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UNITED STATES GOVERNMENT

Memorandum

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TO : Files
THRU: C. L. Dunham, M.D., Director, DBM

DATE: February 16, 1966

FROM : H. D. Bruner, M.D., Assistant Director for
Medical & Health Research, DBM

SUBJECT: ROUGH NOTES OF PROCEEDINGS OF ACBM AT PUERTO RICO NUCLEAR CENTER,
JANUARY 13-15, 1966.

ADMHR:HDB

Dr. Bugher reviewed the ideas behind the Puerto Rico Nuclear Center and the progress over the past five years.

Mr. Trent noted the progress over his four and a half years at the Area Office, and assigned a good part of the progress to DBM. BONUS is still not happy, although it passed its first power test; it has been rescheduled to go to full power on line in about six months.

Dr. Bugher introduced new staff members. a) H. Andrews: Health physics, industrial health and education. b) Dr. Chariboga: Was Dean at the new school in Peru; he will strengthen relations with teaching of medicine in South America.

He discussed the decision of five years ago to institute a graduate level instruction at both Mayaguez and Rio Piedras. The PRNC staff has joint appointments on the University Faculties.

Plant and equipment expenditures are at \$13 M, not bad considering that 1200 students have been in the courses.

The Puerto Rico Water Resources Board will build one more coal station and the rest will be nuclear.

The Medical Center is actively enlarging, and PRNC is participating.

The PRNC has emphasized a base program in education with associated researches. Added on to this are researches supported by DBM and others. He did not go into the details of how the DNET and DBM programs are meshed. The research projects for students are picked to suit the student and his time--the research data are of secondary importance. On the other hand, Odum's work and Lowman's are done for scientific data

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Howard (Thomas) Odum's study of tropical forest's response to irradiation is "becoming a test system for many projects--60 phases are going on now." There have been changes in emphasis of projects as some developed more than others. There are three control areas under study: An intensively trampled area, an isolated non-trampled area, and a Machete-chopped area.

Exposures from the 10,000 curie source were measured by LiF dosimeters and others. Trees are dying off, especially those whose roots are exposed due to slope of the hillside.

Light is measured as an optical density by relating $\frac{\log \text{canopy intensity}}{\log \text{floor intensity}}$ over the years. In many areas of the hillside, solar cells can be used because different wave lengths are not selectively transmitted into the forest. End points are: Birds; green and yellow leaves as the floor; in-growth of seedlings (depending also on protection and amount of sunlight reaching the floor and giving germination); start-up of palm seedlings; diversity of insects (increases with irradiation) and diversity of plant species (decreases with irradiation, although later when sunlight can come in there may be diversity; new trunk-shoots (decreases although more light); amount of chlorophyll; growth of exotic (introduced) plants; complete weather and temperature data; coqui frog sounds; leaf fall, in grams/m²/day; per cent of holes chewed out of leaves by insects; sequence of pulses of flowering, fruiting, and falling; germination rates of more than 20 species; lizard populations; density of lichens-affected by light (increases) and by radiation (decreases); metabolic levels of plants (one species puts its energy into net gain and one into net turnover); metabolism of soil surface O₂ and CO₂ and uptake of C in grams per hour; metabolism of small plants in a closed vivarium; transpiration and mineral cycling; conductivity of the tree trunk; mineral composition of roots as to Na, K, Ca, Mg, P, N and relation to trunk and leaves. His effort to make an analogue of the eco-system in terms of electricity with storage and feedback capability did not come off; it was too forced--not a natural analogy. He will publish a big thick book of all their researches with maps, cuts, graphs and colors.

J. Kline will be taking over when Odum leaves. His specialty is studying the mineral cycle from soil to leaves to soil as affected by leaching and runoff and the fixation of soil days. Nutrients may be leached from leaves into the forest litter before they fall. Fallout minerals may not cycle since they seem to precipitate on and follow the leaf cycle; they may run off rather than go into the soil and recycle.

By actual analyses, they find Ce¹⁴⁴, Ru¹⁰³, Sp¹²⁵, and Cs¹³⁷, Mn⁵⁴. The Mn⁵⁴ and Ru¹⁰³ were of Chinese origin.

With different plants, they see different absolute retentions as well as different proportions of the above isotopes. But Cs and Ce are seen! Rain water has only Be^7 in it at present! The ground water runoff has Cs^{137} and Ce^{144} in it, plus some Ra^{226} from weathering of rock. Much Cs and Ce are trapped on leaf surfaces so that rain water may carry it onto lower plants and finally to ground plants, and thus there may be subcycles. Other elements at ppm levels are being studied. The canopy drip gathers much SO_4 , Na, K, Ca, and SiO_3 from somewhere. Insects such as termites, ants, and birds and lizards.

Manganese-54 is lost to a minor degree from the canopy whereas Cs^{137} has a half-life of six months in the canopy.

Different forests may have different accumulation rates possibly due to type of plant or tree, as well as to rainfall per year and type or rate of cycling. He seems well on his way to getting good gamma spectral stripping. Gamma spectra from soils which overlay limestone have much Ra^{226} in them. Contact Van Middlesworth re this.

P. Weinbren (to leave in March) reported that mosquito and ticks and mammals, (the bat, *Rattus-rattus*, and a few wild pussy cats) are carriers of viruses, especially arboviruses.

The rat blood from captures is put into baby mice (the Bugher technique) and beginning in March through August 1964, they isolated coxaxie virus A-10 from 70 animals and from 6 mosquitos. He believes the virus became evident after radiation began as judged by antibody appearance, but not proved according to Koch postulates. Also the virus appeared in outward progressing (radial spread) transmission by oral route.

He has identified five species of mosquitos including *Culex* and *Aedes* and *Anopholes*.

Who will carry on the rat trapping and virology. Without an expert, the project becomes uncertain to meaningless. Odum wants to do the trapping and evidently is doing so now! No one is on hand to do the very tricky blood drawing and viral culture techniques and the interpretations.

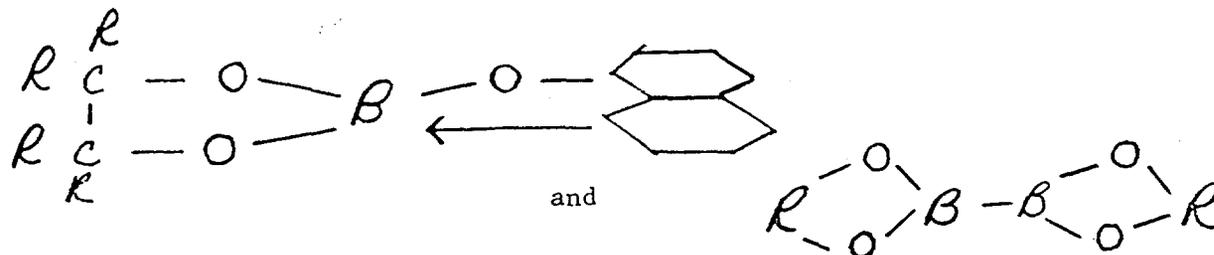
Friday Morning: Amador Cobas gave the full history of the PRNC and the bases for the two programs at Rio Piedras and Mayaguez. Originally, the program grew out of a radioisotopes application course at the University

of Puerto Rico under Cobas. Roig and Cobas are studying solid-state physics, specifically the electrical conductivity of home-grown crystals. This lab is in the Physics Department of the University of Puerto Rico. More recently, they have begun to work on the piezoelectric effect of biological tissues--bone and tooth apatite--which may be associated with growth. Their lab is used for graduate student training and a MS program in the University is thereby resulted.

Dr. Roig noted that all the work in the Division of Isotopes Application is supported by training funds, none by contract. They have three MS graduates that have gone on to the U. S. for PhD work. There are now six MS and BS students, helping to study the optical transmission in heterocyclic organic liquids kept at 77° K as affected by gamma radiation.

They also hope to do some ESR studies on radiation products of the heterocyclics. Another study is on the mechanism of oxidation of dibenzylethane, etc. The basic radioisotopes training for technicians and beginners continues at ~ 30 /yr.

Szmant's ideas of B^{10} containing compounds for neutron capture are:



Dr. Irizarry, Chemical Applications Division, is supported by 07 funds. Between 58 to 62, a more or less fixed format of courses on the clinical uses of radioisotopes was developed. One is two months long and has attracted many men from Latin America. In addition to the "Basic Clinical Applications," also given are a "Semester Residents General Orientation," a "Medical Specialty," and an extended "Informal Training" course tailored to suit requirements of the person; all are very flexible in their approach. The number of students is about 20-25/year, half from Latin America and holding key positions there. Originally, the work was carried out separately from the medical school--but with reorganization of the Medical School and centralization of facilities, this PRNC service has become the center for radioisotopes in the Medical School, doing ~ 4500 procedures per year.

Irizarry and his students are actively reporting their clinical-research observations--eight papers in last five years. He is looking at rapidity of uptake of I^{131} two-three minutes after injection, as a means of separating hypo-, normo, and hyperthyroids. He has found that a gastritis induced in dogs results in a faster loss of RISA- I^{131} from blood plus a shorter $T/2$, and is investigating why this happens.

Dr. V. Marcial noted that his physical facilities, 161 beds, etc., are supported by agencies, while AEC supports salaries and two irradiation facilities by the 07 budget. His group takes care of the radiotherapy for 70% of all cases of cancer in Puerto Rico. He also has commitments for cancer detection and control programs. The island is divided into two treatment areas: San Juan and Ponce, with 1.6 million people for San Juan and 0.9 million for Ponce. They have high rates for cancer of the stomach in the male and for the cervix in the female. Also, the highest cancer of the esophagus rate in the world is in Puerto Rico. Their main objective is to train for radiotherapy and qualify men for Boards, meaning that the residents must diagnose, decide on treatment of choice, treat and maintain follow-up, and be knowledgeable in pathology, surgery, biostatistics, radiobiology and dosimetry. Marcial also gives a month's course to medical students, radiation physicists, nurses, technicians, etc. They see about 1000 cases/year of all kinds. At present, Marcial has a guest therapist and five residents in training. He insists on good, ~100% follow-up. (Cytotechnology training is in Department of Health) Over the years, Marcial has trained 29 physicians and 30 special medical students.

Research is of the clinical sort: Incidences and value of treatment both as collaborator in the big national projects and on his own. They have reported on the value of radiotherapy of cervix in women who had been surgically sterilized; the value of split dose therapy given over seven weeks versus three weeks; and study of chromosome changes in patients being given therapy. But he has also had a go at experimental chondrosarcoma in mice and radiation nephritis in mice. His clinical five-year survival data on cancer of the uterus and esophagus are impressive.

Paul Weinbren reported that baby mice become sensitive to Dengue virus following a $LD_{50/30}$ 400 R X-ray. With Co^{60} , he finds the $LD_{50/30}$ value to be 900 R in air, with Cs^{137} about halfway between.

Strontium-89 is absorbed by snails--in fact, it is entirely removed from solution by the snail and put almost exclusively into the shell. He planned to try autoradiography to localize the Sr^{90} ; such snails produced fewer young.

Coxsackie, ECHO, and polio viruses have been found in anal swabs from Puerto Ricans as proved by transplants into tissue cultures and into baby mice.

Weinbren was also searching for B^{10} -labeled compounds, which would enter cultured cells, e.g., HeLa cells, so as to explore B^{10} -neutron therapy. One compound tried was triethanolamineborate, and by use of a Po-Be source, (10^4 nvt) he could demonstrate radiation damage of the chromosomes. The

karyotyping was done by the Army, but with departure of the Army collaboratory, this has come to an end.

He noted that the DC-2 chondrosarcome can be cultured to give a) a fibrous type; b) a squamous type with droplets; or c) a syncytial type; he will try to observe the effect of radiation.

The schistosomiasis work is based on irradiating the cercaria (SC) to produce an antigen suitable for man. The radiation is critical: 2700 to 3000 roentgen must be given; more or less gives no response in mice. The route and natural resistance of the mice are critical; the percutaneous, not I. P., route must be used. Further, the number of SC given is important. Weinbren uses eight pairs of SC in eight-week old mice percutaneously and tests the feces ten days later. Age is important, as older mice (1 year) require thirty-two pairs of SC for infestation.

Weinbren thinks the future work should be identification of dose required to lower the number of SC pairs to the point at which there will be no active infestation and then test these animals for active resistance--tissue immunity and/or antibody immunity in the blood of the mouse. The monkey is the only animal other than mice that can be used for experimental infestation.

Dr. Luce of the Agricultural Sciences has a MS degree program by collaboration with the Departments of Biology or Agriculture. His group is understaffed and he is looking for people. Puerto Rico Nuclear Center helped staff the USAEC traveling lab exhibit in Central America.

The research program is oriented to tropical crops. Dr. Walker's sugar cane genetics improvement program is three years old. The seeds and germinative buds are irradiated with γ -rays or neutrons and allowed to grow. He is looking for better sucrose production, disease resistance, and tolerance to unfavorable soils such as those low in PO_4 , SO_4 , N, etc. Mineral cycling; Dr. Tukey will try to complete this cycling project and PO_4 ⁺⁺⁺. Dr. Mayer has been studying the effect of wetting agents on the foliar uptake of PO_4 solution by aerial application. Invertase activity in meristem tissues is being studied as it is the enzyme that converts sucrose to glucose and levulose. Research on sterilization of the sugar cane borer, supported by DBM, was notably advanced by development of a diet (250 diets were tested) which permits rearing the larvae of the borer; they have also determined the dose, 20-25 kR, for sterilization, the time of mating, the way the male insect locates the female, but unfortunately they are multiple maters.

Irradiated mangos and bananas are being studied for firmness, acceptability, and food value. With 40 kR ripening, post-irradiation can be slowed without hurting the fruit or taste; stage of ripening, conditions, of storage, variety, etc. are being studied. A twenty-day extension is possible with some varieties of the fruits. Pectins may be degraded but without harm.

On Saturday morning in Mayaguez, Dr. Bugher discussed the areas of physical science selected for study. They are not highly expensive but still are well up in forefront; they have multi-use aspects and could be useful to Latin America. The best example is their solid state physics-neutron diffraction program built up with the help of the BNL physics staff; BNL provided a neutron spectrometer.

At Mayaguez there are the Departments of Nuclear Engineering and Physical Sciences. The PRNC activities are tightly woven into the Departments of Physics and Chemistry of the School of Engineering of the University of Puerto Rico and the Bonus Reactor. The Plowshare Program has suggested that Latin American Engineers could be trained here for the Canal Project. Various ways have been worked out to give MS and PhD programs to students.

Frank Lowman's program in marine biology is solely on O6 funds, although some of the technicians are doing graduate work on the side. New chemical analytic techniques have been added, namely, activation analysis and K-edge diffraction. The research focuses on both the elements brought into the sea and the relation of the organisms in the sea to this mixing environment. He is using three adjacent river systems, which drain limestone, volcanic and serpentine formations, the special discharges of which into the sea allow identification of movement and formation of sediments.

The ratios of concentrations of elements in the organisms relative to those in the discharged detritus are in general less than one; this is interpreted to mean non-specific uptake in the digestive process and/or surface contamination of the organism.

They are also doing analyses of marine organisms, such as sponges and sea urchins, for world-wide fallout. There are differences in species uptake, but river run-off into the sea is a more important determinant of what will be found in the organisms.

The zoo plankton concentrates most elements from the phytoplankton, but except for Zn, the sea animals (marlin) do not concentrate the elements from the zooplankton; Cs¹³⁷ appears in the marlin but not in the zooplankton.

He noted that different elements are best done by different methods, depending on limit of sensitivity required; hence, he must have these various types of analytic systems. It may be, however, that he is getting too involved in analytic expertise, rather than in doing only those elements necessary to get at the ecologic problems.