CEER T-60

ANNUAL REPORT
TERRESTRIAL ECOLOGY DIVISION
FY – 1979

CENTER FOR ENERGY AND ENVIRONMENT RESEARCH
UNIVERSITY OF PUERTO RICO – U.S. DEPARTMENT OF ENERGY

TERRESTRIAL ECOLOGY DIVISION

ANNUAL REPORT FY-1979

Participating Personnel:

Laurence J. Tilly, Director
Arthur McB. Block, Scientist II
Douglas P. Reagan, Senior Sci. I
Johnny Villamil, Scientist I
William R. Bhajan, Scientist I
María B. Riesco, Scientist I
Ronald Bunnell, Res. Associate II
Susan Silander, Res. Associate II
Miguel Canals, Res. Associate I
Alvin Mirabal, Scientific Technician
María de L. Fuentes, Laboratory Technician
Manuel Rivera, Laboratory Technician
Alejo Estrada, Laboratory Technician
Luís Iván Rosa, Laboratory Technician
Ana J. Correa, Adm. Secretary
Juan Martínez, Field Skilled-Maintenance

Students:

Damaris Viera
Dagmar Pelegrina
José A. Zayas
Iris Corujo
Wilmer Tirado
Eddie Laboy
Luís de Andino
Providencia Orona

REPORT PREPARED BY:

ARTHUR McB. BLOCK

Arthur McB. Block

1 Mission of Terrestrial Ecology Division

The Terrestrial Ecology Division is dedicated to the acquisition of an understanding of ecosystems in order to permit a rational development and planned utilization of natural resources. Of particular importance is the resource of energy and studies are carried out to further the understanding of this resource development in Puerto Rico as well as in the Continental United States. The goals of this mission overlap considerably, as will be evident from the project descriptions.

2 Goals and Objectives

2.1 Structure and Function of Tropical Ecosystems

The foremost goal of the Division is to develop an understanding of the structure and processes characteristic of tropical ecosystems for the purpose of predicting which features are sensitive to natural and anthropogenic changes. In particular, the Division has focused its efforts on the El Yunque Tropical Rain Forest and its associated drainage basin. It is reasoned that a sufficiently detailed description of the structure and function of this main forested watershed and its drainage system will provide a model to indicate which subsystems are likely to be impacted adversely by energy development and utilization and related activities.

One of the continuing objectives of the studies realized in the forest and drainage basin is to compare structural and functional features of this ecosystem with other ecosystems located in Puerto Rico and abroad. Another objective has been to devise and carry out field perturbation experiments to determine how changes in structural and process features of the ecosystem are related to altered environmental conditions.

2.2 Ecological Effects

A second principal goal of the Division is to determine the relationships between ecological effects at all levels of organization and energy and other resource development.

The energy efficient control of pests, land-side distribution of wastes and modern methods of pollution control may contribute to long range ecological effects. These effects, per se, may or may not be directly relatable to energy problems but do relate to energy utilization. Consequently the Terrestrial Ecology Division has very recently begun to establish objectives leading to the goal of prediction of long term undesirable ecological effects which at worst could be irreversible. Basically these objectives are as follows:

1. To determine the "assimilative capacity" of different representative ecosystems to ward specific perturbants.
2. To examine and qualify relationships between ecological effects and quantitative bioassays and other measurements.
3. To evaluate the relative influence of: Natural variability, sampling error, measurement errors and sampling effort on detectability of the potential effect.

2.3 Resource Management and Conservation

The most recently developed goal of the Division is to develop information necessary for the management of environmentally important resources such as land, water and wild life. Within the past 2 years, the Division has actively sought local and national roles leading to the application of its background in environmental research to help identify and resolve both short term and long range problems in both the public and private sectors.

The general objectives for realization of this goals are:

1. To evaluate alternative methods for water reclamation in an effort to maximize energy

efficiency, economy and recovery.

2. To evaluate alternative methods for land and space reclamation which complement the alternatives in water reclamation.

3. To examine and describe factors important in the survival and well-being of biotic resources of economic and esthetic importance to man.

3 Projects

A series of projects have been wholly or partially executed to satisfy the goals and objectives stated. A short list and description of each follows:

3.1 Ecosystem Structure and Process Studies

3.1.1 National Environmental Research Park (NERP)

The National Environmental Research Park (NERP) program was funded by the U.S. Department of Energy (DOE) and Commonwealth of Puerto Rico Conservation Trust; it is dedicated to the selection and characterization of certain sites which can be set aside and managed for purposes of ecosystem research. A site receiving DOE approval will be managed for specific studies related to environmental impacts due to energy generation and utilization. Long term comparison with equivalent sites (possibly also NERP sites) would then be practical and could be structured to minimize cost and

and maximize the quantity and quality of data available on ecosystem changes.

3.1.2 Cycling, Transport and Mobilization in Tropical Forested Drainage Basins.

The mineral transport study program is part of the base program of the Division funded by DOE. Measurement of nutrients and changes in nutrients in defined compartments such as leaf litter, soil horizons, tree bark, primary consumers, etc. can be used to define transport models which can then be operated upon synthetically or abstractly. Subsequent measurements after perturbation can demonstrate which compartments are most affected by man-made perturbations. Examples of field perturbations include forest irradiation and clear cutting as well as natural disturbances such as hurricanes and flooding.

3.1.3 Long Term Ecological Monitoring

This program was undertaken in conjunction with the NERP program and potential sources of funds include the NSF Long Term Ecological Research (LTER) Program. It consists of a broad based monitoring program which would examine long term variability of species composition, climatic conditions, stream flow and water quality among other parameters used to characterize a tropical rain forest.

3.1.4 Industrial Siting

With the steadily increasing world cost of petroleum and Puerto Rico's 99% dependence on petroleum for electrical power generation, alternative fuel-fired plants are now in the construction planning phase. Ecological characterization of sites which would be appropriate for the construction of coal-fired plants is required by law and the Puerto Rico Electric Power Authority has requested the Terrestrial Ecology Division to scope and carry out studies on several potential sites. Such studies provide structure and function information on different local sites with which data from the El Yunque Tropical Rain Forest may be compared.

3.2 Ecological Effects

3.2.1 Cooling System Effects on Aquatic Ecosystems

The Savannah River Laboratory in South Carolina is interested in long term effects in water bodies heated above ambient temperature by reactor cooling water. The study realized at the Savannah River Plant will seek to rationalize a large amount of structure and process data accumulated for such a water body over the past 20 years.

3.2.2 Intensive Biomass Culture

Little is known about the ultimate effects of intensive biomass culture upon soil properties, drainage

water quality and insect/predator relationships. Effects associated with potentially massive dispersion of fertilizers, pesticides and soil conditioners are to be assessed for intensive production of grasses to be used for energy production. Potential sources for funding of this research are: DOE, the U.S. Environmental Protection Agency (EPA), the Puerto Rico Land Authority and the U.S. Department of Agriculture (USDA).

3.2.3 Water Hyacinth Cover of Water Bodies

The desireability of harvesting water hyacinth (Eichhornia crassipes) from surfaces of water bodies used as potable water sources has been under debate for the past 10 years. The CEER-DOE Development Fund has supported research aimed at determining nutrient uptake, productivity and ecological parameters associated with water hyacinth mats which currently dominate the surface of Lake Carraízo, a local potable water source.

3.3 Resource Recovery

3.3.1 Energy Reclamation and Water Purification

A program largely financed through the CEER Development Fund, the Puerto Rico Aqueducts and Sewers Authority, and small grants from local industries has produced 2 projects of applied environmental research. They are

devoted to the acquisition of data which would find direct application in the alleviation of water pollution and in the use of noxious weed pests for high quality energy (e.g. methane) generation.

3.3.1.1 Water Hyacinth Water Reclamation and Fermentation

This project aims at determining if small well-managed water hyacinth lagoons can be used effectively for processing domestic sewage and industrial waste water. It is also concerned with economic advantages of harvesting and anaerobically fermenting water hyacinth to obtain methane, a high quality energy source.

3.3.1.2 High Gradient Magnetic Filtration (HGMF)

Particularly refractory waste water streams can be treated more efficiently with respect to energy expenditure using an advanced separation and clarification technique to remove particulate matter, biochemical oxygen demand and heavy metals. The establishment of this project aims at examining applicability of the technique in Puerto Rico, as well as at long term effects of its application.

3.3.2 Waste Sludge Utilization and Disposal

Of potential interest to EPA, USDA and to local funding agencies, composting and land distribution of waste sludge has associated with it some problems which are well encompassed by the goals of the Terrestrial

Ecology Division. The waste sludge must be distributed on land after 1982 by law. Waste sludge, if distributed in forested ecosystems may represent a serious perturbation to its structure and function. Waste sludge may be useful for maintenance of soil productivity and soil structure during long regimes of intensive biomass cultivation. Finally, ecological effects of waste composted sludge for tropical forest cover reclamation has never been studied.

4 Research Progress Review FY-79

4.1 Ecosystem Structure and Function

During 1979, a critical and extensive review of on-going studies was carried out to determine the requirements of the Division with respect to manpower and the limitations imposed by the DOE research budget. Studies in the lower drainage basin were concluded and a volume: "Proceedings of the Seminar on River Basin Energy and Environmental Planning" was prepared and editted. The principal conclusions of some of the papers contained therein were reviewed in the 1978 annual report to the Advisory Committee of the President of the University of Puerto Rico. One of the conclusions which was not presented is as follows.

A drainage basin is not an appropriate planning unit in Puerto Rico owing, in part, to the fact that most drainage

basins in Puerto Rico are already very fragmented with respect to development and that open tracts which are worthy of a planning effort are small and generally widely separated.

Internal reviews of program directions generally indicate that continued commitment to the entire Rio Espiritu Santo (RES) River drainage basin will not yield a cohesive model of the basin due to limitations on resources available. However, there are features of the Luquillo National Forest which can receive more attention and limitation to the forested section of the RES basin can provide information of importance for comparative structure and function studies.

For example while limnological studies carried out in the basin do reveal some of the dynamics of mineral mobilization due to migratory patterns of freshwater shrimp and scrab species, cyling and transport studies limited to the watershed might be very useful for characterizing biomass interfacial transport of carbon dioxide. Atmospheric buildup of carbon dioxide is of world-wide pre-occupation because of its potential impact on climatic patterns.

4.1.1 National Environmental Research Park (NERP) Program

The Terrestrial Ecology Division is proposing that two sites, El Faro and El Verde, be included in the

Department of Energy (DOE) supported National Environmental Research Park (NERP) system. At present this network consists of five such research parks:

Savannah River Plant, S.C.
Idaho National Engineering Lab.
Los Alamos Scientific Lab., N. Mex.
Hanford Reserve
Oak Ridge National Lab. of Tenn.

Designation as NERP's will make these lands available for use as field laboratories in which visiting scientists, staff and university participants may carry out ecological research programsdesigned to develop the data base necessary to make scientifically reasoned environmental decisions. The focus of this program will be to evaluate the current and potential impacts of man's activities, in particular those related to energy use and development, and will address the following NERP objectives:

1. Continuous and quantitative monitoring and assessment of environmental impacts and development of baseline, but site specific comparable data, by means of network-wide standardized methods (e.g. meteorological monitoring network, species lists, mapping, population levels, life histories to identified sensitive species, site manipulation...).

2. The development of methods to estimate or predict environmental response to proposed activities (e.g. nutrient and mineral cycling, succession, pollutant depositon...)

3. Demonstrate impacts to the public and evaluate methods to minimize adverse impacts.

A proposal was submitted in June, 1979 to include El Faro in the NERP network. The 522 acre site is located on the extreme northeastern tip of Puerto Rico near the city of Fajardo and is privately owned by the Conservation Trust. This group contacted the Terrestrial Ecology Division to characterize the site and evaluate its potential as a NERP. Preliminary vegetation and faunal surveys were completed in the fall of 1978 and field work for three theses from UPR was conducted on-site. Included at El Faro are a wide range of habitat types: beaches, rocky shores, mangrove forests, a coastal lagoon, abandoned palm plantations, and xerophytic forest. These types are similar to those being adversely impacted in the coastal zone island-wide, making El Faro an ideal reference area and site for ecological research.

A second site, El Verde, is presently being evaluated with respect to its potential as a NERP and a proposal will be submitted to DOE during this fiscal year. The area

includes research and living facilities located at the El Verde Field Station and the surrounding tracts of tropical rain forest. Already used by visiting scientists, staff and university participants having a long history of ecological research, a large data base exists for the El Verde Site. Continued research concerned with indications of the impact of energy related activities on tropical ecosystems should be facilitated by this data base. Although located within the boundaries of the Luquillo Experimental Forest operated by U.S.D.A. Forest Service, the field station and surrounding 160 acres has been used as a base for ecological research for an extended period of time by other agencies and groups such as the AEC, ERDA, DOE, UPR and other universities. Upon designation as a NERP, activities to be initiated include continued site characterization; further investigation of nutrient and mineral cycling, in particular the fate of sulfur in the system; and studies of the consumer trophic level. In addition data and pertinent literature will be collected and evaluated in order to identify gaps and future research needs. The literature will be organized and a library will be established at the field station. A total evaluation and organization of the already existing herbarium and faunal museum is also a high priority goal. Initital funding by DOE will privide support for the development of a research program,

collection of baseline data (e.g. meteorological monitoring), continued site characterization, site and facilities maintenance, and preparation of a brochure to inform the scientific community of the availability of the site for ecological research. The site and its facilities may be used by investigators with financial support provided their research is concerned with the research program under development by the NERP administration and contributes to knowledge of the structure and function of the system relative to impacts of energy generation and utilization activities. Designation of both sites will permit further intersite comparison.

4.1.2 Cycling Transport and Mobilization

In FY-1979, aspects of energy cycling were the principal accent of this project. In particular 25 stations were selected at random from a gridded map of the forested section of the basin and leaf samples were collected from each station once a month for a period of 3 years between FY-1971 and 1973. Samples were dried, ground and labelled for future reference. Analyses of nutrients sodium, potassium, magnesium and calcium were carried out on each sample. Analyses of selected trace elements were also carried out. In FY-79 oxygen bomb combustion techniques were used to begin a determination of the caloric value of leaf

drop from the same 25 stations. While there is a great diversity of species contributing to the leaf drop, the average caloric content of leaves in each forested section can be related, as a base of comparison, to the average caloric content of Tabonuco (Dacryodes excelsa) leaves. The turnover time for Tabonuco leaf litter has been shown previously to be about 16 months (c.f. personal communication from F. La Caro). Thus it should be possible to derive an approximate value for the energy transfer per year via leaf drop. This number is of great importance in the determination of energy limits to the population of arthropods, soil micro-organisms and leaf eating insect primary consumers. Using data so far available at this time, the estimated average caloric value of leaves from all 25 stations after a single collection (5-31-72) is 4,656 cal/gm with a standard deviation of 189 cal/gm. The estimated uncertainty in the values measured is no greater than 2%.

Measurements of the average nitrogen and sulfur content of the leaves will also be measured since cycling of these elements are related to soil nutrient return and world-wide pollution models.

4.1.3 Long Term Ecological Research (LTER)

The Terrestrial Ecology Division is presently in collaboration with the U.S.D.A. Forest Service, Institute of Tropical Forestry in the preparation of a National Science Foundation (NSF) proposal to designate the Luqui-

llo Experimental Forest as a site in which a Long Term Ecological Research (LTER) program may be initiated. NSF has recognized the need for continuous collection of quantitative data in order that long-term changes, either natural or man-related, in biological systems may be evaluated. Changes through time at the same site and comparisons between sites or in the network are the focus of five core research questions:

1. Pattern of primary productivity.
2. Population dynamics of selected populations-evaluation of population fluctuations and their relationship to physical and climatic variables.
3. Organic (biomass) accumulation and movement through time.
4. Inorganic (atmospheric and hydrologic) accumulation and movements.
5. Spatial and temporal patterns, frequency and responses to disturbances.

Financial support will enable to TED, CEER and ITF to initiate the appropriate long-term measurements required to evaluate these five core research areas.

4.1.4 Industrial Siting

A proposal for the study of 2 potential power facility sites was submitted to the Puerto Rico Electric Power Authority (PREPA). Both flora and fauna on the proposed sites will be characterized with respect to populations, number and frequency and, in the case of flora, percent ground cover. An analysis of damage to fragile aspects of the ecosystems at the sites will also be made.

4.1.5 Other Progress

Limnological survey work on the Rio Espiritu Santo River drainage basin was completed and an analysis of data was made. Preparation of some manuscripts was completed and the limnological survey is being written at this time.

4.2. Ecological Effects

4.2.1 Cooling System Effects on Aquatic Ecosystems

A small water body - Par Pond - has been used for discharge of atomic reactor cooling water for more than 20 years. During that time, a large body of limnological data has been acquired, but little systematization of it has been attempted. An effort begun at Savannah River Laboratory SRL to analyze those data in the context of long term effects has been continued by the CEER Terrestrial Ecology Division in collaboration with SRL. A data base has been assembled for the SRL computer and time series summaries are in preparation.

4.2.2 Intensive Biomass Culture

This a a new project and no data have yet been taken on biomass cultivation effects on soils or water, but a site for the studies has been arranged, and the studies can be carried out in association with yield-per-acre experiments now underway.

4.2.3 Water Hyacinth Cover on Lakes

A man-made lake - Lake Carraízo - is used as a potable water source for San Juan and several other municipalities. During dry seasons, the lake conventionally spports a lush superficial growth of water hyacinths Eichhornia crassipes. Growth of biota associated with the water hyacinth mat is responsible for considerable nitrogen, phosphorus and carbon turnover, effectively treating influencts to the lake, 5 of which are from municipal sewage treatment plants.

Plants havested from Lake Carraízo were re-established in small 3 foot deep pools with plastic liners and fed effleunt from a secondary aerobic activated sludge treatment plant - El Conquistador plant in the municipality of Trujillo Alto. The mean dry weight of plants raised in this manner was 5.2% of the wet weight. A linear regression equation which relates wet weight to dry weight is as follows:

$$Y = 0.05129 + 0.3130X$$

in which Y = dry weight and X = wet weight. Wet weight was determined after drip drying for 5 minutes. No significant relationship between growth rate and water retention time was discernible. Productivity on a dry weight basis was determined to be 108.195 Kg/Ha/day.

4.3 Resource Recovery

4.3.1 Water Reclamation Using Water Hyacinth Culture

Clarification using water hyacinth dominated lagoons, can help secondary treatment plants meet effluent requirements with respect to total suspended solids, nitrogen and phosporous levels. The pond system described in 4.2.3 was used to determine water clarification performance of water hyacinth used to treat effluent from the El Conquistador aerobic activated sludge plant using a nominal holdup time of 2 days. A mean 95% reduction of total nitrogen, 25% reduction of total phosphorus and 90% reduction in total dolids was measured over the short term. Somewhat puzzling was the ability of the water hyacinth mat to re-aerate the water, lagoon effluent frequently showing a dissolved oxygen content between 100% and 200% higher than the treatment plant effluent entering the lagoon. Equally puzzling was an apparent increase (10%) in the 5-day biochemical oxygen

demand after lagoon treatment. This may be related to the chlorination of the final plant effluent. An energy and nutrient interaction diagram for organisms associated with hyacinth lagoon treatment is shown in Figure I.

4.3.2 High Gradient Magnetic Separation

A program of water treatment using a very advanced technology-high gradient magnetic separation- was begun in FY-79. Primarily aimed at industrial and municipally generated waste streams, a 3-day workshop of international and local experts concluded that the use of seeded high gradient magnetic filtration (HGMF) could be of significant benefit for effluent compliance problems in Puerto Rico. A mobile laboratory was rented from Sala Magnetics, Inc. of Cambridge, Massachusetts, and after a brief training period, raw sewage effluent was treated during runs of 55-300 gallons. Sewage was fresh influent to the El Conquistador secondary aerobic activated sludge treatment plant. The plant performance was judged to be between adequate and expensive for that particular waste. Raw sewage from the plant conventionally required an alum dose of 550 mg/l, powdered magnetite at a level of 350-400 mg/l and settler/flocculant Hercofloc 831 at 3 mg/l. Turbidity was routinely reduced by 90-95%, with a total

suspended solids removal of above 90% and biochemical oxygen demand reduction between 60% and 89%. Rum stillage wastes have not been treated as successfully so far.

4.3.3 Waste Sludge Utilization and Disposal

A proposal for detoxification of waste sludge from secondary aerobic sewage treatment plants was submitted to EPA Minority Institute Research Support (MIRS) Program in May of 1979. The detoxification will be tried using static pile thermophilic composting techniques and a locally generated bulking agent-bagass, the cellulosic fibre waste from sugarcane processing. The research will be done in cooperation with the University of Puerto Rico School of Medicine which will be responsible for microbiological and parasitological examination of the treated wastes. The product will be used for perturbation effects in ecosystem structure and function studies, and for agronomical studies of soil amendment regimes for intensive biomass production.

5 Publications, Theses and Reports

5.1 The following publications were accepted and/or appeard in FY-1979.

Block, A.McB. F.A. Santos, R.G. Clements, W.R. Bhajan and G. Goldman, 1978. Survey of the Elemental Burden Potential for Benthic Organism Uptake in the Rio Espiritu Santo River Estuary of Northeast Puerto Rico. Science-Ciencia 6 (1), 30.

Surface sediments collected at some 18 stations in the Rio Espiritu Santo River Estuary were analyzed with respect to 40 different elements using arc emission spectroscopy and visible estimation techniques. Most of the estuary contained a metals distribution typical of saline estuaries probably reflecting the presence of a 5 km. salt wedge.

Canals, M., 1979. Some ecological aspects of the Biology of Macrobrachium crenulatum (Holthuis, 1950) Palaemonidae Decapoda in Puerto Rico including notes on its taxonomy. Science-Ciencia 6 (3): 130-132.

Abstract

The distribution and ecological aspects of Macrobrachium crenulatum in P.R. are discussed. The species is more abundant at middle altitudes (200-400 m.) where it is the dominant species of the Palaemonidae. The distribution is limited to north-eastern Puerto Rico. Taxonomic variations in coloration and length of dactyl is influenced by age and sex. Gravid females present a peculiar coloration of the protopodites never reported for any member of the Palaemonidae.

Villamil, J., 1979. El Jacinto de Agua, Eichhornia crassipes (Mart. (Solms)), Promesa para el Futuro. Science-Ciencia 6, 167-168.

Since its introduction in Puerto Rico, the water hyacinth has gone from a floral curiosity to a nuisance and pest in waterways. This work presents a new image of total utilization of the plant. A wide variety of uses are presented in this paper; some of these are: domestic wastewater treatment, chemical wastes treatment, compost, methane production, paper pulp and management in water reservoirs.

5.2 Theses

The following theses were finished by students working in the Division during 1979.

Corujo, I., 1979. Species Diversity and Distribution of Fish in the Rio Espiritu Santo River Estuary. M.S. Biology, University of Puerto Rico, (in press).

Pelegrina, D., 1979. The Effect of Light and Salinity on Rotation of Rhizophora mangle seedlings, M.S. Biology, University of Puerto Rico (available).

Tirado, W., 1979. Faunal Ecology of the El Faro Reserve. M.S. Biology, University of Puerto Rico (available).

Viera, D., 1979. Colonization of Communities on the Roots of Rhizophora mangle. M.S. University of Puerto Rico. (available).

Zayas, J., 1979. The Ecology of a Coastal Lagoon. Studies on the El Faro Reserve. M.S. University of Puerto Rico. (available).

5.3 Reports

In 1979 a CEER volume summarizing the Rio Espiritu Santo drainage basin was editted by members of the Terrestrial Ecology Division. The volume, entitled "River Basin Energy

and Environmental Planning, Methodologies and Instruments" (CEER No. T-40) is available upon written request. The following papers by members of the Terrestrial Ecology Division appeared in the volume:

Block, A.McB. The Human Waste Problem in Rural Zones of a High Rainfall Watershed. 43-56.

Canals, M. Some Economic Aspects of the Fauna of the Espiritu Santo River Estuary. 29-38.

Clements, R.G.. Physical and Ecological Aspects of the Espiritu Santo Drainage Basin. 7-12.

Clements, R.G. Hydrology of the Espiritu Santo River Basin. 67-76.

Holben, B.N., J.A. Colón, M. Canals, F.A. Santos and R.G. Clements. Precipitation Distribution and Raingage Networks in the Luquillo Mountains. 57-66.

The final report on the El Faro Reserve of the Conservation Trust which was prepared for DOE consideration of the reserve as a NERP site was also finished in June of 1979. The document is available and is referenced as follows:

Clements, R.G. and R.C. Bunnell. Proposal to Establish a National Environmental Research Park at El Faro, Fajardo, Puerto Rico.

One additional report concerning structure and function of ecosystems was completed during 1979. It concerns the impact of fresh water flooding on reef populations and the reference with abstract is as follows:

Goenaga, C. and M. Canals, 1979. Relación de Mortalidad Masiva de Millepora complanata (cnidaria, hydrozoa) con alta pluviosidad y escorrentía del Rio Fajardo en Cayo Ahogado, Fajardo. Rroc. of the Sixth Simposium of Natural Resources, Dept. of Natural Resources, Commonwealth of Puerto Rico (in press).

Salinities lower than 25 ppt. and high turbidity occurred in May 29-31, 1979 in the reefs close to the mouth of the Fajardo River due to high precipitation in Fajardo and the Luquillo Mountains. In Cayo Ahogado these conditions were responsible for high mortalities of the hydrocoral Milleporo complanata. After three days, colonization by algae started on the skeletons of the dead corals. Diversity Index; Percentage of Mortality are compared between Cayo Ahogado and Cayo Largo where salinities were not less than 34 PPT during the period of high precipitation.

The following reports pertaining to resource conservation were completed during 1979.

Block, A.McB., U. Ortabasi, and M.B. Riesco. High Volume, High BOD Wastes: The Magnetic Separations Option. CEER Tech. Publ. C-19 (available).

Ortabasi, U., co-ordinator and A.McB. Block, R.Cruz-Pérez, J.R. Harland, J.A. Oberteuffler, M.B. Riesco and J.H. P. Watson. An Assessment of Magnetic Filtration: A New Approach to Puerto Rico's Effluent Pollution Problems. Proc. Workshop Magnetic Separations Applications in Puerto Rico (available).

Villamil, J. and A.McB. Block. CEER Sewage Management and Research Program: Analysis and Selection of Study Site Location.

Villamil, J., R.G. Clements, A.McB. Block, F.A. Santos, P. Weil, A. García and W. Lao. Water Hyacinths for the Clarification of Wastewaters and the Production of Energy. CEER Tech. Publ. C-36.

Presentations and Seminars

The following is a list of presentations and seminars given by members of the division during FY-1979.

Block, A.McB.*, U. Ortabasi and M.B. Riesco. High Volume, High BOD Wastes: The Magnetic Separations Option. Tech. Cong. Assoc. Engr. of Puerto Rico, San Juan, P.R. May, 1979.

Canals, M.*, La Fauna de Crustaceas del Bosque Nacional del Caribe. Youth Conserv. Corps Camp. Roosevelt Roads Naval Sta., Ceiba, Puerto Rico, July, 1979.

Villamil, J.*, R.G. Clements, A.McB. Block, F.A. Santos, E. Craig, A. García, W. Lao and P. Weil. The Use of Vascular-Plant-Dominated Lagoons for Water Treatment and Wastewater Reclamation. 3rd. ACS/PR Sr. Tech. Meeting Poster Session, Mayaguez Hilton Hotel, Mayaguez, P.R., Dec. 1978.

Villamil, J.*, R.G. Clements, A.McB. Block, F.A. Santos, A. García, W. Lao and P. Weil. Water Hyacinths for the Clarification of Wastewater and the Production of Energy. Tech. Cong. Assoc. Eng. of Puerto Rico, San Juan, P.R., May, 1979.

Villamil, J.*, R.G. Clements, A.McB. Block, F.A. Santos, L. I. Rosa, A. García, W. Lao and P. Weil. Water Hyacinths for the Treatment of Wastewaters. Aquatic Vascular Plant Manage. Soc. Ann. Meeting, Chattanooga, TN., July, 1979.

7 Terrestrial Ecology Division Scientific Staff

During FY-1979, field ecologist Ronald Bunnell left the group to pursue graduate studies at University of California, Berkeley, CA; Félix Santos, Research Technician left to pursue Ph.D. studies in toxicology at the University of Tennessee; Oak Ridge Associated Universities Fellow Fred La Caro returned to the University of California at Davis. In September of 1979 William Bhajan left the Division. Also in September, Richard G. Clements, Director of the Terrestrial Ecology Division for the past 10 years at CEER and its predecessor institution, Puerto Rico Nuclear Center (PRNC) resigned to take a position with the regulatory section of U.S. Environmental Protection Agency.

*Lecturers

Staff additions include Susan Silander, a specialist in tropical forests, Douglas P. Reagan, an ecologist/herpetologist and Laurence J. Tilly, an ecologist, recently of Savannah River Laboratory, as director of Environmental Programs and acting director of Terrestrial Ecology Division. The expertise which Tilly brings to the division is principally primary consumer analysis and aquatic biology.

A complete list of the scientific staff is as follows:

Laurence J. Tilly, Acting Director, Ph.D. (Ecology), State University of Iowa, Iowa City.

Douglas P. Reagan, Senior Scientist I. Ph.D. (Zoology), University of Arkansas.

Arthur McB. Block, Scientist II. Ph.D. (Physical Chemistry), Rutgers University.

Johnny Villamil, Scientist I. M.S. (Biology), University of Puerto Rico.

Susan Silander, Research Associate. M.S. (Biology), University of Tennessee.

Miguel Canals, Research Associate. B.S. (Biology). Interamerican University, San Juan, P.R.

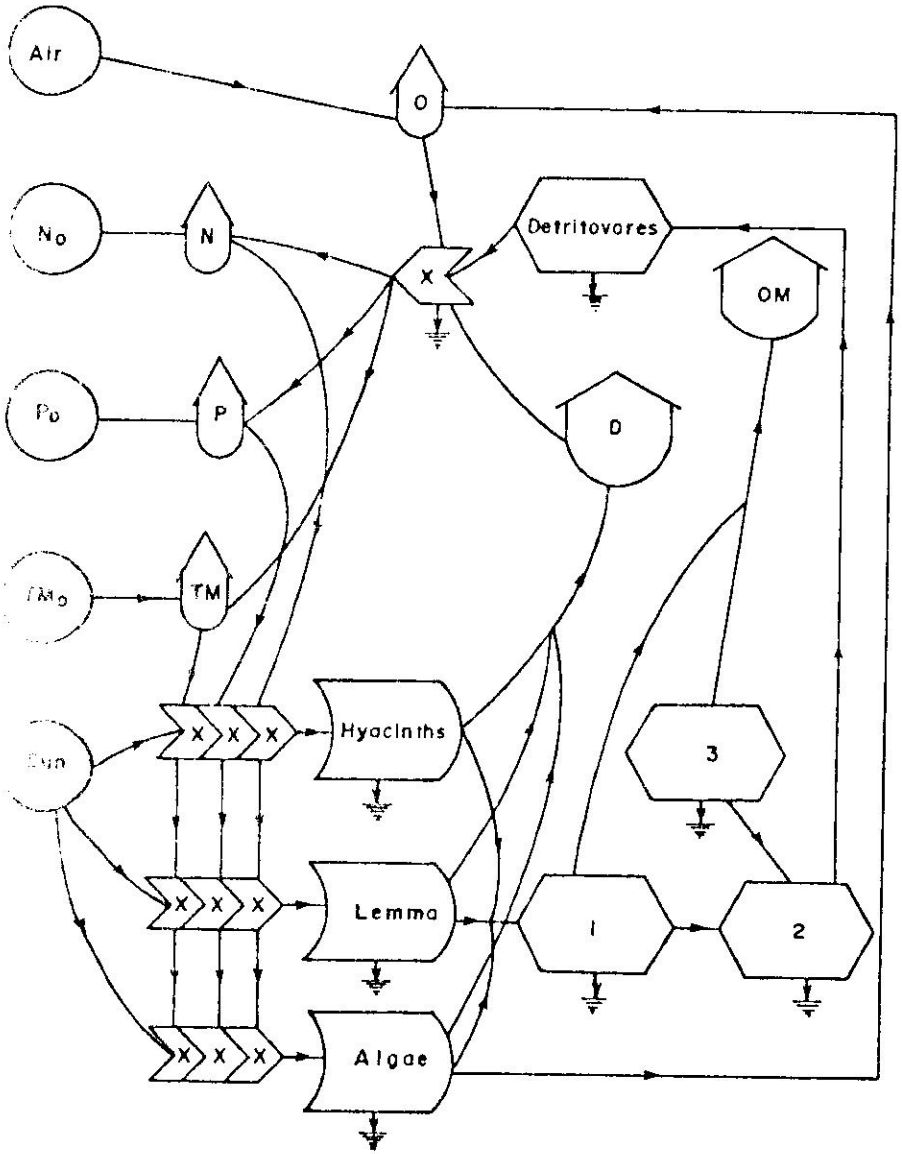
Other Staff Activities

Arthur McB. Block attended the 53rd Colloid and Surface Science Symposium, an American Chemical Society Meeting held June 11-13, 1979 in Rolla, Missouri.

Johnny Villamil attended the Annual Meeting of the Aquatic Vascular Plant Management Society held in July, 1979 in Chattanooga, Tennessee.

Johnny Villamil conferred with members of the Texas Dept. of Health in Austin, Texas in July of 1979 about water treatment strategies using water hyacinth.

Johnny Villamil conferred with NASA officials in Bay St. Louis, Mississippi in July of 1979 about utilization of water hyacinth for energy generation.



N_O - Nitrogen from the influent

N - Nitrogen in the system water

P_O - Phosphorus from the influent

P - Phosphorus in the system water

TM_O - Trace metals from the influent

TM - Trace metals in the system water

D - Detritus or settled solids

OM - Organic matter exported from the lagoon system

1 - Primary consumers, insects, amphibian larvae, protozoans, anelids, molluscs and others

2 - Secondary consumers, insects, amphibians, lizards and others

3 - Tertiary consumers - birds, amphibians, lizards and others

Figure I: Biological Interactions in the Hyacinth lagunal Association