

Keer me an Ahe Lak My sell so Aon yer pane 61 Gu Co minen Aad of enh 5¥ PUERTO RICO NUCLEAR CENTER THE RAIN FOREST PROJECT ANNUAL REPORT FY - 65 ---Page Break--- Tuerte ftco fuckar Conter Ro Piwtvae, Pe Re 'anced Rerort Reports ty Viciti: r g Fortictpante ise Teelde ae 5 hppenal rerrestrial "ealogy Progar: T ---Page Break--- ASCIRATT GENERAL ACCOR? introtuetion, Lege Flies revinte veears m couse: end protection ehonicty 2 tot cubiteation Leaf all, Leaf eles, phenology ete 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 dohneur == dcvia! eonitorine VLEs hoese Le Bootes ne Tekzerry -- Cytology slicing otek ehronosenes vari Tacs 1 Steere jutekt == se heatwehs == wails El tgguir == "Lerouos tn unter cupe OL uimieten + fect » ssterorhta FI iuroc Gs Slot = 'zante © Frogs Ro uiegert => liter, taf fds RL Lave ~- Thocphorue To Se uvingter -+ Foreet chenlewi analys xe 24 23 cy a ee 195 15,97 ---Page Break--- "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 stallation 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 Mological process's savsives come properties wet fe tennnvably constant an cone other petterne which fave definite seasonal patterns: ---Page Break--- "TITRODUCTION 'This 1s an annul progrece report for the rain forest progran at FL Verde, Puerto Rico which hac three objective L. > determine the effects of gam irradiation fron 10,000 Curtes Of Ceetun on @ plot of lower-nontane rain forest. 2. To measure cycles of fall-out

elements in the rain forest ecosystem. 3. To determine the circuit of energy flow and metabolic processes of the ecosystem in order to understand the phenomena observed. The project began in May, 1963, with various preparations of the irradiation and control areas such as trails, electric power, maps, towers, data cables, polar coordinate markers, instrument recording systems, and shelters. Work in the current year has concerned the regular measurement of some forest indices so as to document pre-irradiation properties. Many of these data have not yet been analyzed since the resident staff in the Yact has been largely involved in the logistics of getting the irradiation source installed and health physics aspects cleared. Ninety days of continuous irradiation began January 19, 1965, and continues as this account is written. In last year's proposal and report, the work was described in numbered phases, and for continuity this year's general account of progress is written with the same headings. Some scientific results follow including reports written by visiting participants. Submitted under separate cover is a proposal for work in the coming year. The proposed work involves repetition of the measures taken before irradiation plus work on cycling and metabolic objectives. 1. Loorsres: In the course of the year additional preparations were made of the study area, the El Verde Station, and facilities in Rio Piedras. Electric Power Unit November, 1964, power was supplied by our paired diesel generators. A power line contract was arranged with the Water Resources Authority, the costs of clearing a mile strip charged to the project. After the station was powered, power service was changed from generators ending 13 months of continuous service made possible by continuous troubleshooting by the resident scientist, Mr. Drevry. One of these generators remains as a standby for part of the station circuit, while power lines are now stretched on route through the forest study areas. For some needs

involving critical: Voltage levels at a gasoline generator station are provided in a shelter near the giant cylinder site. The power line to the tower is black, and 220 V lines operating the source are red. Some of the lines have been in the frost for 2 years without failure as yet. Chenega Alta

House, precipitated by the coming of Dr. Robert Foran Smith, former employee and now ORIHS fellow at the University of Georgia, a special 5-year, no-cost lease was taken with the Institute of Tropical Forestry, U.S. Department of Agriculture, for one of the concrete forest houses, located at Cienega Alta about 5 miles further up Route 166 from El Verde Station in a spot of great beauty on the edge of the Luquillo forest. The house with around 900 square feet has propane facilities but no electricity other than some old wiring for generators. With some funds provided by Mr. Smith and matching funds from PRIC, the Water Resource Authority installed a power line to that house. One of our radiation guards (Moisés Parrilla), who is also an electrician, installed house wiring. This dwelling thus provides housing for the visiting biologist in addition to that at the El Verde Station. Concrete platforms prior to the moving in of the source Mr. Renin Mieves and 3 crew members were brought in for several weeks. With materials carried in by the Youth Camp men and assisted by our regular staff, concrete foundations were poured for the Cesium Source, the towers of the giant cylinder, the 15 HP motor and 7-foot fan, and a larger pad 19 feet by 18 feet for Dr. Wentworth's field building for mosquito-catching operations between the river on the ox trail above the control center. This will next be supplied with a power line from the El Verde Station.

Inter-agency Agreement After some delayed negotiations, the inter-agency agreement between the Department of Agriculture and the Atomic Energy Commission was finally signed providing the El Verde Station and 160 acres of rain forest for the research for a 5-year period. This arrangement puts radiation

safety as responsibility of the ABC but provides for approvals by the Institute of Tropical Forestry on matters of construction and forest cutting. ---Page Break--- New Laboratory Building at El Verde After an appropriation of \$20,000 from general plant project funds, preliminary plans and specifications for a small laboratory at the El Verde Station were submitted. Based on this, ABC contract procedures for construction went into operation with final plans by the architectural firm, SogNag. After initial bidding, final negotiations provided a contract with Dot Corporation in Carolina, with construction starting in November. The floor plan is given in Fig. 1. The building should be ready for occupancy by the end of fall. The new laboratory has air conditioning and de-humidification systems, some circuits which are voltage regulated, a hood, and an isotope storage and dilution room. The five main rooms are designated for five main functions: electronics, microscopic work, field tracer work, analytical work, and processing work for handling of botanical and soil samples. The present instrument room remains the control center and office-laboratory of the resident scientist. Station Modifications A gas refrigerator was provided for Dr. Weinbren's progress in the house middle section, a small refrigerator was provided for the northwest room, and a hot water heater was installed for the resident scientist apartment. The visitor's room doubled as laboratories during the year. Further additions of wiring, voltage regulators, and racks were made to the instrument room which is shown in Fig. 2. The electronic bench was equipped with an oscilloscope and cone frequency instruments. The interior of the station was painted. Bridges Murphy and others constructed a steel personnel bridge above the Sonadora River on the main trail from El Verde Station to the study area to eliminate accidents crossing the rocks and relocation of personnel due to flash flooding. There are two rivers on the ox trail above the uphill control.

center, steel reads were cabled to the Yocks to provide firm Tooting in low and medium river stages there. Cron Cable Car: 'To provide access to forest crowns, Mr. Robert Ford Smith, 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 ending near the radiation center. A shorter 3/8 cable was also passed in the crown of the loves center. Cable positions are drawn in Fig. 2 of Smith's report below. ---Page Break--- Mechanically Damaged Control Area Related to Mr. Smith's dissertation

problem, a third area was laid out for later mechanical damage so that succession may be compared with that in the irradiated area. The forest was opened mechanically so that the optical properties at the ground correspond to those in the irradiation area. This area is located on a ridge downhill to the north and is marked with concrete posts. The project room in the basement of the Institute of Tropical Forestry was the center of the grinding, weighing, and 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 hood was assigned to the project. Washing, chlorophyll, and counting are now centered there. Administrative matters, secretarial functions, and communication centralization remained in the office at the Biomedical Building where some new files were added. Mrs. Ana Josefina Correa developed procedures, reports, files, and office-level accounting as Administrative Assistant. PLATS Vegetation and Topography are in collaboration with the Tropical Terrain Research Detachment of the U.S. Army Corps of Engineers Waterways Experiment Station under Mr. William Rushing continued during the year by which data and methods are shared due to common objectives in analyzing vegetation. Very important to the project are three sets of maps in which each tree, major rocks, stumps, logs, and half meter.

Contours in the 30 meter radius circle are plotted by transit. Accompanying data on height, diameter, and other aspects are tabulated. "These maps total 10 sheets and can serve as the basis for the dosimetry map, the primary chemical calculations, etc. These maps will be first reported through any publication outlets. Seedling Drawings Dr. James Duke of the Department of Agriculture in Beltsville, had made two trips to Puerto Rico to identify and characterize vegetation in some herbicide studies not far from El Verde. Common to that project and the El Verde project was the need for identification of seedlings. Dr. Peggy Duke's botanical illustrator was brought down by PRIC and Mr. Alejo Estrada Pinto was commissioned to help locate the seedlings in the rainforest area and in other communities as well. She resulted in a manuscript with 36 plates, which has already been submitted for publication. Dr. Duke has helped members of the project with taxonomic problems, and allowed some of his unpublished reports on vegetation in Puerto Rico to be mimeographed for project use. To aid our participants, a listing of new and old names is included as Smith's table 6. Another aid was the publication of the book "Guide to Trees" by Little, Brown & Company, obtainable from the Superintendent of Documents for \$4.25. Tree Data on Punch Cards containing the data with the Tropical Terrain Research Detachment. RNC set up a punch card machine and operator at Stop 7 1/2 to put the data collected by the Army group in the mapping study on TBH cards to meet their objectives as well as ours. These cards have now been punched according to the format given as Fig. 3. They went to the 'catalogue computer center' for various computations such as means, frequencies, basal areas, volumes, etc. Tree Trunk Growth Measurements Peter Murphy continued his study of tree growth of 5 species with the guidance of Dr. Edsworth. There is now a year's record with some of the data summarized in an appendix section. When it was suspected that the

Catty measurements were 00 equal due to tightening of tapes in the first Souths after installation, additional tapes were added to some of the trees with old tapes in order to get a correction factor. Phenological Record The record of fruit and flowers has now covered a year with data indicated in the data section, Palm Populations Progress on the study of palm populations is given in the report from Dr. Frank McCormick. ---Page Break--- Leaf Tip Growth, begun by Mr. Murphy and continued by Mr. Smith, limb tips along the core cable were marked with metal clips so that the distance from clip to branch tip could be measured before and after irradiation. These trees have no annual limb scars. It was during this work that Mr. Smith fell injuring his back and ankle. Forest Biomass The vegetation map by Dr. Fushing at the Tropical Terrain Research department permits prism

computations of maps in more detail than was formerly contemplated. This work is yet to be done. Roots and Mycorrhiza Dr. Joe Binsten made a working trip to explore relations of the soil and roots as reported in his report in the Results Section that follows. Plants Dr. Cowley, University of South Carolina, and Mr. James W. Holler came in the summer for study of some fungal aspects. Mr. Holler remained making plate counts and isolations for his Master's thesis. Dr. Cowley also made a survey of some higher macroscopic fungi. Their report is included in the scientific results section. Microbiological Processes Dr. Martin Waitess, Biology Division, Oak Ridge National Laboratory, came in December for some microbiological explorations as indicated in the report of his trip. Algae Dr. Phil Halick visited for studies of algae, marked 50 stations, and arranged for the study of palm frond replacements for computing leaf succession. ---Page Break--- Mosses Dr. Wilden C. Steere assisted by Mrs. Steere came from the New York Botanical Garden for a pre-irradiation study of the mosses as indicated in the report that follows in the next section. Leaves on Shrubs

Following Yr. Smith's accident, Mrs. Smith attended by Justin Martinez completed some counts of leaf miner on understory vegetation in the Tatiation area, Chlorophyll. With leaves collected from numbered trees by Mr. Murphy, Marta De Arce and Carmen Laura Fereles made 850 chlorophyll determinations to characterize photosynthetic function before irradiation for comparison afterward. Some summary of these data is given in the results section. A manuscript on chlorophyll work done in 1957-1958 by Odum, Abbott, Selender, Golley, and Wilson was prepared for publication. Forest Cross Section Using the forest cable-car cable as a transect, Mr. Smith made a forest cross-section as indicated in his report in the results section. Seeding Plots Mr. Smith counted surviving seedlings 8 years after he marked quadrats in 1963. Actinobacteria Dr. Andrew Naretzki collected some samples of leaf litter and soil for Dr. J. J. Perry, Dept. of Bacteriology, N.C. State, Raleigh who made some surveys for actinobacteria. 3. WEATHER RECORDS Solar Radiation Measurements The Eppley instruments from U.S. Army of Fort Detrick have been recording for over a year with a few interruptions. When the hurricane was forecast to pass near San Juan, as promised, we pulled down the main tower and removed ---Page Break--- the top platform. Mr. Drewry made some calibration checks at that time and found the faulty making in one gylhelionmeter. The full daylight photometer had a different time developed water leak. Both went back to Eppley Co. for scouting and recalibration. The photometer is back in service and the double hemispherical pyranometers continue their records. A representative from the U.S. Army at Fort Detrick visited the project to observe our use of their instruments and other matters. Forest Optical Density and Sunflecks One string of silicon cells has provided a year's record of optical density. In November, George E. Drewry began recording on three other rings of solar cells including irradiation and control centers. It. Rushing reports & useful years.

Use of the portable device developed for their plots through collaborative effort. A publication note is planned on this instrument. Rainfall, wind, temperature, and humidity measurements pre-radiation annual record for the main tower above and below the canopy is mostly complete for rainfall, wind, temperature, and humidity. The cup anemometer was out of function for part of the period, and there was some drifting in calibration of humidity and both wire anemometer records. Traditional thermistor were added in December. The problem of catching malfunctions, linking, and dating charts was taken over by Bre. Smith on a part-time arrangement which involves a morning instrument routine. So far, three of the Pustrake and Mustrak amplifiers have had to go for factory repair, a better service record than expected considering that many have been snapping away continuously for 18 months. As yet, the weather data have not been analyzed. Digital Systems, a non-linear systems 20 channel digital scanner was purchased and Dr. BALL Moore and Mr. George E. Drewry began wiring the connections for the digital voltmeter, the word, and the scanning

program. A program board was also purchased for an IH tape to card converter and is being wired with the help of the IBM Service Bureau. The digital system is to go into operation when the new laboratory is ready. The system will give some data regularly routed to code in addition to the roll charts. Mrs. Flpidia Rivera began punching temperature chart data on IBM Cards (Fig. 3). ---Page Break --- Cytology Dr. Francis Koo, at FRIC Mayaguez, worked half time on the project assisted by Mrs. E4lth Fobles de Irizarry in the laboratory and Mr. Robert Yenator in the field, completed measurements of nuclear volume, made a study of radiation effect on bronchiolads using a radiation source in Mayaguez and explored some aspects of germination and veritens. To appraise the effect of radiation on the bronchioles, chlorophyll extractions were made and the spectrophotometric measurements done in Mo.

Pledras ty ilarta De Arce along with determinations being made from the site, Dr. Koo's report is given in the Results Section. Walking Sticks Dr. Hitlo Virkkd collaborating from the Experiment Station made cytological preparations of testes of walking stick insects as material permitted, for. Mill Solline during the summer collected nominal for him. Phase microscopic equipment was ordered to replace equipment he has on temporary loan for this work. Ferns Dr. Y. Sorsa and wife, both cytologists, en route to Finland made cytological collections of the ferns. 6. ANIMAL POPULATIONS Shade Des Harold festival, Department of Biology, UFR continued the population study of the large scale with assistance of part-time students paid from the project at various times: Joaquin Solinart, William R. Bhajan, Minilia Hetos, and Zaida Miranda, the report is attached. Daphnia and Lizards The population study of the coqui frog and two dominant species of Anolis Lizards was continued by Dr. Fred Turner and Mr. Clayton Gist of the Radiation laboratory at UCLA. Dr. Turner continued working trips and Mr. Gist and family moved common for the year being attached administratively to PRIC. Salary and scientific direction remained through UCLA, special local expenses and travel were budgeted through the project budget. Mr. Gist returned home in November. Dr. Turner visited in December with Mr. Aovland to put underdosimeter in frogs and lizards. Their report follows in Results. They presented some of the data at meetings in September. ---Page Break--- Birds Dr. Harry Recher made quarterly working trips to census the bird populations, plotting position maps, computing densities, recording aspects of ornithology. His report is included in results. Frog Note Dr. Drowry reports on his annual record of Coqui sound in the Results Section. He has also made progress in circuits for recording other population components. Insect Diversity on Sticky Paper Dr. Drowry took over the sticky-paper sampling with the aid of Joaquin.

Molinari and Butebio Diaz Pagén. This work involved computing species diversity, setting up keys and reference collections for the 500 species, sending specimens off for identification, and making some tests of substrate effect. Herbivore Action on Leaves assisted by Marta De Arce, Peter Murphy and others continued the leaf hole study begun by E. P. Clum. Samples from the leaf fall were placed in the light box and the percent of holes determined by reading first with leaves only and then with leaf holes obscured with pieces of aluminum foil. An animal record is given in the Results Section. Bromeliad Fauna by Dr. Rasset Maguire, The University of Texas, provided results on his working trip in the Results Section. Mosquitos, viruses—these populations are studied under a different project under Dr. Paul Wrenbren which is funded and administered through the PRIC Biomedical Division, and submitted a separate report. ---Page Break--- Some results on this phase are given by Dr. Richard Wegert from his working trip from the Institute of Biodiversity Ecology of University of Georgia at Aiken, S. C. 7. METABOLIC STUDIES Seedling Study of Sh: ant San Species as part of Haster's Thesis at UFR. Ariel Lago completed measurements of photosynthetic rates under light and air flow velocity for the species, whose

seedlings are superadapted and successional on two dominant climax species. Vines seedlings remain for long periods in deep shade and grow when the canopy opens. Some of these data are given in this report in the Results Section. Shade litter experiment: Fourteen plastic containers with seedling plants remained unattended at the future irradiation site for a year. The small hose fittings remained open for gas exchange. Prior to irradiation all were opened, excess water which had accumulated was drained out and the systems attached according to general quantities of vegetation. Seven were placed in the irradiation center and seven in the control center. Diurnal carbon-dioxide curves were previously made after

months of acclimation by removing the microcosm temporarily to an air-conditioned room and a fluorescent light providing similar conditions of light intensity and temperature to that of acclimation. An example is given in the Results Section, Soil metabolites. As shown in last year's progress report, the soil metabolism is highly sensitive to flow rate during its measurement. When some visiting participants repeated cone measurements using our laboratory anemometer box previously described, they obtained values ten times those obtained previously. The principal innovation they added was a foam rubber seal to the soil rather than allowing inflow of air under the edge of the box. There may have been suction created because inflow holes were not large enough. Thus further study of this must follow. ---Page Break--- au chant Cylinder Experiment. About 50 meters from the Irradiation center, construction of the giant cylinder began in late fall. Six small aluminum towers were carried into the forest by Youth Camp and set on concrete pads with guys to the trees. The towers were connected to each other by cables to form a hexagon 60 feet across so that no guys were needed on the inside. The forest at this point is 60 feet high. Lugo, Alejo Betrada Pinto, and others gradually raised the crank-up towers, using small cables to tie back branches to make a framework for a cylinder with space for a plastic curtain. With the aid of a group of seamstresses from El Verde, 10 mil polyethylene was sewed on a wire ring and suspended from the hexagonal tower frame by 12 nylon gravity ropes working through pulleys at about 50 feet. The plastic was readily hauled up as a curtain to about 40 feet, but beyond that the increasing weight began to create strain resulting in plastic tears, broken struts in the aluminum towers, and other problems. The plastic was then cut at ground level and a second plastic curtain sewn so that the weight could be distributed from two heights without the necessity of hanging all the weight from one.

Ring. With the help of ABC Engineer Hr. Keller, the giant fan and 15 HP gasoline motor were installed on the concrete pole. With the plastic at 10 feet, a visible bomb was cleared from the cylinder in less than 5 minutes. The 7-foot fan is presently geared for relatively few RPMs, 200 maximum, and does not use the full power of the engine. The engine exhaust is directed into the outflow of the fan, which carries downward away from the cylinder and does not feed back into the cylinder as determined in a preliminary measurement with the infrared analyzer. The scheduled radiation date caught up with this second priority task, so it must be completed after April when the area is again accessible. A photograph of the cylinder with the plastic at about 25 feet is given as Fig. 4. Transpiration, with one of the Figuredynamic Humidity Systems already built into the regular weather recording from the tower, a second portable system was used to measure transpiration in open flow systems through plant leaf chambers. Although more sluggish than the analyzer, there is less noise in the report. Whether we will be successful in sealing this up to the giant cylinder in order to get forest transpiration remains to be seen. ---Page Break--- 5 8, PHOTOGRAPHIC RECORD. Many pictures were taken during the year and are part of the general record; one series will be published as a pictorial record. Any picture is available for duplication for any participant in connection with his special reporting and publication. Visiting 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 Engineers Watersheds Experiment Station, the Cold Regions Research Laboratory of the U.S. Army at Hanover, New Hampshire, and the Department of Agriculture herbicide project of the Experiment Station at Mayaguez, a helicopter flight was chartered every other month, and Mr. Dave Atwood took pictures with color, infrared,

and camouflage film, br. Pail Johncon of the Army group at Hanover is making a study of the optical density of the fine and relating it to ground measures such as optical density of the forest. Light Plane Series Peter Murphy of the FRIC staff obtained his pilot's license and with the help of Clayton Gist, Robert Ford Smith, and others began taking serial pictures in alternate months from a chartered light plane. Tower Series He. Clayton Gist took a number of pictures of the radiation center at various times from the top of the instrument tower which overlooks the radiation area. Pipe Series Mr. A. Atwood and Dr. Johnson continued their in-forest record of pictures from reproducible positions on sized pipes. Oak Ridge Photographer A pictorial record of forest activity at the time of source installation was made by E. Westcott, ABC photographer on a visit from Oak Ridge. ---Page Break--- Annual Series A series of pictures of representative animals was taken by Mr. Clayton, most of UCLA, RD FLOUS Nomad Gutter Fall Peter Murphy, Alejo Betrais, and Doroteo Martinez collected leaf fall monthly from the 50 stations set up by Dr. Ulegert. After the leaf samples near furnicite were made, the litter was oven dried, fruits were separated, then identified by Alejo Estrada, and arranged separately. See the Results Section Litterbag Decomposition The T1014 experiments of leaf decomposition in fiber-glass bags set up by Dr. Ulegert and some later series set up by Peter Murphy were continued with age removed for drying and weighing at month intervals, 110, CRSIUNI SOURCE AND PROTECTION Manufacture and Installation of the Source A response to the call for bids came from 5 firms; the purchase order for the design and construction of the source went to the low bidder, American Nuclear Corporation of Oak Ridge, Tenn, for \$21,000. Following part T of the procedures set up in the purchase order, plans were drawn and subjected to scrutiny within FRIC and then included with slight modifications in a Hazards Report concerning the entire aspect of source.

installation, operation, and matters of Health Physics and public safety. When this document was approved by the ABC in Oak Ridge, part of the purchase order, the actual construction went into effect. As provided in the order, inspections of the apparatus were made in Oak Ridge in November by Olun, C. B. Shoup, Joe Lehmkuhl, and H. Hacker from ABC Operations in Oak Ridge, and A. Jones, engineer invited from RIL. A series of modifications were recommended and incorporated at that time. The source was shipped by truck and boat arriving at San Juan Harbor Dec. 3. After inspections by FRC Health Physics officers, Dr. Ferrer Ilonge and Faro Cruz, and the Coast Guard responsible for the harbor, the source was loaded on a truck and driven with preceding and following vehicles to the end of ---Page Break--- the Sonadora Road 600 feet from the irradiation center. The helicopter team of GME Puerto Rico Power Authority was enlisted and on the following Monday the apparatus, weighing one ton, was picked from the truck by a 90 feet, 1/2 inch steel cable and within 15 minutes was set down on the concrete pad in the forest by precision flying and ground radio guidance. The blast of the helicopter broke many limbs in the radiation center changing optical properties somewhat. Six red wires for power and control were stretched from El Verde Station to the source site, passing on separated insulators in the very high radiation field near the source. A 10-foot, 3/4 inch conduit was laid over the irregular ground contours and threaded with a 1/16 inch stainless steel safety cable that operates an emergency mechanical trip hook. A two-inch steel tube tripod was placed over the source with feet in concrete so as to deflect any falling tree. George Drew built an additional safety provision, a half-inch steel cable loop about 15 feet above the source for helicopter snatch of the source. The weight apparatus, although

cabled to a 6000-pound concrete pad, is released from these connections by mechanical cable trips that open when

stainless steel rigging wires are drawn as the steel snatch loop is lifted. Thus, should other devices fail, the source could be retrieved by helicopter and carried to a safe pool of water or the river for repair operations. Five feet of water would provide the same protection as the five inches of lead. Helicopter personnel would be partly shielded by the plug. Me, J.H. Wilde, president of American Nuclear Corporation, the manufacturer, came for a day during the final installations making various checks and recommendations. The shipping cover was removed, the hoist machinery was bolted in its place, and the various cables were attached. Fig. 5 was taken at that time. The control box was installed in the instrument room at the site, 2000 feet from the source, along with safety devices. Then water fences were finally completed and two amendments to the hazards report were approved by the AEC area office. An official inspection and radiation test was held January 12. Dr. Roig represented the Director's office, Mr. Pedro Cruz the Health Physics Division, and Mr. Keller the AEC Area Office. The first up-source test, Jan. 12, was made satisfactorily and while the source was up, Cri, Oitm, and Valieciilo surveyed the fences and peripheral sounds with survey equipment with the results given in Fig. 6 and 7. The radiation levels were less than those previously given in proposals for the work. The down-source mechanism also worked. After raising the source again, several mechanical trip devices were tried, with no response. The source was lowered with the Jova mechanism and various inspections made which showed too much friction in the mechanical cable in the conduit and in the electrical hoist devices and fluid brake. ---Page Break--- 8 After a phone conference with Mexican Nuclear Corporation, the mechanical cable was removed from the conduit to the free air, fluid was placed in the fluid brake, and bearing friction was reduced. An electric anti-moisture heater was introduced in power and novel go that it

was not vaporizing lubricating fluids. The counterweight on the trip cable was reduced. A new authorization memorandum was processed, and a second test was made January 18, ALL systems were functional at that time. Once the under-fence holes were sealed, Dr. Dagher made a personal inspection, and final verification began the evening of January 19. A cursory test made a week later showed systems still functional. A partial plan for the course is given as Fig. and the electrical system as Fig. 9. The microswitch that turns the red "source-out of box" lights on is located on the side of the vertical tube and is actuated as the plug passes. Two other microswitches are in the motor box on either end of the hoist spool so that the completion of the turns up or the completion of the turns down sets off a switch, cuts off the motor automatically, and extinguishes the motor light. If there is a power failure, a relay is tripped so that when power is restored, no power passes beyond the control box without active turning of the power key. Either power interruption or turning the scram switch down releases the magnetic switch so that the 45-pound plug with source pulls the free-running hoist cable from the drum, the plug reaching the pig in 3 seconds. Bringing the source down by motor operation of the down button takes 14 seconds. The up button brings the source up to full height in 19 seconds. Source Operation Source operation is made by an approved checklist to help avoid omission of important steps. There is a metal box that contains the key to the up-source button. A bar on the box, something like the one at Brookhaven and Emory, has provision for many locks to be added including one by the official operator. During periods in which the source is down and someone is authorized to go within the 160-meter fence, he puts his lock on that box-bar so that it cannot be raised until he returns and removes it. Source procedures require verification of written authority, 5 minutes of silence, removal of locks, and a test of the time required.

for Light change in the Up process, relocking of the up button, and locking key in the box. 'The screen button is available to anyone who might suspect that someone unauthorized was beyond our controlled areas. After scanning, the one responsible operator is required to raise it again. 'That radiation is on may be determined by (a) the radiation recorder in 'the instrument for whose transducer is 300 feet from the center, (b) by using a survey meter at the control house (0.1 ar.per hr. when up and less than 0.01 fxs per hr. when down), by the Red Lights on the panel board, and by the audio crackle over the phone from the tower shed radiometer. After the source is put ---Page Break--- 9 down, the power is turned off if persons are to enter the 160 meter circle. The responsible operator is the first person to go in with the duty to check that there is a fixed count of source with survey meter. If work is to continue for longer than two days, the source plug is also unhooked from the hoist apparatus, and the electric power turned on so that the heater is operating. Safety Fence and Signs 'The provisions for source operation, safety, and health physics are covered in detail in the Hazards and Safety Report and its two amendments now approved. As shown in Fig. 6 there is a 160 meter hog fence 8 feet high stretched from tree to tree, with holes underneath where gaps are created by rocks and ground gaps are closed with fence patches. At 25 feet intervals are signs with the inscription. Extreme Danger High Intensity Radiation Beyond this fence Do Not Enter Área, Extremamente Peligrosa Radiación Intensa No Pase Más ALLA de Esta Verja 'These signs are masonite and in red and yellow warning colors. At approximately 500 meters on the downhill side of the mountain towards people, a single strand of barbed wire has been stretched at 3 feet and the warning sign placed at 25 feet intervals. where this wire approaches a forest tall it changes into fencing with signs. In the sector on the north side which is nearest to the Route 186 Bridge.

Over the Sonadora River where people sometimes picnic, the line becomes a fence for 600 feet. As shown in Fig. 6, a gate was put across the Sonadora Road with a combination lock. Starting Dec. 4, with the assistance of the Department of Agriculture and the El Verde Ranger and Mr. Joe A. Colén of the administrative division, 4 guards were employed from the village of El Verde. The patrol routine set up involved an 8-hour shift with watch clock stations at the Ranger Station, the El Verde station, the Sonadora gate, and Smith's house. The patrol has four functions: 1. By patrolling road access, keep surveillance of persons who are in the vicinity to prevent anyone from going beyond our outer warning lines. Parenthetically, it should be mentioned that one has to do some rough climbing and get muddy and messy to get that far. 2. Guards require any persons working at the El Verde station or in the zone between the fences to have written passes and valid badges. 3. Guards check the control panel and water for power failure and other malfunctions. 4. Guards provide a personal transportation shuttle to El Verde village and the Cienega Alta house. Radiation Field: when the source is down, radiation at the source is on the low side. In addition, the source trip up, radiation at the 169-meter inner fence ranges 3 to 17 mR/hr depending on topography. At the 600-meter warning line, radiation readings are 0.1 to 0.5 mR/hr. At the public post 106, the readings are less than 0.02 μ R/hr including the points of "Direct Line of Sight" and the Sonadora Bridge. At the El Verde station outside of the concrete buildings, the radiation is 0.12 μ R/hr. At the end of the mechanical trip cable within the inner fence but behind a ridge, the radiation is 10 μ R/hr. A preliminary graph of dosage rate is given in Fig. 7. One survey was conducted by Mr. P. Cruz and Mr. F. Valleilios; another was made by a team of about thirty members of the U.S. Department of Agriculture Soil Conservation Service under Mr. W.E. McKinzie as field.

exercise February 23, 1965. Documented 1000 sealed capsules from Con-Rad Company were placed within the irradiation field by Dr. Frank HeComick assisted by W. Tushing and associates to show the micro-variations as well as provide a documentary map. Some of the 500

microdosimeters which are to be read by Germshausen, Digerton, and Grier were paired with the larger capsules and some were placed in a series along the cable-car cable. 160 microdosimeters were put in frogs and lizards by Turner and Rowland, 50 in scale by Heatvole, and some in rate by Weinbren and associate cobalt Survey. Prior to submission of the latter Report, Pedro Cruz and the Health Physics division brought 5 Curie Cobalt source from Neyaguez, placing it at the end of the Sonslora coal. Air and forest penetration were measured to show that there were no features of the El Verde situation that might cause radiation to be more penetrating than at Brookhaven and at Georgia. Film Badges Starting with the arrival of the source in the area in December, a film badge rack was set up at El Verde station and incorporated in the regular routine at FRC by Ms. Heidi Pabón of Health Physics. Also maintained were temporary film badge packs for the various workmen of Dot Corporation, visitors, etc. ---Page Break--- A Public Relations Interfacing As part of the necessary aspects of health and Safety, a public information program had been conducted. First, Dr. Bugher issued an announcement about Project in the newspapers in 1963. Then when the source was shipped west to Oak Ridge, a news release there was picked up and repeated in several San Juan papers in November. At the time of source arrival, Mr. Rent of the 10 Operations Office took charge of public relations with several meetings. Mr. E. Stockely, Public Relations officer from Oak Ridge came for consultations involving a written plan for the public announcements. According to that plan, a simple announcement was made early December that appeared in all the

papers and in one 7V outlets. When the fence and other preparations were in readiness, a formal public hearing under AEC control and supervision was scheduled and organized by a. Rushford on January 6. Talks were made by Floyd P. Trott, Ory Wassorth, Dr. Arnold Cobas, and Dr. Howard T. Odum, followed by a trip via a bus to El Verde. All attendants walked up the trails, examined the scare, and observed various aspects of the study. Mr. Rushford distributed flyers with large photographs taken by the ABC photographer from Oak Ridge, and beverages and coffees were served. The meeting was attended by various representatives of the press, Commonwealth Government, the mayor of Ric, Grant Bpon Ge, the nearest municipality to the site, and representatives of the neighboring Girl Scout Camp and Youth Camp. The briefing was followed by coverage in the newspapers that week with some feature articles somewhat later. Despite all the explanations and documents given to the press, one article from the source picture described it as a new powerful dosimeter for SEG defense surveys on the island. Most papers did carry the principal message that there was no danger whatever outside the fences, but there was, hazardous radiation within. There have apparently been no editorial comments regarding discussions of these announcements. A radical university student group circulated a paragraph in a mimeographed leaflet denouncing the project. 2. SYSTEMS CHAPTER For the most part, radiation effect studies have taken precedent this year over chemical cycles studies. This emphasis will change after the completion of the erratic radiation experiment, the completion of the EL Verde Laboratory, and the arrival of a staff member to increase this work. Chemical Composition of a Forest Prism. Ms. George Ann Briscoe spent much of her time before leaving for Bogan preparing 90 powdered samples of roots, limbs, trunk-woods, and leaves from three species. After chemical analysis, one may multiply the weights of the samples by the analysis of

that material and sun to get the chemical section of the forest prisms. The detailed tree maps provided by Fushing's Array group will be the best for that. ---Page Break--- 2 In collaboration with Dr. J. D. Ovington who had earlier visited and examined these phases, the samples went to the Monks Wood Experimental Station, Huntingdon, England for analysis of principal common elements by the chemical section there. Some soil samples are also being processed through a

chemical section of the University of Georgia by Dr. Joe Ednisten. Costus and Manganese Peaks in Gamma Spectra. Taking a personal hand, Dr. Bugher assisted by Ada Livia Rodriguez de Colón and Yarte Se Arce made 60 gamma spectra of forest materials. In initial exploratory measurements strong cesium and manganese peaks were found in all leaf materials. With a year elapsed since the cessation of main atmospheric nuclear tests, the leaves showed lower beta counts than were reported in last year's study and the gamma spectra were simpler. As a test of radiation effect from the Cesium Source on the ability of the forest to hold in cycle the cesium and manganese, effort was concentrated on getting measurements of the two elements from numbered trees in the radiation field before irradiation. Ash samples were prepared from new sun leaves, old sun leaves, new shade leaves, and old shade leaves of the 6 species being studied for growth. These measurements will be repeated on the same trees after irradiation. Some data are given in the Results Section, Conductivity of Forest Fluids. A conductivity indicator was set up for remote recording of rain on top of the tower and that falling through the forest. The conductivity was exceedingly variable from 10 to over 100 micro-shohms from rain to rain, often more salinity was found in the electrodes under the forest, possibly due to recycling nutrients. Preliminary exploratory measurements show that some micro-habitat differences can be found. For example, the flow along trunks can be compared. Data will have to be

corrected for the influence of the mobile hydrogen ion by taking concurrent pH measurements. Some exploratory tests were made of salt uptake in resin tubes that were placed in the rain gauge tubes. With the small water flows involved, the method was not sensitive enough to give good gamma spectra after 2 months. Some better funnels will be required as normally involved with this work. Dr. V.S. Bowen, looks like Oceanographic Institute visited and was sent one set of pins for study with some sensitive counting equipment he is using. Depending on this result we can plan our rain studies in connection with next year's water balance effort. ---Page Break--- 12, MEASURES OF TOTAL SYMTH: No further efforts have been made this year in synthesizing data into circuit structures, electrical analogs, energy diagrams, and measures of oxygenation because of the urgent procedures involved with starting irradiation and for lack of some key data now being obtained in other phases as already described. 13. PUBLICATION: Although a number of publications came out during the year by staff on work done elsewhere, no project work was published during the year and most writing awaits the post-irradiation comparisons. The post-irradiation studies will begin approximately May 1, 1965 with the first emphasis to be a year of measurements duplicating those of the pre-irradiation year. Hence, many data on the first objectives will be obtained by May 1966. Recently there has been considerable discussion of possible ways of reporting the project in the regular scientific literature. There now seems to be a consensus among many participants and staff that publication of a group of papers in one volume may be desirable. Although the nature of the outlet is not yet determined, it may be wise to give everyone adequate notice that manuscripts of a combined volume of papers will be assembled in summer of 1966, which is a little over a year from now. A supplementary volume might follow several years thereafter with reports of the long

range effect of the irradiation and emphasis on the mineral cycling studies, RESULTS 'Annual pattern were measured by the various instrumental records, spot surveys and monthly samples of the pre-irradiated forest. Although many of the data are not analyzed for reporting yet, some properties of the year can be given in the following paragraphs and in cone reports of participants that follow. Unquestionably, the F1 Verde forest plot is one of the most stable biological systems on earth, but there were definite seasons in the activity of particular species of plants and animals. Pulses of activity occurred in some processes that were continuous. Some reproduction

phenomena were distinctly seasonal. The time dimension was separating functions, simplifying the life of the forest. The leaf fall at the 50 stations set up by Dr. R. Wegert is reported in Fig. 10. The record confirmed the increased fall in the spring which had been qualitatively observed. With the exception of Buchenavia and one or two other species, new leaves were formed before others were dropped, so that the forest was continuously evergreen as previously reported. ---Page Break--- Phenological Pattern Some phenological patterns are given in Murphy's report. Some other data are given in Fig. 10 and 11. The graph in Fig. 10 shows the reproduction from 20 palus selected by McCormick and Murphy and examined monthly by various staff. Butterpea is one of the most abundant plants and its flowering and fruiting continued through the year but with a pulse with summer seedling burn resulting. The graphs follow for some other species based on notes made each month by Alejo Estrada Pinto and others. In general, the flowering was recorded for shorter periods than the fruiting which was extended throughout the year for many species, but not all. Gamma Spectra from Peltout 'The relatively high levels of fallout radioactivity observed in leaves in 1963 declined during 1964-65 as might be expected with diminished atmospheric testing. A gamma spectrum of leaves

from 1963 is compared with more recent spectra of similar leaf materials in Fig. 13. The later spectrum is simpler since the peaks of shorter-lived elements decline, leaving mainly those of Potassium 40, manganese 55, and Cesium 137. Also shown in Fig. 13 and 14 are spectra of various forest phases and species. Although there are quantitative differences, spectra for the leaves of various species have about the same general appearance, and there is as much difference between leaves of different figs on the same tree as between different species. However, the strong peaks in the gamma spectra for leaves and leaf litter were not in other components of the forest such as inorganic soil, roots, boles, limbs, and lizards. Gamma spectra from the Cesium Source assisted by BILL Moore, Dr. J. C. Bugher carried the gamma spectrometer to the ML Vere Station instrument room placing the 2-inch scintillator crystal outside the window. The station is about 1600 feet from the cesium source, and survey meters show 0.13 mR per hour. The spectra which were found first with the source down (shielded) and second with the source up are given in Fig. 15. It is interesting to compare the background spectrum with the leaf spectrum of Fig. 13 and 14. With the source up, one finds that almost all of the radiation which left the source at about 0.66 MeV had been transformed to much lower energies with the peak at 0.08 MeV. Early Report on the Radiation Effects As this report is being mimeographed, some radiation effects are being observed. The area around the center was examined several times since the start of irradiation during short interruptions. A zone of dead brown leaves is spreading outward as graphed in Fig. 15. Patches of yellowing leaves may be detected further out as also graphed. ---Page Break--- ---Page Break--- SOLER Eee ae, SE pg all && ee morons \ 2 ---Page Break--- 8 : z ef & Be § 5 a8 = z 5 eis gf § # fg : "fs ne Ee BB SE 34 qe Ba i is \$3 oi 2 Gs fn58 3 gs 8 82 2855 2 254 ' 3 i mpaagaagaaity edhe: panpibaaaieend genie adedt

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---Page Break--- 2 Meters from Cesium Source ---Page Break--- a Foe: oa el. see Meters from Cesium Source ---Page Break--- ---Page Break--- 3aB 3 Fig 400" ---Page Break--- UPES= faa ss Moter Opesings RRADIATE, 8 OPERATE MASTER SCRAM PUERTO RICO NUCLEAR CENTER 'oremateo av UNIVERSITY OF PUERTO. RICO U.S ATOMIC ENERGY COMMISSION CUSTOM DESIGNED ANO FG. OF AMERICAN NUCLEAR CORPORATION Ioan ROGE, TENN 233A ---Page Break--- Se ~ FANERICAN NUCLEAR. CORP] Po sox 42 OK Binds TONY S[aeN RBS rv 2a mal ---Page Break--- ---Page Break--- Wan 50 Mg mt stations Fruit deep oh festis falling poe m2 per doy 5 Hues blance) Pilisoures visas Shivb Flowering ol (Cochimbe colorado} at A. tee FEE \$+, Hiceola teizandia (Co mazay priete) . [oe Qasryades excela Tabs nuco) mebpe Teele he o ¥ 1965. Fig. MA Phenological records at El Verde st leaf fall stations. ---Page Break--- Backenelio caplet 24s ca vingala EB net a | Gietes peed ths (Sa. eos Ponlaham bideahih hsab 7 408 ence eB tenn tenn} feet) nee tt eg ll |, a ranad lo) Bajues de atten) a_i os bn day yoy Matigeaia eacktleza ' fest oyr rm A 1463 1. LIB. Phenole ste. ~CBajaco de palma.) m~ TT ney at 50 Lee? fUI) tutions pts Aster OTT pam ---Page Break--- Counts per minute per grem n Shade Leaves Old leaves Slognes berveriana 'Goll, Oct-Dec.

1904 1 +32 gm ash, 22.7 gm ash, rt (00 min run, Feb. 9, 1988 Hes: 10 9.1965 ee 0394] Sei qh Old Leaves 4 - Group pocilanthus 4 CRIN al 40.1 gm ash, 400 min - Fun FED. 7, 2805 0.01 : 44 wT Fig. 13. Gamma spectra of each of Leaves of 4 species, of - trees dominant Oa : z at FI ve = Background ; subtracted. o,o90n.—++ ++ ---Page Break--- 38 Fig. 1a. Gamma spectra of forest a, background subtracted. Pen from cloud forest + Sritton, 3000 fe Soil. ang run in July, 1964 561 ga dry: 100 min O21 \ cs 137 4 0.03 m dry, 100 ding Nov, '1903., 1904, 0 gm dry, 100 min. coll, Nov. 1963 Run duty to) 1964. ¥ 0.0m fix 5.0 ---Page Break--- 39 Fig. 1ab. Rest materials at El Verde, Gamma spectra, bach Fig, LAB. Forest payersans eb EL "gids oORum gBgctre» background "Spall roots. os 963 Goll. Nowy 3 dua 100-abn iduly 9, 1564 [Liege dry oon 0.0. Trunk wood of Dacryodes Goll have 1963; Fig 1BLF Ty 196, ~ 5 803 gm dryf 100 mins 7 ---Page Break--- - Gamma spectra taken at El (unshielded tn 4) ion 385 mater o,boo Curie been YP Ro sanute eur ---Page Break--- Fig. 260 Spread of rad. effect at FI Verde a' Figs 168 Gamma spe 60 ---Page Break--- up Studies on Five Principal Tree Species by Peter Murphy 'Tree Growth 'The tree growth study involves five of the more common rain forest tree species found in the experimental plots. 'These species are: Dacryodes excelsa, Yaniqkara pitida, Croton pocilanthus, Sloanea berteriana, and Cecropia peltata, each representing a different family. Alusinun vernier Growth tenets have been fitted to 50 specimens of each species, i.e. a total of 250 trees, and are read once monthly for evidence of stem diameter growth; the bands being attached to the bole at approximately 1.5 feet above the Ground. Youth by month growth of these trees is graphically represented in Fig 1 (average growth of 25 trees of each species at each center). A note should be made concerning the validity of the first few months readings, "It was suspected that due to the design of the growth bands, which employ a steel spring for

achieving tension around the tool, it would probably take a short period of time for the slack to be removed from the band. During this period the full amount of tree growth would not be indicated due to the tightening of the bend itself. To check this possibility, 25 bends were fitted to trees already having had bands for 10 months. As suspected, a comparison of the two readings after one month showed the new tape to lag the older one by as much as .03 inches diameter change. (See Table 1) Further comparisons will have to be made to determine the period that should be allowed for band adjustment to take place. From Fig. 1 it is apparent that Dacryodes excelsa is the fastest grower. This species showed only a small amount of growth fluctuation throughout the 40 month period, a slight decrease in growth rate during the summer months. However, Vantikara nitida

reached a peak in growth rate during these same summer months. The remaining three species grew fairly uniformly through most of the 10 month period. It can be seen that in the case of all five species both experimental centers showed very similar growth trends. *Vantikara nitida* was the major exception and growth appeared slightly more rapid in the north center. Trees used in this study were limited to a diameter of 10 cm or greater. Specimens in the 20 to 45 cm diameter class of *Dacryodes excelsa* (the fastest growing species) showed the most rapid growth. The largest individuals of this species ranged up to 65 cm in diameter. Growth rates varied considerably in all diameter classes. ---Page Break--- Flowering and Fruiting Once each month a one square meter frame is set down at marked locations beneath each of the 250 trees used in the tree growth study. All flowers and fruits of the same species as the tree beneath which the frame is placed are counted and removed. Later these data will be correlated with observations of flowering and fruiting in the canopy. Fig. 2 shows the average number of flowers and fruits of each species found, month by month, at each

center, 'the values are based on 25 frames for each aspect at each Center. The first month should be differentiated since 1 represents the first resolution of accumulated flowers and fruit. 42 five spectra show some degree of fruiting throughout most of the nine month period. Flowers have not yet been recorded for *Sloanea berteriana* and only during one month for *Cecropia yelloate* and *Dacryodes excelsa*. The flowers, being light in weight, probably do not tend to fall directly beneath the tree, where the fruit is located, as often as do the fruits. *Croton poethlanthus*, however, showed fairly consistent flowering throughout the entire period. Both centers show very similar trends. Bree Growth Card Format - Text I Identification (2) - first card |_—species ~ letter not 'tree 30. (corresponds to tag in field) 1p = letter code c From Center (Meters) ring (Degrees) os reference the tears tag (00.) FESS Setter soon Area (60?) i CS pigment to top of Crown (meters) for height to Bottom of Crown (meters) Height to Lowest Living Branch (Meters) 'Crown Diameter (Meters) — 'Crown Position - Number code TEE numbers over rts (got traitatton Bed of names £8 Separate taxa Aires = Ranker code Bol Moisture (Percent) tree) eeeesel variable Dosage (R) ---Page Break--- a oo oot o = cot ott =e ww ro 60 : oe 6 & 10 or cot dot ot dt a \$0 20 10 2 woe 3 2 co to a en a % 2 bo cor! TOP ° or io 0: - ot oot to oo ad - 7 woo => co 00 3 0 ro to : cer ot to: oo fo : er cor 40 oot cs : ot % i oo Be > wo % we to a aah TT < ms et we ww + « 20" w i jo ret & wo oe w > oot cor Oo 10 wo eiwytod erdous20 lg 2 woos = cot ott 3 © wo! 60: oot or tat TO € 2 7 20" cot tT 06 wo oe 2 % fo att oor for co fo See 2 ea oe 6 aaTTR TRS 301 goss, Moy nar adey nog odoy PIO — doatay Bey step nog OL ADM MARL PTO ToT TE Sa TET tds syquom cod s@ueyo souadayumaz7 soyoUT uF UaATS axe wag seoaay save omy Uo spde2 pro PUB max UP poasqsyBor WACK UP PouATOETIT Toten ---Page Break--- Gent. Table 1. mira Month na Tape New Tape first 'Two Months of New 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 orested Boe bho! aaj jive SouWb Linde \$_ NORM. Carpe " Genetutine? Sourn Conte ESPSR 92R ry Ind CicumeeRENCE CINEMES PER Mong) WS aE ae Sis ole Dare OF MunsoRErEHT ---Page Break--- sen Fine (Pe-fMoness) ales Bo se IS We AS he ene al Meh ---Page Break--- uw Vegetation Structure of the Lower Montane Rainforest at El Verde, and Preliminary Preparations for Measuring the Effect of Radiation on the Forest Robert Ford Smith ORES Fellow, Univ. of Georgia The following are the objectives: 1. Describe the phytogeography of the forest in order to understand its affinity to other tropical rainforests; to define the forest 2. To describe the species structure and species ecological niches in the forest as a basis for understanding functions and long-term succession 3. To describe the gross radiation effects on the forest. The following progress has been made: 1. Profile drawing: A profile drawing is complete,

except for details, from zero to 80 meters underneath the cable along the SSE line of center II, which is being irradiated. The drawing scale is 1 cm = 1 m. The drawing is made from a strip five meters wide instead of 7.5 m, suggested by Richards in the Tropical Rain Forest. All perennial ferns and spermatophytes are included except seedlings and saplings under 1.1 m in height. Herbs, ferns, epiphytes, and lianas are black, understory trees are stippled, transgressives and canopy individuals are left clear. The profile drawing is along a line with two fallen trees which allows light penetration and thus good epiphyte and herb growth. The profile will be redrawn after irradiation showing damage and preliminary regeneration. It will serve as the only planned study of the sensitivity of herbs and lianas. 2. Species composition lists are given in tables 1-5. The following are conclusions drawn from the species lists and from some other data: This forest is much more diverse in trees than temperate forests though less.

diverse than some mainland tropical forests. The total number of species represented on the lists is 200. Over half of the canopy is composed of only five species. If the small species *Euterpe* and *Croton* of the palm dominated areas are eliminated, then *Dacryodes*, *Sloanea* and *Naniikare* remain as the overwhelming dominant. The four species make up the overwhelming preponderance of understory species (79.1) although the understory species themselves compose only about one-third of the understory growth. Other species in the understory growth are young of canopy species. Lianas are about half as abundant as canopy trees. Although epiphytes are common, they are not a major component of the forest and are less numerous than in some other tropical forests. Most of the list of epiphytes includes 48 relatively rare ferns (22-37) and orchids (30-13). Herb level ground coverage is noticeably lacking in the forest. Some species cover rocks only. About four small plants cover each square meter, but of these, only one is an herb, usually the grass or the fern; the others are tree seedlings. Seedlings are about evident. To determine the effect of irradiation on stem tip growth, six hundred feet of cable were suspended in the forest crown between the two centers as shown on the accompanying map. The lengths have been measured on 130 trees. Each tree has ten twigs tagged with a numbered metal band. Toot-irradiation measurements should give a measure of the effect of radiation on stem tip growth at various distances. The cable position is drawn in Fig. 2. Table 1. Species composition list arranged according to density in the various radiations of radiation plots at El Verde. Canopy tree (species over 1cm diameter breast height). Seal absolute density: Relative density below: 0.087 trees/ha. *Croton porphyranthum*, *Roan*, *Balanse berterian*, *Choisy*, *Tapitkara bide state* (A., DC.) *Cher.* *Gynorya N. nitile* (species - lice.) *Dabara Miconta fetandra* (Sw.) 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* (lan.) *Krug ' Urban Alchornea Letifolia* Sv. *Richorneopsis portoricensie \rban Sapfum lauroserasus* Deer. *abebuta paliin 'ers.* synonym 7. *heterophylla* (DC.) *Britton Eapttate inh*) ont. ak, *Suchenavi Mieropholis garciniaetolia* Pierre ---Page Break--- *Seotea Leucocryton* (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 laevie Urten Gasearie eylvectorie* 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.) *Kunttee YWeonta prasine* (Sv.) DC. *Guatteria cariace* (Urban) *saribsea* (Urban) *Dritton '@ulavensis* (AUBL.) *Urban Fagnolia splendens* *Urban Yectandra membranacea* (Sv.) *Griseb. ieLiosma herbertii* *Polse Tientietella faselcularis* (Sv.) C, *Wright lyrete deflexa* (Potx) Dc. *genie jambosa* (L.) *vitie*

Species present at Boringuena 0, F. Cook but not sampled. *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 synonymys *Eroteus albopunctatun* (friseb,) Tritton *Maytenus ponceana* Uritton *Tabernaenontana oppocitifolia* (Spreug.) Urban Seat. chia fucate Ker. stream-side 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 which reproduce under the main canopy ant ao not usually grow to the canopy. 'otal absolute density: 0.228 treee/x? Total density tneiding ati plants frog

Lil tall to 10cm Dit: 0.725 trees/ha Relative density below: *Palicourea riparia* Venth, *Ficus glauca* (Yah). *Gleditsia triacanthos* Urban *Tetraclinis articulata* Tere. Fagaceae *bettie Iryta* 7 *Trichilia palustris* Sv. 'Tears foresee Claca.) > this *Lanceolata* (Crigeb.) "Urban *Gymnogene* L. *Guarea guianensis* (Aubl.) L. pa 12. *Guarea rami* flora vent *Corocladus glabrum* (Schultes) Spreng. Li! *Dephropie philippiana* frug Urban 15. *Hedesia glauciflora* Mirban 'Caynojam *Teacorea glauciflora* (Urban) Dritton 26. *Vallenie penauia* (Urban) vez. 'gморim *Fetesioider pendulum* (Urban) Pritton XT. *Piper treleaseanus* "Fitton 7 Yileon 8. Gera *Haveifers* (T.) coud. 19. *Piper malago* 20, *Bitte miricodes* Grtsen, *Sicyos spinulosus* Vent. 22. *Piper afuneus* Tex *Pleroxpoides* (Sv.) Greteb. *Tayehotria saleotens* 'Urban *Tayehotria patens* Sv. *Tayehotria lignosus* Sy. *Drunfelaiia portoricensis* Krug © 'inten *Hecrenium caygdalinum* (Deer.) C. *Wright Hyreia beriserie* Tc. *Tedyosnum arborescens* Sv. *Tocolobie Bi Githereg ius cautatum* L. *Tarpinia paniculata* Vent. 'Racemose *Cauabl.*) DC. 3li--38 are axial, *Weonfa sintenisii* Cogn, 'free which need *Meoria gutapensis* (DE) Cogn open sunlight. *ane ares* () 'an B. Smith 36. *Hguenetie teeunize* Urban ---Page Break--- a tape 3. Lianas, woody vines which grow into the canopy. 'Total absolute density: 0.133 Lianas/m² Rel. density below: 1. *Hourea 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) "Pritton 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 epiphytic but with aerial roots *Rajania cords* *fkania fragilis ombly* , Epiphytes, species without terrestrial attachment, growing on other plants. Total absolute density (expressed as plants/n if the epiphytes were brought vertically to the ground): 0.072 plants/22

'etchomance copiliacers: 1. "Perieroniens (88) "er, *Tephrolepie rivularte* (Vanl.) vett *Eghoeisaa Flasctfwe* (ree) roore *Folypodium 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. *Tyeopodium 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. *Tyeopodie uniforme tory* 22. *pichonance punctate* Poir. 23. 7. *erispun* 1. 2, *Boiypodium polypotioides* (1) watt 25. *Hlapholosew: pteropus* C. Chr. Ind. 26. *E spoium* (raulf-) foore 27. *E, flaccidua* (Feé) loore -K) rel. 37. *Keplentun cuneatun* Lan. 38. *Jaguinfelia glotosa* (Jacq.) *Schlechter* BB: *Grpthidion cocctanm* (saca,) *Satise, Bolyetanye extincoria* 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.) *aethrostyliidion samentogun* *Pliger* 'Hisophiia *boringueria* Maxon *Peperouia esargizelia* (Sv.) *Polypodiaa 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 below: oo PEE eo RS ---Page

Break--- 3 1h, Anthuriun acaute (Jacq.) Schott 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.) ϕ ,2. Clarke 22, Fitcainria 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. ellipseica J. ξ , 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 low understory trees were 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 and Lirtella rugosa were tagged outside thirty meters in the site being irradiated and in the control site. All tags were the letter "P." Post-irradiation leaf counts will show leaf fall. These data can be compared with leaf fall data being collected in the canopy trees. 6. Some soil moisture data were taken to determine similarity or dissimilarity of sites. Soil was collected after three days without rain. A tendency was found toward less soil moisture on the ridge sites (centers I, II, and III) versus the poorly-drained, palm-dominated areas. Some statistical significance was established (Fig. 7). Areas of soil sampling are drawn in Fig. 2. ---Page Break--- 5h Note to Project Participants: This is the list of higher plant species in the El Verde study areas. Each work has already been recorded using the code list in last year's (1964) report. This new list corrects errors in the earlier table and includes name changes now being recognized in taxonomic work such as in the papers by James Duke and the new book by Little and Vadsforth. To avoid confusion on the project, we suggest that the whole Latin names be used rather than the code (except on the IB cards). Remember that the 7000 aluminum tags on the trees may have the older name. HTO maple T List of Common Plant Species of El Verde Radiation Site, Symbol, Latin Name, Spanish Name, Laportent Synonyms. Changes made from last year's report are underlined to aid those making corrections. Alsophila borin, Anthurium dominicense, Alchornea latifolia, Quena - Palnilla grande, Abe me mi: Achtotitio Ap - Alchorneopsis portoricensis - Palo de gallina.

(palo de pollo Be Racenavin capitata = Grapaainio ot BL = feteropterie laurifolia (Sanisterta 1.) Bejuco de gonsora (vine) Be - Hyrsoniza coriacea (3. spicata) Yaricao auarillo (N. colorado) Ca = Casearia arborea Reto de ratén Ge = Contfa boringuenesis "Palo de auteco") Goi Casesaria bicolor Talantrén o vero de Sapo (Yunquea Ge - Guatteria carinacea (Cenanga e.) Tidn=tide Cep- Gecropia peltata Yogrundo hembra Gg' Casearia guianensis Talo blanco Gig- Clusia guntlachii Cupey © Cupettia de altura Cog= Concclaaia glabra Carasco Cp ~ Croton poecilanthus Sabinbe Cpa- Cassipourea guianensis (C. alba) otro Teta de turre Gr = Gyrlina racemiflora Talo colorado Cs = Casearia sylvestris Palo de cotorro (Palo blanco) Csq- Celycogonium squamosum Jusilio © Canasey justiiic - Cordia euleate oral 5) De - Doliocarpus calinotoides BeJuco de agua (vine) + Dacryodes excelsa Tabomico = Perypetes glauca Varital (cafefito) = Didymopanax morototoni —Yagruso macho = Dryopteris decipiens Palnilla pequeña = Daphnopsis philippinensis MaJagua de sierra = Ratterea globosa (Frestoca montana) Paina de ofrenda 7 Tnesoce Sepania (Exogonism Fepandan) Selda convelda + Bignonia stenostachya Guayabote Securidaca virgata (Elsote virgata) BeJuco de a fen (vine) 'rignonata (F. oressinervia) Jaguey colorao SPERRIRER ISS ---Page Break--- 5 Table 7 ~ Cont. lous laevigata (F. elatior) - Jaguey blanco Guares trichotoma (6. guara) Guaraguao Guettarda laevigata Cacubano Guarea ramiflora Guareguaslo Henriettella fascicularis Tipo de casey HonaLiun recensum Caracolillo Hirtelia rugosa Teta de burra Inora ferrea Palo de clavo Ig - Ardesia glauciflora (Icacorea g.) Ausubo 11 2 Sige Tnubiea (ings fast fos ia) 'ona Ip = lohnanthus pallens Inga vera Giava Linoctora doningenis (Mayepea 4.) Hueso blanco Lasianthe

lenceolatus (I. moraisii) Mata de peo Vingnalia splendens Laurel cabrón Nataybs doningenis egra
lore Nyreia defloxa Cleneguillo Micropholis garciniaefolia Caingtillo verde Neliosna herbertii
—Aguacatillo Manilkara bidentata (M. nitida) Ausubo Naregravia rectiflora

'BeJuco de pelfa (vine) Miconia prasiza Canasey Sentsosa Miconia tetranira Canasey prieto GRE
Ry FEREE By = Neorudoiphia volubilic Bejuco de violeta (vine) Nnem-Nectrandre menbrances
Laurel prieto Omosia krugii Palo de matos Ccotea leveoxylon Laurel geo Ocotea mocchata Henoca
o Tez nosesda Gcotea portoricensis laurel 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: Tetremsgastris balsamifere'
Palo de mea Oe aL Os op 08 Pa BR Fe BL Pr tp Fs Re Re sb Be 51 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 Indivieoad, 58 Pineter cleless
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

individual 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 im Pele area 8 © Men Syanoanb
ERROR OF Rana ---Page Break--- a Progress Report on Seedling Metabolism ay arted Lago 'The
pregent report includes results obtaiized in the study of two. foct groving plant spectes alapted to
succescional situations at high ght intensities, Anthocephalue cadambs, an inported tree from
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 FI 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 neasurement. Fesulte 'were expressed in grams of carbon/lea? urea/hour.
Since the seedlings were in plastic begs during measurement, 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 fliv of 10 liters per minute
war selected as the adct suitable for high light intensity neastrenenti Table 1 has some 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 temperature determinations vere made on A,
cadasba seedlings, and the results shov a sintlar pattern of temperature variation In air and plant
with a difference of 2 or 3 degrees greater In the ccedlings. These results 'show the effect of using

@

plastic bag as a chamber and a flow of 10 L/min, Fig. 4 demonstrates the changes in photosynthesis in relation to light intensity in both species, *TC. Peltata* where data are more complete, the pattern is similar to the typical curve that has been described for light-adapted plants. At high intensities, the species is able to maintain a more or less constant rate of production. ---Page Break--- Table 4 Temperature Natomos Noon x ---Page Break--- ---Page Break--- aay fei Photosynthetic rate as a function of air velocity in photosynthetic plastic bags over leaves of *Autocephalus codeabs* 3 by sealing: ---Page Break--- 5 coctopis, un fr oF Tt EER —f 18 150 Photosys * aga cer lever of *Cecrupte peltata* seedlings. ---Page Break--- 6 *Anthocephalus osdunbe* Pies be Photosynthetic rate of seedlings as a function of Aptanaity (dapiiott) | ---Page Break--- 6 Progress Report by J. Frank HeComick, University of North Carolina, Department of Botany, Chapel Hill and The University of Georgia Institute of Radiation Ecology. Radiation Dosimetry of Forest, Analysis of the ecological effects of ionizing radiations upon natural ecosystems requires accurate determination of the radiation doses to which individual populations and organisms are exposed. Initial studies of this type by Covan and Platt (1) demonstrated the complexities involved in monitoring environmental radiation on a scale appropriate to ecological investigations. Subsequent studies by Covan and Neinhold (2) discussed the difference between theoretical dose rates and those measured in air or in a forest. Recent studies by McCormick and Colley (3) demonstrated microhabitat variations in dose rates and variations in the vertical distribution of exposure doses in a forest community. These data were compared with those obtained during the irradiation of an old field with the same 9,200 Curie portable Cs 137 source, in this study a total of 1000 Con-Rad Lithium fluoride TLD thermoluminescent dosimeters and 250 lithium fluoride microdosimeters were placed in the main forest to

monitor exposure doses to plants and animals. Following irradiation the S-7 dosimeters will be processed by the University of Puerto Rico Nuclear Center. The radiology laboratory retained fifteen S-7 dosimeters in order to prepare a calibration curve for the Cs 137 source. All micro-Geiger counters will be returned to the manufacturer for processing. Two hundred of these were placed in small animals under the direction of Dr. Fred Turner. The remaining fifty were placed in the forest with S-7 dosimeters in order to compare their sensitivities. Maps have been prepared in duplicate which indicate the location of every dosimeter in the forest. The maps also list the dosimeters by code to identify the phase of the study to which they are relevant. Keeping in mind the problems and results discussed in previous studies and upon estimation of the requirements of the numerous investigations, the Rainforest dosimetry program includes seven major phases: (1) A symmetrical grid of dosimeters in the experimental and control areas from which isodose lines can be prepared; (2) A series of dosimeters at varying elevations (0.5 in the soil, ground level, 1 1/2 meters, 3 meters, 6 meters, and 9 meters) at most of the points on the grid in order to estimate the vertical distribution of dose. Although it is desirable to place dosimeters at elevations above 9 meters in a few locations in the forest, the scope of the study was limited by the investigator's ability to ascend higher into the canopy without fear of descending at a rate exceeding his limit of physical tolerance. (3) A series of dosimeters on the front and rear sides of trees at each of the elevations listed previously in order to determine the shielding effects ---Page Break--- 6 of individual tree trunks of various species and diameters. These were located at most of the points on the grid. Dosimeters were placed on the front and rear side of an additional 100 trees scattered throughout the lower center in order to meet the need of a forest tree growth study being

conducted, by Peter Murphy; (4) Several hundred dosimeters were placed in microhabitats to

determine the shielding effects of vegetation, rocks, or terrain upon seedlings or seeds. These dosimeters were distributed in pairs, one being placed behind a potential shield at ground level and the other nearby within line of sight of the irradiator. One hundred of these locations coincide with 1x 1 meter quadrats which are being analyzed in terms of seedling density, diversity, distribution, and growth. The remaining sites were selected on the basis of visible inspection and upon evaluation of maps prepared by the U.S. Corps of Engineers; (5) A series of dosimeters at 1.5 meter elevation measuring the 10 meter and 30 meter perimeters which enclose the anticipated "zone of biological effects". These dosimeters were placed in groups of 2 or 5 and included both Con-Had TLD S~7 and thermoluminescent dosimeters in order to compare the sensitivities of the two types and to estimate variability between sensitivities of individual dosimeters in the forest; (6) Dosimeters at several points on the public road, at entrance gates, and along the river where the public has closest access to the areas or where people frequently congregate for "recreational activities; (7) Consultation and placement of dosimeters for special requirements of individual investigators. Dosimeters placed to meet the requirements of one phase of the study frequently coincide with or occur near dosimeters designed to satisfy other phases of the study. These replications are of value in estimating variability and reduce the chance of losing important data due to the loss of a dosimeter. A code system has been developed to describe the location of each dosimeter when they are harvested at the end of the radiation period. When a single dosimeter is relevant to more than one phase of the study, code numbers for each phase will be listed. By cross-listing dosimeters in this manner approximately one hundred replications will be gained for estimation of dosimeter.

variability. 'The Tropical Terrain Research Detachment of the U. S. Army Corps of Engineers Veterinary Experiment Station assisted in the difficult job of placing docimeters in the forest. ---Page Break--- References Cited 1. Cowan, J. J. and R. B. Platt. Radiation dosages in the vicinity of an unshielded nuclear reactor. Radiobiology 311-318, Reinhold Pub. Co, New York, (1963). 2. Cowan, F. P. and C. D. Meimhold, Radiation dosimetry for co and ca237 gamma-ray field irradiation facilities, Fed. Bot, Vol. 2, 261-250, (1962). McCormick, J.P, an experimental facility B, Golley, Irradiation of natural vegetation, procedures, and commentary. (in preparation). Studies of Forest Seedlings Studies of forest seedlings were initiated with objectives of: (1) determining the density, distribution, and diversity of seedlings in the experimental and control centers of the rain forest; (2) analyzing the direct and indirect effects of ionizing radiation upon forest seedlings in terms of the above listed criteria; (3) determining the extent to which seedlings contribute to recovery of the irradiated forests and (4) a related objective of determining the extent to which small seedlings are shielded from irradiation by vegetation, rocks, and terrain. In order to acquire the data necessary to fulfill these objectives approximately fifty permanent 1x1 meter plots were established in each of the two centers. These plots were located in pairs along transects running from 10m to 30m on four compass bearings which included mild and severe upslope and downslope. Additional transects run from 30m to 80m along two compass bearings, one going up hill and the other downhill from the center. One of the paired plots is behind a potential radiation shield (vegetation, rocks, terrain) while the other is in approximate line-of-sight of the irradiation source. Initial results of this study were presented in Table I and Figure I. In order to later distinguish between the direct effects of ionizing radiation and the indirect effects due to

Changes in the microenvironment of the seedlings measurements were made of light intensity, relative humidity, gut temperature, 3 m, 1 m, ground level, plus soil and litter temperatures, for most of the 100 plots. These instantaneous readings provide data which describe the strength of vertical gradients through the seedling layer of the forest. These data are supplemented by hour recordings

of temperature and humidity in one tenth of the plots. These data are further supplemented by constant temperature recordings of 1 week duration in one location along each of the four 10 m - 30 m transects and by environmental data monitored continuously from environmental towers in the forest. ---Page Break--- These investigations will be repeated at appropriate time intervals following irradiation in order to describe the effects of radiation upon forest seedlings, the recovery of seedling populations, and the contribution of seedling populations to community recovery. Whenever possible, radiation tolerances of seedlings will be compared with tolerances predicted on the basis of nuclear volume, when appropriate. Laboratory studies of seedling tolerances and radiation and other stresses will be conducted in order to distinguish between the direct effects of radiation and the indirect effects of microenvironmental change upon seedling survival. Limits of tolerance observed in the laboratory will be compared with limits of environmental variability in the forest before and after radiation. *Euterpe globosa* populations Although the rain forest is noted for the extremely high diversity, the *Euterpe* palm comprises one fourth of the vegetation. For this reason, the palm serves as a good species for autecological studies and evaluation of radiation effects upon tree populations. In four of the 16 sectors from the center of the study area to 30 m, all palms were counted, measured, and mapped. Similar data were recorded for transects from 30 m to 8 m in two of these 16 sectors. These data were collected in both the experimental and

control centers. These studies of palm populations will be repeated following irradiation. Results thus far indicate a 95% mortality rate for young seedlings, a 12% mortality rate for established seedlings, and a 6% mortality rate for shrub site plants. Approximately 1.6% of the palm seedlings survive to become trees of the sub-canopy or canopy. "Those trees which do survive make up 1 out of every 3 trees in the forest according to Treadsworth. Observations of palm phenology indicate that the trees fruit and flower at any and all times of the year. Estimates of palm biomass, productivity, growth requirements, and radiation sensitivity are yet to be conducted. ---Page Break--- The following data are for the forest seedling study. There were 51 plots in the upper center and 52 plots in the lower. Each of the 103 plots was one. Density is individuals per m² and frequency is the % of the plots in which a species occurred. The mean number of species per m² is: Upper Center 4.08 Lower Center 5.86 The mean number of individuals per m² is: Upper Center 10.83 Lower Center 12.63. Diversity determined as species/individuals is 1 to 26. The data for the two centers seem to be quite comparable. This is gratifying since Alejo counted most of the plots in the upper center and I did most of those in the lower center. Additional size class data were obtained for *Utterpe*. Both the quadrats and transects were used; the data were quite comparable for each method. I grouped the plants into 4 classes: seedlings, established seedlings, shrubs, and trees. The data have been converted to mortality of a particular age class and are as follows: Seedling mortality 95% Established seedlings 12% Shrubs 6% Thus, only 1.6% of the seedlings survive to the tree stage. ---Page Break--- Table 1. R Forest Seedlings Density and Percent Frequency Species Upper Lower Total Upper Lower Total Bg = *Butia eriospatha* 166 3.1 2.62 5 GG = *G. wok* 0 ton 2 o 0 Fonarosa, 2 1 Ee ~ *Fugenta stabilit-Guaysbota* 2.33 133 183 T2335 Ab = *Algophila*

boringuena-Puintlle grande 129 110119, 8 AL = *Aichornia Ystisolia - Achotills OO*) ° ° oo up - *Trichilia 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 laurifolia - 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 gutanensis - Otro palo o 8 ° ° o 0 'lance Cig - Clusia gundiacti - cupey o 8 ° ° o 0 Op = Croton poecilanthus ~ Sabino 2 3 8 Cpa - Cassipourea alba -**

Teta de barra 0) {03 Toho ek Cr = *Cyrilla racemosa* - Talo coloraio 0 0 ° ° oo Os = *Casearia sylvestris* - Pulo blanco 0 0 ° ° ar) Gel - *Cordia ecalypta* ~ Horral o 8 ° ° 2 0 ss~ *Foliocarpus calinoides* 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* Plantia 5 ke MB eT pequelia Dp = *Dephnopeis phillippiana* - Najegua 0 0 ° ° o 0 de sierra 8) = *Bagenta jambosa* 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 racemosum* - 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 = *Inga laurina* = Guanes oun 1b 6 5 = Iv = *Inga vera* ~ Guava feo "lo gw ---Page Break--- B Density a? Percent Frequency Species Upper Lower Total Upper Lower Total Hgs - *Magnolia 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 ~ *Manilkara 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 Leucoxyton-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 - Phlodendron 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 ---Page Break--- species Species Seedlings ~ Fi. McCormle 5 10 30 Individuals Macroscopic Fungi — GT Cowley Fl. Th Redia'hion ceiltn beter radicion Individuals ---Page Break--- 6 A SURVEY oF wu PUES.Y RRG T 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 eight 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 each entity in each center was determined as follows: 1) 'The frequency of occurrence of each species in each center was determined by calculating the percentages of marked sectors (i.e., V-HE, MEH BB, etc.) in which it appeared. 2) The density of each species in each center was determined by dividing the number of individuals by the number of sectors sampled. 3) Expected density was determined from a modified Fracker and Brigham table relating frequency to density (Curtis and Cottam, 1962). (a) Observed density (b) divided by expected density (a) yields a figure for the degree of aggregation. A species was considered to be aggregated if the D/a ratio was 2.00 or higher and random if below 2.00. 'The majority of species were determined to be randomly distributed. 'Those aggregated in

both centers were 2, 6, 8, and 65. Those appearing in only one center were 21, 54, 59, 64, and 65 in the north center and 26, 30, 31, 35, 36, 49, and 61 in the south center. Those segregated in the north center and random in the south center were 85, 15, 43, 51, and 57 while 60 and 62 were aggregated in the south center and random in the north. 'Two reasons for aggregation may be recognized. First, many fruiting bodies may have arisen from a single mycelium or mycelial network, and second, a particular species may have had an affinity for a particular substrate type. The latter would seem to be true for species 6 and 66 which were found exclusively on leaf litter. 'The similarity between the populations was calculated using the formula $2u/(A + B) \times 100$ (Curtis, 1959) where A is the total of the same value for the south center, B is the same value for the north center, and u is the species found frequencies in common between centers. If the index is 100, the populations are identical, and if it is 0 the populations are totally dissimilar. 'The index of similarity between the populations of the two centers was exactly 50. Figure 1 shows the

diversity curve for fungi as encountered when counted by sector. See P. Th. ---Page Break--- 6
 Latter Decomposition Fungi A socioactively var initiated in the forest to determine the succession of microfungi on decaying leaves of *Dacryodea exclea*, *Lisinkare nitide*, *Groton poecianthus*, *Cecreople peltata*, *Sloanes berteriana*, and *Hunterpe globosa*. Seen hetise Litter SF care BP tices tee apesice were collected and an air dried and weighed amount was put into litter bags. Two bags of each species were frozen, and 10 bags of each species were placed at 11-12 meters from the center of each study center of the forest. Duplicate bags are taken in and frozen each month until irradiation is begun, another similar set of bags is to be placed out at the beginning of irradiation, and another immediately after. These sets will be harvested at the first. The contents of these bags will be weighed and populations of microfungi isolated from each to attempt to correlate the fungal populations on each species with the stages of decomposition before, during, and after irradiation. Table 1, Name, location, and substrate of each fruiting body type detected. For Fungi Fruiting Bodies Seen Substrate North South Total 1. *Tyropenton pasitiun* a a e 2. *Amellaria* sp. 6 wb a 3. *Irpex farenaceus* 1 2 3 a 4. *Auricularia* sp. 6 6 a 5. *Polyporus* sp. 2 23 a 6. *Tarasmue rota* 9 wb Y > T. *thmmlarie* sp. 5 1 6 a 7. *Peathyrella dicentnata* 2 1 3 > 8. *Vinumula earls* 2 2 a 9. *Leptota neueina* 3 3 e 10. Reams' olneyt a B > az 4 307 e Be 1 1 . a L a a 15. *Crepidotus matachius* B 2 4 and 36. *Hylaria* sp. 3 5 8 a Vf. *Collybie* abundance i 1 > 18. *Poria* sp. a 12 a a9) *Polyporus* sp. a a a 20. *Collybia temutpee* a 12 a fa! *ygropnorus* sp. (") 3 3 > 22. *Crepidotus milits* L i 23. *Collybia* sp. a 1 zh. *Inocybe* <pl. 1 1 25. (Agaricales) 2 2 26. *Tricholone* sp. 7 7 27. *Hylaria* sp. aoa ---Page Break--- 2 Pungue 28. *Iaramun detactans* 29. *Leptonie* #0. 30. (Geterotersatetes) 31. (Agaricales) Bo) *Sterium* sp. 3. *Porta* sp. 35. "Mtelephora sp. 36. *Stereum* sp. svolur brazilien 38.

(agaricates) 30. *Lycoperdon hacnatope* (~) Bo. *Clitocybe deatbara* BL. *Yutinue canine* 42. *lebelona* ep, 23. *Oyeena en*, AA *Clgarteates*) 5. *Cortinarius deceptivus* 46. *Clavaria stricta* We. *Stereum* sp. 48. *Stereum* ep. 49. *Clitocybe* sp. 50. *Schizophyllum commune* 52. *Polyporus pieipes* 53. *Stereum* ep. 5h. (Agaricaceae) 55. (Renellaceae) 56. *Peattyra Sr. Lycena* ep. 58. (Agaricaceae) 59. *Tones senex* ©. *Nerarue* 61. *Mycena atroalba* 62. *Yaracmae* 63. *Xylaria* sp. 6h. *Narasmis* ep. 65. *Clitocybe* sp. 66. *Xylaria* ep, 1 Fruiting losses Seen Substrate forth South Total yoo » 2 oL > 2 a y 9 a ze a 2 4 a 1 oo a 21 ® nt a b5 i 30 4 2 a loo e 2 1 e a 1 e 10 3 0B e B 79 © 303 e 2 c 1 e 2 7 9 a 33 e 2 i e 1 1 e a 1 a 2 1 3 . 2 2 a a i a rou e 2 1 3 a aod a 2 2 a 2 33 Wh . 2 2 © 2 8 0 > aon > 3 3 > 2 2 © 3 kt » FT a dead wood, 0 TTEr, 6. sil, Cie wea References: Curtis, J. and ©. Cottem, 1962. Plant Ecology Workbook. Burgess Pub. Co. Curtis, J. 1959. The Vegetation of Wisconsin, Univ. of Me. Press, ---Page Break--- 6 Soil, Root Layer, and Litter Layer Microfungal Analysis. 'Water University of South Carolina A study of the pre-radiation microfungal populations of the litter, root, and soil layers in the Luquillo Experimental Forest, Puerto Rico, was initiated in late July and

August of 1961. In each of the two study centers, samples of soil, roots, and litter were taken at 3.2, 10, 39, and 55 meters from the center point. Serial dilutions to 1:1000 of the soil samples were made with sterile distilled water, and serial dilution to 1:10,000 of root and litter samples were made after grinding in a varying manner. One ml of each dilution was pipetted into each of 5 plates of a modified Martin's medium (Allen, 1957). The modification consisted of replacing tryptone with lactic acid to lower the pH of the medium to approximately 4.5 to eliminate bacterial contamination. After incubation for 3 to 10 days, colonies on the plates were counted and the total population of fungi per gram of sample were calculated for each sample. When 30 random...

Isolates were transferred from each sample to tubes of malt extract agar, incubated for one week, and sorted into separate entities by cultural characteristics. The number of isolates of each entity from each sample was recorded. To isolate less abundant, but more resistant forms (particularly Ascomycetes), a portion of each sample was treated for two minutes with 65% ethyl alcohol. A small amount of this material from each sample was placed in a sterile petri dish, and a modified Artie's medium was poured over it. After incubation for 3 to 4 days, 10 isolates were taken from each sample, with an attempt to isolate as many different forms as possible. These isolates were then treated as above. Cultures of each entity isolated were returned to our laboratory at the University of South Carolina for identification. Although there is a great deal of work yet to be done on identification, it is possible to arrange the entities for analysis from a distributional point of view. Total populations per gram of sample as determined from the dilution plates are found in Table 1. Populations in the three layers were quite distinct, with 9 species isolated from soil only, 10 from root only, 11 from litter only, and 17 from 2 or more layers (Table II). These 183 entities represent 1448 isolates. A determination of the index of similarity (Curtis, 1999) between layers and centers further demonstrates the difference between populations in the three layers and similarity between the same layers in the different centers (Table II). ---Page Break--- A similar treatment of the alcohol treated samples showed similar results (Tables IV and V). These cultures have been kept separate from those of the dilution plates; however, it will undoubtedly be found that some of the species are the same in the two groups. These studies will be followed by similar post-irradiation studies to detect changes in the populations induced by irradiation either directly or indirectly. References: Allen, O./ 1957. A Laboratory Manual for Soil Microbiology.

Turgese Publishing Co., Minneapolis, Curtie, J. 1959. "The Vegetation of Wisconsin." The Univ. of Wis, Press, Madison, Title. Table I, Range of populations of fungi per gram in samples taken from soil, roots, and litter in each study center, center saver so. foots north Vida. 2×10^3 1.6×10^9 1×10^9 Wax. 85×10^3 11.05% $10 > \& \times 10^9$ south Jan. 3×0 $2 \text{ a} \times 8 \text{ L} \times ?$ wax, 93×10 : $119 \times 10^?$ $7.95 \times 10^?$ ---Page Break--- Table II. Frequency percent of isolates from dilution plates by layer and study center. Code number Soil Roots Litter A Trichoderma sp. Liriodendron viride Penicillium sp. Aveldia butleri 18. 2 : ae. 6: Trichoderma sp. 38 Penicillium sp. 6: 12: 6 é 1 7 6: 18. x Penicillium sp. 1 3. 2. 36. 9 39. ho. a 7 8, 20. 22. Yi 62. 1. 15. 36. a iis. 2 4 23. 2. 28. 50, 36. 6 io. Penicillium Aspergillus niger ---Page Break--- Code number Soil Roots Litter North South __North South __North — South B. Te 16, 6.25 6. Penicillium multicolor 68.75 62.50 13. Aspergillus japonicus 43.75 10.75 143. Penicillium sp. 126. ier. 136. a8, 133, uz, lk; Penicillium sp. us. Penicillium sp. Yeast Trichoderma sp. 93.75. 81.50 6.25 6.35 B75 6.25 ---Page Break--- Soil Roots Litter North South North South __North South Penicillium sp. 625 6.25 32.50 Penicillium sp. oakabB5E oo BB oBBaBEEE aBBBaa BEsagt! 256.25 12.50 =~ 1.50 se : 6.25 Yeast - 6.25 6 2 6.85 2 6.25 : 6.25 200: nc) 103. Penicillium sp. 825 hao. 6.85 a. 87.50 75.00 35. Penicillium sp. 56.25, 26. 62.50 31.25 6h, 43.75 50.00 P) Penicillium sp. 3125 18.75 ---Page Break--- Table III. Soil Litter matrix showing the index of similarity ($2\% / A$ - set of examples. More South North South North South North

South 25.5 28.0 we 22.5 %.0 ako 15.3 16.8 Roots North South 0.6 oe 20.2 9.1 LT 9.9 x 100) for each Litter North South Species distribution among the alcohol treated samples. Species isolated from soil only roots only Litter only soil area

root soil! and litter roots and litter fall three layers 'total number of spectra ---Page Break--- - a - Gable Y. Matrix showing the index of similarity for each set of samples. - South North South ___North South - North son South 56 vee - North Bug eT. a - South 17 29.3 52.7 'North 13.0 16.2 Ob NL Litter - South 3.2 83 2.2 36.7 33.9 Circuit of Optical Density Device 'The circuit of the portable optical density device which was developed by the project in collaboration with Tropical Terrain Research Detachment - of the University Experiment Station (San Juan) is drawn below. This device has now been used in various systems throughout Puerto Rico. For the theoretical discussion see the 1964 report, the paper by H.T. Odum in 1963 - Giett. Acad, Sci, 49:429-434), and i. Monel and T. Secki in 1953 (Japan J. Bot., 1:22). The portable device in its final form involved contributions of George Drewry, William Helmut, W. Rushing, Robert Benn, and H 7. Of. + - © kxeun cot set Pon'pste above adjust 0.0. pot - trees for zero meter deflection, spasm \$3900 G. Drewry ---Page Break--- 85 MICROVIAL DENSITY AND ACTIVITY OF SE LOVER CREEK December 15, 196% Martin Witkesp nk Bdge !ational laboratory Microbial population density and activity were characterized for the top 2.5 cm of litter and soil at 10, 20, 30, 45, 60, 100, and 150 m from the source. The transect runs from Zo to FE,9p uphill in line of sight of the source. A topographically stable control was located in the same direction at 150 m from the source. At each distance from the source two samples were taken, one in plain sight of the source, another close by. Behind a large rock providing at least 25 cm of shielding and over 90% attenuation. The transect enables characterization of 1) pre-irradiation levels and variability at various distances from the source 2) trends along the transect which will have to be corrected for in order to evaluate radiation effects and 3) radiation effects at various distances. The paired samples enable additional

Evaluation of direct radiation effects on the microflora without secondary effects from changes in vegetation and fauna. Paired measurements at each sampling distance were made of organic matter, moisture content, pH, fungal and bacterial densities, and O₂ consumption. In addition, CO₂ production was measured volumetrically using dishes with 5 ml 0.1 M sodium bicarbonate under inverted metal boxes (15 cm diameter, 30 cm high) on the forest floor at each sampling site. Paired measurements were made on 10 cm soil cores (23 cm diameter, 25 mm deep) using stationary Warburg technique at 30°C for O₂ consumption, and 1 g of wet soil dilution plates with pepton-dextrose agar and nutrient agar for fungi and bacteria respectively. To evaluate radiation effects on microbiota below 2.5 cm, the same measurements as on the paired samples were made on cores from 2.5 to 5.0 cm depth taken between 10 and 30 m from the source. Effects on microbes, shielded by 2.5 cm of soil, are not expected beyond 30 m from the source. Increase in litter production during radiation and possible reduction of microbial activity may lead to litter accumulation. This situation may resemble decomposition in the mountain forest with considerable humus formation. To enable a comparison between the two cages of litter accumulation in respect to microflora and microbial activity, measurements as before were made on four soil cores from mossy cloud-forest from the top of EL Toro. Results (Table 1) show for the transect series that 1) there is no significant difference between the projected exposed (1-3) and shielded (5-5) series ($p > 0.60$). 2) There are no significant linear regressions for the measured variables along the transect with the exception of organic matter ($p < 0.05$), moisture ($p < 0.15$), and O₂ evolution ($p < 0.01$), all of which increase going uphill away from the source.

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---Page Break--- ara 'The subsot1 (25-5 en) coneuned significantly tees Op (P-<2%) than the top
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(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 from 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-seasonal nature of the fovest an will be analyzed for phenological information of specific
Individuale, lesults 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 now have permitted direct assessment of vegetation cover over the 11
sample points for comparison with changes due to treatment. The serial photography will be
analyzed using a microdensitometer to associate changes in the photographic pattern with the
gamma gradient introduced. It may also be possible to correlate film densities with various species
or phenological events. See Fig. 1 on page 815. ---Page Break--- ---Page Break--- Radiation
Genetics and Radiation Botany By P.M. B. Koo and Biith Robles de Irizarry A. Nuclear volume and
radiosensitivity Radiosensitivity is a measure of the degree of biological response to radiation. The
end points employed in the sensitivity assaying can be either the lethality, growth inhibition, sterility,
mutation, chromosomal aberration, physiological or biochemical changes. Often, the cause of
lethality, growth inhibition, or sterility in plants is mainly genetic in nature; if the observed end point
can be traced to its genetic origin, the site of the primary radiation damage must lie in the nucleus
and then certain nuclear characteristics may be related to the radiosensitivity. It has been
demonstrated that the nuclear volume, particularly the nuclear volume per chromosome at
interphase, strongly correlates with the radiosensitivity in plant species. If the growth inhibition or
lethality is used to measure the radiosensitivity, it would be most logical to study the nuclear
parameters in the meristem of the shoot apices because these end points simply reflect the
radiation damages in the meristems. In the area of El Verde, a great number of plant species
including trees, vines, ferns, grasses, etc. are known. Within a radius of 30 meters in both
experimental sites, some 65 species, mainly trees, were tagged for study. The abundance of the
material provides an unusual opportunity for studying the relationship between nuclear volume and
radiosensitivity. To prepare the meristems for nuclear volume measurement, the terminal shoot
apices were collected.

ani fixed in Cra® ITT. The soterial, after being washed thoroughly, was processed through a
dehydration-infiltration schedule using ethyl and tertiary butyl alcohol, embedded in paraffin,
sectioned at the thickness of 10-12 µ, stained with safranin, crystal violet, and orange G, and

counted. The nuclei of the cells in the tunica and outer corpus were measured with an ocular micrometer at a magnification of 800 x, for each nucleus two measurements in diameter at right angles to each other were taken. For each species, in general, two meristems with 10 nuclei in each were measured and the average nuclear volume was calculated from the measurements of individual nuclei assuming a spherical shape of the nucleus. Presented in Table 1 are the nuclear volume measurements for 66 plant species. *Miconia tetrandra* has the smallest nuclear volume which measured 23.6 μ^3 and *Smilax coriacea* the largest, 335.6 μ^3 . The two extremes represent a 1-fold difference in nuclear size. In the Table, there are 33 species with a nuclear volume less than 100 μ^3 , 25 species in the range of 100-300 μ^3 , 6 species in the range of 200-300 μ^3 , and only 2 species over 300 μ^3 . Based on the known fact that certain pine and other species have large nuclear volumes and high radiosensitivity, ---Page Break---

Table 1. Nuclear volume measurements (in μ^3) of shoot apices of plant species grown at the radiobiology experimental sites at FL Verte.

Species *Miconia tetrandra* 6.6 *Tilledeta curvata* 83.0 *Elsota virgata* 83.0 *Matayba domingensis* 82.0 *Sloanea berteriana* 86.0 *Conocarpus glabra* 3.0 *Ficus laevigata* 192.0 7.8 *Casearia bicolor* 38.0 + 13.5 *Omosia krugii* 40.5 4 13.6 *Casearia sylvestris* 43 513.7 *Allopyleus overdentatus* 116 *Rourea glabra* 14.0 *Heuroplatia volubilis* 14.0 *Dacryodes excelsa* 52.6 + 16.9 *Casearia arborea* 58.2 + 19.6 *Conia eulesta* 603 15.9 *Tetragastris balconifera* 62.5 + 12.5 *Casearia gulanensis* 64.0 + 9.3 *Cassipourea alba* 64.8 + 116 *Guiania lingulata* 61.7 + 18.0 *Socratea portoricensis* 68.8 + 313.3 *Rheedia acuminata* 6.4 + 15.8 + *Homalitus*

recenosum 6k 2 12.3 *Guettara leevie* 6.7 5 963) *Tabebuia heterophylla* 323 § *Baa scyrilla racemiflora* 75.6 39.8 *Mangifera indica* *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 leucoxyton* 101.8 25: *Drypetes glauca yo1.g* ϕ 19.5. *Guarea guara* 10210 + 20.6 *Paullinia pinnata qoeie* \$13.8 *Butia globose* 303-7 \$27.1 *Banisteria laurifolia zit* 3 26.0 *Bxogontun repandum agi* \$21.6 *Dicyropanax sorototont ab.* 3 27.6 Note: These names are based on the old table and have not yet been converted to names given on page Sk. Some of these grow at the El Verde station but not actually in the relation center. ---Page Break---

90 nucleer Specter vole + SF (u^3) *Alchomeopsis portoricensis us.* = *Ilyreonia spicata weak Prychotrie berteriana* 330.9) *Thylodendron Lingulatus* 3-2 *Roystonea berteriana iN5.6 Pseudodendron krebett N63, Cananga odorata aga Daphropsis philippinensis* 118.9 *Anthurium deninicens!* 3 *Ccatea moschata.* 18.7 *Skelegelia portoricensis ais Duchenavia capitata* 161 *Palicourea riparia* 176.5 *kara nitida* 179.3 *Fajania cordata* 159.2 *Alchornea latifolia* 219.2 *Dryopteris deltoidea eer.* *Heliconia herbertiana* 1.6 *Marcgravia rectifolia* 232.3, *Cordia leringensias* 252.8 *Croton poecilantus* 260.0 *Magnolia splendens Bio Srilax coriacea* 335.6 sth only 2 meristems studied Measurement for dormant meristems most of these tropical species may be considered relatively tolerant to defoliation and some of them highly drought-resistant. "The nuclear volume of a species often varies with the season. More precisely, it varies with the state of the meristem. In this study, a number of species have been measured for both the actively growing and non-active or slow-growing meristems (Table 2). The differences in all cases are very pronounced. The percent increases of the actively growing shoot apices over the inactive or slow-growing ones are from 27) for *Contin*

borinquensisto 157% for *Euterpe globo*. It is of both theoretical and practical interest to make predictions on the radiosensitivity of the species based on the nuclear volume measurements. However, it should be pointed out that the predictions can be regarded only as approximations and they represent only the general range of the sensitivity of the species with that nuclear volume. In this study, the total dose levels that could cause over 90% mortality, 20%, and 60% shoot growth

reductions (Table 3) are predicted by considering the predicted and actual doses for the same effects presented by Woodwell and Sparrow for the species in the Sable-pine forest at Brookhaven. The total dose level for lethality is therefore calculated on the basis of 1-year exposure and that for shoot growth reduction on a 6-month exposure basis. Since our total irradiation period is scheduled for 3 months only, the results may differ somewhat from that observed under a much longer period of radiation exposure. In Table 2, on the percentage of increase in nuclear volume measurements of actively growing shoot species over inactive or slow-growing ones. Species *Cassipourea alba*, *Guarea glabra*, *Miconia prasina*, *Euterpe globosa*, *Pellicourea riparia*, *Nannorrhops bidentata*, *Cordia borinquensis*. Nuclear volume + SE (x3 Actively growing shoot samples (A) 64.8 + 11.6, 81.9 + 1.2, 93.6 + 18.9, 62.3 + 3.1, 31.6, 26.2. Table 3. Predicted total dose levels for 90% mortality, 60% and 20% shoot growth reductions in tree species with various nuclear volumes grown at 5-137 gamma irradiation site at El Verde. Nuclear volume 90% mortality dose 198.0 80% growth reduction dose 28.28 20% growth reduction dose. 92 Nuclear volume 90% mortality 80% growth reduction dose reduction dose 2: i 15 i) 380 2t.0 3.85 25.8 3.68 158 200 2.6 250 156 210 305 3.35 353 220 22.5 1 230 2.8 3.08 20.8 219.6 250 201.0 218.5 260 19.3, 2.5 270 28.6 2.65 260 18.9 2.57 20 15 2050 139 300 11.0 pike 138.

16:5 2136 31 320 16.0 2128 136 330 15.6 2122 135 30 i.e. eat 335 'addition, other factors such as biological and uninsulated shieldings could 'also contribute many discrepancies to the predictions. Above all, the standard errors for the nuclear volume measurements are relatively high, so 'the predicted value for each of the effects may very well vary within 20% even though other factors are not considered. A count of plants in each species killed by radiation will be made soon after a three-month exposure and at intervals thereafter for a period of about one year. Because the number of species is large only a few species can be found within a small area close to the radiation source where the total accumulative dose is high enough to produce the killing effect. For the species which have some killing and also are abundant in the area, their response to radiation may be studied at all dose levels. But for others, only the low-dose effects may be assessed. For the growth inhibition measurements, two studies, one on shoot growth reduction and the other on trunk circumference growth reduction, have been initiated by other investigators of the Program. Their results certainly can be correlated with the nuclear volume measurements to check 'out the validity of the prediction. However, the most critical information on the radiosensitivity of 'these species must come from irradiation experiments performed under controlled conditions. In this type of study, acute gamma irradiation can be used to study the survival and growth reduction of seedlings in the greenhouse. Seeds of several tree species have been studied for their germinability and the most serious problem so far encountered has been the poor and uneven germination. Improvement in methods of germination may be found after further testing, at least for some of the species. So the radiosensitivity for a selected group of species can be studied. ---Page Break--- 8 B, Hose Investigation Dr. Ul, C, Steere of the New York Botanical Garden collected and identified 25 species of

noces in the rainforest at FL Verde. Preliminary results on the nuclear volumetric measurements for all 20 species have been obtained. 'The range varies from approximately & ud to 1h0 3, indicating | 35-fold difference in volume between the two extremes. A number of species show that the nuclear volume taken from the base cells of the top "leaf" is quite different from that of the lower "leaf". In some instances, a 10-fold difference in volume is observed. In general, the cells from the top "leaf" have larger nuclear volume, but this is by no means the rule. For a few species, the apical points have also been studied for the nuclear volume. 'The measurements appear to be comparable to the ones on the top "leaf" of the species. 'The nuclear volume study has been done

with the aceto-carmines squash method. Attempts have been made to culture and propagate the moss species in the growth chamber. Eight out of 20 species have survived and begun to show new growth. This survey would help to determine the feasibility of radio-sensitivity study with mosses under controlled conditions. (-Made investigation has been assisted by Robert Venstor)
Bromeliad Investigation 'the species of Bromeliad collected at EL Verde were irradiated with gamma rays at doses of 0, 3, 6, 12, 24, 48, 96, and 192 kr. Ten plants from each treatment for each species were planted in the shaded greenhouse with ample mist spray. At the end of one month following irradiation, all plants of both species that received 192 kr died. The plants at intermediate dose levels showed some browning and spotting. There were no apparent signs of any radiation damage at low doses. At the end of 2 months, 5 and 3 plants of the broad-leaf and narrow-leaf species, respectively, died in the 96 kr series and one plant of broad-leaf species died in the 48 kr series. At the end of 3 months, all the plants of both species in the 96 kr series, and one plant each from the two species in the 48 kr series died. In the broad-leaf species, one and two plants in 12 kr and 6 kr series,

respectively, also died. It is apparent both species are tolerant to radiation although the broadleaf species is less so. Another set of experiments with the same two species has been underway at the irradiation site at EL Verde. The plants were grown on the plates cut out from tree fern trunks for a period of one month in the shaded greenhouse under constant mist spray and then moved to the rainforest before the beginning of irradiation. The plates were hanged on the tree trunks about 6-6 feet from the ground at a distance interval of approximately every 5 meters up to 50 meters from the Cs-137 gamma source. At each location randomly placed was a set of 4 plates consisting of two replications with 20 plants in each replication for each species. Two sets of controls were also placed at two locations some distance from the radiation source. All the ---Page Break--- sets were tagged with doimeters. Data on survival and growth of new leaves have been collected on two occasions. Further information will be gathered following a 3 month exposure period. The study has been accepted by Robert Venator. Other Studies Planned the Cytogenetic effects of chronic gamma irradiation on tree species are of special interest to us. Plans have been drawn up to study the chromosomal aberrations in the microsporocytes and sterility in the pollens of a selected group of species. Also a limited number of tree species will be studied for the radiation damage to the meristeme. The material for these studies will be collected at various distances from the source, preferably at locations where the dose levels are known. Gamma radiation effect on chlorophyll A content in Bromeliads. F, K. 8. Kooy Hs Te Cluny Baith Robles de Trizarry and Harta De tree Under the same environmental conditions the ratio of photosynthetic rate of a plant to its chlorophyll content holds constant and 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 is known to affect chlorophyll biosynthesis. In this study, chlorophyll content was assayed to serve as an indirect measure of radiation interference with the photosynthetic mechanism in the irradiated plants. The broad-leaf Bromeliad plants, 17 in each group, were treated with gamma rays 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 hr. of mist spray 2 a day. For chlorophyll A determination, at each collection date, leaf samples, one from each plant, were collected from the control and each of the 50 irradiated series. A single disk in the size of 1 cm was then taken from each leaf using a cork hole puncher. Leaf disks were extracted individually in acetone, optical density was measured, and chlorophyll A was computed according to the standards given by Richards and Zicupson. An abbreviated procedure was used involving the determination of optical density at 665 nanometers only using the relatively broad band pass of

the Pausch and Leck spectrophotometric colorimeter. Readings in this instrument were calibrated using the same solutions in a Beckman Quartz band pass spectrophotometer according to Richards and Thompson's procedures. Seven collections were made over a period of 2 months, beginning on the day of irradiation and thereafter about every 10 days. Only the younger leaves were taken, and all plants were about equally sampled in the whole period of study. Starting with the second date of collection, leaves sampled were first read on a transmission densitometer "Densichron" for diffuse transmission densities before leaf disks were taken. Presented in Table 1 are mean chlorophyll A content ($\mu\text{g/g}$) in young leaves of the control and gamma irradiated series. The samples collected on the first date in general yielded about 0.2 g/m^2 or more except that in the 50 irradiated samples collected 11 days later showed a drastic 50% decrease.

Chlorophyll content but further decrease at later collections were less pronounced. With the exceptions that occurred in the first two dates of collections, in general, the chlorophyll content decreased with increasing irradiation dose. The increase in content at low dose levels as shown in the second collection (Oct. 26) may indicate a stimulative effect. However, the increase 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 basis as these samples were collected immediately following irradiation. Statistical analysis indicates that the differences were not significant. On the other hand, the ---Page Break--- analyses of variances for the other 6 collections indicate in each case the variance ratio of "between treatments" to "within treatments" is highly significant. Since the data in Table 1 also show that the chlorophyll content generally decreased as the length of time the plants growing under the shaded greenhouse conditions increased. The results from the statistical analyses indicate that in all cases the variances for "between collection dates" over that for "within collection dates" are highly significant. At each collection,

Difficulties in sampling the young leaves of the same age were encountered. Also, on some occasions, some necrotic tissues were included in the sampling as the browning effect spread over the leaves at high dose levels, especially at later collections. These factors might have contributed to some 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 at the 3 highest dose levels were nearly dead or completely dead. The mean diffuse transmission density readings for the leaves collected for chlorophyll A determination are presented in Table 2. The readings, almost following the same patterns as for the chlorophyll content variation, decreased as the doses and the days grown in the greenhouse increased. The readings of the individual leaf samples were used to correlate with the chlorophyll A content of the cane sample. The results in Table 2 Mean diffuse transmission density readings (with Welch Densichron) of young leaves of control and gamma-irradiated Broccoli plants collected for chlorophyll A determination.

Treatment Collection date Gamma rays (in kGy)

Oct. 26
Nov. 4
Nov. 13
Nov. 24
Dec. 2
0 0.57
0.56
0.58
0.450
0.65
0.158
0.154
0.160
0.52
0.63
0.62
0.51
0.951
0.61
0.530
0.58
0.58
0.52
0.80
0.59
0.58
0.87
0.60
0.56
0.53
0.55
0.50
0.38
2
0.56
0.36
0.40
6
0.59
0.58
0.53
0.136
0.136
150
0.52
0.31
0.36
0.38

200
0.39
0.32

The results of the correlation study for the samples collected at each date are presented in Table 3 and the r values in all cases are highly significant. Therefore, the diffuse transmission density determination may be substituted for the full chlorophyll determination which appears to be much more tedious than the Densichron reading.

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In conclusion, it may be stressed that in general gamma radiation at a dose level of some or higher produces a profound damaging effect on chlorophyll biosynthesis in Broccoli plants, and

that no recovery from Fedlation damage was observed at these high dose levels. However, the plants that received lower doses tended to recover at a later date. Table 3 correlation between chlorophyll A content and diffuse transmission density readings of individual leaf samples of control and gamma-irradiated Broseliad plants collected at 6 dates. Collection No. pars: date of values Oct. 26 by Year, a Year. 33, a Nov. 2 a Dec. # my Dec. 15, 28 0.508 Significant at 1% level. Note: The thin leaves of bronelio's are very young individuals which later develop broader leaves. The population in these experiments was a mixture of Gumanta and Trichouanes. ---Page Break--- 8 Chromosome relations in the insect populations of El Verde. Rilo Virkt. Cytogeneticist Agricultural Experiment Station Alo Pledras, P. Re Since the last report, work could be continued with Phasmids only. 1150 permanent slides were made from 1-5 species occurring in the irradiation area. The material will be studied in detail after the identification of the specimens has been arranged. In most specimens, 1x (male) or 14x (female) is the meiotic chromosome number. In one single specimen, a naturally occurring chromosomal rearrangement was detected. The specimen was heterozygous in relation with an autosomal centric fusion, the number being: 15 bivalents + 1 trivalent + X. Frog noise Progress Report By George Drewry The record of frog noise now includes a complete annual cycle. It is interesting to note that the winter of 1964-65 had had the same effect on the overall activity pattern as the winter of 1963-64, although the 63-64 winter was much drier. In addition to the equipment described, a second frequency has been added to the one used in the study of Eleutherodactylus portoricensis. The second frequency was chosen to be the dominant sound of two species, E. hedeikti and E. eneidac. The occurrence of considerable sound from E. porto Ficensis at this frequency requires detailed analysis of the record to separate the other two species. Preliminary analysis

Combined with field notes, it suggests that these species use time separation to avoid interference under normal circumstances. A definite decline in the activity of E. hedriki precedes the development of the peak sound intensity of E. eneidse, whose principal activity occurs after midnight. A detailed analysis of call structure in these and several other species is now underway, with plans for development of multi-channel recording instruments plotting each species separately. ---Page Break--- Cytological Study of Ferns and Fern Allies in El Verde by Veikko Sorsa Associate Cytogeneticist Institute of Genetics, University of Helsinki, Finland Eighteen different species of ferns and fern allies were registered in the Project Areas by me and my wife, Marja Sorsa, in August 1964. Material for cytological studies was fixed from all species found in the sporophytic stage. In case the chromosome number could not be counted from material fixed from the Project Areas, it was determined from material of the same species collected around the Project Areas in

El Verde. Microscope preparations were made and the investigation was carried out in the Institute of Genetics, University of Helsinki, Finland. Camera lucida drawings have been made of the chromosomes of the species studied. Photomicrographs have been taken of the cytologically most interesting species. The herbarium specimens of the collected material were kindly named by Dr. R. Woodbury in the Agricultural Experiment Station, Rio Piedras. Observations Center: Distance None of species Chromosome number counted from the center From Project Area From outside 3.2m of *Adiantum cristatum* 1. chromosomes not countable less *Alsophila borinquena* Maxon $n=69+70$ $n=69$ *Dryopteris deltoidea* (Sw.) Kuntze $n=$ not 3.2 - 10m *Polypodium chrootes* Super chromosomes not countable *Dryopteris deltoidea* (Sw.) Kuntze $n=$ " *Alsophila borinquena* Maxon $n=$ " *Flaphoglossum flaccidum* (Poe) Moore 10 - 30m —*Alsophila borinquena* Maxon $n=6$ *Dryopteris deltoidea* (Sw.) Kuntze $n=$ *Adiantum cristatum*

L. *Elaphoglossum flaccidum* (Fée) Moore *Hephrrolepis rivularis* (Walsh) Nett. *Oleandra articulata* (Sw.) Presl. *Asplenium cuneatum* Lam. *Polypodium ehrenbergianum* ---Page Break--- 00 *Henttelia horrida* (L.) R. Br., Spreng. $n=70$ $n=69-1$ *Trichomanes capillaceum* L., chromosomes not countable. Lindsey's *montana* Fée, chromosomes not countable. *Elaphoglossum firmum* (Mett.) Urban $n=kL$ a ML 30-80% —*Alsophila borinquensis* Maxon $n=69$ $n=69$ *Polypodium lycopodioides* L. chromosomes not countable. *Henttelia horrida* (U.) R. Br., Spreng. $n=70$ *Hypolepis repens* (L.) Presl. $a=39$ *Blechnum occidentale* L. B. oh *Lycopodium linifolium* L. nec, 140 *Lycopodium dichotomum* Jacq. $n=132137$ South Central Distance — distance of species from the center. *Alsophila borinquensis* axon. *Dryopteris deltoidea* (Sw.) Kuntze. *Hephrrolepis rivularis* (Wahl) Mett. *Alsophila borinquensis* axon. *Dryopteris deltoidea* (Sw.) Kuntze. *Gleichenia articulata* (Sw.) Presl. *Polypodium feei* Maxon. *Asplenium cuneatum* Lam. *Danaea nodosa* (L.) Smith. *Lindsaea montana* Fée 10-30 —*Dryopteris deltoidea* (Sw.) Kuntze : *Elaphoglossum firmum* (Nett) Urban. *Elaphoglossum flaccidum* (Fée) Moore $n=30-80$ m —*Alsophila borinquensis* axon $n=$ " *Blechnum occidentale* L. $n=6b$ " *Dryopteris deltoidea* (Sw.) Kuntze. Species collected closely outside the circle of 80 m. Spores and gametophytes of these species may possibly be found from inside of 80 m circle on the Project Area as well. € - 300 m —*Nephrolepis biserrata* (Sw.) Schott $a=$ *Dryopteris reticulata* (L.) Urban $n=$ *Polypodium astrolepis* L. $n=$ *Polypodium pectinatum* L. $n=$ *Polypodium piloselloides* L. $a=$ Th. *Asplenium absentis* Willd. Be as *Asplenium salicifolium* L. $n=$ *Dryopteris decussata* (L.) Urban $n=$ *Dryopteris chaerophylloides* (Poir.) C. Chr. $n=$ *Dennstaedtia punctilobula* (Kaulf.) Moore $n=$ *Polypodium taxifolium* L. $n=$ *Polypodium aureum* L. $n=$ Th ---Page Break--- None of the fern species collected from the Project Area have been cytologically studied before. Only three are previously reported in cytological literature: *Gleichenia articulata*.

de Litardiere 1920, Celle 31 255cl73; *Asplenium cuneatum* $n=$ $\phi.72$ and $n=$ $\phi.216$ by Hanton 1959, Alston 195; '5-61; and *Blechnum occidentale* $2n=$ c. 124 by Abraham et al., J. In. Bot. Soc. fa: 339-He1. 'The chromosome number $n=72$ found in one specimen of *Dryopteris* (*D. aemulans* and *D. reticulata*) is interesting, because it is quite different from the numbers $n=11$ and $n=82$ previously counted in the fern genus *Dryopteris*. More detailed reports on chromosome conditions in Puerto Rican ferns will be published later by the author. Summary of Pre-irradiation Chlorophyll Measurements, (Olu, Harta De Arce, Murphy) On each of the following trees, 10 leaves were analyzed for chlorophyll, 10 new sun leaves, 10 new shade leaves, 10 old sun leaves, and 10 old shade leaves. Numbers are those on the stage in the field, Seches Hadistion Center South Control Center ---Page Break--- 02 Report on preliminary survey of bryophytes of El Verde sites, before irradiation, December 11-16, 196h, William C. Steere N.Y. Botanical Garden 'The investigator, William C. Steere, and his assistant, Dorothy O. Steere, arrived in Puerto Rico on December 10, and spent December 11 through 26 in a survey of the El Verde sites and December 17-19 in Rio

Piedras, in supplementary studies. Because mosses turned out to be among the most resistant plants in the Brookhaven experiments on the effect of Cesium irradiation on oak-pine forests on Long Island, I was pleased to be invited to participate in the pre-irradiation survey of the tropical rain-forest near El Verde, in the Luquillo Mountains of eastern Puerto Rico. Whether it is the small nuclear volume of the moss cell or some other factor that gives mosses their unanticipated resistance to ionizing radiation is still not known. Under any circumstances, it is surprising that a haploid plant should be resistant at all because of its lack of duplicate genes and a resultant reduction in genetic resources. Activities. The upper and lower sites were visited on December 12, 13, 15, and 16, and Smith's "equal

area" site, below Site 1, was examined on December 1%, 'the forest above the sites was visited several times, to gain a better understanding of the vegetation as a whole, and the transition from 'the somewhat 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 Verde area. Procedure: In the sites themselves, careful notes were taken on the bryophytes that were especially conspicuous within the 10-meter zones, and photographic records were made. Outside the 10-meter zone, notes and photographs were taken in different types of habitat, and in different degrees of exposure as determined by the lay of the land. Where possible, notes and photographs were tied to points that can be found again after radiation ceases as numbered trees and numbered photographic points. Voucher collections made for permanent reference were documented in the same manner, and left in Ro Plearas. Nuclear volumes, identified lots of living mosses and few hepatics, 2 species in total, were collected for Dr. Koo, for determination of nuclear volumes. Because of the simple structure of bryophytes, whose leaves are normally only a single layer of cells thick, relatively uncomplicated techniques should suffice for this determination. If systematic areas must be used, to conform to the practice already established for higher plants, 'the growing points of moss and hepatic stems are small and easily "squashed" out, thus avoiding the time-consuming and laborious techniques of embedding in paraffin and cutting serial sections. Cytological study: Material of moss capsules at the proper stage to demonstrate meiosis, for chromosome counts of 15 species was collected. —However, as it could not be examined at once, for lack of microscopic facilities ---Page Break--- 103 Table I. Bryophytes of site 1, site 2 and their vicinity 1. Dominant and conspicuous mosses in the site areas: 'Tuldium recurvatum Lor, On stones, rocks, roots, and base of trees. Taxithelium plenum (Brid.)

Mitt. On rocks, roots, and trunks of fallen trees, Syrrhopodon berterianus (Brid) C., Common on trunks of Buteo: 'sterra pain); on tree 410396, for example. 'Syrrhopodon prolifer Schwaegr, On rotten wood and tree bases. Getoblepharis pulvinatus (D. & H.) Mitt. On rotten wood and base of trees; rarely on rock. Leucobryum narianum (Hisch.) Liane. On rotten wood and base of trees. Leucolosa semilatum Brid, On tree trunks, twigs, and rocks. 2, less abundant mosses, but still easily observed: Neckeropsis undulata (Hedv.) Rech. On base of trees. Hoanlia glabella (Hedv.) Mitt. On vertical rock face. Fissidens fasciolatus (Heav.) Mitt, On shaded rocks more rarely on tree trunks. Syrrhopodon lissulatus Mont. On tree trunks; tree #10277 for example. Huziogontium epiphytiforme (Hedv.) Bruch, On moist shaded trunk of Zutorpe. Calymperes lonchocarpum Schwaegr. On base of trees; more rarely on rock. Leucomium compressum Mitt. On stones and clay soil. Crossotrichius orbiculatus C.M. On roots and twigs in moist shaded places; also on living leaves. Fissidens pellucidus Hsch. On moist clay. Fissidens Garberti Sull, & esq. On tree trunks and rocks; on stone at base of tree #01173, ---Page Break--- Corazon hepatics, often abundant: Plagiochila; at least 3 species occur on rocks and tree trunks at and near sites Bazzan: at least two species on base of trees and on rocks; at base of tree 10398. Riccardia: several species on

stumps, rotten wood, and clay. Lophocolea! A common hepatic on rotten wood and base of trees. Calypogeos: 2 common hepatics on moist soil and rotten wood. Many species in many genera of Lejeuneaceae occur over the whole area, but a specialist will be needed to name them. These are the usual hepatics of fallen leaves, at Verde, and were collected only several days inter (December 17 and 18), in the Institute of Tropical Forestry in No Pledras, the cytological data obtained were disappointing. Accurate chromosome counts could be made in only one species, a species of Callicostella still to be identified (probably).

Gz pallide), However, all the species that occur within the area of high irradiation also occur in areas beyond the reach of irradiation, for in areas protected from it. Consequently, if anomalies are found in the cytological behavior of bryophytes after irradiation, good control material can also be easily found and included for comparison. By getting fresh material one day at 51 Verde and culturing it the next in Mo Pledras, thus giving meiosis a chance to "run down," a more successful cytological progress can be forecast for the future. Post-irradiation phase. For the post-irradiation phase, it is proposed to compare the "after" with the "before" in terms of absolute and differential susceptibility among species of bryophytes which will be reflected by changes in normal associations of species. The mortality and survival should be studied from the standpoint of distance from the source, protection given by the habitat, and other variables, especially in comparison with photographs taken in December. A comparative study of the production of sex organs and of sporophytes should be made between irradiated and non-irradiated populations of the same species. Anomalies of all types should be studied critically in an attempt to discover their point of origin. Velocities should be investigated in populations that have been irradiated to determine whether or not meiotic behavior as well as chromosome number has been affected. Since the behavior of tropical mosses under irradiation has never been observed, it is difficult to forecast what will happen—but whatever happens will be significant. ---Page Break--- 105 wee grtt grt0z oa ad oro vm amea8y Ltez ep 6°00 «GEE 9*008 re10y Light o's9 "GT SOOT. -9°AL2 wo OT aaddn Fsy008 9985S ott tiple) Late | T6E2orfat Tem younsa pue go27 Jo THIOL, gE kT LTE gta soypuvaa Supsoduo0eq VEL Lengt 6got STITT. eSB senna Sursoduo99q wt Gee Sek erat soupreaa usany ATSAT IEEE ost ete bet 2tg ote sauna] qeoag ATORTIWLO s 4 . z T perpen, saqou axons sad see "961 (22 "AO sacaduqag "d" Hf JO WOTROATyP

s9PHM Guly 4RaI0F fq paureyge Bysq "HOTA Pu ToAST WEN ysvara SUTPNTOUT Spon Ta ve syedpenb ¢ waxy STel>30U Jo wW9Tan AIP yaKD seyeayg yeotog sano] Uy sseNDTE ---Page Break--- 106 Observations on Algae at EL Verde, Oct. 1-9, 1964 By PRL Haltekt Preliminary observations were made on the distribution of epiphytic, lignophilic, and lithophilic species of algae at the El Verde site. In addition, collections of algae, mosses and liverworts comprising the cryptogamic community on leaves, wood, and rock, were also made. Algae from leaf surfaces were collected during seven transects starting from the outer boundary of the upper center to the outer boundary of the lower center. The epiphytic algae were present on several species, but especially abundant on Euterpe globosa, Dacryodes excelsa, and Sloanea berteriana. In extremely wet and very shady parts of the sites, Dyctiotes glauca also was a good substrate for algal species. Epiphytic algal species were lacking on all specimens of Cecropia peltata. The most common algal genera on the leaf surfaces are Pithyocapitis (villedet) Printe, Cephaleuros Kunze, and Trentepohlia Mart. The microscopic appearance of Pithyocapitis varied with the quantity of light present. Thalli growing in deep shade were green in color. With increasing exposure to light and seemingly less humid conditions the thalli were pale to bright lemon yellow, orange, orange-red or copper-red. The color is due to an increase in the carotenoid pigments and to the storage of oil. At higher elevations than present at the experimental sites on El Yunque, 3,096 ft, the genus became

a deep orange-red. Within the study site, Pithyocapitis was parasitized by Ascomycete fungi and involved in a lichen association. Pithyocapitis was abundant on several species, but most common throughout the study area on Euterpe globosa which is seemingly an excellent site for leafy liverworts, mosses, and algae other than Pithyocapitis. The genus Trentepohlia was second in abundance on the leaf surfaces. le

is perhaps of some ecological worth to note the difference between the brown habit of Trentepohlia and other epiphytic algal genera. "Trentepohlia is a green algal genus closely related by reproduction type to Phycopeltis. Trentepohlia is coarsely filamentous and the filaments occur at random over the leaf surface. The genus Phycopeltis, on the other hand, is a parenchymatous to pseudoparenchymatous thallus tightly appressed to the epidermal surface. Since many representatives of this genus were sterile when collected, living material was sent to the home institution of the investigator for culture and eventual species determination. Much of the Trentepohlia collected was heavily parasitized by ascomycete fungi. The epiphytic algal genus least abundant was Cephaleuros. As with other Trentepohliaceae, Cephaleuros possesses an erect and prostrate system. Unlike Phycopeltis and Trentepohlia, Cephaleuros has filaments which actually penetrate the cuticle and epidermis of the host and may become an intranatural space parasite. In seven transects throughout the site, Cephaleuros was collected only twice on Sloanea berteriana. ---Page Break--- 207 Because of the rather common occurrence of Phycopeltis, Liverworts, mosses, and other algae on the leaves of Euterpe globosa, special emphasis was placed on the study of this palm. A problem of interest is the relative lifespan of a palm frond. Fifty representatives were selected along the trail center to the lower center as shown in the map (Fig. 2). The outermost frond of each individual was marked with a metal tag. Alejo Estrada Pinto makes monthly observations on the life of the palm fronds. After returning to his home institution, the investigator will make total counts for the relative distribution of Phycopeltis on Euterpe leaves. This will again be done after irradiation. In addition to the study of the Euterpe leaf community, 20 rocks or rock-log aggregates were marked for study of lithophilic and lignophilic species. Permanent green concrete markers of these rock-wood

sites were established, and this study will also be repeated after irradiation. It is hoped that Dr. Breen will also give quantitative data on the mosses and leafy invertebrate floras on the Euterpe leaves. A list giving the location of the 20 sites is included as Table 1. Table 1 Approximate locations of rock and rock-log aggregates for algal studies. A1. near Palm #2 #2, near Palm 4 & 3, below "ft 4. Below flag" A1. 10 meters below #6 to the left of the path. A4. Below Palm 3, two "lines" A10. opposite Palm 18 A11. Slightly below Palm #20, The rock surface studied is just below the rock that was marked. A12. just below and to the right of Palm 21, Collection made off stumps and rotting logs. A2. Off lower end of logs studied at A12. A3. Slightly above palm #2b, Collections off rock surface and Teabonuco tree trunk. A4. Below palm [26 collection from marked rock and logs in vicinity. A5. Just below palm #28, Collection off rock only. A6. Rock on path at 10 meter point to lower center. Surface of rock heavily covered with crustose lichens which were not collected. A7. below palm #29, about 50 meters from ground zero, lower center. A8. Below palm 73h. A9. Opposite palm fd at marker #62. A10. opposite palm #45. ---Page Break--- ---Page Break--- 109 [REPORT ON SHATL PROJECT by Harola Hentwole Dept. of Biology, University of Puerto Rico Introduction it is expected that radiation will cause a number of changes in the forest at EL Verde. The effect upon snails may be direct or indirect. The forest category may include effects upon viability, growth rate or pattern formerly growth. Differential effects on different age classes might occur. To evaluate such direct effects several approaches have been taken (a) pre-radiation growth studies have been made for comparison with similar (b) Individual snails at various

distances from the source have received dosimeters, and (c) incidence of abnormal shell growth has been recorded. This study is restricted to snails of the family.

Growth how. The pertinent dealing with direct effects has been carried out on 3 *Conaerset sracolus carcolla*, *Polydontes scutangula* and *Polydontes luauslieness*, are seen on the first-mentioned as it is by far the most abundant in the El Seg oton. In addition to the El Verde site, supplementary studies were carried out at the El Yunque Biological Station. Indirect effects of radiation may include influences upon the distribution of snails in the area through changes brought in the vegetation which in turn affects microclimate, food supply, etc. To evaluate such effects, a comparative geological study of Caribbean snails was initiated. There are six species of Caribbean snails in Puerto Rico, one of which (*Zacuyasia asricona*) was probably introduced from Cuba and is not included in this study. *C. carocolla* is very abundant in the moist forests of the Central mountains and is also present in lowland forests. It is not found in open woodlots or on roadside trees in the lowlands. In such situations, it is replaced by *C. marginella* and *Polydontes liza* which also penetrate the higher altitudes along roadsides and in heavily disturbed areas. On some occasions, *C. marginella* and *C. carocolla* are found together. *P. scutangula*, a resident of the higher altitude forests, seems at least on canal observation, to be a canopy dweller which has secondarily made use of hibiscus hedges and similar vegetation in the more open areas. It is not very abundant. *P. luguillensis*, a still less common species, seems to be ecologically similar to *C. carocolla* although it is restricted to the rain forests of the eastern mountains. Thus, the more open spaces expected to be created by radiation might provide unsuitable habitat for *C. carocolla* and *P. luguillensis*, but cause conditions favorable for *P. acutangula*, which might therefore replace *C. carocolla* on shrubbery parts of the irradiated conc. A less likely possibility is that *C. marginella* and/or *P. liza* may be able to reach, and become established in the area disturbed by radiation.

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Fifty individually-marked snails, at varying distances from the radiation source, were provided with dosimeters by gluing them in the crevice between two whorls and then covering these with black electrical tape. An attempt will be made to recover these after irradiation. Evidence of Abnormal Shell Growth: three of the 131 *C. caracolla* which were marked at El Yunque had an abnormal growth pattern of the shell involving a slight displacement of the whorls. This displacement began when the snail was about half grown, the whorls becoming progressively more offset with age. Two such shells were encountered in the more than 600 individuals marked in El Verde. Home Ranges: In both areas combined, over 1,000 snails have been individually marked. Some of these have not been subsequently recaptured. However, a large proportion have been recaptured 3 or more times and some as many as 17. Their location was plotted on a map each time they were captured. Inasmuch as almost all recapture data were obtained during the day, the "home ranges" thus plotted simply outline the area which the snail uses for its diurnal inactive period. At night they leave this area and forage, returning again the following morning. Thus the true home range is greater than the areas shown here. Home ranges fall into 3 patterns. One of these is for the snail to always be found on the same tree, a small portion of a building, or on one of several trees in close proximity to each other (Fig. 8 and 9). Another common pattern differs in that one or two recaptures may occur away from the area in which the snail is usually found. Afterwards it will be found back at the original site (Fig. 10). A third pattern consists of snails occupying one area for a long time and then moving to a new site where they subsequently remain. This was found to occur after such disturbances as the painting of a building, the wall of which was included in the animal's home range. The above generalizations concerning home range are applicable only to adults. Data on the juveniles are now.

being worked up. Thus far the indications are that they do not limit themselves to as restricted an area as do the adults. After stratification, we plan to follow the movements of snails which might leave the radiated zone and establish home ranges elsewhere. ---Page Break--- Habitat Selection Individuals of *C. caracolla* are not uniformly distributed throughout the forest. They are most abundant on the steeper slopes and they tend to inhabit particular trees. Some trees had as many as 19 snails on the trunk at one time whereas other trees only several feet away had none, nor did they ever have any during the study. The data are now being analyzed to see if suitability for snails is related to taxonomic category, bark texture, or size of tree. The young and adults occupy different situations; the former tend to spend the diurnal inactive hours under the leaf litter, stones, or logs whereas the adults tend to hang on tree trunks. During the drier months, even the adults may seek out refugia such as tree holes or bromeliads. These statements seem to be true for all species involved in the study. Quantitative data are available for *C. marginella*. On 31 December 1964, objects on the ground were lifted and the diameters of all snails beneath were measured and compared to the diameters of those hanging on the trunks during the same sampling period. The difference in habitat between young and adults is evident from Fig. 11. Population structure Inasmuch as juveniles and adults spend the inactive part of the day in different places, data on size obtained during the home range study are not reliable for estimating the size structure of the population. In order to circumvent this difficulty, a search was made by flashlight on humid nights of the concrete walls bordering the road in the rain forest at El Yunque. Under such conditions all snails were actively foraging, and being on a smooth surface, snails of all sizes could be easily detected. For a given sample, all individuals observed were measured until about 100.

Individuals had been captured. Each snail was released near its capture site. In November 1963, size classes were rather evenly distributed without well-defined concentrations of individuals in any particular size range, a condition which persisted in the February 1964 sample (Fig. 12). However, by May 1964, after the early spring period of growth, there were relatively few snails in the smallest size classes and about half of the population consisted of adults. By the end of the year, probably through mortality of many adults, the nearly uniform size distribution was reestablished. It is necessary to continue these samples at more frequent intervals in order to verify the existence of this seasonal change in population structure, describe it more accurately, and possibly relate year-to-year differences with environmental conditions. The breeding cycle of these snails is not known in detail yet. However, of the 13 copulations observed in the field, all occurred in the period between 31 March and 15 June except for 2 in January, one in February, and one in December. Most of the egg clutches were found in November and December. ---Page Break--- During 1965, monthly collections will be made in El Yunque for determining the condition of the gonads. These will be correlated with monthly samples of population structure. Critical Thermal Maximum Eleven *C. caracolla* and an equal number of *C. marginella* were acclimated for 1 week at $20^{\circ} \pm 1^{\circ}\text{C}$ and in nearly saturated air. They were then individually subjected to a determination of the critical thermal maximum by placing each one in a glass jar which was then closed with a 2-hole rubber stopper. Through one hole a Schulthess quick-registering thermometer was inserted whereas a glass tube permitting passage of air was inserted into the other. The jar was then attached to a weight and submerged in a water bath containing a bubbler to cause mixing of the water. It was then heated, raising the temperature 1° at a time and then maintaining that temperature for 5 minutes before

Raising At again, soon after heating began a snail would become active. Two endpoints were used, (1) when the snail retracted its body and fell from the wall of the glass jar on which it had been attached, and (2) when it failed to respond to a tactile stimulus detected at the end of each 5-minute

period subsequent to having reached the first endpoint. The type spectra were remarkably similar. The range in endpoint Y_0 was 35°-80°C (mean 37.1°C) for *O. cazocolla* and 33°-10.5 (mean 38.3°C) for *F. sanguinellin*. That of endpoint for *F. acutangula* was 19°C (mean 33.2°C) for *Serocolla* and to h_2 -WTC (mean h_2 .2°C) for *C. marginella*. Thus, differences between the CIN's of these two species, if real, are very slight and probably of little ecological significance. However, regression of OTM on size gave a straight line with a positive and significant slope for both species and seems that larger individuals can withstand higher temperatures than smaller ones. More data are being collected on this point for use in interpreting possible differential responses of the young and adults in the field. In addition, the other species will be tested as material is available. In the field, body temperatures of *O. cyuarginella* ranged from 26.5°C to 35.5°C, the higher values occurring in animals directly exposed to sunlight. These latter were within the range of temperatures at which animals acclimated at 20°C drop from the substrate. Body temperatures of 17 *C. carocolla* in the field were much lower (19.2+ 23.6°C), although it was difficult to find individuals in bright sun. It is important to get temperature data on *C. carocolla*. In the lowland, this species is less arboreal and is commonly found in leaf litter and under debris. Perhaps it avoids the temperatures to which *C. marginella* is subjected. Only 2 body temperatures of *F. acutangula* were available; they were 20.6° and 21.5°C. In most instances body temperatures in all species were slightly above substrate temperatures and were about the same as air temperatures.

Exceptions were *C. garginella* in sunlight. They were warmer than either air or substrate by several degrees. ---Page Break--- Snails show seasonal periods of relative inactivity, related to moisture conditions. The length of time a snail can remain in a refugium continuously all depends upon the length of time it can go without feeding. This in turn depends on the energy sources stored in the body and the rate at which they are used up. The latter is greatly temperature-dependent and sources with high temperatures may not be suitable for a species which uses up its energy reserves rapidly and therefore be unable to "wait out" unfavorably dry periods. A number of *C. caracolie* were collected near Le Mina, P. R., and transported to the lab where they were acclimated for 8 days at a temperature of 20°C in closed glass aquaria with about 1 cm of water in the bottom to provide a relative humidity near saturation. During this period, all of the snails emptied their digestive tracts completely inasmuch as no defecation occurred during the post-acclimation part of the experiment. After acclimating, the snails were divided into two groups, with approximately the same size distribution. One group (52 individuals, omitting several which ate some paper during the acclimation) were maintained under the acclimation conditions (20°C and about 100% RH) without food until all were fed. The second group (69 individuals) were treated differently in only one respect. They were transferred to a cabinet at 30°C. The light normally was turned on at 0600 and off at 1700. Departure from this schedule was the same for both groups. Figure 13 shows the survival time at the two temperatures related to snail size. Two facts were evident. First, survival time was greater at 20°C than at 30°C and second, the larger (older) snails survived longer than smaller (younger) ones. This effect was more pronounced at the lower temperature. The first is undoubtedly related to the effect of temperature.

on metabolic rate and the second probably because young individuals have higher metabolic rates than older ones at a given temperature. Metabolic studies would be valuable in interpreting these data. ALL but one snail (both temperatures) survived more than 2 weeks, which is probably longer than any continuous period of unfavorable conditions likely to be encountered in the El Verde site and perhaps in the lowlands as well (conclusion pending analysis of environmental data and better definition of tolerances of these snails to moisture conditions). For comparison, a study was made on *C. marginella*. Only adults (24 at 20°C and 11 at 30°C) were used. Survivorship curves for the

adults of both species are presented in Figure 1b. *C. marginella* tended to survive slightly longer at 30° than *C. carocolla*. Although the difference was not great, it suggests either relatively greater energy reserves or lower metabolic rate at that temperature than is true of *C. carocolla*. Of greater interest is the fact that survivorship in *C. marginella* was not much better at 20°C. This suggests that the latter seems much better adapted than the former to this low temperature, a phenomenon reflected in their altitudinal distribution. The relatively poor survival of *C. marginella* at 20°C may reflect an effect of low temperature on visibility operating in some way other than through metabolic depletion of energy stores. An incidental observation resulting from this part of the study was that *C. carocolla* seems to be able to utilize cellulose as food. Between 95 and 100 days of food deprivation (20°C), the snails that were still alive ate part of a 3 x 5 file card which we inadvertently left in their aquarium. They lived much longer than expected on the basis of the shape of the rest of that, and the other, survivorship curves (Fig. 18). Food analysis of fecal material from both *C. carocolla* and *C. marginella* has been collected and preserved. It has not yet been examined to see if identifiable elements are present. Prospectus I propose to (1)

complete analysis of the data already collected, (2) 'expand and complete the current studies as mentioned in the text. and (3) Anticipate several new phases. One of these will consist of behavioral studies, and will include responses of the various species to gradients in temperature, humidity, and soil moisture, as well as correlations of activity period in the field with environmental conditions. Some data have already been collected on the latter part. A second phase will consist of a comparative study of the moisture relations and will involve measurement of water stored in the mantle cavity, rates of water loss under controlled conditions (comparing estivating and non-estivating snails) and changes in body water content. That part has not yet begun although equipment for it is now available. ---Page Break--- ---Page Break--- |||| i it || - A Lo || || \ || | 4 | \ \ S2RR88S 2 ES h 2G gssee . wer moerT Toms ---Page Break--- ---Page Break--- & RAR RES SER EGS ggase YO wr RZOMET THES ---Page Break--- ---Page Break--- 40 - Fig. 6. Relation of shell weight to shell diameter 123 30 in" species of caenid snails, -% = Ce caracolta x 30. marginelis - a2 Pe acutaagla 4 2 Po logutliensss 5 -4 3 2 8 25 * 3 "sau lara by at / / / 7 oe OL . - a a 2 3 4 56 789% 20-30 «MO 50 60 10 BOO 'SHELL, DIAMETER IN 4 ---Page Break--- DRY WEIGHT OF BODY IN OHS 3.0} 2.0} | 1 3 2 Fig. 7. Relationship of body dry weight to 224, shell diameter in Garacolus carovolia ---Page Break--- ---Page Break--- 126 Fig. 9. Home range of an adult Garacolus carecollg at the El Yunque Biological Station between 15 September 1962 and July 1963. ---Page Break--- 127 se8ue2 evoy say uy yong sem 2y ATatenbasqns pue n961 Ainp gz ug *x payaee at uoyirce, 9 48 punoy sem ay mt mya HOTA 4e Z96T suNE OT nts + woas patdnas0 47 yoyun aduer owe} Soy sitoseder Vole jasoTous ays 'uoyyerg jeotseioF] enbunt TR eya le Blpoooses snjooesey jo sues awe OI Std Suypl ENG ---Page Break--- 128 vet NE UREA se 2 Woof 6 oe lz oe Se we te we wo Ot Bt MT St ow ft ner sxo9feo

9700 wee exon ear 0 tad 'seapeta TH ae 961 sequaad TE Jo voouseas» oya FuTAMp S398Cqo Jepun pur sxUNla 9a7 UO 'BTTSUFATEG TATOSEAED jo syenprarpur so sazts Jo uostawdmoy tT *Bya ot eTvnerArNr 2 wa ---Page Break--- 1 MUEER OF INDIVIDUALS 129 November 12, 1963, Fig. 12, Population structure of Caracolus caracolla at different times of the year. Cross hatching signifies adults. pr n my n it (ATL fis | February 2, 196 alt Lolth Ale. 16 May 16, 1964 The olkithleodtlte cad December 27, 196% "cell ale It i 20 21S DIETER Di et 3% 60h ---Page Break--- Figs 13, Relation siz v3 POSES SAREE egg SUEAEN erie foot a x= adults Garacolus caracolla 130 = guventies 5 10 15 20 2 3 3 Mo Ky 0 7 © DIAMETER TH 04 ---Page Break--- " saya 54 cmt Ott oor \$6 06 G8 09 SL oL \$9 09 \$6 OF oy on SE Of Se ce sor ç a a - + a Se SIMCEATOME 20 cas SE ME TWACAINS gResLseRagegage ---Page Break--- ase Preliminary Report yy Passett

tiaguive, Jr. Department of Zoology, University of Texas Forty-two water samples were collected in and near the experimental area in the forest at El Verde Experimental Station, Luquillo National Forest, Puerto Rico. Most of these samples came from the leaf axil of Bromeliads, a few came from the leaf axil of the Screw Pine, Fanjanlis, and one each from a depression in the soil of the forest floor, a hole in a rock near a stream, and a tree hole. The water was derived from rain. Only the rock hole and Bromeliads of samples 10 and 11 had any chance of previous contamination by stream water. All of the samples were examined the day of collection under 30X magnification and organisms identified as far as possible. A compound microscope was used to survey a selection of the samples, and in all but two instances this was completed by the second day after collection (one sample was finished on the third and another on the fourth day after collection). Tables 1 and 2 list the organisms found (not included in the mimeographed report). The average number of organisms seen under 30X in samples from Bromeliads was 6.2. The range was from 1

In a plant valley, it contained only a few drops of water to 11. The pool on the forest floor, which had such greater volume and possibly greater environmental diversity, had 9 different kinds of organisms; the rock hole, which held about the same volume of water as did the larger Bromeliads sampled, had 12 different kinds. The presence of Paranectim and the Cladoceran in this rock hole is probably the result of occasional flooding of the hole by a stream. Three of 32 plants had a variety of more kinds of organisms recognizable under 30X as the pool. This may be due to greater environmental diversity of the pool, lesser dispersal problems, greater volume and surface area, and/or "more favorable" conditions, each with unknown influence. The rock hole, for which there is good evidence for flooding, contained 12 different kinds of organisms including at least two of which were found nowhere else. This is good evidence that dispersal mechanisms for all the species in the stream are not sufficient to take these quickly or at all to Bromeliads. The average number of different kinds of organisms observed in water from Bromeliads with magnifications up to 1000X was 10.3 with a range from 1 to 18. Comparable figures for the forest floor pool and the rock hole are 19 and 13 respectively. This pattern is consistent with that seen under lower magnifications. Totals of the number of kinds of organisms for all samples from the Bromeliad, Guamanas were analyzed to determine if there was a detectable change in number as a function of height of the plant above the ground. The difference correlation coefficients of height with number were -0.130 for samples examined with the dissecting microscope and -0.137 for those examined with the higher magnifications. This shows that there is a little to very little influence of height on the number of organisms in plant-held rainwater. The main variation in the number of organisms which might be caused by or correlated with variation in height ---Page Break--- 233 is estimated by the square of the r , and is 1.9% and 1.7%

repetitively. These low values show that the mechanisms by which aquatic organisms get to water within these Bromeliads, at least within the lowest 20 feet or so of the forest, are efficient and perhaps are equally effective at all levels below this height. It is unlikely that the mechanisms are more efficient at some height or heights than at others, but with the efficiency great enough, even at its lowest, to produce near maximum colonization of all Bromeliad waters. If maximum colonization of all Bromeliads occurred, a large fraction of the pattern of occurrences or absences of various species would be the result of direct inter-species interaction which would produce much more highly developed patterns of associations than those found and described below. Measure of colonization rate starting with containers free of organisms should give information concerning relative rates of species establishment in environments similar to Bromeliad waters. Such data also will give information on recovery rates following community disruption or destruction by ionizing radiation. Table 3 gives the distribution of the most common organisms found in *Gummania* as a

function of height from the ground. None of these distributions hint at a pattern with respect to occurrence and distance from the ground. Figure 1 gives Cole's association coefficient for pairs of organisms from Guzzante common enough to warrant calculation of association coefficients. Of the 21 associations, all are positive (or zero) except for 3. Each of the negative associations involves mosquito larvae as one member of the pair. In addition, the only two zero associations involve Mosquitoes as a member of the pair; however, the average number of organisms for water with and without mosquitoes does not appear to be different. Four of the association coefficients are significant at the 0.5% level and two are very close to this. The significant positive association between Cyclopoid Copepods and naids suggests that Cyclopoids may have been reproducing more.

successfully than Harpacticoidea when the samples were taken or, less likely, that sampling methods adequate to capture Cyclopoid nauplii were much less effective in the capture of Harpacticoid nauplii. The positive, significant association of Tendipedid larvae with Cyclopoid copepods and Rlelioia Rotifer with Harpacticoid copepods may be real. If all the mechanisms which produce the associations are not clear, especially in the case of the Tendipedid and the Cyclopoid which presumably have different means of reaching Eucalina waters, it should also be kept in mind that in a series of this size, one association on average would be expected to be significant because of sampling chance rather than because of causal relationships. By far the most interesting association pattern is that between mosquito larvae and the other common relatively large organisms (see Fig. 1). This suggests that mosquitoes may interfere with other organisms of about the same size, although the lack of appreciable difference between numbers of kinds of organisms in community with and without mosquitoes shows that it is not a general phenomenon.

---Page Break--- A frequent positive nonsignificant association between pairs of organisms in series of isolated habitats such as the coastal waters of Brone-Lisde occurs even in the absence of direct interaction between the organisms. Some factors which might tend to result in such positive associations are: 1. Common transport mechanisms 2. Common kinds of response to some events or characteristics a) amount of water in Drenelia b) kind and/or amount of food (i.e. the number and species of tree leaves in the water) c) toxic effects of: 1) material leached from leaves of some plants which might fall in Drenelia 2) condition of putrefaction, etc. 3) toxic metabolites of a thin organism 4) spotty distribution of other more or less "extreme" conditions. 5. Interdependence of two or more organisms 6. Action of animals which efficiently removes some requirement (Raw data tables)

are not included in this mincographed report for lack of space. List of Some of the Forest Markers Especially for the benefit of our visiting participants who use these reports as a means of orientation, we list some of the markers which have been used in the study areas. To aid communication we ask that all marking be concrete, aluminum, or something equally permanent and the system be cleared with the project. The positions of all the markers are added to the next report. Please do not remove any markers, even your own, since persons often make recommendations using the designations originally put in by others. Square tape concrete notes: Negrén Primary Survey by Negrén R Rat trap stations - Yeinbren u Leaf fall stations - Integreert coy. Litter bags Comey Soot Seedling plots with Round concrete posts. Green, Algal pale stations Halickt Red Palm quadrats - HeCormick imite tree growth trees - Surphy Mite painted signs (1 to 11) Photographe - Johnson & Atwood Aluminum tags (<10,000, radiation center) Basic tree tagging - Smith Ae Snail trees - Heatvole Growth trees - arpa ---Page Break--- 135 srtnew protteea yodoq why prestonter prpedipuay ng vatanen piedor ako oop oakzeH poee3s0. 92 F awororsss00 uovreroosy sate :t gunOTE ---Page Break--- 236 Brogreee Report for PRC. De, Joo A, Dineteten

Roteny Department - University of Georgia Athens, Georgia During mid-September of 1964 a ten day visit to the rainforest project at EL Verde was made. The visit had two major objectives. The establishment of a M.D. research program for Robert Fort Smith dealing with the structure of the rainforest before and after radiation treatment was the first objective. The second major objective was to initiate new studies in the three following areas: (1) the analysis of the physical and chemical properties of the existing soils and parent material associated with the EL Verde vegetation, (2) the biological investigation of the root tips of three major trees of the rainforest area in reference to mycorrhizal association, (3) subecological.

Investigations of the germination and seedling growth of palo mato (*Ornoe lorugtt*). Soils of the area belong to the Los Guineos clay series. Los Guineos clay is quite similar to Cetalins and Cialitos soils, but is found at higher elevations with better, cooler climates. The soil of the El Verde rainforest area characterizes by steep or very steep relief and has a 6 to 6 inch grayish-brown slightly granular, plastic, strongly acidic surface soil. The subsoil consists of a 3 to 6 inch layer of brownish-yellow clay that abruptly changes to red plastic but permeable, strongly acidic clay. This layer gradually changes at about 3 to 4 feet to lighter red more friable acid clay. Many large boulders are on the surface of the soil with as much as 50% of the surface covered with rocks. Smaller rocks (up to 10 inches in diameter) may be found throughout the profile. Under forest conditions, the soil has an excellent soil structure which results in unusually good internal drainage for such a clay soil with as much as 60% clay-sized particles. Soil samples, taken in a systematic manner from areas in the El Verde forest are being tested for total cation exchange capacity, organic matter content, soil separates, clay type, ppm Na, ppm Mg, ppm Zn, ppm Cu, ppm P and ppm NO₃. Although the tests and interpretation of tests are incomplete, the following table indicates something of the chemical nature of the soil. ---Page Break---

Table 1 Exchangeable (pu) ___: Acta. Sol. Depth Location "Inches O.1Kel %s0 Ne/100g Ca Mg K Mm Zn Cu P(pmm) Upper Center 10-23 LD eT eh aT Tower Center = 5-10 3 9-6 MS HT wk Bob's Area Sao k5 0 Stk Ip. 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 5-10 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 0-5 3.63 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 lfo <1 7 B Tower Center 0-5 5.30. 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. It is of further significance that the roots of such early succession species *Cecropta peltata* ani *Didymo-* 'pansx morotctont are always at the bottom of this 4 to 5 inch thick mat and their root tips are large ant knob-1tke with a manimm of branching. Such morphology 1s in keeping with the habits of early, fast growth but doubtful longevity of any one given tree. Particle size distribution as determined by the hydrometer method Aescribed 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 ---Page Break--- 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 Department. This basalt contains caleite inluetons 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, however, dark, fine grained volcanic natrcial 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 September of 1954, These roots were preserved and fixed in a solution of ethanol, acetic acid and chreatic acid. Stained slides are now being prepared from the root tips for examinations relating to possible endotrophic and ectotrophic mycorrhizal associations. External examination of the roots reveal that only 1 of the 32 species of roots collected exhibit root hairs. All of the other 31 species appear to have some degree of fungus-root association. Dr. W. C. Bryan of the U.S.D.A. Forestry Laboratory at

Athens, Georgia is being consulted with concerning the mycorrhizal problem. The 30 species under investigation are listed in the following table. Table II
Duchenaia capitata *Euterpe globosa* *Melanthus herbertii* *Casuarina arborea* *Ficus crassinervis* *Mantikara nitida* *Cyathea arborea* *Mitella rugosa*, *Marquisia splendens* *Cordia boerhavia* *Hemiphanes racemosum* *Conocarpus tetrandra* *Cananga cartilaginea* *Tournefortia ferrea* *Omosia krugii* *Croton poeciniifolius* *Inga laurina* *Ocotea portoricensis* *Cecropia peltata* *Inga vera*, *Palicourea riparia* *Guarea racemosa* *Sapotanea doiingensis* *Rourea glabra* *Dacryodes excelsa* *Myrsine derrixi* *Stoanea berteriana* *Drypetes glauca* *Hatayba costaricensis* *Tetranogaster balea* *Dyggymopanax arototont*, *Weropholis garcinifolia nigrifera* In such an area as the El Verde rainforest, where 120 inches of rainfall per year could leach out nutrients as fast as they were mobilized, a fungus-root association could act as a trap. Such a mechanism has been described by Kroner in Science, 110, 8-9. Ecological Studies of *Omosia krugii* Palo mato (*Omosia kingii*) is one of the many trees which share dominance in the El Verde tropical rainforest. This species belongs to the legume family and reaches a height of 80 to 90 feet and a diameter of up to 30 to 40 inches when ---Page Break--- 139 mature. During germination experiments, the cotyledons were not rated with the shoot because palo mato's germination is typical. Four hundred seeds taken from the ground outside the study area were subjected to four different treatments. Each germination experiment was conducted on 100 seeds in lots of ten seeds. The first treatment consisted of wrapping seeds in wet paper towels which were placed in jars, the jars with loose fitting tops were placed in an incubator with the temperature set at 60° F and left for 3 weeks with daily checks. The second treatment involved germination of chemically sterilized seeds in heat sterilized Sphagnum moss. A thin layer of 100 seeds was placed in untreated Sphagnum moss without any treatment to the seeds. The fourth set of

seeds was chemically sterilized with clorox as in treatment number 2 and then coated with a commercial preparation of Rhizobium bacteria and planted in sterile moss. ALL of the seeds in moss were placed in shallow trays on tables in the greenhouse where temperatures ranged from 65°F to 75°F. The light intensity of natural light reached 900 footcandles on the clearest days. Forty-eight percent of the seeds in the paper dolls of the first treatment swelled and took up water in relation to initial dry seed weight, a fact true of all seeds in all treatments. ALL of these seeds decayed and the remaining set of seeds stayed small, firm and impervious. In treatment number 2, with sterile seeds in sterile Sphagnum, 26% of the seeds resulted in seedlings after 1 month of observation. The remaining seeds were hard, shiny and impervious. The third set of seeds with untreated seeds and untreated moss exhibited slightly higher rate of germination (19%) but 11 of the other seeds decayed. In the fourth experiment in which sterilized seeds treated with "nitrogen" and planted in sterile moss, the rate of producing seedlings was 36% after one month and 6% of the seeds decayed. In the light of these studies, it appears that a biochemical digestion of the hard seed coat of the palo mato seeds greatly aids the water uptake and sprouting of these black and red seeds. ALL seedlings, regardless of germination treatment were potted in individual non-pots in medium sand and divided into 2 groups. One group was placed in a crowded greenhouse area which simulated the low light intensities of the closed canopy forest at El Verde. In this shaded area the light intensity never exceeded 60 footcandles. Both groups of potted *Omosia krugii* seedlings

were fertilized regularly with a solution of 5-20-10. The well-lighted group of seedlings were left in the area of germination where the light intensity ranged from 1000 to 2560 footcandles during the day. ALL seedlings had only 2 leaves at the start of this phase of the experiment and these

Leaves were definitely opposite. These leaves all have distinct drip tips. All seedlings in the low light intensity area remained in this two-leaf stage while all seedlings in the area of higher light intensity put out one to three more leaves. About half of these added leaves are arranged in an alternate manner on the shoot. All of the leaves, original and subsequent, are simple, entire with drip tips. Experiments are planned to test the alleged survival value of drip tips in the high rainfall areas. Studies by H.T. Olfun in the forest at El Verde have suggested that many seedlings of potential canopy stature exist in a state of "suspended animation," waiting for a hole to open in the dense canopy. The differential behavior of shaded and well-lighted seedlings of palo santo can substantiate such a theory. ---Page Break--- Also, the root type collected from mature palo santo trees in the El Verde forest exhibits both ectotrophic mycorrhizae and bacterial nodules. The seedlings from all germination treatments exhibit both these features at the end of two months. Further experiments are planned in which these seedlings will be treated with soils from the rainforest area and observed closely. The existing roots on the palo santo seedlings are without root hairs; they are generally short, knobby, and highly branched while in the soil but extend downward to equal about one-third the length of the shoot when transplanted to the can in pots. Dr. James Duke at Pelteville, Maryland is being consulted about the future work with drip tips, mycorrhizal and bacterial root swelling, and response to light. Dr. P.W. Richards will visit the Botany Department of the University of Georgia within ten days for consultation. Pre-irradiation studies of lizards and trees in the Tuquillie Experimental Forest, Puerto Rico. Frederick Z. Turner, Clayton Giet, Richard Rowland, Laboratory of Nuclear Medicine and Radiation Biology, University of California, Los Angeles. Amese studies were supported in part by Contract An(ob~L) GBN-12 between the U.S. Atomic Energy

Commission and the University of California. ---Page Break--- aa Introduction Knowledge of the influences of ionizing radiation on natural populations and communities is as important today as understanding the effects of such radiation on individual organisms and cells. The impact of ionizing radiation on man and his well-being is largely dependent upon the responses of the natural assemblages of plants and animals, which of species; alternations in the energy utilization of component populations; and changes in species diversity may have subtle--or drastic--effects on man's environment. To date, many such influences owing to ionizing radiation have been extremely subtle~ except in a few highly localized areas. Studies at Brookhaven National Laboratory (Voovelt 1962, 1963; Brover, 1964) and in Georgia (HeCommick and Platt 1962, 1963; VeComnick, 1963; Danfel 1963; HeGinnis 1963; Pedigo 1963) have shown that such trivial effects may become important once higher levels of radioactivity are involved. Correlations between radiation dose and the severity of observed effects are known only for a few areas, and over a relatively narrow range of exposure. For most environments, we have no direct measurements of such effects. The forest irradiation experiment conducted by the Puerto Rico Nuclear Institute is designed to explore the effect of three months of chronic gamma radiation (from a 10,000 curie Cs-137 source) on the composition and function of a montane tropical forest. The study area is located in the Luquillo Experimental Forest near the town of El Verde--about 25 miles east of San Juan--at an elevation of approximately 1900 feet above sea level. The dominant tree in the forest is the tabonuco (*Dacryodes excelsa*), but Sierra palm (*Prestoea montana*), Cecropia (*Cecropia peltata*), and palo colorado (*Erythrina borinquena*) are also common. A study of the effects of radiation on a community requires attention to a large number of species or species groups. Usually, the diversity

of the biota makes it

impossible for any one individual to successfully undertake investigations of all of the constituent species of evident abundance and importance. Consequently, a number of specialists have cooperated in the Puerto Rican study (Odum 1964). Our contribution to the Puerto Rican experiment involves certain species of amphibians and reptiles in the forest. Some of these species are conspicuous and obviously abundant. Others are observed infrequently and may indeed be rare. There may be a few species present of which we are unaware. Following a year of continued observations in two 0.7-acre circular plots, we consider the species composition of the areas to be as follows: Amphibia *Eleutherodactylus portoricensis*, *E. vighteana*, *Ichthyodactylus hedricki*, and *Leptodactylus albilabris*. ---Page Break--- Reptilia *Tyalope* sp., *Anolis cuprigena*, *A. carolinensis*. The tree frogs and lizards are listed in order of apparent abundance, with full recognition of the possible inaccuracies of such a ranking. There is no doubt that *Anolis gundlischii*, *A. carolinensis*, and *Eleutherodactylus portoricensis* are abundant—in an absolute sense. *E. vighteana* and *B. hedricki* are also numerous. Other species are rarely encountered and are probably present in low numbers: *Sphaerodactylus albigularis* and *Guibemontana*. The secretive species like *Zygoscincus*, *Diplosoma*, and *Sphaerodactylus* were only captured after traps were buried and tended. Their presence was shown. The Cuban tree frog (*Osteocephalus*) is probably as rare as its very rare observations indicate. One minor difference between the two areas is suspected: in the upper area, *E. hedricki* seems to be more abundant than *E. hedricki*. Whatever the absolute numbers of lizards and tree frogs, and whatever the true relative abundances may be, we believe that these animals—in a functional sense—are the most important vertebrates in the community. There are no native mammals except for bats. Feral mice and rats sustain themselves at varying but low densities. Birds are not numerous. Kah (1964) estimated

about # birds per acre in the Bi Verde forest. Our efforts have been focused almost exclusively on three species: *Anolis gunllachi*, *A. everuanni*, and *Eleutherodactylus portoricensis*. The form of the data acquired is illustrated by the accompanying machine tabulated relations. The analyses which follow pertain almost exclusively to *Anolis distichus*, but indicate the questions involved and the technical approach to the data. We designate the lower center as Area 1, the upper center as Area 2. Sex designations are: 1 for males, 2 for females and 3 for undetermined. What we expect to occur as a result of the irradiation of the forest? In a precise sense, no one knows. We do have the Brookhaven work and some theoretical considerations on which to base projections. However, there are no clear precedents relating to natural populations of mobile animals. The following effects are deemed reasonable possibilities: 1. acute mortality of individuals 2. prolonged debilitation followed by death or recovery of individuals 3. suggestion of the alteration of the populations 4. changes in vertical stratification of the populations 5. interruption of reproduction and resultant changes in age-or size-distributions of populations 6. changes in mobility of individuals. Accordingly, the following data are keyed to two general objectives: First, to determine whether the two study areas are indeed alike. Can one area legitimately be used as a "control" after the other is irradiated? Second, to develop quantified measures of the makeup and behavior of the assemblages of selected animals in the two areas—parameters which can be again evaluated after the irradiation, and which can be used to demonstrate effects of the kind enumerated above. Methods: Preliminary coupling was carried out in July, 1963, but formal initiation of the project did not begin until November, 1963. Observations were largely restricted to the areas between 10 and 30 meters of the centers of the two plots. Areas were examined during alternate weeks.

Animals were captured by a number of means, but the most effective proved to be by hand. New

animals captured were marked by toe clipping, measured, and released at the point of capture. Perch heights were recorded to the nearest 6 inches. Perch diameters less than one inch were recorded as 1/2". Greater diameters were measured and recorded on tape. Sex designations were made when possible. During the spring and summer of 1964, the sampling schedule was modified to include periodic counts of all visible lizards in representative subsections of the two study plots. In June of 1964, two 5 x 5 grids of 25 can traps were installed in each area. The grid interval was 2 meters. These grids were subsequently operated for one day each week. Starting in April 1966, weekly samples of ovaries of male quail, *A. cvermennt*, and *Sphaerodactylus partoricensis* were collected; periodicity for the analysis of normal weight-length relationships. Masue samples (testes, skin, and retinal epithelium) of the three selected species were preserved and given to Dr. F. K. S. Koo of the Puerto Rico Nuclear Center at Mayaguez. Field data were transcribed to a special form, from which the data were punched on TEM cards. All background data have now been processed in this manner. Two Fortran programs were written during the summer of 1964 and were used in preliminary data reduction and analysis. Regression analyses and factorial analyses of variance were carried out using programs in the library of the Biostatistics Unit of the UCLA Medical School. The computer used was an IBM 7094. Other less complex analyses were made by mechanical sorting and listing. Results A. Density of *Anolis gundlachi*. Table 1 illustrates a series of density estimates based on capture-recapture analyses of a chain of samples from each of the two areas (Delury 1958). ---Page Break---

1 Sampling was during alternating weeks in each area. The Xp column shows the cumulative number of marked animals at risk in the populations (assuming

no mortality). The m4 column shows the size of the samples taken, and the x column above the number of marked animals in each sample. It may be observed that after the fifth sample (at Table 4) the incorporation of further data does not alter the population estimate significantly. In fact, the samples taken at Times 5, 6, and 7 are so removed in time from the beginning of the study that the x column is no longer valid. This is because the x column reflects only the addition of marked animals to the population and makes no allowances for the death of these individuals. Further treatment of these data by other methods is in progress. While it may be assumed that the population estimates of 600 per 0.7 acre are high (because of mortality among marked animals), it is clear that the two areas are remarkably similar. We believe it useful to develop density estimates by two independent methods. The other technique used was developed by Davis (1942) to estimate densities of forest birds in Cuba. The system involves a complete enumeration of the animals in a representative subsection of the overall area, and an appropriate correction of this count according to the relative sizes of the area censused and the entire area under study. In the Puerto Rican forest, representative areas were selected in the two 30 m circles. The extent of one was about 21% of the entire area under consideration, and that of the other was about 23% of the entire area. Over a period of 4 months, three sets of 10 censuses were made in each area. The results of these procedures are shown in Table 2. As may be seen, the numbers of animals observed during each of the three trials were quite similar, and the adjusted estimates of the number of individuals in the two 0.7 acre circles are almost identical. However, these estimates are not in accord with those based on capture-recapture analysis. The disparity is owing primarily to two sources of error. First, the capture-recapture estimates are high, and the reasons for this have already been discussed.

We believe that the Davis estimates are low because of an inability to actually enumerate every lizard ever in a small section of forest. In fact, it is likely that at any one time every member of the population is not active and visible. Hence, in the course of any one census, the observer registers only a fraction of the entire population. We believe that the actual density of *Anolis gundlachi* lies

between 250 and 650 per 0.7 acre—or between about 350 and 900 per acre. Five hundred per acre is probably a reasonable compromise and quite possibly conservative. It is a remarkable number of lizards. In the desert of southern Nevada, 20-30 lizards per acre is "numerous," and some species exist at densities as low as 2 to 10 per acre (Tanner and Jorgensen 1963, Turner 1963, Turner and Gist 1965). However, in more mesic environments, higher densities have been recorded (Table 3). In general, numbers are less than 100 per acre, but apparently in favorable situations much higher densities may occur. There is some uncertainty as to the size of the population of whiptail lizards studied by Carpenter along the shore of Lake Texoma. However, in an area 130 feet long and 0 to 50 feet wide (ca. 1/6 acre), Carpenter registered 32 different animals in one week period in July 1955. The data for *Lyposoma*—Page Break—are based on the registration of different individuals in a one-week period. We believe that the density of *Anolis gundlachi* observed in these week periods considerably exceeds the usual density of north temperate lizard species. In terms of the evolution of the tropical forest community, it is interesting to consider how the high densities of *Anolis gundlachi* have been reached. We believe that the productivity of the tropical forest is higher than that of northern temperate systems. However, we believe it is also important to recognize the presence of a strong vertical component to the activity range of *Anolis*, whereas temperate lizards occupy a planar habitat.

ouumce, Davie (29K2) made this main point with regard to the Ooben Seer & vorgund that when habitats were compared on an aerial basis, the Cigaret densities of the size avian species were not similar. However, when samples were compared in terms of volumes (by taking into account canopy height) specific densities were in good accord. Weight-length relationships in *Anolis gundlach* Figure 1 illustrates the regression of only weight on body length in OO snore *Zuniaachis*. These data were based on animals collected in the vicinity of the study plots; the idea here is that in the evaluated year, this relationship may be significantly modified (L.c-) by use of similar weight-length data that have been acquired for *Anolis evermanni* and *Eleutherodactylus portoricensis*. Growth and size distributions in *Anolis gundschi* populations show the observed growth in lizards of different sizes. The typical form of such data is one of relatively rapid growth, followed by a progressive decline in growth rate. The data in Table 2 seem to follow this pattern, most notably because of the apparent decline in the size of animal length, and the more rapid growth of others to GI mn. What is actually illustrated by Table 4 is the cessation of growth in nature for females at a short-vent length of approximately 47 to 50 mm, while the continued growth of males is to 60 mm or more in length. The picture most clearly portrays in Figure 2, which shows our estimate of growth patterns in male and female *Anolis guadalacki*. The size distribution is much better pronounced than that observed in any American lizards. It is extremely rare to discriminate between male and female lizards less than 50 mm in length because both sexes have a similar development and show no reliable differences in morphology or coloration. Hence, most of our designations of female lizards represent phases based on observed growth rates. The table also indicates the similarity between data obtained in the two study areas. Figure 3 shows

size-Aietributtons based on all cximale registered in the tee eee etmen November, 1963, and July, 196k. Approximately the same feo areat Ugimaie were recorded in each area. The elze-distributions appear number Oc sonthiy congruent. The peaks above 50 um represent mature walee were strong penke at 5 nm reflect nature females plus younger sales. Snalter: inule mec'a mixture of both sexes, cease of the difficulty in aiserinina- ---Page Break--- 1s (see above), no ott 1 veen made to subdivide the 'ting between size-distributions accor soht in the forest st 1h, Position of *Anolis 2* tested by the "etveturat hapstate" of Puerto Rese ere Oa basnea in terat of perch neigh ent, perch Mepsteh: 'According noes a ctlone, hy gantlach occurs, grinartiy clone 7° St) os veers

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Ucee Ge cores separations the container resulted in the death of tease Oç Eoneruily, however, the injection appeared to have no 11. OF ene ata December 19,00, and 21, animals which had previously been processed were observed alive and active in the forest, ---Page Break--- us some animals processed were as follows: poole, punts yer Fo ewermanns Ea Sac 6 z 1 & sive §, Rievstectyive portorieonste 2, remem # gpetsec 7, Teoldentat observations on Bi gcetyluc Betvtclt (2953). showleage font tis dissertation of During 1908 Gtet manuesn, 'the booming call of Gijan will ff, the locations of all Te area. Ten males were recorded Sapear to be strongly This cece' of the epeeter te bes6, The type species and 7 serctypecy eb? h was able to further o3eer ye males te distinctive nee 2 calling aeiec vese mapze' 10 ce Gh the upper center and far in the dn the under coe bacrvd a frame th the vicinity of @ See's Tek Oy Sune 12. seaenteny:, Oiesates ove attracted £ the ene of che amiees Some nating Possibly the femg ane pale's holes ent the egge are deponster Cer 'anplexae secure a oF SAE tiy dune, One clutch Of eGfe 2812 02 OF SBOMS 2 Thatebed was observed The eggs are protected by the male, Ho c6Ue Yer 'observed Un- on ane 225 ge were found during June, July's, srl AUBETs Bey fot during Septen- Beare rember 20, 8 clutch of cage var noted ant these Cate 'hatched of. Bex. on October 22 indicated that the time of development 1 the e6 {= 'about 15 to 20 days. SARE spe repeated sampling of Anolis qupilaeht in two 0-7 gore acas 3 This tugutitg iagerinentel Forest states that for every SEST!uS 'far evaluated, uagetito Beperincy tc evo circles are virtually identical ee ioe {he Pome Oly aged ax a control following the trradianion oF 'experimental Ye 2ech eine tified eeocuree of members of Lizards, woteit 2593s relationship, area, Saentitty, and other characteristics have been fw sops4s with which Gravity compared the same parameters following the ixreitaticns he density of Aposta qunilacnt te estimated, et between 350 an) 200 per one, nen 500.

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Ye .003 x? ~,091K +308 | ot 20 30.0 50 6070 80 SNOUT-VENT LENGTH (mm) Fig. 2. Relationship
of Pedy wosght and Length in 6k Anolis tiacht from the Taguillo Forest, Puerto Rice: ---Page
Break--- 160 sory owsena FESTTETN FFTORY orwnas re orm Jo 8 ---Page Break--- 28 (wu)
HLONST 1 ---Page Break--- area 1 (_)(N=489) anea 2 [I] inesi0 wo = Fes KO nun 161
SNOUT-VENT LENGTH (mm) Fig. 31. Size distributions of Anolis gundlecht registered in two

0.7 acre areas in the Luquillo Forest, Puerto Rico. Data were acquired between November 1963
and July 1964. ---Page Break--- Leaf Tails, Decomposition, and Litter Annuals, Richard "Egert"
Institute of Radiation Ecology, University of Georgia. Animals use litter extraction samples that are
now sorted to broad categories - summary sheets are given to both centers. Although no specific
expectation was made for the white, I was impressed with the uniformity, (for many years) for the
species from different samples. I am certain of the constancy of differences between the two
centers with respect to species recent, as you know, the stratification of the samples was designed
to assess radiation effects. Pre-irradiation, there is no reason for significant stratification between
the centers. I have therefore compared the outcomes regarding the following ways: (1) regarding all
25 samples at a single reason being tested (2) computing a weighted mean, which now of course
takes the values in the largest strain only and therefore, for one certain test, the supposition that the
strata are not different can be considered. Since there is variability within strata (significant),
Chi-square tests of the mean strata values would be of statistical significance. Comparative
analyses of variance (Kruskal-Wallis) applied to the white data from each center gave: lower center

A: $p < 0.80$; upper center B: $p > 0.30$. This suggests that the strata do not differ within centers and, just regarding the total sample as a combined sample from the centers. When these means are compared: upper center 181.7 mites/200 ex; lower center 181.3 mites/100, there is little to choose between them. I have not tested any of the other data because the lower numbers and numerous blanks create problems. I have grouped percentages to mind about the best overall analysis for this study. I will be sure to consult with our statistician about this matter. But for the present statement, I believe that the two centers are gratifyingly similar with respect to species appearance.

and probably with respect to the densities and species dissemination of the other group of litter fauna, I have not yet extracted the arisals from the clay soil cores. I do not expect to find much except ants and, judged by the litter samples, they have a very spotty distribution. + Paragraph extracted from letters, not checked by author. ---Page Break--- 163 station 1a18, 4/2/9, Stations 1985, 64/1/28. New Litter Samples ALL values are assumed to be 250 (except) 'spread 2970 (observed) 'residual (sve) frequent00 eyes cig Preece PREM EQN OE ynacgan powermeans eqn, eres regeenonaag 'asen" penameganeragregmenge tet? agnenagy | agagr nada Rese Me Goleapeers Afted as Geanidae (scale insect) so Larvae and adult "end Chilopods tentatively identified 'of one species are jlopeda 7 two expected 'expect total fp 'are majority seen Veines ---Page Break--- 16 Stations bh-50, 64/1/28 Station 26-2: Upper Center. Forest. 2 Litter samples - ML Verde ALL values are per 100 co! REET QE Ens te tdmad rns og gro seotounny ang] min oH er EEL aE ENR aazusze) covet etree (9220880) | ane camer ve eenes ootoe, |ogascans sey nemane metas erat san9) OS gees avad (299103) Te cet e erence ren en ena # | pantie Swe homme raed arg srowre) [ogy meg rang hed ESONQoegs (rv0y020900092)| oop gs ng en + PETIA 2UCT ID a8 a (em) | gESegRBORegsAgnssgsggar' y g gang2a, 23 weg | SERORAMMAMBRRASTSLSIVIBIR PYARTY * # tare of one species majority are insect Larvae and adult Coleoptera 'not Diplopoda and Chilopoda Some species tentatively identified as Coccidae (scale insect) [Probably two species Bie' 3 iy y ---Page Break--- 165 A variance estimate is difficult to supply at present. Deviating from weighted samples would destroy their value for later species determination. Weighing the correct additional samples on any set trip and weigh these. I anticipate "the present samples are in alcohol and their weights. Probably species, inertia. What can do at present is to estimate about one gram, or de dav Me oS Gg ane volume of animals in the sample vials). OF this jovty ree a

(oetion (73, oF more) Would consist of a variety of end insects, the master Pongn maneroue, weigh very little, but their respiration rate per mite, will presumably be much higher than that of the larger fo7=2- Jneidenterty, the numbers of mites per/i in the rain forests is quite low compared to Literature values for temperate forests and my own seapict set ceereryae. I do not yet know if this is due to inefficient extraction, or if the len? Tetter taken from the extractor will answer this point. Beat Felt and Decomposition put on the first set of Litter age show an instantaneous rate of Ateappecs nice for the Doper Center: of 0.35" per day and for the Lower Center 'only 0.20!) per day. Referring to the annual second of leaf fall, one finds an obvious similarity of the tee centers with regard to leaf fall. The similarity of Pint ee landing crops of detritus, however, is based on my struggle, sean! then for extraction of arthropods, The sean values were 2350 g/s for the face Contes and 1290 g/e for the Upper Centex. These values include sl2 heavy plus inevitably some coil and roots, fininols extracted from Litter samples at the leaf fol), stations are given in tables on page 163 and 16h, Trese stations are marked with coat forts designated V-1, U2, Wa3, etc tue vecen's o- cc of and fruit fall at the 50 stations set ost by Bre FREESE Condimed by the seeldent star? are given on pp. 31-36 Rete Ge the 50 leaf Tall stations which were located with random numbers was given in the 196h report Related data on Litter extractions in prior to 1963 is contained in a manuscript by Otus, Abbott, Gelanier, Colley, and Wilson, Low numbers in berlese

funnels were noted in that work also. Some data on leaf Litter samples are given in this report on page 105- ---Page Break--- 66 maint quarterly Census Report of the Avifauna of the El Verde Experimental Area by, Harry Secher, University of Pennsylvania Introduction The following report is the third in a series on the avifauna of the El Verde experimental area, 'The data presented here are

the result of observation by Verde and Detyoen 2 December and 8 December, 1964. This is a period of the funds calls morally mark the beginning of the dry season (Figures 7 and 71), year which given of the bird species density and of territorial or home-range limits of individuals are determined by a series of population censuses. Data are also presented from a census area located on the Britton, El Yunque National Forest (Figures III and IV). The area differs from the previous one in being at a greater elevation (approximately 850 meters; it was previously reported as 1,100 meters, but now corrected to 650 meters) and receiving a greater amount of precipitation. The forest on this plot has tree density which exceeds 50 feet and probably averages 35-40 feet. Over, some of the canopy trees are Sabal Palms (*Euterpe globosa*). According to Hob Suitn (personal communication), the forest composition compares to that found on the wetter sites at El Verde. Observations were made in this area from 9 December through 15 December, 1964. Included is an annotated checklist of the birds observed on the experimental area. Procedure The same census as procedure was followed as recorded previously in reports. A total of 61 censuses comprising twenty-eight hours of actual census time were made on the El Verde area. The Britton census was completed in seventeen hours and also involved six separate censuses. An unrecorded number of hours was spent in non-censusing observation. Results Territory and Home Range are shown in Figures 5-11 showing the recorded territories or positions of the species most frequently recorded during the census period. Maps have been omitted for the Puerto Rican Bullfinch (*Loxigilia portoricensis*). Only one bullfinch was recorded and the vireo is a migrant currently wintering in South America. Territorial limits are given for the bananaquit (*Coereba flaveola*) and the gray kingbird (*Tyrannus mexicanus*) as these two species only appeared to be defending territories. ---Page Break--- 166 Tatra Quarterly Census Report

of the forkgouna of the \$1 Verde Experimental Area by Marry Recher, University of Pennsylvania Introduction 'The following report is the third in a series on the avifauna of the El Verde experimental area. The data presented here are the result of observations made between 2 December and 8 December, 1964. This data covers a period of the year which normally marks the beginning of the xy season (Figures I and II). Estimates are given of the bird species density and of territorial or home-range limits of individuals as determined by a series of population censuses. Data are also presented from a census area located on Mt. Britton, El Yunque National Forest (Figures III and IV), which area differs from the El Verde plot in being at a greater elevation (approximately 850 meters; given as 900 meters in the second report, but now corrected to 850 meters) and receiving a greater amount of precipitation. The forest on this plot has a canopy which seldom exceeds 50 feet and probably averages 35-40 feet. Over 50 percent of the canopy trees are Sycamore Palms (*Euterpe globosa*). According to Bob Smith (personal communication), the forest composition compares to that found on the wetter sites at El Verde. Observations were made in this area from 9 December through 15 December, 1964. Included is an annotated checklist of the birds observed on the experimental area. Procedure 'The same census procedure was followed as recorded previously in reports I and II. A total of six censuses comprising twenty-eight hours of actual census time were made on the El Verde area. The Mt. Britton census was completed in seventeen hours and also involved six separate censuses. An unrecorded number of hours was spent in non-censusing observation. Results Territory and Home Range are shown in Figures 5-14,

which show the recorded territories or positions of the species most frequently recorded during the census period. Species have been omitted for the Puerto Rican Bullfinch (*Loxigilia portoricensis*). Only one bullfinch was recorded and the vireo is a migrant currently.

wintering in South America (Bond, 1961). Territorial limits are given for the bananaquit (*Coerba flaveola*) and tody (*Todus mexicanus*) as these two species, only, appeared to be defending territories. ---Page Break--- The reproductive activity in general, there was an increase in singing activity (relative to August) seeing all species present except the bananaquit and ruddy-quail dove (*Geotrygon noctana*). However, vigorous singing with full song was recorded only for the Pesaragust, red-necked pigeon (*Columba squamosa*), bullfinch and fuerte Pison owl (*Otus judoie*). Hesitant and weak singing was recorded for the pearly-eyed thrasher (*Margarops fuscatus*) and the red-legged thrush (*Turdus plumbeus*). Striped-breasted tanagers (*Ramphocelus nigrogularis*) were not recorded singing, but males were frequently heard giving their "weep" call. "Wing rattling" by todies was recorded three times. It appears that overall reproductive activity is now lower than in August, and that most species are just entering the beginning of their reproductive period, April through June would therefore appear to be the peak of the breeding season with several species commencing courtship activities in December and January. Only the bananaquit nests with any regularity throughout the year (Figure 16). Population Density As in August, the absence of territorial behavior presented an accurate determination of population density for most species. The figures presented in Table 1 are therefore subject to more caution than those given for the March-April census. In all probability, the estimates are below the actual number of individuals in the census areas. Bananaquit The figure given for the bananaquit represents the number of territorial males. The decrease from March-April through August and December probably reflects a decrease in reproductive activity rather than any decrease in the number of individuals. In addition, numerous immature individuals were observed, but not counted. There has been a decrease in numbers on both census areas; 9.88 on the El

Verde plot at 9.0% on the Nt, Britton plot. The greater accuracy at lit. Britton may reflect the effect of altitude on environmental seasonality and indicates that the Verde plot is a more stable environment. Today particular attention was placed on the covenants, home range and population density of the toly. As a result, several problems arising during the previous two censuses were resolved. It now appears that the home range of the toly is large relative to its daily movements and that outside of the breeding season, individuals are solitary. Red-Headed Pigeons and Ruddy Quail Doves once again the number of pigeons and doves heard calling during the census were recorded (see Reports I and II). In contrast to the August census, Red-headed pigeons were frequently heard calling, though less often than during the March-April period, while ruddy quail doves were heard only infrequently (Table 11). ---Page Break--- 2) Foraging Groups Mixed flocks of foraging birds are generally considered characteristic of tropical forests. At El Verde and in the I. Britton-El Yunque area, foraging groups are commonly observed. The Puerto Rican Tanager (*Habia atricollis*) is the most commonly encountered species within these mixed FSG and appears to be the species about which individuals of other species group themselves. Migrant warblers and juvenile bananaquits are also regular participants of these mixed flocks. In the March-April period, and especially in August, there were fewer groups noted, and those encountered were smaller and contained fewer species than the ones seen in December. The greater number of wintering warblers and the apparent tendency of the Puerto Rican Warbler to form larger flocks during December results not only in larger groups, but in a greater number of such groups. In the majority of cases (50%) where a group of foraging Puerto Rican Tanagers were observed they were accompanied by Dominican and warblers. However, occasional groups were also encountered which were comprised only of

migrant warblers. During the March-April period and in August, small groups (3-5 individuals) of bananaquits were observed. The tanagers observed in such flocks tend to bunch together so that all the tanagers in the flock might be found within two or three trees. Warblers and bananaquits tend to be more dispersed with the result that the entire group may trail out thirty or more meters. In foraging through the forest, these flocks are often joined by individuals of other species (Tody, pearly-eyed thrasher, black-whiskered Vireo, bullfinch, bananaquit adults) through whose territories the flock is passing. These birds crop out after a short distance. Discussion Seasonal Changes in Population Composition is now seen Well established that there is a pronounced seasonal change in reproductive activity among the birds inhabiting the Guatiguillo National Forest (Figure 16). Coincident with the reproductive cycle are various changes in formulation, competition, migration, altitudinal movements, and flocking behavior resulting in pronounced changes in the species composition of the forest as well as affecting local population densities. The migration of the black-whiskered vireo to South America, the altitudinal movements of the red-necked pigeon, and the migration of the North American warblers greatly change the population composition between the fall-winter and spring-summer. A lesser change is affected by the post-reproductive aggregations and flocks of the red-necked pigeon, ruddy-quail dove, and Puerto Rican tanager. Changes in population density occurring through reproduction and mortality appear to be less spectacular. Indeed, it is difficult to detect any changes in population size among resident bird species that cannot be accounted for by sampling error (Table 1). This is in contrast to the situation found in temperate climates where non-migrant bird populations fluctuate widely between reproductive peak and the pre-reproductive low. ---Page Break--- 270 the contrast offered by a seasonal change in reproductive activity

with 'the relative stability in population numbers of resident bird species indicated that there is a seasonal fluctuation in available energy, but that the oyster for a vole is more stable than those found in temperate climates. 'The influx of North American warblers the greatest change in population composition results from the migration of North American warblers. Unfortunately, it is impossible at the present time to even estimate the number of warblers occurring as inter-residents within the forest. Certainly, it is a considerable number and as such, these birds become an important component of the ecosystem during the winter months. The question must therefore be posed as to whether or not there is a surplus of sherey (unoccupied niches) which these birds utilize during their winter stay and which remain unutilized during the summer period while they are absent. "In part, the migrations of the black-throated vireo account for some of these energy differences, but probably the energy utilized by the wintering warblers is greater than that utilized by the breeding vireo population. It is a point which should be more fully resolved. Possibly, the energy demands of the resident bird population are sufficiently lower outside of the breeding season to accommodate the wintering warblers. However, it seems likely that if there were chance available, the resident bird species would continue to breed throughout the year. Possibly the answer lies with the types of food organisms available and the abilities of the various kinds of birds to utilize them. The "stability" of the bananaquit to breed throughout the year may be a result of its utilizing a relatively rich food source (flower nectar, insects attracted to and presumably concentrated at flowers, and perhaps pollen). Annotated Checklist of the Bird Species Found on or Around the El Verde Experimental Area. Observations are included for species occurring either at the El Verde Station or on El Yunque (including Mt. Britton), but which may not have been

recorded for the experimental area proper. Birds not seen on the Upland area are marked with asterisks. Only observations which complement those recorded in previous reports (I and II) are

included. Sharp-shinned Hawk (*Accipiter striatus*): A single individual of this species was observed over the Santurce River below the El Verde experimental area on 5 December. There is supposed to exist a rare Puerto Rican subspecies of this bird which is confined chiefly to the Maricao Forest (Leopold, 1963). Whether the individual reported here was this subspecies or a vagrant from North America could not be determined. Red-Tailed Hawk (*Buteo jamaicensis*): Individuals of this species were regularly observed soaring over the forested areas at El Verde and El Yunque. ---Page Break--- Red-necked Pigeon (*Columba squamosa*): Rallied Quail Dove (*Geotrygon montana*) See text pp. Puerto Rican Parrot (*Amazona vittata*) were seen or heard during the census period. Doves (personal the north section and seemed to be so: South section were "they were roosting regularly on the experimental area throughout murteatitot,) as a group of thirteen on Trequcat in the axes South-East of the area feeding and gathering in an evening. Puerto Rican Lizard Cuckoo (*Coccyzus vieilloti*): They have yet to be observed frequently up close at hand. One bird in the forest even though individuals Puerto Rican Owl (*Otus nudipes*): There appeared to be an increase in calling activity over the August period and several individuals were heard calling after sunrise (7:30 a.m.) and before sunset (5:15 p.m). Two individuals were heard in the El Verde area. In general, this bird is more abundant at lower elevations though it ranges to at least 1,000 meters. Puerto Rican Emerald Hummingbird (*Chlorostilbon maugae*) The male previously recorded from the El Yunque Biology Station was still in the area and defending it against other hummingbirds (males only?). Because of the better conditions encountered during this trip, fewer hummingbirds than previously were encountered. During wet and cool

weather these birds tend to stay tight". Puerto Rican Tody (*Todus mexicanus*): No burrowing activity was noted, but "wing rattling" was recorded three times. Wing rattling is a sound made by the attenuate outer primaries of both sexes and is heard only during the breeding season (Brewster, 1927). Territorial defense was noted on one occasion. See text by the Puerto Rican Woodpecker (*Melanerpes portoricensis*) Loggerhead Kingbird (*Tyrannus caudifasciatus*): A single individual was recorded twice from the north section of the El Verde area. I have yet to observe this species in the El Yunque area, ---Page Break --- the Pearly-eyed Thrasher (*Margarops fuscatus*): The raucous calling noted during the August period was heard very infrequently in December, but several individuals were recorded giving very "weak" renditions of their breeding season song. Individuals were observed feeding on green and ripe fruits of the sabal palm and ripe catkins of the cecropia (*Cecropia peltata*). Red-Legged Thrush (*Mimocichla plumbea*): Individuals were heard giving a very "weak and hesitant" song. Bananaquit (*Coereba flaveola*): Individuals were observed constructing nests on several occasions, but only once was a male and female observed working together. Territorial males appeared to tolerate juvenile and female bananaquits within their territories. However, the passage of mixed foraging groups containing juvenile bananaquits often excited the male through whose territory the group was passing so that he sang vigorously. It is possible that territories are defended only against other singing males. Certainly, these birds forage over a larger area than is indicated by constructing a line about their singing positions. Several males have been observed together in areas where there was a great concentration of food. Bananaquits sing throughout the day, but there is a pronounced morning and evening chorus (Figure 18). As the scatter of points on the graphs indicates, there is considerable variation throughout the day in the number of

songs 'that are heard at any one time. Singing may be most consistent during the late morning hours (10:00-12:00 a.m.). Each point on the graph may represent 'the songs of several individuals. Bananaquit (*Coereba flaveola*) were observed feeding on ripening grapefruits and oranges. Black-and-White Warbler (*Mniotilta varia*), Parula Warbler (*Parula americana*), Cape May Warbler

(*Dendroica tigrina*): 'A group of eight plus were observed feeding daily in a fruiting and flowering tree in the station yard at El Verde. 'This tree also attracted pearly-eyed thrashers, red-legged thrushes, bullfinches, bananaquits, Black-faced Grassquit, Black-throated Blue Warblers, Black-cowled Orioles (*Icterus dominicensis*) and stripe-headed tanagers. Intraspecific aggression was observed among all species with the exception of the latter four, which occurred either as single individuals or mated pairs. No interspecific aggression was observed. Cape May Warblers were frequently observed hawking insects. ---Page Break---

Black-Throated Blue Warbler (*Dendroica caerulescens*): The males of this species are perhaps the easiest warblers to see and identify in the forest canopy. Of the fifteen Black-throated Blues seen, only two were females, but this may be a factor of the greater visibility of the males. As with all the warblers seen (except the waterthrush), these birds restricted their activities to the canopy. Louisiana Waterthrush (*Parkesia motacilla*): Individuals were observed in the Britton area feeding on insects knocked to the asphalt road by rain. An individual was heard singing. Scarlet Tanager (*Piranga olivacea*): Blue-headed Sapphire (*Zonotrichia leucophrys*): Reported during November, 196% by Bob Smith. Stripe-tailed Tanager (*Spindalis zena*): Two contrasting observations were made during this trip on this species: 1) Males were observed to frequent a particular singing post for at least a week in succession and to call from the perch throughout the day; 2) Males were also observed to fly long distances between singing perches. The

possibility i.e. therefore raised that while some individuals are breeding, others are not. At no time was the "Warble" song heard. Males were noted to sing ("ceep" song) in flight. No aggregations of the bird were noted but on one occasion, individuals of that species were recorded in a mixed foraging flock of Puerto Rican tanagers and warblers. Puerto Rican Tanager (*Jesoplingus speculariter*): See text pg. 6-7 The "ceep-seep" call which was absent in August was once again heard regularly. In addition, a new series of warble notes was recorded - but not as a song. Wetmore (1967) reports this species as having a pretty warbling song during the breeding season (Suns). The notes heard in December were exchanged between two tanagers following each other about in a Limbo tangle. On one occasion, an individual was observed to pick up a piece of fiber. This was later dropped and left. Coloration differences which may have represented a sexual dimorphism were particularly obvious. On 12 December, 1964, tanagers were observed in groups of 2, 2, 2, 2, 2, 8 and 10 (there may have been unseen individuals in all the groups observed).

---Page Break--- © Hooded Weaver (*Ploceus exculiatus*) Observed along road leading to El Verde. © Black-Faced Grassquit (*Tiaris bicolor*): Present, but not singing in the station yard at El Verde. Puerto Rican Bullfinch (*Loxigilla portoricensis*): It is interesting to note that while some males were calling regularly, others known to be in the area were silent or called only infrequently. There is the possibility that a few individuals may be breeding throughout the year. # Yellow-Faced Grassquit (*Tiaris olivaceus*): Hard singing in the lowlands, but not along the road near the station turnoff where it had been previously recorded. Note: For reasons of space, Dr. Recher's first and second reports are not included here although they contain various important data with little overlap with report | ---Page Break---

175 T Population Composition (individuals) of the El Verde and Mt. Britton Census Areas During

Decanter, 1964 Mt. Britton (ap. 8 scree Species December Red-necked Pigeon 0.25 Ruddy Quail Dove ° Puerto Rican Parrot + ° Lizard Cuckoo 0.65 + Puerto Rican Owl 2.0 + Bearded Hummingbird — 2.0 2.0 'Today 20.5 3.0 Puerto Rican Woodpecker Pearly-eyed Thrasher 7.0 2.0 Bananaquit 64.0% singing males 13.0 singing male (228.0 individuals: (26.0 individuals) Black-whiskered Vireo ° ° Stripe-headed Tanager singing males 2.0 singing male Puerto Rican Tanager had at Bullfinch x. 2.0 Loggerhead Kingbird male ° (*depanune dominicensis*) ee ---Page

Break--- © Number of Red-necked Pigeons and Ruddy Quail Doves Calling in the Area around the El Verde experimental Plot Red-necked 5 2 : s 5 Pigeon es Ruddy Quail o 2 o 3 ay 3 ° 1 Table III Warblers Observed Between 2 December and 15 December, 1964 at the El Verde and Mt. Britton-#1 Yunque Area: El Verde Mt. Britton Total Louisiana Waterthrush (*Seiurus motacilla*) © 4 4 Black-throated Blue Warbler (*Dendroica caerulescens*) 7 8 35 Redstart (*Setophaga ruticilla*) 2 4 6 Parula (*Parula americana*) 2 4 6 Black-and-white Warbler (*Mniotilta varia*) 5 4 3 Unidentified 2 2 ---Page Break--- ° a x a o ---Page Break--- ---Page Break--- 179 4 El Yunque 3496" Mt. Britton 3075" meus Area —>+ Palmer Naguabo Fig. 3 Location of Mt. Britton Census Area ---Page Break--- N [Ss Shelter mire Water Fire TP wives wet Teal marker 7 6 300 Meter a 3 Loop Road shelter ol' ! 1 ---Page Break--- ---Page Break--- a & g Px ---Page Break--- ---Page Break--- Puerto Rican Bearded Hummingbird (*Chlorostilbon maugaeus*) — was observed December 1964 { ry 44 > ' 1 \ ---Page Break--- Puerto Rican Tody (*Todus mexicanus*) ---Page Break--- Puerto Rican Woodpecker (*Melanerpes portoricensis*) 186 mH ---Page Break--- mame meee eee eee yh, i ---Page Break--- 188 flaveota) Coereba, Bananaquit (*Coereba flaveola*) December 1964 ---Page Break--- 189 Stripe-headed Tanager (*Spindalis zena*) ---Page Break--- Puerto Rican (*Euphonia musica*) ---Page Break--- wo CALishe a WE NUMBER OF BIRDS Ss ° Nagch-APaint RuGust |

DECEMBER Red-Necked Pigeon (*Columba squamosa*) Ruddy Quail-Dove (*Geotrygon montana*) ---Page Break--- SHINOW . WAN Or SVS WW Wal: tinsaga "gu Sta HONIAH MG NVA aa3znd YIOUNUL NUDIN OL8aNd "BIDE NY C30 U3H -3d1WIS atmo vnvNvea OBYIA GIVI STHM -NDUTE "BIUGMANL Q39h3-ATWEBE GTU!SONIA GY2HIZ99OT ¥3929dd00M NWS "and AGU, NVDY OLIN "aai@onquuuinl CWI7N2 NYY O1¥3Nd entree IEG ey 2d3Nd OxIND axYZIT NVZIY O1¥3Nd WOYAdd NYA O1YINd 30d Tlany KEGna NO39ld G7A23N-03U ---Page Break--- ---Page Break--- PW 00:8 OG: OOH «LZ GOL Or 90:01 Go: OB 90:4 90:9 Pa gg Saosra 'ONOS YIEWNN zs AGbt'43INIII 8 -I3QWIIIA Z Buh 13 uY BINNIW /S9N0S LINDUNUNY SE, ---Page Break--- ws 'The Phosphate Cycle by Bike Tuscan PRIC, with assistance of GAL Bets In our previous report for 1963 the movement from litter to plant and soil of the plant macronutrient phosphorus in the tropical rainforest was noted with the aid of tracer 232. The data indicated considerable absorption by plant roots of P released during litter 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 rainforest plant materials. Results obtained from chemical analysis (some with Technicon Auto-Analyzer) of acid digests of plant tissue are tabulated below. While the data are insufficiently replicated in most cases, certain trends seem evident. These are: 1) Plant species differ in P content from each other and at different sites, though the level of humidification is not a factor. 2) Mature leaves contain significantly less P than young leaves of the same tree. 3) Root content of P is equal to or higher than that of mature leaves, but this is less than that of the decomposing leaf matter in contact with the root. 4) Non-leaf debris is significantly lower in P than leaves ready to fall or the litter itself. On the basis of these fragmentary results, one may hypothesize a picture of movement in which P content is high in young leaves, where phosphorylated compounds are demanded by

photosynthesis and metabolic activity. This P is drained from the leaves as they mature, due to demands in new growth elsewhere. Upon fall and decomposition, the leaf tissue loses C.H., and O more rapidly than P, thus rising in apparent P content over that of the leaves themselves. The phosphorus is absorbed by the network of tree roots at or near the surface; this movement is rapid, so that P content of the roots is low. ---Page Break--- Sample Leaves. Young Tabonuco sp. - Bet a. Mature - oo Fallen * 2. Young e. Young Dryocotyles excelsa (#2695), 'Leaves in shade fn, Mature Dryocotyles 4 Young Mantique attide (#2680), 'Leaves in sun J. Mature Dryopteris deltoidea Roots ke, Tabonuco sp., near soil surface ther A. Organic matter in contact with 'root (lc) 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 aver. 0.28, .32} 9.30 aver. 0.66 4 Values represent replicated samples taken of the material ---Page Break--- Chemical Analyses of Trees at El Verde from J. D. Ovington Yonk'e Wood Experimental Station, England. As listed in the last year's annual report, some representative trees were cut, weighed and sampled during November 1963 by the project team during Dr. Ovington's working trip. During the remainder of the year Mrs. San Briscoe prepared samples for chemical analyses by drying and powdering in Kiley file with the aid of the Soils Division of the University of Puerto Rico Agricultural Experimental Station through the courtesy of Dr. Alonso Riera. The main portion of each sample of leaves, wood, limbs, etc. was then sent to Dr. Ovington for chemical analysis by the Chemical Service of his organization, The Nature Conservancy Woodland Research Section, Monkey Wood Experimental Station, England. In the first 3 months of 1964, roots of the felled trees were dug out by Alejo Estrada Pinto, Juan Haisonet, Sara Doroteo Martives Garcia, and these were also processed for analyses. The

raw tables are included below. Ultimately, the chemical content of forest components is to be computed by combining these data and the data collected by the Tropical Terrain Detachment on trees out to 30 meters in the two study area circles. Table 1 Chemical data on forest components at the El Verde Site. Numbers are percent of oven dry weight. Type of sample setter =—sLab, aK Ck Me material Species code code and number Seal roots Heliosna, herbertii Mh, 1 0.08 0.42 0.38 0.081 0.81 sae 2 0.1200158 0.116 0.32 0.032 0.48 Banistere. Yourizole == BL 50. 30.06 OAT 0.78 0.412 0.031 0.78 Buchensvia capitata Be1S hk .0L 0.423 0.4KG 0.08 0.019 0.39 Be 22 © § (0103. O23. 0.175 0.09 0.1023 0.52 Bek = 6 (0.08 0.173 0.123 0.025 0.60 Byrsonema spleata BeT T 0.03 0.26 0.47 0.25 0.026 0.82 ---Page Break--- 198 type of Mane of setter «== at, «as KC MP material Species. code code and tree number Seal roots Casearia arborea cat B 0.04 0.68 0.25 0.17 0.032 0.64 ca 9 9 0r1001kG 0.422 0.34 0.026 0.39 ca &r Yo 0.103 0.182 0.16 0.24 0.032 0.55 Coscarta bicolor cut 53 LL oySL 520433 OLN 0.032 OTT Cacearte sylvestric 120.26 OTH 0.39 0.28 0.027 0.89 calyogetian squamulosuz sq 5 23005 O17 0.469 0.413 0.024 0.68 C29 53 Tk 0.103 OAT 0.61 0.112 0.025 0.64 Cocropta peltata pag 6 o.ole 0.65 cp 48 a6 (01028 0.53 op ah VW 0.1032 0.96 conta orinquensic Cb 56 ~ 0.038 1.24 © 2h a» 91025 0.82 35 20 Ts" 105 cb 28 Bt orobe 0.75 coe 2 robo 0.69 cn 3 0.1058 0.72 conta suleats cet ho ak 0.035 0.98 cyritia ra cemiflora Cr 101 1 O11 0.100.22 0.413 0.015 0.455 Drypetes bg 10 2 O83 OO 0.461 O.2h 0.032 0.455 glauca Diaynopanax Da 61 3 0.05 0.60 0.95 0.31 0.033 0.87 'moretotont Drypetes glauca D5 17 hk yok 0.13 OTH 0.30 0.024 0.59 Dacryodes: excelsa De 20 5 0.03 0.07 0.36 0.32 0.026 0.64 ---Page Break--- 199 type of Mane of | Letter Lab. kK co mw oP © Material Species code code and tree number Sul. roots: Dacryodes excelsa De 90 6 De 54, T be 102 8 De 21 9 De 51 io Eugenia stanlit = Bc 5 a Bs 15 w Bef B Be 36 ib Bs 13 6 Hirtenta rugosa Hr 83 a6 Br 70 1 ir ST we mg6 0.07

0.38 2.00 Inga vera wh 2 «LS 0.52 072 0.12 0.029 1.07 Teoria ferrea If 60 BL 0.08 0.56 0.73 0.06 0.021 0.95 ir 8 22 0.030.36 0.38 0.07 0.028 0.84 Miconia prasina =p 27 23 0.03 0.22 0.19 9.07 0.020 0.55 Mp 3h 2b 0.03. 0.28 OT 0.05 0.021 O.NT Up 72 25 0.05 0121 0.2h 0.07 0.020 0.87 Mp 95 2% = 01D 03h OLTL OL O.02T 0.51. Miconta tetanira Mt TL 1 0.05 0.22 0420 9.08 0.019 0.42 Mt 90 2 0.02 0120 O46 0112 0.032 0.TH Mieropholis garciniae-" Ne 52 3 0.29 9.08 0.30 0.06 0.002 0.65 folie Ms 52 Hola org. 4.98 0112 0.006 0.78 Mg 101 5 0:13 0:20 1.82 0109 01027 0.88 Matayba Aouirgensis va 55 6 o,c3 0.38 0.54 0.17 0.030 0.52 ---Page Break--- 200 Ne ca in, Fa cole letter coke ane of Species material and tree umber. 2 root: va 3199 va v Mat ayba. doningensis fyreia 0.5 0.029 1.00 0.28 0.05 0415, 9 a 96 Derberis bs 1 es 5, Yn 95 in Mandikara nitida Nyreia z splendens 2 a1 61 a ok Leucaylon cotea ccoten portoricens 0. 0.089 19 0.0L 0.28 0.26 0.05 op

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0125 0.30 De 52 25 0.02 0.19 De 50 26 010 ova De 102 2T 0.06 0.13 Didymopanax morototoni Dn 81 L 0.72 0.79 0.23 0.022 0.43 be 2 0152 0.73 0:13 0.020 01h Drypetes glaucus be 27 3 nT 0.63 0.22 0.019 0.39 Bugenta etahlit Bs 3 ' Bo 5 5 Bs 15 é Bs 6 1 Inga ep. TL M6 8 oe2l 0.65 0.06 0.018 0.59 Inga vere wt 9 0.21 0.436 0.03 0.015 0.49 iron ferrea rr 60 20 0.28 0.97 9.07 0.55 le a 0120 0.36 0.06 0.153 ---Page Break--- - 203 ee of tame of = tatters Ma Kk Material 'Species cote ode ext ee mae — Tange & Yedton Foote - austell 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 nctropholio arcentectoite ve 52 o.01s 0.38 - mex orca Oli 'in 3 orce3Oist 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 berberis "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 ---Page Break--- Z sRABRRSEHR BR GR YY 5 yaggeagess g8 88 22 8 3 & 2 % SSsgcgeies 2 383 3 8 B gaggageggs By By 2 99% 8 " g aR89 442° 888 2 a 48 4% O8NBIRANMS 4a me no eH wah 4 amane ogy A 2O8RRRRRpo 83 MA TH A BSS wBRPK a7 a 8 RERRAEEE ae 22 86 @ s6& * gaaae i 4 3 2 3 a 4 a. 33 a3 a ; i 38 233 z ae 3 & as & | Bo Gob a By : 2 Bio] RE #8 ---Page Break--- 205 Banteteria 0.57 o on 0.2 0.20 BL 50 Tauri folia 0.32 on oui. 0.023 (01026 01033, 0.25 0.26 9.13, 0116 ors2 018 50 6 68 o! Cascaria ob 3 o 5: 'bicolor 3B csg5it ab Catyeogontun 'equamulosun Csq53 58a Rae 0.22 0.010 0.N6 0.05 0.21 22 Facemiflora Cr 61 cyrtiia conta sulleate Coearta, cs

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