PD-ABL-188

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U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

Dr. Franklin Hamilton, Director
Division of Sponsored Research
Florida Agricultural and Mechanical University
Tallahassee, FL 32307

Subject: Grant No. PCE-5053-G-00-3049-00

Dear Dr. Hamilton:

Pursuant to the authority contained in the Foreign Assistance Act of 1961 and the Federal Grant and Cooperative Agreement Act of 1982, as amended, the Agency for International Development (hereinafter referred to as "A.I.D.") hereby grants to Florida Agricultural and Mechanical Universiy (hereinfter referred to as "Florida A&M" or "the Grantee") the sum of $96,787 to provide financial support for the program described in Attachment 2 of this Grant entitled "Program Description."

This Grant is effective and obligation is made as of the date of this letter and shall apply to expenditures made by the Grantee in furtherance of program objectives during the period beginning with the effective date and ending September 30, 1995.

This Grant is made to the Grantee on the condition that the funds will be administered in accordance with the terms and conditions as set forth in Attachment 1 (the Schedule); Attachment 2 (the Program Description); and Attachment 3 (the Standard Provisions); all of which have been agreed to by your organization.

Please sign the original and all enclosed copies of this letter to acknowledge your receipt of this grant and return the original and all but one copy to the undersigned.

If you have any questions, please contact Ms. Karin Kolstrom of my staff at (703) 875-1189.

Sincerely,

Gary V. Kinney
Grant Officer
Chief, PCE Branch
Division B
Office of Procurement



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Attachments:

1. Schedule
2. Program Description
3. ~~Standard Provisions~~

ACKNOWLEDGED:

Florida Agricultural and Mechanical University

BY: _____

TYPED NAME: Franklin D. Hamilton

TITLE: Dir. Div of Sponsored Research

DATE: 10/01/93

97671

## FISCAL DATA

### A. GENERAL

A.1. Total Estimated A.I.D. Amount: $96,787
A.2. Total Obligated A.I.D. Amount: $96,787
A.3. Cost-Sharing Amount (Non-Federal):$19,962
A.4. Other Contributions (Federal): $0
A.5. Project No.:936-5053
A.6. A.I.D. Project Office: R&D/UC
A.7. Funding Source: A.I.D./W
A.8. Tax I.D. No.: 59-0977035
A.9. CEC No.: N/A
A.10. LOC No.: 72-00-1455

### B. SPECIFIC

B.1.(a) PIO/T No.: 936-5053-3692945
B.1.(b) Appropriation: 72-1131021.1
B.1.(c) Allotment: 341-36-099-06-20-31
B.1.(d) BPC: DDVA-93-16900-EG11
B.1.(e) Amount: $96,787

ATTACHMENT 1

SCHEDULE

1A. PURPOSE OF GRANT

The purpose of this Grant is to provide financial support for the program described in Attachment 2 of this Grant entitled "Program Description."

1B. PERIOD OF GRANT

The effective date of this Grant is the date of the Cover Letter and the estimated completion date is September 30, 1995. Funds obligated hereunder (see Section 1C.2. below) shall be used to reimburse the Grantee for allowable program expenditures incurred by the Grantee in pursuit of program objectives during such period. Funds obligated hereunder are anticipated to be sufficient for completion by the Grantee of the program described in Attachment 2 of this Grant by the estimated completion date.

1C. AMOUNT OF GRANT AND PAYMENT

1C.1. The total estimated amount of this Grant for its full period, as set forth in Section 1B. above, is $96,787.

1C.2. A.I.D. hereby obligates the amount of $96,787 for the purposes of this Grant during the indicated period set forth in Section 1B. above, thereby fulfilling A.I.D.'s funding requirements. A.I.D. shall not be liable for reimbursing the Grantee for any costs in excess of the obligated amount, except as specified in paragraph (f) of the Standard Provision of this Grant entitled "Revision of Grant Budget."

1C.3. Payment shall be made to the Grantee in accordance with procedures set forth in the Standard Provision of this Grant entitled "Payment - Letter of Credit," as shown in Attachment 3.

1D. GRANT BUDGET

1D.1. The following is the Budget for the total estimated amount of this Grant (see Section 1C.1. above) for its full period (see Section 1B. above). The Grantee may not exceed the total estimated amount or the obligated amount of this Grant, whichever is less (see Sections 1C.1. and 1C.2., respectively, above). Except as specified in the Standard Provision of this Grant entitled "Revision of Grant Budget," as shown in Attachment 3, the Grantee may adjust line item amounts as may be reasonably necessary for the attainment of program objectives.

1D.2. Budget

| Cost Element | A.I.D. | Cost-Sharing Non-Federal | Total |
|---|---|---|---|
| Salaries | $49,664 | $14,832 | $64,496 |
| Fringe | $1,483 | $4,450 | $5,933 |
| Travel | $14,660 | $0 | $14,660 |
| Non-Exp. Equip. | $0 | $0 | $0 |
| ODC | $11,008 | $39,080 | $50,088 |
| Overhead | $19,972 | $0 | $19,972 |
| Total: | $96,787 | $58,362 | $155,149 |

1D.3. Inclusion of any cost in the budget of this Grant does not obviate the requirement for prior approval by the Grant Officer of cost items designated as requiring prior approval by the applicable cost principles (see the Standard Provision of this Grant set forth in Attachment 3 entitled "Allowable Costs") and other terms and conditions of this Grant, unless specifically stated in Section 11. below.

1E. REPORTING

1E.1. Financial Reporting

1E.1.(a) Financial reporting requirements shall be in accordance with the Standard Provision of this Grant entitled "Payment - Letter of Credit," as shown in Attachment 3. If a Standard Form 269 is required by the aforesaid Standard Provision, the "Long Form" of said form shall be used.

1E.1.(b) All financial reports shall be submitted to A.I.D., Office of Financial Management, FA/FM/CMPD/DCB, Room 700 SA-2, Washington, D.C. 20523-0209. In addition, three copies of all financial reports shall be submitted to the A.I.D. Project Office specified in the Cover Letter of this Grant, concurrently with submission of the Quarterly Technical Reports (See Section 1E.2. below).

1E.1.(c) The frequency of financial reporting and the due dates of reports shall be as specified in the Standard Provision of this Grant referred to in Section 1E.1.(a) above.

1E.2. Program Reporting

1E.2.(a) Annual Workplan

1E.2.(a)(1) The Grantee shall submit an annual workplan for this Grant which shall contain the following:

1E.2.(a)(1)(A) An action-oriented workplan describing planned activities for the next year, delineated by calendar quarter, and linked to the project goals and objectives, which describes the individuals to be involved, the activities to be

conducted, and where and when they will be conducted. Planned activities shall be grouped by subject category, and then related to project objectives;

1E.2.(a)(1)(B) A projected budget, utilizing the same budget line items as are set forth in the budget of this Grant, for each calendar quarter, corresponding to the workplan; and

1E.2.(a)(1)(C) Publications, reports, workshops, seminars, and other information dissemination activities planned, by calendar quarter.

1E.2.(a)(2) The Grantee may develop the annual workplan in consultation with the A.I.D. Project Officer for this Grant.

1E.2.(a)(3) Five (5) copies of the annual workplan shall be submitted to the designated A.I.D. Project Officer for this Grant and one copy submitted to the Grant Officer. The annual workplan shall be submitted by the Grantee not later than sixty (60) days from the effective date of this Grant (see Section 1B. above).

1E.2.(b) Quarterly Reports

The Grantee shall submit five (5) copies of brief quarterly program performance reports, which coincide with the financial reporting periods described in Section 1E.1. above, to the A.I.D. Project Office specified in the Cover Letter of this Grant. In addition, two copies shall be submitted to A.I.D., POL/CDIE/DI, Washington, DC 20523-1802. These reports shall be submitted within 30 days following the end of the reporting period, and shall briefly present the following information:

1E.2.(b)(1) A comparison of actual accomplishments with the goals established for the period, the findings of the investigator, or both. If the output of programs can be readily quantified, such quantitative data should be related to cost data for computation of unit costs.

1E.2.(b)(2) Reasons why established goals were not met, if applicable.

1E.2.(b)(3) Other pertinent information including the status of finances and expenditures and, when appropriate, analysis and explanation of cost overruns or high unit costs.

1E.2.(c) Special Reports

1E.2.(c)(1) Within 30 days following the completion of each international trip, the Grantee shall submit 3 copies of a trip report summarizing the accomplishments of the trip to the A.I.D. Project Officer specified in the cover letter of this

Grant. If several individuals are travelling together to one site, a single report representing the group will suffice. The report shall include the purpose of the trip, technical observations, suggestions and recommendations, overall impressions of the site situation (if appropriate), and a list of persons visited with their title and organization affiliation.

1E.2.(c)(2) Between the required program performance reporting dates, events may occur that have significant impact upon the program. In such instances, the Grantee shall inform the A.I.D. Project Officer as soon as the following types of conditions become known:

1E.2.(c)(2)(A) Problems, delays, or adverse conditions that will materially affect the ability to attain program objectives, prevent the meeting of time schedules and goals, or preclude the attainment of work units by established time periods. This disclosure shall be accompanied by a statement of the action taken, or contemplated, and any A.I.D. assistance needed to resolve the situation.

1E.2.(c)(2)(B) Favorable developments or events that enable time schedules to be met sooner than anticipated or more work units to be produced than originally projected.

1E.2.(c)(3) If any performance review conducted by the Grantee discloses the need for change in the budget estimates in accordance with the criteria established in the Standard Provision of this Grant entitled "Revision of Grant Budget," the Grantee shall submit a request for budget revision to the Grant Officer and the A.I.D. Project Officer specified in the Cover Letter of this Grant.

1E.2.(d) Environmental Impact

If it appears that the outputs of this project will result in an adverse environmental impact, the Grantee shall notify the A.I.D. Project Officer prior to implementation, in order to allow for orderly preparation of an environmental impact statement. The Grantee shall assure that appropriate U.S. Government and/or host country procedures are followed.

1E.2.(e) Care of Laboratory Animals

If the Standard Provision entitled "Care of Laboratory Animals" applies to this Grant, the Grantee shall include the certificate required by paragraph (c) of said Standard Provision in all of its reports which pertain to the use of laboratory animals.

1E.2.(f) Final Report

Within 90 days following the estimated completion date of this Grant (see Section 1B. above), the Grantee shall submit five (5) copies of a final report to the A.I.D. Project Office specified in the cover letter of this Grant. In addition, two copies shall be submitted to A.I.D., POL/CDIE/DI, Washington, DC 20523-1802. It will cover the entire period of the Grant and include all information shown in Sections 1E.2.(a) and 1E.2.(c) above.

1F. SPECIAL PROVISIONS

1F.1. OPTIONAL STANDARD PROVISIONS

The following Optional Standard Provisions for U.S., Nongovernmental Grantees, as listed in Attachment 3 of this Grant, are hereby deleted as follows:



All other Optional Standard Provisions are hereby incorporated into this Grant and have been checked off on page 9 of Attachment 3.

1F.2. Limitations on Reimbursement of Costs of Compensation for Personal Services and Professional Service Costs

1F.2.(a) Employee Salaries

Except as the Grant Officer may otherwise agree in writing, A.I.D. shall not be liable for reimbursing the Grantee for any costs allocable to the salary portion of direct compensation paid by the Grantee to its employees for personal services which exceed the highest salary level for a Foreign Service Officer, Class 1 (FS-1), as periodically amended.

1F.2.(b) Consultant Fees

Compensation for consultants retained by the Grantee hereunder shall not exceed, without specific approval of the rate by the Grant Officer: either the highest rate of annual compensation received by the consultant during any full year of the

immediately preceding three years; or the maximum rate of a Foreign Service Officer, Class 1 (FS-1) (as periodically amended), whichever is less. A daily rate is derived by dividing the annual compensation by 2,087 and multiplying the result by 8.

1F.3. Defense Base Act (DBA) and Medical Evacuation Insurance

Pursuant to Section J.16. of OMB Circular A-21 (for educational institutions) or Section 18 of Attachment B of OMB Circular A-122 (for nonprofit organizations other than educational institutions), the Grantee is authorized to purchase DBA and/or medical evacuation insurance under this Grant. If DBA insurance is purchased, it shall be purchased from the insurance company or agent with which A.I.D. has a contract to provide DBA insurance for A.I.D. contracts. The Grant Officer will provide the name, address, and telephone number of such insurance company or agent upon request.

1G. INDIRECT COST RATE

1G.1. Pursuant to the Standard Provisions of this Grant entitled "Negotiated Indirect Cost Rates - Predetermined" and "Negotiated Indirect Cost Rates - Provisional (Nonprofits)," a predetermined indirect cost rate or rates shall be established for each of the Grantee's accounting periods which apply to this Grant. Payments on account of allowable indirect costs shall be made on the basis of such predetermined rates. The rate(s) for the initial period and the base(s) to which it is (they are) applied is (are) as follows:

| Type | Rate | Base | Period | Applicable To |
|---|---|---|---|---|
| On-Campus | 42.0% | 1/ | 7/1/92-6/30/95 | Research |
| Off-Campus | 26.0% | 1/ | 7/1/92-6/30/95 | Research |
| On-Campus | 32.0% | 1/ | 7/1/92-6/30/95 | Rsch - Ag |
| Off-Campus | 26.0% | 1/ | 7/1/92-6/30/95 | Rsch - Ag |
| On-Campus | 42.5% | 1/ | 7/1/92-6/30/95 | Other Sponsored activities |

1/ Base of Application: Total direct costs excluding: capital expenditures; that portion of each subaward in excess of $25,000; hospitalization and other fees associated with patient care whether the services are obtained from an owned, related or third party hospital or other medical facility; rental/maintenance of off-site activities; student tuition remission and student support costs.

1.G.2 Pending establishment of predetermined indirect cost rates for the initial period (6/01/92 - 6/30/95), provisional payments on account of allowable indirect costs shall be made on the basis of the following negotiated provisional rate(s) applied to the base(s) which is (are) set forth below:

| Type | Rate | Applicability | Base |
|---|---|---|---|
| On-Campus/Home Office | 53.0% | Instruction | 1/ |

1/ Base of Application: see above

1G.3. Rates for subsequent periods shall be established in accordance with the Standard Provision of this Grant entitled "Negotiated Indirect Cost Rates - Predetermined."

1H. PROPERTY REQUIREMENTS

1H.1. Title to Property

Title to property acquired hereunder shall vest in the Grantee subject to the requirements of the Standard Provision of this grant entitled "Title To and Use of Property (Grantee Title)" regarding use, accountability, and disposition of such property.

1H.2. Equipment Purchases

Equipment purchases under this Grant must be made in accordance with the Standard Provisions entitled "Procurement of Goods and Services" and "AID Eligibility Rules for Goods and Services" included in Attachment 3 of this Grant. Inclusion of costs in the budget of this Grant for the purchase of nonexpendable equipment does not obviate the requirements of Section J.13. of OMB Circular A-21 (for educational institutions) or Section 13 of Attachment B of OMB Circular A-122 (for nonprofit organizations other than educational institutions) for prior approval of such purchases by the Grant Officer, nor any other terms and conditions of this Grant, unless specifically stated in Section 1H.2.(a)(3) below.

1H.2.(a) Requirement for Prior Approval

Pursuant to Sections 1D.3. and 1G.3. above and the Standard Provisions of this Grant entitled "Allowable Costs" and "Revision of Grant Budget," and by extension, Section 13 of Attachment B of OMB Circular A-122, the Grantee must obtain A.I.D. Grant Officer approval for purchases of the following:

1H.2.(a)(1) General Purpose Equipment, which is defined as an article of nonexpendable tangible personal property which is usable for other than research, medical, scientific or technical activities, whether or not special modifications are needed to make them suitable for a particular purpose (e.g., office equipment and furnishings, air conditioning equipment, reproduction and printing equipment, motor vehicles, and automatic data processing equipment), having a useful life of more than two years and an acquisition cost of $500 or more per unit); and

1H.2.(a)(2) Special Purpose Equipment, which is defined as an article of nonexpendable tangible personal property, which is used only for research, medical, scientific, or technical activities (e.g., microscopes, x-ray machines, surgical instruments, and spectrometers), and which has a useful life of more than two years and an acquisition cost of $1,000 or more per unit).

1H.2.(a)(3) Approvals

In furtherance of the foregoing, the Grant Officer does hereby provide approval for the following purchases, which shall not be construed as authorization to exceed the total estimated amount or the obligated amount of this Grant, whichever is less (see Section 1C. above):

N/A

1H.2.(a)(4) Exception for Automation Equipment

Any approval for the purchase of automation equipment which may be provided in Section 1H.2.(a)(3) above or subsequently provided by the Grant Officer is not valid if the total cost of purchases of automation equipment (e.g., computers, word processors, etc.), software, or related services made hereunder will exceed $100,000. The Grantee must, under such circumstances, obtain the approval of the Grant Officer for the total planned system of any automation equipment, software, or related services.

1I. RESOLUTION OF CONFLICTS

Conflicts between any of the Attachments of this Grant shall be resolved by applying the following descending order of precedence:

Attachment 1 - Schedule
Attachment 3 - Standard Provisions
Attachment 2 - Program Description

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**AGENCY FOR INTERNATIONAL DEVELOPMENT**
**RESEARCH GRANTS PROGRAM**
**FOR**
**HISTORICALLY BLACK COLLEGES AND UNIVERSITIES**

**Submitted by**

Florida A&M University
Tallahassee, FL 32307

# A BIOTIC INDEX FOR WATER QUALITY MONITORING IN CENTRAL AMERICA

Principal Investigator: R. Wills Flowers, Professor of Entomology

Date of Submission: Mar. 30, 1993


Dr. R. Wills Flowers
Agricultural Research Programs
Florida A&M University
Tallahassee, FL 32307 USA
904-561-2215; FAX 904-561-2221

Dr. Frederick S. Humphries
President

Director, Div of Sponsored Research




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5. Conduct workshops and other training activities to train Costa Rican biologists to identify aquatic insects, conduct field surveys, and use data to both continue the work of this proposal and conduct additional surveys in other areas of Costa Rica.

## NEED FOR THE PROPOSED RESEARCH

Costa Rica has become a world model of protection for natural ecosystems. Almost 27% of her land area receives some form of protection from seven Regional Conservation Areas (ACs). One area, the Area de Conservación Palo Verde includes the Palo Verde National Park and the Rafael Lucas Rodríguez Reserve in seasonally dry Guanacaste Province. These areas are in the delta of the Río Tempisque and they protect large tracts of wetlands that are important bird nesting areas. At the same time, the Río Tempisque and its tributaries are the source of water for a large agricultural development, the Arenal-Tempisque Irrigation Project (ATIP) which is being developed by the Costa Rican National Service for Ground Water Irrigation and Drainage (SENARA) and which will cover 66675 ha. by the year 2000. The land under development is fertile with relatively flat topography and with soils of Classes I, II, and III in the USDA classification of suitability for irrigation (unpublished report). To monitor this development for detrimental side effects, the Center for Investigation of Environmental Contamination (CICA) in the Department of Chemistry of the University of Costa Rica has set up a four-year monitoring program, called Viligencia Ambiental en la Zona de Influencia del Projecto de Riego Arenal-Tempisque (hereafter referred to as the Environmental Monitoring project), in and below the project basin.

The object of this proposal is to develop a sub-project on aquatic insects and other invertebrates within the Environmental Monitoring project now being conducted by CICA. CICA currently monitors only chemical parameters of the waters in the project area: this proposal is for a two-year program of research and teaching to add aquatic insect data to the water quality database of CICA and to conduct training so that CICA personnel and other interested Costa Rican biologists will have the knowledge and resources to continue aquatic insect and invertebrate studies beyond the length of this project.

The research proposed here is the application of widespread and highly successful water quality assessment procedures, now used in the United States and other industrialized nations, to aquatic ecosystems in a tropical country. Instead of directly testing water samples for various pollutants, levels of pollution tolerance for aquatic insects and other macroinvertebrates are established. This information is used to set up biotic indices and other water monitoring protocols wherein water quality is evaluated by looking at the structure of macroinvertebrate communities in the streams and rivers of interest. In the original intent of the United States' Clean Water Act, the biological integrity of waters was as important as their physical and chemical integrity. However, water chemistry has too often become a surrogate for measuring biological conditions of a stream (1). Using aquatic macroinvertebrate communities as water quality indicators provides direct evidence on whether or not chemicals in a stream or lake are having adverse environmental impact. Moreover, chemical monitoring gives information about water quality at the moment the

methods to assess water quality in southeastern streams. At the end of 1992, we became the Center for Water Quality, a Class IV Center in the State of Florida University System.

Florida A&M already has institutional linkages with Costa Rica. I have participated for two years in the FAMU-UCR Language, Culture, and Professional Development Program, funded by USAID. I am also involved as a "foreign volunteer" in the National Biodiversity Institute's biodiversity survey. Three other A&M faculty have also participated in the AID program. Outside of Costa Rica, colleagues are involved with projects in Haiti, Peru and Puerto Rico.

## COLLABORATIVE MECHANISM/ NETWORKS:

CICA has established 18 permanent monitoring stations in the rivers and canals of the Arenal-Tempisque project, located as follows:

a) In the Cabuyo, Tempisque and Piedras rivers, two stations in each above and below the irrigated areas; in the Blanco, Paso Ancho, and Corobicí rivers and at the Represa Magdalena, one station each.

b) Two stations in the Canal del Oeste.

c) Five stations within Palo Verde and Rafael Lucas Rodríguez areas.

d) One station in the Gulf of Nicoya at the mouth of the Río Tempisque. This is a marine station and will not be part of the proposed study.

Chemical monitoring at these stations will be done monthly for four years, beginning in the summer of 1991. Chemicals to be monitored include nitrogen, phosphorous, sodium, potassium, chlorides, suspended solids, conductivity, and pesticides. According to a survey conducted in the project area, the most important pesticides include two organophosphate and two pyrethroid insecticides, two rodenticides, two fungicides, and no less than 12 different herbicides.

Host country collaborators will be Dr. Alexis Rodriguez, Director of CICA; and Dr. Carlos de la Rosa, biologist with Oficina de Manejo Ambiental in Upala, who will be a consultant on aquatic Diptera for this project.

As the Costa Rican contribution in this proposal, physical facilities and laboratory space will be provided by the CICA offices in the University of Costa Rica in San José and by the Sede Regional de Guanacaste of the University of Costa Rica; and space in a building of SENARA will be available for on-site processing of samples. CICA will also furnish a vehicle to this project with the stipulation that fuel and maintenance will be paid for by this project. CICA is equipped with a modern chemical analytical laboratory and extensive library resources. Chemical and biological data relevant to this project will be freely interchanged between CICA and the University of Costa Rica, and Florida A&M University.

A second line of research has developed diversity indices which express both the number of species and their relative abundances at a locality. In theory, the higher the index number, the more pristine the habitat. The best known of these indices is the Shannon-Weaver index. This index has been widely used (and is required for water quality evaluations in Florida). Although some aquatic biologists now dislike indices and claim that even simple species lists (now called "species richness measures") are more reliable, the ability of an index to reduce the complexities of biological diversity into a single number makes them very attractive to decision-makers and they will continue to be used in some form. Some indices, such as the Margalef index (5) and alpha of the log series (6) appear to be free of some of the draw-backs of Shannon-Weaver and other related indices.

A third approach has been development of biotic indices. The term was first used by Chutter (7) for an index which measures numbers of organisms multiplied by a tolerance value for each species. This tolerance value reflects the species' tolerance of pollution. In 1977, Hilsenhoff (8) introduced a variety of Chutter's biotic index which was both simplified and tailored to water quality problems in Wisconsin. Tolerance values are arrived at through extensive field experience with aquatic ecosystems and detailed familiarity with the organisms involved. For some orders of aquatic insects, tolerance values have been compiled for many of the species occurring in the United States (9). The existing literature on biotic indices and diversity measures has recently been reviewed by Huggins and Moffett (10). Their findings suggested that the Hiisenhoff biotic index (8,11) is the most appropriate but that it must be adapted to local conditions. Recently, a family biotic index has been developed (12) for rapid preliminary assessments of water quality. Hilsenhoff's biotic index has steadily gained popularity, especially in the Midwest where it is being adapted for use in other states (10)

A frequent complaint about both biotic and diversity indices is that they require both large samples and identifications of organisms to the species level. This means long processing times by taxonomists before any sort of conclusion about a stream or lake's quality can be reached. The U.S. Environmental Protection Agency (USEPA)(13) has recently developed a rapid monitoring technique designed to cut down the number of specimens needed in biotic assays, thus cutting down on field and lab time needed for identifications. The rapid bioassessment approach has shown some promise, if an appropriate analysis is done on the "rapidly collected" data. Resh & Jackson (5) compared results of several types of measures (richness, diversity, enumerations, functional measures) on biological data taken over a number of years from some California streams where human-induced and natural variations have occurred and are well documented. In general, richness measures (numbers of taxa, of families, etc.), one diversity index (Margalef's), and Hilsenhoff's biotic index gave good results but other measures (enumerations, functionals, the Shannon diversity index) did poorly in that they did not reliably separate anthropogenic and natural variations, or reliably track known variability over time.

A common problem in all these approaches to measuring water quality is that values from one region are rarely transferable to another. The Hilsenhoff index, for example, works very well for assessing organic stream pollution (principally from dairy operations) in

groups can be efficiently sorted to morphospecies after only a short period of training. Aquatic Diptera are an exception due to the family Chironomidae (midges). This family is extremely abundant in a wide variety of aquatic habitats but the small larvae must be slide mounted for identification and identification itself is more difficult due to the specialized characters. For these reasons, this family is often excluded or simply lumped into one family-level taxon in aquatic studies. This is probably a serious mistake, especially in the tropics. In the upper Río Tempisquito, upstream from the study area, it is now know that there are over 260 species of Chironomidae (de la Rosa, unpublished). For this reason, Dr. Carlos de la Rosa will be hired as a consultant on this project to help train other project personnel in chironomid mounting and identification, and to assist with the identifications themselves. Dr. de la Rosa is a specialist in this family and is familiar with the local fauna through his work at Guanacaste National Park.

Invertebrate diversity will be quantified using the alpha and Margalef's indices mentioned above. Determination of significant chemical and physical factors affecting aquatic insect communities will be determined by multiple regression of diversity on physical and chemical parameters, and by multivariate analyses similar to those described in the Florida Department of Environmental Regulation studies on river basins in that state (16).

As the above analyses reveal how chemical and physical factors affect aquatic invertebrate communities, the individual invertebrate species will be assigned one of five tolerance values ranging from "tolerant" to "intolerant" with respect to these factors. (Some factors are not directly linked to human activities: an insect can be intolerant of slow currents and thus absent from naturally occurring ponds and slow moving streams -- as well as from artificial impoundments. A necessary part of this research will be separating natural from human-caused effects on stream biotas.) Once tolerance values have been assigned to each species, calculation of the biotic index for a site is straight-forward (11).

An obstacle to this project which will no doubt be apparent is the difficulty of setting tolerance values for all aquatic insects in the study area in the two years of this project. However, development of a biotic index is an on-going process which can be refined as new data come in. Initially, tolerance values can be based on genera and, if all species in a genus are relatively alike in their ecological requirements, generic values are adequate. As data accumulate, tolerance values can be revised, as has happened several times already with the Hilsenhoff index (10,16).

The proposed research will involve two-month visits by the PI to Costa Rica during the first year of the project, and two one-month visits the second year, following this timetable:

Visit 1, initial inspection of sampling sites, construction of Hester-Dendy samplers from local materials, placement of samplers in streams; first collection of samples after one month. During this visit a full-time Costa Rican assistant and two student assistants will be given training in collecting, sorting and identifying aquatic insects and macroinvertebrates so that samples can be collected and processed on a monthly basis.

conservation biology. Conservation Biol. 4:244-250.

2. Hurlbert, S.H. and A. Villalobos-Figueroa (eds.) 1982. Aquatic biota of Mexico, Central America and the West Indies. San Diego, 529 + xv pp.

3. Flowers, R.W. 1992. Review of the genera of mayflies (Ephemeroptera) of Panamá, with a checklist of Panamanian and Costa Rican species. p. 37-50. *In* D. Quintero & A. Aiello, eds. Insects of Panamá and Mesoamerica: selected studies. Oxford Univ. Press. Oxford. 692+xxii pp.

4. -----. 1991. Diversity of stream-living insects in northwestern Panamá. J. N. Am. Benthol. Soc. 10:322-334.

5. Resh, V.H. & J.K. Jackson. 1993. Rapid assessment approaches to biomonitoring using benthic macroinvertebrates. p. 195-233. *In* V. H. Resh & J.K. Jackson, eds. Freshwater biomonitoring and benthic macroinvertebrates. Chapman & Hall, London. 488+ix pp.

6. Wolda, H. 1981. Similarity indices, sample size and diversity. Oecologia 50:296-302.

7. Chutter, F.M. 1972. An empirical biotic index of the quality of water in South African streams and rivers. Water Res. 6:19-30.

8. Hilsenhoff, W.L. 1977. Use of arthropods to evaluate water quality in streams. Tech. Bull. Wisconsin Dept. Nat. Resour. 100. 15pp.

9. Hubbard, M.D. and W.L. Peters. 1978. Environmental requirements and pollution tolerance of Ephemeroptera. EPA Environmental Monitoring Series. 461 pp.

10. Huggins, D.G. and M.F. Moffett. 1988. Proposed biotic and habitat indices for use in Kansas streams. Report No. 53. Kansas Biol. Surv. 128 pp.

11. Hilsenhoff, W.L. 1982. Using biotic index to evaluate water quality in streams. Tech. Bull. Wisconsin Dept. Nat. Resour. 132. 22pp.

12. -----. 1988. Rapid field assessment of organic pollution with a family level biotic index. J. N. Am. Benthol. Soc. 7:65-68.

13. Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross and R.M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers. Benthic macroinvertebrates and Fish. U.S. Environmental Protection Agency. Assessment and Watershed Protection Div. Washington, D.C.

14. Wolda, H.. and R.W. Flowers. 1985. Seasonality and diversity of mayfly dults (Ephemeroptera) in a "nonseasonal" tropical environment. Biotropica. 17:330-335.

**BUDGET**

| | Yr 1 | Yr 2 | Total |
|---|---|---|---|
| **Salaries & Honoraria** | | | |
| PI (5% release time) | $2,250.00 | $2,250.00 | $4,500.00 |
| Fringe Benefits (30%) | $675.00 | $675.00 | $1,350.00 |
| Costa Rican Asst. (Full Time) (includes 48% fringe benefits) | $16,000.00 | $16,000.00 | $32,000.00 |
| 2 Student Assistants (half-time in Costa Rica) | $3,360.00 | $3,360.00 | $6,720.00 |
| Consultant Honorarium | $3,000.00 | $3,000.00 | $6,000.00 |
| **Total Salaries** | | | **$50,570.00** |
| **Travel** | | | |
| Air Fare for PI | $1,000.00 | $1,000.00 | $2,000.00 |
| Per Diem for PI | $2,333.33 | $2,333.33 | $4,666.66 |
| Air Fare for Costa Rican personnel | | $1,500.00 | $1,500.00 |
| Per Diem for Costa Rican personnel | | $2,100.00 | $2,100.00 |
| **Total Travel** | | | **$10,266.66** |
| **Other Direct Costs** | | | |
| Vehicle (fuel & maintenance); | $1,250.00 | $1,250.00 | **$2,500.00** |
| Supplies and Equipment | | | |
| Literature | $326.95 | | |
| Honda Generator | $700.00 | | |
| Microscope Slides | $140.12 | | |
| Hach Field Test Kit | $700.00 | | |
| Sieve Set | $66.00 | | |
| Net | $189.00 | | |
| Sorting Tray, Forceps, Mounting Media | $500.00 | | |
| Alcohol | $200.00 | | |
| Dissecting Forceps | $175.00 | | |
| Waders, Hip boots (5) | $400.00 | | |
| Coleman Coolers (3) | $240.00 | | |
| Glass Vials (36 gross) | $1,080.00 | | |
| Stoppers | $2,000.00 | | |
| Mercury Vapor light (2) | $175.00 | | |
| Hester-Dendy blocks | $1,296.00 | | |
| **Total Supplies & Equipment** | | | **$8,188.00** |
| Publication Costs | | $1,000.00 | **$1,000.00** |

$168/day

# CURRICULUM VITA

NAME: Ralph Wills Flowers

ADDRESS: Agricultural Research Programs
Entomology and Structural Pest Control
Florida A&M University
Tallahassee, FL 32307
Tel: (904) 599-3972
561-2215
Fax: (904) 561-2221

EDUCATION:

1966-1970. Cornell University. B.S. in Entomology

1970-1972. North Carolina State University. M.S. in Entomology; Minor in Zoology

1972-1975. University of Wisconsin.Ph.D. in Entomology; Minor in Zoology

EXPERIENCE:

1988- Professor, Agricultural Research Programs, Florida A&M University, Tallahassee, Florida. Duties: research involving plant-insect interactions.

1979-1988. Associate Professor, Entomology and Structural Pest Control, Florida A&M University. Duties: Curation of mayfly collection; courses in General Entomology, Tropical Insect Ecology;individual research.

1975-1979. Assistant Professor, Entomology and Structural Pest Control, Florida A&M University.

1974-1975. Project Assistant, University of Wisconsin Supervisor: Dr. William L. Hilsenhoff, Professor of Entomology, University of Wisconsin. Study of the effects of antimycin on freshwater mussels.

1972-1974. Research Assistant, University Wisconsin. Supervisor: Dr. William L. Hilsenhoff, Professor of Entomology, University of Wisconsin. Doctorate Research: taxonomic and ecological studies of the Heptageniidae (Ephemeroptera) of Wisconsin.

1970-1972. Research Assistant, North Carolina State University. Supervisor: Dr. Robert T. Yamamoto, Associate Professor of Entomology. Master's Research: feeding behavior of the tobacco hornworm.

1969-1970. Honors Research, Cornell University. Supervisor: Dr. John G. Franclemont, Professor of

Member: Phi Kappa Phi, Sigma Xi, Gamma Sigma Delta.

PROFESSIONAL SOCIETIES:

Entomological Society of America
Florida Entomological Society
North American Benthological Society
Lepidopterists' Society
Coleopterists' Society
Association for Tropical Biology
American Orchid Society
Great Lakes Entomological Society

RESEARCH INTERESTS: Systematics and biogeography of Ephemeroptera, esp. systematics and ecology of the Hermanella complex of the Leptophlebiidae; ecology of Central American Ephemeroptera. Taxonomy and ecology of the Chrysomelidae (Coleoptera), esp. the Eumolpinae.

PROFESSIONAL TRAVEL:

1972- *Trinidad, Tobago, Guadeloupe*. Collected frogs for USNM and Univ. of Maryland personnel, and aquatic insects.
1973- *Costa Rica*. Visited O.T.S. facilities and collected insects.
1975- *Jamaica*. Collected aquatic insects in the Blue Mountains
1977- *Panama*, Chiriqui Province. Collected aquatic insects and reared mayflies.
1979- *Canada*, Winnipeg. Gave paper at 3rd International Conference on Ephemeroptera.
1982- *Panama*, Colon Province. Collected aquatic insects.
1983- Aurora, N.Y. Gave seminars on mayfly biogeography and insect-plant interactions at Wells College.
1984- *Mexico*,Merida, Gave paper at Symposium on the Biogeography of Meso-America.
1985- *Panama*, Bocas del Toro Province. Collected aquatic insects and reared mayflies.
Aurora, N.Y. Gave seminars on biogeography, systematic ecology and insect-plant interactions at Wells College.
1986- Houston, Texas. Presented paper at Prairie View A&M University's Image Dynamics '95 Symposium.
1989- *Costa Rica*. Participated in USAID sponsored Language, Culture and Professional Development program. Studied Spanish at University of Costa Rica and worked on Chrysomelidae at the University, the Museo Nacional and at Guanacaste National Park.
*Brazil*, Rondonia. Studied Chrysomelidae and their hostplants at a ranch in the Polonoreste development region.

**PUBLICATIONS**

R. Wills Flowers

1971. The forgotten bonanza. Of Sea and Shore. 2:41-43.

1972. Shelling in southern freshwaters. Of Sea and Shore. 3:117-118,126.

1975. Notes on the current status of Wisconsin Unionidae. Sterkiana. 57:40-42.

____ Heptageniidae (Ephemeroptera) of Wisconsin. The Great Lakes Entomologist. 8:201-218. (with W.L. Hilsenhoff as junior author).

1976. The occurrence of three species of aquatic Coleoptera on Grand Cayman Island. The Coleopterists Bulletin. 30:56. (with W.L. Klenke as junior author).

1978. Occurrence of *Cloeon cognatum* Stephens in the United States (Ephemeroptera,Baetidae). Entomological News. 89: 79-80.

____ Life cycles and habitats of Wisconsin Heptageniidae (Ephemeroptera). Hydrobiologia. 60:159-172.

1979. A new species of *Baetis* from Panama (Ephemeroptera: Baetidae). Pan-Pacific Entomologist. 55:187-191.

1980. *Atopophlebia fortunensis*, a new genus and species from Panama (Ephemeroptera:Leptophlebiidae). Florida Entomologist. 63:162-165.

____ A review of the Nearctic Heptagenia (Heptageniidae, Ephemeroptera). in: Advances in Ephemeroptera Biology. J. F. Flannagan, ed. Plenum. pp. 93-102.

____ Two new genera of Nearctic Heptageniidae (Ephemeroptera). Florida Entomologist. 63:296-307.

1981. Orchids of Fortuna, Panama. Bulletin of the American Orchid Society. 50:920-924.

____ On growth mania. The Bulletin of the Atomic Scientists. 37:63.

____ *Stenonema mexicana* (Heptageniidae: Ephemeroptera) in southern Central America. Entomological News. 92:152-154. (with W.L. Peters as junior author).

1982. A review of the genus *Macdunnoa* (Heptageniidae:

Islands. In Mayflies and Stoneflies: biology and life histories. I. Campbell, ed. Kluwer 125-133.

____ Intersexuality and homeotic manifestation of secondary Sexual characters in Baetodes (Ephemeroptera: Baetidae: Baetinae). In Mayflies and Stoneflies: biology and life histories; I. Campbell, ed. Kluwer 351-355. (with M.D. Hubbard as senior author).

____ New records of Chrysomelidae (Coleoptera) from Florida. The Coleopterists Bulletin 44:65.

1991. Preliminary cladistics of the *Hermanella* complex (Ephemeroptera: Leptophlebiidae, Atalophlebiinae. *in* J. Alba-Tercedor & A. Sanchez-Ortega (eds.), Overview and Strategies of Ephemeroptera and Plecoptera, Sandhill Crane Press, Gainesville, FL. (with E. Dominguez as junior author).

_____. Aggregations of Cassidinae (Chrysomelidae) in Santa Rosa and Guanacaste National Parks, Costa Rica. Biotropica, 23:308-310.

_____. Diversity of stream-living insects in northwestern Panamá. J.N. Am. Benthol. Soc. 10:322-334.

1992. Feeding on non-host plants by partially maxillectomized tobacco hornworms (Lepidoptera: Sphingidae). Florida Entomologist, 75:89-93. (with R.T. Yamamoto as junior author).

_____. The biogeography of Mesoamerican mayflies. *in* S.P. Darwin and A.L. Welden (eds.) Biogeography of Mesoamerica. Special Publ. of the Mesoamerican Ecol. Inst., Tulane Univ., New Orleans. (with W.P. McCafferty as senior author and R.D. Waltz).

_____. A review of the genera of mayflies of Panama, with a checklist of Panamanian and Costa Rican species. (Ephemeroptera). *in* D. Quintero and A. Aiello (eds.) Insects of Panama and Mesoamerica, Oxford Univ. Press, Oxford.

_____. New genus of Leptophlebiidae (Ephemeroptera) from Central and South America. Ann. Entomol. Soc. Amer. 85:655-661. (with E. Dominguez).

(in press). Yearly fluctuations in the mayflly community of a tropical stream draining lowland pasture in Costa Rica. *in* Proceedings of the VIIth International Conference on Ephemeroptera. (with C.M. Pringle).

UNIVERSIDAD DE COSTA RICA
Costa Rica – América Central
TELEX: UNICORI 2544

October 15, 1991

Professor
Frederick Humphries
President
Florida A & M University

Dear Prof. Humphries:

Dr. Flowers in your Institution, have proposed a cooperative research project to us. Such project would complete the one currently underway on surveillance of river waters, which is being carried out at our Center for Research on Environmental Pollution.

I have learnt Flowers' proposal titled "A Biotic Index for Water Quality Monitoring in Central America", and we are enthusiastic about this joint endevour.

Please, take this letter as our will to carry out the project, based on the terms agreed.

Nevertheless I must inform you that all projects must be submitted to the Center's Scientific Council which in turn send it to the Vice-Presidency for Research for it's final approval.

I think it won't have any problem for approval but we must wait for their final decision.

Yours,

M.Sc. Alexis Rodriguez
Director
Center for Research on
Environmental Pollution

ARU:ksq