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Interaction of Biomolecules with Metal Compounds

Research Coordinator: Professor Mohammed Bakir
Department of Chemistry

Research Fellow: Dr. Kamaludin Abdur-Rashid

Research Assistants Mr. Colin Gyles

The interaction between biomolecules and metal compounds has attracted a lot of research. The interest in this area is due in part to the development of metal based pharmaceuticals, the elucidation of the role of metal atoms in many enzymatic transformations that may include electron- and atom-transfer, and the structure activity relationship and determination of active sites of biomolecules.

Chemotaxis, the directional migration of cells toward chemical substances in their environment, is of interest for its role in many biological processes. The activation of this process is important in the migration of macrophage and neutrophils during wound healing, homing of thymocytes, migration of neural crest cells, and aggregation of Dictyostelium cells to form multicellular organisms. The ability of the cells to sense and respond to a slight variation in the concentration of chemotactic agents is required for all chemosensory responses. A variety of chemical substances that include native and denatured proteins, synthetic *N*-formylpeptides, amino acids and others, have been reported to trigger chemotactic responses.

Given the importance of *N*-formylpeptides as chemosensory agents for cells, the aim of this completed research project was to develop procedures for sensing and measuring the concentrations of *N*-formylamino acids in nonaqueous media. The focus of much of the work has been on the chemistry of polypyridyl-like ligands and their metal compounds for their rich physicochemical properties and electro- and opto-sensing behavior. The research also generated information on the isolation of di-2-pyridyl ketone *p*-nitrophenyl hydrazone (dpknph) and its rhenium carbonyl compound *fac*-$Re(CO)_3$(dpknph)Cl. Spectroscopic and electrochemical measurements on solutions of these compounds demonstrated rich electro-optical properties and revealed that the metal compound undergoes faster electron transfer than the free ligand. Optical measurements on *fac*-$Re(CO)_3$(dpknph)Cl in polar non-aqueous solvents in the presence and absence of $NaBH_4/KPF_6$ revealed reversible interconversion between the high (α-) and low (β-) energy electronic states of *fac*-$Re(CO)_3$(dpknph)Cl.

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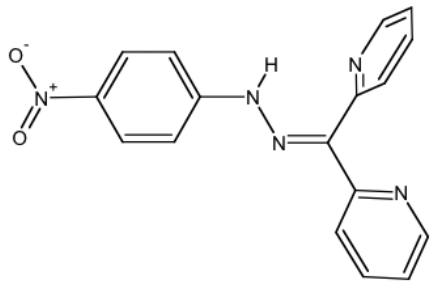
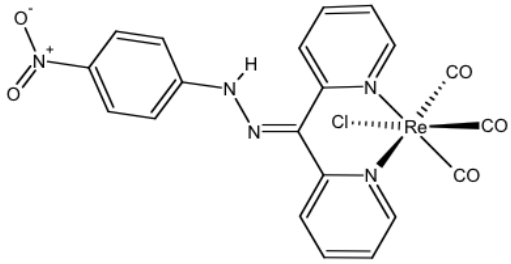


dpknph



***fac*-Re(CO)$_3$(dpknph)Cl**

The reversibility of these interactions and the disturbance of the equilibrium distribution of the low (a-) and high (b-) energy electronic state upon addition of $NaBH_4/KPF_6$ marked an improvement in the optosensing properties of *fac*-Re(CO)$_3$(dpknph)Cl. The optical behavior of *fac*-Re(CO)$_3$(dpknph)Cl in the presence and absence of the L-methionine and chemotactic *N*-formylamino acids, *N*-formyl-L-methionine (NFM), *N*-formyl-Lglycine (NFG) and *N*-formyl-L-phenylalanine (NFP), showed the α- and β-electronic states of *fac*-Re(CO)$_3$(dpknph)Cl to be insensitive to L-methinonine and highly sensitive to *N*-formylamino acids. *N*-formylamino acids in concentrations <1.0 x10^{-5} M could be determined with the use of the optical sensor *fac*-Re(CO)$_3$(dpknph)Cl in non-aqueous polar solvents. It was also found that the optosensing power of *fac*-Re(CO)$_3$(dpknph)Cl towards *N*-formylamino acids depends on the concentration and polarity of the side chain of the amino acids and increases in the following order: NFM>NFG>NFP.

The results that came out of this research project led to the publication of several papers, some of which are listed below:

- M. Bakir and K. Abdul-rashid, "Electro-optical Properties of the First Rhenium-Hydrazne Complex, *fac*-Re-(CO)$_3$(dpnph)Cl (dpknph = di-2-pyridyl p-nitrophenylhydrazone)", *Trans. Metal Chem.*, 1999, 24, 364.
- M. Bakir, K. Abdur-Rashid and W. Mulder, "Optosensing Properties of *fac*-Re-(CO)$_3$(dpknph)Cl (dpknph = di-2-pyridyl p-nitrophenylhydrazone)", *Talanta*, 2000, 51, 735.
- M. Bakir and Colin Gyles, "Optosensing Properties of *fac*-Re(CO)$_3$ (dpknph)Cl (dpknph. = di-2-pyridyl ketone p-nitrophenyl hydrazone)

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New Generation of Nitro Vasodilators – Syntheses, Characterization, Nitric Oxide Release and Bioefficacy

Principal Researcher: Professor Tara Dasgupta
Department of Chemistry

Research Fellow: Dr. Sujit Dutta

Researcher using a high-tech stopped-flow instrument for measurement

In recent years the chemistry and biology of s-nitrosothiols (RSNOs) have been the focus of major research interests because of their unique ability to release the most powerful biological messenger, nitric oxide (NO) under physiological conditions. RSNOs, also known as nitro vasodilators, are essentially NO carriers in the body and in fact have been detected in human fluid plasma, platelets and neutrophils. Hence, nitrosothiols have been used as therapeutic drugs for the treatment of various diseases such as 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 moity from one thiol to another residue in protein and enzyme. The process is known as *'Transnitrosation'*. This ongoing research project therefore seeks to study various transnitrosation processes involving some well known nitrovasodilators in order to understand the intricate mechanism by which NO molecules are carried rapidly to the active site in the body.

Work has been undertaken on the preparation and characterization of a series of nitric oxide releasing compounds whose structures are shown below. These compounds can be regarded as a new generation of nitro vasodilators and have the potential to be developed into first choice drugs for the treatment of cardiovascular disorders. Further work is now being carried out to investigate both the formation and transnitrosation mechanisms involving these new vasodilators.

There has also been an investigation of the mechanism of uptake of NO by cytochrome C which has important implications for the inhibition of mitochondrial oxygen consumption by NO. The complex cytochrome C-NO has been identified and its reactions with vitamin C have been investigated.

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The Investigation of Marine Organisms in Jamaican Waters for Bioactive Metabolites

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

The Jamaican coastline is teeming with a vast array of under-explored marine plants and invertebrates, some of which represent hitherto undescribed biota. The search for new and more effective drug therapies represents an ongoing endeavour especially in light of the continued identification of viral strains resistant to current drug therapies. While drug discovery from marine organisms lack the benefit of extensive folklore ethnocultural applications, many marine-derived compounds have been found to be effective as treatments for a myriad of disease conditions. Several marine invertebrates, e.g. sponges, have been found to contain potent anticancer agents which are currently undergoing clinical evaluation. Marine algae, the plants that form the basis of the food chain on the marine ecosystem, have traditionally served as sources of polysaccharides (e.g. agar and carrageenan) which have enjoyed numerous applications in the food industry. Currently valued at over US$6.0 billion, new research initiatives with algal species are expected to afford new applications such as health food additives and antiviral agents.

This research project seeks to unearth new bioactive compounds with potential in disease mitigation and also to develop commercial products not dissimilar to the anti-inflammatory agent found in a Caribbean gorgonian coral which has become a component of an anti-ageing cream by Estee Lauder, *Resilience*. This marine research should serve to broaden the bioprospecting efforts at the University of the West Indies which have been largely focused on the terrestrial plant landscape.

Work on Jamaican marine organisms has commenced with the examination of several marine algal species. Organic extractions have been effected with several species including *Cymopolia barbata, Caulerpa racemosa, Galaxaura rugosa, Jania* sp., *Bryothamnion* sp., *Chaetomorpha aerea* and *Hypnea cervicornis*. The *Hypnea cervicornis* is of particular interest as it was observed to be a skin irritant on prolonged contact and exposure.

Extensive isolation and characterization work has commenced with *Cympolia barbata*, collected from the Fairy Hill Beach in Portland, the extract of which has been found by previous researchers to possess antifungal, antibiotic and antimutagenic activity while antifeedant activity has been observed with mollusks and sea urchins. To date, five of the compounds isolated from the *C. barbata* extract have been characterized.

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Caulerpa racemosa, considered to be a salad delicacy in many Pacific countries, was collected from the Port Royal coastline where it was found growing in large quantities. Preliminary research work on the *C. racemosa* extracts has unearthed at least three analogues of its common red pigment, caulerpin.

The results coming out of this work should contribute to the identification of new drug therapies through the anticancer screening of algal, sponge and mollusc extracts and their pure compounds for bioactivity. It is also anticipated that investigations of extracts for other commercial applications, for example, antifouling properties, will be pursued so that the sustainable utilization of Jamaica's natural resources can lead to the development of new viable commercial ventures that should ultimately result in the island's economic growth and development.

Popular Jamaican beach front

Caulerpa Racemosa

Cymopolia Barbata

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Establishment of a Butterfly Industry in Jamaica

Principal Researcher: Dr. Eric Garraway
Department of Life Sciences

Research Fellow: Dr. Audette J. A. Bailey


Agraulis Vanillae mating in captivity

Jamaica is blessed with a variety of fauna that offer unlimited opportunities for research. The island is home to several species of butterfly which provide the opportunity for breeding, whether for conservation or commercial development.

The aim of this research project is to investigate the ecology and development of selected butterfly species in order to:

- identify attractive, robust, fast-developing species which are amenable to lab oratory cultivation in large numbers;
- study the western population of endangered Giant Swallowtail Butterfly, *Papilio homerus*; and
- establish a lower-volume, controlled production system for these butterflies to aid in conservation, to stock a local butterfly house and for sale on the international market.

This work will be done in conjunction with other interested parties towards the establishment of a commercial butterfly industry in Jamaica. The opportunities that exist in this industry are the release of butterflies at weddings and special occasions, the use as livestock to butterfly farmers, zoos and butterfly houses, and for use in rearing kits, public displays, and collector's specimens.

The choice of butterflies chosen for breeding will depend on the type of product that will be developed. Zoos and butterfly houses, for example, will require species which fly relatively slowly and low. Several species of butterflies have been reared in breeding cages of varying sizes. Work will be undertaken to determine the optimum size breeding cage for different species of butterflies. The species that are being reared include: *Phoebis sennae sennae, Ascia monuste eubotea, Heliconius charitonia simulator, Papilio andraemon, Siproeta stelenes stelenes, Euptoieta claudia and Junonia genoveva.* Mating, egg laying behaviour and feeding habits were observed and noted. Different rearing techniques were also employed.

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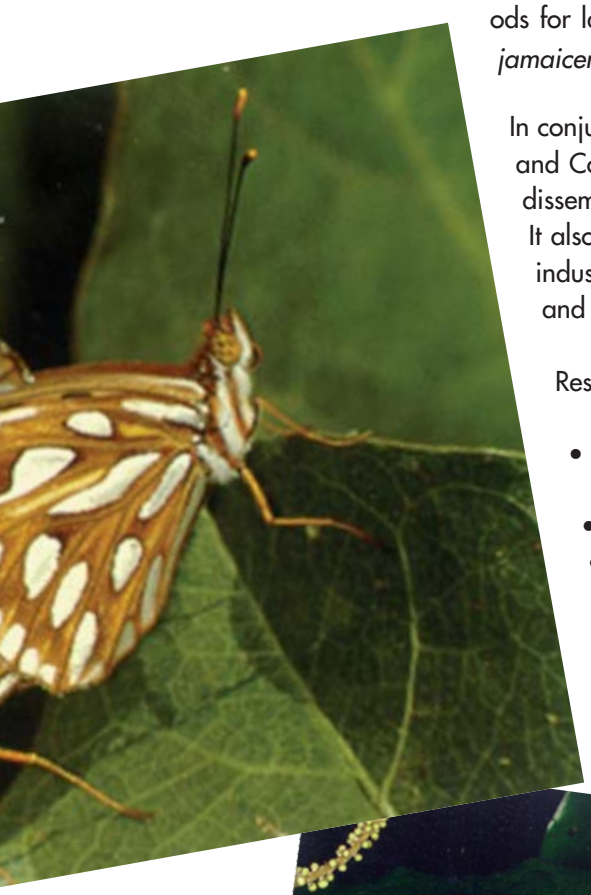
Investigations were also conducted on the best propagation techniques and pest control methods for larval host plants, such as *Cassia occidentalis, Cleome spinosa and Stachytarpheta jamaicensis*, in addition to nectar sources such as *Lantana camara* and *Salvia serotina*.

In conjunction with the McGuire Centre, University of Florida, a seminar entitled "Utilization and Conservation of Jamaica's Fauna: A Case Study of Jamaica's Butterflies" was held to disseminate information on research that has been conducted on Lepidoptera in the island. It also provided a forum for potential butterfly farmers to discuss the nature of a butterfly industry. Information was given on the requirements for establishing butterfly attractions and the challenges associated with the implementation of such projects.

Research findings coming out of the project will also be used to:

- facilitate an intensive study of the western populations of *Papilio homerus* and other butterfly species;
- generate significant income for the University of the West Indies;
- demonstrate how research and commerce can be mutually supportive; and
- provide a model for the utilization of a natural resource in a sustainable and ecologically sound manner.



The endangered Pappilio homerus (Giant Swallowtail)

Aphrissa Statira puddling in moist mud

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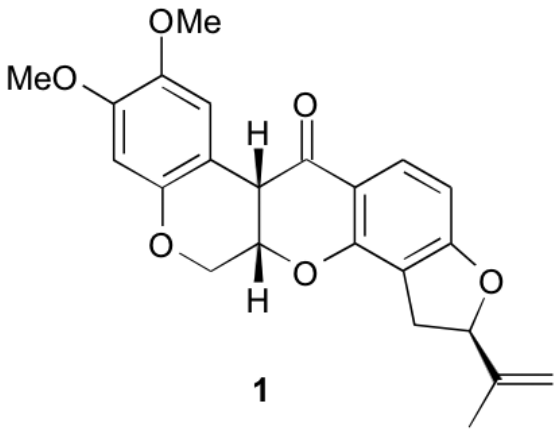
Synthesis of Azarotenoids – Novel Nitrogen Analogues of Insecticidal, Antiviral and Anticancer Agents

Principal Researcher: Professor Yvette Jackson
Department of Chemistry

Research Fellow: Dr. Norman Townsend

In the 1800's fishermen from different parts of the world used certain plants which were known to be fish poisons, to aid their trade. The major chemical component of most of these plants was found to be rotenone **(1)**. Over the last fifty years rotenone has been the number one fish control agent used in North America. Rotenone belongs to a family of chemical substances called rotenoids which have found various medical uses in today's society such as diuretics, pain killers, stimulants for heart muscle, and anti-inflammatory agents. Common commercial uses of rotenoids are as insecticides, antiviral and antibacterial agents and also as fish management chemicals.



1

Work on this ongoing research project has focused on synthesizing the novel rotenoid **(2)** and β-rotenonoid **(3)**. Chemical compounds that contain nitrogen atom(s) usually have more potent biological activity than analogous compounds containing oxygen atoms. The aim of the project is to investigate the synthesis of azarotenoids of type **(4)** - new analogues of rotenoids which contain nitrogen atoms in place of oxygen atoms in the ring structure.

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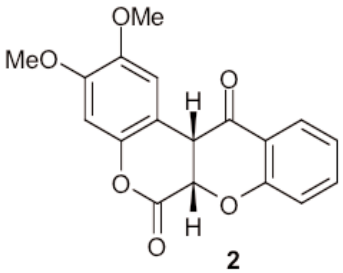

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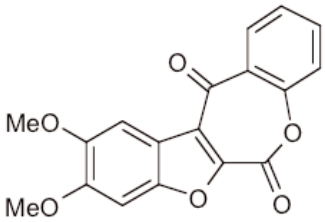

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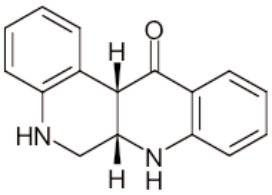

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Based on the work that will be undertaken, it is expected that there will be the development of new methods for producing rotenoids and azarotenoids. Once the azarotenoids have been made, information will be gained on their medical, biological and chemical uses. The information coming out of the research should allow for the exploitation of opportunities in the market for novel chemical substances, especially for those with useful biological activity.

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Mobility and Migration: Exploring Transnationalism in the Context of Jamaica

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

The goal of this ongoing project is to explore the experiences of Jamaican migrants and community organizations in the cities of New York (NY), London, and Toronto 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, and to produce a book, website, and documentary film that will record the diversity of these stories. It is also hoped that findings from this study will contribute to policy discussions in relation to migration to, and from, Jamaica.

There are three key components to the project. The first addresses the historical context of Jamaicans migrating to the United Kingdom (UK), United States (US) and Canada. This part of the project examines both the host country residents' responses to, and representations of, Jamaican immigrants, as represented in newspaper and television coverage of the Caribbean community. The second component explores the experiences of Jamaican migrants in New York, London, and Toronto. For this part of the project, interviews have been conducted with a wide 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/events in Jamaica. Finally, the third aspect of the research examines the experiences of returning residents to Jamaica as captured in interviews with residents who have returned to Jamaica after living overseas for several years.

Dr. Susan Mains undertaking filming on Mona campus for a documentary project

In order to document the wide diversity of Jamaican migrant experiences, over 90 interviews conducted in New York, London, and Toronto have been filmed. Preliminary research findings and film segments have been presented and screened at various international conferences in the US, UK, Germany and Finland, and have received very positive responses.

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Supplementary funding was provided by grants from the American Geographical Society's (AGS) McColl Family Fellowship and the Association of American Geographers' Research Grants scheme which enabled the addition of Toronto as a case study, and led to efforts to publish an article in the AGS Magazine, *Focus on Geography*.

Often we lose sight of the personal side of migration and the many vast and varied stories that people carry with them. Part of the aim of this project is to give a voice to these significant experiences and to challenge many of the negative media stereotypes of Jamaicans that are depicted in mainstream media overseas. The interviews conducted so far have highlighted the many diverse ways in which people relate to Jamaica, both as an identity that transcends physical national boundaries, and as symbolizing specific material and personal spaces and experiences. The project also illustrates the ways in which the Jamaican Diaspora continues to influence a range of international locations, even as it is itself affected by its ties to these locations.

) The Jamaican flag colours illuminate the Empire State building in New York, as part of Independence celebrations in Manhattan during August 2004.

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Development of Nutraceuticals from a Jamaican Plant

Research Coordinators: Professor Ajai Mansingh
Dr. Trevor Yee
Natural Products Institute

Collaborator: Professor Ronald Young
Faculty of Pure and Applied Sciences

Research Fellow: Ms. Arlene Wilson

Modern lifestyle characterized by its sedentary nature, social and professional pressures and heavy-dependence on fast, processed and imbalanced diets makes one prone to diseases such as diabetes, artherosclerosis, cholesterolaemia, hypertension and cardiac disorders. These diseases which have high incidence in the Caribbean, have traditionally been managed by herbal formulations. This completed research project sought to develop nutritional supplements from a Jamaican plant. This plant has been consumed as a vegetable for centuries and has been used in the alleviation of these diseases and many other disorders.

Work was undertaken on the chemical and biological profiling of the plant. In addition to the 144 compounds that had been reported previously, 14 minerals and 41 fatty acids have been found. The plant is rich in calcium, potassium, sodium (1.7, 5.9 and 0.4 % respectively), manganese, vanadium and vitamin C (113, 0.8 and 612 ppm respectively). An extract of the plant showed the presence of C_{16} to C_{24} fatty acids, with relatively high concentrations of omega-3 fatty acids. Total carbohydrates, protein and total fat constituted 5.3, 2.5 and 0.2 % respectively with total caloric value being 612 kcal/100 g. The vitamin C content, found in high concentration along with phenolic compounds which are present in the plant may have attributed to its potent antioxidant property, when compared with the powerful antioxidant, vitamin E.

It was also found that the plant had positive effects on diabetes. The aqueous extract of the plant administered by oral gavage on streptozotocin-induced diabetic rats resulted in the lowering of blood glucose levels after it was fed daily to Sprague Dawley rats over a period of 7 days, 14 days and 5 weeks.

Further studies on the mechanism of action for its diabetic property, cholesterol-lowering and anti-hypertensive effects are being pursued. However, the findings to date validate the role of the plant as a good nutraceutical candidate and have been documented in the following papers:

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Wilson, A., Mansingh, A., Yee, T. and Young, R. *Chemical Profiling of a Jamaican Plant by GC-MS and Multi-elemental Analyses*. 19th Annual Seminar and Workshop of the Malaysian Natural Products Society, October 2003.

Wilson, A., Mansingh, A. and Young, R. *Exploration of Therapeutic Potential of a Common Tropical Weed: Chemical and Bioactivity Assays*. 3rd International Conference on Natural Products, Nanjing, China, October 2004.

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Air Pollution Modelling over Kingston

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

The "State of the Environment Reports" published by the National Environmental Planning Agency (NEPA) over the past couple of years have all pointed to "drastic increases" in the incidence of respiratory illnesses in Jamaica over time. They have attributed this, at least in part, to the deterioration of air quality especially in urban areas. Unfortunately it is a very costly and technically demanding task to monitor the pollutants which are likely to cause these illnesses, and so from the scientific point of view, the claims of deteriorating air quality remain mere speculation.

Conventional monitors for a single pollutant cost in the region of US$6,000 – $15,000. In addition, the cost of keeping such monitors operating in a manner that guarantees the results they produce are accurate and reliable, is also quite daunting.

Work has been undertaken in the Department of Chemistry on the development of inexpensive and easy-to-operate monitors for the measurement of the pollutants which are likely to be responsible for the deterioration in respiratory health in urban areas such as Kingston. As a result, workable monitors are now available which can be used to provide pollution data upon which proper assessments can be made. These all use the passive collection technique and so require no electrical power or any significant expertise to operate. This aspect of the project has been facilitated by a grant from the Environmental Foundation of Jamaica.

The project that is supported by the Mona Research Fellowship Programme aims to add a modelling component to the study, employing one of several models which are available on the market at reasonable cost. The one selected, ISC-AERMOD, was developed by the US Environmental Protection Agency. It requires as input, information on the sources of pollution, which will allow the estimation of pollutant emission rates from these sources, and detailed meteorological and terrain data for the area under review.

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. When the results of measured and modelled pollutant concentrations are comparable it is a sign that one has achieved some measure of accuracy in representing the situation in the modelled area, and one then has an excellent predictive tool to use, for example, in predicting the impact of planned industrial development.

The use of passive monitors and modelling together, provide a very cost-effective way of tracking not just short term trends in pollution concentrations, but long term trends as well, and these provide an excellent base upon which both regulatory action and future policy decisions can be effected. Monitoring is already underway, the model has been purchased and persons are being trained in its use. Information is also being collected so that the modelling process can start before the end of the calendar year.

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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 Ruddock

The objective of this completed research project was the preparation of a range of new pharmaceuticals and agrochemicals from readily available plant compounds. The methodology involved the conversion, by the fungus *Mucor plumbeus*, of isolated natural plant products to novel compounds. The fungus, *Mucor plumbeus*, is well known for its ability to chemically transform compounds to new ones. These novel analogues cannot normally be produced by conventional methods of laboratory synthesis.

Under the project, the following terpenes were isolated from freshly collected plant material and their identities were confirmed:

The plant *Stemodia maritima*, which belongs to the Scrophulariaceae family, produces a number of natural products (known as terpenes) which possess antiviral and anticancer properties. These compounds are stemodin, stemodinone and stemarin.

Hyptis verticillata is a herb (from the Labiatae family) from which a natural product (also a terpene) is isolated. This natural product is toxic to certain agriculturally important insects and is known as the cadinane. Its isolation, characterisation and determination of its agricultural importance were first performed in the laboratories in the Chemistry Department.

After the confirmation of their identities, they were converted by the microorganism to a series of new products. Stemodin was chemically transformed by the fungus to four products, three of them being new. Similarly, stemodin and stemarin were converted 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 would increase the number of therapeutic agents available in the fight against disease and in particular, viral infections and cancer.

Mucor plumbeus was found to biotransform the cadinane 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. This should broaden the range of insecticides currently available on the market.

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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 local natural products can be increased through biotransformation. It has also laid the foundation for subsequent studies by various Chemistry graduate students in this new emerging area of Biocatalysis.

The use of passive monitors and modelling together, provide a very cost-effective way of tracking not just short term trends in pollution concentrations, but long term trends as well, and these provide an excellent base upon which both regulatory action and future policy decisions can be effected. Monitoring is already underway, the model has been purchased and persons are being trained in its use. Information is also being collected so that the modelling process can start before the end of the calendar year.

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Generating Seasonal (Three-monthly) Rainfall Forecasts for the Caribbean

Principal Investigator: Dr. Michael A. Taylor
Department of Physics: The Climate Studies Group, Mona

The aim of this ongoing research project is to produce seasonal rainfall forecasts for the Caribbean. The development of these forecasts 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 an enhanced or depressed rainfall season. The project involves the execution of four main tasks: (i) completing a synoptic analysis of the Caribbean Region to determine the primary forcing mechanisms for the rainfall season; (ii) developing statistical models for the Caribbean rainy seasons; (iii) installing a regional scale dynamical model; and (iv) issuing a forecast for the wet seasons of 2005.

The completed synoptic analysis of the Caribbean rainy season (May to November) suggests the North Atlantic subtropical High (NAH), tropical Atlantic sea surface temperatures (SST), and the tropical low pressure zone as the primary forcing mechanisms for both the early season (May-July) and late season (August-November) rainfall. Variations in the motion, timing, and extent of these features yield variations in the Caribbean rainfall season in terms of the onset, demise and severity.

Using the information gleaned from the synoptic studies, initial statistical models of early and late season rainfall were developed for a representative Caribbean precipitation index. Four variables have been confirmed as predictors for the early season: 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 have been retained in the late season model. Equatorial Pacific sea surface temperature anomalies become significant in both seasons on the interannual time-scale. The results also indicate spatial variation in the importance of the seasonal predictors.

Work will be carried out on (i) the refinement of the statistical models and their use in creating seasonal forecasts for the Caribbean in 2005; (ii) an examination of the predictability of the dry season; and (iii) the instalment and use of a regional dynamical model for Caribbean climate prediction so as to complement the statistical models. Based on the research findings, two papers have been submitted to appropriate journals, and are currently in the peer review process.

For further information on this research project, please visit the website,
http://www.mona.uwi.edu/physics/Research/csg/index.htm

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The Role of Environmental Management in Caribbean Economic Performance

Principal Researcher: Professor Elizabeth Thomas-Hope
Department of Geography and Geology

Research Fellow: Mrs. Adonna Jardine-Comrie

This project examines the factors contributing to the divergence in economic development that has occurred in the Caribbean over the second half of the twentieth century in relation to traditional and new uses of natural resources. A database was developed of economic performance indicators and environmental impact variables for the period 1960-2002 and a selection of variables used to identify the levels of association between economic performance (as indicated by the national accounts) and environmental degradation.

The strongest association between economic performance and environmental change were observed in the correlations between gross domestic product (GDP) per capita and resources of the tourist industry, such as water and land. There were also significant correlations between GDP per capita and the environmental indicators of increased urban activities, such as carbon dioxide emissions and electricity production and consumption. In contrast, there were only low levels of association between regional trends in GDP per capita and trends in agriculture. While the measures of association largely confirm the linkages that one would expect, what they cannot reveal is the sustainability of the respective economic activities, and whether the increases in resource use for tourism and urban services are contributing more to the sustainability or the non-sustainability of these resources and thus, ultimately, to the national economies and their future development.

The second part of the project thus seeks to establish the extent to which the present use of resources for economic growth contributes to the replenishment of comparable reserves for the future development of the respective countries. This question is pursued through research in five territories selected on the basis of their level of economic growth over the period 1960 to 2002. The countries are the Bahamas, Barbados, St. Vincent, Jamaica and Haiti, representing different levels in the range from high to low economic growth that occurred in the Caribbean. Within each case and as relevant, the research focuses upon the major economic sectors – namely tourism, agriculture and mining. Measures of the extent of use of natural resources of each of these economic activities and their impact on the environment are balanced against the contributions they make to the sustainability of the economy of the respective country.

On completion of the project, the environmental database developed for use in this project will be made available to other researchers as well as national and regional agencies. Efforts will also be made to keep the database updated.

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The proposed analysis of the sustainability of economic activities and the environment will also serve to provide policy guidelines, critical to the sustainability of the region.

Three papers have so far emanated from the research as follows:

- *The Future of Caribbean Agriculture in the New Global Environment,* presented at the Royal Institute of International Affairs, Chatham House, London, November 25, 2003, and has been accepted for publication by the Royal Institute of International Affairs, London.
- *The Sustainability of Caribbean Small Island Developing States: Evaluating the Environmental Resource Base of Traditional and New Economic Activities,* presented at the International Geographical Union Conference, August 16th – 20th, 2004.
- The paper *Taking more than giving back? Tourism and the Sustainability of Caribbean Small Island Developing States,* for World Forum and Side Event on Small Island Developing States: Challenges, Prospects and International Cooperation for Sustainable Development, Mauritius, 10-14 January, 2005.

Mining, agriculture and tourism - contributors to economic development and environmental degradation.

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Biodiversity Conservation in Jamaica's Remaining Natural Forests: Status Assessments and Impacts of Invasive Species

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Jamaica is well known globally as an important biodiversity "hotspot," yet the status and conservation needs of the most threatened species are not well known. This ongoing research project seeks to document the occurrence, status, and conservation needs of Jamaica's most imperiled terrestrial vertebrates. Given the global amphibian crisis, the project will focus on the examination of Jamaica's unique but threatened frog fauna. The last 20 years have witnessed an alarming number of frog extinctions across the world, and the status of Jamaica's critically endangered frog fauna is currently of both national and international concern. One species has apparently gone extinct in the last 15 years, and most other species are IUCN red-listed as either endangered or critically endangered.

As the primary source of amphibian endangerment in the West Indies appears to be habitat loss through forest deterioration, the research effort will be directed at correlating endemic frog diversity with habitat quality. In collaboration with Dr. Kurt McLaren of the Department of Life Sciences, work will be undertaken to quantify the structure and composition of Jamaica's remaining limestone forests and correlate these quantitatively derived measures of habitat quality with the occurrence of endangered frog species. This effort should help clarify the extent to which Jamaica's native frogs are dependent on high quality, undisturbed forest. To this end, permanent monitoring plots will be established to track future changes in the abundance of these threatened animals. By considering both forest structure and a faunal group sensitive to habitat perturbation, these permanent monitoring plots will provide a solid foundation for tracking long-term trends in environmental quality.

Another collaborative effort seeks to document the extent and quality of a highly endangered habitat type – swamp forest in the Black River morass. This endeavor grew out of a more focused effort to assess the habitat suitability and status of a large Jamaican lizard (the Giant Galliwasp). This lizard is generally considered to be extinct because it has not been documented in over a hundred years. However, the species has never been the subject of intensive surveys. If a remnant population exists somewhere in the Black River area, work will be undertaken to find it and institute the appropriate conservation measures to prevent yet another extinction of a unique Jamaican endemic.

A second major research thrust focuses on documenting the occurrence and conservation implications of invasive, non-native species. Aside from outright habitat destruction, the deleterious impact of non-native species on naturally occurring biotas is now considered to be the leading cause of species extinctions and endangerment; this influence of invasive species is nowhere more

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acute than on oceanic islands. Jamaica is a textbook example of the tragic collision between an endemic island biota and exotic species introduced by man. Indeed, Jamaica now harbors a number of the most damaging invasive species (such as rats, mongooses, cats, pigs and deer), yet few studies have attempted to assess the influence of these alien invaders, or to investigate possible strategies for reducing and even eliminating the negative impacts.

Current field work is concentrated on mammalian predators occurring in the Hellshire Hills – the last remaining habitat of the critically endangered Jamaican Iguana. With the completion of a study on the diet and control tactics for the Indian mongoose, attention will now turn to the study and control of other invasive predators. In particular, methods to trap and remove feral cats and dogs are being refined, and a programme will be initiated to remove and study wild pigs. Wild pigs prey on a variety of naturally occurring plant and animal species, and are especially virulent predators of nests such as those of endangered sea turtles and iguanas. In addition, wild pigs may carry diseases that represent a threat to human health and livestock rearing operations. In collaboration with Professor Ralph Robinson of the Department of Life Sciences, work is now underway on the collection of material to assess the parasite loads harbored by these wild pigs.

Investigations are also being carried out to understand the ecological impacts of two introduced amphibians, the Cane Toad (*Bufo marinus*) and the American Bullfrog (*Rana catesbian*). These two species have been introduced to many parts of the world, and their negative impacts on native biotas have been well documented. However, the impact of these two invaders has not been assessed in Jamaica. Work has started on the collection of material to assess the native species that may be impacted by predation from these non-native anurans. The American Bullfrog was introduced to Jamaica relatively recently (in the 1960's), and appears to be expanding its range rapidly. Documenting the spread of this invasion is another objective of this research project.

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Investigation of Bioactivity Claims of Herbal Formulae and Locally Grown Plants, Towards the Development of a Nutraceutical Industry in Jamaica

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Numerous formulae have been developed by local herbalists that claim to possess effective anti-hypertensive properties. Although there has been anecdotal evidence from human trials, these formulae do not attract much attention from local or international consumers and entrepreneurs as they have not undergone scientific validation. Consequently, several of the herbalists have approached the Natural Products Institute for assistance in obtaining scientific validation of their formulae which are not yet commercially available. This research project therefore sought to investigate the anti-hypertensive properties of one such herbal formula (denoted as Formula 1).

Carried out as an interdisciplinary research initiative, the work focused on the use of an animal model to generate physiological and toxicological data. Under the project, Formula 1 was administered to normal and spontaneously hypertensive rats according to the herbalist's dosage instructions. Accordingly, the effects on blood pressure (both systolic and diastolic) and heart rate were recorded on a daily basis. The Electrocardiogram (ECG) patterns of anaesthetised animals were also recorded. Additionally, the samples of blood sera and also the major organs (heart, kidney, lung, liver, testes and ovaries) of the sacrificed animals were weighed and stored for toxicological analysis.

Initial research findings did support the anecdotal claims of the formula. It was found that Formula 1 does not significantly lower the blood pressure or heart rate and has no statistically significant effect on ECG patterns even after 12 weeks of administration.

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These findings were documented in the form of an Abstract that was submitted to the 3rd International conference (October 2004) on natural products held in Nanjing, China.

Although the toxicological study on Formula 1 is currently underway, work should commence shortly on the investigation of the anti-hypertensive claims of another herbal formula (Formula 2). Scientific investigations of this kind are aimed at placing the supportable claims from the local herbal industry on a firm scientific base, with the hope of building a credible nutraceutical industry in Jamaica.