



### NEW GENERATION OF NITRO VASODILATORS - SYNTHESSES, CHARACTERIZATION, NITIC OXIDE RELEASE AND BIOEFFICACY

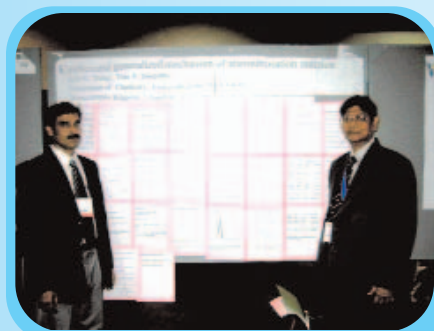
**Principal Researcher:**  
**Professor Tara Dasgupta**

**Research Fellow:**  
Dr. Sujit Dutta

It has been firmly established during the last decade that s-nitrosothiols (RSNOs) play a vital role in a variety of human physiological processes and also in heart disease, hypertension and cognitive processes. Hence, nitrosothiols have been used as therapeutic drugs for the treatment of diseases like hypertension, cardiovascular disorders, atherosclerosis and penile erectile dysfunction. It is now generally agreed that the formation of reactive RSNOs in the body occurs by the transfer of the nitrosyl moiety from one thiol to another residue in protein and enzyme. The process is known as 'Transnitrosation'. Work was carried out under this research project on the preparation of large varieties of S-nitrosothiols. There was also an in-depth study of transnitrosation processes involving these nitrovasodilators in order to understand the intricate mechanism by which NO are carried rapidly to the active site in the body.

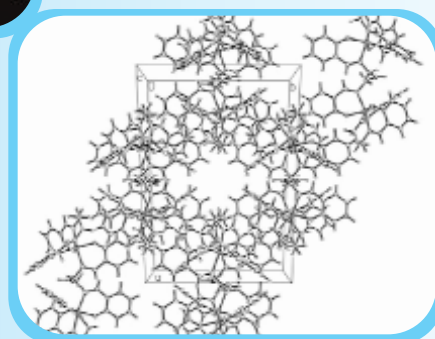
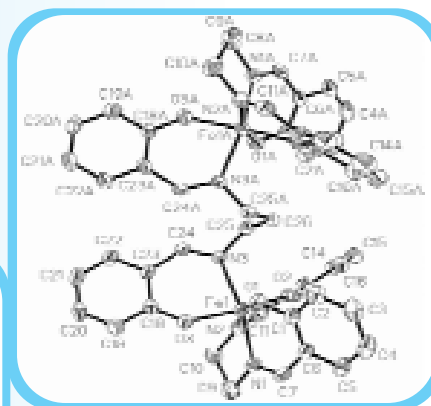
Another component of the study was the preparation of nitrosothiols which contain sugar unit in order to enhance the water solubility and cell penetration properties. Some precursor complexes of sugar containing NO donor compounds had been synthesized. In addition, the Rapid kinetic technique was used in the study of the mechanism of uptake of NO by cytochrome C. This reaction has important implications for the inhibition of mitochondrial oxygen consumption by NO. As part of the project's activities, the complex cytochrome C-NO was identified and its reactions with vitamin C were investigated.

There was also the investigation kinetically of the NO- scavenging power of [Ru(edta)OH<sub>2</sub>]- by reacting the complex ion with NO and various nitrosothiols. The detail mechanism of NO transfer has been proposed. One of the project's achievements was the synthesis of a new iron compound which has void spaces as confirmed by X-ray diffraction study. Work will commence shortly on trapping the NO in these void spaces, so that the release of NO could be controlled easily. ■



Presentation on the research project by Dr. Sujit Dutta (left) and Professor Tara Dasgupta.

A drawing of the molecular structure of iron complex, [Fe<sub>2</sub>(C<sub>17</sub>H<sub>16</sub>N<sub>2</sub>O<sub>2</sub>)<sub>3</sub>].



Crystal packing diagram of iron complex showing wide spaces.



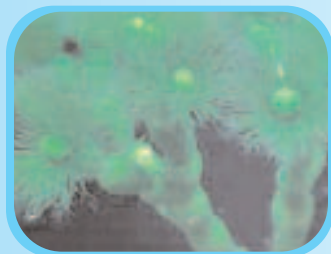
### THE INVESTIGATION OF MARINE ORGANISMS IN JAMAICAN WATERS FOR BIOACTIVE METABOLITES

**Principal Researcher:**  
**Dr. Winklet Gallimore**  
Department of Chemistry

**Research Assistants:**  
Miss Jenise Smith  
Miss Tavia Riggon  
Larjai Francis

The Caribbean Sea boasts a rich diversity of marine organisms which are sources of novel compounds with applicability as constituents of agrochemicals, pharmaceuticals, health food additives and cosmetics. Global research in marine natural products chemistry continues to be a pivotal source from which compounds with potential therapeutic applications may be obtained. In fact, a significant percentage of the natural products compounds currently in Anticancer Phases I, II and III clinical trials are actually of marine origin. Compounds from marine sources have been found to exhibit greater structural diversity than their phytochemical counterparts hence the reason for the hope that future drug candidates will be found in the waters of the world.

Work on locally-sourced species encompasses the investigation of sessile, soft-bodied marine invertebrates which are thought to utilize chemical defence as a means of protection against predators. The aims of this research project are therefore to discover compounds with novel architectural frameworks and to identify compounds for which new bioactive applications may be found. Commercial applications are expected to be found for the algal and sponge species under investigation and, with the development of relevant mariculture techniques, large-scale production of the species can be facilitated thereby safeguarding Mother Nature's fragile reserves.



Cymopolia barbata

To date, several sponge species including the black-brown sponge *Chondrilla nucula* have been collected from Port Royal and Montego Bay, many of which have been extracted and preliminary fractionation performed on small portions of the extracts. Sample collections of a variety of algal species have been made in Port Royal, Montego Bay, Great Goat Island and Salt Island (off the coast of St. Catherine and Clarendon respectively), Discovery Bay, Pear Tree River and Ocho Rios. *Terpios zeteki*, a common sponge found in the shallow waters of Port Royal, occurs in a variety of hues ranging from orange to orange-green to orange-blue. Samples of *Terpios zeteki* were collected and extracted to give a gum consisting of a mixture of compounds. Purification of the compounds is underway and, to date, a group of steroids have been identified.

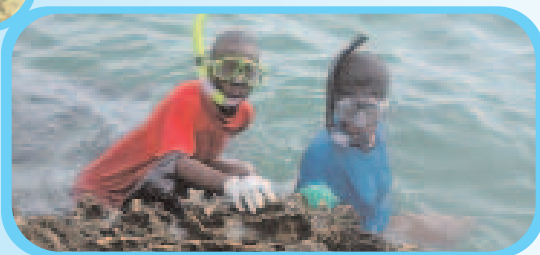


Caulerpa

Research has also continued with several algal species including *Avrainvillea rawsonii*, the extract of which has been found to contain steroidal compounds. Preliminary bioassays of crude sample extracts screened for insecticidal activity suggests that the algal species *Galaxaura rugosa* (collected on the Clarendon south coast) and *Udotea sp.* (collected off the Ocho Rios coast) are bioactive against the sweet potato weevil, *Cylas formicarius*. Research is also in progress on a commercially important edible *Enteromorpha sp.* which is used in the Pacific as a seasoning for soups and salads. ■



Udotea sp - marine organisms



Diving for samples



### ESTABLISHMENT OF A BUTTERFLY INDUSTRY IN JAMAICA

#### Principal Researchers:

**Dr. Eric Garraway**  
Department of Life Sciences  
and  
**Professor Ronald Young**  
Faculty of Pure & Applied  
Sciences

#### Research Fellow:

Dr. Audette J. A. Bailey

This research project seeks to investigate the ecology and development of selected butterfly species, the western population of endangered Giant Swallowtail Butterfly, *Papilio homerus*. It will entail the identification of attractive, robust, fast-developing species which are amenable to laboratory cultivation in large numbers. Another component of the project will be the establishment a lower-volume, controlled production system for these butterflies in order to support conservation efforts, enable the stocking of a local butterfly house, and also for sale on the international market. This will be carried out as a collaborative effort with other interested parties and should contribute to the establishment of a commercial butterfly industry in Jamaica.

Despite the passage of Hurricane Ivan in September 2004, many breeding colonies of several species were established. It was found that the employment of different types of rearing techniques for individual species led to the improvement of the survival rate of these species. Work was also carried out on the documentation of the mating behaviour, egg laying behaviour and feeding habits of butterflies and this was done primarily through the use of photography. Other project activities included the propagation of nectar sources and the identification of commercial suppliers for these products. In addition, fieldtrips to the Cockpit Country yielded further data on the biology and ecology of *Papilio homerus*.

As part of the project's efforts to increase its output, one large commercial farm is being constructed at Drax Hall, St. Ann and a smaller one has been planned for the outskirts of Bamboo, St. Ann. It is expected that the Drax Hall farm will produce butterflies for the stocking of a public display house and also for export. However, activities at the Bamboo Hall farm will be geared towards the rearing of a particular butterfly species for release at weddings.

The information produced from the project's butterfly research has been documented in various publications such as "Butterflies of Jamaica" (an illustrated field guide that is to be released by Macmillan, Caribbean in December 2005), "Butterflies and Flowers of Jamaica", and "Surviving the Odds, the Story of the Endangered Giant Swallowtail Butterfly". These publications are geared towards providing the general public with useful information about butterflies rather than informing the scientific community about the research.

Based on the results of the research, discussions were also held to investigate the possibility of establishing a butterfly facility at the University of the West Indies (UWI). Early indications suggest that this project could be carried out as a collaborative effort with the Mona Institute of Applied Sciences (MIAS) and the McGuire Centre at the University of Florida. ■



Agraulis Vanillae mating in captivity.



The endangered Pappilio homerus (Giant Swallowtail)



Aphrissa Satira pudding in moist mud.

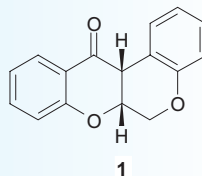


## SYNTHESIS OF AZAROTENONDS - NOVEL NITROGEN ANALOGUES OF INSECTICIDAL, ANTIVIRAL AND ANTICANCER AGENTS

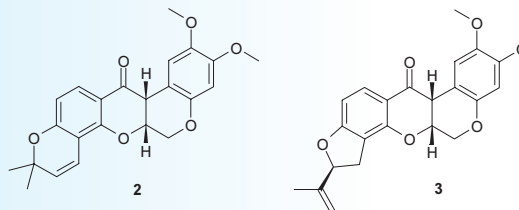
**Principal Researcher:**  
**Professor Yvette Jackson**  
Department of Chemistry

**Research Fellow:**  
Dr. Norman Townsend

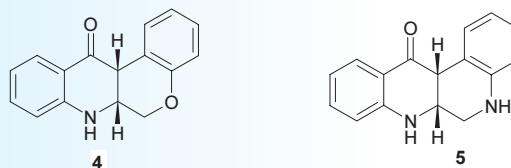
Rotenoids are naturally occurring compounds usually isolated from plant sources. They are identified by the characteristic cis-fused tetrahydrochromeno [3,4-b] chromene nucleus (1).



Rotenoids possess a wide range of pharmacological activity. Rotenone (2) has been used many years as a fish control agent. Deguelin (3) shows tremendous potential as an anti-tumor agent.



The objectives of this research project are therefore to synthesize azarotenoids (a new class of compounds which are closely related to the biologically active rotenoids), to assess the biological activity of these new compounds and to complete a structure-activity relationship study for the rotenoids and azarotenoids. Under the study, a number of synthetic pathways designed to produce the nitrogen analogue of rotenoids are being explored. These analogues would have the core nucleus 4 or 5 where one or both oxygen atoms are replaced by nitrogen atoms.



It is expected that these novel nitrogenous compounds should possess higher pharmacological activity than their oxygen containing analogues. Since no synthetic route to making 5,7-diazarotenoids has been established, it is expected that through the work of this project, new methods for making these compounds will be made available to the wider society. ■



# MOBILITY AND MIGRATION: EXPLORING TRANSNATIONALISM IN THE CONTEXT OF JAMAICA

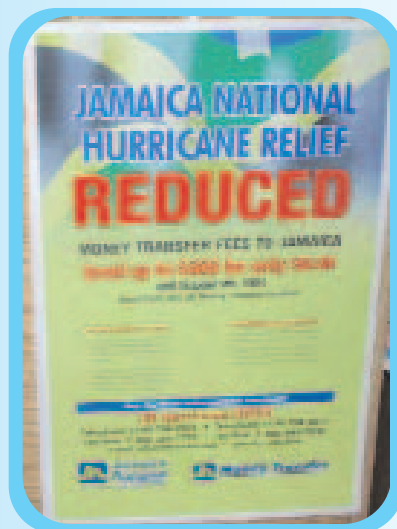


**Principal Researcher:**  
**Dr. Susan P. Mains**  
Department of Geography  
and Geology

This research project seeks to explore the experiences of Jamaican migrants and community organizations in the cities of London, New York, Toronto, and Miami and those who have returned to live in Jamaica after residing overseas. The study aims to understand and document the decisions, challenges, and strategies that migrants face when they move. This effort will culminate in the production of a book, website, and documentary film that records the diversity of these stories and places. Information emanating from the research will also be used to guide policy discussions about Diasporas in urban spaces, and migration to, and from, Jamaica.

There are three key components to the study. The first addresses the historical context of Jamaicans migrating to the United Kingdom (UK), United States (US) and Canada, examining host country residents' responses to, and representations of, Jamaican immigrants. The second component explores the experiences of Jamaican migrants in London, New York, Toronto, and Miami. For this part of the study, interviews have been conducted with a range of Jamaicans living in these cities in order to explore why people move, the challenges/opportunities they have experienced living overseas, how people create a sense of community while living off the island, and how people keep in touch with family, friends and events in Jamaica. Finally, the third aspect of the research examines the experiences of returning residents to Jamaica. It involves interviewing residents who have returned to Jamaica after living overseas for several years. Over 100 interviews - between New York, London, Toronto, Miami, and Kingston - have been filmed. Preliminary research findings and film segments have been presented and screened at international conferences in the US, UK, Brazil, Mexico, Germany and Finland, and have received very positive responses.

Supplementary funding provided by grants from the American Geographical Society's McColl Family Fellowship and the Association of American Geographers' Research Grants scheme, enabled the addition of Toronto as a case study (to be published in *Focus on Geography*). Further funding from a Global Partnerships Grant has facilitated the inclusion of Miami as an additional case study.



Fundraising in Toronto.



Grocery store shop in Toronto.



## MOBILITY AND MIGRATION: EXPLORING TRANSNATIONALISM IN THE CONTEXT OF JAMAICA

Often we lose the personal side of migration and the many vast and varied stories that people carry with them. For example, during fieldwork in Toronto, Hurricane Ivan passed through the Caribbean, and for many of the Jamaican Diaspora, this was a cause for significant concern. Based on an analysis of interviews with Jamaican/Canadian residents, it was found that there was a wide dissemination of the message that stressed the importance of maintaining ties with Jamaica. This occurred at two levels, firstly: through government and community organizations based in Toronto as well as radio and newspaper media oriented towards the Caribbean diaspora in the city, and secondly: through television and newspaper coverage aimed at national and international audiences. The creation of new activist networks could be seen as a significant source of support and assistance in the post-hurricane period, illustrating the diversity and strength of diaspora populations and community groups.

The findings have been published in the following Journals:

- Mains, S. 2004. "Monumentally Caribbean: Borders, Bodies, and Redemptive City Spaces," *Small Axe: A Caribbean Journal of Criticism*, (16): 179-198.
- Mains, S. 2004. "Cultural Geography in a New Millennium: Translation, Borders, and Resistance." *Journal of Cultural Geography*, Fall/Winter 22(1):151-153. ■



Diverse landscapes in Toronto.



Randy's patty shop in Toronto.



## SUSTAINABLE AIR POLLUTION MEASUREMENT AND MODELLING FOR KINGSTON AND ST. ANDREW CONURBATION

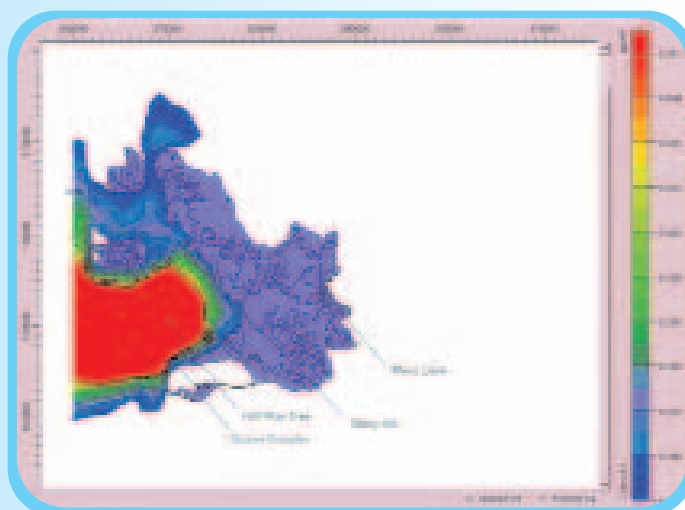
**Principal Researcher:**  
**Dr. Willard Pinnock**  
Department of Chemistry

**Research Fellow:**  
Mr. Mark Richards

The State of the Environment Reports published by the National Environmental Planning Agency (NEPA) in recent years have all pointed to "drastic increases" in the incidence of respiratory illnesses in Jamaica. These studies have identified the deterioration of the air quality, especially in urban areas, as one of the main factors responsible for this development. However, since it is a very costly and technically demanding task to monitor the pollutants which are likely to be responsible for increased incidence of these illnesses, not much data are available and claims of deteriorating air quality have remained in the realm of mere speculation.

Work has been carried out by the Department of Chemistry to develop inexpensive and easy-to-operate monitors for measuring those pollutants which are indicators of the state of pollution of the atmosphere in Kingston. Workable monitors have been developed and used to provide pollution data upon which proper assessments can be based. These monitors all use the passive collection technique and so require no electrical power to operate and are relatively maintenance-free in the field. This component of the project has been facilitated by a grant from the Environmental Foundation of Jamaica.

The project supported by the Research Fellowship Programme adds a modelling component to the study, employing the ISC-AERMOD computer model which was developed by the US Environmental Protection Agency. The model requires input data in the form of estimates of pollutant emission rates from the main sources, detailed meteorological data, and terrain use and elevation data for the modelled area. When these inputs are accurate, one can rely on the model to predict with reasonable accuracy the short term variation of most of the important primary pollutants.



Preliminary model predictions of SO<sub>2</sub> over Kingston from a hypothetical source complex on Marcus Garvey Drive.



## **SUSTAINABLE AIR POLLUTION MEASUREMENT AND MODELLING FOR KINGSTON AND ST. ANDREW CONURBATION**

Pollutants have been measured at several sites across the City and work is underway to analyze the data using the ISC-AERMOD computer model. Results suggest so far that transportation is the activity that provides the main source of pollution for the City's atmosphere. The findings also indicate that particulate pollution levels are highly variable with location around the City and very seasonally dependent. In addition, the measurements suggest that the secondary pollutant, ozone, may be closer to exceeding internationally accepted limits, than any other pollutant.

Some preliminary results were presented at the Jamaica Institute of Environmental Professional's Conference in June 2005 and this presentation will be published in the Conference Proceedings. Those results have also been utilized to develop a detailed and more effective monitoring programme. ■



Monitoring traffic dust in Liguanea





## FUNGAL TRANSFORMATION OF SCROPHULARIACEAE AND LABIATAE TERPENES TO BIOACTIVE ANALOGUES BY *MUCOR PLUMBEUS*



**Principal Researcher:**

**Professor Paul B. Reese**  
Department of Chemistry

**Research Fellow:**

Dr. Peter L. Ruddock

This completed research project sought to prepare a range of new pharmaceuticals and agrochemicals from readily available plant compounds, through the conversion of isolated natural plant products to novel compounds, by the fungus *Mucor plumbeus*. This fungus is well known for its ability to chemically transform compounds into new ones, and these novel analogues cannot normally be produced by conventional methods of laboratory synthesis.

Under the project the following terpenes (natural products) were isolated from freshly collected plant material and their identities confirmed:

- Stemodin, stemodinone and stemarin were separated from the extract of the shrub *Stemodia maritima*, a member of the Scrophulariaceae family. These natural products are known to possess antiviral and anti-cancer activity.
- Cadina-4,10(15)-dien-3-one, purified from the aromatic herb *Hyptis verticillata* (Labiatae family), is toxic to certain agriculturally important insects. Its isolation, chemical characterisation, and the determination of its agricultural importance were first performed in the laboratories of the Chemistry Department.

The above-mentioned terpenes were converted by the microorganism to a series of new products. Stemodin was chemically transformed into four products, three of which are new. Similarly stemodin and stemarin were converted by the fungus to one new compound each. The six compounds produced will be assayed so as to determine their activity against viruses and cancer cells. It is hoped that these transformed terpenes will increase the number of therapeutic agents available in the fight against diseases, and in particular, viral infections and cancer.



*Hyptis verticillata*

*Mucor plumbeus* was found to biotransform cadina-4,10(15)-dien-3-one to five new compounds. Since the parent compound is toxic to the sweet potato weevil and limits the reproductive capacity of the southern cattle tick, it is expected that the novel compounds will have similar or enhanced biological activity in this area. These compounds are all natural products and therefore should be more "environmentally friendly" than chlorinated pesticides which persist for long periods in the ecosystem. Their discovery should broaden the range of insecticides currently available on the market.

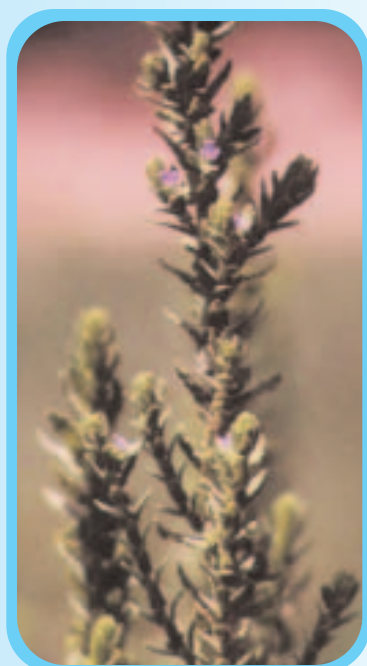


## FUNGAL TRANSFORMATION OF SCROPHULARIACEAE AND LABIATAE TERPENES TO BIOACTIVE ANALOGUES BY *MUCOR PLUMBEUS*

Apart from the proposed benefits to medicine and agriculture, the execution of the project has provided new information on the range of compounds that can be chemically modified by this fungus. The research has shown that the potential of our local natural products can be increased through biotransformation. It has also laid the foundation for subsequent studies by graduate students in chemistry in this new emerging area of Biocatalysis.

The research findings have been documented in conference presentations and in the following journal articles:

- Microbial transformation of cadina-4,10(15)-dien-3-one, aromadendr-1(10)-en-9-one and methyl ursolate by *Mucor plumbeus* ATCC 4740. D.O. Collins, P.L.D. Ruddock, J. Chiverton de Grasse, W.F. Reynolds and P.B. Reese, *Phytochemistry*, 2002, 59, 479-488.
- Stemodane and stemarane diterpenoid hydroxylation by *Mucor plumbeus* and *Whetzelinia sclerotiorum*. A.R.M. Chen, P.L.D. Ruddock, A.S. Lamm, W.F. Reynolds and P.B. Reese, *Phytochemistry*, 2005, 66, 1898. ■



*Stemodia maritima*



# THE GPS/GALILEO RESEARCH GROUP

**Principal Researcher:**  
**Dr. Joseph Skobla**  
Department of Physics

**Collaborators:**  
Mr. Leonardo Clarke  
Mr. Andrew Young  
Mr. Ryan Turner

The GPS Research Group was established in the Department of Physics in 1999. The group's main activities include developing a tracking and navigation system for Jamaica using the Global Positioning System (GPS) and Galileo System. The group also offers consultation and cooperation in the field of GPS/Galileo, GSM, RF and low orbit systems, specifically:

- GPS Time Dissemination
- GPS/Galileo Data Acquisition Systems
- Wireless Remote Sensing & Transmission of Data using (RF Systems, GSM Systems - SMS and/or GPRS Data Service, and Low Orbit Satellite Systems)
- Development of Microelectronics (Intelligent Instrumentation and Microcontroller Application)
- Management of R&D projects, starting from circuit design, to the implementation of prototypes and Printed Circuits Boards (PCBs).
- Industrial Measurements, System Integration and Automation

The projects been undertaken by the group include:

- The design and development of an efficient Micro-Tracking System for Jamaica, utilising the GPS system and the SMS service of the Digicel GSM network. This project led to the development of a SMS micro-tracking hardware/software module shown in Figure 1.
- The development of a cost effective *Cellular Based GPS Error Correction System*, for designing and implementing a complete navigation and tracking system. The project is divided into three parts as described in Figure 2.



Figure 1 - SMS Micro-Tracker Module



Figure 3 - GPRS Processing & Communication Module

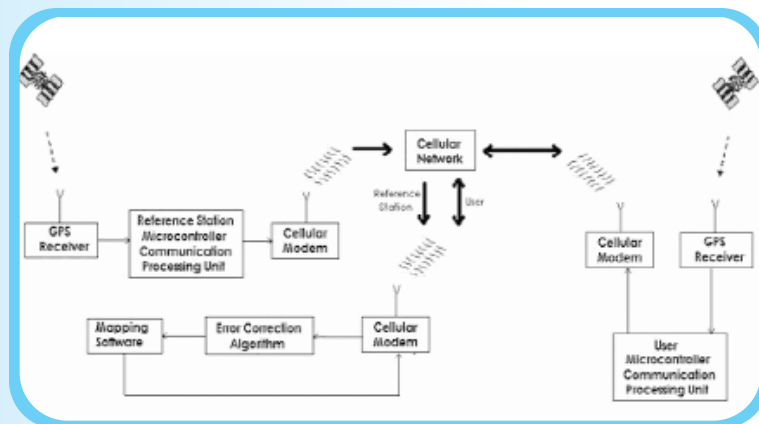


Figure 2 - Cellular Based GPS Error Correction System

Firstly, the cost effective system with an error correction method was designed, using the GPRS Communication and Processing Module which was developed to achieve this objective (Figure 3). This module is based on the original Micro-Tracking module but uses GPRS data transfer for data communication.



## THE GPS/GALILEO RESEARCH GROUP



Figure 4 - Illustration of Map Correction

Secondly, map correction exercises were undertaken, as the available maps of Jamaica are not very accurate. It has been observed from driving on Jamaican roads and plotting results on a map using position collected by a GPS receiver that you are often times off-course or off the road as illustrated in Figure 4, because of errors in the maps.

The final part involves position correction as they relate to the GPS system, including the development of error correction algorithms with mapping software. There are several methods which can be used to develop these algorithms, and they will be examined in the projects that are presently being initiated. The error correction algorithms are being investigated taking the following into consideration: Kalman Filtering, Inertial Navigation Systems and the emerging Galileo system. Special consideration of the Jamaican terrain and maps are also being taken into account.

The following are some of the papers that have emanated from this research project:

1. Skobla J., Turner R., Clarke L., Scarlett C., "Contribution To Error Correction For A GPS Tracking System," Proceedings The 2nd International Symposium On Measurement, Analysis and Modeling Of Human Functions, The 1st Mediterranean Conference On Measurement, Genova, Italy, June 14-16, 2004.
2. Clarke L.A., Skobla J., "A Microcontroller Cellular Based Communication Network for a GPS Error Correction System," Proceedings 2004 IEEE Aerospace Conference, Big Sky, Montana, March 6-13, 2004.
3. Turner R., Skobla J., "A Mapping Solution for GPS/GIS in Kingston, Jamaica," Proceedings 2004 IEEE Aerospace Conference, Big Sky, Montana, March 6-13, 2004.
4. McFarlane G., Skobla J., "GPS Based Marine Communicator," Proceedings 2004 IEEE Aerospace Conference, Big Sky, Montana, March 6-13, 2004.
5. Skobla J., Clarke L.A., Scarlett C.D., Turner R., Skobla J., "Cellular Based GPS Error Correction System", Proceedings XVII IMEKO World Congress on Metrology in the 3rd Millennium, Dubrovnik, Croatia, June 2003, pp 83-86.
6. McFarlane G., Skobla J., "GPS Based Marine Vessel Tracking Device," Proceedings 2003 IEEE Aerospace Conference, Big Sky, Montana, March 8-15, 2003.
7. Young A., Skobla J., "Robust GPS - SMS Communication Channel for the AVL System," Proceedings 2003 IEEE Aerospace Conference, Big Sky, Montana, March 8-15, 2003.
8. Young A., Skobla J., "SMS TCP/IP Interface," Proceedings 2003 IEEE Aerospace Conference, Big Sky, Montana, March 8-15, 2003. ■



## GENERATING SEASONAL (THREE MONTHLY) RAINFALL FORECASTS FOR THE CARIBBEAN



**Principal Researcher:**  
**Dr. Michael A. Taylor**  
Department of Physics

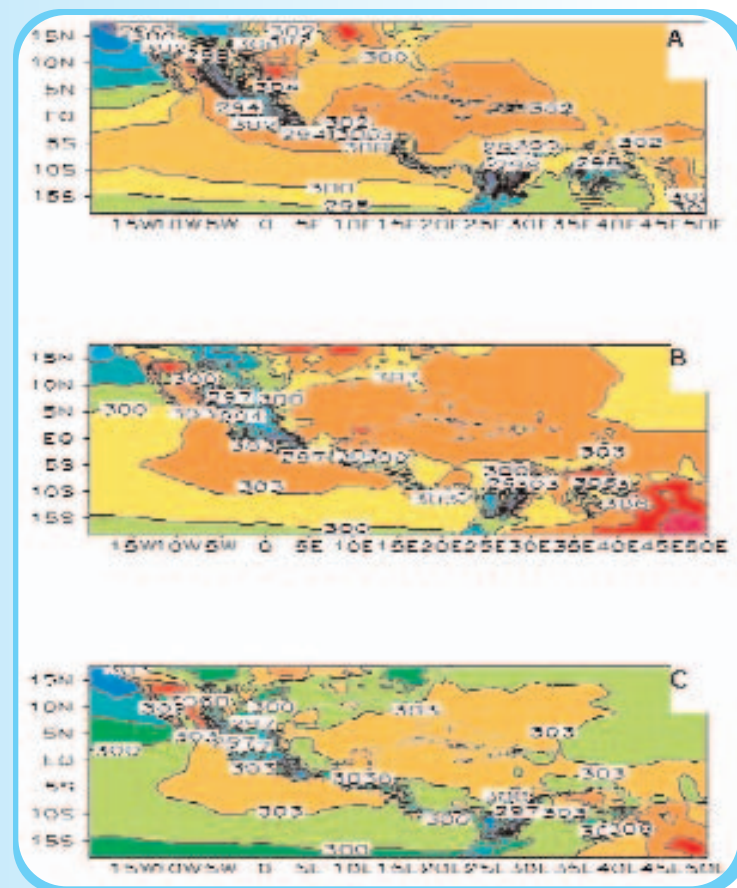
**Research Fellow:**  
Dr. Tannecia Stephenson

This research project seeks to build capacity within the Climate Studies Group, Mona (CSGM) to enable the production of seasonal rainfall forecasts for the Caribbean. Work on this project involves four components:

- i. the completion of a Synoptic Analysis of the Caribbean region to determine the primary forcing mechanisms for the rainfall seasons;
- ii. the development of statistical models for the Caribbean rainy seasons;
- iii the installation of a regional Scale Dynamical Model; and,
- iv. the issuing of a forecast for the wet seasons .

It is expected that the results of this research project will enable decision makers responsible for climate-dependent or climate related sectors in the Caribbean region to mitigate or take advantage of the effects of enhanced or depressed rainfall seasons.

To date work has been completed on the synoptic analysis of the Caribbean rainy season, which runs from May to November. The results have revealed that the north Atlantic subtropical high (NAH), tropical Atlantic sea surface temperatures (SST), and the tropical low pressure zone are the primary forcing mechanisms for both the early season (May - July) and late season (August to November) rainfall. Variations in the motion, timing, and extent of these features have been shown to be drivers of the Caribbean rainfall season.



Caribbean surface temperatures for November:  
(a) Mean (1961-1990 baseline)  
(b) projection for 2071 using IPCC A2 and  
(c) B2 climate change scenarios. Maps generated from PRECIS regional model.



## GENERATING SEASONAL (THREE MONTHLY) RAINFALL FORECASTS FOR THE CARIBBEAN

These factors are responsible for modulating its onset, demise, and severity. The southwest Caribbean has also been identified as a useful proxy for the entire region.

Based on the results obtained, initial statistical models of early and late season rainfall have been developed for a representative Caribbean precipitation index. Four variables are confirmed as predictors for the early season rainfall activity: the Caribbean Sea surface temperature anomalies, tropical North Atlantic sea level pressure anomalies, vertical shear anomalies in the equatorial Atlantic, and the size of the Atlantic portion of the Western Hemisphere Warm Pool. Only the first two variables have been retained in the late season model, while equatorial Pacific sea surface temperature anomalies become significant in both seasons on the interannual time-scale. An initial attempt was made to predict the early and late season rainfall of 2005, and work is currently underway on the validation of these predictions. The results however also indicate spatial variation in the importance of the seasonal predictors. Consequently, an attempt is being made to refine the prediction scheme by dividing the Caribbean into rainfall zones and developing models for each zone. Also, the predictability of the dry season is being explored, with the aim of developing similar predictive models for this period.

Additionally, the ETA and PRECIS regional models have recently been installed. Both models are being used to explore climate variability and climate change respectively and will complement the statistical models (see figure).

Research findings to date have been published in the journal article by Ashby, S. A., M. A. Taylor and A. A. Chen in 2005 on "Statistical models for predicting rainfall in the Caribbean". *Theoretical and Applied Climatology*, 82, 65-80. DOI 10.1007/s00704-004-0118-8. ■



## THE ROLE OF ENVIRONMENTAL MANAGEMENT IN CARIBBEAN ECONOMIC PERFORMANCE



**Principal Researcher:**  
**Professor Elizabeth Thomas-Hope**

Department of of Geography & Geology

**Research Fellow:**  
Mrs. Adonna Jardine-Comrie

The focus of the research over the past year has been on the management of natural resources used in the tourism industry, taking as case studies, Jamaica, Barbados and the Bahamas. This aspect of the overall research project sought to establish the extent to which the present use of resources for economic growth contributes to the replenishment of comparable reserves for the sustainable development of the respective countries.

Tourism has become one of the most important economic sectors for many countries in the Caribbean, as it is for other small island developing states (SIDS). The relative success of the industry has led a number of islands to invest heavily in the sector. The income from tourism services comprises over fifty percent of the total exports in some independent Caribbean island states, namely Antigua and Barbuda, the Bahamas, Barbados, St Kitts and Nevis and St. Lucia over the period 1985 to 2000, and for many other states it accounts for over twenty-five percent. Those Caribbean countries that have experienced the highest increases in GDP since the 1990s, namely the Bahamas, Antigua and Barbados are also the ones that have invested heavily in tourism. Other states are currently accelerating expansion of the sector.

Despite the apparent economic successes of the industry, it is important to note that promoting tourism as the way forward brings to the fore the challenge of balancing the increased use of natural resources and the resulting environmental degradation with the goals of sustainable development. Tourism expansion has major implications for natural resources that include water and ecological services such as waste assimilation.



The natural resource base of Caribbean tourism



A fundamental consideration of sustainable development is that natural capital (that is environmental resources and ecosystem services) is as necessary to any economic sector as other forms of capital. The contribution of natural capital to the tourism sector is both direct and indirect and, like other forms of capital in the production process, is subject to deterioration and degradation in both quantity and quality. In the case of tourism, the activities of the industry can have a direct impact on the natural resource base through its potential to degrade the environmental amenities on which the industry depends. It also has negative indirect effects on such capital if it disrupts the natural functioning of ecosystem services to the extent that the quality of services they provide, and which supports economic production, declines. The degradation of either the



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required amenities or the environmental services would lead to the collapse of the industry if the process were not arrested.

While the economic sustainability of tourism is widely agreed to be dependent upon the conservation of those natural resources that are directly used by the tourist industry, the indirect services provided by the environment are commonly regarded as 'free' and neither in need of protection or replenishment. They do not therefore enter into evaluations of the real cost of the industry, which raises questions of whether the economic contribution of the industry to the national economy is commensurate with the use of and, therefore, the preservation and/or replenishment of comparable reserves for future use.

The research addresses these questions through the environmental valuation of resources and ecosystem services used in the tourism industry - estimates of water use, production of sewage effluent, carbon dioxide emissions, and solid waste generation. A first approximation is made of the value of these natural resources and ecosystem services used in the tourism industry and this is compared with the sector's contribution to the country's Gross Domestic Product. These monetary values can then be used as the basis for: 1) providing a first approximation of the value of some of the natural resources and ecosystem services used in the tourism industry; and 2) setting up a framework for their further analysis and use in the assessment of sustainability in respect of tourism and other industries in SIDS.

The following publications are forthcoming:

1. *"The Future of Caribbean Agriculture in the New Global Environment"* in Gordon Baker (ed.), *Impact of Globalisation on the Caribbean Region* London: Royal Institute of International Affairs (RIIA), Chatham House.
2. *"Taking more than giving back? Tourism and the Sustainability of Caribbean Small Island Developing States"*. Proceedings of the International Research Foundation for Development (IRFD) World Forum on Small Island Developing States: Challenges, Prospects and International Cooperation for Sustainable Development", (Mauritius).
3. *"Valuation of Environmental Resources for Tourism: The Case of Jamaica"*, International Development Planning Review.
4. *"Evaluating the Environmental Resource Base of Traditional and New Economic Activities in the Caribbean"*. ■





## BIODIVERSITY CONSERVATION IN JAMAICA'S REMAINING NATURAL FORESTS: STATUS ASSESSMENTS AND IMPACTS OF INVASIVE SPECIES

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Jamaica is well known as a global hotspot for biodiversity conservation. The island harbours a rich variety of species that occur nowhere else in the world, many of which are threatened with extinction. For example, Jamaica's unique frog fauna, consisting of 21 endemic species, is in serious trouble. One species (*Eleutherodactylus orcutti*) has apparently gone extinct in the past 15 years; and over 70% of the island's native frog species are globally ranked as either endangered or critically endangered.

The situation in Jamaica reflects a global phenomenon - amphibians such as frogs are experiencing dramatic population declines or are disappearing altogether from areas such as Australia, North and South America, and the West Indies. Indeed, amphibians are now considered to be the most endangered group of vertebrates worldwide. They are experiencing unprecedented extinction rates that are far higher than those currently experienced by other vertebrate taxa such as birds and mammals. Because amphibians are considered to be excellent "bioindicators" of environmental health, their precarious existence should serve as a warning (the coal miner's canary is dying).

The aims of this research project are to assess the status and conservation needs of high risk taxa (e.g., frogs, reptiles), and to examine the influence, ecology, and control of alien invasive species (i.e., those introduced by man). Through funding from the Environmental Foundation of Jamaica (with Research Collaborator, Dr. Kurt McLaren), work has begun on the establishment of permanent research plots in the John Crow Mountains and Cockpit Country. The goal is to assess the current status of imperiled frog species, examine the relationship between habitat quality (which equals forest structure) and frog diversity, and establish long-term monitoring programmes that can track future trends in amphibian populations.

Continuing studies of the Jamaican iguana have recently expanded to include a detailed study of hatchling ecology and survival using radio telemetry. Data from 2004 and 2005 have confirmed that predation by exotic predators such as cats and mongooses exert a devastating impact on population recruitment. These novel data are helping to inform future conservation strategies, such as the intensification and expansion of predator control efforts.



Radio tracking hatchling iguanas





## **BIODIVERSITY CONSERVATION IN JAMAICA'S REMAINING NATURAL FORESTS: STATUS ASSESSMENTS AND IMPACTS OF INVASIVE SPECIES**

While the presence of non-native species represent a threat to the naturally occurring biota, they also provide additional research opportunities. For example, wild pigs (brought to Jamaica by the early Spanish explorers) represent a threat both to iguana nests and to the iguana's remaining dry forest habitat. Pig control efforts were initiated in 2002; and, through funding from the Mona Research Fellowship Programme - New Initiative Fund, work is currently underway on the examination of the parasitology of wild pigs captured in the Hellshire Hills. This research, which is being conducted in collaboration with Professor Ralph Robinson of the Department of Life Sciences, UWI, Mona, could have important implications for both the agricultural industry and for individuals that consume wild pig meat.

Additionally, there is on-going research on the impact and ecology of the introduced Indian mongoose. Most notably, there is the continuation of a long-term field experiment in the Hellshire Hills that examines the efficacy of mongoose control as a biodiversity conservation tactic. There are also ongoing collaborative efforts to study the genetic structure and movement dynamics of the mongoose. The molecular determination of the Jamaican mongoose population, a project headed by Columbia University Ph.D. student Ms. Chanda Bennett, has involved collecting DNA samples island-wide. The results could prove useful in devising control mechanisms such as species-specific diseases or immuno-contraceptives. The pursuit of strategies to reduce the negative impacts of mongooses could ultimately have important implications for the preservation of many unique Jamaican species. ■