature variation In air and plant vith a difference of 2 or 3 degrees greater In the ccedlings. These results ?show the effect of using @ plastic bag as a chanter ani e flov of 10 L/ain,

Fig. 4 denonstrates the changes in photosynthesis in relation to Light intensity in both species, TC. Peltata where data are ore complete, ?the pattern ic sinilar to the typical curve that hae been deseribed for Might adapted plants. At high intensities the species is able to maintain a sore or less constant rate of protuction.

---Page Break---

T Taoce 4 Tewrcnaruee

Natomas

Noon

x

---Page Break---

---Page Break---

aay

fei Pas 2

sthetic rate as a function of air velocity tn

Protoayat

plastic begs over leaves of Authocephalus codeabs 3

hy

jeealing:

---Page Break---

5

coctopis,

un

fr

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* aga cer leaver of Cecrupte pebtata secdlinge.

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of eeeslings as a function

Aptanaity (dapiiott)

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6

Progress Report

wy

J. Frank HeComick, University of Horth Carolina,

Departeent of Botany, Chapel wi21 and The University of

Georgia Inctitute of Radiation Feology.

Raddation Dosinetry of Forest,

Analysis of the ecological effects of ionizing radiations upon natural ecosystens requires accurate determinstion of the radiation doses to which Gntivigual populetions and orgenisns are exposed. Initial studtes of this type by Covan and Platt (1)descnetvaced the complexities involved in mont~ toring environmental radiation on a seale appropriate to ecological investi~ gations. Subsequent studies ty Covan and Neinhold (2) discussed the aiffei eneee between theoretical doce rates an] those meacured in air or in a forest. Recent studies ty !eCormick and Colley (3) denostrated microhabitet variations in dose rates ani variations In the vertical distribution of exposure doses ina forest community. These dsta vere conpared with those obtained during {rvediation of an old fiela with the eane 9,200 Curie portable Cs 137 eource,

im thie stuly @ total of 1000 Con-Rad Lithiu fluoride S~7 thermolunin= escent dosimeters and 250 1ithiun fluoride microdosineters vere placed in the fain forest to monitor exposure doses to plants ani anizals. Following [rradiation the S-7 dosimeters vill be processed ty the University of Puerto Rico Muclear Center. The radiology laboratory retained fifteen 5-7 dosincters in onder to prepare a calibration curve for the Cs 137 source. All micro- Goeizeters will be etumed to the manufacturer for processing. Two hundred of these were placed in emall anizals under the direction of Dr. Fred Turner, ?The resaining Fifty vere placed in the forest with S-7 docineters in order to compare their seneitivities.

ape have been prepare! in duplicate vhich indicate the location of

every dosineter in the forest. The maps also list the dosineters ty code to

Sdertity the phase of the study to which they are relevant.

Keeping in mind the problens end results discussed in previous studies

and upon eetination of the requirenents of the nunerous investigations, the

Tain forest dosimetry program Includes seven major phases: (1) A symettical

Grid of dosineters in the experimental and control areas fron vhich isodose

Vince can be prepared; (2) A series of dosineters at varying elevations (b"

in the so12, ground level, 1 1/2 metere, 3 meters, 6 meters, and 9 meters)

?at most of the points on the grid in order to estinete the vertical distri-

ution of dose. Although {t ie desirable to place dosimeters at elevations

above 9 meters in a few locations in the forest, the seope of the study was

[inited ty the investigator's ability to ascend higher into the canopy without

fear of descending at a rate exceeding his limite of a physical tolerance.

(Ye series of dosineters on the front and rear sides of trees at each of

?the elevations listed previously in order to determine the shielding effects

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of individual tree trunks of vartous species and dianetere. These vere lo-
cated at most of the points on the grit. Doeinetera were placea on the front ani rear side of an afditional 100 trees scattered throughout the lover center in order to meet the need of a forest tree grovth ctuly being contucted, by Peter tuurphy; (4) Several hundred doviucters were placed in microhabitate to determine the shielding effects of vegetation, rocks, or terrain upon seedlings or ceeds. These dosimeters vere distributed in paire, one being placed behint a potential shield at ground level and the other near-by within Line of sight of the irradtator, One hundred of these Locations coincide vith 1x 1 meter quadrats vhich are being analyzed in terms of seedling density, Aiversity, distribution, ant grovth. The reauining sites were selected on the basis of visible inspection and upon evaluation of mape prepared by the U.S. Corps of Tngineers; (5) A series of dosimeters et 11/2 meter elevation gnetreling the 10 neter and_30 neter perimeters which enclose the anticipated ?gone of biological effects", These dosiesters were placcd in groupe of 2 or 5) and included both Con-Had TLD S~7 and merodocinetere in onder to compare the censitivities of the tvo types ani to estinate variability between senei~ tivities of individual dosineters in the forest; (6) Docinetere st ceveral points on the public road, st entrance gates, and along the rivere where the Public hae closest access to the areas or vhere people frequently congregate for "recreational activitics; (7) Coneultation and placement of doeineters for special requiresents of individual investigators.

Dosineters placed to nect the requirexents of one phase of the stuly frequently coineide vith or occur near docineters designed to satisfy other phases of the study. ?These replications are of value in estizating varia~ bility and reduce the chance of losing inportant data due to the lose of @ dosineter. A cote systen has been developed to deseribe the location of each Aosineter when they are harveeted at the end of the radiation period. hen a single dosimeter 1s relevant to nore than one phase of the stuly,code mmbers for each phase will be listed. ly erose-listing dosineters in this manner approxinately onc munired replications will be gained for estimation of dosimeter variability.

?The Tropical Terrain Research Detachnent of the U. 8, Amy Corps of Bogineers Vetervaye Experiment Station assisted in the Agfieult job of placing docineters in the forcot.

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MeCoraick, J.P, ant experinental factlitie

B, Golley, Irradiation of natural vegetation, ?procedures, and gosinetay. (in preperation).

Studies of Forest Seedlings

Studies of forest seedlings vere initiated with objectives of: (1) determining the density, distribution, and liversity of seedlings in the experimental and control centers of the rain forest; (2) analyzing the Airect and indizect effects of ionizing radiation upon forest seedlings in terms of the above Listed criteria; (3) determining the extent to vhich Seedlings contribute to recovery of the irradiated forests and (bh) a related Objective of determining the extent to which small ceedlings are shielded fron irradiation ty vegetation, rocks, and terrain,

In order to acquire the data necessary to fulfill these objectives approxinately fifty pemanent 1x 1 neter plots were established in each of fhe two centers. These plots were located in pairs along transects running frea 10 = to 30m on four compass bearings vhtch included mild and severe upeslopes and down-slopes. A2aitional transects run from 30 m to 80 = along ho compass bearinge, one going up Mill and the other downhill from the center. One of the paired plots ie tehind a potential radistion shteld (vegetation, rocks, terrain) while the other is in approximate line-of-sight of the irradiation source.

Initial results of this study ere presented in Table I ani Figure I.

In order to later distinguish between the direct effects of tonizing radiation and the indirect effects due to changes in the microenvironment Of the seedlings measurements vere made of Light intensity, relative munidity, Gut teuperature,'3 m, 1m, ground level, plus so{I and litter temperatures, fat most of the 100 plote.? These instantaneous readings provide date which Qeserite the strength of vertical gradients through the seedling layer of ?the forest. These data are supplesented by eh hour recordings of temperature fant muntaity in one tenth of the plots. These date are further supplemented by constant temperature recordings of 1 week duration in one location along each of the four 10 m- 30m tranceete and ty environmental data monitored continuously fron environmental tover in the forest.

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?These investigations vill be repeated at appropriate tine intervals folloving irradiation in order to describe the effecte of ratiation upon forest seedlings, the recovery of seedling populations, and the contribution of seedling populations to coumunity recovery.

Whenever possible, radiation tolerances of seedlings will be coupared, with tolerances! predicted on the basis of nuclear voluze, hen appropriate, Asboratory studies of seedling tolerances ani radiation and other stresses, vill be conducte2 in onder to @ietinguiah between the direct effects of radiation and the indirect effects of microenviromental change upon seedling burvivial, Lintts of tolerance observed in the laboratory vill be compared with limite of environmental variability in the forest before and after radiation.

Buterpe globoss Populations

?ALthough the rain forest 1s noted for the extrenely high diversity, the Euterpe palm couprizes one fourth of the vegetation. Por this reason the pela gerves as a goot species for autecological studies and evaluation of radiation effects upon tree populations.

In four of the 16 sectors from the center of the stuly area to 30 = all palns vere counted, meesured, and mapped. Similar data vere recorded for transects fron 30m to?8 m in to of these 16 sectors. These date vere collected in both the experinental ani control centers. These studies of pals populations vill be repeated folloving irradiation.

Focults thus far indicate a 954 mortality rate for young seedlings, a 12f mortality rate for established seedlings ana Gif mortality rate for shrub cite plants. Approxinately 1.6% of the palm seedlings curvive to becone trees of the sub canopy or canopy. ?Those trees which do survive make up 1 out of every trees in the forest according to tiadsvorth.

Obeervations of palm phenology indicate thet the trees fruit and flower at ary and all times of the year.

Eetinates of palm bicnaes, proiuctivity,grovth requieents, ant redi-ation sensitivity are yet to be contucted.

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a

The following data are for the forest ecedling etudy. There vere 51

plots ip the upper center and $2 plote jn the lover. Tach of the 103 plots

war Lné, Density is individuals per m? and | frequency is the ?+ of the plote

In whieh? a species occurred.

whe mean musber of species per n® ie:

Upper Center Lover Center

4.08 5.86

?The mean number of individuale per a? se:

Upper Center Lover Center ota,

1.83, 13.01 12.63,

Diverstty determined as spectec/tndividuale 1

cher to 26

whe data for the two centers seen to be quite couparable. This ie

gratifying since Alejo counted most of the plots in the upper center and I

ia most of those in the lover center.

Ada *ovel size clans data vere obtained for uterpe. Toth the a

quadrats and traneecte vere used, ?the date vere quite comparable for each

method. I grouped the plants into 4 classes: seedlings, established seed-

?Longe, shrube, and trees, The data have been converted to? mortality of @

particular ag¢ class and ere ae follovs:

Seeding mortality 95%

Eotatlished seedlings sr

Shrube ae

?hus, only 1.6:' of the seedlings survive to the tree stage

---Page Break---

Table 1. R

Forest Seedlings

Density a2 Pereent Frequency

Species Upper Lover Total Upper Lover Total

Bg = Buterpe globosa 166 3.1 2.62 5 GG

fs. wok 0 ton 2 o 0

Fonarosa, ° 2 1

Ee ~ Fugenta etahlit-Guaysbota 2.33 133 183 T2335

Ab = Algophila boringuena-Pulntlle grande 129 110119, 8

AL = Aichornia Ystisolia - Achotills OO) ° ° oo

up - Trichi}ia pallida ~ Gacta wk an 8

Ap = Alchorneopsis portoricensis-Palo de 112 0 166 o 3

?polo

Be = Tuchenavia capitata - Granaaillo 0 R wr 0 202

Bl = Banicteria laurifolis-3e Juco gona- 620-125 122 10a

dora

Bs = Byreonina epicata-ifaricao coloraio .02 0 wr 2 9 1

Ca = Casearia arborea- Rabo de ratén 102 0h 103.2 wo3

ce = Suatteris caribaca = UAn-lién 0? ° ° o 8

Cep- Cecropia peltata-Grayuma henbra 0. ° ° o 0

Cg'~ Casearia gutanencis-Otro palo o 8 ° ° o 0

?lance

Cig- Clusia gundiachti - cupey o 8 ° ° o 0

Op = Croton poecilanthus ~ Sabino 2 3 8

Cpa- Cassipourea alba - Teta de barra 0) {03 Toho ek

Cr = Cyrille racestfiora - Talo coloraio0 0 ° ° oo

Os = Casearia sylvestric-Pulo blanco 0 0 ° ° ar)

Gel- Cordia evlesta ~ Horral o 8 ° ° 2 0

ss~ Foliocarpus ealinoides 120 0 oe oo

Gy = Chione venosa oe ° ° 2 8

De = Decryodes excelsa - Tebonuco 2 3833 ha

Dg = Drypetes glauca - Cafeilio 6 385 HHL

Dh = Duggena hirsuta oe ° 0 Cec)

DA = Dryopteris Aeltordeas Palntlia 5 ke MB eT

pequelia

Dp = Dephnopeis phillippiane - Najegua 0 0 ° ° o 0

de sierra

8) = Bagenta janbosa Ca) ° ° 0 0

By = Eleatn virgeta ~ Bejueo de Aen 08 5k? 3B

Fi = Ficus laevigata - Colorado ° 102 tok 21

Og = Guarea ep. 39 Bt 5 3

CL = Guttanda laevis = Cueubano 0? 0 ° 0 0 0

He - Henrietta fasciculata Cs ° ° a)

Hor- Homaliun racenosun-Caracolitlo 2.05 hk hog

Hr.- Mirtella rugosa ~ Teta de burre WB toe fae 2 7

Ig = nora ferrea ~ Palo de clavo ° toh oz hoe

TL = Inge laurina = Guanes oun 1b 6 5 =

Iv = Inga vera ~ Guava feo ?lo gw

---Page Break---

B

Density a? Percent Frequency

Spectes Upper lover Total Upper Lover Total

Hgs- Vagnolia spleniens-Laurel sabino 0 = 0 0 eo 9 oO

MA = Matayba doningensis ~ Hlegralors, 05 38 AT BSD

Mg = Meropholis garciniacrolin-Cniuetilio

verde 02 0 ol 2 8 2

Mh - Heliosna herberti - Aguacatillo woe 2 eB

Yn ~ Maniikare nitida - Ausubo 6 2B wm 8§ B on

Mr = Maregravia rectiflora-LeJuco de

Palma ° 2 wl 09 2 2

t+ Miconia tetandra-Cemasei (Prieto) 02 102, 02s 2B

Bw ~ Neorudolpiita volubilis _DeJuco de

violete 90 0 0 o 9 0

0k - Ormosia krugti - Palo xato 2 06 16

01 - Ceotea Leucoxylon-Laurel geo m2 toe lor 2 2 T

On = Oeotes moschato = Sexoca 260g

Op = Geotes portoricensis = taurel prieto ?oh toe 03k 23

Pb - Psychotria berteriana-Palo de

eackinbo blanco .04 ° 2 0 2

Fk - Phflodendron kreteii-Be,jueo de

celabazén ° Co a a

PL - Pitiogendron 1tngulatum o 0 o 0 9 0

Pr - Palicourea reparia -Cachinto colora-

ao 06.29 hoa ow

Pp -Puinie pinnata-Be Juco de cabra 020) 2 0 0

Re ~ Rajanie cordata-cuayaro oO o 0 0

2g ~ Rourea glebra-Pejuco de Juan

Caliente 2 2 4 aS

Sb - Sloanes berteriana-Cacao mortilla 65169 67-1638 AT

Se = Satlax cortucea-Lejuco escenbron = 110, ML 6

Sp - Skelegelie portoricensis-Be Juco de

?trapos 0 6 oO 0 0 0

T% - Tetranogastris balsanifera-Pelo de

Vase 12 e 8 6

- Tabeduta heteroptylla - Roble blanco 2 6 &

© = Cordie boringensie wow 6 6

Mp woe 7

De = Didymonanax @ oo 4

Da = 2 09 21

aan = 2 0 2

Me = 6 2 &

Caliente o 6 8

PE ~ Piperctreleaceamm o % 6

Fe wo 2

Hasse blanco w 2 6

Be 2 0 1

As = 2 0 2

> 2 9 2

tan 6 0 3

Pon wee wg Ba

S4 ~ Mato © payo ° cr a

Palo Guara guao ° we fl 0 2

Ryrsonina - Bs-sp ° we fl 00 2

Taurel anarias ° we fn 0 2 2

Carratoe ° oe fr 0 BT

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species

Species

Seedlings ~ Fi. MeCormle

5 10 30

Individuals

Macroscopic Fungi ? GT Cowley

Fl.

Th

Redia'hion ceiltn

beter radicion

Individuals

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A SURVEY oF wu PUES.Y RRGT

Couey,

University of South Carolina

Tm late July an carly August, 196h, a emvey of all detectable fungus frulting bodice vithin a 10 meter raliue dnd out to 30 acters in four sectors (UAiiE, E-ESE, 5-851, UAWiN) in both etudy centers vac made. ?Thue a total area of 917.46 square meters vas sampled in cach center, All detectable fruiting Bodice ?vere eounted ani identified as nearly ae posedble vith the facilities ae band.

?Three hundred eixty cight fruiting bodies representing 66 aéfrerent scler vere detected. ?Twenty three of these vere common to both centers, all vere fount only in? the south center and 19 only in the north center (table 1).

?The spatial distribution of cach entity in cach center was determined ?ac follove: 1) ?The Frequency of occurance of each epecice in each center was determined by calculating the percentages of uarked scetors (i.e, V-HE, MEH BB, etc.) tn vhich it appeared. 2) the density of each species in cach center wa determined by dividing the muber of individuals by the musber of sectors senpled, 3) Expected denetty vac determined frou a modified Fracker ant

Brigchle table relating frequency to density (Curtis and Cottan, 1962). hk) Observed dencity (b) divided by expected density (a) yleide a figure for the degree of aggregation, A species was considered to be aggregated if the D/a ratio vas 2,00 or higher and ranton if below 2,00,

?Te majority of species vere determined to be rantonly distributed, ?Mose aggregated in both centers vere "2 6,8, and G5, Those appearing In only one centers vere j*s 21, 54, 59, 64, and 65 in the north center and 26, 30, 31, 35, 6, 49, and 61 1 the couth center. Those segregated in the north center and? randox in the south center vere "85, 15, 43, sly ana 5f vhile "5 60 and 62 vere aggregated in the couth center snd rendoa in the north.

?Two reasons for aggregation may be recognized, First many fruiting bodies nay have arisen from # ingle wyceliin or mycelial network, ant second a particular species ray have had an affinity for a particular substrate type. The latter would seem to be truc for spectce ;*e 6h and 66 which vere found exelusively on pala litter,

?The siudlarity between the populations vac calculated using the formula 2u/keB X 100 (Curtis, 1959) weere A is the total of the sane value for the south center, B tz the sane value for the south center, and w ie the species fand frequencies in comon between centers. This if the index ts 100, the populations are identical, and if it is 0 the populations are totally Aiccinilar. ?the index of sinilerity betveen the populations of the two centers vas exactly 50.

Figure 1 shove the diversity curve for ungi as eneountered when counted

by eector. See P. Th.

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Latter Decemposition Fungi

A socou ativly var initiated in the forest to determine the succession

of mierofimg! on decaying Leaver of Ducryodee excclea, lisnilkare nitide

Groton poeceianthus, Cecrople pelteta, Sloanes berteriana, and Huterpe globosa. Seen hetise Litter SF care BP tices tee apecice wer coilected anf an air Gried and weighed amount vas pot into litter bags. ?vo bage of cach specice were frozen, and 10 bage of euch epeciee were placed at 11-12 meters from the centor of each study center of the forest. Duplicate bags are taken in and frozen cach month until irradiation ic begun, fnothcr similar set of bage 1s to be placed fut at the veginning of irradiation, end another inncdlately after, These sets Will be harvested av the first.

?The contents of these tage will be weighed and populations of microfungt isolated from each to attempt to correlate the fungal populations on each epecies vith the stages of decomposition before, during and after irradiation,

?able 1, Hane, location, and eubetrate of each fmutting boty type detected.

Fo Pngus Fruiting Dodiee Seon Substrate

orth South Total

1. Tyeopenton pasitiun a a e

2. Amellaria sp. 6 wb a

3. Irpex farenaceus 1 2 3 a

AL quricutaria sp. 6 6 a

5. Polyporus ep. 2 23 a

8. tarasmue rota 9 wb Y >

T. thmmlarie sp. 5 1 6 a

8] Peathyrella diceentnata 2 1 3 >

9 Vinmmula earls 2 2 a

10, Leptota neueina 3 3 e

BA. reams? olneyt a B »

az 4 307 e

Be 1 1 .

a L a a

15, Crepidotus matachius B 2 4 and

36, Yylaria ep, 3 5 8 a

Vf. Collybie abundane i 1 »

18. Poria sp. a 12 a

a9) Polyporus ep. a a a

20. Collybia temutpee a 12 a

fa! ygropnorus ep. (") 3 3 >

22, Crepidotus milits L i

23. Coliybia ep. a 1

zh, Inocybe <pl. 1 1

25. (Agaricales) 2 2

26. Tricholone sp. 7 7

27, wylaria op. aoa

---Page Break---

2 Pungue

28, iaramun detactans

29. leptonie #0.

30. (Geterotersatetes)

31. (Agaricaies)

Bo) Sterium op.

3. Porta ep.

35. ?Mtelephora ep,

36. Stereum ep.

svolur brazilien

38. (agaricates)

30. liyecna hacnatope (~)

Bo. clitocybe deatbara

BL. Yutinue canine

42. iebelona ep,

23. oyeena en,

AA Clgarteates)

5. Cortinariu deceptivus

46. Clavaria stricta

We. Stereum sp.

48. Stereum ep.

49. CLitocybe sp.

50. Seh{zophy1lun comme

52. Polyporus pieipes

53. Stereum ep.

5h. (Agarieaies)

55. (renellalee)

56. Peattyra

Sr. 2ycena ep.

58. (Agaricaice)

59. Tones senex

©. Nerarue

61. Mycena atroalba

62. Yaracmae

63. Xylaria sp.

6h. Narasmis ep.

65. clitoeybe sp.

66. Xylaria cp,

1

Fruiting losies Seen Substrate

forth South Total

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vurgese Pub, Co.

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6

Soil, Hoot Layer, and Litter Layer !lierofunet

lane?. ?oter

miversity of South Carolina

A study of the pre-trradiation mierofungal popelations of the litter, root and coil layers into the ?uquille Experinental Forest, Puerto Rico, veer initiated in late July and Auguet of 196).

In each of the two study centers, | camper of soll, roots, and litter were taken at 3.2, 10, 39, ad 55 netere from the center point. ?Serial ail-[utions to 1:1000'of the go{1 samples were made vith oterile dietilled water, ?and serial dilution tc 1:10,000 of root ant litter samples vere made after grinling in q varing i Lewor, One ml, of each dilution was pipetted into each of 5 plates of a modified ?artin's medium (Allen, 1957). the modifi-cation consisted of replacing etveptgsin with iucti® acid to Lover the pil. of the sedivm to approximately 4.5 to ¢Liminate bacterial contanination.

?After sneubation for 3 tol days, colonies on the plates were conted and

the tetal population of fungi per gram of carple vere calculated for each sample. ?hen 30 random ieolates vere trancferrea fron each sample to tubes of malt extract agar, incubated for one veek,aré sorted into separate entities dy cultural characteristics, The mmter of isolates of each entity fron esch ?sample vas recorted, To isolate less abundant, but more resistant foras (particularly Asconycetes), a portion of cach campie vas treated for two minutes with 65% ety! alcohol. A suall enount of thir material from cach earple was placed ina sterile petri ain, and vam modifies artic's medium vas poured over it. After incubation for 3 tol days, 10 isolates vere taken fron each sxple, With an attenp* to leolate as many different foms as poceible. These isolates vere then trested as shove.

cultures of each entity isolated vere retumed to our laboratory at the Univ. of South Carolina for identification, Although there is a great deal of vork yet to be done on identification, 1t 4s possible to arrange tthe entities for analycis from @ dictributional point of view.

?Total populations per gran of sample as determined from the a{llution plates are found In able 1.

Fopulations in the three layers vere quite distinct, with ky species isolated fron goil only, 10 from reote only, /1 fron litter only, and 17 from 2 or nore layers (Table TT). ?These 183 entities represent 1448 isolates.

A determination of the index of similarity (Curtis, 1999) between layers and centers furrher denostretcs the difference between poptlations

in the three layere and sluilerity between the sane leyere in the different centers (Table TI:).

---Page Break---

A cimilar treatwent of the alcohol treated saxplee shoved siniler results (Tables TV and V). ?These cultures have been kept separate from ?those of the <t2utton plates, however, 1t will undoubtedly be found that some of the species are the tane in the (vo groupe,

hese studies will be followed by similar poet-irradtation studice to detect changes in the popilatious indveed ty irradiation either directly on indirectly.

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Turgese Publighing Co., :linneapolic

curtie, J.

1959. ?he Vegetation of Haconsin. ?he Univ. of Wis, Frees,

Yadicon, ?ite.

?able I, Range of populations cf fungi per grax in samples taken from

soil, roote, and litter in each etudy center,

center saver

so. foots

ortn

Vida. 2 x 103 1.6 x 109 1x 109

Wax. 85 x 103 11.05% 10> & x 109

south

ian. 3x0} 2a x8 Lx?

vax, 93 x lo: 119 x 10? 7.95 x 10?

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&

able IT. Frequency percent of isolates fron asiution plates by layer and study center.

Code msber Soil Rote Litter

A

?oriehoderma ep.

lomodendron viride

PenieilLiun ep.

Aveldia butlert

aSBBEBRIESEY |e

BSSSBSBVaVsVayysos sas sys soy 2as3e

Yeast

18.

2

: ae.

6:

Trichoderse sp. 38

Fenie{liiun sp, 6:

12:

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Penietitun ep.

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Pendet1liua

Aspergillus niger

IPSSLBEESSS

3

Tarp aaaaaa: ant: BBa: 8: SEBBob

nm

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a

Cote munber Sold Hoots Litter

orth South __Yorth South __Yorth ? South

B.

Te

16, 6.25

6. Reniciilium multicolor 68.75 62.50

13. Aepergillus japonicus 43.75 10.75

143. Fenietilium 2p.

ue!

126.

ier.

136.

a8,

133,

uz,

lk; Pentetiiien ep.

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&

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Spectes distribution azong the alcohol treated samples.

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- Gable Y. Matrix shoving the index of einilarity for each set of saxples.

- Soin Boots jitter

orth South orth South __Horth South

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?orth 13.0 16.2 Ob NL

Litter

- South 3.2 83 2.2 36.7 33.9

Cireust of Optical Density Device

?The circuit of the portable optical density device vhteh vas developed vy the project in collaboration vith Tropical Terrain Research Detaciment - of the Ustervays Hxperizent Station (San Juan) 1s dram telov. This device hae now been used in various systems throughout Puerto Rico. For the theoretical discussion see the 1964 report, the paper ty H.T. Odum in 2963 - Gieti. Acad, Sei, 49:429-434), and i. Monel ana T. Secki 1n 1953 (Japan J. Bot., 1:22). The portable device in ite final fom involved contributions of George Drewry, Willien Helmut, W. Rushing, Robert Benn, and H 7. Of.

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- © kxeun cot

set Pon'pste

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WICROVIAL DEYSETY AD ACLYESY OF SE LOVER CEER

December 15, 196%

Martin Witkesp

nk Bdge !ational laboratory

Merobial population deneity and activity vere characterized for the top 2.5 cx of Litter ant sofl at 10,20,30,45,60,00,100, and 150 m fran the source. The transect rune from Zo to FE,9p uphtll in Line of sight of the source. A topographically sbteidea control. vas located tn the ane Alrection at 150 m fron the eource, At each distance from the source two sanples vere taken, one in plain sight of the source, another cloce ty. Yehind a large rock providing at least 25 oa of shielding and over 90! attenuation. The transect enables characterization of 1) pre-irradiation levels and variability at various distance fron the source 2) trends along ?the transect uhich viID have to be corrected for in order to evaluate radi-ation effects ani 3) radiation effects at various distances. "he paired samples enable afaitional evaluation of direct radiation effects on the microflora without secondary effects from changes in vegetation and fauna, Paired mensurenente at each sampling distance vere made of organic xatter, and moisture content, pl, fungal and bacterial densities, and Op consumption. In addition CO, production was meagurea Uitrinetri¢ally Uf using dishes vith 5 mi 0.1 @tunder inverted metal boxes (15 em dian, 30 fem high) on the forest floor at each caupling site, Paired seasurencnts were made on 10 ni soil cores (23 nm dian., 25 mm deep) using stationary Warburg technique et 30°C for Op consumption, and 1 g of wet soil dilution plates vith pepton-dextrose agaf and nutrient agar for fungi and bacteria Feepectively,

To evaluate radiation effects on microbiota below 2.5 en the sane meagurenents as on the paired samples vere nade on cores from 2.5 to 5.0 cm Gepth taker between 10 and 30 = fron the source, Effects on microben, shielded by 2.5 cx of soll are not expected beyond 30 a from the source.

Increase in Litter production during radiation and possible reduction of microbial activity may lead to litter accumlation. This eituation aay resexble decouposition in the mountain forest with considerable humie formation. To enable @ comparison between the tvo cage of litter accumu-Astion in respect to microflora and microbial activity, neasurenents ac before were made on four soil cores fron mossy cloud-forest from the top of EL Toro.

Results (Sable 1) show for the transect series that 1) there 18 0 significant difference between the projected exposed (1-3) and shielded (5y-5g) series (P.>60)). 2) There are no significant inear regressions for the measured varisbles along the transect vith the exception of organic

patter (Feo5(), moisture (P15) aid Gop evolution (Pel), ell of witeh

inerease going uphill avay from the soubce

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?The subsot1 (25-5 en) coneuned significantly tees Op (P-<2%) than

the top layer (0-2.5 ca) of the transect series, Subcof]?aleo contained

significentiy lees hums and notsture (P 1) and consumed less Op (P=?)

than mountain soll (02.5 en).

Mountain cot) contained significantly sore humus ant noteture and less vacterta (Pz.1:)) than surface soll fron the transect.

his caracterizetion of the pre~{rradiation statue of the microflora wil be the basie for evaluation of airect and indirect effects of radiation Amediately at the ent of the three montis {radiation perica.

Aerial Honitoring of Cama Forest

By Philip L, Johnson

?Ae CREEL = llanover, i

Binonthly photographic missions have been eonducted for one year prior to treatment and will continue during the post-radiation year, Aerial and ground photographs vere obtained vith ¥ouax Flus X, Infrared, Fktachrone and Ektachrore Infrared Aero (C-D) films fron @ helicopter and from 11 permanent pipes within the gama field, Reculte during the pre-treatment year confira ?the non-ceasonal nature of the fovest an will be analyzed for phenological information of specific Individuale, Iesults in the post-treatment year Will demonstrate the vegetation response to treatneat as opposed to normal phenological events, A series of hemispherical photographs of the forest nowy hac permitted direct assessnent of vegetation cover over the 11 sample pointe for ccmparicon with changes due to treatment,

?The serial photography will be analyzed using a microdensitoneter

to associate changes in the photographic pattern vith the gama gradient

Introduced, It may aleo be possible to correlate film densities with

various species or phenological events.

See Fig. 1 on page 815.

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Radiation Genetics and Radiation Botany

By

P.M, 8, Koo and Biith Robles de Irizarry

A, Muclear volume and radtorenastivity

Radiosencitivity is a measure of the degree of blologieal response

to radiation. The cnt pointe exployed in the sensitivity assaying can be cither the lethality, groveh dnhibition, sterility, mutation, chromocosal aberration, plysiologicel or blochenical changes. ?Often, the cause of lethality, grovth inhibition, or sterility im plants io muinly genetic in nature, if the observed en? point can be traced to ite genetic origin, the site of the primary radiation damage must lie in the micleus and then certain nuclear characteristics may be related to the radiosensitivity. Tt has been Aenonstrated that the nuclear voluse, particularly the muclear volure per chronoson? at interphase, strongly correlates with the radiosensitivity in plant epectes. If the grovth inhibition or lethality is ured to measure

the radlogensitivity, £t would be sost logical to study the mclear paraneters An the meristene of the shoot apices because these emi pointe simply reflect ?the radiation damages in the meristems.

In the area st El Verde, a great mmber of plant epectes including trees, vines, fers, rosses, ete. ere known, Within a radius of 30 meters in both experinental cites, some 65 epectes, nainly trees, were tagged for study. The abundance of the material provides an unusual? opportunity for studying the relationship between miclear voluse ond raifosensitivity.

Wo prepare the meristene for nuclear volume meaguresent, the terminal shoot apices were collected ani fixed in Cra® ITT. The soterial, after deing Vashed thorogughly, was proccesed through a dehydration - infiltration schedule using ethyl ant tertiary butyl alcoboic, exbedded in paraffin, sectioned at the thlokness of 10- 12 u, stained vith safranin, crystal violet, and orange G, and sounted. The nuclei of the cells inthe tunica and outer corpus vere measured with an ocular micrometer at a magnification of 800 x, or each nucleus tvo meacurenente in diameter at right angles to feach other were tazen. Por eacli species, in general tvo meristens with 10 tuclei in ench vere meacured ani the averoge tuclear volune was calculated from the nenourenente of individual muclei aesuning a spherteel shape of ?the mcleus,

Presented in Table 1 are the nuclear voluse reasurenents for 66 plant species. Miconia tetrandra has the snellest mclear volune vhich measured. 23.6 u3 and Snilax coriacea the largest, 335.6 w3, The two extrenes reprecent a 1-fold difference in nuclear sizg, Ih the Table there are 33 species with a nuclear volume lets than 100 w, 25 species in the range of 100-300 3 6 species in the range of 200 ~300'u3, and only 2 species over 300u%, Based on the known fact that piten pine and other species heve large fuclear volumes ani high radiosensitivity,

---Page Break---

Table 1.

Muclear volume measurements (in v3) of shoot apices of plant spectes grow

at the redioccology experimental sites at FL Verte.

Specks

Méconia tetranira 6.6

TiLledeta curvate gh

Elsota virgata 83.

Matayba domingensis 82

Sloanes berteriana ae

Conoeladia glabra 3.0

Ficus laevigata 192 7.8

Casearia bicolor 38.0 + 13.5

Omosia krugit Wo.5 4 13.6

Casearia sylvestris 43 513.7

?Alloplylus ovefdentalic un6 $1310

Rourea glabra tart $ lo

Heoruolpaia volubilis wh $ 1klo

Dacryoaes excelea 52.6 § 16.9

Carearia erborea 58.2 $ 19:6

Conia eulesta 603 15.9

?Tetragastris balconifera 62.5 + 12.5

Carearia gulanensis 64.0 £ 9.3)

Cassiepourea alba 64.8 #116

Gusnania Linguls 61.7 3 18.0

s0cates portortoensie 68.8 313.3

?Rheedia acuninata, 6.4 2 15.8

?+Homalitus recenosum 6k 2 12.3

Guettaraa leevie 6.7 5 963)

?Tabeduia heterophylla 323 § Baa

scyrilla racenifiora 75.6 39.8

Mangifera indice Trek Be

Inga laurina pit ick

Cecropia peltata 80.3 1219

sBugenia stanlii aie 272

Ixora ferrea 6 : 13.6

shiconie prasina 93.6 3 18.9

Piper treleaseamin gh. 3 21.9

titeonta sintenstt 100.0 3 2h.2

SMéeropholis gareinaefolia 300.3 $ 20.7

+Ocotea leuecxylon 101.8 25:

Drypetes glauca yo1.g ¢ 19.5.

Guarea guara 10210 + 20.6

Paullinie pinnata qoeie $13.8

Buterpe globose 303-7 $27.1

Banteteria laurifolia zit 3 26.0

Bxogontun repandum agi $21.6

Digyropanax soroototont ab. 3 27.6

Note: These nanes are besed on the old table and have not yet be converted

to nance given on page Sk, Sone of these grov at the El Verde station but not

setually in the reliation center.

---Page Break---

sucleer

Specter vole + SF (u3)

Alchomeopsis portorricensie us. =

Iyreonina spicata weak

Prychotrie berteriana 330.9)

Thylodendron Lingulatus 3-2

Roystonea berieriana iN5.6

Pryledendron krebett N63,

Cananga cartoaca aga

Daphropsis philippians 118.9

Anthurium deninicens! 3

Ccatea moschata. 18.7

Skelegelia portorricensis ais

VDuchenavia capiteta 161

Palicourea riparia 176.5

kara nitiaa 179.3

Fajania cordata 159.2

Alehornes latifolie 219.2

Drypteris deltotdea eer.

HeLioena. hevbertit 1.6

Marcgravia rectifiers 232.3,

sCordia Leringensas 252.8

Croton poecilantins 260.0

Magnolia eplendens Bio

Srilax coriacea 335.6

sth only 2 meristem studied

eMeaurenent for dormant nerietens

most of these tropical epceies may be considered relatively tolerant to

Feliation ani cone of then highly ratloresietant.

"me nuclear volume of a epectes often varies with the season, Hore precisely, it varice with the state of the merfsten, Tn thie stuly, & Ruuber of species have been meacurea for Eoth the actively groving and non-fective or slow-groving merieteus (Table 2). The differences in all cases fare very pronounced, The pereent Increases of the actively groving shoot apices over the inactive or slov-groving ones are tron 27) for Contin borinquensisto 157% for Euterpe globo

It is of both theoretical and practical interest to make predictions on the rallosensitivity of the species based on the mclear volume measurements. Rovever, it should be pointed out that the predictions can ve regarded only

fas approxinatione ani they represent only the general range of the sensitivity of the species with that mclcar volume, In this study, the total dose levels That cowl? cause over 90% mortality, 20% and 60," shoot growth reductions

(Satie 3) are predicted ty considering the preaicted and actual doses for

the sane effects presented ty Woodvell and Sparrov for the species in the Sak-pine forest ut Brookhaven, The total doce level for lethality is there fore calewated on the basis of 1-year exposure and that for shoot grovth reduction on a S-nonth expogure basis. Since cur total irredlation period is scheduled for 3 monthe only, the results may differ concvhat fron that

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observed under much longer period of radiation exposure. In

table 2.

on

Percentage of increase in mcleer volume meacurenents of actively groving

shoot spices over inactive or elowegroving ones.

Species

Casstapourea alba

Bugeria etahlit

Miconia prasina

Euterpe glctoca

Pelicourea riparie

Naniikara bidentata

Cordia boringuensic

Muclear volune + SE (x3

Actively groving

shoot antess (A)

64.8 + 11.6

a1. + Ire

93.6 © 18.9

ere

3h

316

262

?Table 3.

Predicted total dose levels for 90% mortality, 60% and 20% shoot grovth reductions in tree species with various nuclear volunes grown at 5-137 goma irradiation site at B1 Verde.

tuclear voluxe

BIOyEss }

908 Hortality

dose

a)

198.0

80% groves

reduction dose

Ke)

28.28

20% growth,

reduction doce

SeREoeaaa F

BS

---Page Break---

Ruclear volte 90% Hortantty 80% growth 208 grove,

?dose reduction dove reduction dove

2: i 15 i)

380 2t.0 3.85 Bae

aso 25.8 3.68 158

200 2.6 250 156

210 B05 3.35 353

220 22.5 Bet 1

230 Bue 3.08 tho

ho 20.8 2196 a

250 2010 2185 ths

260 19-3, a5 th

270 28.6 2.65 the

260 18.9 2.57 ca

20 15 2050 139

300 I1.0 pike 138

Ro. 16:5 2136 31

320 16.0 2128 136

330 15.6 2122 135

30 i.e eat 335

?adaition, other factore such as biological ant inaninsted shieldings could

?algo contribute mery discrepancies to the predictions. Above all, the standard errors for the nuclear volune neasurenente are relatively high, so ?the predicted dove for each of the effects may very Well vary within 220% even though other factors are not considered.

A count of plante in each spectes Killed by roiiation vill be made son after a 3emonth expocure and at intervals thereafter Tor a period of about one year. Teeause the nunber of species is large only a fev species can be found within a small area close to the reliation source vnere the total accumiative dose is high enough to produce the killing effect. For the species vhich have sone killing ant alo are abundant in the area, their response to radiation may De studied at ali dose levels. But for others, only the low-dose effects aay be sesesced.

for the grovth inhtb{tion neasuresente, two studies, one on shoot grovth reduction and the other on trunk elreunference growth eduction, have teen initiated by other investigators of the Program. Their results certainly can be correlated vith the mielear volune neagurenente to check ?out the validity of the prediction,

However, the most critical information on the radfocensitivity of ?these specice must conc from irradiation experiments perfored under controlled conditions. In this type of study, acute gama irradiation can be used to study the curvival ant grovth reduction of seedlings in the ereen house.

Seeds of several tree species have been stuiicd for their germinability and the most serious problen #0 far encoutered has been the poor and uneven germination, Inprovenent in methods of germination may be found after further testing, at least for cone of the species. So the radiosensitivity for a selected group of species can be stulied.

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B, Hose Investigation

Dr. Ul, C, Steere of the ew York Botanteal Ganten collected ani tden-tigiea 25 epeoice of nocces in the rainforest at FL Verdc. Preliminary regulte on the nuclear voluic eacurenente for all 20 species have been obtained. ?The range varies fron approximately & ud to 1h0 3, indicating

| 35-fold aifverence in volune betueen the two extremes. A nuiber of species Show that the nuclear volume taken fron the base cells of the top ?leaf? is quite difterent fron thet of the lover "leaf", In some instances, 10-fold Aifference in volume is observed. Tn general? the cells fron the top ?eat? have larger ruclear volune, but thie is by no means the rule. For a fev epectes the apical pointe have also been studied for the nuclear volune.

?The meacurenente eppear to be conparabic to the once on the top ?leaf? of the epecics. ?The muclear volune etuly hee been done with the aceto-camine ?squash methoa.

Attempts have been made to culture and propagate the moss species in ?the grovth chanber. Eight out of 20 species have survived and begun to show new grovth. Thig survey would help to detemaine the feasibility of radto-Seneitivity study ¥ith mosses unier controlled coniitions.

(-Made investigation has been assisted ty Robert Venstor)

Bronelied Investigation

?ho epectes of Broneliad collected at EL Verde vere irradiated vith gama rays at doves of 0, 3, 6, 12, 2h, WB, 96, and 192 kr. Ten plants

from each treatenent for each species were planted in the shaded greenhouse with ample mist epray. At the end of one month folloving irradiation, ol] plants of both epecies that received 192 kr died, The plants at intermediate

Goce levels showed sone browning and spotting. There vee no apparent sign of any radiation damage at lov dosee. At the end of 2 monthe, 5 and 3 plante fof the broai-leaf and narrou-leaf epecies, respectively died in the 96 kr series and one plant of Proad-leaf species died in the 4B kr ceries. At the end of 3 monthe ell the plante of both species in the 96 kr ecries, and one Plant each fron the two species in the kb kr series dled. In the broad-lest Species, one and tvo plants in 1? kr ani 6 kr series, recpectively, also Aled. Tt 1s apparent both epeciee are tolerant to radistion although the vroai-leaf species Je less 60.

Amother set of experiments with the came tvo species has been under vay at the irrodiation site at EL Verde, The plants vere grow on the plates cut out frow tree fern trunks for = period of one tlonth in the shated green= house under constont mist spray and then roved to the rainforest before the beginning of irradiation. ?The plates vere hanged on the tree trunke about 6-6 feet fron the ground at a Aistanee interval of approxinately every 5 neters up to 50 neters from the Ce-137 gamma cource. At each location randonly placed was a set of 4 plates coneisting two replications with 20 plants in each replication for each species. TWo sets of controls vere also placed at two locstions sone distance tron the radiation source. All the

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gh

sete vere tagged vith doeineters. Data on eurvivel and grovth of nev leaves

have been collected on two occassione. Further information vill be gathered

following a 3 month expocure period.

Tale etuiy has been accieted by Robert Venator)

D, Other Studies Flenned

the Cytogenetic effects of chronic ganna irradiation on tree apectes

are of special intercet to us, Flons heve been dravn up to study the chro=

nosoval aberrations in the mlcrosporocytes ani eterility in the pollens of

& celected group of species.

Aso s Limited nuiber of tree species vill ve studied for the rediation

Gunage to the neristene.

?the material for these stulies vill be collected at various distances

from the ecurce, preferably at locations where the dose levels are known.

Gamma radiation effect on chloropiyll A content in Bronelieds.

F, K. 8. Kooy Hs Te Cluny

Baith Robles de Trizarry and Harta De sree

Unter the sane cavironsental conditions the ratio of photosynthetic rate of a plant to its chloroptyll content holds constant ant any change in the amount of chlorophyll in the plant is reflected in the change in its photosynthesis. So an estimate of the photosynthetic rate may be made by ?measuring the amount of chlorophyll. Ionizing radiation te known to affect chlorophyll biceynthesis, In this study, chlorphyll content war assayed to serve as an indirect measure of radiation interference with the photo-synthetic sechanien in the irrediatea plante.

?The broat-leaf Bromeliad plants,1? in each group, were treated with gammanrays at dose levels of 0, 2.5, 5, 7-5, 10, 25, 50, 75, 100, 150 and 200 kr and planted in the shaded greenhouse with about 6 hre. of miet spray ?2 aay, For chlorophyll A? determination, st each collection date leat

---Page Break---

samples, one fron cach plant, vere collected from the control snd each of the SO irradiated series. A single dick in the size of 1 on vas then taken fron tech Ieef using © cork hole puncher, Leaf dleke vere extracted individually

Ie Got acetone, optical density wae measured,and chloropkyll A was computed according 29 svcortencics given ¥y Richarde ant Zicupson. An abbrevigted frocedure wae used involving the deteruination of optical density at 665 Efilinicrone only using the relatively broad band pass of the Pausch and Leck Gpectrophotenetric colorineter. Readings in this instrunent vere calibrated Ging the some solutions ina fcckan marzov band pase epéetrophoteueter accord {ing to Richards ani Thompson's procedures,

Seven collections were made over a periot of 2 months, beginning on the day of irradiation end thereafter about every 10 days. ?Only the youre [eaves were token, ent ell plants vere about equally campled in the whole period of stuly. Starting with the second date of collection, leaves sampled Rene first real on a trensniseion densitoncter "\leleh Densichron? for ASA Biffuse traneniselon densities before leat disks vere taken.

Presented in Table 1 are mean chlorophyll A content (¢/s°) tn voung qeaves of tx control end gama irradicted series. ?The saxples collected on the first date in general yielded about 0.2 g/m? or more except that in the Bo urecricss Samplee collected 1i days later shoved a drastic 50% decrease se eklorepiyll content but further decrease at later collections vere less FHonounced. With the exeeptions that occurred in the firet two dates of Pelicctions, in general the chlorophyll content decreased with increasing SChittion dose, The increase An content at low dose levels es show in the Tecont collection (Cct. 26) nay indicate a stimiative effect. towever, the Skerease of content observed at dose levels of 5 - 150 kr over the control Value at the first collection (Oct. 15) cannot be explained on the same

Yacis ap these cenples were collected Imediatcly folloving irradiation.

Btatisticel analyst indicates that the differences ere not eignificant.

on the other hana, the

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Ca

analyses of vartences for the other 6 collections indicate in each case

the variance ratio of "between treatnents? to ?within treatoonte? 1¢

Righly significant, Since the date in Table 1 also show that the chloropryl?

J eeontent generally decreased as the Length of tine the plents groving under

fhe shaded greenhouse conditions increased. The results from the statistical

anslysee indicate thet in all casce the variances for ?between collection

dates? over that fer "within collection dates? are highly eignificant. At

Gach collection, alfficulties in sampling the young leaves of the same age

Sere encountered. Aleo on gone occasions some necrotic tissues were included

Tn the sampling as the browning effect spread over the leaves at high dose

Ynvels, especially at later collections. These Tactors might have contributed

to sone of the unexpected irregular variations in Table 1, Also it should be

pointed out that at the end of one month following irradiation, all plants

Bt the 3 highest dose levele vere nearly dead or completely deoa.

?the mean diffuse transnission dereity readings for the leaves collected

for chloropiyli A determination are presented in Table 2, The readings, almost following the came potters as for the chlorephyli content variation,

Gecreaced as the doses and the daye grovn in the greenhouse increased. The

Geadings of the inlividual leaf samples vere used to correlate with the

chlorophyll A content of the cane sample. The results

?able 2

Mean diffuse transndssion density readings (with Welch Densichron) of young

Jeeves of control ani gamna-trradéated Sroaelia? plants collected for chlcro-

phyll A detersination

?Treatment Gollection date

gona rays,

inkz) Oct. 26 tov. 4__Movs 13 tov. 2h Dee. b__Deos 2

° 0.57 56 0.58 0450 OME ONG

20 0:65 0158 (OG 0154 kB Osho

5 0160 0.52 (0.63, 0.62 ol5h L951

us 0.61 0153058 0158 0:52 0.80

0 0159 15k 0.58 0.87 onl OLkG

25 0056 0153 0.55 ona 0500.38

2 0156 or5e Oh ont 0:36 o.ho

6 0.59 onl OLhT 0138 nhs

200 0.58 onky 0153, 0136 0136

150 0.52 only 0131 0:36 0138

200 nhs 0:39 (0.32 ork orig

of the correlation stuly for the gamples collected at cach date sre presented

$n Table 3 ani the r values in all cases are highly significant. Therefore,

the diffure tranmmesion density determination may be substituted for the

fll Adetersination which eppears to te mich more tedious than the

Densichron reading.

---Page Break---

oe

in conclusion {t may be stressed thet in general ganna radiation at

a dose level of Soke or Mgher produces 8 profound danaging effect on

Chlorophyll biosynthesis in Broseliad plants, and that no recovery from

Fedlation danage vas observed at these high dose levels. Hovever, the

Plants that recetved lover doses tened to recover at later date,

?Teble 3

correlation between chlorptyll A content and diffuse transmission density

feuding of iniividuel leaf samples of control and gamea-irradiated Broseliad

Plante collected at 6 dates.

Coltection No. pars:

?ate of values

oct. 26 hy

Yor, a

Yor. 33, a

Nov, 2 a

Dees # my

Dee. 15, 28 0.508

¥etgniticant at If level.

ote: ?The thin leavea bronelio?s are very young infividusls which

Tater develop brosder leaves. The population in these

experinents vas a mixture of Gumanta and Trichouanes.

---Page Break---

8

Chromosome relations in the Insect Fopulations of EL Verde.

Rilo Virkt.

oytogeneticist

Agricultural Experinent Station

Alo Pledras, P. Re

Since the last report, work could be continued vith Phasmids only.

1150 permanent alidee vere made fron l-5 species occurring in the irradiation ?area, The material vill be stuifed in detail efter the identification of the specinens has been arranged.

In most epecinens, 1x (male) or 14x (female) 1s the meiotic chromosome number, In one eingle epecinen was o naturally occurred chromosomal rearrange-nent detected, The epecinen ves heterozygous in relation vith an autosomal centric fusion, the number being: 15 bivalents + 1 trivalent + X.

Frog loise Progress Report

By George Drewry

?The record of frog nose nov includes a complete annual cycle. Tt is interesting to note that the Vinter of 1964-65 hac had the sane effect or the overall activity pattern as the Winter of 1963-64, although the 63-64 vinter was much drier. in addition to the equiment deccribed a second frequency has been added to the one used in the stuly of Hleutherodactylus portoricensis. The second frequency wae chosen to be the doninent sound of tvo species, E. hedeikt and £, eneidac, The occurrence of considerable sound from E. porto Ficensis at thie frequency requires detailed analysis of the record to separate fhe other tvo species. Preliminary analysis combined with field notes suggests that these species use tine separation to avoid interference under normal cireumstances, A definite deciine in the activity of E. hedrikt precedes the Gevelopaent of the peak sound intensity of E. eneidse, vhose principle activity occurs after midnight, A detailed anslysic of call structure in these and Several other species ie nov under way, vith plans for developgment of multi-channel recording inetrunent plotting each species separately.

---Page Break---

cytological Stuay of Ferns ant Fern Allies

in EL Verde

by Veikko Sorsa

Associate Cytogencticist

Institute of Genetics, University of Helsinki, Finland

Eighteen different species of ferns and fern allies vere registered in the Project Areas by me and uy vife rs. Marja Sorsa in August 1964. Material for cytological studies vas fixed? from all species found in the nelotie stage. In ease the chromosone mumber could not be counted from materiel fixed fron the Project Areas, it vas determined fron material of ?the seme epecies collected around the Project Areas in El Verde, Microscope preparations vere male and the investigation vas carried

out in the Institute of Genetics, University of Helsinki, Finland. Canera

{ueide dravinge have been made of the chromosomes of the species studied,

Puotomterographe have been taken of the eytologically most interesting

speci

?the herbarive specinens of the collected material vere kindly named

by Dr. R. Woodbury in the Agricultural Bxperinent Station, Rio Piedras.

Obeervations

Center:

Distance None of spectes Chromosane muber counted

from the

center From Project Area Fron outside

3.2m oF Adiantum eristatun 1. chromosomes not countable

less Alsophila borinquelia Maxon n= 69+ 70 n= 69

Dryopterie deltoidea (Sv.)Kuntee n= nol

3,2 - 10m Polypodiun chrootes Sprer

?chromosomes not countable

Dryopteris deltoides (Sv.)iuntce cs

ne

" Alsophila borinquefis Maxon n=

" Flaphoglossun flaccidum (P&e)Moore aah

10 - 30m ?Aleophtle borinquefia Maxon n= 6

Dryopterie deltoides (Sv.) Kuntze neha

?AMientun cristetua L.

Elaphoglossum flacesdun (Fée)Moore

Hephrolepis rivalarte (WanL)Nett.

Oleandra articulate (Sv.) Presl.

Espleniun cunestuz Lam.

Polypoditun ehnoones fring

---Page Break---

00

Henttelia horride (L.) R, Brs, Spreng. n= 70 n= 69-1

Trichouanes captiiaceun L, chronosoues not countable

Lindsees uontana Fee ?chromogoses not countable

Hlaphogloesum firm (Mett.) Urban n= kL a ML

30-80% ?Alsophila borinquefia Maxon n= 69 n= 69

Polypodiun 1ycopodiotées L. chromosomes not countable

Henitelia horrida (U.) R, Bre, Spreng. n= 7D

Hypolepis repens (Le) Presi. a= 39

Bleshnin occidentale L. Bs oh

Lyeopodiue Linifoliom 1. nec, 140

Tycopodius dichotomun Jacs. ne 132137

South Contre) Center

Distance ane of spectes

from the

center

Alsophila borinquetia axon

Dryopteric deltoides (Su.) Kuntze

Rephrolepis rivularie (Wahl) Mett.

Alsophila borinquefia Yaxon

Dryopteris deltoidea (Sv.) Kuntze

Gleanira articulata (Sv.) Presi.

Polytuentum feei Maxon

Asplenium cuneatuz Lam,

Danaea nodoea (L.) Sith

Lindsaca montana Fée

10-30 ?_Dryopteria deitotdea (Sv.) Kuntze

: Elaphoglossu firmun (Nett) Urban

. Elaphoglossun flaceidun (Fée) toore nek

30-80 m ?Alsophile borinquetia isxon ne

" Blechnun occidentale 1. ae 6b

" Dryopteris deltoidea (Sv.) Kuntze nahh

Species collected closely outside the cirele of 80 m.

Spore and ganetophytes of these species may possibly be fount from inside

of 80 nis eirele on the Project Area as vel.

? - 300 m ?Nephrolepis biserrata (Sv,) Schott a-k

Duyopteris reticulata (L.) Urben nee

Polypodium astrolepis Licba, ast

Polypotiun pectinstun L. nT

Polypodiun piloselloide: Le a= Th

Asplenim abseisoun Willd. Be uh

Acplentum salictfoliun Ly ner

Dryopteris decussate (L.) Urban n=

Dryopterie chaerophylioides (Poir.) C. Chr. aah

Dennstaedtia ordinate (Kaulf.) Nore nel

Folypodiun taxifoliua L. nat

Folypodiun aureun Le ne Th

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aon

Noct of the fern species collected from the Project Areae have not been

cytologically studied before. Only three are previously reported in cytological

Literature: Ghendra artiowlata ® = c. 1hh ty de Litardiere 1920, Celle 31

255cI73; Aopleniun cuneatue n= ¢.72 and n= ¢.216 by Hanton 1959, Alston 195;

?5-61; ond Blenchmm: occidentale 2n= c. 124 by Abrahan et al., J, In. Bot.

Soe. fa: 339-He1.

?The chromosone rusher ne72 found in one specter of Dryopterte (D.

Aecussata and D. reticulata) is intererting, because it is quite different

from the numbers n= hi and ne 82 previously counted in the fera genus Dryopteris.

More dctatied reports on chromosome conditions in Puerto Rican ferne vill

?be published later by the author.

Susasry of Pre-trradiation Chlorophyll Measurements,

(Olu, Harta De Arce, lurphy)

On each of the folloving trees, lO leaves vere analyzed for chlorophyll,

10 nev sun leaves, 10 nev shade leaves, 10 old oun leavee, and 10 old shade

Leaves. iusbere are thoce on the tage in the field, sehes Hadistion Center South Control Center

---Page Break---

02

Report on prelininary survey of bryophytes of EL verde

sites, before irradiation, Deceuber 11-16, 196h,

Willian C. Steere

N.Y. Rotanieal Garden

?he investigator, ?llien C. Steere, and ais assistant, Dorothy 0.
Steere, arrived in Fuerto Rico on Decenber 10, and spent December 11 through
26 in a survey of the H1 Venie sites and December 17-19 in Rio Pledras, in
?supplenentary studies,

Fecause mosses turued out to be song the most reeistant plante in the
Brookhaven experinents on the effect of Cesium irradiation on oak-pine forests
on Long Zelan?, I was pleased to be invited to participate in the pre-irradi-

ation survey of the tropical rain-forest near El Vere, in the Luquitio Nountaine of eactermort Fuerte Rico. Whether it ts the emai nuclear volwe Of the moss cell or sone other factor that giver noses their unanticipated resistance to lonizing radiation is still not known under ery circumstances, it to surprising that a haploid plant chouli be resistant at all because of its lack of duplicate genes ani a resultant reduction in genetic resources.

Activities. The upper snd lover sites vere vieited on Deceuber 12, 12, 33, 15,and 16, and Saith's "equal area" site, below Site 1, was exasined on Decenber 1%, ?the forest sbove the sites was visited several tines, to gain a better understanding of the vogetation as a vhole, ani the transition from ?the souevhat reduced montane forest to the high rain forest. December 2b was spent largely in the montane forest about Mt. El Toro, southeast of the El Verte area,

Procedure, In the sites thenselves, careful notes were taken on the bryoplytes that were especially conspicuous within the 10-ncter zones, and Photographic records were made, Outside the 10-neter zone, notes and photo grephe vere taken in different types of habitat, ani in different degrece of exposure as determined ty thelay of the land, here possible, notes ani photographs vere tied to pointe that can be found agein after radiation ceases fas mmnbered trees and mmbered photographie points, Voucher collections mde for pernanent reference vere docusented in the sane manner, ani left in Ro Plearas.

Muclear volimes, Flentifid lots of Living mosses and few hepatics,

2 species invall, vere collected for Dr, Koo, for determination of miclear

volumes. Because of the simple structure of bryophytes, whose leaves are

pornally only a cingle layer of cells thick, relatively uncoaplicated

technique should suffice for this dotemsination, If weristenatic areae cust

be used, to confom to the practice already eetabliched for higher plants,

?the growing points of noss and hepatic stene are anall and eacily ?equashed?

gut, thus avoiding the tine-concuning and laborious techniques of embedding

in paraffin snd cutting serial sections.

Cytological study. Material of moss capsules at the proper stage to

denonstrate uefosie, for chronosore counts of 15 species vas colleetes. ?tow-

ever, as it could not be examined at once, for lack of microscopic facilities

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Tele I. Bryoplytes of cite 1, site 2 and their vieinity

1, Doatnant and conspicuous mosses in the eite areas:

?Tuldium urecolatun Lor, On stones, rocks, roots, and base of trees.

Taxitheliue plenum (Brid.) Mitt. On rocks, roots and trunke of fallen trees

Syrrhopoton bertertanus (brid) C,, Coamon on trunks of Bute: ?sterra pain); on tree 410396, for example.

?Syrrhopoton prottfer Schvacgr, On rotten vood and tree bases.

Qetoblepharun pulvinatun (D. & 11,) Mitt. On rotten vood and base of ?trees; rarely on rock

Leueobryun nartianum (Hisch.) liane. On rotten wood and base of treet

Leucolosa sermiletun Brid, On tree trunks, twigs and rocks.

2, less abundant mosses, but still easily oberved:

Neckeropsis undulata (Hedv,) Refch. On base of trees

Hoanlia glabella (Jedv.) Mitt. On vertical rock-face

Forotrichum fasctoulatuz (Heav.) Mitt, On shaded rocks more rarely fon tree trunke.

Syrphopodon Lisulatus Mont. On tree trunks; tree #10277 for example.

Huizogontim epintforme (Hedv.) Bruch, On moist shaded trunk of Zutorpe.

Calymperes lonchorkyllum Schwaegr. On base of trees; more rarely

?on rock

Leucomiun conpressun Mitt. On stones and clay soil

Crossonttrius orbiculetus C.M. On roote and twigs 4n motst shaded places;

?alco on living leaves,

Fissidens pelluctdus Hsch, On moist clay

Hissidens Garbert Sull, & esq. On tree trunks and rocks; on stone

at base of tree #01173,

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Corazon hepatios, often sbundant:

Plagiochiie; st least 3 epectes occur on rocks and tree trunk at

?and near sites

Bazzan:

fat least tvo epecies on base of trees and on rocks;

fat base of tree 10398

Riccardia: several epecies on stumps, rotten wood ani clay

Lophocolee! @ comzon hepatic on rotten vood and base of trees

Galypogets: 2 comon hepatic on moist soll end rotten wood

Many species in sany genera of Lejucaneaceae occur over the vole

?any sre s area, but a specislist vill be needed

?fo nae then. ?These are the Usual

hepatice of fatlen leaves,

at 1 Verde, and vos etulted only several days inter (Decenber 17 ant 18),

in the Inetitute of Tropical Forestry in No Pledras, the cytological data

obtained vere disappointing. Accurate chromosore counte could be nade in

fonly one species, © pectic of Caliicoctella still to be identifies, (probably Gz pallide), Tovever, all the species that occur within the

aurea of high trvaiistion also occur in areas beyond the reach of irrasiatton, for in areas protected frou it, Consequently, if ancaalies are found in the cytological behavior of bryoplytes after irradiation, good control material can also be easily found and cluded for couparizon.? Sy getting fresh saterial one day at 51 Verde anf ctulying it the next in Mo Pledras, thus giving meiosis fo chance to "run dom", s more successful cytological progres an be forecast for the future.

Postetrradietion phase. For the post-irradiation phase, it 1¢ proposed to coupare the ?after? vith the ?before? in teras of absolute and differential susceptibitity anong species of bryophytes vhich vill be reflected by changes in normal acsoctations of species. The mortality and survival should be studied fron the ctandpoint of distance froa the source, protection given ty the habitat and other variables, especially in comparison with photographs taken in Decenber. A comparative stuly of the production of sex ongans and of sporophytes should be made between {radiates ani non-irradiatea populations of the sene species, Anomalies of all types should be otudted critically in lan attempt to discover their point of origin. Velosis should be investigated in populations that have been Irradiated to determine vhether or not meiotic behavior ac Well ac chronosone muber has been affected, Since the behavior of tropical mocces unler irradiation has never becn observed, it ie difficult to forecast vhat vill happen--but whatever happens vill be significant.

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Observations on Algue at EL Verte, Oct, 1-9, 1964

By PRL Haltekt

Preliminary observations vere uate on the distribution of epiphytic, Lignophilic, and Lithophilie species of alga ot the Ti Yerde ite. In addition, céllections of algae, nosecs and Liverworte comprising the eryptoganic community on leaves, vood, ani rock, vere also mate.

Algae frou leaf eurfacee were collected during seven transects starting fron the outer boundary of the upper center to the outer boundary of the lover center. The epipiytic algee were present on several epecies, but expecially

Sbundant on Euterpe qlobosa, Dacryodes excclsa, ant Sloanea berteriane. In extrenely vet ani very hacia parts of the sites Dxypetes glauca also was a

good eubstratun for algal eyecies. Epiphytic algat species were lacking on fll specinens of Cecropia peltate rxanine?.

?The most comion algal genera on the leat surfaces are Piycopeltis

(viiiedet) Printe, Cephaleuros Kunze, and Trentepoblia Yart.?

?Te uncroscopie appearance of Fiycoveltie varied vith the quantity

of light present. ?Thali growing in deep shade were green in color. With Snereseing expocure to light and seemingly less husid conditions the thallt were pate to Bright lenon yellow, orange, orange-red or copper-red. ?the color ie due to an increase in the carotenoid pignents und to the carotenoid pignente and t0 the storege of oll, At higher elevations than present at the experimental ites on Bl Yunque, 3U96 Ft, the genus became e deep orange-red. Within the Stuiy cite Pyeoveltie wae parasitized by Acconycete fungi and involved in a Uiehen assoelation. Thycopeltis vse sbundant on several species, but nost ccomon throughout the etuly area on Duterpa globosa vhich is seemingly an excellent site for leafy livervorte, mocces, ant algae other than Fiycopeltts.

?The gene renterohlie was second in ebundance on the leaf surfaces. Ie is perhaps of fone ecological vorth to note the difference betveen the Grown hevit of Zrentepohlin ond other epipiytic algal genera. "Trentepohie fon ercen algel genus closciy related by reproduction type to Piycopeltis, Trentepohlia is coarsely Pilanentous ani the filanente occur at random over

The leaf surface. ?The genus Fyconeltis, on the other hant, ?¢ a parenchymatous to peewloparenciymatoue thellus tightly appressed to the epidemal surface.

Since many representatives of thie genus were sterile vhen collected, Living material tas sent to the hore inst{tution of the investigator for culture ?and eventual cpeciee dotentination, luch of the Trentepohlia collected was leo parceitized by Acomyeete fungi.

?me epipiytic algal genus least abundant wae Cephaleuros. As vith other ?rentepohliaeeour general Cepheleuros possesses an erect and prostrate system, Unlike Phycopeltie and Trentepohita, Cenhaleuros has filenents vhich actually penetrate the cuticle ant epidermis of the host and nay become an intranatrical space parazite, In seven transects throughout the cite Cephaleuros was collected only twice on Sloanea berterians

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Because of the rether cmon occurrence of Prycopeltis, Livervorts, nosses, and other algae on the leaves of Euterpe globosa special ewphaeis

Mas placed on study of thie pals. A problem of interest is the relative 1ife~ span of a pala frond, Fifty representatives vere selected along the trail center to the lower Genter ar shown in the map (Fig. 2). The outermost frond of each individual wae marked with a metel tag, AleJo Estrada Pinto sakes monthly observations on the Life of the palm fronds.

After returning to his hone inetitution the Investigator will make total counte for the relative dictribution of Pyycopeltis on Euterpe leaves. ?Mie vill again be done after Irradiation. In addition to the etudy of the Ruterpe leaf community, 20 rocks or rock-log aggregates vere marked for stuly of Lithophilic end lignophilie epectes, Permanent green concrete markers of ?these rock-vood sites vere ectablished, and this stuly vill also be repeated after irraliation, It Je hoped that Dr. Breen vill also give quantitative Gata on the nosses end leafy ivervort floras on the Buterpe leaves. A list eiving the location of the 20 sites is included as Teble 1.

?able 1

Approximate locations of rock and rock-log aggregates for algal studies.

AL. nesr Palm #2

#2, near Paln i

4&3. below "fT

4. Delon | fl

ag" AL

8 he

AT. 10 meters below #6 to the left of the path.

4B. Below Pain 313

wo "ine

AlO.opposite Pain 18

AILISLightly below Palx #20, The rock curface studied is just below the

?rock that 0 sarked.

?aaz.)1) gust below and tothe right of Palm 21, Collection made off stusp

?and rotting log.

n2.(2) Off lover end of loge studied at Al2. (1).

AU3.SLightly above palm #2b, Collections off rock surface end Tebonuco tree

?crunk

?Alk,Below pala [26 collection from marked rock and logs in vicinity

?ASiJust belov palm #28, Collection off rock only.

?Al6-Rock on path at 10 eter point to lover center. Surface of rock heavily

covered with crustose lichens which vere not collected.

?M7.below palm #29, about 50 weters fron ground zero, lover center.

?AAB.Below pabs 73h.

?19 Opposite palm fd et rat marker #62.

420,0pposite paln #45.

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[REPORT OX SHATL PROJECT

by Harola Hentwole

Dept. of Biology, University of Fuerte Rico

Iatroduetion

et de expected that radiation wilt cause a mnber of changes in the forest at EL verde. The effect upon snaile nay be direct or tniirect. The foreet category may include effects upon viability, grovth rater o= patter fomerli grawth. Differential effects on disferent age classes might occur.

OF arene So evaluste such direct effects several approaches have been taken {ey peecinradtation growth ctulics have becn sade for comparison with ¢kn{iar () Pie brmace after irradiation, (b) Individual snails various distances

ones source have received dosineters, ani (c) incidence of abnormal shell Growth hae been recorded, Tus stuiy is restricted to enaile of the Tan{ly Growth hoe. iat pert dealing with airect effects has been carried out on 3 Conaerset sracolus carcrolla, Polydontee, scutangula and Folydontes luauslieness, are ee? onthe first-entioned ar it is by far the most abundant in the EL Seg oton In addition co the El Verde eite, eupplenentaxy studies vere carried out at the EL Yunque Biological Station.

Indirect effects of railation may inclule influences upon the distribution of snailo in the area through charges vrought in the vegetation whieh in tum cEeett nicroclinate, £000 supply, ete. To evaluate such effects a comparative Geological study of canacnia snails was initieted.

?mere are six epecics of casmenia onails in Puerto Rico, one of which (zacuaysia asricona) ves probebly introduced fros Cubs and te not included eee Stuy, Ce carocolla 12 very abuntant in the soist forests of the Sentral mountain ani is also present in lovlani forests, It is not found {i"open woodlote or on rondeide trees in the lovlands. Tn such eftuations Te Wiveplacea ty . arginelia and Polydontes Liza which also penetrate the higher altitudes elong roadside? and in heavily Aisturbed areas. On some Ragotes Cs parginella and C. carocolla sre found together.

P, scutangula, a resident of the higher altitule forests, seeus at least on canal sbervation, to be a canopy dveller which has secondarily made use Sf hibiscus hedges and similar vegetation in the more open areas. It 18 not very abuniant. P. luguillensis, a ctill lese common species, sens to be ?eElogically sisflar to C. carscolla elthough it is restricted to the rain fforeets of the eastern sountains.

?thus, the more open exces expected to be created by radiation night provide uneuttabis habitat for ?. carocolla ard P, luguillensis, but cause conditions fovorsble for 2. acutangila, vilch aight therefore replace C. carocolla on shrube [iyart of the irradiated conc. A leso Likely poseibility is that C. gargine}ia ana/or P, lina nay be able to reach, and becone established in the area dic- turbed by Tadietion.

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Dosinetzy

Fifty individually-nerked suils, at varying distances from the radiation souce, were provided vith dosincters ty gluing then in the erevice detween two whorle and then covering thes with black electrical tape. An ?attempt vill be made to recover thece after irradiation,

Tnetdence of Abnormal Shell Grovth

three of the 131 C, carvcolla whieh were marked at EL Yunque had an abnormal grovth pattern of the shell involving a olight Atsplacenent of the veorls. This Gieplacenent began when the snail was about half grown, the vhorls becoming progreesively more offset with age. To such shells were encountered in the more than 600 individuale marked in E1 Verde.

Mowe Ranges

In both areas combined, over 1,000 enatie have been individually marked. Sone of these have rot been cubsequently recaptured, However, a large proportion have been recaptured 3 or nore tince and sone as many as 17. Their Location waa plotted on anap cach tine they vere captured. Thasmuch as alnoct fall recapture cata vere obtaine? during the day, the "home ranges" thus Plotted simply outline the area which the snail? uses for its dturnal inactive

Perio?, At night they leave thie area and forage, returning again the following morning. ?Thue the true hone range ie greater than the areas sho here.

ome ranges fall into 3 patterns, One of these is for the enail to atvaye be found on the sane tree, onali portion of @ building, or on one

of several trees in close proxinity to each other (Fig. 8 and 9). Another Gounon pattern differs in that one or tvo recaptures may occur away fro he area in vbich the snail is usually found, Afterwards it vill be found dack at the Original site (Fig. 10). A third pattern consiste of snaile oceurying one area for # long tine ané then noving to a new site where they bubsequently renain, hie vac founl to occur after such disturbance as the painting of a building, the wall of vhich vas incluted in the animal's hone range.

?The above generalizations concerning hone range is applicable only to adults, Data on the Juveniles are nov being worked up. Thus far the indi~ ations are that they do aot Limit theneelves to as restricted an area ac do ?the adulte.

Aster Srradtation ve plan to foliov the novenents of sninals vhich might leave the {radiated zone and establish home ranges eleevhere.

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Mabttat Selection

Individuals of C. carocolla are not untforaly dtetributed throughout ?the forest. They are ese abundant on the etecper elopes and they tend to imbsbit particular trees, Some trees hal as mary as 19 snails on the trunk fat one time vhereas other trece only ccveral fect avay had none, nor aid they ever have any during the atuy. The data are nov being anclyzed to sce if sultebility for cnalls is related to taxonule category, bark texture, or size of tree.

The young and adudte occupy Aifferent situations; the former tend to spend the Miurnal inactive hours under the leaf litter, stones, oF loge

Whereas the adults tend to hang on tree trunke. During the drier months, even the adults may ceek out refugia ouch ar tree holes or broneliads. These? state ments sccm to be truc for all cpecice involved in the study. Cuantitative data fare available for C, marginella, On 31 December 1964, objects on the ground were lifted ani the dianeters of ali enaile benesth were weasured and compared to the diameters of those hanging on the trunks during the sase campling perio?. ?he difference in habitat between young ani adults is evident from Fig. 11.

Fopulation ctructure

Inasmuch as juventles and adults speni the inactive part of the day in airrerent places, 3ata on size obtained during the hone range ctudy are not reliable for estizating the size structure of the population. In order to Chreunvent thie difficulty s search wac made by flachiight on hunt nichts

of the concrete walle bordering the road in the rain forest at EL Yunque, Under such conditions all snails vere actively foraging, an? being on a enooth surface, snaile of all stzes could be easily detected. For a given sample, ?all intividuals observe? vere measured until about 100 individuals had been captured. Each enail wae released near its capture cite,

In llovenber 1963 eize elacses vere rather evenly distribute without well defined concentrations of inllviduals in any particular eize range, @ condition whieh pereieted in the February 196h sample (Fig. 12). However,

ty May 1964, after the early spring periot of growth, there vere relatively fev snails in the smallest stze classes and bout half of the population consisted of adults. Hy the end of the year, probably through mortality of any adults, the nearly uniform cise dictritition var veestabliched, Tt is necessary tO continue these samples, at nore frequent intervals in onder to verify the existence of this seasonal change in population structure, deseribe it more accurately, ani possibly to relate year-to-year differences with ?environaontal conditions.

The breeding cycle of these snails ie not mown in detail yet. However, of the 13 copulations observed in the field, ali occurred in the period between 31 March nd 15 June except for 2 in January, one in February, and

one in Decenber, oct of the egg clutches were found in Yevenber and? Deceaber,

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During 1965, nonthly collections vill be made in SL Yunque for deter mining the condition of the gonads, hese vill be correlated with monthly samples of population structure.

Critical Thermal Haxina

Bleven C,cargcolia and an equal mmber of C. panginelte vere acclimated. for 1 week at 20° 1°C ani in nearly saturated air. They vere then individually subjected to a defernination of the eritical thermal maximum ty placing each one dna glace jar uhich vac then closed with a 2-hole rubber stopper. Through one hole & Schulthess quick-registering thersoacter vas inserted vhereac a gloss tube pomaitting passage of alr vas inserted into the other. The jer vae then attached to a veight and cubnorgcd ina water bath containing a bubbler

to cause tixing of the water, It vae then heated, raising the texperature 1?

at a tine and then maintaining that teuperature for 5 minutes before raieing

At again, Soon after heating began a snail would become active. Tvo end= points were used, (1) vhen the enail retracted its body ani fell fron the wall Of the glass Jar on which 1t hed been attached, and (2) vien it failed to respond to a tactile stimulus vhen tected at the en of each 5 minute period subsequent to having reached the first end point.

Je tye specter vere reuaruably sintlar, The renge in end potnt Yo. 1 was 35°- 80°C (mean 37.1°C) for 0, cazocolla and 33°~ 10.5 (wean 38,3°C) for fr sanginelin. That of ond point for Faas te" 19°C (oean b3.2°C) for Serocolla and to"~ WTC (zean h.2°C) for C. uarginetia, Thue, differences Between the CIN's of these tio species, if Teal, are very slight ant probably of little ecological stgrificance. liovever, regression of OTM on size gave sistraight Line with @ positive and significant elope for both species and Se soens that larger individuals con vithetand higher tenperaretures than sealer ones. lore date are being collected on this point for use in inter preting pooeibie differential Teeponses. of the young and aduite in the field.

Tn addition, the other species vill be tested a2 material ie available.

In the field, body temperatures of Ol Cyuarginella ranged fron 26.5°C to 35.5°C, the higher values occurring in aninale directly exposed to eunlight. ?Thece latter vere within the range of tenperatures at vhich animals acclinated at 20°C drop fron the substrate.

Body tenperaturee of 17 C. carocolia in the field were much lower (19.2+ 23.6°C), although it vac difficult to fini individuale in bright oun, Tt is Important to get temperature data on rovlani C. carocolla, In the lovlande ?this spectes is less arbores) and ts comonly found in leat litter and under debris. Perhaps it avoids the temperatures to vhich C, narginella is subjected.

Only 2 boiy temperatures of F, acutangula vere available; they were 20.6"

?and 21.5°C. In most inetances body temperatures in all epectes were slightly hove substrate tenperatures and vere about the sane as alr temperatures. Exceptions vere C. garginella in sunlight, They vere varmer than either air

or substrate by several degrees.

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Survival tine under Aifferent thermal conditions

Snails shov seaccnal periods of relative inactivity, related to moisture conditions. The length of tine a cnatl can renain in a refugium continuously ALL depen? upon the length of tine it can go without feeding. This in tum Gepenie on the energy cources tored in the body and the rate at which they

fare used up, The latter ie greatly tenperature-depndent and arces with high

?teuperatures may not be suitable for a species vhich uses up its energy reserves rapidly an? therefore ve unable to "walt out" unfavorably dry periods.

?A mmber of C. carocolie vere collected near Le Mina, P, Re, and trans~ ported to the lab where they Were acclinated for 8 days at'a temperature of 20" £1°C in closed glace aquaria vith sbout 1 en of water in the bottom to to provide a relative humidity near eaturation. During thic pericd all of the anaile enptied their digestive tracts completely dnasmich as no defecation occurred during the yost-acclimation part of the experiment.

Arter scclimating, the onafle were divided into two groupe, with approximately the same size distribution. One group (52 amisvidiels, omitting Stveral which ate sone paper daring the caperdacnt) were aainteined unter the acclination contitions (20°C and about 100) rh) without food urtt] ell vere feed. the secon! group (69 indtvidunle) vere treatea differently tn only

One respect. hey were transferred to'a cabinet at 30 1c. The Tghte nuelly were tuned on et O60) an} off st 1700. Departire from tate schedule wes the ase for both groupe,

Figure 13 shows the survival tine st the tvo temperatures related to ensii size, Two facte ere evident, First, curvival time was greater at 20° C'than at 30°C and second, the larger (clder) snails survived longer than smaller (younger)ones. This effect vas more pronounced at the lover tenperature. The first is Undoubtedly related to the effect of tenperature on metabolic rate and the second probably beemuee young individuals have higher metabolic rates than older ones at a given tenperature, Metabolic studiee would be valuable in Interpreting these data,

ALL but one enail (Doth temperatures) eurvived more than 2 veeks, vnich is probably longer than any continuous period of unfavorable conditions Likely fo be encountered in the El Verde site ana perhaps in the lovlande as vell (conetuston pending analysis of enviromental data and better definition of folerancee of these enaile to nofsture coniitions), For comparison, =

study was made on C, marginella, Only adults (24 at 20°C and ili at 30°C)

were used.

Survivorship curves for the adults of both species are presented 1n Figure Ib, C. panginella tended to survive slightly longer at 30° than C. garocolla, Although the difference vas not great, it suggests either Felatively greater enengy reserves or lover metabolic rete at that temperature ?than is true of C. carocolla, Of greater interest is the fact that survivor-ship in C. marginelle was not such better at 20°C, This the latter seems mich better alapted than the fomer to thie lov tenperature, a phencaenon

reflected in their altitulinal distribution, The relatively poor survival

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us

of C. marginetla at 20°C my reflect an effect of lov texperature on visbility

operating in some vay other than through metabolic depletion of energy store:

dn incidental observation reeulting fron this pert of the etuly was that

&. carocalla seens to be able to utilize cellulose as food, Between 95 and

?oo days of fool deprivation (20°C), the snails that vere otIl alive ate

part of a 3 x5 file cant which we? inulvertentiy left im thelr aguarfur.

?hoy lived much longer than expected on the asia of the shape of the reat

of that, and the other, survivorship curves (Tig, 18), Food analysis

Fecal material fron both C, carocola and C, sarginella has been collected ani preserved. Tt has not yet becn exanined to sce 1f identifiable elenents are present,

Prospectus

I propose to (1) couplete analysis of the data already collected, (2) ?expand aha conplete the eurrent studies as mentioned in the text. and (3) Anttiate several new phases. One of these will consist of behavioral studies, and will include responses of the various species to gradients in texperature, huntaity, and soil moisture, as vell as correlations of activity period in the field vith environmental conditions. Sere data have already been collected on the latter part. A second phase will consist of a conparative study of the uoisture relations and will involve measurenent of water stored in the mantle cavity, rates of water lose under controlled conditiom (coaparing estivating and nof-estivating snails) and changes in boly vater content. Tats part has not yet begun although equipment for it 1e nov available.

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- Fig. 6. Relation of shell weight to sheld diameter 123

30 in" species of cansenid snails,

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x 30. marginelis

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DRY WRIGHT OF BODY DN OHS

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Fig. 7. Relationship of body dry weight to 224,

shell diameter in Garacolus carovolia

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Fig. 9. Homw range of an adult Garacolus carecollg at the

Ey Yunque 2 ological Station becween 15 September 1962 and

uly 1963.

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MUEER OF INDIVIDUALS

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Yovenber 12, 1963,

Fig. 12, Population structure of

Caracolus carocolia at different times

| of the year. Cross havching eianifies adults.

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Figs 13,Relation siz v3

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x= adults Garacolus carocol! 130

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Preliminary Report

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Passett tiaguive, Jr.

Departuent of Zoology, University of Texas

Forty-two vater samples were collected in and near the exporinental farea in the forest st El Verde Fxperinental Station, Luquillc Nstional Forest, Puerto Rico, Most of these cauples cane fron the Leaf axile of Broneliage,

a few cane from leaf axila of the Serew Pine, Fanlanis, ani one each from & depression in the sotl of the forest floor, a hole in a rock near a streaz,

and a tree hole. The water vuc derived fron rain, Only the rock hole and Bronelinds of samples 10 and 11 hai had any chance of previous contamination

by stream water, All of the sanples vere exanined the day of collection under 30X magnification and organisne identified ae far as possible, A coxpoun? microscope vac used to survey selection of the samples, and in all but vo instances thie vas completed ty the second day after eolicction (one cazple

vas finished on the third ant another oa the fourth day after collection).

Tables 1 and 2 List the organisms found(not ineluled in mimcographed report).

?The average number of organtsns seen unter 30X in samples from Bromeliads was 6.2, The range wae fron 1 in a plant valeh contained only a fow drope of water to 11, The pool on the forest floor, vhich hal auch greater yolune ani poseibly greater enviromental diversity, hai 9 different kinds of organisas; ?the rock hole, vhich held about the sane volume of vater ac dia the larger Droveliads saipled, had 12 different icinds. The presence of Paranectim and the CAadoceran in this rock hole io probably the result of occasional flooding of the hole by a ctreaz, Three of 32 plants had a naxy of nore kinds of orgentene recognizable under 30X as the pool, This say be due to greater environmental Aiversity of the pool, lessee] aispersal problems, greater volume and surface area, sna/or ?nore favorable? conditions, each with umknom influence. The rock?hole, for vhich there is good evidence for flooding, contained 12 atf-ferent kinds of organisms including at least tvo of wien vere found nowhere else, Tis ie good evidence that diopersal mechaniont for all the epeci:

in the strean are not cuffictent to take thes quickly or at all to Bromeliads,

?The everage munber of different kinds of organisms obecrved in water from Bromeliads vith negnifications up to 1000X was 10,3 with a range trom to 1h, Comparable figures for the forest Floor pool ani the rock hole are 19 and 13 respectively. This pattern ie consietant with that ecen under lover magnifi-estions.

Totals of munber of kinds of organise for all samples fren the Froceliad,

Gummanta vere analyzed to determine 1 there wae detectable. change in mimber

4 a fletion of height of the plant stove the growd, Ras difterence

Correlation coefficients of height with mnber were -0,130 for easplee, examined

with the Mssecting microscope ani °0.137 for those exisined with the higher

hnagrifications. This shove thet tore 1a little 4 ery influence of height on

Iusber of omjantens in plant held rain veter. fhe mania variation in tuber

of organisrs whieh might be caused by or correlated vith variation in height

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ie eotinated by the square of the rq, and i¢ 1.9%) and 1.7 reapeetively.

These lov values chow that the wechatisss by vhich aquatic organiens get to

water within these Promeliads, at least vithin the lowest 20 feet or so of

the forest, are efficient and?perhaps arc equally effective at ail levele

below this height. Tt io unlikely that the mechaniene are nore efficient at sone height or heights than at others, but with the efficieney great enough, even at its lovest, to produce near miximim colonization of all Dreseliaa Waters, If maxim colonization of ali Eroueliads occurred, a large fraction Of the pattern of occurrences or absences of various species would be the Feoult of direct inter-species interaction uhieh would produce much sore highly Aeveloped patterns of associations than thoze foun? and described belov. Heacure of colonization rate starting vith containers frec of organisms should give information concerning relative rates of species establishment in envi-ronments similar to Troneliad vaters, Such data also vill give infomation fon recovery rates folloving community disruption or destruction ty ionizing radiation.

Table 3 gives the distribution of the most common organiens found in Gummania as a function ofmeight fros the ground, Hone of these distributions hint et a pattern with respect to occurrence ani distance from the ground.

Figure 1 gives Cole's association coefficient 42 ¢ for pairs of orgeniens from Guzzante comon enough to warrant calculation of association coefficients. Of the 21 associations, all are positive (or vero) except for 3. Each of the negative associations involves maquito larvae as one member of the pair. In addition, tho only tvo zero associations involve Bosguitoes as a neber of the pair; hovever, average number of Onganians for water with and without mosquitoes does not appear to be different.

Four of the association cocfficients are significant st the 0.5%

evel and two ore are very close to this, The significant positive aeso-
elation between Cyclopoia Copepods and naiplii suggests that Cyclopoide may
have been reproducing nore successfully than Harpacticoide vhen the sonples
were taken or, less likely, that sampling methods stequate to capture Cyelopota
nouplit were mich less effective in the eapture of Harpecticota nasplit.

?he positive, significant accociation of Tenipedsd larvae with Cyelopoia
copepod and Rlelioia Rotifer with Harpecticoid copepos nay be real. If a0 the
nechanion which produce the asscciatiors are not clear, especially in the

case of the Tendipedia ant the Cyclopoid whieh rrecumbly have different

means of reaching Eroceliad waters, It choald also be kept in mind that in
series of thio size, one association on the average vould be expected to de
significant because of saxpling chance rather than because of causal relation-
ships,

By far the moct interestirg association yattern 12 that between mosquito
larvae and the other cormon relatively large organiens (ece Tig. 1). Thie
suggests that nosquitoes may interfere with other organiams of ctout the

sane size, although the lack of appreciable difference between mucbers of

Kinds of Organiens in Gumanie vith and without mosquitoes shows that tt is

not a general. phenenenoh.

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ah

Frequent positive nonsignificant association between pairs of

onganions in series of isolated habitats such ac the exil vaters of Brone-

Lisde occur even in the absence of direct interaction between the organieas.

Sone factors which might tem to result in euch positive associations are:

+ Comion transport mechentsm

2, Comson Kinds of response to sone events or characteristic

a) snount of water in Dreneliaa

b) kind and/or amount of food (1.e. the musber ant spectes of

?trec leaves in the veter)

e) toxic efveete of:

1) material leached tron Leaves of sone plante

Which might f211 in Droneliaa

2) condition or putrifsetion, ete.

3) toxie metabolitics of @ thin organion

4) spotty @istribution of other nore or lese ?extrene? conditions.

3+ Interdepentence of tvo or more ongentane

+ hetion of antzal predation

5. Action of antnal vhich efficiently renoves come requirement

(Baw data tables are not included in this mincographed report

for lack of space),

List of Some of the Forest liarkers

Bopecially for the benefit of our visiting participants vho use theee

reporte as a means of orientation, ve 1ivt cone of the markers whieh have

been used in the stuiy areas. To aid communication ve ask that all marking

one be concrete, alusinu, Or something equally permanent and the systen be cleared with the project, The positions of all the markere are edded to

?the next report. Fleas do not resove ary markere, even your ove, slace

Persons often make recomis using the deeignations originally put in ty others.

Square atte congrets noste: Negrén Primary Survey by Hegrén

R Rat trap stations-Yeinbren

u Leat fall stations-iHtegert

coy. Litter bage Comey

Soot Seedling plots saith

Round concrete posts. Green, ?Algal pale stations Halickt

Red Palm quairats - HeCormick

imite ree grovth treee = Surphy

Mite painted signs (1 te 11) Frotographe ~ Johngon & Atwood

Aluminum tage (<10,000, radiation center) Basic tree tagging - Suith

Ae Snail trees = Heatvole

* Growth trees = arpa

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Brogreee Report for PRC.

De, Joo A, Dineteten

Roteny Departnent - University of Georgia

Athens, Georgia

During mid-Septenber of 1964 a ten doy viet to the rainforest project at EL Verte vas made. The visit het tvo major objectives. The ecteblisiment of @ M.D. recearen progran for Robert Fort Snith dealing with the structure of the rainforest tefore and after ratiation treatment vas the first objective. ?The second major object vas to Initiate uy ow stultes in the three following areas: (2) the analyeie of the physical and cherical properties of the Gxisting coils und parent material agsociated with the Zl Verde vegetation,

(2) the bietological investigation of the root tips of 3h major trees of the

rainforest area in reference to weorrhizal association, (3) sutecological Investigations of the germination and reedLing grovth of palo mato (Ornoe lorugtt).

Sots

?he soils of the area belong to the Los Guineos clay series. Los Guineos clay de quite siniiar to Cetalins and Cialitos soile, but is found at higher elevations with vetter, cooler climates. The soil of the El Verde rainforest area 42 characterizes ty steep or very steep relief and hae a6 to 6 inch grayish-brown slightly granular sediun plastic, etrongly acid surface soil. ?The subsoil consiste of a 3 to 6 inch loyer of bromishwyeliow clay thet abruptly changes to red plastic but permeable, strongiy acid clay. This layer gratually changes at about 3 to feet to lighter red more friable acid clay. Tlany large boulders are on the surface cf the coil vith ae mich es 50% of the surface covered vith rocks, Smaller roeke (up to 10 inches in diameter) may be found throughout the profile, Under forest conditions, the sotl has an excellent erm structure which results in unusually good? internal drainage for such a clay soil with az mich ac 60/) clay sivea particles. Soil samples,

taken dn « systenatic nenner fron reas in the Bl Verde forest are being

tected for totel cation exchange capacity, organic matter content, soil

separates, clay type, ppm tig, pin Ma, ppm Za, ppm Cu, pom P and pm NO.

Aitough the tests and interpretation of teste are incomplete, the following

?table Indicetes something of the chemical nature of the coil.

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aT

?Table 1

Exchangeable (pu) __: Acta. Sol.

Derth

Location ?Inches O.1Kel ¥s0 Ne/100g Ca Ng K Mm zm Cu P(pmm)

Upper Center 1023 LD eT eh aT

Tower Center = 5-103 9-6 MS HT wk

Bob's Area Sao k5 0 Stk lp. 40 83 30 Mh A oT 6

Water Supply 0-5 5.7 16.8 15860 7TH 32 ko <a T 2

Tower Center 0-5. 5.2 5:T«1T.0 "Bey «We 58 IT] A OT 6

Bob's Area 510 i756 128 1,260 5 32 * aA Tt 4

Water Supply 0-5 ng 5:7 19.0 Ayko TAL 3B ko <P 2

Upper Center 0-53.63 50.8 ?202 300 10k * <T a

Tower Center 0-5, .B 20.5 HO 285 96 OT a

Bob's Area, 0-5 «5:3. SLT aL 3,840 1,515 186 Ifo <1 7 B

Tower Center 0-55.30. i200 ?so 58 25 <1 oT %

?ouly

* Missing date.

Trace

It 1e of particular interest to note that most roots of trees and shrubs are restricted to a mat found on top of the soil. Tt is of further significance that the roots of such early succession species Cecropta peltata ani Didymo- ?pansx morotctont are alvays at the bottom of this 4 to 5 inch thick mat and their root tips are large ant knob-1tke vith a manimm of branching. Such morphology 1s in keeping with the habits of early, fast grovth but doubtful longivity of any one given tree.

Particle size distribution as determined by the hydroneter method Aeseribed by Bouyoucos (Soil Science, 42:225-230, 1936) may be seen in Table m

Teble TT

Very very

Depth Coarse Coarse Mediuz «Fine = Fine

Inches Sand Sand_?Sand__?Sand_?Sand__?SAUt Chay.

0-5, 0.2 La 18 9.0 ae 38.23.

515 0.3 13 19 TS 89 9.2 50.9

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8

?The parent material oc represented by the exieting rocks and boulders of

?the orca has been identified se basalt by Dr. Vernon Hurst of the University of

Gcorgla Geology Departnent. This basalt contains caleite incluetons ar amyg~

Aololas, One sample of rock taken frou the B1 Verde arca consisted of chert

with pyrite exystalls in It, oct of the parent material 1s, hovever, dark,

fine grained volcanic natcrial classified ar basalt. lore detailed tects of

?thin sectione are being sale ant chemteal analysis will be made in the near suture.

Root-tip Stultcs of BL Verde Trees

Foot-tips from 32 epecter of plants representing eunopice and understory of the rainforest were taken in Septenber of 1954, These roots were preserved ani fixed in a solution of ethanol, acctic acid and chreate acid. Stained slides are nov being prepared fron the root tipe for exuainations relating to possible enotrophie ani ectotrophic mycorrhizal associations. External examination of the roots reveal that only 1 of the 32 epecics of roote collected exhibit root hairs. All of the other 31 species appear to heve sone degree of fungus-root association. Dr. W. C. Bryan of the U.S.D.A. Forestry Laboratory tat Athens, Georgia 4e being consuléed with concerning the mycorrhizal problex. ?The 3U species unter invectigation are Licted in the folloving table.

Tubie IIT

Duchenavia capitate Euterpe globora MeLioans herberti

Casearia arborea Ficus crassinerva Mantikara nitiaa

Cyathea arborea Mrtille rugosa, Magrolis eplendens

Cordia boringensis Honalium racenosun conse tetandre

Cananga cartbace Trove ferrea Omosia krugit

Croton poecinianthae Ings laurina Ocotea portoricensis

Cecropia peltata Inga vera, Palicourea riparia

Gyriila raceaifiora sayepea doaingensis Rourea glabra

Dacryodes exeelea tyrete deriexn Stoanea berteriana

Drypetos glauca Hatayba costngensis ?Tetranogactric balea-

Digymopanex aorototont, Weropholis garcinifolta ?nifera

In such an area as the El Verte rainforest, where 120 inches of rainfall Per year could leaca out anions as fast ac they vere mbilized, a fungue-root ascoclation could act ac a trap. Such a mechanion has been described ty Kroner in Setence, 110, 8-9.

Aatecological Stuiies of Ormosie kruglt

Palo mato (Omocia kmgii) is one of the many trees vaich ehare dominance in the El Verde tropical rainforest. This species belongs to the lemme fanily ?and reaches a height of 80 to 90 fect and a abi of up to 30 to 40 inches vhen

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nature, During gensination cxperinente, the cotyledons vere not rated vith fthe shoot co palo nato's germination is typoceal. Four hundred ceeds taken frou the ground outelde the ctudy area vere subjected to four different trest- nents, Dach jeraination experiuent vac conlucted on 100 seeds in lots of ten seeds, The first treutncnt consicted of vrapping seeds in vet paper tovels Whieh were placed in gises Jare, the jare vith loose fitting tope vere placed in an ineubutor vith the teuperature ect at G0" P an left for 3 weeks with Gatly cheeks. the coeond treatneut Lrvolved germination of chentenily sterili~ zed seeds in heat oterilized Sphogem uoce, A thin ect of 100 seeds vas placed in untreated Sphagnum moce without ary treatnent to the seeds. The fourth set of seeis was chemically steriltzed vith clorox as in treatment muber 2 and then coated vith a comereial preparation of Rhizobtun bacteria ani planted tn sterile more. ALL of the seede in soss vere placed in shallow trays on tables {in the greenhouse vheve temperatures ranged tron 65°F to GF. The ight intensity of natural Light reached £900 footeaniles on the clearest days. Fortyeight per cent of the ceeds in the paper dolls of the first treatment svelled and took up Water inal to lvetio to initial dry ceed weight, o

fact true of all aeede in all treatments, ALl of these seeds decayed and the remaining Sef of seeda atsyed enall, fim and impervious. In treatnent number 2, vith sterile eceds in sterile Sphagnut, 26)! of the secde resulted in seed~ Lings after 1 eonth of observation. The ranaining seeds vere hard, shiny end impervious. The third aet of seeds vith untreates ceeds and untreated no exhibited slightly higher rate of gensination (19%) but 11 of the other Seeds decayed. In the fourth experinent in vkich oterilized seeds treated with ?udtrogen" and plantes in sterile nos, the rete of producing seedlings wes 36% after one conth and 6%; of the ccedt decayed.

In the Light of these ctudtes, {t appears that a blochentecal digestion of the hard seedeoat of the palo mato seeds greatly aids the vater uptake and sprouting of these black and red seeds.

ALL sccdlings, vegardlees of germination treatment were potted in individual dnon pote in medium sand and divided in the 2 groupe. One group vas placed in a crowied greenhouse arca vhich elmilsted the lov Light intensities of the closed canopy forest at £2 Verde, In this chaded arca the light inten« bity never exceeded 60 feoteantles. Both groupe of pottcd Omosia krugit seedling vere fertilized regularly with a solution of 5-20-10, ?The well Lighted group of seedlings vere Jeft in the area of gerainutton where the Light intensi- ?Hee ranged fron 1000 to 2560 Tootcendles during the Gay. ALL seedlings had only 2 leaves at the etart of this phase of the experiment and these leaves

were Metinetly opposite. These leaves ali hai distinct drip tips. All eeed~ Lings in the low Light intensity area remained In this 2 leaf stage vhile all ?seedlings in the area of higher Light intensity vx: out 1 to 3 more leaves. About Sf of these added leuvee are arranged in un alternate manner on the

shoot. ALL of the leaves, original ond cubsequent, are cimple, entire with

Grip tips. Experinents are planned to test the alledged survival value of

drip tipe in the igh reinfall areas. Studies by H.T, Ofun in the forest ot

El Verde have suggested that many ceedlinge of potential canopy stature exist

in a etate of ?euspended animation? vaiting for a hole to open in the dense canowy. The differential behavior of shaded and vell Lighted seedlings of palo Sato cen to substantiate such a theory.

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ako

?The root tipe collected from mutuwe pelo mato trees in the Zl Verde forest exnibites both cetotrophie aycorrhizac ani bacterial nodules, The seedlings fren all genuination treatzents lscl both these features et the end of 2 months. Further experiuents ene planned in Which there seedlings will be treated vith Soils fron the rainforest area ani observed closely. The existing roots on the palo mato seedlings ure withost root hairs, they are generally short, knobyy nd highly branched while in the ors but extend downward to equal about 1/3 ?the length of the shoot vhen traneplanted to the cand in pote.

De, Janes Duke st Pelteville, slarylent ie being consulted about the future work vith drip tipe, mycormiizel ond bacterial root svelling, and response to Vight. Dr. P. W. Richards will visit the Potany Departaent of the University of Georgia within 10 days for consultation,

Pre-irradiation ctudics of Lizards and tree in the

Tuquilie Experinental Forest, Puerto Ric

Frederick 2. Turner, Clayton Giet, Richard. Rowland

Laboratory of fucléar Yedictne and Raiiation Piology

University of California, Los Angeles

Amese studies vere supported in part ty Contract An(ob~L) GBN-12 between

?the U. 8, Atomic Energy Commiseion and the University of Californie.

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Introduction

Knowledge of the influences of onizing radiation on natural populations and communities ic as important today as understanding the effects of such radiations on {ndividual. organisms and cells, ?The impact of Jonizing ratiatiua fon nan end hie vell-being is Lergsly dependent upon the responses of the

atural assenblages of plants ani animale with vaich of epecies; alternations in the energy utilization of couponent popalations; and changes in species Siversity nay have subtle--or drastic--effects on man's environment. To date, lary such influences oving to ionizing rodiation have been extrenely eubtle~ except in a few highly localized areas. Siudice at Brockhaven Jlational Lsbo- ratory (Voovelt 1962, 1963; Brover, 1964) ond in Georgia (HeCommick and Platt 1962, 1963; VeComnick' 1963, Danfel 1963, HeGinnis 1963, Pedigo 1963) have shown that?such trivisl effects nay becone important once when higher levele of radio~ activity are involved, Correlations betueca radiation dove ant the severity of observed effects are known only for a fev areas, and over a relatively narrov range of exposure, For wost chvironnents ve have no @izect nescurenente of such effects,

?he forest irradiation experiment conducted by the Puerto Rico Nuclear Institute 1s designed to explore the effect of three uonthe of chronic gama veifation (fron a 10,000 curie C5131 source) on the composition and function

of a montane tropical forest. ?The ctuly area te located in the Luquillo Experinental Forect near the tom of Fl Verde--about 25 miles east of San Juan-~ sf mclevation of approximately 1900 feet above eee level. he danlnant tree in the forest is the tabomseo et excelsa), but Sierra palm (Bute Blobosa), cecropta,(cesrosia seltatay fale colorado (Opriiia recent FiSeahS

nd Sloaiea berteriana are also comnon.

A otudy of the effects of ratiation on a comity requires attention to a large mmber of spectes or species groups, Usually the diversity of the Biota makes it impossible for any one individual to successfully under-take investigations of all of the constituent species of evident abundance ant importance. Consequently « munber of specialists have cooperated in the Pierto Mean study (Odum 1964).

Our contribution to the Purrto Rican experiment involves certain of the

species of amphibians and reptiles in the forest. Sone of these species are

eonspicuous and obviously abundant. Others are Sbserved infrequently and may infeed be rare. There may be a few epcoies present of which ve are unaware, Folloving a year of continued observations in tvo 0.7 acre circular plots, ve

consider the species composition of the areas to be at follove:

?Anphtbia

Hleutherodactylus portoricensie

E vighteanse

ichnondi

hearickt

poser

Leptodactylue albsienrie

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ake

Reptilia

Typalope ep.

Anolis quntlacht

A. cvernanad

eae

?The tree Frogs end Iizands are Licted in onlcr of apparent abundance, with full recognition of the poceibie inaccuracies of such a ranking, There 18 no doudt thet Anolis gundisch{, A. cvermanai, and Lleutherolactylus portori-gensie are abundant--in ah abscluve sense. fi. vighituanae and B. richeonat fre also munerous, Other spectes une rarely encountered and are probably present in Loy muitere:/Shedrloki tentodantylus alba,

guienL. The sceretive eyceies Like Zyablont, Diplasloseue snd Sohaer

fylue were only captured after cane vere Buried ant teed aa traps. Their Senet ie wassown, Ye cedubrtd smute (Alsopite) te probably as arcoaroe as its very rare observations indicate. Gne minor difference between the two areas is suspected: in the upper area E. eneidac secne to be nore abundent than E, hedricki, Uhatever the absolute mmbers of Lizards ani tree frogs, and vhatever the true relative abundances ay be, we belicve that these animalse-in a funetional sense--are the ost important vertebratec in the community. There are no native numals excent for bats. Feral mice ani rate suctatn thenselves at varying but lov deneitics, Binis are not muorour, Kah (2964) estinated about # birds per acre in the Bi Verde forest.

Our efforts have becn Focused aluost exclusively on three species: Apolis gunllachi, A. everuanni, api Eloutherolastylus portoricensis. The form of the data acquired is Tilustrated ty the accompanying machine tabue lations. ?The analyzes whiten follow pertain almost exclusively to Anolie

idlschd, but indicate the questions involved ani the technical approach to the data, We designate the lover center as Area 1, the upper center as Area 2, Sex designst ions arc: 1 for males, 2 Yor females ani 3 for une determined,

Nhat wey che eapect to occur as a result of the irradiation of the forest? In a precise sence, no one Imows, ie do have the Brookhaven work and sone ?theoretical consiazrations on viiich to base projections. ovever, there are no clear precedents relating to natural populations of mobile anizale. The folloving effects are decned reazonable Doeeibilities:

1, acute mortality of indiviquale

21 prolonged tebilitation followed by death or recovery of individuals

Br Sitesstion of the algperston of the noputattons

changes in vertical stratification of the populations

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5. Ateruption of reproduction and resultant changes in age-oF

size-aictributions of populations

6, changes in mobility of iraividuale

Accordingly, the following dete are keyed to tvo general objectives: First, to detemsine whether the tvo ctuly areas are indced alike. Can one area Legitinately be used ac a ?control " after the other is irradiate? Second, to develop quantified measures of the make-up and behavior of the assenblages of selected anizals in the tvo arca--paraneters hich can be again evaluated after the irradiation, eid which can be used to denostrate effects of the kind enumerated above.

iethoas

Prelizinary coupling vac carried out in July, 1963, but formal initiation of the project 1a not begin until Yoveuber, 3963, Observations vere largely Feotricted to the areas betwecn 10 and 30 meters of the centers of the tvo plots. Areas were examined during aiternate veeke. Aninale vere ceptured ty

A nuier of neans, tut the most effective proved to be by hand, New aninals coptured vere marked by tor clipping, measured, ani released at point of cepture, Perch heights were reeorlel to the nearest 6 inches. Perch diameters ?less thin one inch vere recorded ap 1/2", Greater Glancters were measured

?ani recorded on nape, Sex designations were made vhen possible. During the spring and summer of 1964 the sanpling schedule vas modified to include periodate counts of all visible lizards in representative cubsections of the tvo study plots. In June of 196% two 5 x 5 grids of 25 can trape vere installed in each Erea,? The grid Interval vac 2 neters, These grids were cubsequently operated for one day cach week, Starting in April, 1966, weekly eexples of ovaries

of dale quullachl, A, cvermennt, ani Sleutherodactylus partoricensis were Gian Ruane dhice?ofettes une coulscted: periestoahy: for the anahyeis

of normal weight-length relationships, Masue samples (testes, skin, and Sneeetinal epithelium) of the three aclected species vere precerved ard

given to Dr. F. K. 5. Koo of the Puerto Bieo Wuclear Center at Mayaguez.

Field data vere transcribed to a special fom, trom vhich the data were Punched on TEM cards, AIL backgroun! data have nov been processed in this

Manner, Tvo Fortran prograns vere written during the sumer of 1964 and vere used 4n preliminary data reduetion and analyeie, Regreseion analyses and factorial analyses of variance vere carried out using prograas in the itbrary of the Bioetatietice Unit of the UCLA Nedicel School. The computer used was fan IB 7094, Other lese complex analyses vere made ty mechanical sorting and Listing.

Results

A, Density of Anolis gund2achi.

table 1 tliuwtrates a series of density eottantes beeed on capture-re~ capture analyses of 2 chain of samples fron each of the tvo exeae (Delury 1958).

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1

Swmpling vac during alternating vecko in each area, The Xp column shows the cumilative number of worked animals at riek in the populations (assuming no rortality). The m4 column chows the size of the samples taken, and the x, colin ahove the nisber of marked aninals In cech cumple. It fay be obsctved ?that after the fifth emple (at Tae 4) the incorporation of further date does rot alter the population estinate significantly, In fact, the samples teken ft Times 5,6, ani 7 are so rezoved in tine from the beginting of the study that the % colin te no longer valid, this 48 because the X colum reflects only ?the aldition of marked animale to the population and makes no allovanees for

the death of theee individwls. Further trestnent of these data by other methods ie in progress. While it may be ascuned that the population estinates of 600" per 0.7 acre are high (becaice of mortality anong marked animals), it is clesr thet the tvo arcas are remarkably siniler.

lie believe {t useful to develop density cetinates by tvo independent methods. ?The other technique used wae Aeveloped by Davis (1942) to estimate Aencitics of foreat birds in Cuba, ?The eysten involves a complete enumeration of the aninale ina representative subsection of the overall area, and an appropriate correction of this count according to the relative sites of the area censused ani the entire area under ctusy.

In the Puerto Rican forest representative areas vere selected in the tvo 30 m circles. The extent of one vas about 21!) of the entire arva under con bideration, ani that of the other uas about 23$ of the entire area, Over a period of 4 nonthe three eet of 10 censuses vere made in each area, The Feeulte of these procedures are shovn in Table 2, As nay be seen, the mumbers fof animale observed during cach of the three trials vere quite sitilar, and the aijusted eatizates of the munbere of individuals in the two 0.7 acre cir clee are almost identical. ?ovever, these estinates are not in accord vith ?those based on capture-recapture analyse:

?me disparity 9 oving primartiy to tvo ggurces of errors First, the capture-recapture eotinates are high, snk the Seasons for this have already Secu discussed. ve belicve that the Davi" estunates. are. Low beosuse of an inability to actually enuserate every Iizan ever in a snail section of forest,? th fact, it ie Likely tint at any one tive every member of the Population io not active ani visible, Hence, 17 the course of ary one census The obecrver segicters only a fraction of the entire population. Ye

telieve that the actual devoity of Anolis gundiashi Ice between 250 and

650 per 0.7 acre--or between about 350 and 900 per acre, Five hundred per tere ie probably a Feaschable compronsercvani Af quite possibly conservative.

?Tic ic a venarkuble munber of Lizaric, In the desert of southern Nevada 20-30 Lizarde per acre ts ?nunerous", and cone species exist at densities at lou ag 2 to 10 per acre (Tanne? ani Jorgensen 1963, Turner 1963,

?Turner and Gist 1965). Yovever, in nore mesic environente higher densities hhave becn recorded (Table 3). In general, nusters are less than 100 per acre but apparently in favorable situations mich higher deneities way occur. There de cone uncertainty ae to the eize of the population of vhiptailed Lizanis atudied by Carpenter along the chore of Lake Texona, However, in an area 130 feet long and 0 to 50 fect wise (ca, 1/6 acre) Carpenter registered 32 ifferent aninale ine oneveck period in July, 1955. the data for Lyposona

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ah5.

Jateralgare based on the registeration of LIT tfferent individuals in a ones URGES Tas tte bebieve that the density of Anois guntlachL cbserved 1? tee week periods sores consilerebly exceeds the usial density of north temperate Lizard species.

In terms of the evolution of the tropiesl forest community, it 16 interse~ ting to consider how the high densities of Auotie qunllechs teve ariech. | Fee {ing to cone ee Ge proluction of the tropical Forest is higher than that of norte TOON tte aystens.? wovever, we believe 1 ts alee important te reeogntae the seerte of 2 strong vertical component to the activity range of Anolis

tere OF e ctnenal, march tonperate Lizards occugy @ plane. frboreai, species SREB ouumce, Davie (29K2) nate this mane point with regard to the Ooben

Seer & vorgund that when habitats Were conpered on sn aerial basis, the Cigarot densitice of the suze avien species vere not stutter. | Hovevers wher saeerts vere compared in terms of volumes (ty taking into account canoRy height) conspeeifie densities vere in good sccord.

2s Weight-tength relationehipe in Anolte gundach

Figure 1 illuetrates the regression of oly wefght on body length in OO snore Zuniaachis "These data vere based on animale collected in the vicinésy Mere SBP thin) the study plots, he idea here is that in the trvaltated sear thie relationship may be significantly modified (L.c-) by ose of SUTIN 'sintlar welght-Length date have been acquired for Anolis evermannl fant Eleutherodactyiug portoricensic.

5. Grovth and size-distributions in Anolis gundlseht populstions

avle & chovs the observed growth in Lizards of aifterent efzea. | The typical fom of such data ie one of relatively repid growth $2 gual) aniestsy Peetta ty a progrecsive decline in grovth rate, The data in Table © seen! fotteves Moos thie pattern, most notably beceuse of the apparent decline tn to sererte of aniuole bl (o hO ws in length, and the wore rapid grovth of ee eee to Gl mn What 1s actually izlustreted ty Table 4 ie the cessation Spine tan nature? fenalee st 0 shovt-vent Length Of epproxiaately 47 to OS oe ere the continued groven of nalcs to GO m or nore in .ength. |The picture Mont Clearly portroyes in Pigure 2, vhieh shove our egtimate of grovth HEetems in male and fenale Anolie guiilacki. ?he size dinorphten is, mich pettermpounecs then thet oteerved in ary American licaris. Tt ie extrenely mare rete dieerizinate between mnie ana fcmale lizards tees than 50 mi fn {eheth, becmse both cexes have a devlap and chov no reliable @ifferences tn Uopliosas or coloration. ence, most of our designations of Tenale Liters jepiaets pases. on obecrved grovth rates. Table also indicates the eintlarity Detween dete obteined in the two study orcas.

Figure 3 shows slze-Aietributtons based on alll cximale regictered in the tee eee etmen Hovenber, 1963, and Wy, 196k. Approxinately the sane

feo areat Ugimaie wwe recorded in eack area, The elze-ddstributions appear

musber Oc sonthiy congruent. she peaks above 50 um represent mature walee

wee trong penke at 5 nm veflect nature femiles plus younger sales. Snalter:

inule mec'a mixture of both sexes, cease of the difficulty in aiserinina-

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(sce above), no ott 1 veen made to subdivide the

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sooht in the forest st

1h, Fosition of Anolis 2

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ond (196%) ss i

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malic in ewe sng tac pooition of th. ?0 species Su the forest MATE Table

sn constertng oo Pageportvion of PLT? eapturce of folie guNAIASS end 13

Capture of A. everaamni, Table 7 indicates the ?adetribution of eapture of

captures of ft SezSnting to perch disneter. Captures of Mzants on the ground

Sion rocks axe not recorded in Table 7.

hus data are not in particstarly geod scoora wit those of Rand (196H)-

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of captures of fs SYM Tererene ie stovisesoany shgndficant is, tows

Be er a ee ie tn the forest near La lina rather ?han tp the F2

Rand's observations wert D3; laipteiuution of the troee of the forest, Tilt Vere area, Cerin te eee utiiised ty reekdent Lisarde, However, fend? snfloenee, the ite OF Uecedpecles any e manked ccolagteal ceparation, vith

sts ola is Sint prices cqaceding 3? in fsoter Oy) of he tine (As gunilay

A Seem SiS). our figures do rot saply thie Scarce of Segregation.

fe wave also inguirec as to the pozstbic influence of size on these bebitat parnmicran. the date eet forth in Tables 5,6, ond T probably Go not snideoe Params celetioally elgnificont 2tfference between animale greater ond ese, thie ory teihoutevent length. This 12 certainly Cw of A evermanni- There Se % Braibility thet enall Anolis gundisehi occur on or close to the grown! sere ore? tan tesge ones; eter Ghalyeis of the regression of pereh height fon snout vent iin Anolis gunfiacht shoved no significent correlation of these variables (r for Area I= Sp tor area & 0.20).

5. Movenente of Anolie gunazacht .

?an analyste of bGo movements of Mzards in the two ereas vas mate. Ve

locked for poselbic Influences due to the site of aninals ant to the tine of

jeantas well as for differences bctveen the areas, The basic data are Shown

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6. Internal dorinetry

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tn ce a SoeaeG dove, ?Pree-alr dorae axe to te docimsntee actatl bY

sn Serie OF eeeyer, it ie expected thet absorbe? doses vit te appreciably

Hecommck spay covsieerably) Lower than fecemade doseh 06 NTP fo eetiante (one ee angaitete and variability of absorbel doses 1 various indi

?he mpronsets Pocintione by the ues of iqplanted <?nermoleminsoress ?dosimeters.

viduals of he Tei were prepared ty Dagerton, Genechausen & Oiees nd

The dossncters ws0) ?OT uer 6.0 ra long ant?) mx in Ghaneter contessy

gonsteted of 6 Glacsacr, Decinctere recovered after the, irratiation Vita Os

Leis Tuorlds Peeicared, abi then calabroted sgsinet Sov dosagses ee

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Original vee petvcen } to 100,000 roentgena, | Tese dosinetsre Ohne Pe

a a rane eeeece co loueensrgy gamma rediations (Lag-» eRe response 46

Yery close to energy-incepentent)

between Decenber 1h oni 22, 172 dorimeters vere implanted beneath US

itn oe titans and tree frogs in the exptrinental arca, lost of the animals 29

ane oe eeerdaptured ani released between, 10 and 30 m from the sources

freeten Moone nere treated between 30 and 45 a A fev antieals, tn the SPPEE

However, sou jlerly processed. Dosimeters vere Inserted subsemally Vth &

are ve poteraie needle. ?The resulting wound var sealed vith colleaions yg Ucee Ge cores seplarttns he foctneter resulted in the death

gt tease O¢ Eoneruily, however, thc injection appeared to have no 11.

OF ene ata Deceaber 19,00, and 21, anizels vhich hod previously been

frocessed vere observed alfve and cctive in the forest,

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Te aear. Ten males were recorded

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able 9. Analysis of 480 movuuents of Anolis guadlacht in two 0.7 acre

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SNOUT-VENT LENGTH (mm)

Fig. 2. Relationship of Pedy wosght and Length in 6k Anolis

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SNOUT-VENT LENGTH (mm)

Fig. 31.

Size distributions of Anolis gundlecht registered in two

0.7 acre areas in the Luguillo Forest, Puerto Rico.

Data vere acquired between Hovenber, 1963, and July 196h.

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Leaf Tail, Decomposition, and Litter Aniuele

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Aninals

ue Litter extraction samples are nov sorted to Drowd categertes-

cumary theets for given toth centers. Although mo spectee epee tony

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aerectin Uy radiation effects, Pre-irmaiation, there 1s no reason for

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IUSCATIGDS Chi square teste of the mean strate values world be of 114ti¢

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tower center a. f.

f

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Upper center 4. 4

9150> p> 0.30

sis ovggeste that the strata do not differ within centers and, justt=

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Tower center 181.3 mites/100

there 1s Little to chose between then, T have not tested any of the other

Tere fecause the lower pusbers and tumerous blanks ercate problese, | T ot

Sroupe pecenes ow mind about the best overall enalysis for this stwiy. F

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Stent live thas the two centers are gratifyingly stntlar vith respeet tc ne

Af appear gearina, and probably with respect to the densities and species

seeemaeition of the other groupe of litter fauna,

1 nave not yet extracted the arisals from the clay soil cores. 7

ao not capest to find much except ants and, judged by the litter samples,

they have a very spotty distribution.

+ Paregraphe extracted from letters, not checked by author.

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Litter Samples

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Stations bh-50, 64/1/28

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Litter eanplee - ML Verde

ALL values are per 100 co!

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?aot Diplopota and Chilopoda

Sone species tentatively identified as Coceidse (scale insect)

[Probably two epecies

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J antegt ?tne present eomplee are in alcohol ont their weighs Toot ?peobasly specks. inertia Deat cen do at present is to entinate sbgut one git, oF

de dav Me oS Gg ane volume of aninals in the sample vials). OF this jovty ree a (oetion (73, oF more) Would consist of =yriapodn end insects, the maser Pongn maneroue, weigh very little, but their respiration Fase Yer mites, dant wll precumséty be much higher than that of the larger fo7=2-

Jneidenterty, the numbers of mites per/i in the rain forests is quite ow commesat to Literature values for temperate forests nd my ow seapict set ceereryae. 1 ao aot yet know if thic Ss duc to inefficient extraction, OF ete aae the len? Tetter taken fron the extractor will enswer this point.

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puta on the first cet of Litter age show an instiatanecus rate of

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Pint ee landing crops of detritus, hovever, 12 based on ay strgle, sean!

then for extrection of agthropods, The sean values vere 2350 g/s) Sor th

face Contes and 1290 g/e for the Upper Centex. These values inclule sl2

heaue plus inevitnbly sone coil snd rsots,

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given in tables on pace 163 and 16h, Trese stations axe mowced with coat

forts designesed V-l, U2, Wa3, etc

tue vecen's o- ccf and sruit fall at the 50 stations set ost by Bre

FREESE Gondimed vy the seeldent star? are gives om pp. 31-36

Rete Ge the 50 icaf Tall stations wieh vere located with rendcx

numbers waa given in the 196h report

Related data on Litter extzactions in vo: prier to 1963 ts contained

in a nowseript by Otus, Abbott, Gelanier, Colley, end Wilson, Low mumbers

in berlese fu:nels vere noted in thnt works cleo.

Sone date on leaf Litter sa.see cre given in this report on page 105-

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maint quarterly Censue Report of the

Avitouna of the El Verde Experinental Area

ty,

arry Secher, University of Pennsylvania

Introdvetion

The following report is the third in a series on the avifaune of the

Fi Verde cxperinental area, ?The data presented bere arc the result of obyervar

By Verde e*Detyoen 2 Deceaber ant O Deceaber, 1964, This is a period of ths

fons cals moraally marke the beginning of the ary season (Figures 7 ent 71),

year wich ne given of the bint species density and of territorial or homt-

Pekie Lintts of individuals ac determine] by a serice of poysiation censuses.

pata are also presented from # cengus area located on tit, Britton, El

yunque Hational Forest (Figures TIT end IV), Thie area differs fron the Pi

vent ot in being at a greater elevation (approximately 850 seters; élvcn

wereeoPhcters in the second report, but now corrected to 650 peters) nd

Se ting a greater anourt of precipitation. The forest on this plot bars

TeeSty unieh selion exceeds 50 fect ant probably averages 35-40 feet. Over,

SERIE Sone of the cenony trees are Sicrra Palzs (Euterpe globose). _Aeconiing

% Hob Suitn (personel comunieation), the forest Composition compares to that

Found on the wetter sites at El Verde,

coeervetions vere mae in this area from 9 Decenber through 15 Decesber, 196.

included ie an annotated checklist of the binis obverved on the experi-

mental area.

Procedure

?The sane cers

Tana 11.

1s procedure vee Followed ac recorded previously in reports

A totel of 61x censuses copprieing tventy-etght hours of actual cencus

time vere mate on the Fl Verde area, Tae iit. Britton census was completed

{iN eventeen hours ant also involved six ceparats censuses, An unrecorded munber

of hours wes opent in non-censusing observation,

Reeuite

Territory and Nome Range ape

Figuree 5-Ii shov the recorded territories or positions of the species

most frequently recorie! during the census period. Viaps have been omitted

Tee the fuerte Rican Bullfinch (Loxigilis portorieensia). Only one bullfine

ABs seconded ani the vireo 1e @ migrant currently vintering in South Anerfes

ee SEL). Territorial Linits are given for the bananaquit (Coerba, flaveols) toa tay (Telus sexicana) at these Wo enecies, Only, appeared to be defending

territories.

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Tatra quarterly Cencus Report of the

forkgouna of the $1 Verde Experinental Ares

wy

Marry Recher, University of Pennsylvania

Introduction

?The folloving report is the thir? in a series on the avifame of the EL Verde experinental area, The data prezented here are the result of observa tions made between 2 Decenver ani £ Decesber, 1y6k. Tats de a period of the year which normally marke the beginning of the xy season (Pigures I and IZ), Estinates ere given of the bint species density and of territorial or hone- range Lintte of Individuals se determine! by a series of ropulation ceneuse:

Data axe aleo presented fron a census area Located on Mt. Britton, BL Yunque Hational Forest (Pigures IIT ant IV), hic arca differs trom the? Fl Verde plot in being at a greater elevation (epproxinately 050 neters; given

as 900 weters in the second report, but nov corrected to 850 neters).ant receiving a greater arount of precipitation. The forest on this plot has © canopy which seldon exceeds 50 fect and probably averages 35-H0 feet. Over 50 per cent of the canopy trees are Sicrra Palus (Euterpe globosa). ?According fo Bob Snith (personal conuniestion), the forest composition compares to that found on the wetter eites at Fl Verde.

Observations were maile tn this area fron 9 Deceaber through 15 December, 1964,

Included is an annotated checklist of the birds observed on the experi-
mental area,

Procedure

?The sane census procedure vac followeA ee recorded previously in reports i ana II.

A total of six censusce cogprieing twenty-eight hours of actual census time vere nade on the El Verde sca, The Tit. Britton census wae completed

in seventeen hours ami also involved six separate censuses. An unrecorded number of hours was spent in non-censusing observation,

Resuite

Territory and Hone Renge ape

Figures 5-14 show the reconted territoriec or positions of the species nost frequently recorded during the census period. spe have been omitted

for the Puerto Rican Bulifinch (Loxigiila portoricensiz). Only one bullfinch yas recorded and the vireo is a migrant currently vintering in South Aneriea (Bond, 1961). Territorial limits are given for the bananequit (Coerba flaveola) and tody (Todus mexicans) ac these two species, only, appeared fo be defending territories.

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abr

Teproductive Activity

tn general, there vas an insrease in singing activity (relative to August) seeng all gpceice proseat except the Dananagait end ruddy-queil dove (Geotrygon noctana).fowever, vigorout singing vith full song vas recorded oniy Tor the Pesaragust, redcneked pigeon. (Coluibe squmzoss), bullfineh ant fuerte Fison orl (Otus judinee).iesitant aki veak singing Was recorded for the pearly-eyed thruaher (Msgavope Tuscatue) el the red-legged thrush Uingeicnte qustea). Stripes Beate] tonapers (Gointalis zera),vere not Fecorded singing, but males were frequently heard giving their "eveep? cell: ?Wing rattling" by todies was recorded three times.

?Tt appears that over-all reproductive activity is now lover than in August, ant that ost species are juet eutering the beginning of their reproductive period, April through shine would therefore appear to be the

peak of the breeding ceason witn eeveral opecles comencing courtship activities in Decenber and Jamiary, Only the bananaquit nests with any regularity through-out the year (Figure 16).

Population Density

Ae in August, the abeence of territorial behavior presented an accurate determination of population density for nost specics. The figures presented Sn Table T are therefore eubject to more caution than those given for the March-April ceneus. In all probeb!iity, the estimates are below the actual nunber of individuals on the census areds.

Senanaqutt

?The figure given for the benansquit represents the munber of territorial males. ?he decrease from thrch-April through August and December probebly reflects a decreas: én reproductive activity rather than ary decrease in the hunber of individuals, In addition, mmerous inusture individuals vere observed, Dut noteounted, There has been a decrease in muzbers on both census areas;

9.88 on the El Verde plot ani 9.0% on the Nt, Britton plot. The greater Accreace at lit. Britton may reflect the effect of altitule On environmental ?seasonality end indicates that the i Verde plot 1s e more etable environment .

?Toay

Particular attention ves placed on the covenents, hone range ant population density of the tody. As a result, scveral problens arising during The Previous two censuses vere recolved, Tt nov appears that the hone range of the toly 4e large relative to Ixs daily movements and that outside of the breeding seascn, individuals are colitary.

Red-Hecked Pigeons an Ruddy Quail Doves

nee again the mumber of pigeons and doves heard calling during the conoue were recorded (see Reports I ant Tz). In contract to the August census, Fed-necked pigeons vere frequently heard calling, though less often than during ?the March-April pericd, while ruddy quail doves were heard only infrequently (Gable 11).

---Page Break---

2)

Foraging Groups

Mixed flocke of foraging binds are generally considered characteristic of tropical foreets. At El Verde ond in the I. Pritton-El Yunque area, foraging groupe are conmonly obeerved. The Tuerto Rican Tanager (Heogpingus specuLiforus) 1c the most commonly encountered species vithin these mixed

FSG acd appears to be the epeckes about which individuals of other species [roup thenselice. Migrant wareleze and juvenile bananaquits are aleo regular EXpenente of these nixed flocks, In the Varch-April period, and especially

Se hagust, there were fever groups noted, ani those encountered were smaller

i ee tha ?containea fever species than? the once seen in Decenber. The greater number of wintering warblere ana the apparent tendency of the Puerto Risen Ringer to form larger flocke during Decesber results not only in larger sroups, Tut in a greater minber of auch groups. In the majority of cases (50%) where

f group of Toreging Auerto Mean tanagers were observed they vere accompanied fy Donmnequite and warbiers. lfovever, cecasetonal groupe were also encountered Uhich were compriced only of migrant varblere. During thie March-April period land in Auguet, small groups (3-5 individusle) of benanaguite vere observed.

?The tanagers observed in auch flocks tend to bunch together so that all the tanagexe ins flock might be foun within two or three trees. Varblere fand dananaguits ter? to be more dispersed with the result thet the entire Group may trail out thirty or more meters.

In foraging through the forest, these flocks are often Joined wy Andiviguate of other species (Tody, pearly-eyed thracher, black-whiskersd

Vireo, bullfinch, banaraquit adults) through vhose territories the flock 4s passing. These birds crop out after a short distance.

Diseuscion

Seasonal Changes in Population Composition

ie nov seen Well established that there 1s @ pronounced seasonal change in reproductive activity aong the birds inhab{ting the Enguillo National Forest (gure 16). Coinetient with the reproductive cyele ere various changes in fomulstion coupecition, ?gration, al(itaiinal novenento end flocking behavior Feoult in proncunced changer in the epecles conposition of the forest as well fae affecting local population densitice.

?the migration of the black-vhiekered vireo to South America, the altituiinal novenents of the ed-neekea pigeon and the migration of the North Guerican varblers greatly change the population composition between the fall~ sicter ant spring-sismer. A lecser change ic affected ty the post-reproductive Regregetions and flocks of the red-necke4 pigeon, ruddy-quai} dove and Puerto Rican tanager.

Chonges in population density aeemuing through reproduction and mortality

appear to be lose spectscular, Indeed, It {s difficult to detect any changes

qrPeShulation size onong resident birt syecice that cannot be accovnted for ty

Gaupling error (Table 1). Thig ie ip contrast to the situation found in

fenperate clinates vhere nonenigrant bird populations Tuletuate widely between Sreproiuetive peak and the precproductive low.

---Page Break---

the contrast offered by a seasonal change in reporductive activity vith ?the velative stability in population aunbers of resident bint species indicated Ghat there de a seasonal fluctuation in avatlable energy, but thet the oyster fc a vole is more stable than thoce found in temperate clinates.

?The Influx of Worth Anerican Varblers

the greatest change in population composition results from the migration of Worth imcrican varbiers. Unfortunately, 1t is inpossible at the present tine fo even estimate the number of varblere occurring as inter reeidents within

the forest, Certainly, it fe @ considerable mmber and ae euch, these binks Tecone an impertant ceeponent of the eccayster during the winter months. The Question mst therefore be posed az to vhcther or not there is a curplus of

Sherey (unoccupied niches) which these birds utilize during their winter steteeney ond thich renaine unutilizes during the sumer pericd while they are Thecnt. "In part, the migrations of the Blackevhiekered vireo accounts for sone ab these energy aifferences, bat probably the energy utilized by the wintering Sarviers ic greater than that utilized vy the breeding vireo popalation. Tt te ?yoint whieh should be wore fully resolved. Possibly, the eneray demands of the oeehent ?bind population ate sufficiently lover outside of the breeding season fe acconodate the vintering warblers. lowever, it sceus likely that if there wee cheney available, the resident bird species would continue to breed through~ Cat the year. Possibly the answer Lies with the types of food organtsns Ghellabie and the ebilities of the various Kinde of birds to utilize then,

+ me ?sbtLity" of the bananaquit to breed throughout the year may bea result of its utilizing a relatively rich food source (flover hectar, insects attracted to and presumably concentrated at flovers, ?and perhaps pollen).

Annotated Checklist of the Bind Spectes Found on or ?Around the 21 Verde Experimental Area.

observations are incluted for species occurring either at the EL Verde Station or on £1 Yunque (including Mt. Britton), put whieh may pot have been recorded for the experizental area proper. Birds not seen on the Ufperinental area are irked With asterisk. Only observations vhich QMiplenent thoee recorded in previous reports (I and Tt) are included.

ssharpahin Havk (Acctotter atriatus):

A single individual of thie species vas observed over the Santurce River below fhe Bl Verde experinental area on 5 December, There 1e supposed fo vexist a rare Puerto Rican subepectes of this bint vhich te confined chiefly {0 the Mariceo Forest (Leopold, 1963). Whether the indivigual reported here Mle ee hic subspecies or a vegrant fron Worth Anerica could not be determined.

Red-Tailed lav: (Buteo Jonaicensis):

Individuale of this species vere regularly observed soaring over the forested areas at El Verde and 1 Yunque.

---Page Break---

wm

Red-llecked Pigeon (Golusbe equansea):

Rally Quali Dove (Geotryrca aoutana)

See text pp.

Puerto Riear Parrot (ser

Parrote vere eeen ot heard 2

the census period. Drewy (personal

the liorth section and ceenet to be so:

South eection vere ?hey vere 9%

roost.

?regularly on the experimental area throughout

murteatiot,) ea a group of thirteen on

Trequcat in the axes South-Best of the

eved feeding ard gathering in an evening

Puerto Riean Ltzart Cuckoo (Sauscthery vietLiott):

Theve yet to observe

frequently cel close at hand.

¢ bird tn the Zorset even though individuale

Puerto Rican Ovi (Qtus mines):

There appeard to be an increase in calling activity over the August

period and several inividials vere heard calling after sunrise (7:30 a.t.)

ant before sunset (#15 p.m). Ivo indivituale were heard on the EL Verde area,

In general, this bird ie more eburdant at lover elevations though it ranges to

?at least 1,000 meters.

Puerto Rican Bnerala Munningbird (Chio

Ab

augacue

?The nale previously recorted from the EL Yangue Mology Station wae sti11 in the area ant defending 1t against other huneingbirds (neles only?). Becauce of the etter conditions encountered during this trip, fever humningbirde than previously were encountered. During vet and cool weather these binds tend to Tait tight".

Puerto Ricon Tody (Tedus zexicamus):

No burvoving activity was noted, but "wing rattling" vas recorded three tines. Wing rettling 1e a cound nade ty the attenuate outer primaries of both sexes and 16 heart only during the breeding season (etuore, 1927), Territorial defense vas noted on one occasion. See text py ly

Puerto Rican Woodpecker (Nelanerpes. portorice

Lnggerhesd Kingbird (?yranms cauditagctatue):

A single individ-al war recorded twice fron the orth Section of the EL

Verde area, T have yet to observe this species in the Ht. Britton-E Yunque area,

---Page Break---

are

Fearly-Byed Thrasher (Naxerope fuseatus):

?the reucous calling noted during the August period was heard very

infrequently in December, but several individuals vere reconded giving very

"week" revditions uf their breeding season song.

Individuals vere observed feeding on green and ripe fruits of the elerra

palm and ripe catkino of the cecropie (Cecropia peltata).

Red-Legged Thrush (iMimocichle pubes):

Individuals vere heard giving a very "weak ant hesttant? eons.

Bananagutt (Coereba aveota):

Individuals vere observed constructing nests ca ceveral occasions, but

only once vas a male and feusle obecrved working together.

Tesritortal nales appeared to tolerate Juvenile and female bensnaquite within their territories. Hovever, the passag: of mixed foraging groupe containing juvenile bananaquite often excitea the male through vhose territory ?the group Vas pacing eo that he seng vigorously. It is possible that terri tories are defenied only against other singing nales. Certainly these binds forage over a larger area then Je indieated by constructing a Line about their singing positions, Several males have been observed together in areas where ?there was a great concentration of food.

Benanaguits sing throughout the day, but there te a pronounced morning and evening chorus (Figure 18). As the scatter of points on the graphs indica~ tos, there {s considerable variation throughout the day in the number of songs ?that are heard st any one time. Singing may be most consistent during the ate morning house (10:00-12:00 a.a.). Each point on the graph may represent ?the songe of severcl individuals

Bananaquite vere observed feeding on ripening grapefruite and orenges.

Bleck-ani-White Varblor (Jniotilta varia)

Parula Varble~ (aul anerieane):

Cape Ney Warbler (Dendroica tigrina):

?A group of eight plus vere observed feeding daily in a fruiting ant flowering «....(?) tree in the station yard at El Verde. ?This tree also attracted pearly-cyod thrashers, red-legged thrushes, bullfinches, bananagutts, Dlack-faced grasequite, black-throated blue varblers, Dlack-covled orioles (eters doninicensie) and stripe-heaied tanagers. intraspecific aggression Was observed among all specice with the exception of the latter four, vhich occurred either ae single individials or mated pairs. lo interspecific ?aggression vac observed.

Cape Mey varblers vere frequently observed hawking insects.

---Page Break---

2B

Elack-Thronted Blue lavbler (Dentros

vhrone):

The alee of thie species are perhaps the casiest warblere to see and identity in the forest canory. OF the Tifteen black-thrested tiuec seen, only two were females, but thie noy Uc a factor of the greater visibility Of the males. Ar vith all the varolere eecn (exeept the waterthrush) these birle restricted their activities to the canory.

Houtsiana Vaterthrust (Selurvs sotactlis)

Individuals were observed in the it, Britton area feeding on insects Ynotked to the asphalt rost by rein. An individual vae heard singing.

Skeericon Redstart (Sotoshoga rutietiia):

Blue-Hooted Suphonte (Zanagra gustea):

Reported during Zovenber, 196% ty Bob Gnith,

Stipe-tested Tanager (Spinialie zena):

Qo contrasting observations were made during thic trip on thie trip fon this species: 1) Iles were observed to frequent » particular singing

post for at least a veek in evccession and to call from thie perch throughout

the day; 2) iales were also observed to fly long distances between singing

perehes. The possibility ie therefore raised that vhile come individuale

Gre breeding, other are not. At no tine vas the Warble? song heard.

Males were noted to sing)"seep" song) in flight.

io aggregations of thte bird were noted but on one occacion, individuale

of tate species were recorded in a mixed foraging flock of Puerto Rican tanagers

and varblere.

Puerto Rican Tanger (Jeospingus speculitere):

See tert yp. 6-7

Tae ?ceep-seep" coil which wae abecnt Sm August wae once egain heard

regularly. in eiditior, © ne) series o? warble motes var recorded - but not

as a cong. Wetuore (2967) revorts this epecier as having a pretty warbling

song during the breeaing seacons (Suns), The notes hear! in December vare

exchanged between tvo tenegers Zolloving caca other about in a Lemboo tangle.

Om one occasion, an ind?vidvsl vas observed tc pick up a plece of fiber. This

wes later dropped and leit.

Coloration differences hich may have represented a sexual Ainorphiew

were particularly obvious.

On 12 Decesber, 1964, tenegers vere observed in groupe of 2, 2, 2, 2,

2, 8 and 10 (there any have ween tnseen inaividuais in all the groupe observed).

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vt

© Hooded Yeaver (Loneture exculiat

Observed slong rod leading to EL Verde.

© Black-Faced Grasequit (Marie bicolor):

Present, but not singing in the station yard at EL Verde.

Puerto Rican Pullfineh (Loxigilla protorieensis):

4s intereeting to note that vile cone males were calling regulariy, others inom to te in the aree vere eilent or called only infrequently. There fe the poseibiitty tet a fev iniéviduale may be breeding throughout the year.

Yellow-Faced Grassqutt (2s

2 olivaces):

lard singing in the lovlanis, but not along the road near the station tumof? where it hae been previously recoried.

Wiote: For reasons of space, Ur. Recher's first ond second reports are not included here although they contain various inportent data with Little overlap vith report |

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175

marie T

Population Compoeition (individuals) of the GL Verde and Mt,

?Britton Ceneus Areas During Decanter, 1964

__Mt, Bpitton (ap. 8 scree

Species

December

Red-necked Pigeon 0.25

Ruddy Quail Dove °

Puerto Rican Parrot + °

Lizard Cuckoo O65, +

Puerto Rican Owl 2.0 +

Beorald Hummingbird ? 2.0 2.0

?Today 20.5 3.0

Puerto Rican Bt +

Woodpecker

Pearly-syed Thrasher 7.0 2.0

Bananaquit 64.0% oinging males 13,0 singing mal

(228.0 individuals: (26,0 individuals)

Black-Wniakered

Vireo ° °

Stripe-Headed

?Tanager Be ing males 2,0 singing male?

Puerto Rican

?Tanager had at

Bullfinch x. 2,0

Loggerhead Kingbird male °

(iepannue doninicenets)

ee

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© ar

Wunber of Red-Neckod Pigeona od Ruddy Quai? Doves Calling

An the Aree arcuné the it Verde experimental Plot

Red-Necked 5 2 : s 5

Pigeon es ?

Ruddy Quail o 2 o 3

ay 3 ° 1

Table IIT

Warblers Observed Betweon 2 December and 15 December, 1964

at the Hl Verde and Mt,Britton-#1 Yunque Area:

HL Verde Mt, Britton Total

Louisiana Waterthrush

(Seturus sotaetiza) © 4 4

Bleck-Throatoé Blas 7 8 35

(Dendrotce gaerul

Redstart ° L a

(Setophaga rutiotie)

Parule 2 4 6

(Parule anertoang!

Blaok-and=Whit: 2 4 6

(Mptotiita varia)

cape a 5 43

Mes

(Depareles Ligrina)

Unidentified ° 2 2

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179

4 EL Yunque 3496"

Mt, Britton 3075"

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Fig. 3

Location of Mt. Britton Census Area

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Puerto Rican Buerald Hummingbird (Ghlorostilbon maugaous) ?

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Syes we December 1964 {

ry 44 >

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Fuerto Rican Tody (Jotun wexicanus!

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Puerto Ricen Woodpecker (He2anorses portoricensis) 186

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yh,

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188

flaveota)

Goereba,

Benansquit (

my AN

ye December 1964

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189

Stripe-Headed Tanager (Spindalie zena)

---Page Break---

Puerto Ricer © (Heoepingus speci iterus)

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CAlishe

a

WE

NumBER OF BIRDS

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◦

NagcH-APaint RuGust | DECEMBER

Red-Necked Pigeon (Columba sguuzoss)

Ruddy quail Dove (Geotrygon gontans)

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?The Phosphate Cyele

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Bike Tuscy PRIC,

with aseistance Of GAL Bets

In our previous report for 1963 the movenont from Litter to plant and sofl of she plant nacromitrient phoephorus in the tropical rainforest was noted with the ald of tracer 232, The data inicated considerable absorption by plant yoote of P released during les? decay. Little loss

Of P seems due to leaching from the root zone by rainfall.

Further studies have concentrated on a survey of the total P content of various rain forest plant aaterials. Reeulte obteined fron chemical fanslysis (soxe with Technicon Auto-Anslyzer) of acid digests of plant tissue fare tabulated belov.

nile the data are uncuffictently replicated tn most cases, certain ?trends seem evident, These aret

1) Plant species dizfer in P content fron each other and at different sites, though the level of Hitutinatien fe not a factor.

2) riture leaves contain significantly leas P than young leaves of the sare tree,

3) Root content of P de equal to or higher than that of mature Leaves, but tits is less than that of the decomposing leaf matter 1n contact vith the root.

4) Non-Leaf debriz ie significantly lover in P than leaves ready

to fall or the Hitter itself,

on the bests of these fragmentary results, one may typothesise

picture of Puovenent in wiich P content 1s hign?in young leaves, vhere

Phoephoryleted cospounds are denanaed ty photosynthesis end melete acta

Ruplication. This P is drained fron the leaves ao they oture, due to

denands in new grovth eleevhere, Upon fall ani decomposition, the leat

Cfooue loses C.H, and 0 more vaplaly than P, thus rising in apparent P

Content over that of the 1eaves thenselves.? Thosphorus te absorbed

by the network of tree roots at or near the ourfsce; this movement ts

rapid, 80 that P content of the roots 1s lov.

---Page Break---

utente

Teaves

. Yourg Tabomuco gp. -

Bet

a. Mature" -

oo Fallen *

2. Young

e. Young Dacuyotes excelan (#2695),

?Leaves in shade

fn, Mature Decryotes

4 Young Manttknre attide (#2680),

?Meaves in sun

J. Mature Dryoptert@ deltolia

Roots

ke, Tahonuco ep., near sotl surface

ther

A. Organte matter in contact with

?root (Ic)

fm. Fotted wood

296

?Total phosphorus content,

as nex 2) sigcue"!

+208, 080, .085,

1208, 1086; 0.93 aver.

+100, «125, -106,

YoB6, 1056; 9.95 aver

+33, 34s O.3h aver.

2.10, 2.32, 2.89; 2.2 avers

0.28, .32} 9.30 aver.

0.66

4 Vaues represent replicated samples taken of the material

---Page Break---

wt

Chemical Analyses of Trees st El Verde

from J. D. Ovington

Yonk'e Wood Experinentel Station, BngLand

Az Listed in the last years annual report, sone representative trees

were cut, weighed ard sampled during llovenber 1963 by the project tesa

Guring Dr. Ovington's vorking trip. During the remainder of the year Mrs.

San Briscoe prepared senplee for cherical analyses ty drying and powiering

in Kiley file vith the ald of the Sotls Division of the University of

Picrto Rico Agricultural Experinent Station through the courtesy of Dr.

?Alonso Riere, The main portion of cach esmple of leaves, wood, Linbs,

?ete. wes then sent to Dr. Ovington for chemical analysis ty the Chemical

Eervice of bie organization, The ature Conservancy Woodland Research Section,

Monke Wood Experizentel Station, Englané, tm the first 3 months of 1964

roots of the felled trees were dug out by Alejo Estrada Pinto, Juan Haisonet,

fara Doroteo Nartives Garefa, ant these wore aleo processed for analyses.

The raw tables are included belov, Ultinately, the chenfcal content of forest components are to be computed by combining these date and the dats

Collected ty the Tropical Terrain Detachent on trees out to 30 meters in

the tvo study area circles.

teble 1

Chemical tata on forest components at the EL Verde Site.

Wurbers ere percent of oven ary weight.

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material Species cote cote

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sae 2 01200158 0116 0,32 0.032 0.48

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Bek = 6 (0.08 0173 0123 0.025 0.60

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?roots

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ca 9 9 0r10O1kG 0422 0.34 0.026 0.39

ca &r Yo 0103 0182 0,16 0.24 0.032 0.55

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199

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0480 0.06 0.036

os 97 20 0,08 0426

spathulata

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?Type of

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Roots

None of letter

Species ?code

and tree

?punber

Sloanea

vertertana Sb 23

Bb 23

Sb 38

Casearta Co 33

bicolor

be

Rourea

glebra Rg 2

Re 31

?Tabebuia

heteroptyLla Th 16

? 62

Buchenevia

cepitata Bo 18

Be 22

Be ob

Banisterte

leurifolie BL 50

Be T

ca 9

cab,

ca 87

Cosearta,

dicolor bt 33

cet 53

cs 86

op ag

cp 48

op Bb

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Type of ? tane of letter je ok co Mm PO ON

material Species cone

end tree

munber, _??____?-

Torge & Medium

roots

conte

?borinquensis Cb 2% 150,36 0.72 0.67 O-h 0.017 0,58

Casearia 6 0.038 9.57

sylvestris yy O10 0.46

8 01025 0.70

19 o10h5 0.59

Contta

suleata Cs 2 20 0.20 0,018 0.54

cyrinia

Yeceniflora Cr 101 BL On 0,05 0425 0.06 0,003 0.12

Dacryodes

exeisa, De 20 22 0,03 0.08

De 21 23 o.0k 919

De 39 ak 0125 0.30

De 52 25 0.02 0.19

De 50 26 010 ova

De 102 2T 0,06 0.13

Didymopanan

morototont Dn 81 L 0.72 0.79 0.23. 0.022 0.43

be 2 0152 0.73 0:13 0,020 01h

Drypetes

glnuce be 27 3 nT 0.63 0.22 0.019 0.39

Bugenta

etahlit Bs 3 ?

Bo 5 5

Bs 15 é

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Inga ep. TL M6 8 oe2l 0.65 0.06 0.018 0.59

Ings

vere wt 9 0.21 0436 0.03 0.015 0.49

rrora

ferrea rr 60 20 0.28 0.97 9.07 0.55

Ie a 0120 0.36 0.06 0153

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ee of tame of = tatters Ma Kk

Taterial ?Species cote ode

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Foote

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rugosa Br ST 2 0.10 0.38 0.19 0,022

He 58 a 0.16 0.17 0.12 0,016

- =p ot 809 8115 0122 01080

ee Sret 0123 Oak 01018

mo Orel 9158 109 0101

- conta

prasina Mp er Ww 0.32 0.36 0.06 0,013

Mp 3h 16 0.28 0,32 0.05 0,017

- Miconia

feemme ot age 0.05 0.07 0.012 0.33

. RO 8 0130 OL Oroh lott 0.36

ntcropholio

arcentectoite ve 52 o.01s 0.38

- mex orca Oli

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large Roots

- atayba

Soingensio 2550 one 0.20 0.08 0.019 0.32

wa 99 2 0.20 0.50 0,08 0,025 0.34

Myrcia, Me 56 3 Oak O.h2 0.0h 0.015 0.36

erberis

"Maya rs 4 o.42 0.38 0.05 0.029 0.26

- vansikara

nitide Mm 5 0. 0.34 0.05

me 8 Oras Olgh 108

mo OT Olas 8122. Oios

votes

Aeueoxylon = OL 8 0.28 0,46 0.09 0,025 0,42

- ae 5 0158 O50 0105 01009 LMT

on 85 10 0,38 0,06 0,02 0,023 0.55

aa oo O18 OnN6 Olan 910150108

- Ocotea

?portoricensis Op 2 12 0.26 0,38 0.03 0,032 0,00

- ccoten spathulata ce 9713 0.26 0.30 0.02 0.033 0.77

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Facemiflora Cr 61

cyrtiia

conta

suleate

Coearta,

cs He

ce 28

cs 92

sylvestris

aygese

Radar

S&RRAS

excelsa,

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Type of Mane of letter Tab, Ha come OP 8

Eaterial Species ?_?_ cote cole

ard tree

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roots,

Daeryodes

fexcelss De 102 20 0.22 0440 0,09 0,027 0.2%

Diaymopanae

morototont Dn BL a 04M) 0431 0,08 0.016 0.39

De 8 Be 0126 0.25 0,08 01012 0.21

Prypetes

glauca Dg 10 B 0.40 0,48 0.05 0,025 0.80

Dg 37 a 0,28 0.60 0128 9,022 0.0

agente,

stahlit Bs 15 5 0.15 0.65 0.08 9,018 0.25

Fs 15 6 0115 0148 0,06 0.018 0.25

Be 36 1 0:28 0175 0.15 01018 0.28

ard 1B O18 LW 0.31 0.020 0.3%

Inga sp. AG 29 0.29 0.0 0,016 0.35

ny 2 O1k2 010k 0.013 OL

Inga vera WL a 0.20 O17 0.03 0.011 0.48

eora

ferrea 6 22 0.18 O.t2 0.03 0.012 0.29

18 6 3 0113 0138 006 0.025 9.29

Hirtelia

rugosa, ur $7 a

He 58. 2

Be 70, 3

Br 83 R

Miconle

prasing =D 27 5

Mp 3h é

Mp TL 1

Up 72 8

Mp 95 9

Miconta

tetrandra Mt 90 10 0.21 0.10 0.08 0.015 0.22

Meropholis

garcinfaefolia Ng 5

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0,oh 0,13 0.08 0,008 0.24

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?Type of Mane of Letter a a a a

material Species cole coe

and tree

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roots,

Micropholis

garcinisefolia Ym 52 12 QxrB oto O11 0.0T 9653

gia 3 0116 0.69 0.07 0.083 0

Matayba

doningonsis M8 55. 0.12 0.29 0.05 0.0Lk 0.18

m #9915 0119 0150 0105 0.023 0.28

dyreia

verberis ms 6 0.16 Osh 0.06 0,013 0,28

?Maya! woo 038 0.27 0.05 0,026 0.15

Mont tiara

nitida Mm ik 8 0.19 0.23 0.03 0,007 0.13

M3019 OL1T 0:23 0.05 0.006 0:16

mas 20 0115 0127 0.08 0.013 0.25

M95 AL Orah 0,34 0.05 0.006 0.3

Wyreta

splendens MeS 22 0.32 0438 0.06 0,026

M73 23 0132 0121 0.06 0.027

ccotea

leveorylon = LL bk 0.62 0.02 0,026 0.33

a6 2 0128 0.73 0.03 0.021 0.64.

as 3 0128 0.6) 0.03 0.003 O-k5

100} 0120 0.23 0.07 0,018 0,25

ccotea,

portoricensis Op2 5 0,20 0.29 0,02 0.004 0,52

ovotea,

spatmlata = 08 9T 6 0.19 0,12 0.02 0,029 0.56

omosia

logit oe LT 0,08 0,10 0,02 0.015 0.47

Palicouren,

sparta Pgh 6 202

Be 9 1

Pr 2 10 06

bss 02

Ror OL

p59 13 4

Pro2 1k ob

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Type of Mane of letter labs Ma Kk MP

material Species ote cole

and tree

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Butt

roots

Palo

?Blanco B3 5 ote 0,61 0,50

Pato ae

polio 5 16 O.tk 0.27 0.08 0,026 0.61

Prychotate

derteriana Pb 29 38 0.36 0.29 0.04 0.016 0.2

R39 Ww 0:30 0129 0.08 0.021 0132

pik » O1N8 0,21 0.03 0.020 0.24

Stoanca

verteriana Sb 13 2 ©.1T 0.50 0.04 0.013 0.20

5b 3 a 0116 0161 0108 0.015 0.27

sen 2 0,26 0,69 0.06 9.019 070

?Tabebuia

heterophylla Th 16 3 OAT O12 0.01 0.012 0.28

m 6 2h 0:38 O37 108 0,022 0.38

Boles

Achorneopsis

portoricensis Ap 7% a 0.13 0.19 0,09 0.020 0.32

Bonisteris

Yaurifolla BL 50 2 0.24 0468 0,09 0.039 0.58

Byreonina

pleat Be 7 3 0.26 0.48 0,08 0.033 0.35

Buchenavia

capitate, Be 18 4 0.25

Be 22 5 0:28

Be 90 é 0.26

Cascorie

arbores 9 1 0.33

bs 8 0126

9 13k

Casearta

gulenensis Ce 78 20 0.87

Cosearta

Beolor = tah ovat

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?ype of Nano of letter lab, Ma KC

material Species ?cote ?cole

ana tree

amber

Boles

Coscaria

?bicolor oi 33 oe 0.36 0.56 0.16 0.023

oi 5313 0:38 0.38 0.21 0.019

Cascaria

sylvestris co 214 0.52 0436 0.32 0.034

ce 2815 0.92 0136 0.24 0.054

ce 16 0158 0.33 0.22 0.036

Calycogontun

squamulosm cys Sh 1T 0.21 0,91 0.08 0,018

Cecropis,

peltata cepig 8 0.62 0.40 0,32 9.029

cep 48 19 O1Wo 0129 0.22 0.017

Cop Bh 20 0128 0.19 O37 0.010

contia

oringensis ?Cb 35 2 odo 0.54 0.16 0.032

8 0140 0.34 0-12, 0.037

8 oyho o1k2 0.08 01033

Contia celta ak 058 0438 0.13 0.005

suleata cel 8585 0128 0.36 0.13 0.018

cyritia

Facomiflora cr 1061. 0.07 0.13 0421 0.005

Dacryodes:

excelse Be 2 8 (9.005

De a 3 oot

be hk 0.067

be 5h 5 ovo

de 96 6 (01009

beet 7 o.o1t

Diaymopanex

morototeni «=m ?&1 0428 0,32 0430 0,008

& 9 0136 0.31 0-2 0.013

Drypetes

glauca be 1010, uw 0,85 0.06 0.033

won 0128 01h 0L18 0.022

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Boles

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berterians = 29015 0.52 0.32 0.07 0.017 0,38

m9 16 0136 0035

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Patiodentron 710818 3.00 1.7L 0.20 9.06) 0.69

kebess

Toures

glabra Rele 19 0.19 O32 0,082 o.b

Re 30 oval G15 01026 OL

Stoanea

verteriana = STL 0.28 0.72 0.06 0.018 0,28

S13 Be 0120 0.46 0.0% 0.010 0.21

823083 0115 0.36 0106 01015 0.2%

?Tabeduta,

heteroptylla Th 16 ah ova 0.023 0.29

mh 25 o.se 010230132

m6 6 0128 croak 0.30

Tetragastris

Dalsmifere B75 oT 0.56 0.25 0.06 0.034 0,34

Branches Alchorneopede

portoricensie Ap 7h C682 0.19 0,08 0.032 0,18

Bontsteria

dourifelia = BL 502 036 0.93 0413 0.088 0,60

Byrsonena

spicata, BT 3 OM 1,07 0.16 0.085 0.78

Buchenavia,

copitata Beeb 0.58 o.oak

meee 5 133 01038

Beg 6 ovis 0.027

Coscarte

arborea coo oT oe oy 0.078 o.TT

cabs 0:84 0, 0105 0.86

ce 9 0198 0 21038 0.72

Caserta

Bheolor Coed 0,80 0 0.086

33 ole 0, 0.033

oss 0164, 0.027

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a3

Type of Hane of letter lab. Me KC MP W

Eaterial Species code cote

ana tree

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Branches

Cascarta

guionenese Cg 78 0.82 0.17 0.18 0.032 0.56

cazearia

sylvestris Cs 2B 1h 1.80 0.82

os. 15 1000.29

Catycogontun

?squamulosuz ?cys53 «16 0432 1450 0436 0.035 1.03

cye5h AT 0132 ial ol o.c2k 0157

Cecropia

peltata cophB 18 1.W0 0.06 0434 9.060 0.62

copBs 19 O27 9180 0116 0.030 0.55

corte

vorinquentis Cb 35 2 0.56 0.61 0.62 0.038 0.87

3 al 0128 0186 0126 0.080 0.72

3 0166 0.83 0:28 OL08e 0.83

corti

suleata cone 23 1.06 0.56 0.32 0.050 0.59

cs185 2k 158 0,56 0124 0.076 0.63,

oyrtaa

Teceniflora Crl06 1. 0.09 0,20 0.07 0.023 0.26

casearta cs 2 2 1.34 0,38 0.80 0,03 0.81

sylvestris

Dacryodes

excelsa Pee 3 0.30 0.5K 0.12 0.038 0.6

pear 0128 0130 0.06 0.020 0.23

beSL 5 0.20 0.16 0.03 0,019 0.19

re 6 Oke 0.72 9,12 0,020 0.53

e596 OLLT 0138 0107 o10xT 0.32

Dew? 8 0120 0138 0112 0.086 0.35

Diaymopansic

morototent = Tal 0.66 1416 0.19 0.004 0.48

Drypetes

glauca tei 10 0,96 1,58 0.28 9.069 1.06

reir} 0150 O1ke 0116 0.029 0.59

Eugenia

stahlit Bs 3 w 0,38 0.96 0436 0.084 0,59

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aa

Leb, He

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Species cote

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Materia

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Momingensis:

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Miconia,

?tetrandra,

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Tabebuia,

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portoricensie Ap 7h 1. Lok 1.26 0.32 0.116 2.65

Benioterta

lewrifolia ml 502 1,08 1.00 O.bh 0.096 1.99

Byrzonina

spicata BT 3 0.64 0.68 0.88 0,070 1.90

Buchenavia,

capitate nee 0.96 1.26 0.32 0.097 2.12

e905 0180 0,60 o.h 0401 1.82

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casearia

?arbores cag 9 2.08

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Cosearie

?icolor i332 2.76 0,68 0.22 0.100 1.98

os 3 0192 0.84 0:28 01095 2.23

ua LPh 0192 0.46 0.07 o.gh

om 1S 2,63 12h 0.92 0,102 2.17

sylvestris cs 2516 2.88 1,00 0.92 0.101 2.00

col aT 2.36 1,08 Lok O16 2.62

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Decryodes

RAAARE

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Drypetes

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Leaves

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Buchenavia

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?m16 Th orga 2268 9.82 0.32 Oust 183

Tw M0106 16h 0133 0126 0n}00 1.20

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Retragaerte gy TS BOs 10 0692 9.08 0.066 1.28

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