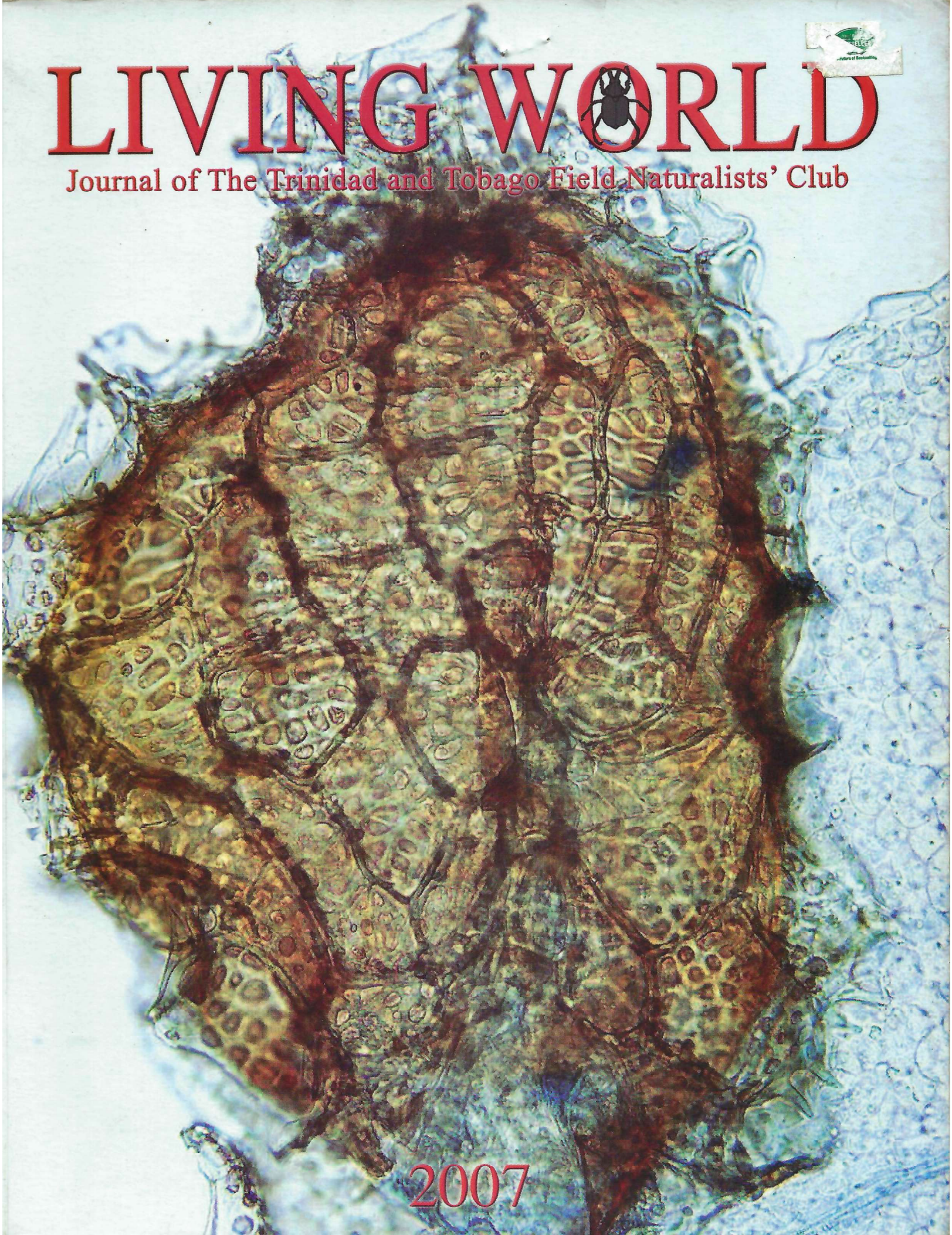
LIVING WORLD

Journal of The Trinidad and Tobago Field Naturalists' Club



2007

THE TRINIDAD AND TOBAGO FIELD NATURALISTS' CLUB

The Trinidad and Tobago Field Naturalists' Club was founded on 10 July, 1891. Its name was incorporated by an Act of Parliament (Act 17 of 1991). The objects of the Club are to bring together persons interested in the study of natural history, the diffusion of knowledge thereof and the conservation of nature.
Monthly meetings are held at St. Mary's College on the second Thursday of every month except December.
Membership is open to all persons of at least fifteen years of age who subscribe to the objects of the Club.

Mission Statement
To foster education and knowledge of natural history and to encourage and promote activities that lead to the appreciation, preservation and conservation of our natural heritage.

Enquiries

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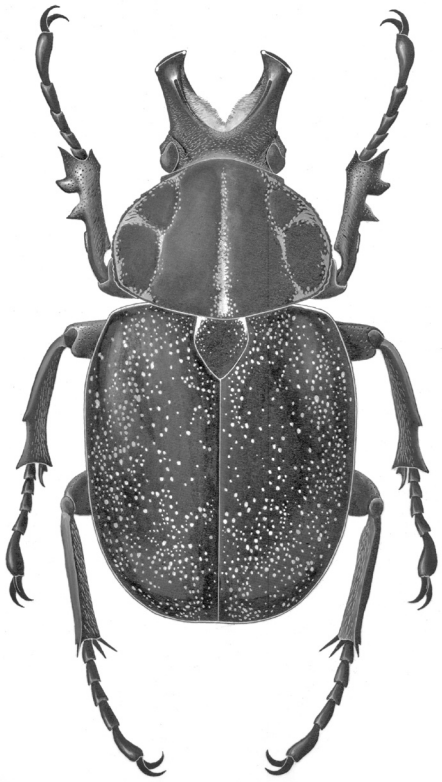

Inca clathrata quesneli Boos and Ratcliffe

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Special thanks to Michael E. Tikasingh for the design and layout
of the front and back covers as well as the Acknowledgements' page.

Editorial

As we were preparing the 2007 issue of Living World for publication, we learnt of the death of Dr. Thomas H. G. Aitken at 94 years. Tommy, as he was known to us, lived in Trinidad from 1954 to 1966 during which time he made significant contributions to our scientific culture. He was a member of our Club shortly after it was revived in the 1950's and was a member of the Editorial Committee of the Club's journal. We respectfully dedicate this issue of Living World to his memory.

The Guest Editorial comes from the President of our Club. He has chosen to write about the growth of human populations and its effects on society and development.

There are two review articles in this issue. Prof. Julian Duncan reviews the reproductive biology, development and propagation of the 'David Auyong' cultivar of the Chaconia plant, while E. Devenish and C. Sayer review the literature and recent research in Trinidad on the Neotropical river otter *Lontra longicaudis.*

Louis Garraway and Rean Maharaj conducted research on some mushrooms in Trinidad and found the psychoactive substances, psilocin and psilocybin, in one species of mushroom, *Psilocybe caerulescens,* from Santa Flora in south Trinidad. This is a first study of its kind in Trinidad and Tobago.

The crustacean *Metamysidopsis insularis* is used in toxicological testing in Trinidad, but not much is known about its life cycle. Najila Elias-Samlalsingh *et al.* describe the development stages of the species.

In his continuing series on freshwater macroinvertebrates in the various West Indian islands, David Bass writes this time on the results obtained in Dominica. He reported an additional 29 taxa for the island bringing the total to 116. Locally, W. G. Rostant *et al.* report on their research on the fish fauna of five rivers in southeast Trinidad. They noted that *Mugil curema* was the most abundant species and accounted for 56% of the total catch.

There are two articles by Matthew Cock: one on Skipper Butterflies, the 15th of his series; and the other, a research note on the sphingid moth *Xylophanes titana.*

Graham White revised the list of birds recorded from Trinidad and Tobago and provides an assessment of abundance, while M. Kenefick writes on the rare birds of Trinidad and Tobago in 2004 and 2005, the Fourth Report of the Rare Bird Committee.

The Madamas Watershed in the Northern Range, has been proposed as a National Park, but there is little information on the natural history of the area. E. Devenish *et al.* give a preliminary assessment of the species richness of the area.

There are five Nature Notes in this issue in addition to sphingid moth by Cock: one on the girth of the Sandbox tree; one on the Tobago caiman and one on a new locality record for the lizard *Gonatodes ceciliae*. There are two papers on spiders: Jo-Anne Sewlal is the senior author in both, one gives a preliminary survey of spiders found on Nevis and the other updates the list of family spiders for Trinidad and Tobago.

There are two book reviews: one on the second edition of 'The Trinidad & Tobago Field Naturalists' Club Trail Guide' and the other on the latest of Professor Kenny's books, the 'Flowers of Trinidad and Tobago'.

We have a small change to the way we cite references. Starting with the present issue, authors must now give the full title of each Journal.

EST

Guest Editorial: Growth of Populations and its Effects

Never was there a better time, never was the issue more urgent, never was there greater need for common sense, logical thought, drastic action ……. before now. How many times have we heard or thought these words in respect to some issue or another? Concerning the effect that man has on our planet there is indeed a case for these words to be spoken again. As we "progress" towards ever greater crowds, water shortages, atmospheric pollution, deforestation, energy shortages, congested roads, public health deficiencies, schooling problems, landfill rubbish disposal taking ever more available land, and generally more stress, the world should be looking urgently at controlling its population.

When do we pass the earth's "carrying capacity" or when did we pass it? Did it slip by unnoticed only leaving us carried onward by our momentum, to reach ever greater numbers?

I feel extremely frustrated whenever I attempt a journey in or out of town and am delayed by seemingly endless traffic jams. I look at all the crawling traffic and think "there are just too many people on the road". But planners will tell you this is a simple problem that could be solved by any government that plans instead of the successive governments that we've had who wait for events to overtake them then react. A flyover here and there, an extra lane on the highway or a rapid railway, or bus route and presto its solved! (We can now presumably proceed to buy more cars and fill up the new capacity and get back to the same old congestion).

Practically all the effects of population can be dismissed in this way. Technology will provide better farm productivity and feed the extra numbers. Some new invention will provide an alternative energy source so why worry about oil reserves. We can build bigger schools, bigger hospitals, bigger police stations, bigger offices and so on. All in all we haven't begun to see how many people the earth can accommodate, so relax don't worry, just go for growth!

But there must logically be a point where we have gone too far and overdone it. With advances in scientific knowledge this point appears to be shifting so that it seems to be always ahead of us, but quite possibly we have passed the "overload" point long ago with some of the many criteria and have set in motion a tide of "natural" reactions that will be extremely difficult to reverse.

The new awareness of global warming is probably the most alarming consequence of man's over-abundance in the world. Even if the earth can "carry" the current population, apparently it can't handle the people *plus* their inventions. Man's inventions spew carbon dioxide into the atmosphere in disproportionately greater amounts to the population itself, so that twice the population creates more than twice the damage. If global warming produces the predicted rises in sea level (and it seems that consequences of global warming are accelerating faster than predicted) we can expect large-scale losses of land area. In a world where we are already struggling to defend the natural environment from ever more encroachment by man, the future looks extremely unpleasant, but it's a future that takes more than a generation to be upon us, so we all see bits of the degradation, but it takes two or three life spans to capture large changes. For instance, anyone born today grows up with traffic jams being the norm and doesn't understand why older people think traffic is a problem.

Now you would think that logical minds would realise this problem and expect governments to plan preventative measures. Reducing the population through painless prevention of births is so obvious a solution that it is mind-boggling that it is not at the top of every politician's priorities. In fact in practise we see the opposite. Politicians disassociate themselves from anyone who proposes a solution and hope the problem will just go away. Also a fall in population means a reduction in GDP, lower sales figures, less voters in a particular constituency, less *growth*. Heaven forbid we might even experience *deflation!* Countries like Singapore, Italy, and France are going to great lengths to encourage their people to have more children for fear of an economic downturn. Only China, and to some extent India, try to decrease their populations and the world frowns on them. China actually has a most enlightened population policy, but in world comment we hear only of the killing of girl children and the surplus of males that results. This is not a criticism of the policy, it is a criticism of the people who apply it.

We have grown up in a world that understands only growth. Success is measured in growth of GDP, turnover, profits, assets etc. A nation or a company or a town or a community that is not *growing* in as many measurable markers as possible is seen as a failure.

I would propose that this view is 180 degrees off course. If we all want to enjoy man's inventions at every level of society the result will be no enjoyment at all. Trinidad and Tobago has seen this in the motor car, now so easily affordable to wider sections of the population. The result is the near gridlock we see in the mornings and afternoons. Imagine if every African or Indian were to have a motor car tomorrow, what a cloud of pollution would be added to the atmosphere from all those vehicles standing stationary in their respective gridlocks! If every Chinese or Indonesian could afford a cruise every year on a luxury liner imagine the congestion of every port and shipping channel, because not only would they be travelling but the increased world trade to support such wealth would require shipping of goods hither and thither. We can easily dream up horrific scenarios based on more people being able to enjoy the world's inventions and the resulting chaos, even with a *static* population. These are quite clearly impossible, so "progress" is evidently aimed at those who are already wealthy and the gap between rich and poor widens, with the rich advancing and the poor staying where they are. By

this means the effects of progress are very much muted as the incremental numbers of the wealthy are much smaller than the total increase in numbers of people.

It is long past time for world leaders to recognise this and plan for a reduction in earth's population. If deflation were to result so be it. If everything costs less, why shouldn't one's assets decrease also? The sales value of my house to me is measured only in terms of what profit I would make, or how much more I would have to raise through a mortgage, if I were to sell it and buy another house. But it takes a bold and honest politician to admit this, and these are hard to find. Democracy would ensure that such a politician would have a very short term in office. But my personal Utopia is a world with a shrinking population. A world where hospital waiting lists reduce, every child easily finds a school place, where towns shrink or stand still, forests expand, where technology advances and is available to all levels, where garbage disposal ceases to be a problem, where greenhouse gases drop dramatically and the oceans breathe again and fish stocks increase.

And I say to myself "what a wonderful world"!

I. Reginald Potter
E-Mail: rjpotter@opus.co.tt

Cover photograph

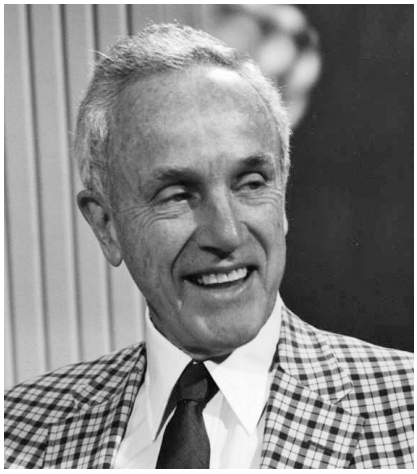
The testa of the seed of the Chaconia after germination has taken place. A part of a cotyledon can be seen beneath the testa. The testa is highly ornamented with a network of ridges dividing the surface into 4 - 5 sided segments. The exposed surface of each segment is ornamented with reticulate to pitted thickenings. The colour of the testa is golden-brown; the blue tinge seen is caused by the stain used during preparation of the specimen. (EJD).

DEDICATION

DR. THOMAS HENRY GARDINER AITKEN (1912 – 2007)

(ENTOMOLOGIST AND NATURALIST)

Dr. Thomas Henry Gardiner Aitken, a former member of the Trinidad Field Naturalists' Club and a member of the Editorial Committee (1956 and 1957) of the Club's Journal, died in Corning, New York on 19 April, 2007 at 94 years. He was a former entomologist at the Trinidad Regional Virus Laboratory (TRVL) and Consultant to the Caribbean Epidemiology Centre (CAREC).



Dr. Thomas H. G. Aitken

Dr. Aitken or Tommy as we knew him, received his early education in England, France and his home town of Porterville, California. He received his B.S. Degree in entomology and zoology in 1935 and his Ph. D. in entomology and parasitology in 1940, both from the University of California (Berkeley). His Ph. D. thesis on "The Anopheline Complexes of the Western U.S.A.", where he described a new species of mosquito *Anopheles freeborni,* still stands today as originally described. This is a tribute to his painstaking attention to care and detail which has characterized his entire life.

He joined the army in 1941 as a First Lieutenant in the Sanitary Corps, later becoming a Lieutenant-Colonel. He served for a short time as a technical advisor in the Preventive Medicine Division in the Surgeon-General's Office in Washington, D.C., then he was stationed in Puerto Rico where he was in charge of the Entomology and Parasitology Laboratory. Brief stints took him to Central America as a Malaria Control Officer and to the Armed Forces School of Malariology, Florida in 1943 where he was Liaison Officer and Instructor.

In 1943, he was transferred to Algeria to work with the Rockefeller Foundation's team engaged in a programme of controlling an epidemic of typhus fever. Typhus fever is caused by a spirochaete and carried by the body louse. An effective way to control the epidemic was to kill the louse. By this time, a remarkable insecticide, DDT, was developed. The Rockefeller Foundation devised a machine to blow DDT powder onto people's clothing to kill the lice and therefore control the epidemic. That same year, there was an outbreak of epidemic typhus in Naples and Dr. Aitken received orders on Christmas Eve to go there to assist in controlling the epidemic.

By 1944, he became Chief Malariologist of Malaria Control Operations under the Allied Forces Command in Corsica and then at Naples.

In 1946, Tommy became a staff member of the International Health Division of the Rockefeller Foundation and he was to remain a staff member for some 28 years. His first assignment with them was that of entomologist in the malaria eradication programme in Sardinia. This was the first large scale experimental programme using DDT to control the Anopheline vector of malaria. Before the start of this programme, malaria had infected nine out of every 10 individuals on the island which was then known as the "hell hole of the Mediterranean". By spraying emulsions of DDT on the interior walls of houses at the rate of 2 gms per square metre, a long lasting effect, up to eight months, of the insecticide was achieved. The Rockefeller Foundation's methods were to revolutionise malaria control around the world, and many countries, including Trinidad and Tobago, subsequently eradicated malaria from their shores. This basic technique of using DDT emulsions is still used by many countries where the Anopheline mosquito is still susceptible to the insecticide.

In the early 1950's the Rockefeller Foundation turned their attention to the study of arboviruses – viruses transmitted by insects, ticks and mites. Previously their staff members had studied the natural history of yellow fever in Latin America. It was during these studies their staff had discovered a number of other viruses which they had set aside in deep freezers for later studies. Thus, in 1951 they turned their attention to these viruses and set up field laboratories in India, South Africa, Egypt, Nigeria, Colombia, Brazil and Trinidad. Dr. Aitken was re-assigned to the Trinidad Regional Virus Laboratory (TRVL) in 1954.

When he arrived in Trinidad very little was known about the arthropods of medical importance, except the Anopheline mosquitoes, the vectors of malaria. His first step was to see what blood sucking arthropods were present on the island and then determine their identity. Using a variety of techniques he spent most of his time collecting mosquitoes and studying them. Consequently, we now know that there are about 165 species of mosquitoes on Trinidad. During this work he also collected other arthropods of medical importance – horse flies, stable flies, sand flies, bed bugs, kissing bugs, lice, fleas, mites,

ticks and scorpions. The result today, is that TRVL and its successor, CAREC, has one of the finest collections of arthropods of medical importance in the region. Some these arthropods were new to science when he collected them and many were named after him including a new genus of mite, *Aitkenius*.

Dr. Aitken's contributions were not only in the field of taxonomy and biology of arthropods, but he also experimentally infected mosquitoes in the laboratory to determine their role in the transmission of some viruses isolated in Trinidad. And together with staff of TRVL he demonstrated that rodents played an important part in the cycle of some of the viruses. His contribution to the study of the natural history of yellow fever is also outstanding, not only in extending our knowledge on the biology of the sylvan vector *Haemagogus*, but also in field investigations of epizootics. Long after he had left Trinidad and retired from the Rockefeller Foundation, he returned to CAREC as a Consultant sponsored by the International Development Research Centre of Canada, to advise on techniques that could be used in demonstrating the possible natural transovarial transmission of yellow fever, something he had already demonstrated in the laboratory at the Yale Arbovirus Research Unit.

Dr. Aitken worked with Doctors Wilbur Downs, C. R. Anderson and Leslie Spence to make the TRVL, the forerunner of CAREC, one of the world's leading institutions on the field study of arboviruses. Many distinguished scientists had visited the TRVL, while students from India, Japan, Argentina the USA and the Caribbean came for longer periods to study our methods and techniques.

While most of Dr. Aitken's scientific contributions have been documented in journals, and he has written some 160 articles, it was his desire to transfer technology by "on-the-bench training" to local staff that set him apart from the others.

Tommy took a keen interest in the natural history of Trinidad and he was able to infect many local persons with his enthusiasm to learn more about our environment. One example of this was his discovery, while on a mosquito-collecting expedition to the Cedros Swamp, of a balisier species, *Heliconia marginata,* considered new to Trinidad at the time. He was an avid gardener and was very proud of his living collection of Trinidad orchids and bromeliads. He joined our Club shortly after his arrival in Trinidad and became a member of the Editorial Committee of the Journal shortly after it was restarted in 1956. He was also a member of the Horticultural Society, winning trophies for his exhibits at their Annual Flower Show and when that group celebrated their Diamond Jubilee in 1974, they awarded him the Gilt Medal. He took a leading role in persuading the Forestry Division of the Ministry of Agriculture, Government of Trinidad & Tobago, to declare the Bush Bush Forest a Wildlife Sanctuary.

He was transferred to the Belem Virus Laboratory, Belem, Brazil in 1967 and then to Yale Arbovirus Research Unit (YARU) in 1971 retiring from the Rockefeller Foundation in 1974. His last appointment was that as a Senior Research Scientist at YARU from which he finally retired in 1983.

Because of his wide knowledge and experience, many agencies have sought his advice. Thus, after his experience working with DDT, he was appointed a member on WHO's Expert Committee on Insecticides and was a member of that Committee for five years. He has also been a member of various sub-committees of the American Committee of Arthropod-borne Viruses and has also served as a member on the Editorial Boards of the Journal of Medical Entomology and Annals of Medical Entomology. He has been a Consultant for short periods to USPHS, Arbovirus Ecology Branch (1974), the Gorgas Memorial Laboratory (1976) and CAREC (1981, 1982).

Tommy received many awards because of his distinguished career. Among these is the Gold Medal he received from the Government of Sardinia for his contribution to the malaria eradication programme. Likewise, he was awarded an honorary doctor's degree from the University of Cagliari, Sardinia. Other awards included the Richard Moreland Taylor Medal (arbovirology) in 1984; the Harry Hoogstraal Medal in 1993 "For Oustanding Achievement in Medical Entomology". In 1993, also, CAREC dedicated its newly renovated entomology-parasitology laboratory "The Thomas Aitken Laboratory" in his honour. The following year, 1994, he was the recipient of the John Belkin Award from the American Mosquito Control Association "in recognition for more than 50 years of outstanding contributions to the field of mosquito biosystematics".

He was a devoted husband and father. In 1948, he married Virginia Gale of Boxford, Massachusetts. His wife preceded him in death in 1999. He leaves to mourn two sons, Bruce and Brian, a daughter-in-law, Lina Maria, and two grandchildren, Colin and Maia. Bruce has a Ph. D. degree and is a fiber optics researcher at Corning, Inc., while Brian is an antiquities dealer in New York City.

We, therefore, affectionately dedicate this issue of Living World to the memory of Dr. Tommy Aitken.

Elisha S. Tikasingh

A Review on *Warszewiczia coccinea* (Vahl) Klotzsch – the 'Chaconia'

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ABSTRACT
Warszewiczia coccinea an evergreen shrub to a small tree belonging to the family Rubiaceae, is found primarily in Central and South America and in Trinidad, where it grows in abundance in moist, semi-shaded, flat lands and the lower wooded hillsides. The plant, is known as Wild Poinsettia, Pride of Trinidad and Chaconia, the last of these is thought to commemorate the last Spanish governor of Trinidad, General Chacon. The plant is an evergreen shrub to small tree 4 - 6 m in height, which flowers at intervals throughout the year, particularly in the wet months from about February to November. A plant thought to be a mutant of *W. coccinea* was discovered in Trinidad in 1957 and was assigned the cultivar name 'David Auyong.' The reproductive biology, methods of propagation and known pests and diseases of the plant are recorded.

Key words: *Warszewiczia coccinea,* Chaconia, Pride of Trinidad, national flower of Trinidad and Tobago.

INTRODUCTION

Warszewiczia coccinea – a member of the angiosperm family Rubiaceae – is an evergreen shrub to small tree found growing primarily in Central and South America (Costa Rica to equatorial Peru) and Trinidad, where it grows in abundance in moist, semi-shaded flat lands and the lower wooded hillsides (Williams and Cheesman 1928).

The genus was named after Jósef Warszewicz, a 19th century Polish orchid collector and inspector of the botanic gardens at Krakow, Poland, who first discovered it in Central America (Adams, 1976; http://www.arikah.net/encyclopedia/Warszewiczia coccinea. 1/24/2007). The plant is known as 'Wild Poinsettia' on account of its superficial resemblance to *Euphorbia pulcherrima* (Christmas plant of Mexico) of the Euphorbiaceae, to which it is in no way related. In Trinidad it is known as 'Pride of Trinidad' and 'Chaconia.' Menninger (1962) states that the latter of these two names 'commemorates the last Spanish governor of Trinidad, General Chacon.' Dennis Adams, as recorded by Kenny (2004), argues that "the name does not commemorate Chacon, the last Spanish governor of Trinidad and should not be spelt Chaconia". The name is derived from Chaconne, the dance, for which dancers decorated themselves with little flags and should be spelt Chaconier. It is instructive to note that the plant is referred to as 'Flag Tree' in MANU Native and Medicinal Plants (http://www.enjoyperu.com/peru_travel_tours) accessed on 1/30/2007. In a later publication, Kenny (2005) in support of the use of the word Chaconier, draws attention to the fact that "for more than a generation of settlement, Trinidad culture was essentially French and the language spoken was French and French Patois, hence names such as balisier, gommier, oliviere, chaconier……." Williams and Cheesman (1928) record it as Chaconier.

BOTANY

Vegetative

The plant is an evergreen shrub to small tree of 4 - 6 m in height. The main trunk is short, dividing into long, slender branches at about 35 cm above ground level (Raymond 1978). The leaves are 40 - 65 cm long and 15 - 20 cm at their widest point. They are opposite, simple with an entire margin, obovate with acute bases and pinnately veined. They are supported by a short petiole enlarged at its base. A pair of deciduous stipules is found between the paired leaves.

Reproductive

The plant flowers at intervals throughout the year, particularly during the wet months from about February to November and not specifically on August 31st as may be inferred from the statement made in reference to the plant *'coincidentally blooms on every anniversary of our Independence (August 31, 1962)'* (http://users .rcn.com/alana.interport/flower.html) accessed on 2007/01/29. It produces an inflorescence which is a panicle consisting of a main axis 30 - 50 cm long, along which paired, pedunculate cymes (Fig. 1) are borne. At the base of this axis and at right angles to it, are two smaller branches which also bear paired pedunculate cymes. This arrangement gives the inflorescence the appearance of an inverted 'T.' (Fig. 2). The entire inflorescence produces between 600 - 800 flowers.

Each flower consists of a small yellow, epigynous corolla, the petals of which are fused to form a short tube

PLATE I

Fig. 1. Cyme – oldest flower central, younger ones peripheral.

Fig. 2. Young inflorescence showing main branch and two side branches (inverted 'T').

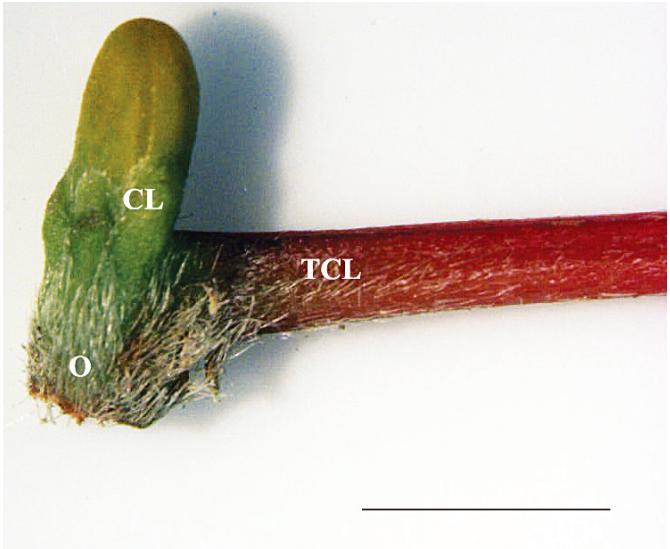

Fig. 3. Single flower showing stalk of single transformed calyx lobe (TCL). O – ovary; CL – calyx lobe. Bar 5 mm.

Fig. 4. Portion of inflorescence showing transformed sepals, one per cyme.

Fig. 5. Stages in the development of the flower. Stigma (**S**) protruding from unopened bud. Bar 2 mm.

Fig. 6. Inflorescence of the 'David Auyong' cultivar.

PLATE II

Fig. 7. Cymes of wild type; note single transformed sepal stalk at left.

Fig. 9. Fruit produced from the ‘David Auyong’ cultivar.

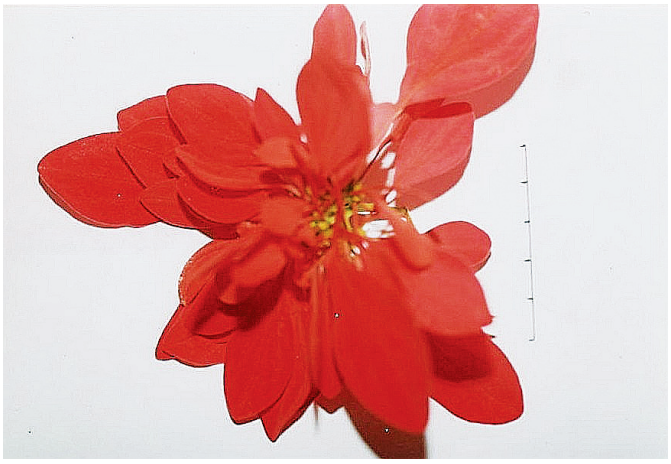

Fig. 8. Cyme of ‘David Auyong’ cultivar.

Fig. 17. Sepal showing leaf miner damage.

with free tips that are imbricate in the unopened bud. The calyx consists of 5 sometimes 6 sepals which are adnate to the ovary and fused for most of their length; the free tips are broad and rounded. In any given cyme which may consist of up to 30 flowers, one calyx lobe of one of the peripheral flowers is transformed into a long-stalked, obovate, red petaloid structure up to 7 cm long (Fig. 3). This feature accounts for the attractiveness of the inflorescence (Fig. 4).

The flowers are hermaphrodite; the hairy ovary is inferior (all other floral parts are above it), bicarpellate and produces numerous ovules. The style terminates in a bifid stigma. A fleshy nectary is found at the base of the style. The anthers have short filaments which are attached to the corolla tube.

The plant is protogynous, that is the pistil (female reproductive organ) matures before the anthers do. The bifid stigma protrudes through the unopened bud pushed aloft by growth of the style. (Fig. 5, 2 and 3).

The anthers dehisce after the bud has opened by which time the stigma is no longer receptive and has withered (Figure 4:4). This means that autogamy (self fertilization) is not possible; a flower must be pollinated with pollen from an older flower. After pollination and fertilization, embryo formation and seed development take place and a dry fruit – a 2-celled capsule is formed. This splits septicidally (along the septum separating the two carpels) in a dry atmosphere.

In 1975 a spectacular flowering tree was observed in the Blanchisseuse Valley. Nichols (1963) records the event as follows:

"Mrs. Grace Mulloon (nee Atteck), accompanied by Mr. David Auyong, spotted an outstandingly brilliant scarlet inflorescence at the top of a group of Chaconias. They immediately realised the importance of their find but not until some time later, after attempts had been made at propagation, was it brought to my attention. Subsequently, Mr. Auyong and I made numerous journeys to procure suitable propagation material. It may be pointed out that, although the parent tree was apparently quite close to the road, the bole was some 2 m below road level, down a steep embankment. It is to Mr. Auyong's credit that he took considerable risks to bring the material down for propagation".

By February of 1958 three plants from the rooted cuttings had been established at the Imperial College of Tropical Agriculture (now part of the Faculty of Science and Agriculture of The University of the West Indies at St. Augustine). Unfortunately the parent plant was cut down when the Blanchisseuse-Arima Road was widened. One of the plants established was sent to Kew (United Kingdom) in February 1961, where Mr. J. Simmonds of the Kew tropical propagating house established four more rooted cuttings by November 1962. (Nichols, ibid). The plant is thought to be a mutant of *Warszewiczia coccinea* and was assigned the cultivar name 'David Auyong'.

Raymond (1978) found both wild type and the cultivar have the same chromosome number 44. The most obvious difference between the two is to be found in the greater showiness of the inflorescence of the cultivar. In this plant, instead of one sepal of one of the peripheral flowers of the cyme becoming petaloid, one or all of the sepals of every flower in the cyme is transformed (Fig. 6).

The proliferation of transformed sepals in the cultivar obscures the presence of the petals; these are thus less obvious than those of the flowers of the wild type (Figs. 7 and 8).

In the 1982 edition of *EXOTICA International - Pictorial cyclopedia of Exotic Plants* Series 4 (Graf 1982), an illustration of the cultivar is printed with the caption '*Warszewiczia coccinea plenissima* (Trinidad).' I communicated with the author, Dr. Graf in 1983, questioning the name given. In his reply he stated that he obtained the picture from a staff member of the New York Botanical Gardens (at which a plant grows), marked *Warszewiczia coccinea forma.* He substituted the 'plenissima.' He assured me that he has made the correction and amended the text appropriately in the 2nd Edition of his publication *TROPICA,* and planned to do the same when *EXOTICA* is reprinted.

Raymond (1978) conducted a thorough investigation of the floral biology and cytology of the 'David Auyong' cultivar and found pollination, fertilization, seed and fruit formation proceeded normally. The statement made by Barwick (2004) that "the double-flowered form lacks a functional pistil and does not produce fruit" is thus erroneous.

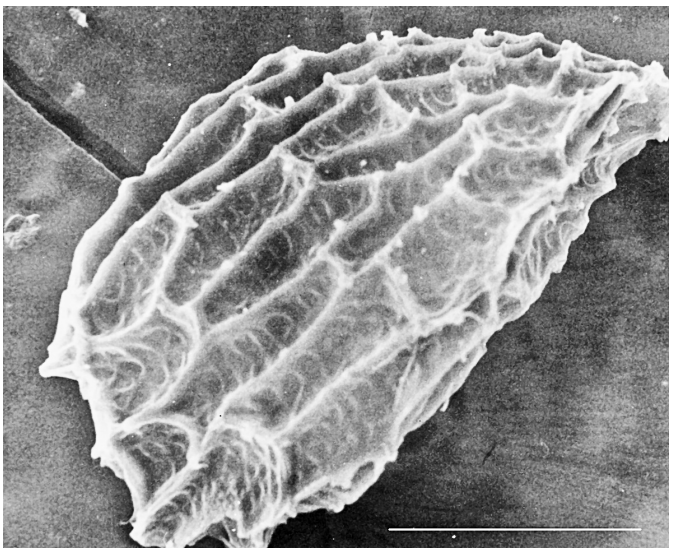

Fig. 10. Scanned Electron Micrograph of seed. Bar 50 µm.

In a series of experiments, Raymond (1978) found that geitonogamy (transfer of pollen from the anther of a flower to the stigma of another flower on the same plant) is possible.

The fruit, as in the wild type, is a globose capsule with a scabrous surface (Fig. 9).

The seeds are minute and possess a highly ornamented testa (Fig. 10).

The fruits split septicidally under dry atmospheric conditions and the seeds are wind dispersed. At the time of dispersal the embryo is underdeveloped and still in the cigar-stage. The cotyledons are defined, but the shoot and the root apical meristems are ill-defined. The developing embryo is surrounded by a disintegrating endosperm, the whole enveloped by the one-cell-layered testa (Fig. 11).

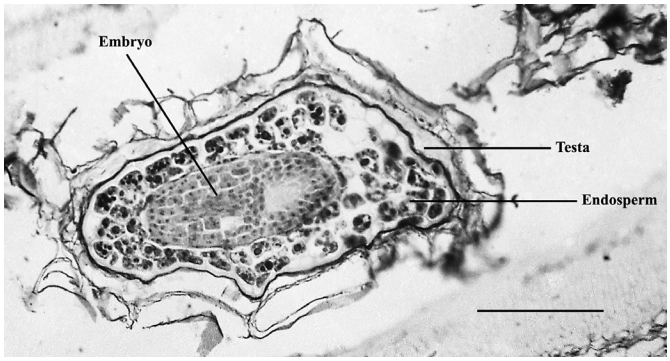

Fig. 11. Longitudinal section through seed. Bar 100 µm.

The seed thus exhibits morphological dormancy (underdeveloped embryo) and requires a period of 10 -12 days in sunlight before it germinates. On germination, the hypocotyl emerges, pushing the cotyledons aloft still enclosed within the testa. As the cotyledons expand, the testa falls off (Fig. 12). The cotyledons are round - ovate; the outer walls of the marginal epidermal cells are curved, giving the margin a crenulate appearance. At the tip of each cotyledon there is a functionless stoma. Occasionally, a seedling with three cotyledons is seen. The seedlings remain at this stage for months during which the root elongates and may produce laterals (Fig. 13), but the stem apex remains dormant. Efforts are currently in train at the St. Augustine campus of The University of the West Indies to determine the constraints to seedling establishment.

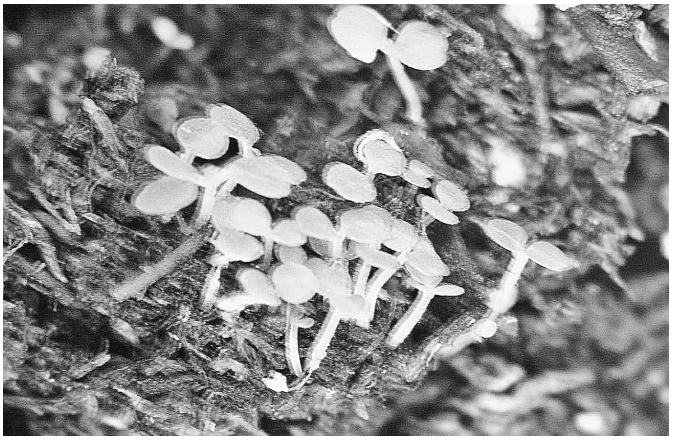

Fig. 12. 2-month old seedlings of the 'David Auyong' cultivar.

Fig. 13. 3-month old seedlings showing elongated root with lateral; stem apex is dormant.

PROPAGATION

Menninger (1962) with reference to the wild type recommends that the minute seeds should be dusted on to finely sifted soil in pots or seed flats and watered with a syringe. He further suggests that the pots or flats should be covered with glass to ensure warmth and a saturated atmosphere. Under those conditions germination takes place within ten days. From the foregoing it would appear that seeds of the wild type exhibit morphological dormancy as do those of the cultivar. Menninger reports that the seedlings may be transplanted after two months and are about 6 inches tall after a year's growth. Plants may also be propagated from greenwood cuttings (http://www.sunnygardens.com/garden_plants/Warszewiczia) accessed on 2007/01/30. There are no reports on successful propagation of the cultivar by seed. Rawlings (1963) suggests that cuttings should be inserted in a mixture of peat and silver sand and placed in a propagation frame with bottom heat. Within four weeks a root system is established and the young plants may be potted in a mixture of four parts fibrous loam, two parts peat, one part sand and kept closed in the propagating frame for a further six weeks after which they may be taken to the open greenhouse with a temperature of 75 - 80°F.

PESTS AND DISEASES

Baker and Dale (1951) reported the occurrence of a fungal disease caused by *Lembrosia warszewiczia* P. Herr

on plants of the wild type in the Arena Forest. Raymond (1978) reported on an unidentified fungus which caused alternaria-like patches showing concentric circles of varying shades of brown on the 'David Auyong' cultivar.

The cultivar is claimed to be susceptible to attack by mealy bug and red spider mite (http://www.sunnygardens.com/garden.com/garden_plants/Warszewiczia accessed on 2007/01/30).

Duncan (1983) recorded damage done to the leaves and calyx lobes of the cultivar by the eriophyoid mite *Caryoloptes* sp. On the abaxial surface of the foliage leaves between the lateral veins and on both the abaxial and adaxial surfaces of the sepals, a felt of hairs (erineal patch) develops, leading to discoloration and in instances distortion (Fig. 14). These patches become brown with age. A water-soaked area above the older erineal patches is seen on the adaxial surface of the leaf.

The mites are gall forming and the effect on the leaf of the growth hormone that they produce is the proliferation of epidermal cells to form many-celled papillae (Figs. 15 and 16).

Fig. 14. Erineal patch on the abaxial surface of a foliage leaf of the 'David Auyong' cultivar.

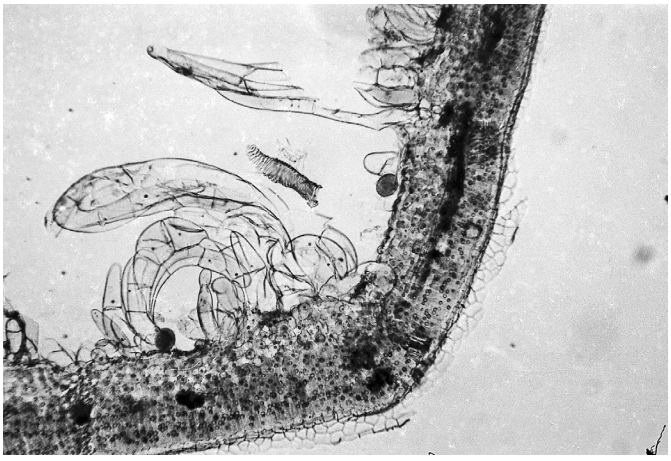

Fig. 15. Transverse section through leaf of 'David Auyong' cultivar sowing septate papillae.

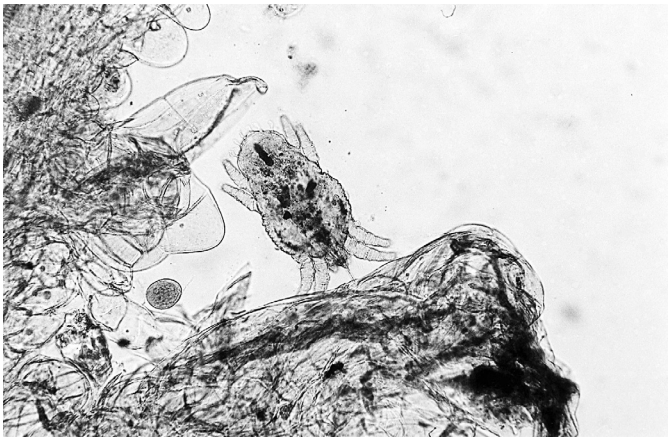

Fig. 16. Mature mite seen among papillae formed by leaf in response to attack.

Leaf miner has been found on the sepals of the cultivar (Plate II, Fig. 17).

'MEDICINAL' PROPERTIES

The anise-odoured roots are said to exhibit aphrodisiac properties (http://arikah.net/encyclopedia/Warszewiczia_coccinea) accessed on 2007/10/24.

THE NATIONAL FLOWER

When emblems were chosen for the new nation of Trinidad and Tobago, *Warszewiczia coccinea* was named the national flower for "as an indigenous flower it has been witness to our entire history. It can therefore be said to represent the imperishability of life and the continuity of our Nation". http://www.nalis.gov.tt/NationalAwardsEmblems/National_Emblems2.html) accessed on 2007/01/31.

The image on the 25 cent coin is that of the wild type, an indication that this is the flower the selection committee had in mind when the choice was made. The argument has been advanced that since we share the wild type in common with other countries, but the 'David Auyong' cultivar is specific to Trinidad, the latter should be considered to be designated as the national flower. There is no doubt there are those who would argue that the cultivar – discovered in 1957 – was not around to "witness to our entire history".

GLOSSARY

abaxial:	lower surface
adaxial:	upper surface
adnate:	closely attached to side of; conjoined
autogamy:	self fertilization
bicarpellate:	with two carpels

bifid:	forked
cyme:	a determinate inflorescence
epigynous:	above the ovary
imbricate:	overlapping irregularly
obovate:	inversely egg-shaped
pedunculate:	growing on or having a peduncle (stem or stalk supporting a flower or fruit)
petaloid:	like a petal
pinnate:	divided in a feathery manner
scabrous:	rough with a covering of stiff hairs or scales
septicidal:	dividing through the middle of ovary septa; dehiscing at septum

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A Review of the Ecology and Conservation of the Neotropical River Otter, *Lontra longicaudis* (Olfers, 1818), with Special Reference to Trinidad

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ABSTRACT
Trinidad hosts the only insular population of the Neotropical River Otter, *Lontra longicaudis*. A brief literature review of the species is given here, based on studies from the mainland South American population and recent research in Trinidad. The conservation status of this island species is poorly known, and an overview is presented, together with some distributional data for Trinidad.

Key words: *Lontra longicaudis,* insular population, ecology, conservation.

INTRODUCTION

The Neotropical River Otter, *Lontra longicaudis,* is one of the least studied otter species in the New World (Quadros and Monteiro-Filho 2002; Pardini 1998; Chehébar 1990). Indeed, relatively few published studies exist of the mainland population (see Quadros and Monteiro-Filho 2002; Pardini and Trajano 1999; Pardini 1998), and no published ecological studies exist for the Trinidad population.

CLASSIFICATION

There are 13 species of otter spanning Europe, Africa, Asia and the Americas, belonging to the order Carnivora, family Mustelidae. *Lontra* was proposed as a new genus due to the morphological differences between the New World species and the Old World *Lutra* species (van Zyll de Jong 1972). The genus *Lontra* has four species: North American River Otter, *L. canadensis;* Sea Cat, *L. felina;* Southern River Otter, *L. provocax* and Neotropical River Otter, *L. longicaudis.*

The Neotropical River Otter was described fifteen times in Latin America between 1818 and 1924 and Cuvier initially classified the Trinidadian subpopulation in 1823 as *Lutra insularis* (Larivière 1999). Currently there are three recognised subspecies of *L. longicaudis* (Larivière 1999): *L.l. annectens*; *L.l. enudris* (= with *L. insularis*); and *L.l. longicaudis* (= *L. platensis*). Little is known about their geographic distribution and genetic variation (van Zyll de Jong 1972).

RANGE

Lontra longicaudis has the most extensive range of the four Latin American otters (Giant otter, *Pteronura brasiliensis, L. provocax* and *L. felina*) and is sympatric in parts of its range with *P. brasiliensis* (Mason and MacDonald 1986). Its mainland distribution spans from northern Mexico to Argentina, and it is found up to an elevation of 3000 m (Emmons 1997). Trinidad hosts the only Caribbean and only insular population of *L. longicaudis.*

IDENTIFICATION

Lontra longicaudis has short, dense fur, with a dark brown upper body, whitish belly, a long tail and webbed feet (Emmons 1997). Sexual dimorphism is exhibited, with males 20 - 25% larger than females (Larivière 1999). Average measurements for *L. longicaudis* are 400 - 809 mm for head-body, 360 - 570 mm for tail length, with average weights of 5 - 14.75 kg (combined from Emmons 1997 and Eisenberg 1989).

The distinguishing features of *L. longicaudis* are the variable shapes of the rhinarhium (muzzle) (Larivière 1999). In Trinidad, the rhinarhium is reportedly divided by a median strip of hair (van Zyll de Jong 1972).

HABITAT PREFERENCES

Like the majority of otter species, *Lontra longicaudis* is solitary (Emmons 1997). Owing to their semi-aquatic behaviour, home ranges are linearly spaced along waterways. Home ranges in Brazil are approximately 5 km (Quadros and Monteiro-Filho 2002) and density of the Argentinean population is estimated at between 0.81 to 2.76 otters per km of river (Larivière 1999).

L. longicaudis has a plastic denning behaviour, using natural cavities as well as excavating burrows (Quadros and Monteiro-Filho 2002; Pardini and Trajano 1999; Eisenberg 1989). Holts (dens) are used to rest, sleep, give birth and rear young. Several are utilised by an individual, and apart from natal holts can be used by more than one otter, although not simultaneously (Pardini and Trajano 1999).

Although foraging occurs throughout the day, activity is concentrated in the late afternoon (Larivière 1999).

Preferred habitats of *L. longicaudis* are fast-flowing rivers and streams in both deciduous and evergreen forests (Emmons 1997).

A recent study of three watersheds in the Northern Range of Trinidad (Madamas, Marianne, and Arima), found that deep rocky pools with abundant potential holt sites were favoured by *L. longicaudis* (Devenish 2003). Similar preferences for substrates and size of river are found for *L. lutra* (see Kruuk 1995; Prenda and Granados-Lorencio 1996) and are likely to be due to the distribution and biomass of prey species (Kruuk 1995). Alternatively, heavily silted rivers in disturbed catchments (e.g. Arima) inhibit fish presence and had fewer signs of otter habitation (Devenish 2003). Studies show tolerance of human disturbance may depend on the availability of sufficient shelter (MacDonald and Mason 1990). In this context disturbance may become a major limiting factor only if other habitat attributes are not satisfied. As habitat features have strong associations with each other, it is likely that multiple factors affect the distribution of *L. longicaudis*. Rivers with a combination of variables below a certain threshold may sustain lower populations of *L. longicaudis*, or of their prey, resulting in a population decline.

SPRAINTING BEHAVIOUR

The role of sprainting in communication and information transfer is indicated by routine sprainting on exposed locations and centres of activity, such as banks, logs and boulders (Melquist and Hornocker 1979) and holts (Quadros and Monteiro-Filho 2002). There is evidence that habitat change and anthropogenic impacts can affect sprainting behaviour (Hutchings and White 2000) with fragmented and declining otter populations leaving fewer signs than healthy ones (Hussain and Choudhury 1997).

Sprainting behaviour fluctuates throughout the year. A proliferation in spraints and spraint sites was observed for *L. longicaudis* in Brazil during July to September, coinciding with a reduction in one of the major prey items (in this case members of the armoured catfish family, Loricariidae) (Pardini and Trajano 1999). Possible explanations include the greater need to advertise resource use due to decreased prey availability. Fewer spraints were also observed for *L. longicaudis* while cubs were present (Quadros and Monteiro-Filho 2002) probably due to the risk of attracting predators.

Fig. 1. Spraint of the Neotropical Otter, *L. longicaudis*, found along the Madamas River.

DIET

Lontra longicaudis is classified as piscivorous (Eisenberg 1989; Emmons 1997). However, Pardini (1998) found that invertebrates made up a substantially higher proportion of prey items of a Brazilian population of *L. longicaudis*, compared to the Eurasian otter *Lutra lutra*. Similarly, crustaceans (*Aegla, Macrobrachium* spp.) appear to be dominant prey items of Trinidadian otters (Devenish and Nelson pers. obs.). A possible explanation for this specialisation is variation in dentition, as the crowns of molars are wider in *L. longicaudis* than in *L. lutra* (Pardini 1998).

Additionally, preference for slow-moving, bottom-dwelling prey such as *Aegla schmitti,* and *Trichodactylus fluviatilis* has been reported for *L. longicaudis* (Pardini 1998), suggesting the importance of low escape ability. Prey choice is therefore a trade-off between foraging success and prey quality (i.e. calorific value).

BREEDING

Most otter species typically reach sexual maturity at two years (Kruuk 1995). Although no reproductive records exist for the wild population in Trinidad, *Lontra longicaudis* is thought to breed mainly from March to May (Larivière 1999). However, cubs have been reported during October and December in Suriname (Mason and MacDonald 1986). Litters are typically made up of one to five cubs (Larivière 1999). Male *L. longicaudis* play no role in rearing offspring (Larivière 1999). *L. longicaudis* females show evidence of delayed implantation (Larivière 1999). This ability to suppress the development of an embryo for months, allowing a female to mate while still having dependent offspring, is also found in *L. canadensis* (Kruuk 1995).

CONSERVATION STATUS

The status of the Neotropical River Otter is categorised as 'data deficient' in the IUCN Red List 2004 (IUCN 2005). However, it is designated as 'vulnerable' in Mexico, Argentina, Brazil and Uruguay (IUCN 2005) and is commonly classified as 'endangered' in Trinidad (EMA 2001). Although the IUCN (2005) lists its pres-

ence in Trinidad as 'uncertain' it has long been known to exist there (Thomas 1892; Urich 1895; Harris 1968; Alkins 1979). Harris (1968), in his review of the Lutrinae, described the Trinidad subspecies *L.l. enudris* as rare. Another indication of its conservation status is the fact that *L. longicaudis* remains listed on Appendix I of the Convention on International Trade in Endangered Species (CITES) (Emmons 1997), which prohibits the commercial trade in species threatened with extinction. *L. longicaudis* is currently legally protected within most countries where it occurs and in Trinidad it is protected under the Conservation of Wildlife Act (Ch 67:01).

The status of *L. longicaudis* is poorly known in Trinidad. According to the IUCN Specialist Group 'Otter Action Plan' *L. longicaudis* has been recorded in rivers located in the north, east and south of the island (Chehébar 1990). Nelson (pers. comm.) estimated the population to be between 200 and 500. More recent studies have recorded Neotropical River Otters in the Arima, Aripo, Las Cuevas, Madamas, Marianne, North Oropouche, Ortoire, Shark, and Yarra river systems in Trinidad (Lucas pers. comm.; Nelson pers. comm.; Quesnel pers. comm.; Nelson *et al.* 2004; Devenish 2003). Furthermore, a recent survey suggests that the distribution of otters is higher on the north-facing slopes of the Northern Range, in particular the Madamas Valley (Devenish 2003).

More mammals are in danger of extinction than species from all other major taxon (Bright 2000) and nearly a third of recent mammalian extinctions have occurred in the Caribbean islands (Pimm 1998). Additionally, a higher number of mustelids (38%) are threatened compared to all other mammal species (15%) (Bright 2000). The Trinidadian population of *L. longicaudis* falls into several categories of vulnerability to extinction (Primack 1998), including: small population size, low population density, specialised niche requirements, hunted by people, and large body size.

L. longicaudis is currently extirpated throughout much of its range (Eisenberg 1989), with intense hunting for fur, and human-induced habitat degradation and pollution, being likely causes of its decline and continued rarity (Larivière 1999; IUCN 2005). In this context, the specific conservation priorities listed for Trinidad in the IUCN Otter Action Plan are to initiate surveys to establish the distribution and to determine existing threats (Chehébar 1990) to *L. longicaudis*.

The unique semi-aquatic life of the otter requires that conservation strategies consider both its riverine and terrestrial habitat requirements. Otter conservation, through protecting a top-predator and a highly charismatic species, offers a chance to achieve this if done in conjunction with a wider watershed approach.

The Neotropical River Otter probably exists at a low population density in Trinidad. Little prime habitat remains on the island yet with increased awareness and watershed management, this species may be able to coexist with humans. In this context, stringent protected area infrastructure is necessary to protect vital *Lontra longicaudis* strongholds such as the Madamas Watershed.

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The Screening of Mushrooms Found in Trinidad to Determine the Presence of the Psychoactive Substances Psilocin and Psilocybin

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ABSTRACT
The questions of whether psilocybe type mushrooms exist in Trinidad, and if they exist, whether they contain psychoactive drugs namely psilocin and psilocybin were addressed in this paper. To answer these questions naturally-growing mushrooms were collected and classified by trained mycologists. Thin layer chromatography and high-pressure liquid chromatography techniques were employed to screen the samples for the psychoactive drugs. One of the samples found in Santa Flora, South Trinidad was identified as *Psilocybe caerulescens*. The sample contained 0.01% and 0.003% of psilocybin and psilocin respectively.

Key words: Psilocybe, psilocybin, psilocin, mushroom.

INTRODUCTION

Psilocybin and psilocin are the active ingredients present in a number of psychedelic mushrooms found in Mexico, the United States, South America, South-East Asia and Europe. These mushrooms were used in Mexican and pre-Columbian American religious ceremonies dating back to 1000 BC (Furst 1976). These two psychedelic substances are found in over 75 species in the genera: *Psilocybe, Panaeolus, Stropharia* and *Conocybe* (Shultes and Hoffman 1980). So far there have been no reported findings in literature on psychedelic mushroom distribution in the Lesser Antilles.

There have been many studies on the analysis of psilocin and psilocybin using paper chromatography (Hofmann *et al.* 1976; Benedict *et al.* 1962), thin layer chromatography (Heim *et al.* 1966; Repke *et al.* 1977), and classical liquid chromatography (Leung *et al.* 1965; Koike *et al*. 1981). Today, the analysis of hallucinogenic mushrooms usually employs high performance liquid chromatography (HPLC) using ultraviolet (UV) detection (Christiansen *et al.* 1981; Thompson 1980). Gas chromatography/mass spectroscopy (GC/MS) can be used in the analysis of the hallucinogenic mushrooms. However, in the inlet system of the gas chromatograph, thermal dephosporylation of psilocybin occur readily converting psilocybin to psilocin. Hence, it is not possible to determine if the starting material contains psilocin, psilocybin or a mixture of both drugs (Gross 2000).

This investigation utilizes thin layer chromatography (TLC) and high performance liquid chromatography (HPLC) techniques using ultraviolet (UV) detection method to determine the presence, if any, of psilocin and psilocybin in mushrooms found in Trinidad.

EXPERIMENTAL

Collection and Classification of Mushrooms

Mushroom specimens were collected from various geographical locations in Trinidad. Specimens were placed individually in small brown paper bags. Dr. M. Alkins-Koo, Dr. M. D. Oatham and Ms. Doreen Jodhan of the Life Sciences Unit, University of the West Indies, St. Augustine, Trinidad, classified the specimens.

Sample Preparation

The mushroom samples were allowed to dry at ambient for 3-4 days. The samples were homogenized using a mortar and pestle. The powdered material was transferred to a Petri dish and further dried to constant weight at 100ºC.

A known mass of this prepared sample was allowed to soak in 10 ml methanol (analytical grade, Fisher) for two hours. The mixture was then shaken on a Gallenkamp orbital shaker for one hour (30 rev/min).

The methanolic extracts were evaporated using a stream of hot air to near dryness (1 ml). All the methanolic extracts were stored in darkened sample bottles in a freezer.

Thin Layer Chromatography

Chromatographic separation was carried out using thin layer chromatography on activated silica gel G support on 10 cm x 10 cm glass plates (Fluka); support coating (0.25 mm) thickness contained a fluorescing additive which fluoresces at 254 nm.

The presence of psilocin and psilocybin standards (Lipomed) in methanolic sample extracts were identified by simultaneously running standards on each plate. The plates were developed to 6 cm in a development tank using two

Table 1. Results of the Classification of mushroom samples.

Sample #	Mushroom sample
1	*Leucoprinus* sp.
2	*Cookeina* sp.
3	*Schizophyllum* sp.
4	*Pleurotus* sp.
5	*Pleurotus* sp.
6	*Macroleptiota molybdites* sp.
7	*Polypore* sp.
8	*Ascomycete* sp.
9	*Auricalaria* sp.
10	*Lentinus* sp.
11	*Coprinaceae* sp.
12	*Psilocybe* sp.
13	*Lentinus* sp.
14	*Trametes* sp.
15	*Daldinia* sp.
16	*Trametes* sp.
17	*Lenzites* sp.

(2) solvent systems: Solvent System 1 (n – butanol, acetic acid, water 20:10:10 ml). Solvent System 2 (methanol, concentrated ammonia 100:1.5 ml).

Upon completion of the runs, the bands on plates were visualised using initially UV light at short wavelength (254 nm) and followed by Ehrlich reagent. Ehrlich reagent consist of 1g of p-dimethylaminobenzaldehyde in 10 ml methanol, to which is added 10 ml concentrated ortho-phosphoric acid. The colours of all the spots obtained by the specimens were noted along with their R_f values.

The lower detection limits of the psilocin and psilocybin standards were determined by serial dilutions of the respective standards and separated by chromatography until the spots were not seen.

High Pressure Liquid Chromatography

The model used was a Hewlett Packard Series 1050 liquid Chromatograph equipped with a variable wavelength UV detector, a Valco model AH 60 injection valve (10 µl by loop) and a HP series II integrator. The separation was performed on a 250 mm x 4.6 mm I.D. column, packed with sperisorb 5 µm ODS –1. Solvent A was water containing 0.3M ammonium acetate and buffered to pH 8 with ammonia, solvent B was methanol containing 0.3M ammonia acetate. The solvents were filtered using a 0.45 µm nylon membrane filter (Supelco) and degassed using helium. The mobile flow composition was 75% solvent A and 25% solvent B carried out at room temperature.

RESULTS AND DISCUSSION

Table 1 shows the results of the classification of seventeen samples collected in the study. Sample 12 was collected on a playing field at Santa Flora, Southern Trinidad. The mushroom was further classified to be the species *Psilocybe caerulescens*.

Psilocybe caerulescens has been found in Alabama, Northern Florida and Mexico, but until now has not been known to occur in Trinidad.

The TLC results indicated that sample 12 contains both psilocin and psilocybin. Table 2 shows the R_f values obtained for psilocin and psilocybin present in sample 12 using both solvent systems.

Table 2. Results of Thin Layer Chromatography on sample 12.

Solvent System	A	B
Retention time (Rf) of Psilocybin Standard	40	15
Retention time (Rf) of Psilocin Standard	70	38
Retention time (Rf) of the components of sample 12 extract	40, 70	15, 38

The lower detection limit of psilocin and psilocybin was determined to be approximately 0.05 mg/ml.

The methanolic extract of sample 12 was efficiently separated by HPLC using the 5 μm spherical C18 packing support material, isocratic water/methanol solvent system containing ammonium acetate buffer. Psilocin and psilocybin were identified. The retention times were 2.88 minutes and 4.22 minutes respectively.

Quantitation of psilocin and psilocybin was done using an internal standard calibration method, i.e. addition of 80 µg/ml internal standard solution to standard solutions of psilocin and psilocybin in the concentration range 9 - 75 µg/ml. The data was analysed using linear regression. A linear relationship of ($r>0.999$) was found at 269 nm.

The amount of psilocybin and psilocin contained in the *Psilocybe caerulescens* mushroom was found to be

0.01% and 0.003% respectively.

CONCLUSION

A mushroom collected on a playing field in South Trinidad has been identified as *Psilocybe caerulescens* and found to contain 0.01% psilocybin and 0.003% psilocin. This is the first record of a psychedelic mushroom in Trinidad.

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Metamysidopsis insularis (Crustacea: Mysidacea): The Life History of a Mysid Species Suitable for Toxicological Testing in the Tropical Americas

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ABSTRACT
Mysid species are routinely used in many regions temperate for toxicological assessment of chemicals and industrial and municipal effluents. *Metamysidopsis insularis* has recently been used in Trinidad and Tobago for toxicity tests, however, not much is known about its life cycle. Newly hatched juveniles were maintained under laboratory conditions and sampled daily for a period of 26 days. The mean body length was determined and used to generate a growth curve for *M. insularis.* It was found that for *M. insularis,* the maximum growth phase occurred during the first sixteen days and organisms attained sexual maturity between 12 - 15 days. Eight moults in five growth phases were identified for this species. The main stages identified were, early juveniles (0 - 2 days), juveniles (3 - 6 days), late juveniles (7 - 12 days), early adults (13 - 15 days) and adults (>16 days). These growth phases (early juvenile, juvenile, late juvenile, early adult and adult) were similar to those identified for *Americamysis bahia,* however, the days at which these stages occurred were different from *M. insularis.*

INTRODUCTION

Mysids are small shrimp-like crustaceans which vary in size from 0.5 - 20 mm. They live in a variety of aquatic environments, including coastal and open sea waters, estuaries and other brackish water ecosystems. Mysid species are routinely used in many temperate regions for toxicological assessment of chemicals and industrial and municipal effluents. Investigators first began using the estuarine mysid species, *Americamysis bahia* (formerly *Mysidopsis bahia*) for toxicity tests, at the U.S. Environmental Protection Agency, Environmental Research Laboratory in Gulf Breeze, Florida, (Nimmo *et al.* 1977). Mysids have proven to be highly sensitive to a wide range of toxic substances (Nimmo and Hamaker 1982; Gentile *et al.* 1982; Gentile *et al.* 1983; ASTM 1987; Lussier *et al*. 1991; Suter and Rosen 1988; US EPA 1993; Buckler *et al.* 2003). Toxicity data presently exists for several temperate mysid species, *Americamysis bahia*, *Americamysis bigelowi* (formerly *Mysidopsis bigelowi*) and *Americamysis almyra* (formerly *Mysidopsis almyra*) (Buckler *et al.* 2003). However, the largest body of toxicological data (Ward 1984; Buckler *et al.* 2003) exist for *Americamysis bahia* which is a designate standard test species in programs such as the US EPA Ocean Disposal Permit Program and the National Pollutant Discharge Elimination System (NPDES), as well as other toxicological testing programs (Lussier *et al.* 1999; Kuhn *et al.* 2000).

Though information is readily available about the responses of these organisms to various toxicants, very little is available on their life cycle. McKenney (1998) investigating the effects of pesticide exposure on *Americamysis bahia*, identified five general phases throughout its life cycle (Early Juvenile [day 1], Juvenile [day 4], Advanced Juvenile [day 10], Young Adult [day 16] and Adults [day 20]). Lussier *et al*. (1988) indicated that the first moult for *Mysidopsis* species occurs within 24 h of release from the brood pouch. The US EPA (1993) also reported that *Americamysis bahia* reaches sexual maturity in 12 - 20 days, however they did not identify specific moults. Lussier *et al*. (1991) reported an average of six moults during the first 18 days, with 2 to 4 days intervals between moults for both *Americamysis bahia* and *Americamysis bigelowi*.

Metamysidopsis insularis, a tropical mysid species, is commonly found along the western coast of Trinidad, with large populations occurring in mangrove swamps (Caroni and Oropouche). This species is also reportedly found throughout the Caribbean (Lesser Antilles, Brattegard 1970) and Latin America (Quintero and Zoppi de Roa 1973). Mysids are pericarids with a well developed carapace. They typically occur in large swarms in the upper 30 cm of the water column. Though toxicity tests have been conducted using this species, (Elias-Samlalsingh 2000; Garcia 2001; Elias-Samlalsingh and Agard 2004; Mohammed 2005), little is known about its life cycle. Quintero and Zoppi de Roa (1973) identified five stages in the brood pouch of adult females but no investigation was done on development, post hatching.

Though *Metamysidopsis insularis* has been proposed as a suitable toxicity test species for use in Trinidad and the wider Caribbean, nothing is known of its life cycle. This present study sought to investigate the life history of *Metamysidopsis insularis,* a tropical mysid species.

METHODS

Laboratory Culture

M. insularis was collected from the Caroni Swamp in Trinidad, and identified using taxonomic keys by Brattegard (1970). Culture methods generally followed those published by Nimmo *et al*. (1978), Reitsema and Neff (1980) and US EPA (1993). Animals were maintained in a re-circulating system which consisted of a large glass aquarium (76 L) with an undergravel filter (Ward 1984; Nimmo *et al*. 1991).

Culture tanks were maintained at a salinity of 25‰, a temperature of 25°±1° C, pH at 8.0 - 8.4 and dissolved oxygen at greater than 80% saturation. Cultures were illuminated on a 12 h light:12 h dark regime using "cool-white" fluorescent bulb. Animals were fed twice daily with *Artemia salina* (Bio-Marine, California) nauplii.

Culture Technique

Adult mysids were transferred from the holding tanks with an aquarium net (500 µm mesh) to the hatching assembly. The hatching assembly consisted of a spawning chamber made from a 2 L plastic container in which the base was covered with a 1mm mesh. This was then suspended in a 20 L glass aquarium fitted with an undergravel filter, fed with newly hatched *Artemia* nauplii and left overnight.

This hatching system proved quite efficient in achieving good separation of juveniles from adults, thus preventing predation of the young by adults and damage to juveniles by use of mechanical separation techniques. When the juveniles were released, they passed through the mesh and into the aquaria, while the adults were retained in the spawning chamber. The spawning chamber was subsequently removed and the adults transferred back to the holding tank. Juveniles were maintained in the spawning tank and fed ad libitum with newly hatched *Artemia* nauplii, which were found to be an appropriate size for young mysids.

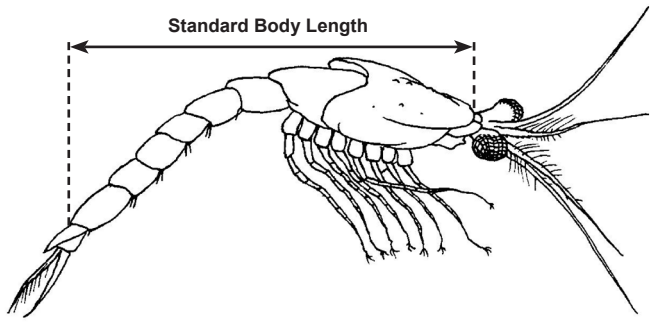

Fig. 1. Diagram showing the distance measured to determine the total standard body length (Modified from Quintero and Zoppi de Roa 1973).

Life History Assessment

A minimum of ten juveniles were sampled daily, preserved in Baker's formol calcium and stored at 4º C until required for analysis. Sampling was conducted over a 26 day period. The standard body length (base of eyestalk to anterior of the telson) (Fig. 1) was determined for each animal. The body length for each day was ranked and the upper and lower quantiles and median range determined. The lower quantile was determined as the $\frac{1}{4}(n + 1)^{th}$ value and the upper quantile was the $\frac{3}{4}(n + 1)^{th}$ value, where n = total number of animals. The mean length was calculated from the median range and used to generate a growth curve for *M. insularis*. Morphological characteristics such as changes in the telson and the appearance of male and female reproductive structures were also noted. Specific moults were identified from the growth curve, as these resulted in a significant change in average body length of the organism. ANOVA and TUKEY HSD analysis (SYSTAT Ver. 5.0) was used to determine whether the mean body lengths were significantly different between days.

RESULTS

Life History Studies

The growth cycle of *M. insularis* was determined from the time juveniles were release from the brood pouch (Day 0) until they became adults. Embryos hatch in the brood pouch of the females, where they remain until appendages develop. When released, juveniles are morphologically similar to the adults. Larval development in *M. insularis* can therefore be described as being epimorphic.

Adults (Fig. 1) range in length from 4 - 5 mm with females (4.0 - 4.9 mm) being slightly larger than males (3.0 - 4.3 mm). Adult males are easily distinguished from females by the presence of pleopods in the first five abdominal segments as well as male reproductive structures. Adult females have a well defined brood pouch.

Morphological Studies

The maximal growth period occurred during the first sixteen days, after which, no substantial increase in size (length) was apparent (Fig. 2). During this time, eight moults was evident (Fig. 2). Using the moults, it was possible to identify five distinct growth phases for this species (Table 1).

No significant increase in size ($P>0.05$) occurring between day 0 - 2 (Early Juvenile Phase). The average length increased from 1.120 ± 0.009 mm (day 0) to 1.350 ± 0.006 mm (day 2). Day 0 animals ranged in length from 1.04 - 1.14 mm, after day one the length ranged from 1.23 - 1.35 mm. The first moult of the early juvenile phase was identified on day two (Fig 2). Juvenile organisms showed no distinct morphological features that could

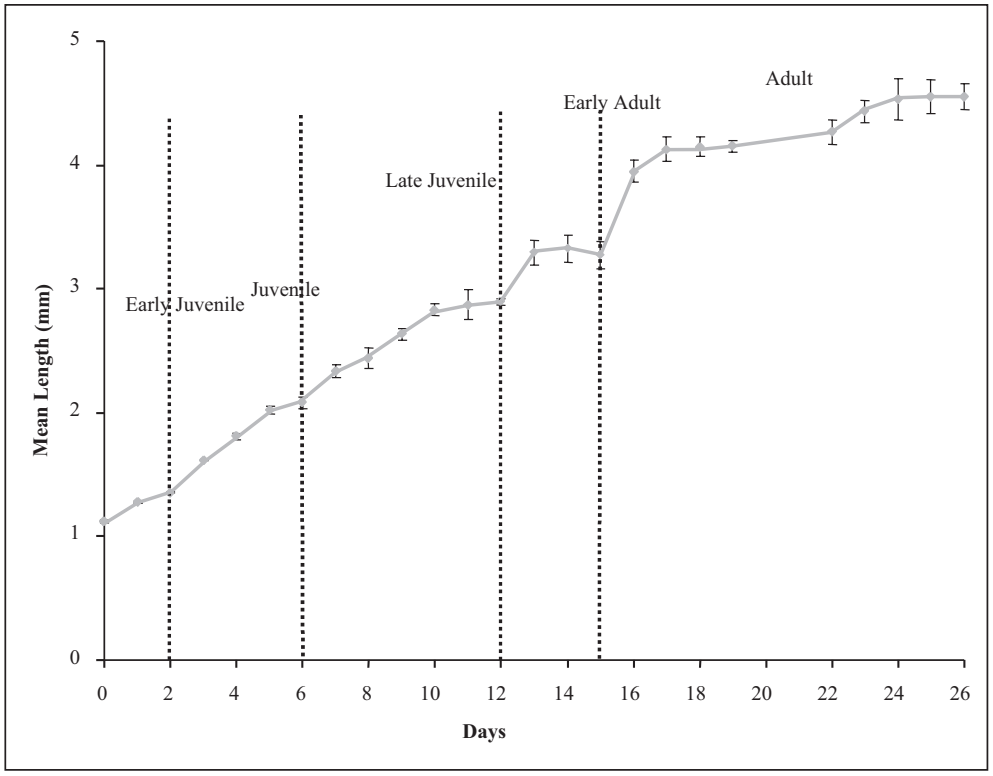

Fig. 2. Growth curve for *Metamysidopsis insularis.*

be used to differentiate males and females. The telson generally appeared flattened, with two centrally positioned spines (Fig. 3a). This growth phase (between 0 - 2 days) represents the early juvenile phase at the end of which (on day 2) the organism moults and enters the juvenile phase.

The juvenile phase extends from day 3 to 6, during which three moults were identified (Table 1). The organisms in this phase show significant ($P<0.05$) increases in body length when compared with the early juveniles. The average body length increased from 1.35 ± 0.006 mm (day 2) to 1.61 ± 0.004 mm (day 3). At the end of the juvenile phase, on day 6, the average body length was 2.08 ± 0.05 mm with moults on day three, four and six during this phase (Table 1, Fig 2). It was found that variation in

Table 1. Growth pattern of *Metamysidopsis insularis* in the laboratory and general characteristics of each growth phase.

Growth Phase	Growth Period (days)	No. of Moults	Standard body length (mm) for each growth phase	Recognised Characteristics
Early juvenile	0 - 2	1	1.12 – 1.35 (*n*=31)*	Eyes of moderate size. Apex of telson appears flattened with two centrally positioned spines of equal length. No morphological differences between males and females.
Juvenile	3 - 6	3	1.61 – 2.08 (*n*=31)*	Apex of telson appears rounded with two centrally positioned spines still present up to day four. At day five approximately seven spines were present, with the central two being the longest. No morphological differences between males and females were evident.
Late juvenile	7 - 12	3	2.33 – 2.89 (*n*=54)*	The apex of the telson appears rounded with at least twelve spines of which the central two are the longest. Between days 8 - 9, developing biramous pleopods and gonads were visible in males. Female brood pouch was visible (8 - 10 days).
Early adult	13 - 15	1	3.27 – 3.32 (*n*=78)*	Apex of telson rounded with no further increase in the number of spines. Well-developed biramous pleopods and fully developed gonads in males were evident. Female brood pouch shows increase vascularisation through this phase.
Adult	> 16	Infrequent moults	3.95 – 4.55 (*n*=72)*	Apex of telson rounded with a regular row of approximately twenty-four blunt spines of which the central two are the longest. Eggs become apparent in the now mature brood pouch. No significant changes were observed in male reproductive structures.

**n* = sample size

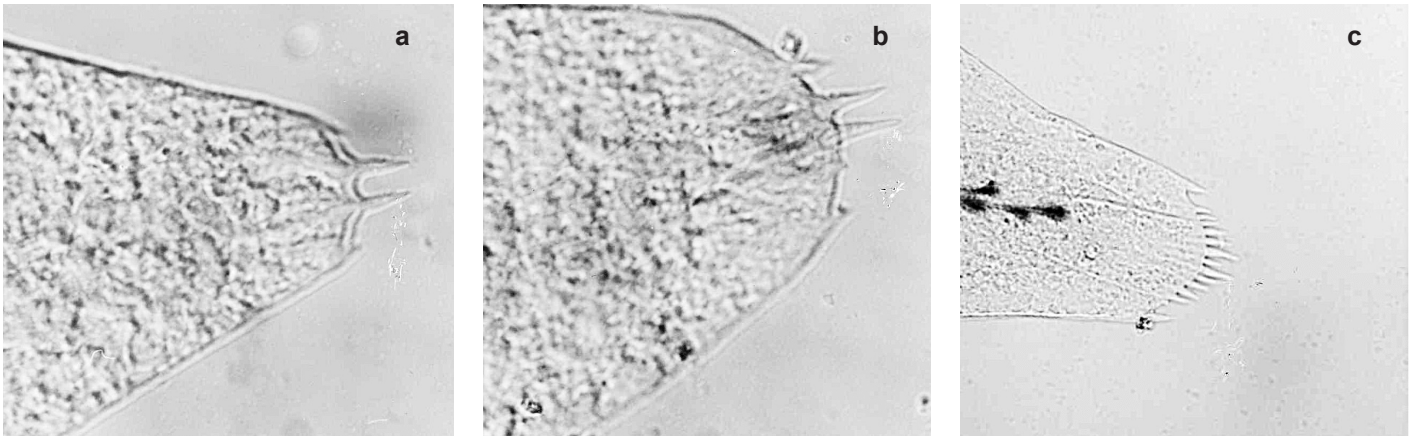

Fig. 3. Morphological changes in the telson at different growth stages, (a) 2-day olds, (b) 4-day olds and (c) 7-day olds.

body length became increasingly distinct from this stage onwards. At day four, the telson appeared rounded with two spines (Fig. 3b). However, seven spines were evident in 5-day old animals.

The late juvenile phase occurred between days 7 to 12, during which three moults (Table 1, Fig. 2) were identified. The average length of animals increased from 2.08 ± 0.05 mm on day six to 2.33 ± 0.05 mm on day seven, the beginning of the late juvenile phase (Table 1). The telson of seven day old animals had about twelve spines (Fig. 3c). However, no increase in the number of telson spines was observed following subsequent moults within this phase. During the latter part of this growth phase (days 10 - 12), reproductive structures became evident. In the females, early brood pouches appeared by day 9 (Fig. 4a) and by day 10, blood vessels became evident. Male gonads appear at about day 9 (Fig. 4b) and pleopods were apparent at about day 7.

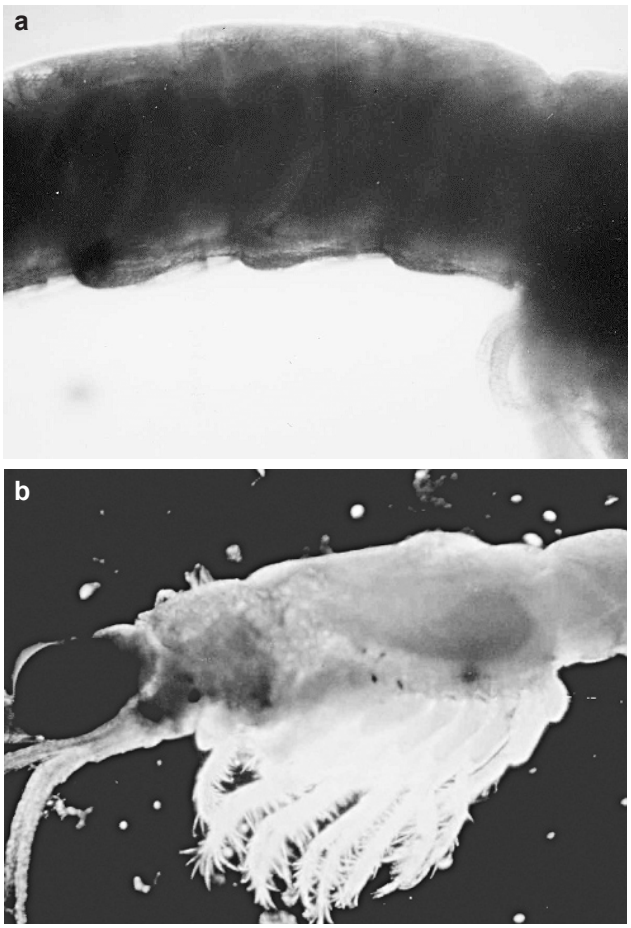

Fig. 4. Appearance of sexual characteristics in (a) females and (b) males.

On day 12, the organism moulted and entered the early adult phase which extended from day 13 - 15. During this phase they attained sexual maturity, with both males and females having fully developed reproductive structures. Only one moult occurred at the end of this phase. The average length of animals showed a significant increase from 2.89 ± 0.03 mm at the end of the late juvenile phase to 3.27 ± 0.11 mm at the start of the early adult phase ($P<0.05$). Eggs become apparent in the brood pouch which also showed increased vascularisation, and male reproductive organs appear fully developed. No additional changes in the structure of the telson became evident during this phase. Moults did not occur as frequently as in the earlier growth phases.

The adult stage began after day 16 (Table 1) with few moults evident. Average body lengths of 16 day old animals were 3.95 ± 0.09 mm. A large number (approximately 12 pairs) of very closely set apical spines were apparent on the telson. After day 18, moulting can be described as sporadic and no substantial increase in size was evident.

DISCUSSION

M. insularis has been maintained successfully in the laboratory using a re-circulating system with an undergravel filter. This method is quite similar to those described by other authors working on temperate species such as *Americamysis bigelowi* (Lussier *et al.* 1988). The methods also proved adequate for successful spawning

of the mysids under laboratory conditions. Spawning was best achieved by a small increase in salinity (<10‰) above or below that of the holding water. It was observed that salinity increases greater than this often resulted in high adult mortality. Generally, *Metamysidopsis insularis* were maintained in the laboratory for approximately three months. Lussier *et al*. (1988) reported that the normal life span of mysids varied, but *Americamysis bahia* and *Americamysis bigelowi* in laboratory cultures had a maximum life span of 3 - 5 months at a temperature of 25°C and 30‰ salinity.

The maximum growth period for *Metamysidopsis insularis* occurred between days 0 and 16 and was characterised by five distinct growth phases (Table 1) with eight moults. Each growth phase was defined by a significant increase in body length after moulting. These growth phases (early juvenile, juvenile, late juvenile, early adult and adult) were similar to those identified by McKenney (1998). However, the days at which McKenney (1998) identified these stages (Early Juvenile [day 1], Juvenile [day 4], Advanced Juvenile [day 10], Young Adult [day 16] and Adults [day 20]) for *Americamysis bahia*, were different from *M. insularis*. For *M. insularis,* the stages were; Early Juvenile [day 0 - 2], Juvenile [day 3 - 6], Late Juvenile [day 7 - 12], Early Adult [day 13 - 15] and Adult [> day 16]. Lussier *et al*. (1988) identified nine moults in the first eighteen days for *Americamysis bahia* cultured at 25°C and 30‰ in the laboratory. For *Americamysis bigelowi*, the first moult occurred on day four followed by six successive moults up to day 12. At sexual maturity, moults were generally less frequent, averaging one every three days (Lussier *et al*. 1991). The first moult for *Metamysidopsis insularis* occurred two days after release from the brood pouch. Moulting occurs frequently and at regular intervals, until sexual maturity (day 13 - 15), after which it becomes less frequent. Laboratory cultures of *Americamysis bahia* reached sexual maturity in 12 to 20 days, depending on the culture conditions of water temperature and diet (Nimmo *et al.* 1977).

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NATURE NOTE

Capture and Breeding of the Tobago Caiman

While conducting studies and collecting specimens for his two volume work, "Los Crocodylia de Sur America," Professor Frederico M. Medem (1912-1984) visited Trinidad in 1972, and with my brother Julius O. Boos, made a trip to Tobago to collect and examine specimens of the "alligators" which had been recorded from this island by Woodcock (1867), though not officially listed until 1969 by Mertens.

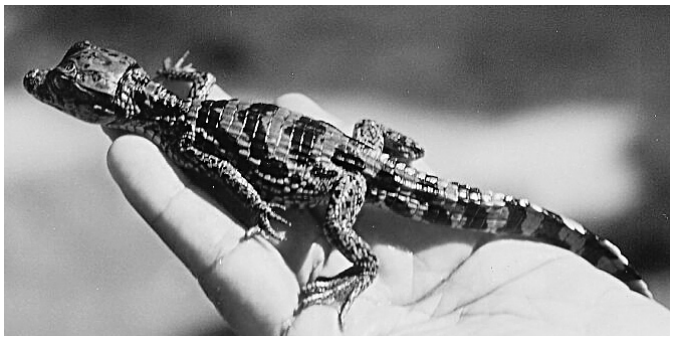
The specimens, collected at Hillsborough Dam in the mountains of central Tobago, sparked the interest of Medem, as they seemed below the 'normal' adult size for the species *Caiman crocodilurus*. Medem (1983) later stated that the Tobago population "posiblemente representa un nueva subspecie," and in correspondence with the author, in February 1983, he again stated, "I am almost sure that the caimans from Tobago represent a new subspecies, possibly due to island dwarfism." In August, 1983 he encouraged me to "catch several caimans from Tobago alive, adults of both sexes, and to establish a controlled breeding unit somewhere in Trinidad".

Four years after Medem's death, an expedition was mounted by the Zoological Society of Trinidad and Tobago Inc. Between the 19th and 21st of September, 1988 the author, keepers John Seyjagat and Nicholas Leith, and Council member Geoffrey Gomes, captured three adults (one male, two females,) and two juvenile caimans at Hillsborough Dam in Tobago. These caimans were collected at night, after locating them by reflected eye-shine, by slowly approaching in an inflatable boat and noosing them from the end of a bamboo pole. This required powerful hand-held flashlights, two men to paddle and a fourth man to slip the noose over the head of the caiman. One female was captured during the daylight hours, while apparently intent on protecting her territory; she kept returning to within noosing range as we imitated the calls of young caimans.

By July, 1990 both females looked gravid although no mating had been observed. The pond in the enclosure measured 6.5 x 6 m and was about 1 m deep. There was an adjacent area of "land" semi-circular in shape with a diameter of 6.5 m. On this land, chopped up bush and grasses was supplied for the nest construction by the females. However, on the morning of August 17, 1990, and again on August 22, first, 21 and then 24 eggs were seen to have been discarded in the meter-deep water of the pond. These eggs were hurriedly retrieved, and placed into an artificial incubator, in the hope that they were fertile and that they had not drowned. Incubation consisted of placing the eggs in a glass aquarium with a substrate of peat-moss, and temperatures between 31 and 32 ^{0}C were maintained by a heat lamp suspended above the open top of the aquarium.

Egg weight and measurements were as follows:
August, 17: 55-59 g, 53-63 mm x 29-30 mm diameter; August 22: 63-73 g, 58-69 mm x 30-31 mm diameter.

By November 16, 1990, two caimans hatched from the first batch laid. In this batch there were nine spoiled eggs, ten were fertile but the embryos were dead, and the total incubation was 75 days. Between November 26 and December 2, 1990 nine more eggs hatched from the second batch, eight were spoiled, seven were fertile but dead, and the total incubation was from 96 to 102 days. Of the eleven Tobago caimans that hatched, six survived for several years until I lost track of them. By January 31, 1991 they averaged 24.3 cm total length and 40.2 g in weight. These young should be carefully monitored to chart their progress and periodic measurements made of the adults to monitor their growth. The progress of any future breeding should also be recorded.



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Freshwater Macroinvertebrates and Their Habitats in Dominica

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ABSTRACT

A survey of macroinvertebrates inhabiting freshwater habitats of Dominica was conducted from 1995 to 2005. Qualitative collections were made by sweeping a dip net through the water column, agitating the bottom substrate, and by hand examination of rocks, plants, and debris submerged in both standing and flowing bodies of water across the island. Water temperature and elevation were also recorded at each site. Ecological conditions were generally suitable to support many groups of freshwater macroinvertebrates, although high water temperatures, suspected low dissolved oxygen concentrations, and low pH values at some sites may have limited some populations. These collections yielded at least 62 taxa, 29 of which are reported for the first time from Dominica, bringing the total number of freshwater macroinvertebrates known from this island to 116. Dominant taxa collected included gastropods, ephemeropterans, odonates, hemipterans, trichopterans, and dipterans. Waterfalls, which were thought to act as barriers to upstream movement of non-flying invertebrates, appear not to limit the distribution of most decapods, but may impede nerite snails. Generally the freshwater macroinvertebrate fauna of Dominica is sparse, most likely due to the oceanic origin of the island and challenges colonizing such a habitat.

Key words: Freshwater invertebrates, Dominica, Lesser Antilles, stream, waterfall.

INTRODUCTION

Dominica is the southernmost of the Windward Islands in the Lesser Antilles. This island is volcanic in origin, emerging from the sea floor about 25 million years ago, with associated geothermal activities continuing today. Dominica comprises an area of approximately 746 square kilometers and rises to an elevation of 1,424 meters. The combination of high elevation and humid trade winds results in high precipitation which drains into the many streams and rivers that flow swiftly down the mountains toward the sea.

A limited amount of information regarding the freshwater invertebrates of the Lesser Antilles and other small Caribbean islands is available. Biodiversity surveys of aquatic macroinvertebrates have been conducted on some islands including Barbados (Bass 2003a), St. Vincent (Harrison and Rankin 1975, 1976a, 1976b), St. Lucia (McKillop and Harrison 1980), Antigua (Bass 2005), Grenada (Flint and Sykora 1993; Bass 2004b), St. Kitts (Bass 2006), Nevis (Bass 2000, 2006), Tobago (Hart 1980; Nieser and Alkins-Koo 1991; Botosaneanu and Alkins-Koo 1993; Flint 1996; Bass 2003b), and Trinidad (Hynes 1971; Alkins *et al*. 1981; Alkins-Koo 1990; Nieser and Alkins-Koo 1991; Botosaneanu and Alkins-Koo 1993; Flint 1996). Investigations describing the fauna of decapods (Chace and Hobbs 1969), odonates (Donnelly 1970), trichopterans (Flint 1968), and invertebrate stream drift (Bass 2004a) have already been conducted in Dominica. However, these previous investigations in Dominica were limited in scope or may be outdated, and additional collections may yield previously unknown populations or species.

The objectives of this investigation include: 1) to determine the species of aquatic macroinvertebrates inhabiting freshwaters of Dominica, 2) to note the microhabitat preferences of each species, 3) to determine the relative abundance of each species, and 4) to compare the Dominica freshwater macroinvertebrate fauna to other such fauna on the different Lesser Antillean islands.

MATERIALS AND METHODS

Sixty-six sampling sites were established in various freshwater habitats across Dominica (Fig. 1). Collections were made during December 1995, January 1996, June 1996, May 2001, and March 2005. Water temperature was also recorded from each site at the time of collection. Some of those sites were visited more than once. In addition, the effect of waterfalls on the species composition of stream macroinvertebrate communities was addressed in Dominica by comparing collections made from streams 200 m above and below five waterfalls during March 2005.

Several methods of collecting were employed to ensure as many species as possible were captured. Submerged debris, such as stones, leaves, and wood, were carefully examined and inhabitants were picked from the substrate using forceps. A dip net (mesh = 0.5 mm) was swept through aquatic vegetation and the water column to capture macroinvertebrates occupying those microhabitats. The microhabitat from where each specimen occurred was noted. Collecting efforts continued at each site until no additional species were encountered. These collecting methods were similar to those used on other islands (Bass 2003a, 2003b, 2003c, 2004b, 2005, 2006) so comparisons of the results could be made. In addition, drift nets were used twice at one site to collect samples

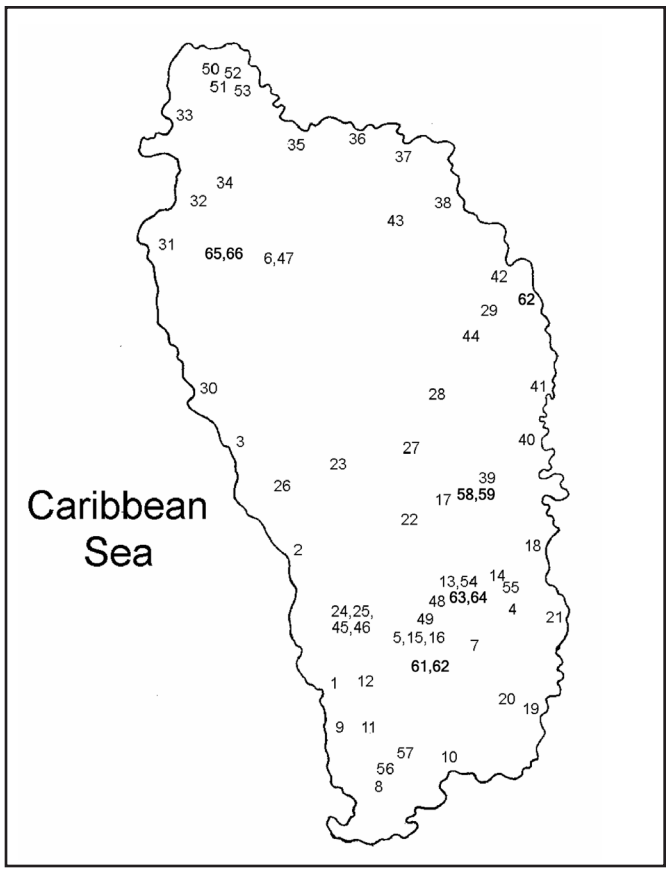

Fig. 1. Map indicating location of collecting sites in Dominica. Specific locations, dates, approximate elevations, and water temperatures at sites of collections are listed in legend of Table 1.

during the diel cycle.

Decapod crustaceans were sometimes noted and released because they have been already well-studied in Dominica (Chace and Hobbs 1969). Other specimens were preserved in 70% ethanol and returned to the laboratory for further identification. Taxa that could not be identified to the species level were separated into morphospecies for subsequent analysis. Sorenson's index of similarity (1948) was used to compare these collections in Dominica with similar endeavors on other small Caribbean islands. Published collections by other researchers were also consulted and included in the final listing of species, although they were not used in the similarity analysis, due to variations in collecting efforts.

RESULTS AND DISCUSSION

Freshwater Habitats

There is probably no other island of the Lesser Antilles that has more freshwater habitats than Dominica. These include streams, rivers, lakes, and springs.

There are 365 named streams on Dominica. High annual rainfall provides the water necessary to maintain flow year round in most streams and rivers, even during the relatively drier winter months. The few streams that do cease to flow and become dry are re-colonized quickly by populations that survived in the persistent headwaters or moved upstream when flow resumed (Chace and Hobbs 1969). The steep slopes result in many areas of fast flowing water, presumably contributing to high dissolved oxygen levels. In addition, Chace and Hobbs (1969) suggest Dominican waters are the least polluted of any in the Caribbean region due to the lack of upstream development and high flushing rates. Large waterfalls also exist in several of the drainages.

Only three lakes exist on Dominica: Freshwater Lake, Boeri Lake, and Boiling Lake. Freshwater Lake is actually a reservoir created to store water. Boeri Lake, formed within the crater of an old volcano, possesses steep sides and a maximum depth of approximately 40 meters. Boiling Lake resulted from a flooded fumarole and is the second largest lake in the world that actually boils. All of these lentic environments are located on the southern portion of the island.

Some of the lesser-known freshwater habitats on Dominica are its springs and seeps, locally known as soufreires. Water emerging from these soufreires may be either hot or cold, depending on the geology of the local area and the origin of the emerging water. High water temperatures, sometimes exceeding 41° C and pH values measured as low as 3.0 would likely lead to low dissolved oxygen concentrations. Usually these waters are rich in sulfur as evidenced from the strong odor they emit.

Freshwater Macroinvertebrates

I collected a total of at least 62 species representing 13 major groups from the freshwater habitats of Dominica. Twenty-nine of these species are reported for the first time from the island (Table 1). This brings the total number of freshwater macroinvertebrates known from Dominica to 116 taxa.

Platyhelminthes

Only one flatworm, *Girardia* sp., was found with specimens being collected from only two stream sites in south-central Dominica (Table 1). Although this is the first report of an aquatic flatworm from Dominica, this genus has been reported from the other Lesser Antillean islands of Barbados (Bass 2003a), Grenada (Bass 2004b), St. Kitts (Bass 2006), and Nevis (Bass 2006).

Gastropoda

A total of five species of freshwater snails were collected from Dominica (Table 1). Two of these, *Neritina punctulata* and *N. virginea*, are nerites which require marine waters during a portion of their life cycle. *N. virginea* has a highly variable shell pattern and is widespread in

Table 1. List of freshwater macroinvertebrates, including collecting sites, life cycle stages present, relative occurrence, and microhabitats in Dominica during December 1995, January 1996, June 1996, May 2001, and March 2005. *Indicates taxa previously not reported from Dominica. **Indicates individuals of this group were often observed, but not always collected, at many sites. Life cycle: A, adult; J, juvenile; L, larva; N, nymph. Occurrence: +++ abundant, ++ common, + rare.

Taxa	Collection	Life Cycle	Occurrence	Microhabitat	Trophic Relationship[1]
Platyhelminthes					
Girardia sp.*	25, 64	Adult	+	Detritus	Predator
Gastropoda					
Melanoides tuberculata	1, 4, 9-10, 12, 18, 23, 27-29, 31-34, 36-37, 39-41, 43-44, 53, 62	Juvenile, Adult	+++	Rock, Detritus	Herbivore
Neritina punctulata	1-2, 18, 23, 26-27, 29-35, 37-38, 42-43	Juvenile, Adult	+++	Rock	Herbivore
Neritina virginea	18, 38, 46	Adult	++	Rock	Herbivore
*Physella acuta**	4, 55	Juvenile, Adult	+	Detritus	Detritivor
Biomphalaria sp.	4, 13	Adult	+	Detritus	Detritivor
Amphipoda					
*Hyalella azteca**	13, 54-55	Juvenile, Adult	++	Detritus	Detritivor
Decapoda**					
Atya innocous	63, 67	Juvenile, Adult	++	Detritus	Detritivor
Atya scabra	67				Detritivor
Coenobita clypeatus	62, 67	Adult	+	Detritus	Detritivor
Guinotia dentata	46, 48-49, 58-60, 67	Juvenile, Adult	++	Detritus	Detritivor
Jonga serrei	67				Detritivor
Macrobrachium acanthurus	67				Predator
Macrobrachium carcinus	67				Predator
Macrobrachium crenulatum	67				Predator
Macrobrachium faustinum	45-46, 48, 62, 65, 67	Juvenile, Adult	++	Detritus	Predator
Macrobrachium heterochirus	67				Predator
Micratya poeyi	45, 58-59, 62, 64, 67	Juvenile, Adult	++	Detritus	Detritivor
Potimiram glabra	45-46, 48, 62, 65, 67	Juvenile, Adult	++	Detritus	Detritivor
Xiphocaris elongata	67				Detritivor
Acari					
Hydrachnida*	12	Adult	+	Detritus	Predator
Ephemeroptera					
Baetidae	2, 5-6, 9-12, 14-18, 20, 23-25, 27-29, 32-33, 35-40, 44-45, 52, 61-64, 66	Nymph	+++	Detritus	Collector
Baetidae - new species?*	27	Nymph	+	Detritus	Collector
Borinquena traverae	67				
Caenis sp.*	30	Nymph	+	Detritus	Collector
Allenhyphes flinti	1, 5, 9-12, 16, 18, 20, 24-25, 27-29, 31, 35, 39-40, 43-45	Nymph	+++	Detritus	Collector
Tricorythodes sp.*	10-12, 15, 20, 23, 25, 27, 32, 35-36, 39-41, 62	Nymph	+++	Detritus	Collector
Odonata					
Anax concolor	67				Predator
Anomalagrion hastatum	67				Predator
Aeshna psilus	67				Predator
Argia concinna	5, 24, 27-29, 31-33, 35, 39, 44-45, 58, 61-64, 67	Nymph	+++	Detritus	Predator
Brachymesia furcata	50, 67	Nymph	+	Detritus	Predator
Brechymorhoga praecox grenadensis	9, 11, 14, 49	Nymph	++	Detritus	Predator
Cannacria herbida	67				Predator
Dythemis sterilis	67				Predator
Enallagma coecum	44, 67	Nymph	+	Detritus	Predator
Erythrodiplax umbrata	67				Predator
Ischnura ramburi	30, 67	Nymph	+	Detritus	Predator
Leptothemis vesiculosa	67				Predator
Lestes forficula	67				Predator
Micrathyria aequalis	67				Predator
Micrathyria didyma	67				Predator
Orthemis ferruginea	56-57, 67	Nymph	+	Detritus	Predator
Pantala flavescens	67				Predator
Protoneura ailsa	67				Predator
Scapanea archboldi	67				Predator
Telebasis sanguinalis	67				Predator
Tramea abdominalis	67				Predator
Triacanthagyna trifida	67				Predator
Unknown Coenagrionidae	53	Nymph	+	Detritus	Predator
Hemiptera					
*Brachymetra albinervis**	3, 6, 17, 24, 26, 28, 31, 33-38, 41-42, 44, 46	Nymph, Adult	+++	Neuston	Predator
Buenoa sp.*	24	Adult	+	Water Column	Predator
*Mesovelia mulsanti**	31	Adult	+	Neuston	Predator
Microvelia sp.*	7, 12, 22, 24, 48, 50-52, 65	Nymph, Adult	+++	Neuston	Predator
*Rhagovelia pulchra**	5-6, 9-15, 17-18, 23-33, 35-36, 38-44, 46-47, 49-50, 53-55, 58-59, 61-63, 65	Nymph, Adult	+++	Neuston	Predator
Lepidoptera					
Noctuidae*	27	Larva	+	Rock	Herbivore

Petrophila sp.*	17, 24-26, 28, 33, 35, 37-42, 46, 49, 52-53, 59-62	Larva	+++	Rock	Herbivore
Trichoptera					
Alisotrichia dominicensis	67				Collector
Alisotrichia lobatus	67				Collector
Alisotrichia orophila	67				Collector
Alisotrichia septempunctata	67				Collector
Alisotrichia wirthi	67				Collector
Atanatolica dominicana	67				Collector
Brachysetodes insularis	67				Collector
Bredinia dominicensis	67				Collector
Cerotina lutea	67				Collector
Chimarra (Chimarra) antilliana	5, 16, 18, 24-25, 28-29, 31-33, 35, 37, 39-41, 43-46, 53, 58, 63-64, 66-67	Larva	+++	Detritus	Collector
Chimarra dominicana	37				Collector
Helicopsyche apicauda	37				Collector
Helicopsyche guadeloupensis	7, 17, 20, 23, 27-28, 31, 34, 36, 67	Larva	+++	Detritus	Collector
Leptonema archboldi	13-14, 67	Larva	+	Detritus	Collector
Neotrichia coniculans	67				Collector
Ochrotrichia brayi	67				Collector
Ochrotrichia campana	67				Collector
Ochrotrichia exclamationis	67				Collector
Ochrotrichia ponta	67				Collector
Ochrotrichia similis	67				Collector
Ochrotrichia spinossima	67				Collector
Oecetis pratti	67				Collector
Oxyethira cirrifera	67				Collector
Oxyethira tega	67				Collector
Phylloicus montisolus	67				Collector
Polyplectropus bredini	67				Collector
Polycentropus insularis	51, 55, 67	Larva	+	Detritus	Collector
Prototilia dominicensis	7, 64, 67	Larva	+	Detritus	Collector
Smicridea (Smicridea) cariba	5, 10, 12, 16, 20, 24-28, 31-32, 43-46, 53, 58, 64, 66-67	Larva	+++	Detritus	Collector
Xiphocentron albolineatum	67				Collector
Xiphocentron fuscum	67				Collector
Xiphocentron sp.	11, 46, 49	Larva	+	Detritus	Collector
Zumatrichia anomaloptera	67				Collector
Zumatrichia antilliensis	67				Collector
Unidentified Trichoptera	52	Larva	+	Detritus	Collector
Megaloptera					
Chloronia antilliensis	7, 67	Larva	+	Detritus	Predator
Coleoptera					
Aleocharinae*	26, 31, 33, 37, 40, 66	Adult	++	Detritus	Predator
Cyphon sp.*	50-51	Larva	+	Detritus	Collector
*Hexanchorus caraibus**	11, 16-18, 25, 27, 58	Larva, Adult	++	Detritus	Collector
*Laccophilus proximus**	13	Adult	+	Detritus	Predator
*Psephenops smithi**	64	Larva	+	Detritus	Scraper
Diptera					
Atrichopogon sp.*	33	Larva	+	Detritus	Collector
Canacidae*	66	Larva	+	Detritus	Scraper
Ceratopogonidae	57	Larva	+	Sediment	Predator
Chironomus sp.*	50-51, 56-57	Larva	++	Sediment	Collector
Corynoneura sp.	29-31, 53, 62	Larva	++	Sediment	Collector
Cricotopus sp.	62, 64, 66	Larva	+	Sediment	Collector
Cryptochironomus sp.*	26	Larva	+	Sediment	Collector
Empididae	48, 57	Larva	+	Detritus	Predator
Endochironomus sp.*	26, 35, 43	Larva	+	Sediment	Collector
Eukiefferiella sp.*	7, 55, 60	Larva	+	Sediment	Collector
Paltostoma sp.	25, 46, 48, 67	Larva	++	Detritus	Collector
Paramerina sp.*	28, 52	Larva	+	Sediment	Collector
Rheocricotopus sp.*	11, 31-33, 35-36, 40, 45-46	Larva	+++	Sediment	Collector
Rheotanytarsus sp.*	33	Larva	+	Sediment	Collector
Simulium antillarum	67				Collector
Simulium spilmani	67				Collector
Simulium tarsale	67				Collector
Simulium sp.	11, 14-16, 28, 45-46, 53, 59, 61, 63, 66	Larva	+++	Sediment	Collector
Thienemanniella sp.	62	Larva	+	Sediment	Collector
Tvetinia sp.*	7, 32-33	Larva	++	Rock	Collector

Trophic relationship[1] – Trophic relationships of insects based on Merritt and Cummins (1996) and non-insects on Thorp and Covich (2001).

Collection Sites (including location, date, approximate elevation, and water temperature at time of collection): 1) Roseau River, Roseau, 30 December 1995 (Elevation = 10m, Water temperature = 24°C); 2) Belfast River, Mahaut, 30 December 1995 (Elevation = 10m, Water temperature = 23°C); 3) Macoucheri River, Macoucheri Estate, 30 December 1995 (Elevation = 10m, Water temperature = 24°C); 4) Freshwater Lake, Morne Macaque, 1 January 1996 (Elevation = 770m, Water temperature = 22°C); 5)

Mourne Paix Bouche River, Providence Estate, 2 January 1996 (Elevation = 500m, Water temperature = 21°C); 6) Syndicate Creek, Syndicate Estate, 2 January 1996 (Elevation = 540m, Water temperature = 21°C); 7) Trois Pitons River (Breakfast River), Boiling Lake Trail, 3 January 1996 (Elevation = 690m, Water temperature = 21°C); 8) Glou Gyak Stream, Soufriere, 6 June 1996 (Elevation = 75m, Water temperature = 44°C); 9) Loubiere Creek, Loubiere, 6 June 1996 (Elevation = 70m, Water temperature = 25°C); 10) Geneva River, Geneva, 7 June 1996 (Elevation = 70m, Water temperature = 26°C); 11) Loubiere Creek Tributary, Chateau Estate, 7 June 1996 (Elevation = 25m, Water temperature = 25°C); 12) Roseau River, Morne Louis, 7 June 1996 (Elevation = 70m, Water temperature = 27°C); 13) Boeri Lake, Morne Macaque, 7 June 1996 (Elevation = 905m, Water temperature = 21°C); 14) Clarkes River, Boeri Lake Trail, 7 June 1996 (Elevation = 770m, Water temperature = 21°C); 15) Morne Paix Bouche River, Providence Estate, 7 June 1996 (Elevation = 500m, Water temperature = 23°C); 16) Morne Paix Bouche River - Drift Sample, Providence Estate, 7-8 June 1996 (Elevation = 500m, Water temperature = 23°C); 17) Emerald Pool, 8 June 1996 (Elevation = 410m, Water temperature = 24°C); 18) Roselie River, Roselie, 8 June 1996 (Elevation = 2m, Water temperature = 26°C); 19) Pointe Mulatre River, Ford, 8 June 1996 (Elevation = 10m, Water temperature = 26°C); 20) River Blanche, Laroche, 8 June 1996 (Elevation = 115m, Water temperature = 26°C); 21) Taberi River, Corosol, 8 June 1996 (Elevation = 5m, Water temperature = 26°C); 22) River Deux Branches, Morne Trois Pitons, 8 June 1996 (Elevation = 540m, Water temperature = 23°C); 23) Layou River, Suspension Bridge, 8 June 1996 (Elevation = 60m, Water temperature = 27°C); 24) Check Hall River, Springfield Estate, 9 June 1996 (Elevation = 290m, Water temperature = 22°C); 25) Check Hall River - Drift Sample, Springfield Estate, 8-9 June 1996 (Elevation = 290m, Water temperature = 22°C); 26) Layou River, near Boxing Shed, 9 June 1996 (Elevation = 15m, Water temperature = 26°C); 27) River Deux Branches, Bells, 9 June 1996 (Elevation = 225m, Water temperature = 25°C); 28) Riviere d'Or, Bassin Will, 9 June 1996 (Elevation = 225m, Water temperature = 25°C); 29) Pagua River, Concord, 9 June 1996 (Elevation = 65m, Water temperature = 28°C); 30) Bateli River, Morne Raquette, 9 June 1996 (Elevation = 5m, Water temperature = 23°C); 31) Espagnol River, Pointe Ronde, 9 June 1996 (Elevation = 10m, Water temperature = 25°C); 32) Picard River, Picard Estate, 10 June 1996 (Elevation = 15m, Water temperature = 26°C); 33) Manicou River, Tanetane, 10 June 1996 (Elevation = 30m, Water temperature = 26°C); 34) Indian River, Sugar Loaf Estate, 10 June 1996 (Elevation = 25m, Water temperature = 26°C); 35) Blenheim River, Blenheim Estate, 10 June 1996 (Elevation = 15m, Water temperature = 27°C); 36) Hampstead River, Hampstead Estate, 10 June 1996 (Elevation = 10m, Water temperature = 28°C); 37) Hodges River, Hodges Estate, 10 June 1996 (Elevation = 15m, Water temperature = 26°C); 38) Melville Hall River, Melville Hall, 10 June 1996 (Elevation = 2m, Water temperature = 28°C); 39) L 'Or River, Fond Melle, 11 June 1996 (Elevation = 115m, Water temperature = 24°C); 40) Castle Bruce River, Raymondstone, 11 June 1996 (Elevation = 25m, Water temperature = 26°C); 41) Richmond River, Richmond, 11 June 1996 (Elevation = 55m, Water temperature = 26°C); 42) Pagua River, Barakua, 11 June 1996 (Elevation = 10m, Water temperature = 26°C); 43) Melville Hall River, Vauxhall, 11 June 1996 (Elevation = 60m, Water temperature = 25°C); 44) Banana Gutter Creek, Stonefield Estate, 11 June 1996 (Elevation = 145m, Water temperature = 25°C); 45) Check Hall River - Drift Sample, Springfield Estate, 14-15 May 2001 (Elevation = 290m, Water temperature = 22°C); 46) Check Hall River, Springfield Estate, 15 May 2001 (Elevation = 290m, Water temperature = 22°C); 47) Syndicate Creek, Syndicate Estate, 16 May 2001 (Elevation = 540m, Water temperature = 22°C); 48) Middleham Falls, Middleham Estate, 17 May 2001 (Elevation = 620m, Water temperature = 21°C); 49) Mourne Paix Bouche River, Providence Estate, 17 May 2001 (Elevation = 500m, Water temperature = 21°C); 50) Soufriere River, Bellevue Mountain, 19 May 2001 (Elevation = 610m, Water temperature = 23°C); 51) Cold Soufriere, Harrogate Estate, 19 May 2001 (Elevation = 490m, Water temperature = 24°C); 52) Demitrie River, Delaford Estate, 19 May 2001 (Elevation = 285m, Water temperature = 25°C); 53) Aouya River, Aouya, 19 May 2001 (Elevation = 130m, Water temperature = 25°C); 54) Boeri Lake, Morne Macaque, 20 May 2001 (Elevation = 905m, Water temperature = 21°C); 55) Freshwater Lake Inflow Stream, Morne Macaque, 20 May 2001 (Elevation = 780m, Water temperature = 21°C); 56) Soufreire Sulpher Springs Pool, Terre Elm, 21 May 2001 (Elevation = 150m, Water temperature = 29°C); 57) Glou Gayk Stream, Terre Elm, 21 May 2001 (Elevation = 575m, Water temperature = 27°C); 58) Emerald Pool, below Emerald Falls, 13 March 2005 (Elevation = 410m, Water temperature = 23°C); 59) Emerald Pool, above Emerald Falls, 13 March 2005 (Elevation = 425m, Water temperature = 23°C); 60) Breakfast River, below Trafalgar Falls, 13 March 2005 (Elevation = 310m, Water temperature = 25°C); 61) Breakfast River, above Trafalgar Falls, 13 March 2005 (Elevation = 415m, Water temperature = 25°C); 62) Crayfish River, above Isulukati Falls, 14 March 2005 (Elevation = 30m, Water temperature = 27°C); 63) Middleham Falls, above Middleham Falls, 15 March 2005 (Elevation = 660m, Water temperature = 19°C); 64) Middleham Falls, below Middleham Falls, 15 March 2005 (Elevation = 615m, Water temperature = 20°C); 65) DuBlanc River, below Milton Falls, 16 March 2005 (Elevation = 240m, Water temperature = 21°C); 66) DuBlanc River, above Milton Falls, 16 March 2005 (Elevation = 270m, Water temperature = 20°C); 67) Previously reported by other researchers.

streams on other small eastern Caribbean islands, including Tobago (Bass 2003b), Grenada (Bass 2004b), St. Kitts (Bass 2006), and Nevis (Bass 2006). The most abundant freshwater snail in these collections was *Melanoides tuberculata*, an introduced species reported on other small islands of the eastern Caribbean basin (Bacon *et al*. 1978; Bass 2003a, 2003b, 2003c, 2004b, 2005, 2006). Although limited to a couple of sites on Dominica, *Physella* is possibly the most widespread freshwater mollusk in the Caribbean basin (Bass 2003c). It should be noted that genetic analysis by Dillion *et al.* (2005) indicates that specimens previously reported as *Physella cubensis* should actually be a synonym of *P. acuta. Biomphalaria* is also common in cool standing waters of Dominica. It is possible there may be several species of this genus present, but it is extremely difficult to distinguish these species morphologically (P. Jarne, pers. comm).

Amphipoda

The widespread amphipod, *Hyalella azteca*, was common in Freshwater and Boeri Lakes, and nearby sites (Table 1). This species is common among plant detritus in other standing water habitats of Barbados (Bass 2003a), Grenada (Bass 2004b), and Antigua (Bass 2005).

Decapoda

An extensive study of the decapod crustaceans by Chace and Hobbs (1969) yielded 13 species associated with freshwater habitats on Dominica. Because data from their study were easily available, I chose not to collect additional decapod specimens and limited my data to field observations. I noted at least six different decapod species from various streams across the island (Table 1), all of which were previously reported by Chace and Hobbs.

Acari

A single specimen of water mite was collected among a leaf pack from the Roseau River at Morne Louis. These small predators are often abundant in aquatic ecosystems (Thorp and Covich 2001) so it is likely they exist elsewhere, but this appears to be the first report of a hydrachnid from the Lesser Antilles.

Ephemeroptera

Five taxa of mayflies were collected in this study, increasing the number known from Dominica to six (Table 1). Of these, three are being reported from the island for the first time, including a nymph of a possible new species of Baetidae found in the River Deux Branches at Bells. However, it is necessary to collect an adult in order to describe a new species. Other baetids and *Tricorythodes* were abundant collectors, occurring in numerous streams across the island. Another abundant species in Dominica, *Allenhyphes flinti*, was previously reported from Montserrat (Baumgardner *et al.* 2003).

Odonata

Donnelly (1970) reported 21 species of odonates from Dominica. I found five of these and one additional species, *Brechymorhoga praecox grenadensis*, which he did not report (Table 1). The most abundant species was the damselfly, *Argia concinna*. Both of these species are also known from other mountainous islands in the eastern Caribbean region (Bass 2003b, 2004b, 2006).

Hemiptera

Five species of aquatic hemipterans were collected (Table 1). All of these are being reported for the first time from Dominica. *Brachymetra albinervis*, *Microvelia,* and *Rhagovelia pulchra* were abundant in streams throughout the island. *Microvelia* is extremely widespread throughout the Caribbean region and occurs on most islands having freshwater environments (Bass 2003c). Several species of *Rhagovelia* have been found on other nearby islands, but *R. pulchra* was recorded only from Dominica. Often these water striders exhibited wing polymorphism, a phenomenon that has been well documented among hemipterans living in isolated habitats (Roff 1990; Schuh and Slater 1995; Thorp and Covich 2001), and as observed on other small Caribbean islands (Bass 2003c).

Lepidoptera

The larvae of two species of aquatic moths were found on submerged rocks in stream riffles (Table 1). *Petrophila* was abundant in Dominica, as it was on other mountainous Caribbean islands (Bass 2003b, 2006). However, the larvae were inconspicuous as they existed in tiny crevices of the rocks beneath layers of silk during the daylight, only emerging during periods of darkness to scrape algae growing on the rocks.

Trichoptera

Flint (1968) reported 33 species of caddisflies from Dominica during his investigation and I collected at least seven of those species during the present study (Table 1). His efforts were focused on caddisflies, especially adults, and as a result he collected many more species than I encountered. The most common species found in my collections included *Chimarra antilliana*, *Helicopsyche guadeloupensis*, and *Smicridea cariba*. These three species appear to be widespread throughout the Caribbean region (Botosaneanu 2002).

Megaloptera

Flint (1970) collected only adults of *Chloronia antilliensis* near streams, but failed to find any larvae. His collections were made during April, May, and June while the single larvae I found was collected in early January, indicating the aquatic larval stage was not present during the spring, as suggested by Flint (1970). This species has also been found on the nearby island of Guadaloupe (Flint 1970).

Coleoptera

Only five species of aquatic beetles were collected from Dominica and all of these are new records for the island. Considering the size of Dominica and the large amount of freshwater present, it is surprising that so few species have been collected there (Bass 2003c). Adults of an unidentified species of Aleocharinae were commonly found among submerged leaf packs in streams. Both larvae and adults of the riffle beetle, *Hexanchorus caraibus*, were also common among submerged leaf debris. This species has also been reported from the nearby islands of Guadaloupe (Leng and Mutchler 1914), Martinique, St. Vincent, and Trinidad (Hinton 1971). A species of psephenid, *Psephenops smithi*, was collected at one site.

Diptera

Prior to this investigation, only nine species of aquatic dipterans had been reported from Dominica. I found 17 taxa in my collections, 10 of which are new records for the island, thus increasing the number of aquatic Diptera species known from Dominica to 19. The most abundant of these were larvae of the blackfly, *Simulium*, which could have included as many as three species (Stone 1969). These blackfly larvae often occurred in clusters on rocks where water flow was the greatest. As in St. Kitts and Nevis (Bass 2006), the majority of dipterans collected belonged to one family – the Chironomidae. Larvae of this family are very small and often live inconspicuously in the substrate, making it difficult to determine their abundances and distributions. In an investigation by Helson *et al.* (2006), densities exceeding 100 chironomid individuals / m^2 were observed in similar streams in Trinidad. Larvae of *Rheocricotopus* were the most frequently encountered chironomid in stream sediments across the island.

The Effect of Waterfalls on Species Composition

Covich (1988) reported that the richness of non-insect species declined upstream as insect species richness increased upstream in some Caribbean streams. Similar patterns also have been documented in Pacific island streams (Kinzie & Ford 1977; Resh *et al.* 1990).

It was hypothesized that any waterfalls encountered may impede further upstream movement for those species lacking a flying adult stage or unable to crawl on land. Therefore, the species composition of the macroinvertebrate community above a waterfall might be expected to be different from that below a waterfall. The waterfalls selected to test this hypothesis included Emerald Falls, Trafalgar Falls, Isulukati Falls, Middleham Falls, and Milton Falls. These falls have vertical faces that range in height from approximately 10 m to 90 m.

A total of 26 species of freshwater macroinvertebrates were found in samples collected above and below the waterfalls investigated (Table 1). These included both flying and non-flying taxa. Results of Sorenson's similarity analysis were inconclusive with values between the species compositions of upstream and downstream sites ranging from 0.0 to 0.5.

Several factors may be working in concert to determine the distribution of freshwater macroinvertebrates above and below waterfalls. Insects possessing wings and the ability to fly are able to disperse upstream and beyond waterfalls as adults. Baetidae, *Argia concinna, Rhagovelia pulchra, Chimarra antilliana, Petrophila, Cricotopus*, and *Simulium* are examples of insects commonly observed at collecting sites above waterfalls (Table 1). Studies by Muller (1954, 1982) have shown that adult insects innately fly upstream following mating to lay eggs. Certainly waterfalls do not represent a barrier to these taxa of flying invertebrates.

Waterfalls do not appear to be a barrier to some groups of non-flying aquatic invertebrates. In fact, most taxa of the decapod crustaceans were found above at least one waterfall (Table 1). Some of these species may disperse by leaving the stream, provided their gills remain moist. For example, the shrimps, *Macrobrachium* and *Atya*, were observed climbing on damp, moss-covered vertical rocks and presumably are able to climb waterfalls in this manner. These shrimps were observed to be unable to climb barren rocks in torrential flows, just as shrimps could not move upstream through smooth culverts at road crossings in Moorea (Resh 2004). Several individuals of the crab, *Guinotia dentata*, were observed crawling through damp leaves of the forest floor in the vicinity of Emerald Falls, Trafalgar Falls, and Middleham Falls. The only site above a waterfall where this crab occurred was Emerald Falls, the waterfall having the least vertical drop of all the falls studied. These observations indicate that *G. dentata* exits the water and moves through the forest around smaller waterfalls. Yule (1995) suggested decapod crustaceans in a South Pacific island stream may avoid extremely high flowing reaches of a stream by walking upstream along the banks.

Diadromous snails, such as nerites (Neritidae), that

require the marine environment during part of their life cycle (Maciolek 1978; Ford 1979) find that large waterfalls might act as barriers as they return from the sea. Although nerites were common in collections from several stream sites in Dominica, none was encountered above waterfalls. Starmuhlner (1979) reported that nerites occurring in streams of Indo-Pacific islands were generally limited to lower reaches of the rivers influenced by brackish water. *Neritina canalis* was found over 3 km upstream from the mouth of the Opunochu River on Moorea (Resh *et al.* 1992). In another investigation, Resh (2004) described how elevated culverts used at bridge crossings were barriers to upstream movements of nerites.

The presence of a waterfall alone may not always explain the differences in community composition between upstream and downstream sites. The differences could be due to differences in microhabitats or other environmental conditions at those sites as well. This was observed while collecting at Isulukati Falls and Milton Falls. Isulukati Falls flows directly into the Caribbean Sea, a marine environment unsuitable to freshwater stages of aquatic life. A spring containing high iron and sulfur concentrations emerges at the base of Milton Falls altering the water chemistry and thus changing the downstream community composition. Even if the waterfalls at those two sites were not barriers to upstream movements, it would be expected that differences in species composition would exist due to environmental changes in the waters between the areas above and below the falls.

The data obtained indicate that waterfalls do not represent a barrier to upstream migration for flying insects. In addition, some species of non-flying invertebrates, such as shrimps and crabs, may have the ability to climb or move around waterfalls while others, such as nerites, may find waterfalls impede their upstream movement. If proper microhabitats or suitable environmental conditions are lacking above a waterfall, then an individual that successfully moved over or around the falls may not be able to remain there.

Dominica contained more species of freshwater macroinvertebrates than any of the other small Caribbean islands studied (Bass 2003c). This result was predicted by island biogeography theory (MacArthur and Wilson 1967) because Dominica has considerably larger surface area and has much greater relief. Furthermore, there is a greater abundance of freshwater environments, due to the large amount of precipitation. In addition, there is less development and other detrimental human activities on Dominica that may have negatively impacted the freshwater habitats than on many of the other islands.

Sorenson's similarity index indicates the greatest faunal similarities were between Dominica and Grenada (0.349) and Dominica and St. Kitts (0.341) (Table 2). The similar similarity values shown by St. Kitts and Grenada are somewhat surprising given that Grenada is approximately half the size of St. Kitts and 50% further from Dominica than St. Kitts. This would not have been predicted by island biogeography theory. All three islands have similar mountain stream habitats and there is much overlap in the species assemblages of those flowing waters. Comparisons with other islands of the eastern Caribbean had values ranging from 0.123 to 0.262. The island of the Lesser Antilles having the least faunal similarity with Dominica was Saba, a very small, steep island that lacks streams entirely. Generally the more distant islands of the western Caribbean had lower similarity values when compared with Dominica, as was predicted by island biogeography theory.

Table 2. Sorensen's index of similarity values comparing the freshwater macroinvertebrate fauna of Dominica to that of other small Caribbean islands, including approximate distances to those islands from Dominica and approximate island sizes. Range of values: 0.00 = 0% common taxa and 1.00 = 100% common taxa.

Island	Approximate Distance (km)	Approximate Size (km^2)	Similarity Value
St. Lucia	130	616	0.198
Montserrat	140	83	0.206
Antigua	155	280	0.212
Nevis	200	94	0.175
St. Kitts	220	751	0.341
Barbados	290	430	0.262
Saba	295	13	0.123
Grenada	335	346	0.349
Tobago	450	300	0.252
Cayman Brac	2,045	37	0.029
Little Cayman	2,065	26	0.081
Grand Cayman	2,175	197	0.151
Guanaja	2,675	69	0.074

Dominica is an oceanic island so its freshwater macroinvertebrate fauna had to colonize this island from elsewhere. These immigrants must have suitable dispersal mechanisms and be able to tolerate unfavorable conditions encountered while crossing ocean waters (Bass 2003c). Upon arrival, they must then locate suitable freshwater microhabitats to colonize. Although numerous freshwater taxa, especially trichopterans and dipterans, have been reported only from Dominica, it is uncertain whether they evolved in isolation there and are endemic to the island. As further investigations are conducted on Dominica and nearby islands, additional species may be found and the distribution of freshwater invertebrates on small Caribbean islands will be better understood.

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Diversity of the Ichthyofauna of Estuaries in Southeastern Trinidad

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ABSTRACT
Estuaries are highly productive aquatic systems. Five rivers in Guayaguayare Bay were sampled for fish by seining. During the survey, 25 species in 21 families representing eight orders were collected or observed. The most abundant species, *Mugil curema*, accounted for 56% of total catch. For the majority of species encountered, the size-frequency distributions revealed populations comprised largely of subadults and juveniles. Dissimilarity of inventories between sites may be related to a combination of biotic and abiotic factors. It is proposed that each species is maintained over the entire coastline by a series of incompletely independent populations and that these estuaries collectively represent one large metacommunity.

Key words: estuaries, fish fauna, metacommunity.

INTRODUCTION

An estuary is a semi-enclosed coastal body of water which has a free connection with the open sea, and within which sea water is measurably diluted by fresh water derived from land drainage (Pritchard 1967). Estuaries are often associated with high rates of biological productivity due primarily to the *in situ* photosynthetic activity of phytoplankton, submerged vascular plants, periphyton, benthic algae, tidal marsh detritus, and land runoff, in decreasing order (Correll 1978). The nature of estuaries is such that they are able to trap productive bottom sediments carried in rivers and high levels of nutrients from land runoff (Correll 1978).

Fish communities that are located in estuaries are important to diverse groups such as scientific community, natural resource managers, and user groups. Fish communities that occur in estuarine environments can have their origin in marine or freshwater habitats and it is generally believed that the fish found in these areas are dominated by species that spawn at sea (McHugh 1967 in Berlatta-Bergana *et al.* 2002). Estuarine areas are utilized by the juveniles of marine species as it provides a safer environment for vulnerable larval stages. Hydrological events can play an important role in the temporal variation in densities of many fish taxa with the density of most early life and many juvenile stages being positively related to hydrological events (Morais and Morais 1994; Sylvie *et al.* 1999).

In traversing the coastline bounded by the Moruga River to the south and the Ortoire River to the east, one encounters the discharge points of many small to moderate drainages of quite similar overall topography. All of these streams are of rather gradual gradient, and drain mainly flat land under a varied mosaic of vegetation types from forest to cultivation and coastal shrub, mangrove and strand. None achieve the catchment area of the former-mentioned rivers.

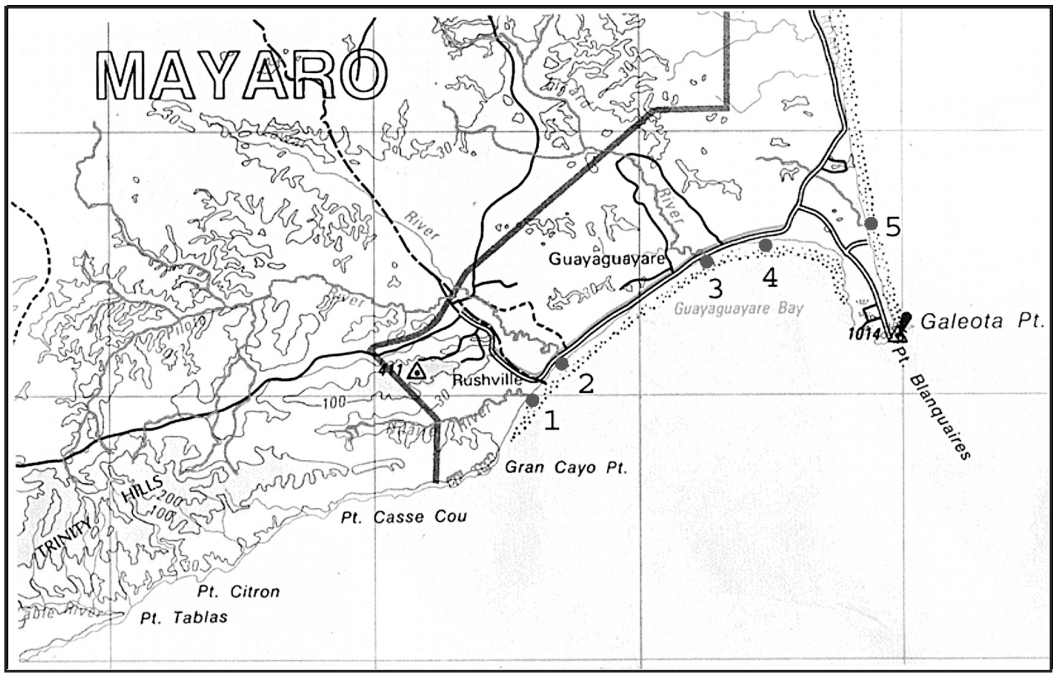

Fig. 1. Map of southeastern Trinidad showing five principal sampling sites.

Because of their low profile, flow is rather slow and the marine influences of tide and salinity tend to extend far inland resulting in well-developed estuarine habitats of untested, but purported high ecological importance. The present baseline study is located at this interface between marine and freshwater systems specifically in the vicinity of Guayaguayare Bay and Pt. Galeota.

Five river mouths (Fig.1) were sampled including those of the (1) St. Hilaire, (2) Pilote and (3) Lizard Rivers on the south coast. Two other unnamed streams were also investigated including (4) Stream A, on the south coast approximately one km east of Lizard; and (5) Stream B, located north of the Briko Air Services helipad on the east coast side of Pt. Galeota. Table 1 gives the UTM coordinates of these five sites along with the times and dates of sampling.

Site Descriptions

1. St. Hilaire River formed an almost enclosed, mangrove-lined lagoon during the rising tide. Sea conditions were fairly rough with the breakers bringing a considerable amount of sea-transported woody and other vegetative debris into the river via the 3 m wide channel. Upstream of this shallow, narrow channel the river attained a wider, deeper profile (approximately 10 m wide and up to 1.5 m deep).

2. Pilote River was the widest and deepest of all sites sampled. The tide was rising and, with fairly rough sea conditions, there was a strong landward tidal current coupled with considerable wave action. Floating mats of vegetation were quite commonly observed entering through the comparatively narrow beach channel (about 5 m wide) into the much wider (>25 m at widest point), deeper (>2 m at deepest point) sandy lagoon downstream of the bridge. All seining was done downstream of the bridge. Upstream of the bridge the river narrowed slightly and was lined with mangrove.

3. Lizard River was approximately 15 m wide and 1.5 m deep at the bridge. Mud/sand flats obtained on either side of the channel immediately upstream of the bridge and at the time of sampling (falling tide) turbid water could be seen entering the main river channel as the surrounding mangrove wetland drained. Downstream of the bridge the river narrowed to about 5 m and gradually became shallower as it flowed over the low-profile beach towards the sea.

4. The first unnamed river, Stream A, was accessed via a trail at the side of the road opposite the "Sit and Chat" Bar. At the time of sampling, the river mouth was almost completely blocked by a sand bar except for a very narrow (~1 m), shallow (~ 5 cm) channel. The actual depth was roughly 1 m within the sampling area. The surrounding vegetation was mainly secondary fringing forest, mangrove and *Bactris* palms.

5. The second unknown river, Stream B, was accessed via Pt. Galeota. From the car park near Briko Air Services helipad, the mouth of the river was accessed by walking to the beach and then north along the coast. This site was sampled at low tide and was almost completely blocked by a sand bar. At its widest point, the river was about 12 m wide and 1.5 m deep and lined with mangrove. There was no detectable flow.

METHODS

All sites were sampled using primarily a 10 m long river seine of mesh size ~ 0.5 cm. Two reaches of approximately 10 m in length were seined by pulling with the direction of the current (which varied between ebb and flow among the sites sampled) or toward the sandbank on the seaward end where there was no discernible flow. Further sampling was done using a long-handled landing net (mesh approximately 0.5 cm) in microhabitats not suited to seining, namely channel margins with undercut banks and amongst submerged and emergent vegetation.

All fish were counted and measured. In keeping with standard practice, total length (TL) was recorded. Easily identified species were counted *in situ* and returned live to the water. However, representative specimens of most species had to be kept for subsequent identification. These individuals were kept on ice and later preserved, using 70% ethanol. Subsequently they were identified using keys and descriptions, FAO (1978), Froese and Pauly (2006), Eshemeyer (1998), Perez-Farfante and Kensley (1997).

To incorporate a measure of evenness into the analysis

Table 1. List of sampling sites, times and coordinates.

Site #	Name	Date sampled	Sample time	Tide	GPS (UTM 20P)
1	St. Hilaire	8 Sep 06	1450 - 1540	rising	713093 E 1120180 N
2	Pilote	8 Sep 06	1320 - 1430	rising	713548 E 1120609 N
3	Lizard	8 Sep 06	0820 - 1000	falling	716404 E 1122843 N
4	Stream A	8 Sep 06	1010 - 1100	low	717405 E 1123109 N
5	Stream B	9 Sep 06	1000 - 1100	low	719497 E 1123382 N

of diversity for each site, Shannon's diversity index was calculated using the following formula:

$$H = -\sum_{i=1}^{s} p_i \, in \, p_i$$

where S = total number of species in the community;
p_i = the proportion of S made up by the ith species.

To get an understanding of site similarity, a matrix based on fourth-root transformed abundance was constructed using the Bray-Curtis measure (Bray and Curtis 1957). This and the subsequent cluster analysis (using group-average linkage) of sites was done using the PRIMER 5 software package, an updated windows-based version of PRIMER (Clarke and Warwick 1994).

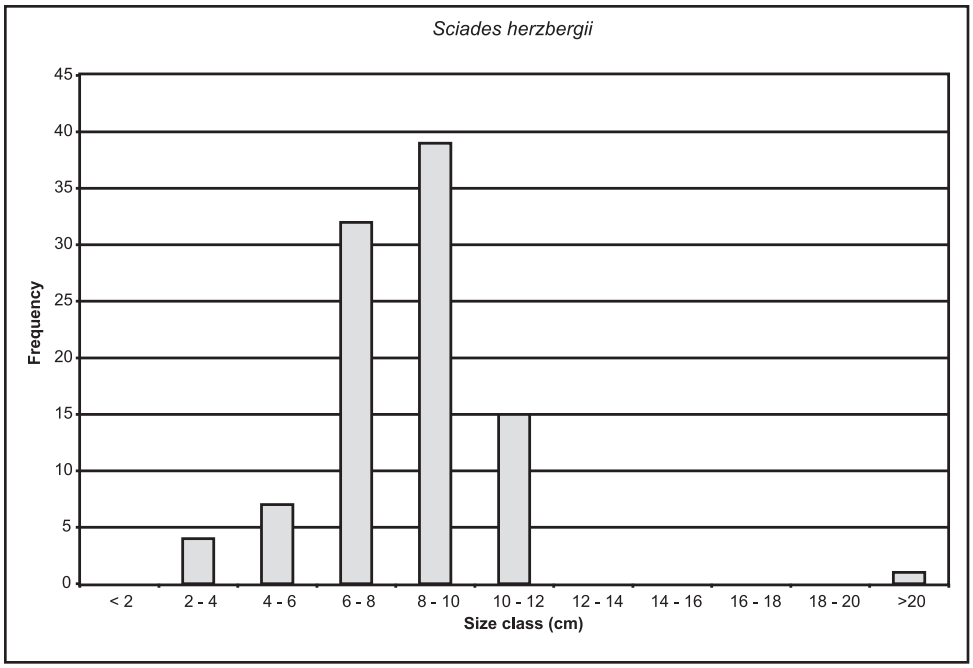

Fig. 2. Frequency-size distribution for all *Sciades herzbergii* caught at sampling sites.

RESULTS

During the survey, 25 species in 21 families representing eight orders were collected or observed (Table 2). Of these, only 9 species were found at more than one sample site. One species, *Selanaspis herzbergii*, was found at all five sample sites while two others (*Atherinella* sp. and *Mugil curema*) were found at four sites. Six species were found at two sites (*Trachinotus carolinus*, *Hyperoglyphe* sp., *Centropomus ensifurus*, *Polydactylus virginicus*, *Menticirrhus saxatilis* and *Trinectes inscriptus*).

The remaining species were either recorded at only one sample site (15) or subsequently observed in and around nearby estuarine habitats but not collected at the five principal sampling sites (the carangid fish *Trachinotus goodei*).

Site #4 had the highest species richness (12) and overall abundance (307 specimens, see Appendix 1) with the other sites having 6 to 9 species each and much lower overall abundance (67 - 205). Conversely, site # 4 scored

Table 2. List of species collected /observed at five principal sampling sites and with general collecting.

Order	Family	Species	Common name	Authority	Presence at site					
					1	2	3	4	5	General
Atheriniformes	Atherinopsidae	*Atherinella* sp.	baitfish, silverside		●	●	●	●		
Beloniformes	Hemiramphidae	*Hyporhamphus unifasciatus*	half beak, balaju	(Ranzani 1842)		●				
Clupeiformes	Pristigasteridae	*Odontognathus compressus*	herring	Meek & Hildebrand (1923)		●				
Cyprinodontiformes	Anablepidae	*Anableps anableps*	four-eyed fish	(Linnaeus 1758)					●	●
	Poeciliidae	*Micropoecilia picta*	swamp guppy, millions	(Regan 1913)			●			●
Elopiformes	Elopidae	*Elops saurus*	ladyfish, banane	Linnaeus (1766)				●		
	Megalopidae	*Megalops atlanticus*	grand-écaille, tarpon	Valenciennes (1847)				●		
Perciformes	Carangidae	*Trachinotus goodei*	palometa, pompano	Jordan & Evermann (1896)						●
		Trachinotus carolinus	pompano	(Linnaeus 1766)				●	●	
		Caranx crysos	carangue	(Mitchill 1815)	●					
	Centrolophidae	*Hyperoglyphe* sp.	ruff			●		●		●
	Centropomidae	*Centropomus pectinatus*	snook	Poey (1860)			●			
		Centropomus ensifurus	snook	Poey (1860)		●		●		
	Gobiidae	*Evorthodus lyricus*	goby	(Girard 1858)				●		
	Haemulidae	*Haemulon bonariense*	grunt	Cuvier (1830)			●			
	Lobotidae	*Lobotes surinamensis*	leaf fish (marine)	(Bloch 1790)		●				
	Lutjanidae	*Lutjanus griseus*	grey snapper	(Linnaeus 1758)			●			
		Lutjanus sp.	snappers						●	
	Mugilidae	*Mugil curema*	white mullet	Valenciennes (1836)	●	●		●	●	
	Polynemidae	*Polydactylus virginicus*	thread fin	(Linnaeus 1758)	●			●		
	Sciaenidae	*Menticirrhus saxatilis*	croaker	(Bloch & Schneider 1801)	●			●		
	Trichiuridae	*Trichiurus lepturus*	cutlassfish	Linnaeus (1758)			●			
Pleuronectiformes	Achiridae	*Trinectes inscriptus*	flatfish	(Gosse 1851)				●	●	
	Paralichthydae	*Cyclopsetta chittendeni*	left eyed flounder	Bean (1895)		●				
Siluriformes	Ariidae	*Selanaspis herzbergii*	catfish	(Bloch 1794)	●	●	●	●	●	
				Total species	6	9	7	12	6	4
				H	1.161	1.401	1.350	1.018	1.084	

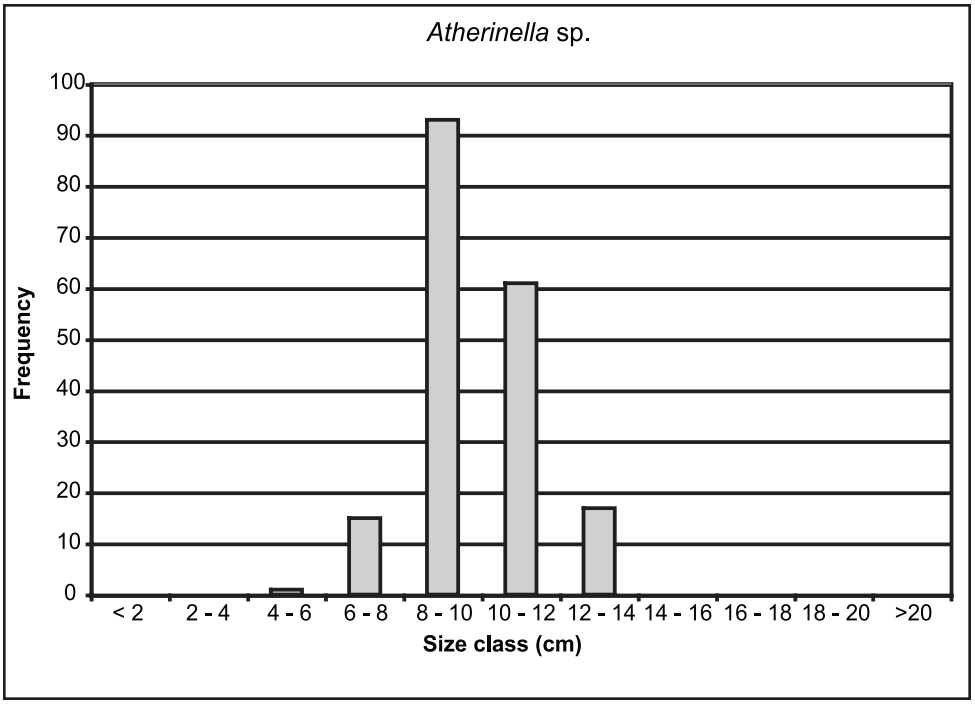

Fig. 3. Frequency-size distribution for all *Atherinella* sp. caught at sampling sites.

the lowest Shannon index (1.018), with site #2 scoring the highest (1.401).

Sites #1 and #5 each had only one unique species (only caught at that one site) while all other sites had three or four unique species. These accounted for 17%, 44%, 57%, 25%, 44% and 17% of the inventories of sites #1 - 5 respectively.

The only species common to all sites, *Selanaspis herzbergii,* had an approximately normal size distribution (Figure 2) with a mode at 8-10 cm. Of the two other common species (caught at minimum of 4 sites) *Atherinella* sp. (with a modal size of 8-10 cm, see Figure 3) has a continuous size distribution; while there is a distinctly disjunct distribution for *Mugil curema* (Figure 4).

This last species was not only very common, but also the most abundant with 475 individuals caught (56% of total catch) and was the most dominant species where present. *Atherinella* sp. was the most abundant species at site #3 and the second most abundant overall with 162 individuals caught (19% of total catch). The next most abundant species include the ubiquitous *S. herzbergii* (80 individuals, 9% of total catch) and *Menticirrhus saxatilis* (two sites, 44 individuals, 5% of total catch).

In the cluster analysis the Lizard River site separates out first at about 28% similarity (Figure 5). Of the remaining sites, Stream B separates next at about 41%. This is followed by Pilote, which is 53% similar to the remaining two sites. St. Hilaire and Stream A are the two most similar sites at about 61%.

All species caught have been recorded from inshore or brackish waters within the Western Central Atlantic and Caribbean fishing area (Froese and Pauly 2006) with no purely freshwater species represented. Important commercial and artisanal fisheries are based on many of the fish species caught.

DISCUSSION

The fact that these catchment areas are only very sparsely inhabited suggests minimal land-based anthropogenic impact on the estuarine communities. Assuming this to be true, and that marine based pollution/disturbance is not a major factor, the inventories produced herein would be representative of the natural communities that exist in

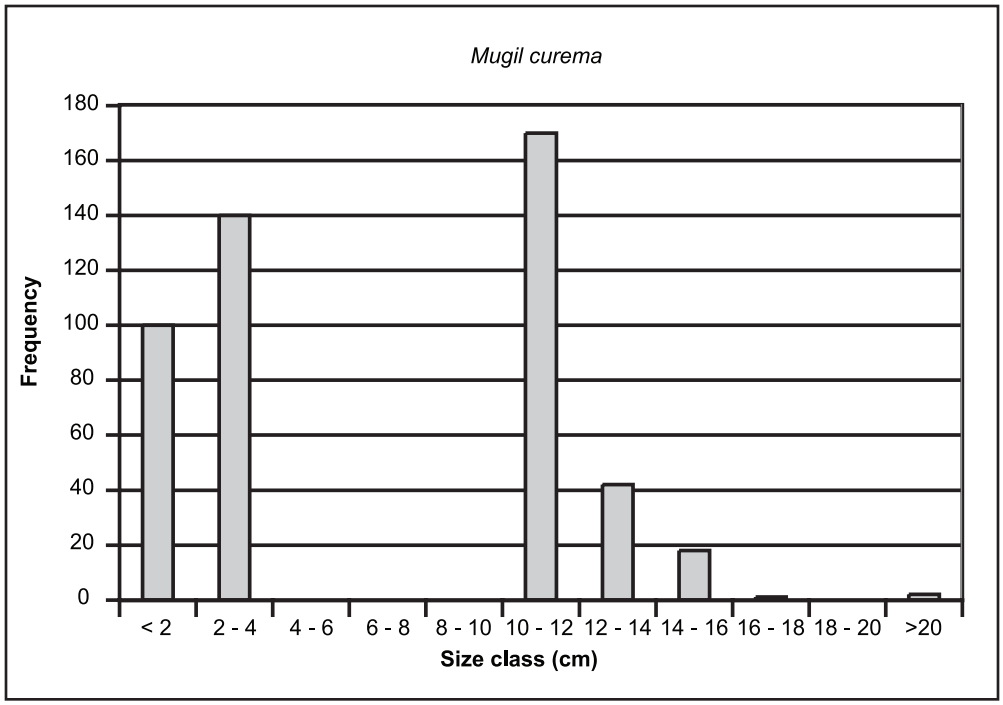

Fig. 4. Frequency-size distribution for all *Mugil curema* caught at sampling sites.

coastal estuaries of the southeast coast.

For the majority of species encountered, the size-frequency distributions revealed populations comprised largely of subadults and juveniles (comparing size ranges caught to maximum sizes listed in Froese and Pauly {2006}). Of the two large *M. curema* captured at site #2 (Pilote), it was discovered that one of two individuals was a mature female that was gravid. These observations indicate the importance of these habitats as nurseries, where some marine species spawn and undergo early development. For other species, juveniles may move between these habitats and the sandy nearshore environment depending on the tide and availability of food.

While the total species count was fairly impressive, each individual site was less so, with the majority of species restricted to one site. *Mugil curema* proved to be quite dominant overall and at each individual site. In fact, the second highest evenness (as shown by the Shannon diversity index), occured at site #3 (Lizard) where this species was not caught. The presence of the large predatory *Trichiurus lepturus* at this site may account for the absence of the highly mobile *M. curema*. On inspection of the gut contents of the predator, remains of several *M. curema* were found, lending credence to this explanation. It is the unique presence of this predator and absence of the prey species in the samples collected at this site that largely account for its highest dissimilarity in the cluster analysis.

The populations found within each small estuarine habitat are more than likely connected via dispersal especially since the majority of the species encountered are either primarily marine or frequently move between the marine and estuarine environment. As such, each species is maintained over the entire coastline by a series of incompletely independent populations, which together can be termed metapopulations (Levin 1969; Hanski and Simberloff 1997; Hanski 1997; Harrison and Taylor 1997; Cronin 2003).

Small estuarine habitats are very dynamic in physical and chemical nature, with current, depth, salinity, turbidity and dissolved oxygen regularly varying on a daily basis. The fact that site #4 (Stream A) had the highest species richness may be a result of the comparatively closed nature of the lagoon found and the small size of the catchment (the stream does not even appear on the map) as these would presumably result in a more stable environment. This may not always be, as tidal regimes change over each month, sea conditions and/or high rainfall can breach sand bars. High rainfall may also significantly alter salinities within the lagoon.

Commonly, daily physical and chemical variation in estuaries produces a particularly demanding environment that has profound effects on biological communities. The first and most intuitive effect is that individual species must either have a wide range of tolerances or else undergo significant daily migration to maintain themselves within suitable niche-space. Even for the species that have wide tolerance ranges, e.g. the euryhaline *Selanaspis herzbergii*, localized populations may undergo quite drastic fluctuations as they are exposed to varying immigration, emigration and extirpation of populations of competitors, prey and predators. It is therefore not surprising that the inventories at the five sites are so different from one another.

The importance of each small estuarine habitat does not necessarily lie in this perceived uniqueness. In fact, if these sites were sampled over a time series that incorporated season it might be expected that the integrated lists would be quite similar. Rather, one should view these small habitats within a larger framework in which local communities are linked by dispersal of individuals of their constituent species i.e. the metacommunity (Holyoak *et al.* 2005).

Thus while localized communities may exhibit quite variable dynamics, the tendency is for the metacommunity to be quite stable and sustained by the combined effects of its many constituent communities. If this interconnectedness on the large scale (over the entire coastline or nearshore ecosystem) is considered, the importance of each small part (community) in stabilizing the whole

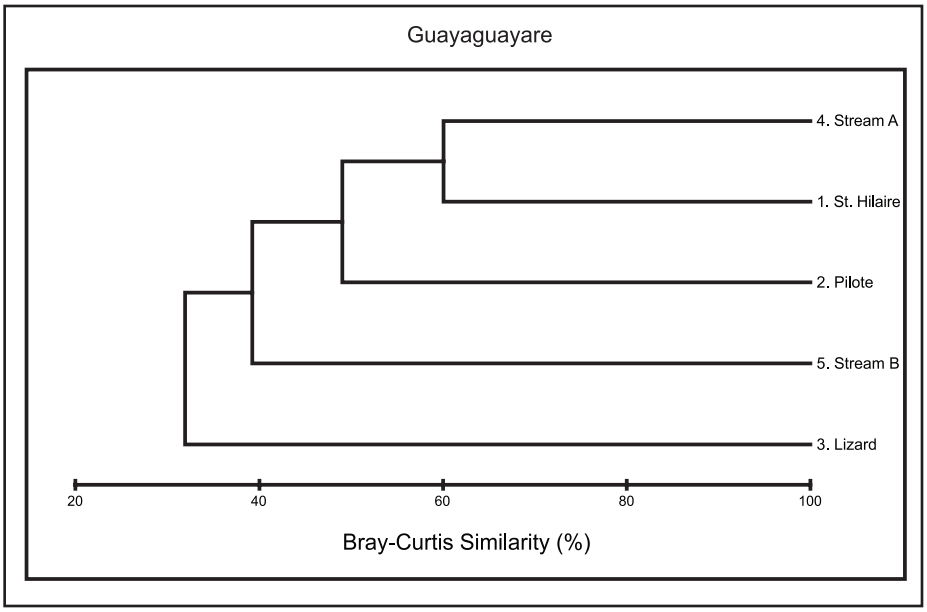

Fig. 5. Dendrogram showing hierarchical clustering of sampling sites using Bray-Curtis similarity (%).

(metacommunity) cannot be discounted.

ACKNOWLEDGEMENTS

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Appendix 1. Raw size-frequency data collected from each site.

Site	Species	Size classes (cm)											Totals	
		< 2	2 - 4	4 - 6	6 - 8	8 - 10	10 - 12	12 - 14	14 - 16	16 - 18	18 - 20	>20	by species	for site
(1) St. Hilaire	*Atherinella* sp.				4	37	8	14					63	
	Caranx crysos			1									1	
	Menticirrhus saxatilis				2	1	1	1		2	1		8	
	Mugil curema	40	60										100	
	Polydactylus virginicus				1	1	1						3	
	Selanaspis herzbergii				12	17	1						30	205
(2) Pilote	*Atherinella* sp.				8	2	38	2					50	
	Centropomus ensiferus					1	2						3	
	Cyclopsetta chittendeni		1										1	
	Hyperoglyphe sp.	4											4	
	Hyporhamphus unifasciatus									5			5	
	Lobotes surinamensis				1	1							2	
	Mugil curema	20	40				2	3				2	67	
	Odontognathus compressus		1	2									3	
	Selanaspis herzbergii			4	8	1							13	148
(3) Lizard	*Atherinella* sp.			1	3	24	5	1					34	
	Centropomus pectinatus			1	1	6	5						13	
	Haemulon bonariense							1					1	
	Lutjanus griseus					1	1						2	
	Micropoecilia picta		3										3	
	Selanaspis herzbergii				6	4	2					1	13	
	Trichiurus lepturus											1	1	67
(4) Stream A	*Atherinella* sp.					12	1						13	
	Centropomus ensiferus	2	1	2									5	
	Elops saurus							1					1	
	Evorthodus lyricus				6								6	
	Hyperoglyphe sp.	4											4	
	Megalops atlanticus											1	1	
	Menticirrhus saxatilis			8	12	16							36	
	Mugil curema		2				168	39	18	1			228	
	Polydactylus virginicus			2									2	
	Selanaspis herzbergii		4	3	2								9	
	Trachinotus carolinus			1									1	
	Trinectes inscriptus		1										1	307
(5) Stream B	*Anableps anableps*					1	1						2	
	Lutjanus sp.	20											20	
	Mugil curema	40	20										60	
	Selanaspis herzbergii				4	8	3						15	
	Trachinotus carolinus			1									1	
	Trinectes inscriptus		1										1	99
	Totals	130	134	26	70	133	239	62	18	8	1	5	826	826

The Skipper Butterflies (Hesperiidae) of Trinidad
Part 15, Hesperiinae, Genera Group M

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ABSTRACT
Figures of adults and details of the taxonomy, history in Trinidad, description, identification and biology are given for the Trinidad species of Genera Group M: *Hylephila p. phyleus* (Drury), *Polites vibex praeceps* (Scudder), *Wallengrenia otho clavus* (Erichson), *W. premnas* (Wallengren), *Pompeius pompeius* (Latreille), *P. amblyspila* (Mabille), *Anatrytone perfida* (Möschler), *Quasimellana eulogius* (Plötz), *Q. servilius* (Möschler), *Euphyes peneia* (Godman), *Arotis kayei* (Bell), *Metron c. chrysogastra* (Butler) and *M. noctis* (Kaye). Of these, *H. p. phyleus*, *Polites vibex praeceps*, *Pompeius pompeius* and *E. peneia* are also reported from Tobago. Two species, *Atalopodes c. campestris* (Boisduval) and *W. ophites* (Mabille), have been recorded from Trinidad, but are considered to need confirmation. The life history of *Q. eulogius* is described and illustrated.

INTRODUCTION

Evans (1955) characterizes this group as generally tawny; varying from species with no apiculus (all nudum segments on the antennal club), to a well-developed apiculus with equal nudum segments on the club and apiculus; the club is always constricted at the beginning of the apiculus (Fig. 1); the palpi vary from slender and quadrate to flattened (i.e. the inner edge is narrower than the edge against the head) (Fig. 2).

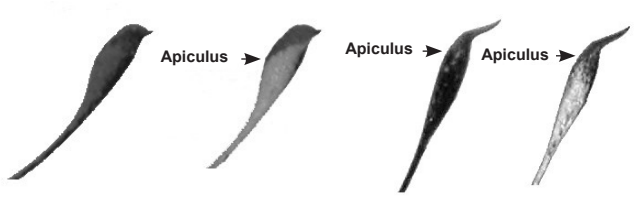

Fig. 1. Antennal club of Group M Hesperiidae. From left to right: male *Hylephila phyleus* dorsal and ventral, male *Anatrytone perfida* dorsal and ventral. The beginning of the apiculus is indicated where apparent.

Fig. 2. Head of male *Hylephila phyleus*, dorsal view.

Evans (1955) treats 182 species in 35 genera for Group M as indigenous to the Americas. Compared to other groups of Hesperiidae, this group is comparatively well represented in North America, with more than 20 genera, several being restricted to the region. Thirteen species of nine genera (not all recognised by Evans) occur in Trinidad, and a further two species have been reported from the island, but are considered to need confirmation. Four species of four different genera are recorded from Tobago.

This group includes several common and conspicuous tawny species associated with open spaces and gardens in Trinidad, notably *Polites vibex praeceps* (Scudder), *Wallengrenia otho clavus* (Erichson), *Pompeius pompeius* (Latreille), and *Quasimellana eulogius* (Plötz). However, several others are uncommon, without clear habitat associations.

To the extent that food plants are known for the Trinidad Group M species, all are grass feeders. It seems likely that many Hesperiinae grass feeders are able to develop successfully on a variety of grasses, even though adult females will not necessarily oviposit on all these different species. Workers such as Laurent (1908) and Dethier (1939) have pointed out that it is quite easy to obtain oviposition by grass feeding field-captured Hesperiinae, and by rearing from these eggs, details of the early stage can be recorded. It is important, therefore, to distinguish carefully field observations of oviposition and caterpillar food plants from observations in captivity, in order to understand the ecology of the different species.

All specimens illustrated are in the author's collection unless indicated otherwise. Similarly, any specimens referred to without attributing a collector or collection, were

collected by the author and are in either the author's collection or the collection of CABI, Curepe, Trinidad. The scale at the bottom of most figures of pinned specimens is in mm. Other conventions and abbreviations follow earlier parts of this series (Cock 2006 and earlier papers). The museum abbreviations can be found in the acknowledgements at the end of the paper.

***Hylephila* Billberg**

This genus is found principally in the Andes and Patagonia, and comprises about 25 rather similar species (Evans 1955; MacNeill and Herrera 1999). The only Trinidad representative is the most common and widespread species: *H. phyleus* (Drury).

231. M6/1 *Hylephila phyleus phyleus* (Drury 1773)
Figs. 3-6.

Evans (1955) treats *H. phyleus* as six subspecies, five restricted to parts of the Andes, and one, ssp. *phyleus*, widespread from USA to Argentina, including all the Caribbean islands (TL Antigua), and also occurring as an exotic species in Hawaii (Tashiro & Mitchell 1985).

Many authors, including Kaye (1904, No. 269; 1921, No. 378), Evans (1955), Barcant (1970) and Cock (1982), mis-spelt this species as *H. phylaeus*. Kaye (1921) considered it abundant in Trinidad. For Tobago, Sheldon (1938) records two males and two females from Roxborough, captured by Frank d'A[badie]; a pair in NHM from the Sheldon bequest labelled Tobago most probably represent two of these.

Both males and females are considered highly variable (Evans 1955), although I have not seen a great deal of Trinidad material so as to be able to characterise this.

Male (Figs. 3, 6). UPS head and body dark brown with tawny hairs, dense on abdomen; UNS white; legs yellow-brown. Antennal shaft and club dark above, and white below; apiculus orange. UPS wings marked in dark brown and yellow-orange; brand black, along base of space 2 and across space 1. UNS light yellow-brown with dark submarginal and discal spots, and space 1B UNH dark. UNH spots are variable: in some specimens, they are distinct, dark and contrasting, ranging to others, in which the spots are barely distinguishable from the ground colour. F male 15 mm.

The extensive yellow-orange markings UPS resemble those of *Polites vibex praeceps* (Figs. 7, 9), but in *H. phyleus* the outer margins are more sharply defined, and the scalloping more extensive and deeper, especially UPH (compare Fig. 3 and Fig. 7); furthermore, the stigma of *P. vibex praeceps* (Figs. 7, 9) has a large broad grey area, whereas that of *H. phyleus* is plain black (Fig. 3). In the field or in photographs, if only the UNS is visible (Fig. 6), *H. phyleus* should be recognisable by the generally sharper edges to the dark spots, together with the straight alignment to the margin of the spots in spaces 2-5 UNH. In contrast *P. vibex praeceps* has the dark spots more diffuse and the UNH spots in a submarginal band (Fig. 7). Finally, the antennae of *H. phyleus* are proportionately shorter than others of the group, and this character may be useful in the field.

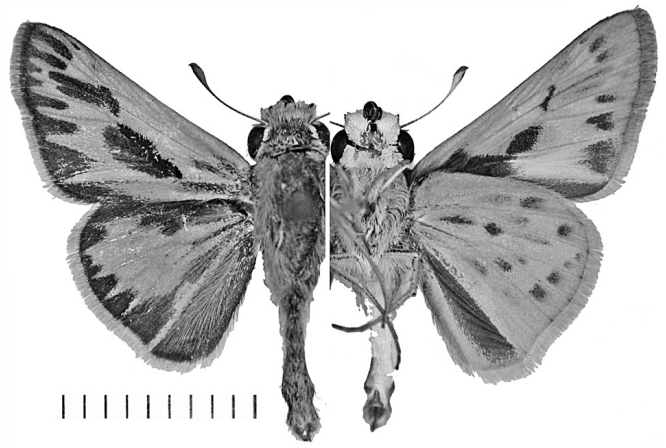

Fig. 3. *Hylephila phyleus phyleus* male, Nariva Swamp, Sand Hill, at *Bidens* flowers, 17.iv.1982.

Female (Figs. 4, 5). Strong sexual dimorphism. Head, antennae and body as male. UPS wings dark brown with orange-brown markings, and pale brown spots in spaces 1-4 and cell UPF. UNS dull pale orange-brown, except the discal and dorsum area UNF dark, space 1B UNH dark and space 1C UNH pale; the UPS orange-brown markings are evident as pale yellow markings, and the light brown spots of UPF as paler spots; dark spots UNS less extensive than in male. The size of the pale spots UPS and UNS is variable. Specimens with reduced spots (e.g. Fig. 4) seem more common, but in others, the spots are quite extensive and run into each other (Fig. 5).

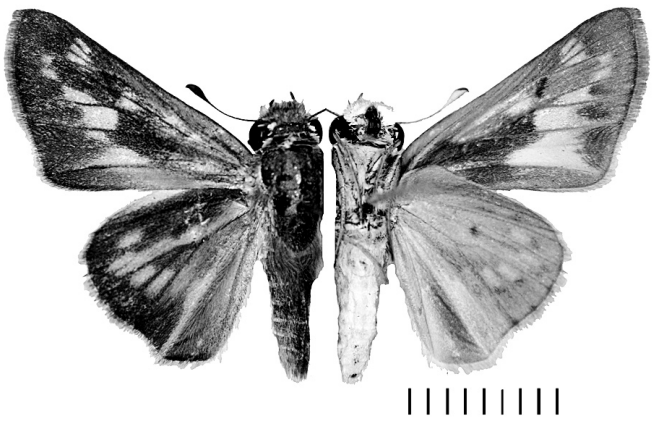

Fig. 4. *Hylephila phyleus phyleus* female, Cats Hill, eupatorium flowers, 19.ix.1982.

The combination of well-defined orange-brown spots UPS and light brown spots UPF is distinctive. The male of *Quasimellana eulogius* is superficially similar, but lacks the light brown spots UPF (Fig. 22). If only the UNS is visible, the dark spots and pale yellow spots UNH should help to distinguish this species from others found in Trinidad. F female 16.5 mm.

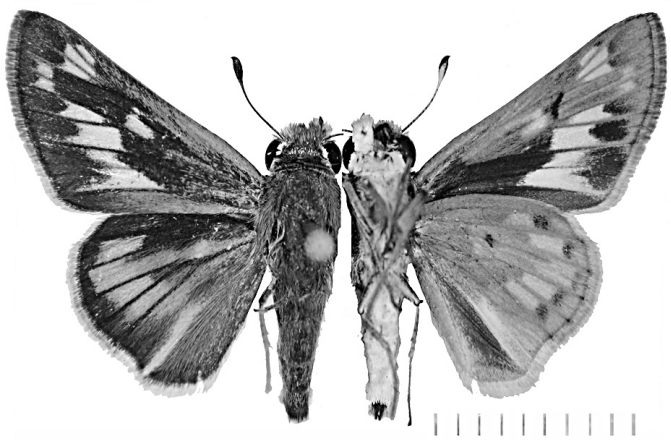

Fig. 5. *Hylephila phyleus phyleus* female, Rio Claro-Guayaguayare Rd., milestone 4½-5½, eupatorium flowers, 1.x.1994.

Illustrations in Lewis (1973, UPS, plate 22.7), Riley (1975, plate 23), Smith *et al*. (1994, plate 30), Brévignon & Brévignon (2003, live female) and a variety of internet sites, including DCLS (2007) and UC (2007).

In Trinidad, this is not a common species, although sometimes several can be found together, e.g. at flowers of *Austroeupatorium inulaefolium* on the Rio Claro - Guayaguayare Road, milestone 4½-5½, 1.x.1994. It seems to be restricted to open, lowland situations with plenty of flowers, such as *Bidens pilosa* and eupatorium, on which it readily feeds. I have seen one male from a light trap in Curepe, xi.1971 (CABI).

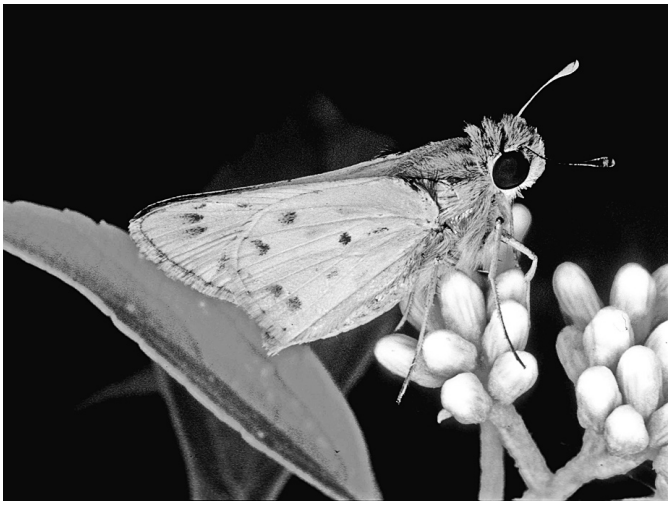

Fig. 6. *Hylephila phyleus phyleus* male, Rio Claro - Guayaguayare Rd., milestone 4½ - 5½, 1.x.1994.

In addition to the Roxborough specimens reported by Sheldon from Tobago, J. Morrall (pers. comm. 2006) has a specimen from Rockley Bay, taken ix.2002. It seems likely that this is also an occasional species in Tobago.

Shapiro (1975) describes mate location and courtship observed on the lawns of the University of California. Males perch on raised objects on the lawn, such as leaves and grass stems, and fly to investigate anything that flies past.

This skipper is a minor lawn pest in parts of its range, particularly in California and Hawaii, USA (Potter & Braman 1991). Caterpillars are seldom seen since they remain concealed in lightly woven silken tubes in the thatch area, i.e. the area of brown grass material between the soil and the green leaves and stems. Pupation often occurs in grass near the surface of the soil in a loosely woven cocoon covered with leaf litter debris, but if debris is not available, the pupa may be free in the grass-root zone (Tashiro & Mitchell 1985).

Grass food plants are recorded from North America: *Agrostis* spp., *Cynodon dactylon* (Bermuda grass), *Eragrostis hypnoides*, *Imperata cylindrica, Digitaria* spp., *Poa pratensis, Sorghum halapense* (Johnson grass), *Saccharum officinarum* (sugar cane), *Stenotaphrum secundatum* (St. Augustine grass), and *Zea mays* (corn) (Bryson & Sudbrink 2000; DCLS 2007; Kendall 1959; Scott 1986; UC 2007).

In addition, Scott (1986) lists *Axonopus compressus* and *Paspalum conjugatum* from the Caribbean. In Jamaica, *Cynodon dactylon*, *Panicum sanguinale* and *Paspalum conjugatum* are food plants (Brown & Heineman 1972; Panton 1897), but it is not clear whether T. Turner's record of *A. compressus* in Brown & Heineman (1972) refers to a field host or captive rearing.

Grasses are also the food plants recorded from South America: sugar cane in Argentina (Box 1953); *Digitaria sanguinalis, Panicum repens*, *Paspalum pumilum*, *P. cromyorrhizon*, *Stenotaphrum secundatum* in Zona Sueste of Rio Grande do Sul, Brazil (Biezanko 1963); *Agrostis*, *Cenchrus*, *Cynodon* and *Eriochloa* spp. (sources in Canals (2003)). I think the record of *Canna* spp. (Cannaceae) in Hayward (1941) must be an error.

Several North American workers have described the life history, including Coolidge (1925) in California. Panton (1897) provides a detailed description from Jamaica, which is quoted in full by Brown and Heineman (1972). Brévignon and Brévignon (2003) illustrate the egg, caterpillar and pupa in colour from the French Antilles. UC (2007), Minno *et al.* (2005) and Wagner (2005) illustrate the caterpillar. The illustrations of egg, caterpillar, pupa and adult in DCLS (2007) are excellent. The caterpillars in all these sources is dark grey-brown with narrow, dark

dorsal and dorso-lateral lines, while the head is mat black and rugose with pale adfrontal sutures, a diffuse line each side of the epicranial suture, and white before the black dorsal plate on T1.

This is in contrast to other reports: pale green caterpillar with darker stripes, black dorsal plate T1, and light brown head from Georgia, USA (based on an original painting by John Abbot (USC 2007, image No. 47) published in Boisduval and LeConte (1829-1837)); a dull green caterpillar, thickly granulated with pale points, and dark brown dorsal plate T1 and head in Florida (Edwards 1879), a light green caterpillar from Brazil (Moss 1949), and a green striped caterpillar with a dark brown head (Riley 1975; no source attributed, but likely to be Boisduval and LeConte (1829-1837)). Since all modern observations of this species from North America are of dark grey-brown caterpillars, it seems that the caterpillar illustrated by Abbot (USC 2007) is incorrectly associated with this species, and this has given rise to subsequent confusion, e.g. Riley (1975) and Scott (1986). Moss (1949) is generally reliable, but his notes on this species are extremely brief, and there is no illustration, so a lapse is not impossible. On balance, there seems no reason to expect the caterpillar of this species, when found in Trinidad, to differ from those described and illustrated from North America and the Caribbean.

I have found no reports of food plants or pest status of this species in Trinidad and Tobago, for example, it is not mentioned in the account of turf pests by Laurence (1987). This might reflect the use of less suitable grasses for lawns in Trinidad, or effective natural enemies, or some other reason.

232. M13/1 *Polites vibex praeceps* (Scudder 1872)
Figs. 7-9.

Evans (1955) treats this species as seven subspecies, of which *praeceps* occurs from Mexico (TL) to northern South America. Other subspecies extend the range north to the southern USA, and south to Argentina. Subspecies *dictynna* (Godman & Salvin) occurs in the Lesser Antilles (TL St. Vincent).

Crowfoot (1893, No. 184) included this species in the original list of Trinidad butterflies as *Pamphila vibex*. Kaye (1904, No. 270; 1921, No. 379) includes it as *Thymelicus vibex*, noting that it is as common as *H. phyleus* (above), which he considered abundant. Sheldon (1936) records a specimen from Charlotteville (Sir N. Lamont).

Male (Figs. 7, 9). Similar in markings and colouring to *H. phyleus* (above) under which species, differences are discussed. The brand is narrowly black against the base of space 2, and broadly grey distal to this from base of vein 3, along base of space 2 and across vein 1. The uniform orange-brown UPH discal area should distinguish the male from other species. F male 17 mm. Illustrations in Barcant (1970, UPS, Fig. 6), Lewis (1973, UNS, plate 22.38).

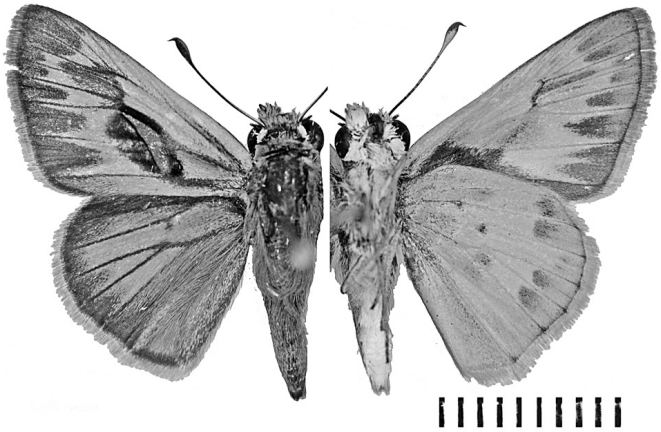

Fig. 7. *Polites vibex praeceps* male, Fort George, 27.ii.1994.

Female (Fig. 8). Strong sexual dimorphism. UPS head and body dark brown with brown hairs; UNS head and body pale. UPS dark brown with tawny scales and hairs basally UPF and on UPH; white hyaline spots in spaces 2, 3 and 6-8, diffuse pale brown spot in lower space 1B. UNF brown, tawny on basal half costa, pale brown spot 1B, larger than UPS, covering width of space. UNH khaki brown, paler basally and in space 1C, broad pale discal band across spaces 2-7, the spots in spaces 4 and 5 displaced towards margin. At first sight, the female might be mistaken for one of several superficially similar species in other groups, but examination of the antennal club should immediately separate these. The female of *Pompeius pompeius* is superficially similar (Fig. 15), but has white hyaline spots in spaces 4 and 5 UPF, and the UNH is more variegated, with the spots in spaces 4 and 5 in line with those in spaces 2 and 3. F female 17 mm.

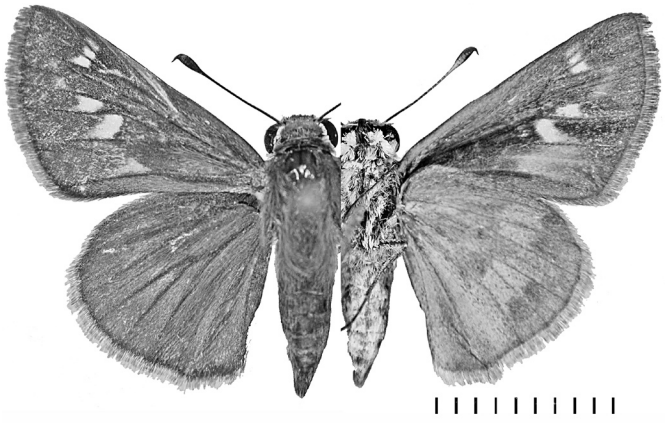

Fig. 8. *Polites vibex praeceps* female, Curepe, iii.1980.

This is one of the commonest skippers in Trinidad, found everywhere in open areas and along roadsides in forested areas. It comes readily to flowers, including *Bidens pilosa*, eupatorium, lantana and *Stachytarpheta* spp. I have seen a specimen from Gasparee (male 11.iii.1928, N. Lamont, RSM). The only recent records from Tobago of which I am aware are those of J. Morrall (pers. comm. 2006), who has taken several specimens at Rockley Bay, Tobago; it is probably sometimes common on the island.

Fig. 9. *Polites vibex praeceps* male, Palo Seco Oilfield, 7.x.1998.

The early stages of ssp. *vibex* (Geyer) have been described from eastern North America by Scudder (1889) and from Florida by Edwards (1879 as *Pamphila brettus* (Boisduval and LeConte), a synonym), and summarised by Smith *et al.* (1994). Minno *et al*. (2005) describe and illustrate the caterpillar from Florida. Edwards (1879) reports oviposition on *Paspalum setaceum*, whereas Kendall (1965) reports oviposition on *Stenotaphrum secundatum* (St. Augustine grass) and *Cynodon dactylon* (Bermuda grass) in Texas, while Minno *et al*. (2005) give the food plants as weedy grasses including *Digitaria ciliaris* and *S. secundatum*. Apart from an unconfirmed oviposition record on *Smilax campestris* (Liliaceae) in Rio Grande do Sul, Brazil (Biezanko 1963), I have located no food plant records for ssp. *praeceps* from South America.

The caterpillar lives in a tubular leaf shelter; it has a black head with a pale line each side of the epicranial suture (similar to *H. phyleus*); dorsal plate T1 black; body pale green with dark spiracles and prolegs (Minno *et al*. 2005).

233. M14/1 *Wallengrenia otho clavus* (Erichson 1848)
Figs. 10-11.

This skipper was treated as *Wallengrenia druryi curassavica* (Snellen) by Evans (1955) and Cock (1982); the correct spelling has now been established as *drury* (Mielke 2004).

Burns (1994) points out that *clavus* has previously been misidentified (as what is now known as *Anatrytone perfida*) and is in fact the senior name for the subspecies previously known as *Wallengrenia druryi curassavica*. Burns (1994) leaves the status of this taxon open, referring to it as *W. clavus*, but suggesting it may prove to be a subspecies of *otho* J. E. Smith. Smith *et al*. (1994) treat *W. drury* (Latreille) as a separate species, restricted to Hispaniola, Puerto Rico and some nearby islands; their taxonomy is based on J. Miller (unpublished). Mielke and Casagrande (2002) introduce the combination *Wallengrenia otho clavus*, which Mielke (2004) follows for the Neotropical checklist. Subspecies *clavus* occurs from the south of Texas – records of ssp. *curassavica* from this region are considered to refer to *clavus* (A. Warren pers. comm. 2007) – south to Brazil (Evans 1955). Other subspecies occur from Canada to Argentina (Evans 1955), and separate species or subspecies on almost all the Caribbean islands: *vesuria* Plötz from Jamaica, *misera* Lucas from Cuba (TL) and northern Bahamas, *drury* from the Bahamas, Turks & Caicos, Hispaniola, Puerto Rico and the Virgin Islands, and *ophites* (Mabille) from the Lesser Antilles south to St. Vincent (Smith *et al*. 1994). Here, I follow the treatment of Mielke (2004) pending the publication of J. Miller's investigations. Furthermore, although the published observations on the caterpillars of the Caribbean subspecies suggest that they may well be valid species, the relationship between ssp. *otho* and ssp. *clavus* remains unclear.

Kaye (1914; 1921, No. 381) reports *Catia pustula* (Hübner) from Trinidad, based on a male from St. Ann's Valley in H. J. Adams' collection (now in the NHM), and *Pamphila misera* Lucas (Kaye 1914; 1921, No. 377) based on another male from St. Ann's Valley (G. E. Tryhane). Hübner's *pustula* is a synonym of ssp. *otho* and as noted above, *misera* is the Cuban subspecies. Both records are assumed to refer to *Wallengrenia otho clavus*. There are three male *W. o. clavus* from St. Ann's Valley in the NHM, which probably include one or both of these specimens.

Male (Fig. 10). UPS head and body dark brown with orange-brown setae and hairs, UNS pale; legs yellow-brown. Antennal shaft dark above, chequered below; apiculus orange-brown. UPF dark brown, orange-brown basally, extending distally along costa, space 3 and space 1A. Conspicuous and distinctive brand: an intense black line along base of space 2, adjacent to base of this, across space 1B, a broad, grey, quadrate area over vein 1B, and basal to the lower half of this, a black spot. UPH brown with diffuse orange-brown markings, strongest in cell and spaces 4-5. UNF costa and apex to space 3 orange-brown; tornal half blackish-brown, most intense at base. UNH rather uniformly pale yellow-brown with only traces of

pale yellow markings. F male 16 mm. The UPS markings and brand are distinctive, but the UNS is similar to that of *Anatrytone perfida* (Figs. 20, 21), *Quasimellana eulogius* (Figs. 22, 26) and *Q. servilius* (Möschler) (Fig. 32), and not easily separated in the field without seeing the UPS.

Fig. 10. *Wallengrenia otho clavus* male, Curepe, at flowers, 7.x.1979.

Female (Fig. 11). Strong sexual dimorphism. Head, antennae and body as male, except apiculus brown. UPF dark brown with costa diffuse orange-yellow, and yellow spots in lower space 1B, 2, 3, 4, 6-8, cell. UPH dark brown with disc diffuse orange-brown, a large and diffuse orange-brown spot in spaces 4-5. UNF costal half orange-brown as male, spots yellow; tornal half dark, more intense basally. UNH uniform light orange-brown, with indistinct yellow spots in space 2, 3, 4-5, 6 and 7. F female 15.5 mm. The diffuse orange-brown spots, especially in spaces 4-5 UPH, should make this species easy to recognise – some superficially similar species in other groups being separated by examination of the antennal club.

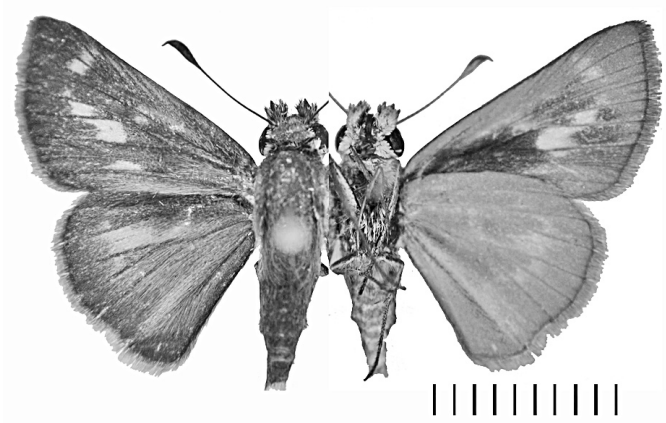

Fig. 11. *Wallengrenia otho clavus* female, Fort George, 27.ii.1994.

This is a common species in Trinidad, found everywhere in open spaces with flowers and along roadsides in forested areas. Cock (1981a) reported it from Nariva Swamp.

I have found no published records of the life history or food plants of *W. otho clavus* from Trinidad, or elsewhere in its range. Therefore published observations on the biology and food plants of other subspecies or *W. otho* may be helpful to anticipate the situation with regard to *W. otho clavus* in Trinidad.

Kendall (1959) observed that in Texas, caterpillars of *W. otho otho* feed readily on St. Augustine grass, *Stenotaphrum secundatum*. In his rearing they made a shelter of a circle of tissue paper (used to line the rearing container) folded in half and carried this around as a mobile shelter; as the caterpillars grew, bigger cases were constructed. Presumably, caterpillars do this using leaf material in the field – Minno *et al.* (2005) refer to a case of grass clippings and silk.

Wolcott (1922) notes that *W. o. drury* is the commonest skipper on sugar cane in Hispaniola, but also feeds on rice and other coarse leaved grasses. He briefly describes the caterpillars of *W. otho drury* from Hispaniola as "green with purplish-brown head, variably marked with silvery or greenish-yellow".

In Cuba, (Dethier 1939) records *W. otho misera* from sugar cane, describes the egg and first four instars and includes a diagram of the head of the fourth instar. The head is black with a broad white stripe from the vertex across each half of the epicranium to the stemmata, body mottled white and dark ferruginous, orange spots on T3 - A8 on stigmatal line; short black hairs from black tubercles; legs fuscous.

Brévignon and Brévignon (2003) note the grasses *Oplismenus hirtellus* and *Rottboellia cochinchinensis* (exotic) as food plants of *W. o. ophites* (as *W. ophites*) in Guadeloupe. They illustrate the egg, caterpillar and pupa from Marie Galante and Guadeloupe. The caterpillar, presumably in the fifth instar, has the head black with a sharply demarcated white line down each side of the epicranial suture, a white spot over or in front of the stemmata; the neck is white anterior to the black transverse plate on T1; body grey-brown in colour, with a dark dorsal line and two pale lateral lines.

Minno *et al*. (2005) give grasses such as *Eleusine indica* as food plants for ssp. *otho*. DCLS (2007) gives more detail, listing the following grass food plants: *Digitaria sanguinalis*, *Oryza sativa* (rice), *Saccharum officinarum* (sugar cane), *Stenotaphrum secundatum* (St. Augustine grass) and *Paspalum* sp. The records on rice and sugar cane may be based on those listed by Scott (1986) from Puerto Rico, which would actually be for ssp. *drury*.

Thus, the food plant records of other ssp of *otho*, in-

dicate that ssp. *clavus* in Trinidad will include sugar cane and other coarse grasses amongst its food plants.

The larva of *W. otho otho* is described and illustrated by Minno *et al*. (2005) from Florida. The head, dorsal plate T1, and true legs are black; body dark greenish-brown with orange marking laterally on the thorax.

J. E. Smith named *otho* from Georgia, USA, based on paintings of the adults, caterpillar and pupa by John Abbot (Smith & Abbot 1797). Abbot's paintings show a greenish caterpillar with longitudinal lines and a brown head (MBG 2007; USC 2007, image No. 47). Calhoun (2006), in his analysis of Smith & Abbot (1797), notes that the caterpillar illustrated is not compatible with US species of *Wallengrenia*.

Riley (1975) describes the caterpillar of "*Wallengrenia otho*" as having a chocolate brown head, but does not attribute this character to any particular subspecies or origin – this description is likely to have been derived from the original illustrations in Smith & Abbot (1797).

Scott's (1986) description of the caterpillar of *W. otho* combines features of the caterpillar illustrated by Smith and Abbot (1797), *W. otho drury* from Hispaniola (Wolcott 1922), and the fourth instar of *W. o. misera* from Cuba described by Dethier (1939).

The early stages of the different subspecies of *W. otho* might be expected to be similar. However, it seems clear that the caterpillars of ssp. *otho* as illustrated by Minno *et al*. (2005), ssp. *drury* (Wolcott 1922), the fourth instar of ssp. *misera* (Dethier 1939), and ssp. *ophites* (Brévignon and Brévignon 2003) are sufficiently different that Smith *et al*. (1994) are likely to be correct in treating these as separate species. Well-documented life histories might provide conclusive support for treating these subspecies as valid species. Hence, recording the life history of ssp. *clavus* from Trinidad would be a useful contribution to clarifying the taxonomy of this group.

233a. M14/1 *Wallengrenia otho ophites* (Mabille 1878)

As discussed under the last species, Mielke (2004) treats *ophites* as a subspecies of *W. otho*, but Smith *et al.* (1994) treated the different Caribbean subspecies of *otho* as distinct species, and given the apparent differences between the caterpillars noted above, this is likely to be correct.

Smith *et al*. (1994) give the distribution of *W. ophites* as the Lesser Antilles, as far south as St. Vincent and Trinidad. The Trinidad record is based on a single male of *W. ophites* in the Carnegie Museum of Natural History, Pittsburgh (J. Miller, pers. comm. 2007). The label data specifies Trinidad and S. H. Parrish (J. Miller, pers. comm. 2007), and I take the latter to be the name of the collector.

The absence of this species from Grenada and Tobago, and lack of further material from Trinidad make this record suspect, especially since such a brightly coloured orange species is unlikely to have been overlooked by other collectors. The specimen from Trinidad may represent a vagrant, a temporary colony now extinct, or it could be mis-labelled. Thus, this subspecies or species needs confirmation before inclusion in the Trinidad fauna.

The male is much more extensively orange than that of *W. otho clavus*. The UPF has only the margin dark brown, except that the grey quadrate brand area extends to the margin in spaces 1A-2. UPH and UNH almost entirely orange. The female is less distinct, but has more extensive orange markings than that of *W. otho clavus*. Illustrations in Riley (1975, male, plate 15b), Smith *et al*. (1994, male and female, plate 31.11), and Brévignon & Brévignon (2003, male).

As noted above, the life history is illustrated by Brévignon & Brévignon (2003) from Marie Galante and Guadeloupe, and the grasses *Oplismenus hirtellus* and *Rottboellia cochinchinensis* (exotic) are given as food plants.

234. M14/2 *Wallengrenia premnas* (Wallengren 1860)
Figs. 12-13.

This species occurs in South America from Venezuela to Argentina (TL), but is seldom common anywhere (Evans 1955).

Referring to a specimen captured near Cap de Ville, 1.iv.1929 by Huntingdon, Kaye (1940, No. 381d) added this species to the Trinidad list as *Catorina pudorina* (Plötz), which is a synonym of *W. premnas* (Evans 1955).

Male (Fig. 12). UPS dark brown; UPS head and base of wings slightly tawny; UPS thorax dark chestnut. Antenna dark above, weakly chequered below; club pale below; apiculus chestnut. No spots UPS; fringe pale brown, shading to brown at apex F. Complex brand: black dash along cubitus from middle of base of space 2 to over origin of vein 3, narrowed basally, rounded distally; below base of this a short, narrow silvery streak, parallel to vein 2; a similar but shorted streak below the base of last under vein 1; the area distal to these dark grey about 1/3 of way to margin; basal to last streak a circular black brand in middle of space 1B. Antenna dark above; UNS shaft chequered; UNS club pale brown; apiculus chestnut. UNS head pale; palp 2 speckled with tawny and black, darker distally; palpi 3 brown; UNS thorax chestnut brown; UNS abdomen grey. UNF costa and apex chestnut brown to vein 2; disc, termen and dorsum dark grey; faint pale spot in space 2. UNH chestnut brown, darker basal to discal

band of diffuse yellow-brown spots in spaces 2-7; space 1B dark grey; fringe grey. F male 16 mm.

Fig. 12. *Wallengrenia premnas* male, Arima-Blanchisseuse Road, milestone 9¼, 8.x.1994.

Female (Fig. 13). Similar to male, but with stronger markings: UPF diffuse pale brown spots in spaces 2-3, 6-8; UNF with pale spots in upper space 1B and 2; yellowish spots in spaces 3 and 4. F female 16 mm.

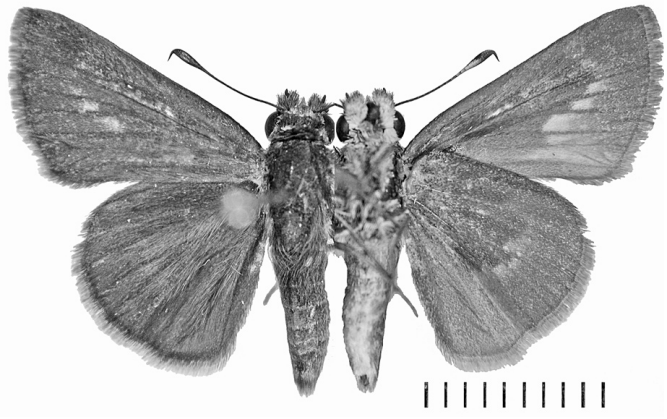

Fig. 13. *Wallengrenia premnas* female, Arima-Blanchisseuse Road, milestone 9¼, Textel Road, at *Austroeupatorium inulaefolium* flowers, 8.x.1979.

This is not a common species in Trinidad, occurring mostly in the Northern Range, particularly on the ridge-tops around the Arima Valley (MJWC), but also to the west of Port of Spain on Cumberland Hill and North Post (S. Alston-Smith, pers. comm. 2006). It also occurs in some lowland areas such as Maracas Bay, Piarco and Waller Field, and I know of just one record from the south of the island (Irois Forest, vii.2003, J. Morrall). Adults come readily to flowers such as *Bidens pilosa* and eupatorium.

Biezanko (1963) lists several grasses as food plants in Zona Sueste, Rio Grande do Sul, Brazil: rice (*Oryza sativa*), *Echinochloa crus-galli*, *Stenotaphrum secundatum* and *Leersia hexandra*. I have found no further information on the life history.

235. M15/1 *Pompeius pompeius* (Latreille 1824)
Figs. 14-16.

This common and widespread species occurs from Mexico to Argentina (TL Brazil), but not on the Caribbean islands (Evans 1955). In the older literature, it is referred to as *athenion* Hübner, which is a nomen nudum (Evans 1955; Mielke 2004).

Crowfoot (1893, No. 188) first recorded this species from Trinidad as *Pamphila athenion*. Kaye (1904, No. 271; 1921, No. 380) reports this species as *Thymelicus athenion*, based on a single specimen which he took in June 1898.

Sheldon (1936, 1938) does not record this species from Tobago, but there is a male in the NHM captured 1-4.ii.1931 by Capt. A. K. Totton, and listed by Evans (1955).

Male (Fig. 14). UPS dark brown; base of costa, head, thorax and disc UPH slightly tawny; obscure pale spots in spaces 2-8; vein 1 and cubitus in space 1B blackish; fringe pale brown, shading to brown at F apex. Complex brand: a thin straight black brand over cubitus, covering upper 2/3 of base of space 2 and covering origin of vein 3; a narrower black brand runs from below origin vein 3, across space 2, where it is interrupted and continues as a short dash under vein 2; on either side of this brand, a more or less circular dark grey area; a black triangle with its base on vein 1, basal to other brands and just beyond origin of vein 2. Antennal shaft dark above, pale at base of club, which is black above with chestnut apiculus; UNS of shaft chequered basally, pale brown distally and under club. UNS of head almost white; palp 2 slightly brown, palp 3 brown; UNS thorax and abdomen pale brown. UNF pale brown; spots of UPF more distinct and a pale patch in space 1B; discal area basal to spots blackish; fringe pale brown. UNH pale brown, variegated with brown discal band; margin narrowly brown. F male 15 mm.

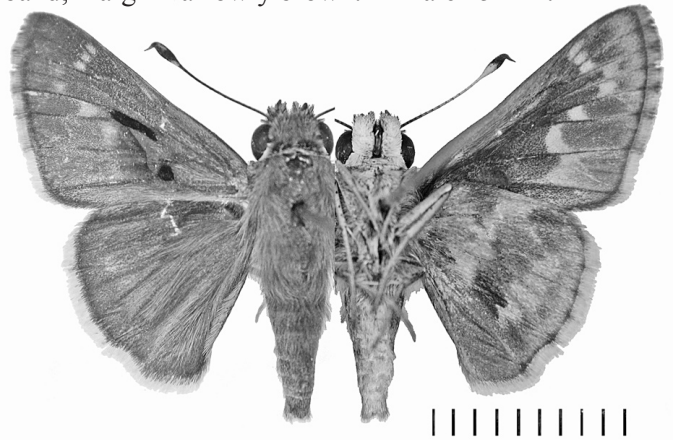

Fig. 14. *Pompeius pompeius* male, Curepe, MV Light, 28.ix-4.x.1981.

Female (Figs. 15, 16). Similar to male, but UPF spots clearly defined, including a spot in space 1B on vein 1; UPH with obscure pale spots in spaces 2-6, the last displaced basally. F female 17 mm.

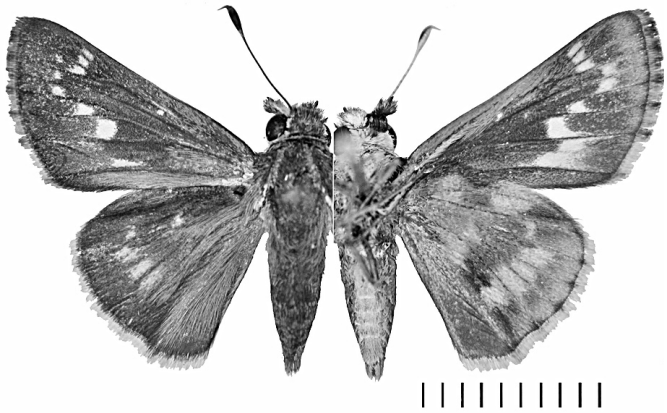

Fig. 15. *Pompeius pompeius* female, Curepe, 1.ix.1980.

This is a common and widespread species in Trinidad, found everywhere in open spaces with flowers and along roadsides in forested areas. I have noted adults feeding at flowers of *Bidens pilosa*, eupatorium and petraea.

Fig. 16. *Pompeius pompeius* female, at *Austroeupatorium inulaefolium* flowers, Brasso, 1.x.1993.

Janzen and Hallwachs (2007) include one record reared from an un-named Poaceae in Costa Rica. I have found no other information on the life history and food plants.

236. M15/4 *Pompeius amblyspila* (Mabille 1897)
Figs. 17-18.

This species is reported from Mexico to Argentine (TL Bolivia), but is not normally common (Evans 1955). However, records from Mexico all refer to *Joanna joanna* Evans (Warren 2002; Warren *et al.* 2007). *Pompeius amblyspila* has not been reported from Trinidad before.

Phlebodes chittara Schaus was described from Trinidad (Schaus 1902), but Evans (1955) lists *chittara* (Schaus) as a possible synonym of *P. amblyspila*. Mielke (2004) considers *chittara* to be a Brazilian species of *Psoralis*, and treats this type locality as an error. I have examined the type in USNM and agree with Mielke (2004) that it does not represent a Trinidad species.

I have females from Piarco (16.i.1982) and Aripo Savannah (12.viii.1979), and SAS has a female from Toco (iv.2000). It may, therefore, be associated with lowland, open areas with low vegetation.

Male (Fig. 17). I have seen no specimens from Trinidad. UPS brown with extensive yellow-brown shading basally. Well marked black stigma. UPF pale spot in space 1B against vein 1; yellowish hyaline spots in cell and spaces 2-8. UPH faint discal band. UNS brown, with heavier pale spot in space 1B UNF, and whitish spots in spaces 1C-7 UNH.

Female (Fig. 18). Moderate sexual dimorphism. UPS brown; pale non-hyaline spots; fringe pale grey-brown. UNS head pale white-brown; antennal shaft chequered for basal 2/3, pale beneath for remainder, and under base of club. Club dark, apiculus dark chestnut; thorax and abdomen UNS pale brown. UNS pale brown; disk and dorsum UNF, space 1B and lower half IC UNH brown; UNH indistinct pale spots in spaces 1C-7. F female 13.5 mm.

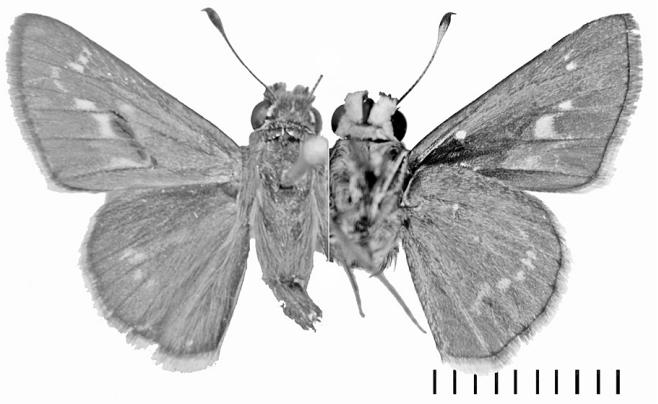

Fig. 17. *Pompeius amblyspila* male, Venezuela; UPS in NHM; UNS in USNM.

Fig. 18. *Pompeius amblyspila* female, Piarco, 16.i.1982.

Theses two females are smaller than typical, so may represent a small island race or a different species, so confirmation of this record with males is desirable. Cock (1982) misidentified this material as *Vehilius inca*, which does not seem to be a Trinidad species.

237. M16/1 *Atalopedes campestris* (Boisduval 1852)
Fig. 19.

This species is common and widespread in the USA (TL California), and its range extends south to Venezuela and Brazil (Evans 1955). The genus was mis-spelt *Atalopodes* in Cock (1982).

Kaye (1940, No. 381c) introduced this species to the Trinidad list, referring to a specimen he captured in Port of Spain (17.ii.1926), and commenting "Doubtless this species has hitherto escaped detection by being confused in the field with *Thymelicus vibex*." This specimen, a male, is in MGCL (A. D. Warren, pers. comm. 2007). I have seen no other Trinidad specimens, so for the moment, this record remains a puzzle, which needs confirmation for the Trinidad list.

The male has a stigma UPF flanked by black patches and set in a large area of specialised scales (Evans 1955) (Fig. 19). Illustrations in Lewis (1973, male UNS, plate 21.14) and Smith *et al*. (1994, male and female, plate 30.19).

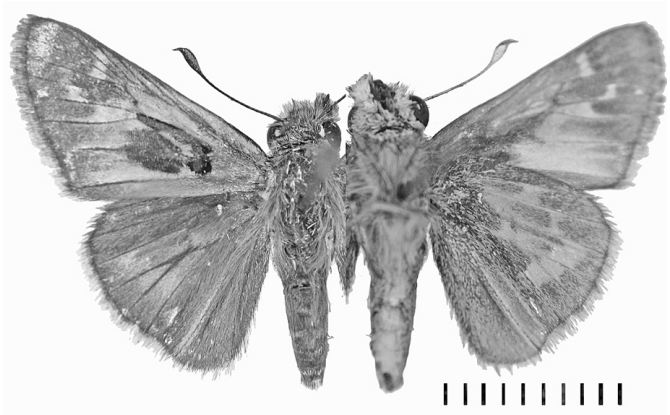

Fig. 19. *Atalopedes campestris* male, Venezuela; specimen in USNM.

Smith *et al*. (1994) summarise information on the life history, which is completed on a wide variety of grasses including St. Augustine grass, *Stenotaphrum secundatum* and Bermuda grass, *Cynodon dactylon* (Kendall 1959).

***Anatrytone* Dyar**

Burns (1994) established that *Anatrytone* Dyar, which had been treated as a synonym of *Atrytone* Scudder (e.g. Evans 1955), is a valid genus. Furthermore, the type species of *Mellana* Hayward belongs to the reinstated genus *Anatrytone*, so that *Mellana* is a synonym of *Anatrytone*. However, many species hitherto treated as *Mellana* are not congeneric with this type species, and for these, Burns (1994) created the new genus *Quasimellana* Burns, treated below.

238. M25/3 *Anatrytone perfida* (Möschler 1879)
Figs. 20-21.

Evans (1955) treats this species partly as *Mellana clavus*. Burns (1994) showed that Evans (1955) misidentified *clavus*. The next available name for the species Evans treated as *Mellana clavus* is *perfida* Möschler (TL Colombia). Since Burns (1994) also showed that *Mellana* is a synonym of *Anatrytone*, the correct name is now *Anatrytone perfida* (Möschler) (Burns 1994; Mielke 2004, 2005). It occurs from Colombia to northern Argentina, including Trinidad (Burns 1994).

Kaye (1940, No. 426a) introduces this species to the Trinidad list as *Atrytone mella*, based on a specimen captured at Palmiste, 7.xi.1929, by Sir Norman Lamont, and states that it is not common. This specimen, a female, is now in RSM.

Male (Fig. 20). UPS brown with extensive orange tawny markings; cilia paler. No brand. UNS head pale yellow-brown; apex of labial palp slightly more intense, orange UPS, segment 3 dark above only; antennal shaft chequered, club pale beneath, apiculus chestnut; UNS thorax tawny; UNS abdomen pale. UNS wings bright yellow-brown; diffuse pale area space 1B UNF; remainder of dorsum blackish-brown. F male 17 mm.

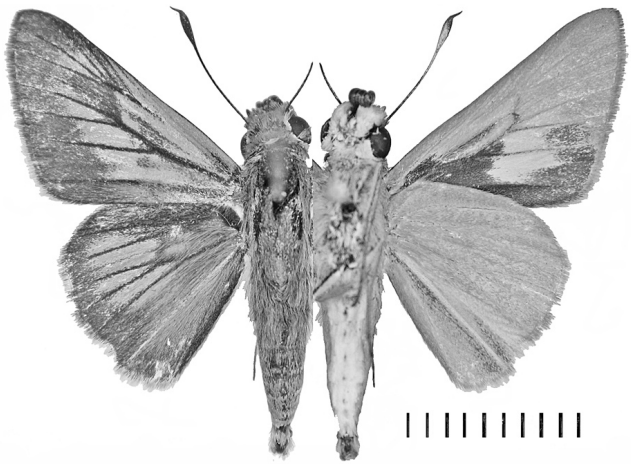

Fig. 20. *Anatrytone perfida* male, Nariva Swamp, Bush Bush Island, 28.iii.2003.

Female (Fig. 21). Strong sexual dimorphism UPS. UPS brown; tawny scales at base of costa UPF and across disc UPH, except veins; UPF yellow-orange spots in spaces 1B-3, 6-8; cilia pale, brown at apex UPF. UNS similar

to male, but a slightly darker shade of yellow-brown. F female 20 mm.

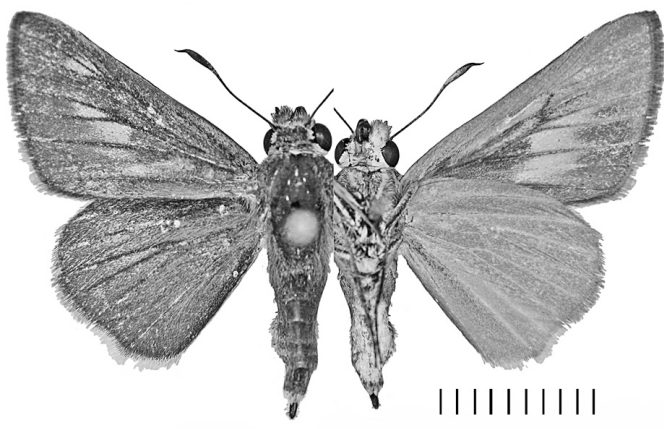

Fig. 21. *Anatrytone perfida* female, Parrylands Oilfield, 22.xii.1980.

This species is closest in colour and markings to *Quasimellana eulogius*, and differences are discussed under that species.

I agree with Kaye (1940) that this is not a common species in Trinidad, but have 21 scattered records from lowland areas of the island, including three from around Nariva Swamp.

This species is reported to have been reared from sugar cane, mostly on the basis of a synonym, *gladolis* Dyar, the type material of which was reared from sugar cane by H.W. B. Moore in Guyana (Box 1953; Dyar 1914; Hall 1939).

Moss (1949) has reared this species at Para (Belem, Brazil) from sugar cane and a wild cane. His paper includes no further observations, but there are reared adults, a pupa case and a cast final instar skin and head capsule in the NHM. The head capsule is 3 mm high, rounded, light brown, with a diffuse brown line parallel to the epicranial and adfrontal suture; the clypeus is missing; anal plate longer than wide, parallel sided, with rounded distal end; no white waxy powder. The pupa is c. 25 mm long; rather cylindrical, only tapering from A7; brown, lighter on abdomen; frontal plate missing; robust, blunt cremaster; brown backward directed setae on A7-8, and ventrally on A5-6; proboscis sheath extends to just short of cremaster.

I know of no information on the life history or food plants from Trinidad.

Quasimellana Burns

Burns (1994) established the new genus *Quasimellana* for many of the species previously placed in *Mellana*, including *eulogius* and *servilius* (= *verba* Evans) (see also under *Anatrytone*, above).

239. M25/7 *Quasimellana eulogius* (Plötz 1883)

Figs. 22-31.

This widespread species is reported from Mexico (TL) to Paraguay (Evans 1955).

Surprisingly, this common species was not recorded from Trinidad until Kaye (1940) recorded it in a footnote to his entry for "*Atrytone mella*", stating that it was recorded by Sir Norman Lamont. The earliest specimens of this common species that I have located date back to 1937 (Sir Norman Lamont in UWI and RSM), so it may well be that this species was previously overlooked. Alternatively, could it have been a recent colonist?

Male (Figs. 22, 26). UPS brown with orange tawny markings; cilia brown. No brand. UNS head pale yellow-brown; apex of labial palp slightly more intense, orange UPS, segment 3 dark; antennal shaft chequered, club pale beneath, apiculus chestnut; UNS thorax tawny; UNS abdomen pale. UNS wings bright yellow-brown; diffuse pale area space 1B UNF; other markings blackish-brown. F male 17 mm. Since the range of this species extends into North America, there are many images available on the internet, often as "*Mellana eulogius*". The male genitalia are illustrated by Godman and Salvin (1879-1901, plate 94) as *Atrytone mellona* Godman (a synonym).

The UPS tawny orange markings are brighter and more extensive than those of *Quasimellana servilius*, while the UNS is a brighter yellow. The UNS is similar to *A. perfida*, but the UPS tawny markings are more continuous in *A. perfida*. Similarly, *Hylephila phyleus*, *Polites vibex praeceps* and *Wallengrenia otho clavus* have more extensive orange markings, but all three also have strong UPF brands. The tawny species of Group I are superficially similar, but in those species the tawny markings extend across space 1B UPF towards the base of the wing.

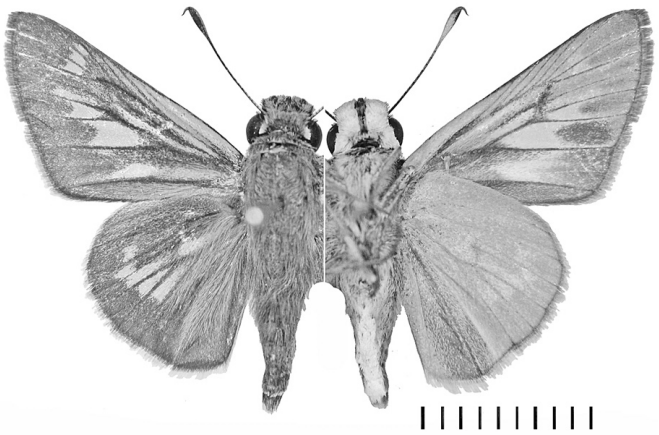

Fig. 22. *Quasimellana eulogius* male, Golden Grove, *Bidens* flowers, 25.viii.1978.

Female (Figs. 23, 24). Strong sexual dimorphism. Variable markings. UPS brown; tawny scales at base of

UPF; tawny setae space 1A UPF and disc to termen UPH; pale yellow spots in spaces 1B, sometimes 5, and in 6-8 (partly hyaline); pale hyaline spots in spaces 2 and 3, sometimes in 4 and sometimes a single or double spot in cell; UPH pale yellow spots in spaces 2-6. UNS similar to male, apart from more extensive spots UNF and faint spots in spaces 2-6 UNH to match UPH. F female 17-18 mm. As noted under the male, images are available on the internet. The female genitalia are illustrated by Burns (1994).

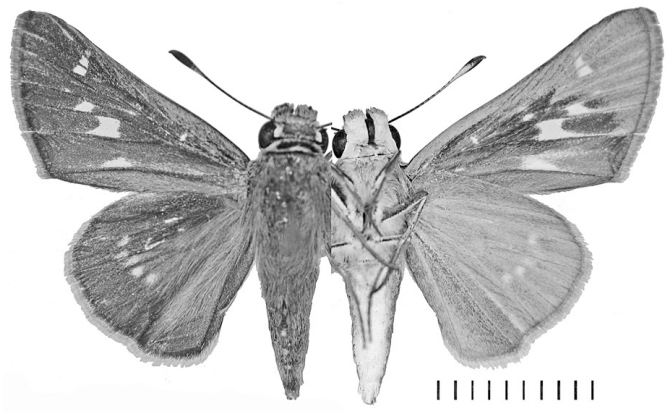

Fig. 23. *Quasimellana eulogius* female, Golden Grove, *Bidens* flowers, 25.viii.1978.

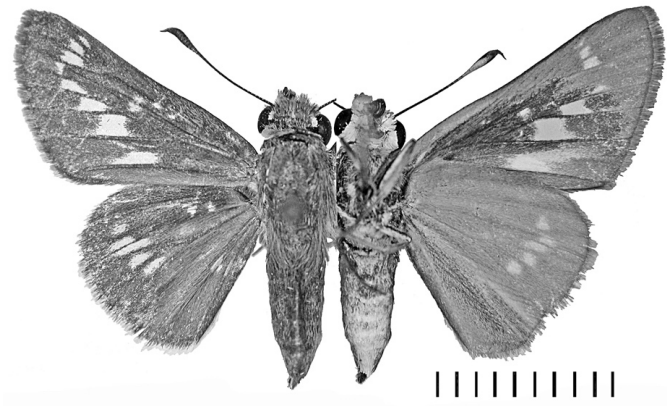

Fig. 24. *Quasimellana eulogius* female, Nariva Swamp, Sand Hill, 17.iv.1982.

The almost plain yellow-brown UNS of the female will separate it from most other Trinidad species. Female *W. otho clavus* have tawny non-hyaline markings including a distinctive tawny marking in cell and spaces 4 and 5 UPH; *A. perfida* has much reduced, diffuse and non-hyaline markings; *Q. servilius* has reduced markings UPF, no markings UPH and the UNS is a much duller yellow-brown.

An atypical small female (Fig. 25) shows reduced markings F and no spots UPH or UNH. Its identity was confirmed by dissection and comparison with Burns (1994). F female 15.5 mm.

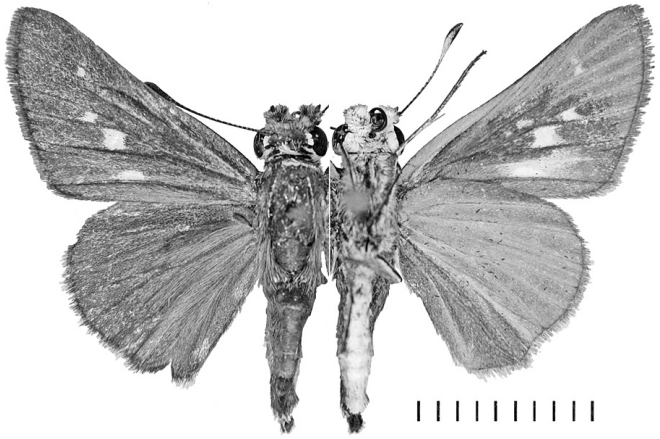

Fig. 25. *Quasimellana eulogius* female, Palo Seco Oilfield, North of San Fernando-Siparia-Erin Road, 7.x.1995.

This is another common and widespread species in Trinidad, associated with open places and roadsides. Adults feed readily at flowers including *Bidens pilosa*, eupatorium and petraea. It occurs on Chacachacare Island (Cock 1981b), but has not been recorded from Tobago.

Fig. 26. *Quasimellana eulogius* adult male, St. Benedict's, 16.x.1993.

Hall (1939) notes that H.W. B. Moore reared this species (as *Atrytone heberia* Dyar, a synonym) from sugar cane in Guyana. This is probably the basis of the record from sugar cane in Box (1953), as *Atrytone eulogius*. Janzen and Hallwachs (2007) include single rearing records from three grasses: *Arundinella deppeana*, *Cynodon nlemfuensis* and *Megathyrsus maximus*.

I have reared this species twice, once from sugar cane, (Curepe, iii.1982, Ref. 82/43D) and once from *Panicum maximum* (Point Gourde, 22.iii.2003, Ref. 03/207). S. Alston-Smith (pers. comm. 2006) has also reared this species several times from caterpillars collected on sugar cane at Khanai Rd., Barrackpore. Given how common and widespread this species is in Trinidad, it seems likely that a variety of grasses are used as food plants. The fol-

lowing description is based upon the male that I reared as 03/207.

The pupal shelter was formed between several pieces of grass and the bottom of the rearing container. The shelter was lined with silk, but there was no white waxy powder. The pupa was formed loose within the shelter, with no girdle or crossbar to support the cremaster. In light of these observations, I suspect pupation normally occurs at the base of the food plant, or amongst leaf litter.

Pupa (Figs. 27, 28) 17 mm. Rounded contours; no frontal spike; cremaster black, arched; proboscis sheath extends two segments beyond end of wing cases. Light brown, with brown dorsal line, weaker on thorax; a faint dark dot at end of cell on F wing case. No white waxy powder on pupa. Spiracle T1 brown, not projecting; other spiracles dark, but inconspicuous. Short, erect pale brown setae on the front of the head; weak recumbent pale brown setae elsewhere on body.

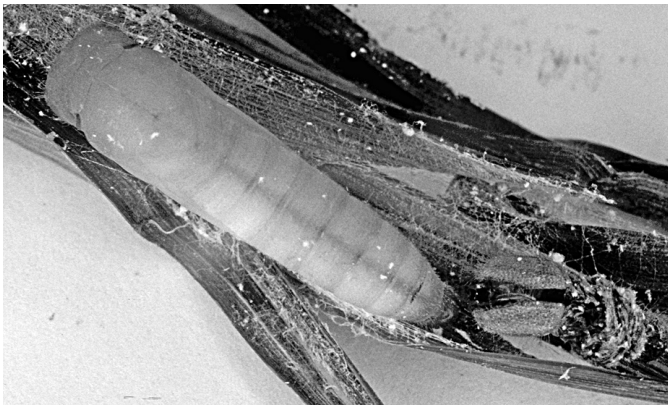

Fig. 27. *Quasimellana eulogius* pupa, dorsal view; Ref. 03/207, 17 mm.

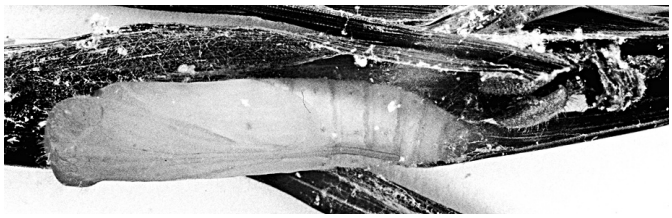

Fig. 28. *Quasimellana eulogius* pupa, ventro-lateral view; Ref. 03/207, 17 mm.

Mature fifth instar caterpillar (Figs. 29, 30) 30 mm. Head oval; pale brown; posterior margin narrowly black; brown markings as follows: a line from vertex laterally to stemmata; a diffuse line from below the apex, running anteriorly down face to end in front of the stemmata, diverging around clypeus; epicranial and adfrontal sutures. T1 pale, a narrow, black transverse dorsal plate extending to T1 spiracle. Body with broad dorsal line of dark khaki; bordered by a broad dorso-lateral stripe of dull yellow-green, marked with transverse ridges, and smooth areas in anterior parts of A1-7; lateral line dull translucent green; ventro-lateral flange paler; ventrally dull translucent green. A8 with orange-brown tint; A9 paler than rest of body. Legs and prolegs pale. Spiracles inconspicuous. The wax glands are formed ventrally in two patches: on the whole ventral surface of A7, and on the posterior half of the ventral surface of A8. However, there is no white waxy powder on the pupa or in the pupal shelter.

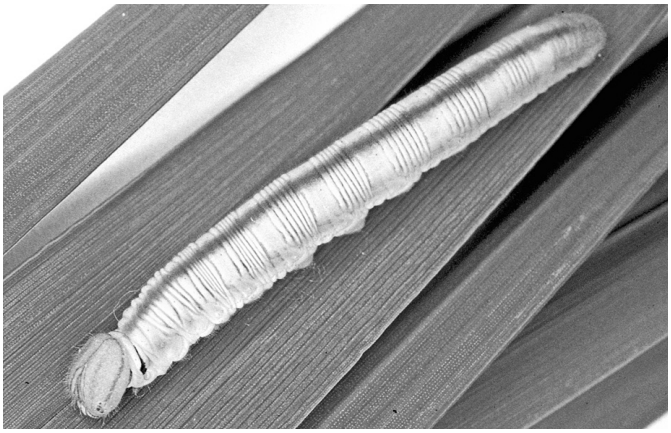

Fig. 29. *Quasimellana eulogius* fifth instar caterpillar, 30 mm, Ref. 03/207.

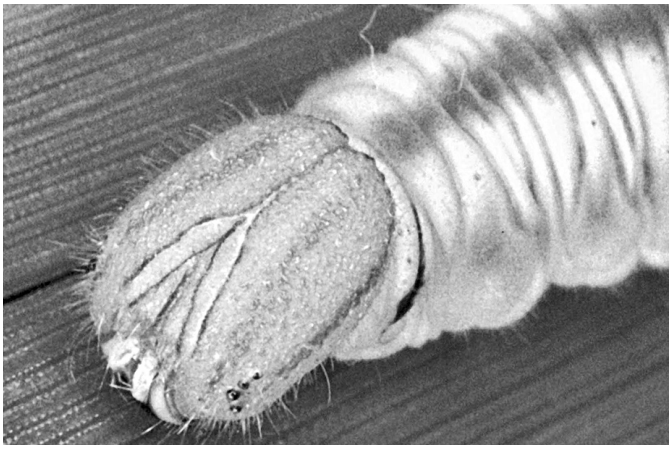

Fig. 30. *Quasimellana eulogius* fifth instar caterpillar, detail of head, Ref. 03/207.

The fourth instar caterpillar (Fig. 31) is similar to the fifth, but the colouring is bolder, and the brown line on the head from apex to in front of the stemmata is less diffuse.

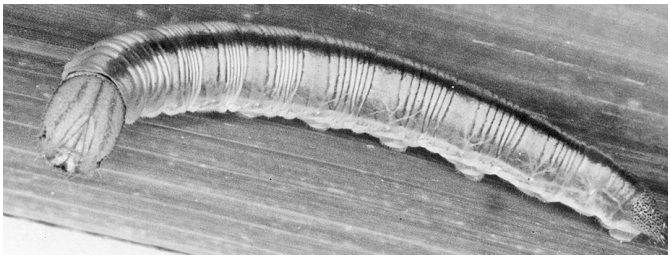

Fig. 31. *Quasimellana eulogius* fourth instar caterpillar, 30 mm, Ref. 03/207.

240. M25/12 *Quasimellana servilius* (Möschler 1883)
Fig. 32.

This species has been reported from Mexico south to Ecuador and the Guianas (Burns 1994; Evans 1955). Evans (1955) described *verba* (TL Ecuador) as a subspecies of *myron* Godman, and it was therefore as *Mellana myron verba*, that I introduced this species to the Trinidad list (Cock 1982). Burns (1994) raised *verba* to species rank, and transferred it to *Quasimellana*. Recently, Mielke and Casagrande (2002) established the correct identity of *servilius* (TL Surinam) as a senior synonym of *verba*, and hence the use of this name here.

It was first recorded from Trinidad by Cock (1982) based on two males from Trinity Hills (29.xii.1981, 4.iv.1982). These records suggest it is restricted to the south of Trinidad, but S. Alston-Smith (pers. comm. 2006) believes he has found it at Sans Souci Estate, Sangre Grande.

Male (Fig. 32). UPS dark brown with tawny markings; cilia brown. No brand. UNS head pale; palps pale basally, dark scales overlaid with pale tawny scales distally, palp 3 dark; antennal shaft chequered, base of club pale below, then dark before chestnut apiculus; UNS thorax tawny; UNS abdomen pale. UNS F pale tawny along costa, including upper half of cell, and apical 1/3, extending narrowly to termen; remainder blackish-brown; pale spot in space 1B, tawny spots in spaces 2 and 3. UNH plain pale tawny, with a slight dull green tint when compared with other tawny species in this group from Trinidad. This green tint is diagnostic for the *myron* group of *Quasimellana* (Burns 1994; Evans 1955) and is stronger in mainland specimens, e.g. Janzen & Hallwachs' (2007) specimens from Costa Rica. However, the markings and genitalia (Evans 1955) are a good match, so I have little doubt as to this identification. F male 13.5 mm. Burns (1994) illustrates a male UPS and UNS.

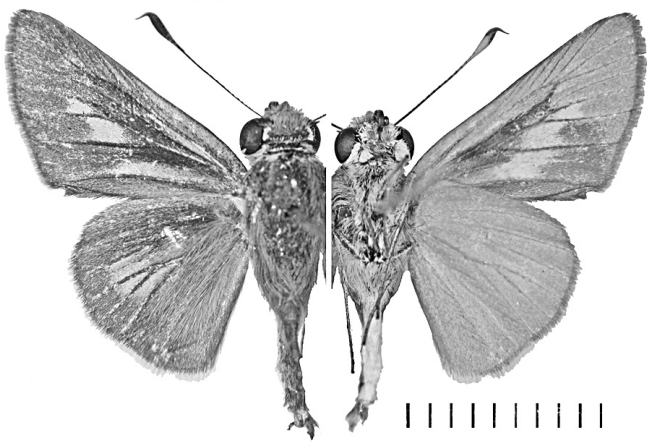

Fig. 32. *Quasimellana servilius* male, Trinity Hills, Morne Derrick, 29.xii.1981.

I have not seen the female from Trinidad. Strong sexual dimorphism UPS. UPS brown, UPF white spot in lower space 1B against vein 1; white hyaline spots in spaces 2, 3, 6 and 7, but reduced compared to male. UNS as male except UNF spot in space 1B is much wider, other spots UPF are white hyaline; UNH with a strong green overlay, except in spaces 1B and 1C.

Janzen and Hallwachs (2007) include several rearing records from *Lasiacis procerrima*, *L. ruscifolia*, *Paspalum nutans* and two further, un-named species of Poaceae, and illustrate the mature caterpillar. I have no information on the life history and food plants from Trinidad.

241. M28/11 *Euphyes peneia* (Godman 1900)
Figs. 33-34.

This species occurs from the Amazon region to Honduras (TL Panama) (Evans 1955), and north to Mexico (Warren *et al*. 2007).

Kaye (1925) described *Euphyes catioides* Kaye from Trinidad, with a single type specimen from Ariapita Road, 15.xi.1920 (W. J. Kaye). This holotype male is in MGCL, although the data label specifies only "Trinidad" for the locality. *Euphyes catioides* is a synonym of *E. peneia* (Evans 1955; Mielke 2004).

Sheldon (1938) reports a specimen from Scarborough as *Atrytone pericia*, a mis-spelling of *peneia*. This is probably the male labelled Tobago in the NHM from the Sheldon bequest.

Male (Fig. 33). UPS brown, with scattered tawny scales and setae especially on disc UPH; diffuse pale spots in spaces 2 (upper part, beyond origin of vein 3), 3, 6-8. Cilia pale, brown towards apex UPF. Brand UPF dark blackish-brown, in a line from under origin vein 3, across spaces 2 and 1B to vein 1, with indistinct interruptions at vein 2 and in space 1B. UNS head white, grading to almost black at labial palp segment 3; antennal shaft slightly chequered, pale beneath club, chestnut apiculus; UNS thorax grey-brown; UNS abdomen pale with narrow brown ventral line. UNF tawny brown along costa and at apex, brown at base of space 3, and outer half spaces 1B and 2; blackish-brown basally; large diffuse pale spot in upper part space 1B; pale spots in spaces 2 and 3, indistinctly in 4-6. UNH tawny brown; spaces 1B and 1 brown; row of diffuse pale yellowish spots in spaces 2-6. F male 18 mm.

Female (Fig. 34). Some sexual dimorphism. UPS brown; pale spots in spaces 2 and 3; a dot in space 6; cilia pale, brown at apex UPF. UNS as male. F female 18.5 mm. Illustrations in Freeman (1967, male UPS and UNS, as *E. donahuei* Freeman, a synonym), Mielke (1972, male & female UPS & UNS, Figs. 23-26), Lewis (1973, female

UNS, plate 82.57). Mielke (1972) and Shuey (1993) illustrate the male and female genitalia, while Freeman (1967) includes the male genitalia of the synonym *E. donahuei*.

This is not a very distinctive species, and it will be necessary to match carefully the markings, colouring and male brand to separate it from other similar species in Group J. *Cynea* spp. (Group K; Cock 2005) are superficially similar, but darker brown, and males have no brand.

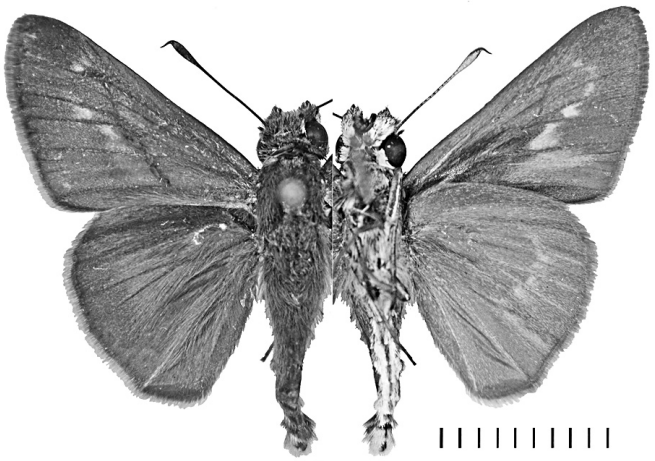

Fig. 33. *Euphyes peneia* male, Palo Seco Oilfield, North of San Fernando-Siparia-Erin Road, 7.x.1995.

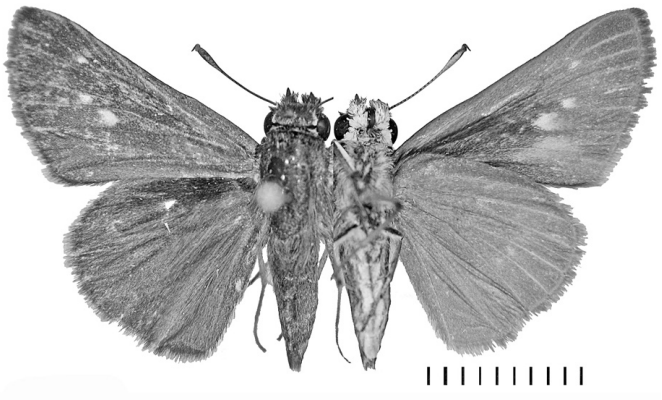

Fig. 34. *Euphyes peneia* female, Curepe, at flowers, 7.x.1979.

This is an occasional species in Trinidad, which could turn up almost anywhere, including the higher parts of the Northern Range. It comes to flowers but perhaps less frequently than the common orange species in this group.

Janzen and Hallwachs (2007) illustrate the caterpillars, which they reared frequently from sedges, four species of *Cyperus* spp. in Costa Rica, and once from a grass, *Oryza latifolia* (broadleaf rice). The head capsule of the mature caterpillar is rather like that of *Q. eulogius* (Fig. 30), but the lateral brown line is more sharply defined for *Q. eulogius*, while the line down each epicranium is stronger in *E. peneia*. The body of *E. peneia* is finely variegated in shades of green with yellow tinted skin folds at the rear of each segment, and no dorsal line, whereas that of *Q. eulogius* (Fig. 31) is more uniform with a strong dorsal line.

There is a pair of this species from British Guiana in the NHM, reared on sugar cane by H. E. Box, iii.1924 (Box 1953). Pupa light brown; cylindrical, slightly wider at head-prothorax, scarcely tapered at abdomen, cremaster very short, and abdomen end truncate; no frontal spike; short erect setae on head; lightly covered white waxy powder. No cast caterpillar skin or head capsule.

S. Alston-Smith (pers. comm. 2006) has reared this species from sugar cane at Barrackpore, but I have no details of the life history.

242. M28/16 *Arotis kayei* (Bell 1931)

Figs. 35-36.

This species, named after W. J. Kaye, was described in the genus *Oeonus* Godman (mis-spelt as *Oenus*) by Bell (1931) based on a Trinidad male. Subsequently, it was placed in *Euphyes* Scudder as a subspecies of *sirene* Mabille (Cock 1982; Evans 1955). In his revision of *Euphyes*, Mielke (1972) treated *kayei* Bell as a valid species. Subsequently, Shuey (1987) resurrected the genus *Arotis* Mabille from synonymy with *Euphyes* and transferred *kayei* to it. Shuey (1987) also illustrates the female genitalia.

Evans (1955) includes records from Venezuela to Belem at the mouth of the Amazon. Kaye (1940) refers to it as *Oenus kayei* and cites a Sir Norman Lamont specimen from Morne Diable, 26.xii.1927; I have not seen this specimen in Lamont's collections, so it may be in MGCL.

Male (Fig. 35). UPS plain dark brown. Brand UPF concolorous, in three parts: a streak across base of space 2, from about middle of cubital portion, diagonally to near origin of vein 2; a round portion in line with this, in upper space 1B, just below vein 2; the third part parallel to first, but displaced very slightly outwards, across lower space 1B, wider at top, tapering slightly to vein 1. UNS head grey-brown, shading to brown distally on palpi; antennal shaft brown, pale under club, apiculus chestnut; UNS thorax and abdomen grey-brown, the later with a diffuse pale ventral line. UNF brown, paler towards margin, with the dividing line displaced outwards in spaces 1B, 4 and 5. UNH brown; spaces 1A-C and margin broadly paler brown. Female (Fig. 36). Similar to male, but with double pale line UNS abdomen (this may also be the case in the male, but I cannot tell because of the way that the abdomen has distorted as it dried). F male 16 mm, female 20 mm.

The plain brown UPS, together with the two shades of brown UNS, should help to recognise this species in Trinidad, especially if combined with the characters of the male brand.

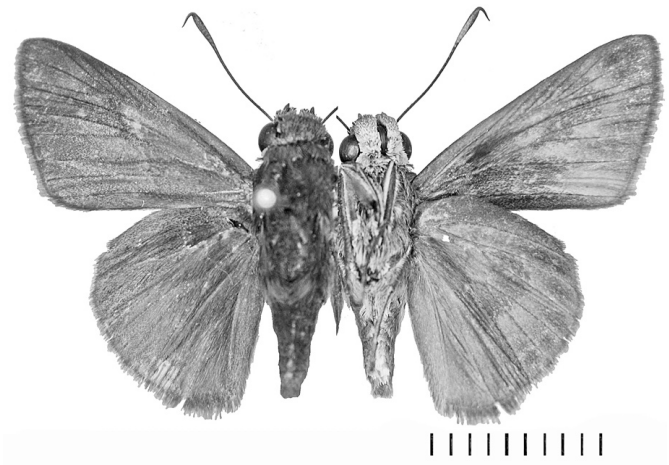

Fig. 35. *Arotis kayei* male, Caura, 2.viii.1976 (J. S. Noyes); specimen in CABI.

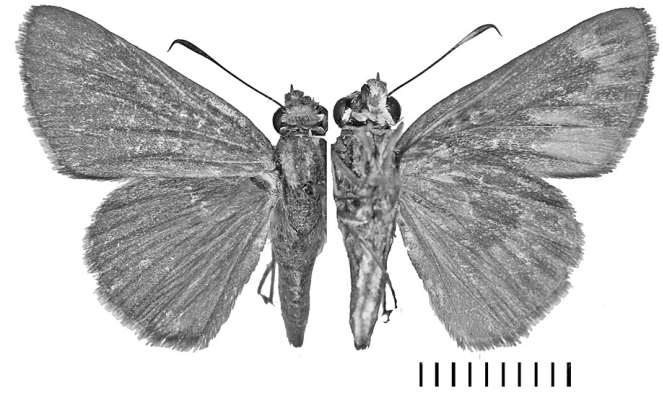

Fig. 36. *Arotis kayei* female, Cumaca Road, 4¾ milestone, 20.xii.1978.

This is a rather uncommon species, and I only have records from the north: Arima (male, ii.1930, A. Hall, BM), Caura (male, 2.viii.1976, J. S. Noyes, IIBC), Cumaca Road, milestone 4¾ (female, 20.xi.1978), Fondes Amandes (male, 8.iii.1933, NHM), and East: Matura (male, x.2000, SAS), Valencia (female, i.1985, SAS), and Bush Bush Island (female, x.1999, SAS).

The life history and food plants seem to be unknown, but the food plants may be sedges, as is the case for the closely related genus *Euphyes* (Scott 1986).

243. M33/2 *Metron chrysogastra chrysogastra* (Butler 1870)

Fig. 37.

Evans (1955) treats this very distinctive species as three subspecies, the nominate ssp. occurring from Mexico to Venezuela (TL) and Trinidad (also Surinam (de Jong 1983)), two other ssp. occurring in Bolivia and Brazil.

Kaye (1904, No. 263; 1921, No. 413) reports a single specimen he captured in the Botanic Gardens, June 1901.

Male (Fig. 37). UPS dark brown; yellow spots in spaces 2 and 3 UPF; discal area UPH diffuse yellow. Brand UPF slightly darker brown than ground colour: along cubitus at base of space 2, under basal area of vein 2 from origin. UNS of head yellow-white; UNS of palpi with strong orange tint; antenna shaft brown, club pale brown basally, chestnut on apiculus. UNS of thorax brown; UNS abdomen white, orange tint at lateral margin. UNS wings brown; yellow spots UNF spaces 2 and 3 as UPF; a white, diagonal spot space 1B, aligned with spot in space 2; UNH with sharply demarcated white discal line in spaces 1A and 3-7. The female is similar but with more rounded wings. Illustration in Lewis (1973, UNS, plate 83.35). F male 14 mm.

The white discal band UNH is distinctive for this species in the Trinidad fauna.

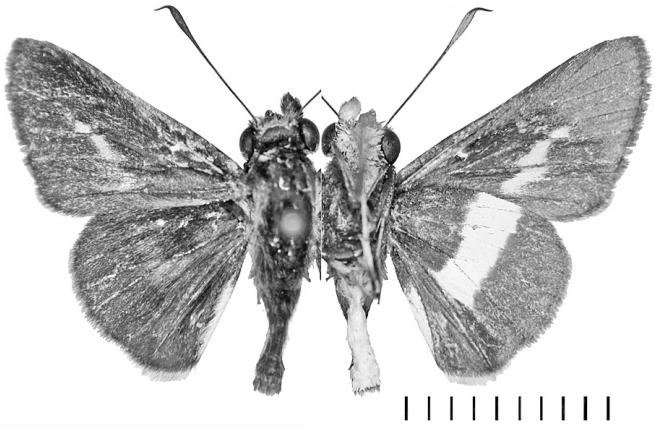

Fig. 37. *Metron chrysogastra chrysogastra* male, Lalaja Ridge, 17.iii.1982.

This distinctive species is rare in Trinidad collections. I have records from Lalaja Ridge (male, 17.iii.1982), Andrew's Trace (male, iii.1989, SAS), Maupertuis (3 males, 16.iii.1922, N. Lamont, RSM, UWI), St. George (?female, x.1891, C. W. Ellacombe, NHM) and 4 males, 1 female labelled only Trinidad (BM, NHM). These records suggest it may be a species of the forests of the Northern Range.

Janzen and Hallwachs (2007) include food plant records on *Rhipidocladum racemiflorum* (Poaceae) in Costa Rica. I have no further information on the life history or food plants.

244. M33/6 *Metron noctis* (Kaye 1914)

Figs. 38-39.

Kaye (1914) described this species as *Atrytone noctis* from a specimen taken by G. E. Tryhane in St. Ann's Val-

ley; the specimen, which is a male, is in the NHM. There are no further records in Kaye (1921, No. 382).

Evans (1955) adds a small number of records from Ecuador, Brazil and Paraguay. A synonym, *subviridis* Hayward, was described from Argentina (Evans 1955; Mielke 2004).

Male (Fig. 38). UPS dark brown; tawny scales on head, basal ½ of F costa, and small indistinct and diffuse spots in spaces 1B, 2 and 3; tawny cilia at base of space 1B, and basal ½ of space 1A; fringe paler brown, especially at dorsum UPH. Brand UPF slightly darker than ground colour: along cubitus at base of space 2 and under vein 2 from origin, both wider basally. UNS head and thorax pale khaki green; antennal shaft brown, pale brown under club, chestnut apiculus; UNS abdomen pale. UNS wings khaki-green, except disc and dorsum UNF black; UNH spaces 1B and 1C shiny green-brown; UNF pale spots in spaces 2 and 3, and white diagonal spot in space 1B; UNH pale yellowish spots in space 1C, and end cell; indistinct line of faint spots in spaces 3-5. Female (Fig. 39) similar but diffuse spots UPF stronger and also present in spaces 1B, 6 and 7. F male 14 mm, female 15 mm.

The khaki-green UNS is unlike any other Trinidad skipper. The female of *Q. servilius* (above) when found will also have a green underside, but will be distinguishable by the white F spots.

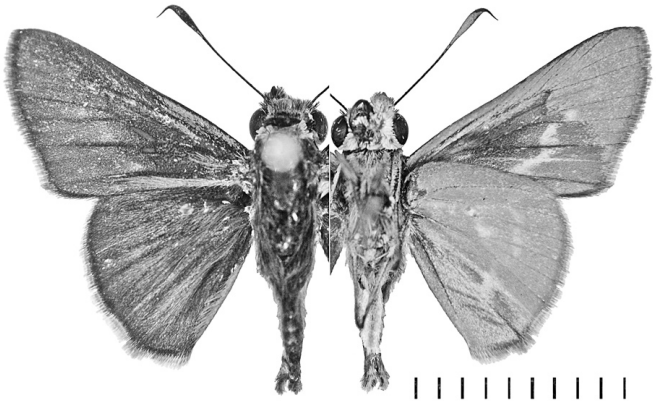

Fig. 38. *Metron noctis* male, Arena Forest, nr. Parrotts Ride, 8.x.1994.

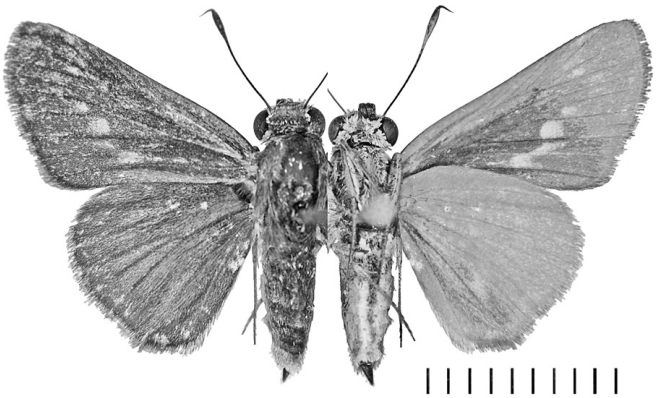

Fig. 39. *Metron noctis* female, Brasso, eupatorium flowers, 11.x.1993.

Like *M. chrysogastra*, this is a rare species in Trinidad collections. Apart from the St. Ann's holotype, I have scattered records from Arena Forest (male, 8.x.1994), Arima-Blanchisseuse Road, milestone 10½ (female, 5.x.1979), Brasso (11.x.1993), west of San Rafael (2 males, 2.x.1982). All except the first of these were taken at flowers of *Austroeupatorium inulaefolium* beside roads in open and forested areas.

I have no information on the life history or food plants, which seem to be unknown.

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The Status and Abundance of Birds in Trinidad and Tobago

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INTRODUCTION

This report presents a revised list of the birds recorded in Trinidad and Tobago as of June 2007 and an assessment of their abundance based on our own observations and documented sightings. Information on status has been gleaned mainly from guides to the birds of Trinidad and Tobago (ffrench 1991), the West Indies (Raffaele *et al*. 1998), and Venezuela (Hilty *et al*. 2003), as well as from recent studies. Pigeonholing of species into status and abundance categories often is unsatisfactory as not all species fit into neat groupings. Nevertheless, a list provides a concise format for presenting information and characterizing the country's avifauna. Previously available lists (ffrench 1996 a, b; Murphy 1988, 2004; NBC 2001) are dated in terms of number of species and systematic order. The most recent lists compiled by the Trinidad and Tobago Rare Bird Committee (TTRBC) (TTRBC 2005) do not present status or abundance.

Taxonomic revisions often lead to changes in species names or relationships and result in changes in the systematic order. ffrench (1996 a, b) and NBC (2000) follow the Wetmore sequence. Murphy (1996, 2004) followed the systematic order of the American Ornithologists' Union (AOU 1998). TTRBC (2005) and this report follow the nomenclature and species order of the AOU Checklist of Birds of South America (Remsen *et al*. 2007). Scientific names of species mentioned are listed in Table 1. Species listed as *incertae sedis* by Remsen *et al*. (2007), are indicated with an asterisk but listed in the family in which they had been placed previously. The names Bare-eyed Thrush, White-necked Thrush, and Moriche Oriole have been used on the basis of proposals pending before the South American Classification Committee (SACC) of the American Ornithologists' Union.

With a few notable exceptions, the status of a species does not change. However, our knowledge of the status of a species and the categories we use to describe status itself may change. Increased observation may make the true status of a species more apparent. For example, increased observation may allow a species considered to be an occasional migrant to be more accurately described as a regular migrant.

Other changes are more substantial. The regularity of Ruff and Lesser Black-backed Gull sightings over the past 10 years suggests that these birds are more likely to be migrants from a North American population than vagrants from the Palearctic. Recent studies leading to further understanding of species status include Lesser Black-backed Gull (Hayes *et al*. 2002), gulls (Hayes *et al*. 2004), Little Egret (Murphy 1992; Hayes and White 2001), Dickcissel (White and Temple 2002), Green and Striated Herons (Hayes 2006), Scarlet Ibis (ffrench and Haverschmidt 1970), caprimulgids (ffrench 1998b), Palearctic vagrants (Kenefick and Hayes 2006), shorebirds (Morrison and Ross 1989), and pelagic seabirds (Murphy 2002). ffrench (2000) discusses the possible local migration of several species. Finally, advances in the knowledge of the status of species in neighbouring countries (Hilty *et al*. 2003; Raffaele *et al*. 1998; Restall *et al*. 2006) contributes to our understanding of the status of these species in Trinidad and Tobago.

The initiation of the TTRBC in 1996 (Hayes and White 2000) provided a forum for capturing and evaluating the observations of many resident and visiting birdwatchers. This has added to our knowledge of the status of many rare or previously unrecorded species in Trinidad and Tobago. Advances in electronic communication have facilitated an increased awareness of the TTRBC, the noteworthiness of certain species, and the reporting of sightings of rare species. From the initiation of the TTRBC to the end of 2006, 512 records have been submitted, and 25 species have been added to the Trinidad and Tobago checklist (Hayes and White 2000; White and Hayes 2002; Kenefick 2005, 2007). This process has been fuelled by a growing number of birdwatchers who, in addition to resources such as local guides and readily available ornithological literature, are now equipped with audio guides (Boesman 1999; Hammick and ffrench 2004; Murphy 1997) and location lists (Murphy 1996, 2004).

The Status categories for this list have been adapted from ffrench (1996 a, b). Categories have been added to distinguish between species that breed locally and migrate

or disperse to the mainland in the non-breeding period, and species which are resident and regularly breeding but whose numbers are augmented during certain seasons by migrants from North or South America. The distinction is also made between species which overwinter in the tropics and transient species whose overwintering range does not extend north of the equator. The few exceptions to this general scheme include non-breeding birds, especially immature birds that may spend their first summer in the wintering grounds, or birds which are primarily passage migrants that may overwinter occasionally in Trinidad or Tobago.

Many species are represented by very few observations. Those species for which Trinidad and Tobago is well outside of their normal range have been categorised as *Vagrants*. Species that exhibit regular seasonal migration which may extend occasionally to Trinidad and Tobago are treated as *Migrants* from the *north* or *south*, albeit very rare ones. It is assumed that these birds will return to their place of origin at the onset of the appropriate season. Species that are generally sedentary, or species that wander, and for which Trinidad and Tobago is at the edge of their range, have been categorised as *Wandering*. These species, generally from South America, occasionally may breed in Trinidad or Tobago, and may eventually wander back to South America. Typical examples include Black-collared Hawk, Pied Lapwing, and Crested Doradito. The term *Resident* has been restricted to species (or populations) that do not show significant movements and which we believe maintain a viable breeding population in Trinidad or Tobago.

Pelagic seabirds have been categorized as *Oceanic*. Those which have bred within the country are categorized as *Oceanic Breeding*. Coastal species are categorised into the same categories used for land birds but a few uncertainties occur. Royal, Roseate, and Common Terns are distributed both north and south of Trinidad and Tobago, and Royal and Roseate Terns occasionally breed on Trinidad or Tobago. There is evidence, however, that those individuals visiting Trinidad and Tobago originate along the Atlantic seaboard of the USA (ffrench 1991), so they have been categorised as visitors from the north.

For some species, available data are insufficient to definitively assign a status category. For these species we have assigned a category based on the balance of evidence. Populations of the seedeaters, popular as cage birds, have been so decimated that it is likely that no viable resident populations remain. Occasional sightings are likely to be escaped cage birds or temporary visitors to Trinidad and Tobago. The term *Extirpated* has been reserved for such species, which previously were considered to have a resident sustainable breeding population on Trinidad or Tobago but which no longer occur on either island or which are restricted to visiting birds only. ffrench (1998a) highlights the uncertain origin of several species. We have generally avoided issues of origin in this account. However, in Tobago the presence of the Greater Bird-of-Paradise and probably the Great Kiskadee and Purple Honeycreeper was a result of introduction by humans. These birds were known to have survived for some period of time, but as they have not been recorded for the past 15 years they have not been included in this list. On the other hand, the Green-rumped Parrotlet, also a likely introduction to Tobago, is listed as resident because its population remains viable there. Common Waxbills, presumably introduced to Trinidad prior to 1987 (White 1988), now appear to constitute a self-sustaining population, so we consider the species to be resident. A recently discovered population of Grassland Yellow-Finch in Trinidad however, has not persisted long enough to be deemed self-sustaining.

Once a species has been documented in the literature as having occurred in Trinidad or Tobago, it is difficult to expunge, especially from a comprehensive account like ffrench (1991). For this list, however, two species listed in ffrench (1991) have been removed from the Tobago list. We determined that the original accounts of Tropical Parula and Gray-breasted Martin, both listed without comment from Tobago, were also unsatisfactorily documented. There have been no records of either species since the original listing.

Categories have been defined as follows:

BR - Resident species without significant movement out of Trinidad and Tobago. Breeding is assumed even if no nest has been documented (Breed/Resident).

BD - Species that breed locally and migrate or disperse to the mainland (sometimes only partially) during the non-breeding period (Breed/Disperse).

BV - Resident, regularly breeding species whose numbers are augmented by visitors from North or South America (Breed/Visit).

MN - Non-breeding migrants from North America. Predominantly overwintering (Migrant/North).

MS - Migrants from South America. These species may be avoiding the Austral winter, or dispersing from breeding grounds, but generally show regular seasonal movements. May occasionally breed (Migrant/South).

PM - Passage migrants. Species whose overwintering range (Boreal winter) is generally south of the equator. Winter records are sparse.

O - Oceanic.
OB - Oceanic, with breeding confirmed in Trinidad or Tobago.
W - Wandering; generally sedentary or wandering species at the edge of their range. Reported less than once per decade.
V - Vagrant. Outside of the accepted range of the species.
F - Feral; escaped from captivity or domestication.
Ext. - Formally resident but now extirpated probably due to human activity.
Hist. - Historically recorded but no records during the past 50 years.

While there is a high level of interest among birders in recording rare species, regular recording of common species is still not the norm for resident birdwatchers. The Southeastern Caribbean Bird Alert (SCBA, http://www.wow.net/ttfnc/rarebird.html) is an e-mail update/website on interesting sightings prepared by M. Kenefick. The SCBA is primarily a communication instrument, however, and sightings are not verified. Commercial bird tour-guides and their clients, increasingly familiar with the status of species in Trinidad and Tobago, thanks to resources such as the SCBA, make numerous observations of scarce species, many of which sightings are noted in a log at the Asa Wright Nature Centre in Trinidad. This log is examined at regular intervals by M. Kenefick for preparation of the SCBA. A few individuals, including the authors, keep regular records of their own sightings, not limited to rare species, and all birders, both resident and visiting, are encouraged to do so.

A few recent objective comparisons of abundance have been based on frequency of capture in mist nets (ffrench & ffrench 2000; White 2002), point counts (Hayes and Samad 1998) or frequency of observation combined with high counts (Chandool 1999; Cuffy 2002; Gochfeld 2002; Hayes *et al*. 2004; White 2000; White and Kenefick 2004). There are not enough of these studies however, to substitute for subjective assessment. Confidence in the assessment of abundance, if not objectivity, can be achieved by defining the categories such that each species can be assigned with some certainty. The abundance data for the values presented in this checklist have been derived from the combined experience of the authors, records of the TTRBC, the SCBA, and published studies.

We have tried to be consistent in applying the abundance categories used herein while acknowledging that fitting diverse data to rigid guidelines may lead to inconsistencies. For example, birds of prey may be listed as Common even though they are present in very small numbers, yet they are frequently observed. Similarly, secretive species may be listed as Rare because they are easily missed, even though they may be comparatively common. We have placed emphasis on the relative abundance within each family; thus Violaceous and Trinidad Euphonias are described as common and uncommon respectively. Similarly, Blue-chinned Sapphire and Long-billed Starthroat are described as common and uncommon, respectively. We acknowledge, however, that in absolute terms Trinidad Euphonia is more abundant than Long-billed Starthroat. It is clear that creating finer divisions of abundance than those used herein likely would have suggested a unwarranted degree of confidence.

The abundance categories have been defined as follows:

A - Abundant; widespread and usually in some numbers in suitable habitat.
C - Common; usually found in suitable habitat.
U - Uncommon; occasionally seen in suitable habitat singly or in small numbers.
Sc - Scarce; very few (less than 5) records per year.
R - Rare; not recorded annually.
VR - Very rare; less than 1 record per decade.
L - Locally distributed in restricted habitat, where it may be not uncommon.

The status and abundance of the 467 species of birds recorded in Trinidad and Tobago is shown in table 1. On the basis of this assessment, the avifauna of Trinidad is comprised of 443 species of which roughly half (227) are resident (BR + BV) and a further 17 regularly breed. Regular seasonal migration is exhibited by 168 species, and 49 species are wanderers or vagrants. Although a few of the latter species may have bred occasionally, they contribute little to the avian ecology. The resident populations of eight species have been extirpated.

The avifauna of Tobago comprises 240 species of which 92 are resident (BR + BV) and a further 17 species regularly breed. Regular seasonal migration is exhibited by 122 species, and 26 species are listed as vagrants or wanderers. The resident populations of three species have been extirpated.

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Table 1. Status and Abundance of Birds in Trinidad and Tobago. (see text for definition of categories)

Species	Status		Abundance	
	Tri.	Tob.	Tri.	Tob.
Tinamidae				
Little Tinamou, *Crypturellus soui*	BR	-	C	-
Anhimidae				
Horned Screamer, *Anhima cornuta*	Ext	-	-	-
Anatidae				
Fulvous Whistling-Duck, *Dendrocygna bicolor*	MS	MS	U	VR
White-faced Whistling-Duck, *Dendrocygna viduata*	MS	-	Sc	-
Black-bellied Whistling-Duck, *Dendrocygna autumnalis*	BV	BR	C	C
Snow Goose, *Chen caerulescens*	V	-	-	-
Muscovy Duck, *Cairina moschata*	W	-	-	-
Comb Duck, *Sarkidiornis melanotos*	MS	-	R	-
American Wigeon, *Anas americana*	MN	MN	R	R
Green-winged Teal, *Anas crecca*	-	MN	-	VR
Northern Pintail, *Anas acuta*	MN	MN	R	R
White-cheeked Pintail, *Anas bahamensis*	MS	BR	U	C
Blue-winged Teal, *Anas discors*	MN	MN	C	C
Northern Shoveler, *Anas clypeata*	MN	MN	R	R
Southern Pochard, *Netta erythrophthalma*	V	-	-	-
Ring-necked Duck, *Aythya collaris*	MN	MN	VR	R
Lesser Scaup, *Aythya affinis*	MN	MN	R	R
Masked Duck, *Nomonyx dominicus*	BR	BR	R	R
Cracidae				
Rufous-vented Chachalaca, *Ortalis ruficauda*	-	BR	-	A
Trinidad Piping-Guan, *Pipile pipile*	BR	-	R	-
Podicipedidae				
Least Grebe, *Tachybaptus dominicus*	BR	BR	U	C
Pied-billed Grebe, *Podilymbus podiceps*	BR	BR	Sc	R
Procellariidae				
Bulwer's Petrel, *Bulweria bulwerii*	V	-	-	-
Cory's Shearwater, *Calonectris diomedea*	O	O	R	R
Sooty Shearwater, *Puffinus griseus*	O	-	VR	-
Greater Shearwater, *Puffinus gravis*	O	O	R	R
Manx Shearwater, *Puffinus puffinus*	O	-	R	-
Audubon's Shearwater, *Puffinus lherminieri*	O	OB	R	C
Hydrobatidae				
Wilson's Storm-Petrel, *Oceanites oceanicus*	O	O	VR	VR
Leach's Storm-Petrel, *Oceanodroma leucorhoa*	O	O	Sc	R
Phaethontidae				
Red-billed Tropicbird, *Phaethon aethereus*	O	OB	R	L
White-tailed Tropicbird, *Phaethon lepturus*	-	O	-	R
Pelecanidae				
Brown Pelican, *Pelecanus occidentalis*	BR	BR	A	C
Sulidae				
Masked Booby, *Sula dactylatra*	O	O	VR	L
Red-footed Booby, *Sula sula*	O	OB	R	L
Brown Booby, *Sula leucogaster*	OB	OB	U	C
Northern Gannet, *Morus bassanus*	-	V	-	-
Phalacrocoracidae				
Neotropic Cormorant, *Phalacrocorax brasilianus*	MS	MS	C	R
Anhingidae				
Anhinga, *Anhinga anhinga*	MS	MS	U	C
Fregatidae				
Magnificent Frigatebird, *Fregata magnificens*	BR	BR	C	A
Ardeidae				
Rufescent Tiger-Heron, *Tigrisoma lineatum*	BR	-	R	-
Agami Heron, *Agamia agami*	W	-	-	-
Boat-billed Heron, *Cochlearius cochlearius*	BR	-	R	-
Pinnated Bittern, *Botaurus pinnatus*	BR	-	U	-
Least Bittern, *Ixobrychus exilis*	BR	-	U	-
Stripe-backed Bittern, *Ixobrychus involucris*	BR	-	U	-
Black-crowned Night-Heron, *Nycticorax nycticorax*	BR	BR	C	C
Yellow-crowned Night-Heron, *Nyctanassa violacea*	BR	BR	C	C
Green Heron, *Butorides virescens*	MN	BR	R	C
Striated Heron, *Butorides striatus*	BR	-	C	-
Cattle Egret, *Bubulcus ibis*	BR	BR	A	A
Grey Heron, *Ardea cinerea*	V	V	-	-
Purple Heron, *Ardea purpurea*	V	-	-	-
Great Blue Heron, *Ardea herodias*	MN	MN	U	U
Cocoi Heron, *Ardea cocoi*	MS	MS	Sc	R
Great Egret, *Ardea alba*	BV	BV	C	C
Tricolored Heron, *Egretta tricolor*	BV	BV	C	C
Reddish Egret, *Egretta rufescens*	W	W	-	-
Western Reef-Heron, *Egretta gularis*	V	V	-	-
Little Egret, *Egretta garzetta*	BR	BR	R	R
Snowy Egret, *Egretta thula*	BV	BV	A	C
Little Blue Heron, *Egretta caerulea*	BV	BV	A	C
Threskiornithidae				
White Ibis, *Eudocimus albus*	V	-	-	-

Table 1 continued. Status and Abundance of Birds in Trinidad and Tobago.

Species	Status		Abundance	
	Tri.	Tob.	Tri.	Tob.
Scarlet Ibis, *Eudocimus ruber*	BV	MS	C	R
Glossy Ibis, *Plegadis falcinellus*	MN/S	MN/S	R	VR
Eurasian Spoonbill, *Platalea leucorodia*	-	V	-	-
Roseate Spoonbill, *Platalea ajaja*	W	W	-	-
Ciconiidae				
Maguari Stork, *Ciconia maguari*	W	-	-	-
Jabiru, *Jabiru mycteria*	W	W	-	-
Wood Stork, *Mycteria americana*	W	-	-	-
Cathartidae				
Turkey Vulture, *Cathartes aura*	BR	-	A	-
Black Vulture, *Coragyps atratus*	BR	W	A	-
King Vulture, *Sarcoramphus papa*	W	-	-	-
Phoenicopteridae				
Greater Flamingo, *Phoenicopterus ruber*	MS	-	R	-
Pandionidae				
Osprey, *Pandion haliaetus*	MN	MN	C	U
Accipitridae				
Gray-headed Kite, *Leptodon cayanensis*	BR	-	U	-
Hook-billed Kite, *Chondrohierax uncinatus*	BR	W	R	-
Swallow-tailed Kite, *Elanoides forficatus*	BD	W	U	-
Pearl Kite, *Gampsonyx swainsonii*	BR	-	U	-
White-tailed Kite, *Elanus leucurus*	W	-	-	-
Snail Kite, *Rostrhamus sociabilis*	W	-	-	-
Double-toothed Kite, *Harpagus bidentatus*	BR	-	Sc	-
Plumbeous Kite, *Ictinia plumbea*	BD	-	C	-
Long-winged Harrier, *Circus buffoni*	BR	-	U	-
Crane Hawk, *Geranospiza caerulescens*	MS	-	R	-
White Hawk, *Leucopternis albicollis*	BR	-	U	-
Common Black-Hawk, *Buteogallus anthracinus*	BR	BR	C	R
Rufous Crab-Hawk, *Buteogallus aequinoctialis*	BR	-	R	-
Great Black-Hawk, *Buteogallus urubitinga*	BR	BR	R	U
Savannah Hawk, *Buteogallus meridionalis*	BR	-	C	-
Black-collared Hawk, *Busarellus nigricollis*	W	-	-	-
Broad-winged Hawk, *Buteo platypterus*	MN	BV	U	C
Gray Hawk, *Buteo nitidus*	BR	W	C	-
Short-tailed Hawk, *Buteo brachyurus*	BR	W	C	-
Swainson's Hawk, *Buteo swainsoni*	MN	MN	VR	VR
White-tailed Hawk, *Buteo albicaudatus*	MS	-	R	-
Zone-tailed Hawk, *Buteo albonotatus*	BR	W	C	-
Black Hawk-Eagle, *Spizaetus tyrannus*	BR	-	R	-
Ornate Hawk-Eagle, *Spizaetus ornatus*	BR	Hist	Sc	-
Falconidae				
Crested Caracara, *Caracara cheriway*	MS	-	R	-
Yellow-headed Caracara, *Milvago chimachima*	BR	BR	C	U
Eurasian Kestrel, *Falco tinnunculus*	V	-	-	-
American Kestrel, *Falco sparverius*	W	W	-	-
Merlin, *Falco columbarius*	MN	MN	U	U
Bat Falcon, *Falco rufigularis*	BR	W	Sc	-
Orange-breasted Falcon, *Falco deiroleucus*	W	-	-	-
Aplomado Falcon, *Falco femoralis*	MS	MS	R	VR
Peregrine Falcon, *Falco peregrinus*	MN	MN	U	U
Aramidae				
Limpkin, *Aramus guarauna*	BR	-	U	-
Rallidae				
Clapper Rail, *Rallus longirostris*	BR	-	L	-
Gray-necked Wood-Rail, *Aramides cajanea*	BR	-	U	-
Rufous-necked Wood-Rail, *Aramides axillaris*	BR	-	L	-
Gray-breasted Crake, *Laterallus exilis*	BR	-	Sc	-
Yellow-breasted Crake, *Porzana flaviventer*	BR	W	U	-
Ash-throated Crake, *Porzana albicollis*	Hist	-	-	-
Sora, *Porzana carolina*	MN	MN	Sc	Sc
Paint-billed Crake, *Neocrex erythrops*	MS	-	VR	-
Spotted Rail, *Pardirallus maculatus*	BR	Hist	R	-
Common Moorhen, *Gallinula chloropus*	BR	BR	C	C
Purple Gallinule, *Porphyrio martinica*	BR	BR	C	U
Azure Gallinule, *Porphyrio flavirostris*	BR	-	L	-
Caribbean Coot, *Fulica caribaea*	W	W	-	-
American Coot, *Fulica americana*	-	MN	-	R
Heliornithidae				
Sungrebe, *Heliornis fulica*	W	-	-	-
Charadriidae				
Pied Lapwing, *Vanellus cayanus*	W	-	-	-
Southern Lapwing, *Vanellus chilensis*	BR	BR	A	C
American Golden-Plover, *Pluvialis dominica*	MN	MN	U	Sc
Black-bellied Plover, *Pluvialis squatarola*	MN	MN	C	U
Semipalmated Plover, *Charadrius semipalmatus*	MN	MN	C	U
Wilson's Plover, *Charadrius wilsonia*	MS	-	U	-
Killdeer, *Charadrius vociferus*	MN	MN	R	R

Table 1 continued. Status and Abundance of Birds in Trinidad and Tobago.

Species	Status		Abundance	
	Tri.	Tob.	Tri.	Tob.
Snowy Plover, *Charadrius alexandrinus*	-	MN	-	VR
Collared Plover, *Charadrius collaris*	BD	BD	C	Sc
Common Ringed Plover, *Charadrius hiaticula*	V	-	-	-
Haematopodidae				
American Oystercatcher, *Haematopus palliatus*	MN	MN	R	R
Recurvirostridae				
Black-necked Stilt, *Himantopus mexicanus*	BD	MS	C	R
American Avocet, *Recurvirostra americana*	-	V	-	-
Burhinidae				
Double-striped Thick-knee, *Burhinus bistriatus*	W	W	-	-
Scolopacidae				
Wilson's Snipe, *Gallinago delicata*	MN	MN	U	U
South American Snipe, *Gallinago paraguaiae*	BD	-	U	-
Short-billed Dowitcher, *Limnodromus griseus*	MN	MN	C	U
Black-tailed Godwit, *Limosa limosa*	V	-	-	-
Hudsonian Godwit, *Limosa haemastica*	MN	MN	Sc	R
Marbled Godwit, *Limosa fedoa*	MN	-	R	-
Eskimo Curlew, *Numenius borealis*	Hist	Hist	-	-
Whimbrel, *Numenius phaeopus*	MN	MN	C	U
Long-billed Curlew, *Numenius americanus*	-	MN	-	R
Upland Sandpiper, *Bartramia longicauda*	MN	MN	R	R
Terek Sandpiper, *Xenus cinereus*	V	-	-	-
Spotted Sandpiper, *Actitis macularia*	MN	MN	C	C
Greater Yellowlegs, *Tringa melanoleuca*	MN	MN	C	C
Lesser Yellowlegs, *Tringa flavipes*	MN	MN	A	C
Spotted Redshank, *Tringa erythropus*	-	V	-	-
Wood Sandpiper, *Tringa glareola*	-	V	-	-
Common Greenshank, *Tringa nebularia*	V	-	-	-
Solitary Sandpiper, *Tringa solitaria*	MN	MN	C	U
Willet, *Tringa semipalmatus*	MN	MN	C	U
Ruddy Turnstone, *Arenaria interpres*	MN	MN	C	C
Red Knot, *Calidris canutus*	MN	MN	U	Sc
Sanderling, *Calidris alba*	MN	MN	U	U
Semipalmated Sandpiper, *Calidris pusilla*	MN	MN	A	C
Western Sandpiper, *Calidris mauri*	MN	MN	A	U
Least Sandpiper, *Calidris minutilla*	MN	MN	A	C
White-rumped Sandpiper, *Calidris fuscicollis*	MN	MN	U	U
Baird's Sandpiper, *Calidris bairdii*	PM	-	R	-
Pectoral Sandpiper, *Calidris melanotos*	MN	MN	U	U
Curlew Sandpiper, *Calidris ferruginea*	V	-	-	-
Stilt Sandpiper, *Calidris himantopus*	MN	MN	C	U
Buff-breasted Sandpiper, *Tryngites subruficollis*	MN	MN	Sc	Sc
Ruff, *Philomachus pugnax*	MN	MN	R	R
Wilson's Phalarope, *Phalaropus tricolor*	PM	PM	R	R
Jacanidae				
Wattled Jacana, *Jacana jacana*	BR	BR	A	C
Stercorariidae				
South Polar Skua, *Stercorcarius maccormicki*	O	-	VR	-
Pomarine Jaeger, *Stercorcarius pomarinus*	O	O	R	R
Parasitic Jaegar, *Stercorcarius parasiticus*	O	O	Sc	R
Laridae				
Ring-billed Gull, *Larus delawarensis*	MN	MN	R	R
Kelp Gull, *Larus dominicanus*	V	-	-	-
Herring Gull, *Larus argentatus*	V	-	-	-
Lesser Black-backed Gull, *Larus fuscus*	MN	MN	U	R
Laughing Gull, *Larus atricilla*	BV	BV	A	A
Franklin's Gull, *Larus pipixcan*	MN	-	R	-
Black-headed Gull, *Larus ridibundus*	MN	MN	R	R
Black-legged Kittiwake, *Rissa tridactyla*	V	-	-	-
Sabine's Gull, *Xema sabini*	W	-	-	-
Brown Noddy, *Anous stolidus*	OB	OB	L	C
White Tern, *Gygis alba*	-	V	-	-
Sooty Tern, *Onychoprion fuscatus*	OB	OB	R	C
Bridled Tern, *Onychoprion anaethetus*	O	OB	R	U
Least Tern, *Sternula antillarum*	MN	MN	Sc	Sc
Yellow-billed Tern, *Sternula superciliaris*	MS	-	C	-
Large-billed Tern, *Phaetusa simplex*	MS	-	C	-
Gull-billed Tern, *Gelochelidon nilotica*	MN	-	U	-
Caspian Tern, *Hydroprogne caspia*	MN	-	VR	-
Black Tern, *Chlidonias niger*	PM	-	Sc	-
Common Tern, *Sterna hirundo*	MN	MN	C	C
Roseate Tern, *Sterna dougallii*	MN	MN(B)	C	C
Sandwich Tern, *Thalasseus sandvicensis*	MN/S	MN/S	U	U
Royal Tern, *Thalasseus maximus*	MN(B)	MN(B)	C	C
Rynchopidae				
Black Skimmer, *Rynchops niger*	MS	MS	C	Sc

Table 1 continued. Status and Abundance of Birds in Trinidad and Tobago.

Species	Status		Abundance	
	Tri.	Tob.	Tri.	Tob.
Columbidae				
Common Ground-Dove, *Columbina passerina*	BR	-	C	-
Plain-breasted Ground-Dove, *Columbina minuta*	BR	-	U	-
Ruddy Ground-Dove, *Columbina talpacoti*	BR	BR	A	A
Scaled Dove, *Columbina squammata*	W	-	-	-
Blue Ground-Dove, *Claravis pretiosa*	BR	-	R	-
Rock Pigeon, *Columba livia*	F	F	A	C
Scaled Pigeon, *Patagioenas speciosa*	BR	-	C	-
Scaly-naped Pigeon, *Patagioenas squamosa*	-	W	-	-
Band-tailed Pigeon, *Patagioenas fasciata*	MS	-	VR	-
Pale-vented Pigeon, *Patagioenas cayennensis*	BR	BR	U	C
Eared Dove, *Zenaida auriculata*	BD	BD	C	C
White-tipped Dove, *Leptotila verreauxi*	BR	BR	C	C
Gray-fronted Dove, *Leptotila rufaxilla*	BR	-	U	-
Lined Quail-Dove, *Geotrygon linearis*	BR	Hist	R	-
Ruddy Quail-Dove, *Geotrygon montana*	BR	-	Sc	-
Psittacidae				
Blue-and-yellow Macaw, *Ara ararauna*	Ext+Int	-	R	-
Scarlet Macaw, *Ara macao*	W	-	-	-
Red-bellied Macaw, *Orthopsittaca manilata*	BR	-	L	-
Brown-throated Parakeet, *Aratinga pertinax*	MS	-	R	-
Green-rumped Parrotlet, *Forpus passerinus*	BR	BR	U	C
Lilac-tailed Parrotlet, *Touit batavica*	BR	-	U	-
Scarlet-shouldered Parrotlet, *Touit huetii*	W	-	-	-
Blue-headed Parrot, *Pionus menstruus*	BR	-	U	-
Yellow-crowned Parrot, *Amazona ochrocephala*	BR	-	C	-
Orange-winged Parrot, *Amazona amazonica*	BR	BR	A	A
Cuculidae				
Black-billed Cuckoo, *Coccyzus erythropthalmus*	MN	-	VR	-
Yellow-billed Cuckoo, *Coccyzus americanus*	PM	PM	Sc	Sc
Mangrove Cuckoo, *Coccyzus minor*	BR	BR	Sc	Sc
Dark-billed Cuckoo, *Coccyzus melacoryphus*	W	-	-	-
Squirrel Cuckoo, *Piaya cayana*	BR	-	C	-
Little Cuckoo, *Piaya minuta*	BR	-	U	-
Greater Ani, *Crotophaga major*	BR	-	U	-
Smooth-billed Ani, *Crotophaga ani*	BR	BR	A	C
Striped Cuckoo, *Tapera naevia*	BR	-	C	-
Tytonidae				
Barn Owl, *Tyto alba*	BR	BR	U	U

Species	Status		Abundance	
	Tri.	Tob.	Tri.	Tob.
Strigidae				
Tropical Screech-Owl, *Megascops choliba*	BR	-	U	-
Spectacled Owl, *Pulsatrix perspicillata*	BR	-	U	-
Mottled Owl, *Ciccaba virgata*	BR	-	R	-
Ferruginous Pygmy-Owl, *Glaucidium brasilianum*	BR	-	C	-
Burrowing Owl, *Athene cunicularia*	W	-	-	-
Striped Owl, *Pseudoscops clamator*	-	BR	-	Sc
Short-eared Owl, *Asio flammeus*	W	-	-	-
Steatornithidae				
Oilbird, *Steatornis caripensis*	BR	V	L	-
Nyctibiidae				
Common Potoo, *Nyctibius griseus*	BR	BR	U	U
Caprimulgidae				
Short-tailed Nighthawk, *Lurocalis semitorquatus*	BR	-	U	-
Lesser Nighthawk, *Chordeiles acutipennis*	MN	MN	C	R
Nacunda Nighthawk, *Podager nacunda*	MS	MS	Sc	VR
Common Pauraque, *Nyctidromus albicollis*	BR	-	C	-
Rufous Nightjar, *Caprilmulgus rufus*	BR	-	L	-
White-tailed Nightjar, *Caprilmulgus cayennensis*	BR	BR	C	U
Apodidae				
Chestnut-collared Swift, *Streptoprocne rutila*	BR	-	U	-
White-collared Swift, *Streptoprocne zonaris*	MS	MS	U	R
Band-rumped Swift, *Chaetura spinicaudus*	BR	-	C	-
Gray-rumped Swift, *Chaetura cinereiventris*	BR	BR	C	C
Chapman's Swift, *Chaetura chapmani*	BR	-	R	-
Short-tailed Swift, *Chaetura brachyura*	BR	BR	A	C
Fork-tailed Palm-Swift, *Tachornis squamata*	BR	W	C	-
Lesser Swallow-tailed Swift, *Panyptila cayennensis*	BR	-	U	-
Trochilidae				
Rufous-breasted Hermit, *Glaucis hirsutus*	BR	BR	C	C
Little Hermit, *Phaethornis longuemareus*	BR	-	C	-
Green Hermit, *Phaethornis guy*	BR	-	C	-
White-tailed Sabrewing, *Campylopterus ensipennis*	-	BR	-	U
White-necked Jacobin, *Florisuga mellivora*	BD	BD	C	U
Brown Violetear, *Colibri delphinae*	BR	-	Sc	-
Green-throated Mango, *Anthracothorax viridigula*	BR	-	L	-
Black-throated Mango, *Anthracothorax nigricollis*	BD	BD	C	C
Ruby-topaz Hummingbird, *Chrysolampis mosquitus*	BD	BD	C	C
Tufted Coquette, *Lophornis ornata*	BR	-	U	-

Table 1 continued. Status and Abundance of Birds in Trinidad and Tobago.

Species	Status		Abundance	
	Tri.	Tob.	Tri.	Tob.
Blue-chinned Sapphire, *Chlorestes notata*	BR	BR	C	R
Blue-tailed Emerald, *Chlorostilbon mellisugus*	BR	-	L	-
White-tailed Goldenthroat, *Polytmus guainumbi*	BD	-	U	-
White-chested Emerald, *Amazilia brevirostris*	BR	-	C	-
Copper-rumped Hummingbird, *Amazilia tobaci*	BR	BR	A	C
Long-billed Starthroat, *Heliomaster longirostris*	BR	-	Sc	-
Rufous-shafted Woodstar, *Chaetocercus jourdanii*	MS	-	VR	-
Trogonidae				
White-tailed Trogon, *Trogon viridis*	BR	-	C	-
Violaceous Trogon, *Trogon violaceus*	BR	-	C	-
Collared Trogon, *Trogon collaris*	BR	BR	C	U
Alcedinidae				
Ringed Kingfisher, *Ceryle torquata*	BR	-	U	-
Belted Kingfisher, *Ceryle alcyon*	MN	MN	Sc	U
Amazon Kingfisher, *Chloroceryle amazona*	W	-	-	-
Green Kingfisher, *Chloroceryle americana*	BR	BR	C	U
American Pygmy Kingfisher, *Chloroceryle aenea*	BR	-	U	-
Momotidae				
Blue-crowned Motmot, *Momotus momota*	BR	BR	U	C
Galbulidae				
Rufous-tailed Jacamar, *Galbula ruficauda*	BR	BR	C	C
Ramphastidae				
Channel-billed Toucan, *Ramphastos vitellinus*	BR	-	C	-
Picidae				
Red-crowned Woodpecker, *Melanerpes rubricapillus*	-	BR	-	C
Red-rumped Woodpecker, *Veniliornis kirkii*	BR	BR	U	U
Golden-olive Woodpecker, *Piculus rubiginosus*	BR	BR	C	C
Chestnut Woodpecker, *Celeus elegans*	BR	-	U	-
Lineated Woodpecker, *Dryocopus lineatus*	BR	-	C	-
Crimson-crested Woodpecker, *Campephilus melanoleucos*	BR	-	U	-
Furnariidae				
Pale-breasted Spinetail, *Synallaxis albescens*	BR	-	U	-
Stripe-breasted Spinetail, *Synallaxis cinnamomea*	BR	BR	C	U
Yellow-chinned Spinetail, *Certhiaxis cinnamomea*	BR	-	C	-
Gray-throated Leaftosser, *Sclerurus albigularis*	BR	BR	U	Sc
Streaked Xenops, *Xenops rutilans*	BR	-	U	-
Plain-brown Woodcreeper, *Dendrocincla fuliginosa*	BR	BR	C	U
Olivaceous Woodcreeper, *Sittasomus griseicapillus*	-	BR	-	U
Straight-billed Woodcreeper, *Xiphorhynchus picus*	BR	-	L	-
Cocoa Woodcreeper, *Xiphorhynchus susurrans*	BR	BR	C	C
Streak-headed Woodcreeper, *Lepidocolaptes souleyetii*	BR	-	U	-
Thamnophilidae				
Great Antshrike, *Taraba major*	BR	-	C	-
Black-crested Antshrike, *Sakesphorus canadensis*	BR	-	C	-
Barred Antshrike, *Thamnophilus doliatus*	BR	BR	C	C
Plain Antvireo, *Dysithamnus mentalis*	BR	BR	U	U
White-flanked Antwren, *Myrmotherula axillaris*	BR	-	C	-
White-fringed Antwren, *Formicivora grisea*	BR	BR	L	C
Silvered Antbird, *Sclateria naevia*	BR	-	U	-
White-bellied Antbird, *Myrmeciza longipes*	BR	-	C	-
Formicariidae				
Black-faced Antthrush, *Formicarius analis*	BR	-	U	-
Grallariidae				
Scaled Antpitta, *Grallaria guatimalensis*	BR	-	R	-
Tyrannidae				
Forest Elaenia, *Myiopagis gaimardii*	BR	-	C	-
Yellow-bellied Elaenia, *Elaenia flavogaster*	BR	BR	C	C
Small-billed Elaenia, *Elaenia parvirostris*	W	-	-	-
Slaty Elaenia, *Elaenia strepera*	MS	-	VR	-
Lesser Elaenia, *Elaenia chiriquensis*	BR	-	R	-
Southern Beardless-Tyrannulet, *Camptostoma obsoletum*	BR	-	C	-
Mouse-colored Tyrannulet, *Phaeomyias murina*	BR	-	L	-
Crested Doradito, *Pseudocolopteryx sclateri*	W	-	-	-
Olive-striped Flycatcher, *Mionectes olivaceus*	BR	-	R	-
Ochre-bellied Flycatcher, *Mionectes oleagineus*	BR	BR	C	C
Slaty-capped Flycatcher, *Leptopogon superciliaris*	BR	-	U	-
Northern Scrub-Flycatcher, *Sublegatus arenarum*	BR	-	U	-
Short-tailed Pygmy-Tyrant, *Myiornis ecaudatus*	BR	-	Sc	-
Spotted Tody-Fycatcher, *Todirostrum maculatum*	BR	-	L	-
Yellow-olive Flycatcher, *Tolmomyias sulphurescens*	BR	-	Sc	-
Yellow-breasted Flycatcher, *Tolmomyias flaviventris*	BR	BR	C	C
White-throated Spadebill, *Platyrinchus mystaceus*	BR	BR	U	U
Bran-colored Flycatcher, *Myiophobus fasciatus*	BR	-	U	-
Euler's Flycatcher, *Lathrotriccus euleri*	BR	-	C	-
Fuscous Flycatcher, *Cnemotriccus fuscatus*	BR	BR	L	U
Olive-sided Flycatcher, *Contopus cooperi*	MN	-	U	-

Table 1 continued. Status and Abundance of Birds in Trinidad and Tobago.

Species	Status		Abundance	
	Tri.	Tob.	Tri.	Tob.
Tropical Pewee, *Contopus cinereus*	BR	-	C	-
Pied Water-Tyrant, *Fluvicola pica*	BR	-	C	-
White-headed Marsh-Tyrant, *Arundinicola leucocephala*	BR	-	C	-
Piratic Flycatcher, *Legatus leucophaius*	BD	BD	C	U
Great Kiskadee, *Pitangus sulphuratus*	BR	-	A	-
Streaked Flycatcher, *Myiodynastes maculatus*	BR	BR	C	C
Boat-billed Flycatcher, *Megarynchus pitangua*	BR	-	C	-
Sulphury Flycatcher, *Tyrannopsis sulphurea*	BR	-	L	-
Variegated Flycatcher, *Empidonomus varius*	MS	-	R	-
Tropical Kingbird, *Tyrannus melancholicus*	BR	BR	A	C
Fork-tailed Flycatcher, *Tyrannus savana*	MS	MS	A	C
Gray Kingbird, *Tyrannus dominicensis*	BV	BV	U	C
Dusky-capped Flycatcher, *Myiarchus tuberculifer*	BR	-	U	-
Swainson's Flycatcher, *Myiarchus swainsoni*	MS	-	VR	-
Venezuelan Flycatcher, *Myiarchus venezuelensis*	-	BR	-	U
Brown-crested Flycatcher, *Myiarchus tyrannulus*	BR	BR	U	C
Bright-rumped Attila, *Attila spadiceus**	BR	-	U	-
Black-tailed Tityra, *Tityra cayana**	BR	-	U	-
White-winged Becard, *Pachyramphus polychopterus**	BR	BR	U	U
Cotingidae				
White Bellbird, *Procnias albus*	W	-	-	-
Bearded Bellbird, *Procnias averano*	BR	-	U	-
Pipridae				
White-bearded Manakin, *Manacus manacus*	BR	-	C	-
Blue-backed Manakin, *Chiroxiphia pareola*	-	BR	-	U
Golden-headed Manakin, *Pipra erythrocephala*	BR	-	C	-
Vireonidae				
Rufous-browed Peppershrike, *Cyclarhis gujanensis*	BR	-	C	-
Yellow-throated Vireo, *Vireo flavifrons*	MN	MN	VR	VR
White-eyed Vireo, *Vireo griseus*	-	MN	-	VR
Red-eyed Vireo, *Vireo olivaceus*	BV	BV	C	C
Black-whiskered Vireo, *Vireo altiloquus*	MN	MN	R	VR
Golden-fronted Greenlet, *Hylophilus aurantiifrons*	BR	-	C	-
Scrub Greenlet, *Hylophilus flavipes*	-	BR	-	C
Hirundinidae				
White-winged Swallow, *Tachycineta albiventer*	BR	BR	C	U
Caribbean Martin, *Progne dominicensis*	MS	BD	R	C
Gray-breasted Martin, *Progne chalybea*	BR	-	A	-
Blue-and-white Swallow, *Pygochelidon cyanoleuca*	MS	-	U	-
Southern Rough-winged Swallow, *Stelgidopteryx ruficollis*	BR	BR	C	R
Bank Swallow, *Riparia riparia*	MN	MN	Sc	VR
Barn Swallow, *Hirundo rustica*	MN	MN	C	C
Cliff Swallow, *Petrochelidon pyrrhonota*	MN	MN	R	R
Troglodytidae				
House Wren, *Troglodytes aedon*	BR	BR	C	C
Rufous-breasted Wren, *Thryothorus rutilus*	BR	BR	C	U
Polioptilidae				
Long-billed Gnatwren, *Ramphocaenus melanurus*	BR	-	C	-
Turdidae				
Orange-billed Nightingale-Thrush, *Catharus aurantiirostris*	BR	-	L	-
Veery, *Catharus fuscescens*	MN	-	VR	-
Gray-cheeked Thrush, *Catharus minimus*	MN	-	VR	-
Yellow-legged Thrush, *Turdus flavipes*	BR	BR	U	U
Cocoa Thrush, *Turdus fumigatus*	BR	-	C	-
Bare-eyed Thrush, *Turdus nudigenis*	BR	BR	C	C
White-necked Thrush, *Turdus albicollis*	BR	BR	C	C
Mimidae				
Tropical Mockingbird, *Mimus gilvus*	BR	BR	C	C
Motacillidae				
White Wagtail, *Motacilla alba*	V	-	-	-
Coerebidae				
Bananaquit, *Coereba flaveola*	BR	BR	A	A
Thraupidae				
White-shouldered Tanager, *Tachyphonus luctuosus*	BR	-	U	-
White-lined Tanager, *Tachyphonus rufus*	BR	BR	C	U
Silver-beaked Tanager, *Ramphocelus carbo*	BR	-	C	-
Blue-gray Tanager, *Thraupis episcopus*	BR	BR	A	C
Palm Tanager, *Thraupis palmarum*	BR	BR	A	C
Blue-capped Tanager, *Thraupis cyanocephala*	BR	-	L	-
Turquoise Tanager, *Tangara mexicana*	BR	-	C	-
Speckled Tanager, *Tangara guttata*	BR	-	L	-
Bay-headed Tanager, *Tangara gyrola*	BR	-	C	-
Swallow Tanager, *Tersina viridis*	BD	-	U	-
Blue Dacnis, *Dacnis cayana*	BR	-	C	-
Purple Honeycreeper, *Cyanerpes caeruleus*	BR	-	C	-

Table 1 continued. Status and Abundance of Birds in Trinidad and Tobago.

Species	Status		Abundance	
	Tri.	Tob.	Tri.	Tob.
Red-legged Honeycreeper, *Cyanerpes cyaneus*	BD	BD	C	C
Green Honeycreeper, *Chlorophanes spiza*	BR	-	C	-
Bicolored Conebill, *Conirostrum bicolor*	BR	-	C	-
Hepatic Tanager, *Piranga flava**	BR	-	L	-
Summer Tanager, *Piranga rubra**	MN	MN	R	R
Scarlet Tanager, *Piranga olivacea**	MN	MN	R	R
Red-crowned Ant-Tanager, *Habia rubica**	BR	-	U	-
Emberizidae				
Orange-fronted Yellow-Finch, *Sicalis columbiana*	W	-	-	-
Saffron Finch, *Sicalis flaveola*	BR	-	U	-
Grassland Yellow-Finch, *Sicalis luteola*	MS	-	L	-
Blue-black Grassquit, *Volatinia jacarina*	BR	BR	A	C
Slate-colored Seedeater, *Sporophila schistacea*	W	-	-	-
Sooty Grassquit, *Tiaris fuliginosa**	BR	-	U	-
Black-faced Grassquit, *Tiaris bicolor**	BR	BR	L	C
Gray Seedeater, *Sporophila intermedia*	Ext	-	-	-
Wing-barred Seedeater, *Sporophila americana*	-	BR	-	VR
Lesson's Seedeater, *Sporophila bouvronides*	Ext MS	Ext	VR	-
Yellow-bellied Seedeater, *Sporophila nigricollis*	Ext MS	Ext	R	-
Ruddy-breasted Seedeater, *Sporophila minuta*	BR	Ext	Sc	-
Chestnut-bellied Seed-Finch, *Oryzoborus angolensis*	Ext	-	-	-
Large-billed Seed-Finch, *Oryzoborus crassirostris*	Ext W	-	-	-
Red-capped Cardinal, *Paroaria gularis*	BR	-	U	-
Cardinalidae				
Rose-breasted Grosbeak, *Pheucticus ludovicianus*	MN	MN	R	R
Grayish Saltator, *Saltator coerulescens*	BR	-	C	-
Streaked Saltator, *Saltator striatipectus*	BR	-	L	-
Indigo Bunting, *Passerina cyanea*	MN	-	VR	-
Dickcissel, *Spiza americana*	MN	MN	C	VR
Parulidae				
Golden-winged Warbler, *Vermivora chrysoptera*	MN	MN	VR	VR
Northern Parula, *Parula americana*	MN	MN	VR	VR
Tropical Parula, *Parula pitiayumi*	BR	-	C	-
Chestnut-sided Warbler, *Dendroica pensylvanica*	MN	-	VR	-
Yellow Warbler, *Dendroica petechia*	MN	MN	C	C
Blackpoll Warbler, *Dendroica striata*	MN	MN	Sc	Sc
Bay-breasted Warbler, *Dendroica castanea*	MN	MN	VR	VR
Blackburnian Warbler, *Dendroica fusca*	MN	-	R	-
Magnolia Warbler, *Dendroica magnolia*	MN	MN	VR	VR

Species	Status		Abundance	
	Tri.	Tob.	Tri.	Tob.
Cerulean Warbler, *Dendroica cerulea*	MN	-	VR	-
Cape May Warbler, *Dendroica tigrina*	MN	MN	VR	VR
Black-throated Blue Warbler, *Dendroica caerulescens*	MN	-	VR	-
Yellow-rumped Warbler, *Dendroica coronata*	-	MN	-	VR
Black-throated Green Warbler, *Dendroica virens*	MN	-	VR	-
Prairie Warbler, *Dendroica discolor*	MN	-	VR	-
American Redstart, *Setophaga ruticilla*	MN	MN	C	U
Black-and-white Warbler, *Mniotilta varia*	MN	MN	Sc	Sc
Prothonotary Warbler, *Protonotaria citrea*	MN	MN	Sc	Sc
Ovenbird, *Seiurus aurocapilla*	MN	MN	VR	VR
Northern Waterthrush, *Seiurus noveboracensis*	MN	MN	C	C
Common Yellowthroat, *Geothlypis trichas*	MN	-	VR	-
Masked Yellowthroat, *Geothlypis aequinoctialis*	BR	-	U	-
Hooded Warbler, *Wilsonia citrina*	MN	-	VR	-
Canada Warbler, *Wilsonia canadensis*	MN	-	VR	-
Golden-crowned Warbler, *Basileuterus culicivorus*	BR	-	C	-
Icteridae				
Crested Oropendola, *Psarocolius decumanus*	BR	BR	A	C
Yellow-rumped Cacique, *Cacicus cela*	BR	-	C	-
Moriche Oriole, *Icterus cayanensis*	BR	-	L	-
Baltimore Oriole, *Icterus galbula*	MN	MN	VR	VR
Orchard Oriole, *Icterus spurius*	MN	-	VR	-
Yellow Oriole, *Icterus nigrogularis*	BR	-	C	-
Yellow-hooded Blackbird, *Chrysomus icterocephalus*	BR	-	A	-
Giant Cowbird, *Molothrus oryzivorus*	BR	BR	U	U
Shiny Cowbird, *Molothrus bonariensis*	BR	BR	A	C
Carib Grackle, *Quiscalus lugubris*	BR	BR	A	C
Red-breasted Blackbird, *Sturnella militaris*	BR	W	C	-
Red-winged Blackbird, *Agelaius phoeniceus*	V	-	-	-
Bobolink, *Dolichonyx oryzivorus*	MN	MN	R	R
Fringillidae				
Red Siskin, *Carduelis cucullata*	Ext	-	-	-
Lesser Goldfinch, *Carduelis psaltria*	W	-	-	-
Trinidad Euphonia, *Euphonia trinitatis*	BR	-	U	-
Violaceous Euphonia, *Euphonia violacea*	BR	BR	C	U
Golden-rumped Euphonia, *Euphonia cyanocephala*	MS	-	VR	-
Estrildidae				
Common Waxbill, *Estrilda astrild*	BR	-	L	-

A Preliminary Assessment of the Species Richness of the Madamas Watershed: A Proposed National Park

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ABSTRACT
A preliminary species inventory and elevational transect was conducted in the Madamas Valley of Trinidad. A total of 50 tree species, 63 bird species, 24 bat species, 8 non-volant mammals, and 21 butterfly species were recorded from eight sample sites. This study recommends that a Protected Natural Area include the Madamas Valley.

Key words: Madamas, elevational gradient, species richness, endangered species.

INTRODUCTION

The Madamas Expedition was developed to fill a critical information gap on the ecology of the Madamas Watershed, the last road-less natural area on the island of Trinidad. Although identified as a candidate National Park by several authors (Thelen and Faizool 1980; CFCA 1998), the site remains unprotected and is threatened by proposals to develop roads through it.

The expedition sought to provide a baseline species inventory, which could be used for the management and conservation of this watershed. The study consisted of an elevational survey of faunal and floral species richness. This article presents the preliminary analysis of this study's findings.

RESEARCH AREA

Located in the north-eastern Northern Range, the Madamas Watershed covers approximately 18 km^2, with elevation rising from sea-level to approximately 610 m (Fig. 1 and 2). The topography is steep and the vegetation consists of closed-canopy tropical forest. The valley receives more than 2000 mm of rainfall annually (Wehekind 1955).

METHODOLOGY

The expedition was undertaken from May 17th to June 12th 2003. Eight sample sites were surveyed along a 502 m elevation transect (Fig. 3).

Modified Whittaker vegetation plots (20 m x 50 m) were established at each sample site (Barnett and Stohlgren 2003), and all woody stems greater than 10 cm diameter at breast height were sampled.

Bird species richness was assessed at each site using fixed-radius point counts and mist-netting (Gibbons *et al.* 1996). Between two and four mist-nets (either 6 or 18 m long, 2.5 m high) were used at any one time, placed across natural flyways. Ten minute point counts of a 20 m radius were carried out during hours of peak bird activity at each sample site.

Call-playback was used to detect the critically threatened endemic *Pipile pipile* and the locally rare *Grallaria guatimalensis*. This was done in the morning and evening for approximately an hour.

Infra-red cameras and sign surveys were used to assess non-volant mammal species richness (Silveira *et al.* 2003; Emmons 1997). Between two and eight wildlife cameras were placed at each study site. The locations of the cameras were determined after surveying for wildlife trails, tracks or scats.

Bat species richness was assessed at each study site using 6 m and 18 m ground-level mist-nets. (Bergallo *et al.* 2003; Estrada *et al.* 1993). Nets were opened at dusk and closed around midnight. Morphometrics of all volant mammals and avian species were recorded.

Opportunistic sampling using a non-fixed point count in natural clearings such as tree fall gaps and along river banks was employed to survey butterfly richness. Sampling was not carried out at all sites due to the absence of the group's butterfly specialist. We ignored the Hesperids for the purposes of this survey.

Species richness was estimated using the Chao2 estimator (Colwell and Coddington 1994). The Jaccard similarity index was used to determine the degree of similarity between plots. Spearman rank correlation was performed to examine the relationship between elevation and species richness.

Fig. 1. The Upper Madamas Watershed.

Fig. 2. The Lower Madamas River.

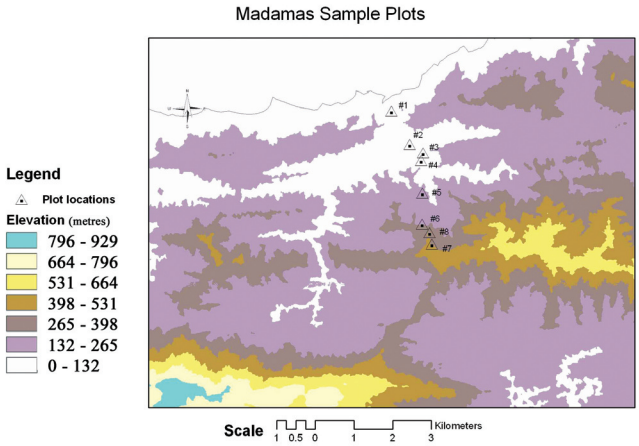

Fig. 3. Sample plot locations.

RESULTS

Vegetation Plots

Fifty woody plant species comprising of 437 individuals were recorded from all vegetation plots (see Appendix I). Figure 4 shows that the observed species richness is slightly lower than that predicted by the Chao2 estimator (64.41). *Licania* sp. were the most commonly recorded species.

The highest degree of similarity exists between sites four and five. No species were shared between sites five and eight with sites one, two and three, and site six with site two.

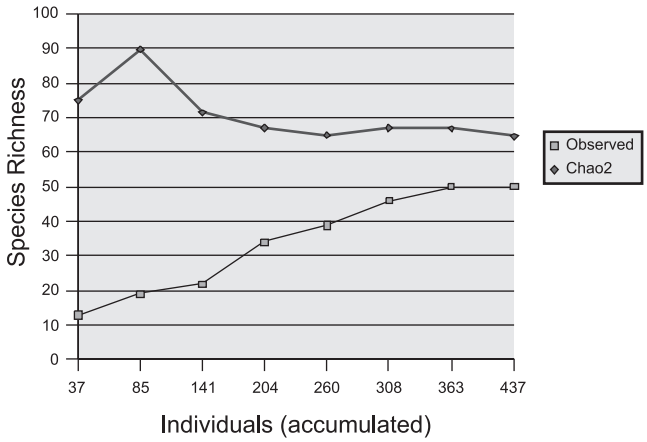

Fig. 4. Vegetation species accumulation curve.

Bird Survey

Sixty-three of the 123 breeding land bird species (51.2 %) recorded for Trinidad (ffrench 1991) were detected using mist-netting and point counts (Appendix I). A total of 109 individuals of 24 bird species were recorded from 131.10 net-hours from all sites (Fig. 5). The Chao2 estimator (35.31) indicates that the mist-netting sampled a large proportion of the predicted species richness.

The most commonly caught species was *Pipra erythrocephala*, accounting for 36.7% of total captures.

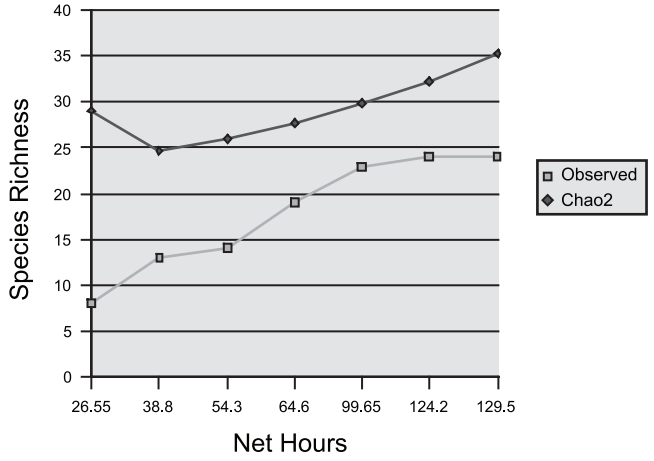

Fig. 5. Mist-netting species accumulation curve.

Sixty-one bird species were recorded using point counts (Fig. 6). Two bird species were added to the total species list by mist-netting (*Platyrinchus mystaceus* and *Mionectes oleaginea*). Observed species richness was lower than that predicted by the Chao2 estimator (130.08).

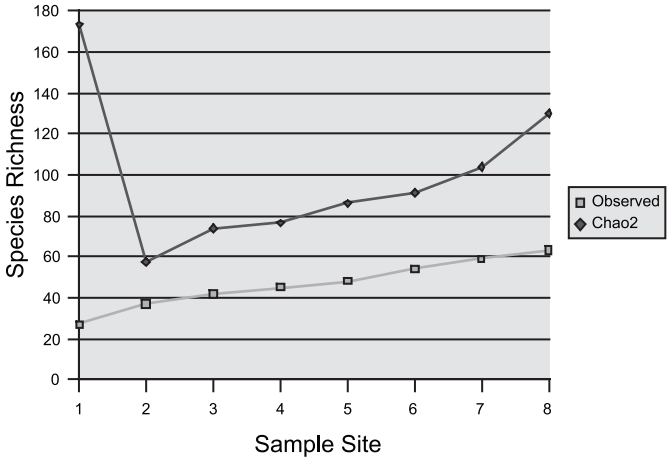

Fig. 6. Point count species accumulation curve.

When both the point count and mist-netting data were combined, the Jaccard similarity index showed that the highest degree of similarity exists between sites four and five, and the lowest degree between sites three and eight.

One confirmed *Pipile pipile* was detected using call-playback (site #6). Another possible *P. pipile* sighting was detected at site #2 where a single bird was briefly seen on the forest floor. No *G. guatimalensis* were observed during our study.

Non-volant Mammal Survey

No non-volant mammals were detected using automatic cameras, after 1332.23 camera-hours of effort.

Mammal-sign surveys detected eight of the thirteen medium-large mammals (above 2 kg) present on Trinidad (Table 1). Although the White-fronted Capuchin monkey, *Cebus albifrons*, was not observed during the survey, hunters in the valley advised the team of their presence.

Table 1. Large, non-volant mammals detected at each survey site.

Site	1	2	3	4	5	6	7	8
Lontra longicaudis †‡	+	+	+					
Agouti paca ‡	+							
Leopardis pardalis †‡	+							
Dasyprocta agouti ‡	+							
Coendou prehensilis §	+							
Mazama americana ‡		+	+					
Tayassu tajacu ‡*			+		+	+		
Alouatta seniculus *				+	+	+		

†Scats *Vocalisations ‡Tracks §Skull

Bat Survey

A total of 312 individuals from 23 species of bats were collected (Appendix I) after 240 net-hours of sampling effort (Fig. 7). We also observed an additional species, (*Lasiurus borealis*), which was not caught. The Chao2 diversity estimator predicts chiropteran species richness of 25.68. These data suggest that our sampling detected the majority of the bat species at the site. Similarity between sites was highest between four and seven and lowest between one and six. *Carollia perspicillata* was the most commonly caught bat, representing 23% of total captures. Phyllostomids accounted for 83% of captures.

Five trophic guilds were detected: aerial insectivores (four species), frugivores (10 species), gleaning animalvores (six species), nectarivores (two species) and omnivores (one species). Frugivores accounted for 79% of individuals captured.

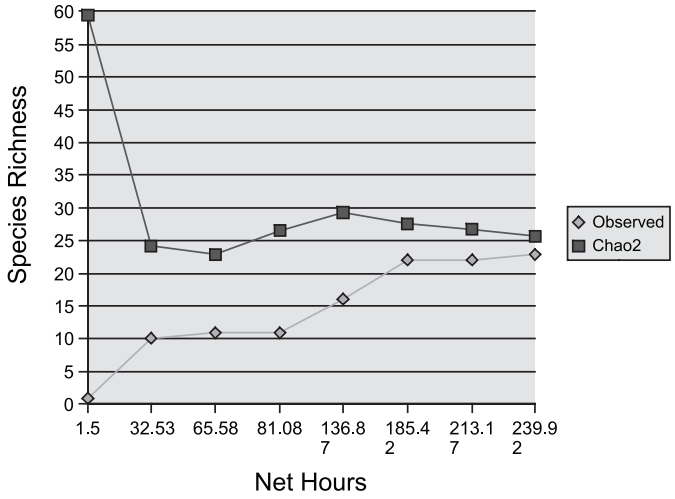

Fig. 7. Bat species accumulation curve.

Butterfly Survey

Twenty-one species of the 612 butterfly species recorded for Trinidad were collected in the Madamas Valley (Appendix I). The Chao2 estimator predicted a species richness of 37.33, indicating sampling was incomplete (Fig. 8). The Lycaenids, Riodinids and Satyrids are well represented in this sample.

Similarity was highest between sites five and six, while there was no similarity between site one with four and five, and between site two with four, five and six, and site four with five and six.

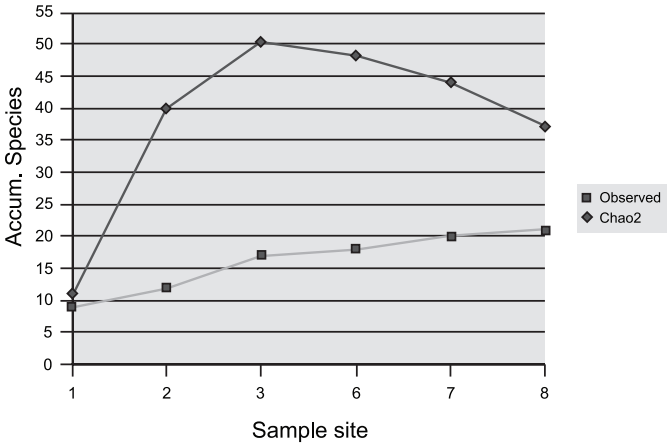

Fig. 8. Butterfly species accumulation curve.

DISCUSSION

Floral Diversity

While there have been no recent systematic published studies of the flora of this watershed, Beard's (1946) work suggests that *Licania* species should be expected to occur as a dominant in many of the forest plots we surveyed, and we did observe this pattern. However, our vegetation plots shared few species, suggesting great differences in stand-level community composition.

Our study did not find a significant relationship between elevation and woody vegetation species richness. This contrasts with previous studies of woody plant species diversity and altitude, which suggest an inverse relationship between these factors (e.g. Vazquez and Givnish 1998).

Richness patterns in the Madamas Valley may reflect a truncated form of those seen for longer elevational gradients, due to the valley's limited vertical displacement (600 m). On islands, high elevation forest types frequently occur at lower elevations in the form of the Massenerhebung effect when the elevation gradient is small (Lomolino 2001). Thus, in Trinidad, cloud forest is found at elevations less than 900 m, whereas in the Andes it occurs above 1400 m (Beard 1946).

Our study suggests that other additional factors further complicate the pattern of woody species richness, for the elevation interval we sampled. This is consistent with a model proposed by Nelson (2004) which suggests stand-level variability in Trinidad forests is driven by moisture availability.

Avian Diversity

Our findings are comparable with similar studies in Trinidad. Hayes and Samad (1998) recorded 66 species during point counts of a native broad-leaf forest. An elevational mist-netting study comparing two forested sites in the Arima Valley recorded 39 species from the higher elevation and 32 from the lower (Smith 2001). In southern Trinidad, 21 species were captured in virgin forest during a mist-netting study (White 2002). As in our study, *P. erythrocephala* was the most commonly caught species (White 2002). The high capture rate of *P. erythrocephala*, a forest interior species, is possibly due to clumped distribution or capture methods.

Bird species diversity typically decreases with elevation, or peaks at intermediate elevations (Graham 1990; Terbough 1977). Our data suggests no correlation between elevation and richness, although this observation may simply be a combination of noise in the data and small sample size. While we recognize that the area of each habitat sampled affects elevational-diversity patterns (Bachman *et al.* 2004; Rahbek 1997), we did not account for this effect in our study.

These data may also be biased due to the difficulty in detecting species typically under-represented in species richness surveys (Terbough 1977). Thus, mist-netting tends to under-represent canopy or large bird species. While the closed canopy and high crown heights precluded observation of secretive, canopy-dwelling species.

Often diversity patterns are not reflected in species

richness changes alone. For example, trophic composition of bird communities can change across an elevation gradient and so affect species distribution (Terbough 1977; Graham 1990). Future investigation into avian guild structure, resource use and elevational breadth in the Madamas Valley may reveal patterns not apparent from our study.

Although the highest similarity between avian species richness corresponded to that of the vegetation, recent work on forest birds in Trinidad suggests that habitat preferences of these species may not be reflected in small scale, stand-level variations in tree species richness (Nelson 2004). Rather, this study suggests that bird species distribution and richness on Trinidad reflects broad spatial-scale changes in forest physiognomy.

The sighting of single individuals of *P. pipile* suggests that the density of this species may be low in the Madamas Valley. With *P. pipile* reported to be a gregarious species (Alexander 2002; ffrench 1991), we expected to observe more individuals. Our results are of concern as the Madamas Valley appears prime habitat for *P. pipile* and especially as cracids are potential keystone species as seed dispersers (Brooks and Fuller 2006).

The absence of *G. guatemalensis* was also of concern as the Madamas Valley again appears to be suitable habitat for this rare species.

Mammalian Diversity

Our survey data suggests that some of the rarest mammals on Trinidad, including *L. longicaudis, T. tajacu,* and *A. seniculus* were fairly abundant in the valley. Species composition in this survey is comparable with research carried out in the Trinity Hills Wildlife Sanctuary (Nelson 1996).

The importance of mammal species as keystone seed dispersers, predators and herbivores should not be underestimated. For example, *A. seniculus* was shown to be the primary seed disperser of 137 species in Brazil (Andresen 2002). Such large-bodied species require substantial areas of habitat to maintain genetically and demographically viable populations (Sunquist and Sunquist 2001). As a result, these species in the Madamas Valley may need to be managed as part of a larger eastern Northern Range meta-population.

The low encounter frequency of *L. pardalis* signs suggests that this species occurs at low densities in the valley. Ocelots are secretive and difficult to survey with sign surveys (Trolle and Kery 2003). However, our observations are consistent with a previous study, which suggested that ocelot densities are low in Trinidad due to hunting and habitat fragmentation (Nelson 1996).

Bat species richness is high in the Madamas Valley with over a third of the 63 bat species recorded for Trinidad being recorded. Our findings are similar to those of a study with comparable net-hours in the Victoria-Mayaro Reserve which captured 143 individuals of 22 species (Clarke and Downie 2001). *C. perspicillata* was similarly the most dominant species, but accounted for a higher percentage of captures (43%) than in our study. Clarke and Downie (2001) suggest density of favoured fruit species may account for their abundance.

Although none of the bats caught are globally threatened, several species caught in this study were defined as locally rare by Clarke *et al.* (2005). These are *Pteronotus parnellii, Micronycteris minuta, Phyllostomus hastatus* and *Chiroderma trinitatum.* In particular, cave-roosting bats such as *P. parnellii* are likely to have low densities due to the paucity of natural cave formations in Trinidad.

Previous research suggests that bat species richness declines monotonically with increasing elevation (Patterson *et al*. 1996; Sanchez-Cordero 2001; Graham 1990). Our data suggests a peak in bat species richness and feeding guild diversity at intermediate elevation. The patterns we observed may be due to i) insufficient sampling effort at each elevation; ii) independence between bat species richness and small elevation gradients (Patterson *et al*. 1996; Graham 1990); or iii) overlap of different forest communities along the transect. The presence of all five feeding guilds at 400-450 m elevation in this study suggests the presence of an ecological transition zone at this elevation. However, our vegetation sampling protocol was not designed to test this hypothesis. High levels of habitat heterogeneity are characteristic of ecotones, and greater levels of species and feeding guild diversity are expected here (White and Pickett 1985). Examination of the presence of the ecological transition zone suggested by our bat data could be the focus of a future study.

The high percentage of Phyllostomids in our study is typical of bat studies in the Neotropics, and could be due to a biased capture rate for this group (Bergallo 2003). Sampling techniques that account for patchiness, rarity, dietary specificity, and canopy use by bats are needed to better estimate richness and distribution of bats in Madamas.

Butterfly Diversity

Although this survey was incomplete, our results are not dissimilar to other work in Trinidad. Wood and Gillman (1998) in two undisturbed forest sites in the southeast recorded 37 and 22 species respectively. The low similarity between sites may reflect a high degree of microhabitat specialisation but requires further studies.

Forest butterflies are especially vulnerable to habitat change and fragmentation due to their specific microclimate requirements (Spitzer *et al*. 1997; Srygley and Chai 1990). This was illustrated for the Satyrids in south Trini-

dad, where fewer species of this family were observed in fragmented forests (Lucas *et al.* 2004).

The Satyrids in this study showed relatively high species richness and a large number of rare species. For example, we recorded *Antirrhaea philoctetes*, the 'Queen of the Night', which is considered the rarest Satyrid in Trinidad (Barcant 1970). The limited Lepidoptera species richness data collected in this study suggests that the Madamas Watershed has some of the rarest, edge sensitive butterflies on Trinidad. This highlights the area's value as a potential study site and conservation area for this group.

CONCLUSION

The Madamas Valley is one of the few areas in Trinidad maintaining a full complement of not only the native large-bodied mammalian and avian keystone species (such as *A. seniculus* and *L. pardalis*) but also some of the rarest vertebrates (*P. pipile*) and butterflies (*A. philoctetes*) on the island. Species richness measures among all taxonomic groups in this study suggest that our surveys detected a large proportion of the species present at this site. This together with the complex stand-level vegetation diversity observed among our plots suggests that the maintenance of the Madamas Watershed as an intact ecosystem should be a conservation priority. Our observations reveal that the area remains largely free from human disturbance, apart from low intensity hunting from nearby villages. These data imply that Madamas is among the most pristine areas on Trinidad, and an ideal site for the protection and study of tropical forest ecosystems on this island.

The incomplete survey of the elevation gradient and the lack of replicates at each elevation interval represent the most significant weaknesses in our study. We were unable to survey the highest elevations or repeat samples, due to funding constraints. As a result, the species richness trends we report may not be representative of the entire Madamas Valley.

We strongly recommend the establishment of a National Park or Environmentally Sensitive Area that includes the Madamas Valley.

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Appendix I. Species Lists for Madamas Valley

Tree Species

Family	Species	Local Name
Flacourtiaceae	*Ryania speciosa*	Bois l'agli
Guttiferae	*Rheedia accuminata*	Wild primrose
	Symphonia globulifera	Yellow mangue
	Tovomita eggersii	Red mangue
Bombacaceae	*Pachira insignis*	Wild chataigne
	Sterculia caribae	Mahoe
	Sterculia pruiens	
Burseraceae	*Protium sergoteanum*	
Meliaceae	*Carapa guanensis*	Crappo
Anacardiaceae	*Spondias monbin*	Hog plum
Leguminosae	*Swartzia* sp.	
	Brownia latifolia	Mountain rose
	Calliandra guildingii	
	Inga heterophylla	
	Inga sp.	
	Pithecellobium jupunba	Puni
Rosaceae	*Hirtella silicea*	
	Hirtella triandra	Fruta paloma
	Licania membranacea	
	Licania heteromorpha	
	Licania sp.	
Rhizophoraceae	*Cassipourea guianensis*	Mountain coffee
Combretaceae	*Buchenavia capitata*	Yellow olivier
	Terminalia amazonia	
	Terminalia sp.	
Myrtaceae	*Eugenia confusa*	Wild coffee
	Eugenia lambertiana	
	Eugenia sp.	
	Marlierea ferruginea	
Lecythidaceae	*Couroupita guianensis*	Cannon ball
	Eschweilera subglandulosa	Guatecare
Melastomaceae	*Miconia* sp.	
Rubiaceae	*Warszewiczia coccinea*	Wild poinsettia
	Psychotria capitata	Café marron
Sapotaceae	*Lucuma multiflora*	Penny piece
	Mimusops balata	Balata
	Mycropholis guyanensis	Wild balata
	Micropholis sp.	
	Sapotacea sp.	
Ebenaceae	*Diospyros ierensis*	Bois charbon
Boraginaceae	*Cordia alliodora*	Cypre
Bignoniaceae	*Tabebuia stenocalex*	Wild calabash
	Tabebuia sp.	
Myristicaceae	*Virola surinamensis*	Wild nutmeg
Lauraceae	*Aouiea densiflora*	Laurier mango
	Aniba panurensis	Laurier cannelle
	Ocotea eggersiana	'Small leaf' Laurier mattack
Moraceae	*Cholophore tinctoria*	Fustic
Palmaceae	*Palmae* sp.	

Bird Species

(Classification follows ffrench, 1991)

Tinamidae
Crypturellus soui, Little Tinamou

Accipitridae
Elanoides forficatus, Swallow-tailed Kite
Buteogallus urubitinga, Common Black-Hawk

Cracidae
Pipile pipile, Common Piping-Guan

Columbidae
Columba sp., Pigeon
Leptotila spp., Dove

Psittacidae
Touit batavica, Lilac-tailed Parrotlet
Pionus menstruus, Blue-headed Parrot
Amazona amazonica, Orange-winged Parrot

Strigidae
Pulsatrix perspicillata, Spectacled Owl
Glaucidium brasilianum, Ferruginous Pygmy-Owl

Caprimulgidae
Lurocalis semitorquatus, Short-tailed Nighthawk

Trochilidae
Glaucis hirsuta, Rufous-breasted Hermit
Phaethornis guy, Green Hermit
Phaethornis longuemareus, Little Hermit
Florisuga mellivora, White-necked Jacobin
Lophornis ornata, Tufted Coquette
Chlorestes notatus, Blue-chinned Sapphire
Chlorostilbon mellisugus, Blue-tailed Emerald
Amazilia chinopectus, White-chested Emerald
Amazilia tobaci, Copper-rumped Hummingbird

Trogonidae
Trogon viridis, White-tailed Trogon
Trogon violaceus, Violaceous Trogon
Trogon collaris, Collared Trogon

Alcedinidae
Chloroceryle americana, Green Kingfisher
Chloroceryle aenea, Pygmy Kingfisher

Momotidae
Momotus momota, Blue-crowned Motmot

Ramphastidae
Ramphastos vitellinus, Channel-billed Toucan

Picidae
Celeus elegans, Chestnut Woodpecker

Dendrocolaptidae
Dendrocincla fuliginosa, Plain-brown Woodcreeper
Xiphorhynchus guttatus, Buff-throated Woodcreeper

Furnariidae
Synallaxis albescens, Pale-breasted Spinetail
Sclerurus albigularis, Grey-throated Leaftosser

Thamnophilidae
Taraba major, Great Antshrike
Myrmotherula axillaris, White-flanked Antwren
Myrmeciza longipes, White-bellied Antbird

Formicaridae
Formicarius analis, Black-faced Antthrush

Cotingidae
Procnias averano, Bearded Bellbird

Pipridae
Pipra erythrocephala, Golden-headed Manakin
Manacus manacus, White-bearded Manakin

Tyrannidae
Attila spadiceus, Bright-rumped Atilla
Lathrotriccus euleri, Euler's Flycatcher
Platyrinchus mystaceus, White-throated Spadebill
Mionectes oleaginea, Ochre-bellied Flycatcher
Pachyramphus polychopterus, White-winged Becard
Tityra cayana, Black-tailed Tityra

Troglodytidae
Thryothorus rutilus, Rufous-breasted Wren

Turdidae
Turdus albicollis, White-necked Thrush

Sylviidae
Ramphocaenus melanurus, Long-billed Gnatwrenv

Vireonidae
Cyclarhis gujanensis, Rufous-browed Peppershrike
Hylophilus aurantiifrons, Golden-fronted Greenlet

Icteridae
Psarocolius decumanus, Crested Oropendola

Coerebidae
Coereba flaveola, Bananaquit

Thraupidae
Cyanerpes caeruleus, Purple Honeycreeper
Cyanerpes cyaneus, Red-legged Honeycreeper
Chlorophanes spiza, Green Honeycreeper
Dacnis cayana, Blue Dacnis
Euphonia trinitatis, Trinidad Euphonia
Euphonia violacea, Violaceous Euphonia
Thraupis palmarum, Palm Tanager
Tachyphonus luctuosus, White-shouldered Tanager

Bat Species

Emballonuridae
Rynchonycteris naso, Brazilian Long-nosed Bat

Mormoopidae
Pteronotus parnellii, Mustached Bat

Phyllostomidae
Micronycteris megalotis, Little Big-eared Bat
Micronycteris minuta, White-bellied Big-eared Bat
Micronycteris hirsute, Hairy Big-eared Bat
Micronycteris nicefori, White-lined Forest Bat
Tonatia bidens, Greater Round-eared Bat
Mimon crenulatum, Hairy-nosed Bat
Phyllostomus hastatus, Pale-faced Spear-nosed Bat
Glossophaga soricina, Common Long-tongued Bat
Anoura geoffroyi, Hairy-legged Long-tongued Bat
Carollia perspicillata, Linnaeus' Short-tailed Fruit Bat
Sturnira tildae, Yellow-shouldered Bat
Uroderma bilobatum, Yellow-eared Tent-making Bat
Platyrrhinus helleri, White-lined Fruit Bat
Chiroderma villosum, Greater Big-eyed Bat
Chiroderma trinitatum, Lesser Big-eyed Bat
Artibeus jamaicensis, Large Fruit Bat
Artibeus lituratus, Greater Fruit Bat
Artibeus cinerus, Pygmy Fruit Bat
Ametrida centurio, Little White-shouldered Bat
Centurio senex, Central American Wrinkle-faced Bat

Vespertilionidae
Myotis nigricans, Little Black Bat
Lasiurus borealis, Costa Rican Red Bat

Butterfly Species

Satyridae
Antirrhaea philoctetes, Queen of the Night
Euptychia junia, Iridescent Blue Night
Euptychia themis, Ringlet
Euptychia calpurnia, Large White Night
Euptychia renata, Ringlet
Euptychia brixiola, Blue Nymph
Euptychia hermes, Ringlet

Ithomiidae
Ithomia pellucida pellucida, Blue Transparent
Tithorea harmonia megara, Tiger

Heliconidae
Heliconius ethillus, Rare Tiger
Heliconius doris, Blue Doris

Morphidae
Morpho peleides peleides, Emperor

Papilionidae
Graphium pausanias, Pausanias

Pieridae
Dismorphia amphione astynomides, Tiger Pierid

Lycaenidae
Arawacus linus, White Lycid
Chalybs romulus, Small Green Hairstreak
Calycopis pion, Blue Metal Hairstreak

Riodinidae
Peplia lamis, Great Bronzed Handkerchief
Cremna thasus, Red-banded Zebra
Lemonias rhodope, Blue-tipped Sammond
Cariomothis erythromelas, Erythromelas

Fourth Report of the Trinidad and Tobago Rare Bird Committee: Rare Birds in Trinidad and Tobago in 2004 and 2005

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The Trinidad and Tobago Rare Birds Committee (TTRBC) was established in 1995 with the principal aim to assess, document and archive the occurrence of rare or unusual birds in Trinidad and Tobago. The Committee has now assessed all records submitted during 2004 and 2005. In all, 75 records were adjudged, representing 52 different species. As a result of these submissions three additional species have been added to the Official List of Birds of Trinidad and Tobago. Additionally, a further six species have been found on Tobago for the first time. Of those assessed, in only seven cases (9%) did the Committee feel that the identification had been inconclusive. The records tabulated below follow the nomenclature and taxonomic order of the American Ornithologists Union South American checklist; 10th version February 2006.

The Committee comprises the following members: Martyn Kenefick (Secretary), Richard ffrench, Geoffrey Gomes, Floyd Hayes, Bill Murphy, Courtenay Rooks and Graham White.

We are aware that a number of other rare birds are found each year in Trinidad and Tobago and urge finders not only to report their sightings to us but to document same. A recently revised list of those species considered by the TTRBC can be accessed, together with our Photo Gallery, from the home page of the TTFNC at *www.wow.net/ttfnc*

RECORDS ACCEPTED

An immature male **American Wigeon,** ***Anas americana,*** was present on Bon Accord sewage ponds, Tobago from 21-24 February, 2005 (MK). There have now been three records since 1995, all in Tobago.

A female **Northern Pintail,** ***Anas acuta,*** was seen briefly at Bon Accord sewage ponds, Tobago on 14 November, 2004 (MK). Only added to the Trinidad and Tobago list in 2001, this is the fifth bird found.

A female **Ring-necked Duck,** ***Aythya collaris,*** was found on Bon Accord sewage ponds, Tobago on 14 November, 2004 (MK) and a male was at Lowlands, Tobago on 19 February, 2005 (DMcC *et al.*). All nine birds found since 1995 have been in Tobago.

Up to eight **Masked Ducks,** ***Nomonyx dominicus,*** including two adult males in breeding plumage, were present at a small pond within Caroni rice project from 6 October, 2002 - 25 January, 2003 at least (CR, MK *et al.*). On 19 June, 2005, two males in breeding plumage were found at the Pitch Lake (RN). Their secretive nature may well belie the true abundance of this rarely seen species.

At least two **Trinidad Piping-Guans,** ***Pipile pipile,*** were found close to the TSTT station at Morne Bleu on 24 March, 2005 (GW, MK). This is the first documented record away from the traditional viewing area at Montevideo since 1995.

A single **Cory's Shearwater,** ***Calonectris diomedea,*** was seen close offshore from Grafton Beach, Tobago on 7 March, 2005 (RH). Only the second record since 1998, this remains an elusive species in Trinidad and Tobago waters.

A single **Greater Shearwater,** ***Puffinus gravis,*** flew offshore from Little Tobago on 13 June, 2004 (NH). This sighting ties in well with the documented annual passage of large shearwaters passed Guadeloupe each June, and is the first record since 1997.

A single **Neotropic Cormorant,** ***Phalacrocorax brasilianus,*** found at Bon Accord sewage ponds on 14 November, 2004 (MK) represents the first record for Tobago.

An adult **Rufescent Tiger-Heron,** ***Tigrisoma lineatum,*** was found in shallow freshwater marsh at Waller Field on 27 January, 2005 (KC, BM *et al.*) and an immature was photographed inside Bush Bush Reserve on 21 June, 2005 (RN). Whilst this species is a rare resident to the Nariva Swamp area, this is the first documented record for Waller Field.

A sub adult **Gray Heron,** ***Ardea cinerea,*** was found in fields beside the highway at Trincity on 27 January, 2005 (KC, BM *et al.*) and a first winter plumaged bird was found at the Aripo Agriculture Research Station on 12 February, 2005 (MK *et al.*). This brings to four the number of birds found in the last six years; prior to that, the last documented record was back in 1959.

An adult **King Vulture,** ***Sarcoramphus papa,*** was seen soaring over the upper Arima Valley on 11 February, 2004 (DL). A true rarity in Trinidad, this brings to just five the number found in the last 12 years.

A flock of at least 85 **Greater (Caribbean) Flamingoes,** ***Phoenicopterus ruber,*** were found feeding at low tide immediately south of Carli Bay on 5 July, 2005 (MK). The only other large flock recorded in Trinidad (137 birds in August, 2003) was at the same locality.

A female **Hook-billed Kite, *Chondrohierax uncinatus,*** soared over Waller Field on 3 November, 2005 (MK, GW). Possibly still resident in south Trinidad, but very scarce; this is just the seventh record for Trinidad and Tobago since 1995.

A single **Swallow-tailed Kite, *Elanoides forficatus,*** was seen flying over Gilpin Trace, Tobago on 8 June, 2005 (NG). This is only the second ever documented record for Tobago, the last being in 1963.

Two **Crane Hawks, *Geranospiza caerulescens*,** likely to be a pair, were found at Waller Field on 18 June, 2004 (KC, BM *et al.*). In the same general area, one was seen on 12 February, 2005 (BM, DR *et al.*) and two seen together on 28 May, 2005 (MK, GW). Elsewhere, one was seen on several dates from 29 November, 2004 at Carlsen Fields (NL). Whilst the very first sighting of this species was as recent as January 2001, there is now every likelihood that it will soon be added to the list of species known to breed in Trinidad.

An adult **Common Black-Hawk, *Buteogallus anthracinus,*** seen soaring over Gilpin Trace, Tobago on 26 October, 2005 (DS, MG) is the first documented record for the island in the last 10 years.

An adult **Black Hawk-Eagle, *Spizaetus tyrannus,*** seen perched beside a small farm at San Francique on 28 December, 2003 (HK) may well have been the same bird found in the same area on 26 June, 2004. Elsewhere, adults were found flying over Sangre Chiquito on 12 March, 2004 (MK) and at Waller Field on 28 July, 2005 (MK). Whilst still undoubtedly rare in Trinidad, this brings to 10 the number of birds documented since 1995.

Two adult **Crested Caracaras, *Caracara cheriway,*** were seen along the coast road at Manzanilla Bay on 7 August, 2005 (GW). Still a rare visitor to Trinidad from mainland South America, this brings to seven the number of birds found since 2000.

Single adult **Aplomado Falcons, *Falco femoralis,*** were observed hunting the high tide shorebird roost at Brickfields on 1 January, 2004 (AM) and perched on a small tree on the track in Bush Bush, 15 April, 2004 (MK). Two records is an average return in recent years. Sadly none were reported in 2005, the first blank year since 1999.

A **Bat Falcon, *Falco rufigularis,*** found on the coast road at Bloody Bay, Tobago on 29 October, 2005 (NG) is the first documented record for Tobago.

A **Spotted Rail, *Rallus maculatus,*** was found dead at Warren Road, Caroni on 15 June, 2004 (GW). Sadly, the only two records of this extremely secretive species since 1995 have both been road kills.

Two adult **Black-necked Stilts, *Himantopus mexicanus,*** found at Bon Accord sewage ponds on 13 August, 2005 (MK) are just the second record for Tobago.

A single **Upland Sandpiper, *Bartramia longicauda,*** was found on Caroni rice project on 17 April, 2004 (MK). This species remains a decidedly rare passage migrant with just seven found in the last 10 years.

A juvenile **Buff-breasted Sandpiper, *Tryngites subruficollis,*** found at Bon Accord sewage ponds, Tobago on 20 September, 2005 (SR) was shortly followed by a further two birds at Caroni rice project on 6 October, 2005 (MK, GW). Despite a blank year in 2004, this brings the total found in the last 10 years to 29 birds.

An adult **Pomarine Jaegar, *Stercorcarius pomarinus,*** seen from a fishing boat offshore Little Tobago on 18 March, 2005 (NH) is only the sixth bird found in the last 10 years.

A **Ring-billed Gull, *Larus delawarensis,*** in first winter plumage was photographed at Waterloo on 12 November, 2004, (RN). Close by at Orange Valley, a bird initially in second winter moulting into adult winter plumage was found on 6 August, 2005 and remained until the year end at least. This latter bird is the first record of over-summering in Trinidad and Tobago. Hitherto, its status was of a scarce winter visitor.

An adult **Franklin's Gull, *Larus pipixcan,*** was found at Orange Valley on 14 February, 2005 (MK *et al*.). This is the seventh record for Trinidad; all previous birds were in first winter plumage.

An adult **Caspian Tern, *Hydroprogne caspia,*** recorded at Orange Valley on 24 November, 2005 (NL) is only the second record for Trinidad, the last being in 1953. Coincidently, an adult was found in Barbados three days later; their first for 40 years.

A party of five **Black Skimmers, *Rynchops niger,*** were found at Bon Accord sewage ponds on 12 September, 2004 (MK). This is the first documented record for Tobago.

An adult **Scaly-naped Pigeon, *Patagioenas squamosa,*** seen and photographed at Speyside, Tobago on 2 January, 2005 (HB) is the first record of this species for Trinidad and Tobago. A second bird, again in Tobago, but at the opposite end of the island, was seen at Mt. Irvine on 18 June, 2005 (GW). This species is a common resident throughout the Lesser Antilles as far south as Grenada.

A **Dark-billed Cuckoo, *Coccyzus melacoryphus,*** was found at a small farm in San Francique on 30 July, 2004 (HK), where it stayed for at least five days. This is just the second record in the last 10 years.

A **Fork-tailed Palm-Swift, *Tachornis squamata,*** seen flying over a residential area in Mt. Irvine on 2 March, 2005 (DH) constitutes the first record for Tobago.

A **Scaled Antpitta, *Grallaria guatimalensis,*** found on a steep forested slope on the Blanchisseuse Rd. on 1 Feb-

ruary, 2004 (MK, AM, GW) is only the third documented record for Trinidad in the last 10 years.

A pair of **Lesser Elaenia, *Elaenia chiriquensis,*** was seen attempting to nest at Waller Field from 20 May, 2005 (MK, GW). Confusion over the identification of Elaenias may contribute to the very few documented reports of this species.

One **Variegated Flycatcher, *Empidonomus varius,*** was found beside the Cunapo River near Sangre Grande on 30 June, 2004 (MK) and two were seen together on Morne Catherine 25 June, 2005 (MK, GW). Four of the seven birds documented in Trinidad in the last 10 years have been found in June.

One **Yellow-throated Vireo, *Vireo flavifrons,*** seen at Buccoo Marsh, Tobago on 28 January, 2005 (NG, BM *et al.*) constitutes only the fourth record for Trinidad and Tobago and the first seen since 1971.

Single **Black-whiskered Vireos, *Vireo altiloquus,*** found at Buccoo Marsh on 16 October, 2000 (FH, MK) and at Gilpin Trace on 24 November, 2005 (DS, MG) represent the first and second records for Tobago.

An adult male **Caribbean Martin, *Progne dominicensis,*** was seen at the Marianne River estuary on 7 February, 2004 (DL). All previous records of this species had come from the extreme northeast corner of Trinidad.

Two different **Cliff Swallows, *Petrochelidon pyrrhonota,*** found on 1 September, 2005 at Turtle Beach (SR) and Bon Accord on 18 September, 2005 (ST) constitute the first and second records for Tobago. This species remains a rare passage migrant through Trinidad with just seven records in the last 10 years.

Two **Scarlet Tanagers, *Piranga olivacea,*** seen and photographed at Crown Pt., Tobago on 3 November, 2004 (NG *et al.*) constitute the first south bound migrants recorded in Trinidad and Tobago.

At least five **Grassland Yellow-Finches, *Sicalis luteola,*** were studied at the Aripo Agriculture Research Station on 26 February, 2004 (MEC *et al.*) and constitutes the first record of this species in Trinidad and Tobago. This site had just re-opened its gates to visitors after a period of at least two years. Up to 25 birds have been ever present at this site until 31 December, 2005 at least.

During the review period, three **Rose-breasted Grosbeaks, *Pheucticus ludovicianus,*** have been documented from Grafton Sanctuary, Tobago, as follows: an adult male on 26 March, 2004 (JS); an immature female on 31 March, 2004 (DH) and a female on 5 March, 2005 (RH). Additionally, an adult male was seen and photographed at Asa Wright Nature Centre on 5 April, 2005 (RN).

A male **Dickcissel, *Spiza americana,*** found at Speyside on 15 October, 2005 (DS, MG) represents just the second record for Tobago. Interestingly, this was found at exactly the same locality as the first record back in 1998.

A male **Blackburnian Warbler, *Dendroica fusca,*** was found along the forested ridge towards Morne Bleu on 24 March, 2005 (GW, MK, NL). Whilst probably under-recorded, this is just the second documented record in the last 10 years.

Three separate **Black-and-white Warblers, *Mniotilta varia,*** were found during the review period, all from Las Lapas Trace, as follows: 28 March, 2004 (MK); 26 December, 2004 (GG, MK, GW) and 16 October, 2005 (NH, MK).

An adult male **Baltimore Oriole, *Icterus galbula,*** was found at Montevideo Trace, Grande Riviere on 18 February, 2005 (MK *et al.*). This is the first documented record since 1981.

Up to nine **Lesser Goldfinches, *Carduelis psaltria,*** were repeatedly watched going to roost on Mt. St. Benedict during the period 11-17 February, 2005 (MK *et al.*). This is the first record of this species for Trinidad and Tobago.

INCONCLUSIVE RECORDS

Records considered inconclusive were of American Wigeon, *Anas americana*, Hook-billed Kite, *Chondrohierax uncinatus,* Red-tailed Hawk, *Buteo jamaicensis*, Amazon Kingfisher, *Chloroceryle amazona*, Euler's Flycatcher, *Lathrotriccus euleri*, Mangrove Swallow, *Tachycineta albilinea* and House Martin, *Delichon urbica.*

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Nature Notes

Xylophanes titana (Druce) (Lepidoptera: Sphingidae) in Trinidad

Xylophanes titana (Druce) was described from Panama, and is reported from Mexico to southern Brazil. Adults can be identified by comparison with Figs. 1-2. The row of pale markings on the hind wing upper surface are pale yellow. Only one other Trinidad sphingid has similar yellow markings: *X. tersa tersa* (Drury), which is a common species found throughout the island in disturbed situations. However, the upper surface of the forewings and body of *X. tersa* is more uniformly brown, and in particular it (and other similar species not found in Trinidad) lacks the pair of white dorsal lines on the abdomen which can be clearly seen in Fig. 1. *Xylophanes tersa* occurs as far north as the southern USA, and there are many pictures of adults and caterpillars available on the internet.

Fig. 1. Male *Xylophanes titana*, collected at light, Morne Bleu Textel Installation, 29.ix.1978, upperside.

Fig. 2. Underside of specimen illustrated in Fig. 1.

In the normal resting position of the living moth (Fig. 3), the yellow hindwings are not visible, and the double dorsal line on the abdomen will distinguish *X. titana* from other *Xylophanes* spp. found in Trinidad.

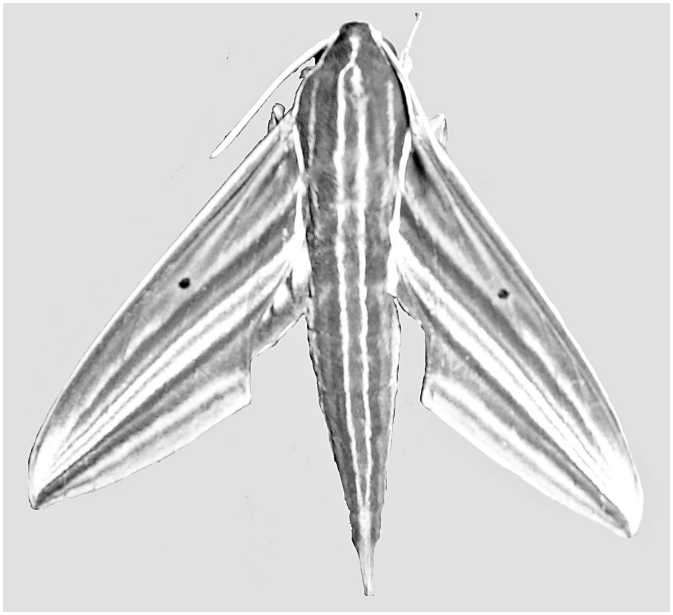

Fig. 3. Adult *X. titana* in normal resting position, Simla, vi.2006 (Photo: M. Botham).

Xylophanes titana was first recorded from Trinidad by Stradling *et al*. (1983), who recorded one male from 3,767 trap-nights using mercury vapour light moth traps in the St. Augustine area, in the period 1969-1977. In contrast, they report six specimens from 20 trap-nights at Simla, Arima Valley. Since then I have found it to be an occasional species, males coming to light in the Northern Range (Arima-Blanchisseuse Road, milestone 9 ¾; Morne Bleu Textel; North Coast Road, Carisal Trace) and have seen up to five specimens in one evening. I have no records from central or southern Trinidad.

In addition to the localities reported above, I have one record from Morne Catharine, based upon a final instar caterpillar that I collected 21.i.1980 on a vine, *Endlichera umbellata* (Rubiaceae), which was identified for me at the time by Dr. C. D. Adams of the National Herbarium. Williams & Cheesman (1928) state that *E. umbellata* is "general in the northern part of Trinidad." If *X. titana* were restricted to this food plant in Trinidad, this would explain its apparent absence from central and southern Trinidad.

The caterpillar pupated 19 days after collection on 9.ii.1980. Pupation was in a flimsy, loose, silken cocoon amongst leaves and soil at the bottom of the rearing

container. I did not record the date of adult emergence, although pupation did not last long, maybe 2-3 weeks.

Thoracic segments 1 (3 mm long) and 2 (5 mm long) are retractable within the following segments (Fig. 4). Sometimes the caterpillar will swing the front part of the body to one side (Fig. 5), appearing to emphasise the eye markings on segments T3-A1, and the resemblance to a snake, i.e. an apparent threat to potential predators.

Description of the Final Instar Caterpillar

The mature caterpillar measured 55 mm at rest (Fig. 4) and 70 mm when extended (Fig. 6). Head rounded, 5 mm width; brown with a lighter brown triangle pointing down each half of the epicranium. T1-A1 with a thin black dorsal line, within a dorsal area that is brown-orange mottled with yellow; this area is separated by a thin dull yellow dorso-lateral line from the dark chestnut lateral area. A pair of false eyes protrude on segments T3-A1 (Figs. 4-6) in the line of the dull yellow dorso-lateral line; the central area of each eye is black with a white arc below this and a yellow arc dorsally, and narrowly black around the circumference. A2-8 with a thin dull orange dorsal line; dorsally with eight dark, speckled bands on each segment on a dull orange background; a slightly brighter orange diamond-shape dorsally in the middle of each segment; a narrow white dorso-lateral line continues from the dull yellow dorso-lateral line on segments T1-A1; below this a pale diagonal stripe on each segment, starting at the dorso-lateral stripe on the posterior margin of each segment and descending into the posterior portion of the anterior segment. On segment A8 the white diagonal lines run posteriorly to the caudal horn, and the dorsal area between the two lines is darker. The horn is dark, short, 5 mm, and droops strongly downwards. Posterior to the horn reddish-brown with a darker dorsal line. The dark spiracles are just below the diagonal line, surrounded by a paler area. Legs and prolegs dark.

Fig. 4. Fifth instar *Xylophanes titana* caterpillar, lateral view, normal resting position.

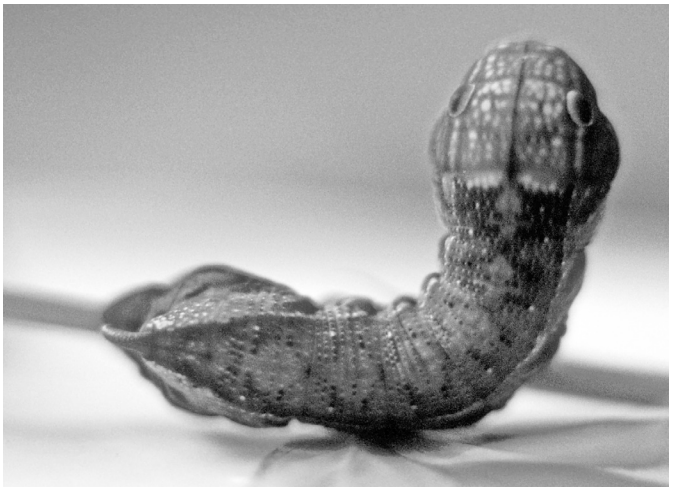

Fig. 5. Fifth instar *Xylophanes titana* caterpillar, dorsal view, possible false threat position.

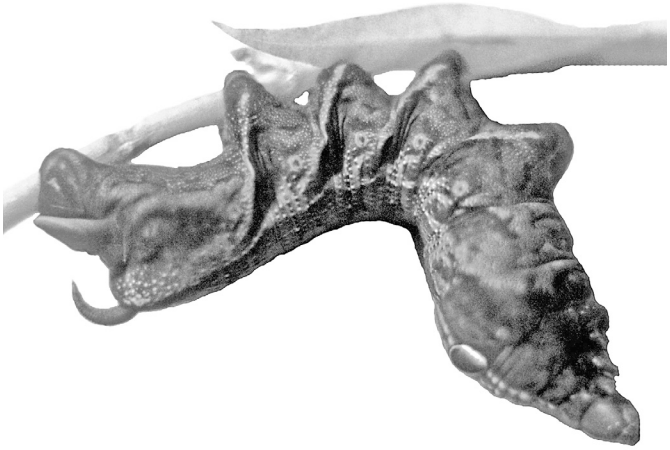

Fig. 6. Fifth instar *Xylophanes titana* caterpillar, lateral view, possible false threat position (the background has been edited out to make the posture clear).

Description of the Pupa

45 mm long, 10 mm at the widest, at the end of the wing cases (Figs. 7 and 8). Proboscis sheath attached to pupa, but the anterior part on the head shows a strong bulge. Cremaster thin, 4 mm long, black. Colour pale creamy brown with black speckles; a strong black dorsal line, and the spiracles and area immediately around them forming a prominent black spot; there is a thin black line across the anterior margin of the eye and the antennae.

Fig. 7. Emerged pupa of *Xylophanes titana*, lateral view.

Fig. 8. Emerged pupa of *Xylophanes titana*, dorso-lateral view.

Moss (1912) reared this species once from two caterpillars collected in eastern Peru, and illustrated one caterpillar. The food plant was an unidentified vine, which he believed to be related to *Spermacoce*, i.e. a species of Rubiaceae. The illustration and description of the caterpillar and pupa match that reported here, i.e. the caterpillar was predominantly brown-orange, except that Moss describes the eye-spots as "light-ringed grey eye-spots".

Janzen and Wallwachs (2007) database of caterpillar rearing in northwest Costa Rica lists eight rearing records of *X. titana*, all from *Manettia reclinata*, another Rubiaceae vine. The database includes excellent photographs of caterpillars, pupae and adults of *X. titana* from Costa Rica. In contrast to my observations and those of Moss (1912), the caterpillars illustrated from Costa Rica, although very similar in form and markings, are green – dull green laterally, brighter dorsally and yellow-green dorsally on segments T1-A1. Different colour morphs of Sphingidae caterpillars, particularly green and brown ones, are well known, but it is curious that in this case the three caterpillars from South America (two found by Moss and the one reported here) are of a brown-orange form, while all the caterpillars from Costa Rica are of a green form. The possibility of local races, or even sibling species merits evaluation.

I thank Marc Botham for letting me use his photo in Fig. 3.

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The Girth of Sandbox Trees (*Hura crepitans*) in Trinidad

The literature on *Hura crepitans* describes the sandbox as a large deciduous tree with a girth of 5 m (Quesnel and Farrell 2000). The writers measured various sandbox trees around the country with girth sizes significantly larger than the 5 m noted (See table).

Measurements of Sandbox trees, *Hura crepitans,* at various locations.

Hura crepitans

Location	Date	Girth (metres)
Ste. Madeleine	February, 2005	6.15
Lizard Springs	April, 2003	8.05
Ridge above Salt River Mud Volcano	April, 2003	8.1
Bush Bush	February, 2007	8.23

The Bush Bush Forest sandbox was particularly impressive as it had the tallest supporting roots. Whereas for the other trees in the survey the circumference of the trunk above the roots was measured 2.43 m above the ground, the girth on the Bush Bush sandbox was 4.83 m above the ground. The rough circumference of the roots at 1.3 m above the ground was 10.17 m.

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Four more Trinidadian Spider (Arachnida: Araneida) Families

Sewlal and Cutler (2003) and Cutler (2005) record 42 spider families for Trinidad and Tobago. During a review of the spider collection at the Land Arthropod Collection, Natural Sciences, University of the West Indies, St. Augustine, between May to June 2006, we identified specimens belonging to the families Liocranidae and Barychelidae.

We came across two specimens which, although not identified to genus or species, both unambiguously belong to the family Liocranidae because of the characters mentioned below. Sewlal and Cutler (2003) inadvertently omitted Trechaleidae from the annotated list of spider families for Trinidad and Tobago. It should be noted that members of both families lack cribellum and calamistrum.

A recent phylogenetic study conducted by Kuntner (2006) removed the species *Nephila clavipes* (Linn.) along with a few others not found in Trinidad and Tobago from the family Tetragnathidae and places it into its own family Nephilidae. However, with the removal of *N. clavipes,* there remain many tetragnathids in Trinidad and Tobago.

Liocranidae

Minute to small araneomorph spiders, legs are short to medium length, but generally less than twice the body length. Most species have rows of large ventral macrosetae present on the tibiae and/or metatarsi of the anterior legs. Eyes in two horizontal rows of four. The eyes take up less than half the width of the carapace. These spiders have two tarsal claws and no tarsal claw tuft. The male palp is enclosed by the cymbium. Spinnerets are unsegmented or one pair with two segments. Anterior spinnerets are close together concealing the median spinnerets. These spiders are mainly nocturnal hunters, and do not build webs. They are mostly found on low vegetation, under stones or in leaf litter.

Trechaleidae

Large to small araneomorph spiders, legs long and slender, large macrosetae with curved tips on ventral surface of most segments. Legs III shortest relative to other pairs which vary in length, tarsi flexible and may appear curved in preserved specimens. Eye arrangement similar to lycosids. However, posterior median and lateral eyes are not as enlarged and the eye rows they form are not as strongly recurved as lycosids (Vink 2002). Oval abdomen, slightly flattened ventrally. Disc-shaped egg sac with frill at the seam between the two valves. It is carried only on the spinnerets. Empty egg sac also used to transport young. Female carries egg sac long after departure of spiderlings, but will abandon it if dislodged. Cursorial species. Margins of bodies of freshwater are preferred habitat. Aquatic species are adept at walking on the water surface and crawling under water (Carico 1993).

Nephilidae

Large araneomorph spiders that display size dimorphism where males are a fraction of the size of the females (Kuntner 2006). During mating the sperm transferring organs of the males are broken off and often remain lodged in the female genital openings. The only species of the family in Trinidad and Tobago (*N. clavipes*) constructs large orb webs made of golden silk. It exhibits a high degree of sexual dimorphism with adult females being as much as 20 times larger than the males. These large females construct huge orb webs made from golden silk which can reach up to 1 m or more in diameter.

Barychelidae

In Sewlal and Cutler (2003) a brief description was included and suggested that this family might occur in Trinidad. We confirm its presence in Trinidad.

With the addition of Liocranidae, Nephilidae, Trechaleidae and the confirmation of the presence of Barychelidae, the total number of spider families known from Trinidad and Tobago is 46.

Thanks to Bruce Cutler for his comments on this note and bringing Trechaleidae and Nephilidae to our attention. Also many thanks to Chris Starr for his comments on an earlier draft of this manuscript.

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Preliminary Survey for Spiders on Nevis, West Indies

The distribution and habitats of spider fauna in the West Indian islands are poorly known. Lists to the species level are available only for Barbados (G. Alayón and J. Horrocks unpubl.) and Cuba (Alayón 1995). The spiders of Trinidad have been surveyed at the family level (Cutler 2005; Sewlal and Alayón 2007; Sewlal and Cutler 2003), but at the species only for the Salticidae (Cutler and Edwards 2002).

During January 2006, we spent two weeks on the island of Nevis with the aim of collecting a substantial part of the spider fauna in a broad variety of habitats. Nevis is a compact oceanic island with an area of 93 km^2, situated in the northern Lesser Antilles 17°10'N 62°35'W. It is relatively topographically simple, with a gradual rise on all sides from the shore to a central peak at 985 m. Nevis has a range of natural and secondary habitats that include montane forest, elfin woodland, palm brake, grassland, coastal scrub, dry woodland and farmland (Robinson and Lowery 2000).

Sampling took place at 14 localities dispersed throughout the island. Our main collecting method was through visual search, both at the ground level and above ground, including in shrubs and low trees. We supplemented this with sweep-netting, especially of coral vine (*Antigonon leptopus*) and other roadside flowering plants that attract insects, which in turn attract spiders. In addition, we searched many more cryptic microhabitats, especially under rocks and rotting logs.

Specimens collected were deposited in the Land Arthropod Collection of the University of the West Indies, St. Augustine, Trinidad and Tobago.

In nine habitat types, we collected a total of 29 species of spiders representing 12 families (See table). Our brief exploration of the montane forest and elfin woodland on Nevis Peak was made under difficult conditions and yielded no spiders.

We found 16 of the 29 species each in only one habitat type (See table). The most ecologically diverse species, by this measure, were the very abundant *Gasteracantha cancriformis* and *Leucauge regnyi*, recorded from seven and six habitats, respectively. The garden habitat yielded the greatest number of species, 13, and the foothills and palm brake the lowest, each with two species. More than half of the species were in the orb-weaving families Araneidae and Tetragnathidae.

Our collecting effort was not an exhaustive survey but an attempt to find a large number of species in a diversity of habitats. Some of our quantitative comparisons are probably an artefact of this approach. As an example, it is much easier and more pleasant to collect in a garden than in the steep-sided, densely-vegetated palm brake. Even so, there is reason to expect tropical gardens to be very biodiverse, so that the high yield of specimens in this habitat is probably not misleading. Similarly, we spent much less time in coastal scrub than in some other habitats.

A more important source of potential bias is in our collecting method, which was directed mainly toward species that can be seen under ordinary circumstances. This undoubtedly accounts for the heavy preponderance of web-building spiders, especially of the orb-weaving families. While our results represent a good beginning, the use of methods suited to collect leaf-litter-dwelling and other cryptic spiders can be expected to yield many additional records.

Thanks to Quentin "Beeman" Henderson for hosting us, the Ministry of Agriculture of Nevis for facilitating our work, and Giraldo Alayón for help in identifying the specimens. We are grateful to the Lumsdon, Robinson and Rule families, Gordon Avery, Pam Barry, Jim Johnson, Thomas Lash and Tony Persaud for various local assistance on Nevis. This project was partly funded by the Dept. of Life Sciences of the University of the West Indies.

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Observed habitat ranges of spiders on Nevis, West Indies. Genus names in quotation marks are of uncertain nomenclatural validity.

Family and Species	Habitat								
	Garden	Inland scrub	Farm_ land	Road_ side	Secondary forest	In and on buildings	Nevis Peak foothills	Palm brake	Coastal scrub
Araneidae									
Sp. A	✓		✓						
Gasteracanta cancriformis	✓	✓	✓	✓	✓	✓		✓	
Aleimosphenus licinus					✓				
Argiope argentata		✓			✓	✓			✓
Chrysometa sp.								✓	
Chrysso sp.					✓				
Cyclosa walkenaeri	✓	✓	✓	✓					
Eriphora sp.				✓					
Eustala anastera					✓				
Eustala sp.	✓								
Mangora sp.	✓								
Metepiera compsa		✓		✓		✓			✓
Neoscona sp.	✓	✓				✓			
Anyphaenidae									
Sp. A				✓	✓				
Clubionidae									
"Xeropigo" sp.					✓				
Linyphidae									
Sp. A	✓			✓					✓
Hibana velox	✓								
Mimetidae									
Sp. A					✓				
Pholcidae									
Physocyclus globosus						✓			
Salticidae									
Sp. A							✓		
Sp. B	✓	✓							
Sparassidae									
"Olios" sp.		✓							
Tetragnathidae									
Leucauge argyra	✓	✓		✓	✓	✓			
Leucauge regnyi	✓	✓		✓	✓	✓	✓		
Theraphosidae	✓								
Sp. A						✓			
Theridiidae									
Argyrodes sp.					✓				
Argyrodes elevatus	✓	✓				✓			
Thomisidae									
Sp. A				✓					
Misumenops sp.	✓								

A First Record of the Gecko *Gonatodes ceciliae* for the Island of Gaspar Grande, Trinidad and Tobago

Gonatodes ceciliae is a small diurnal gecko with a range limited to Trinidad and the Paria Peninsula of Venezuela. Adult males are about 51 mm in snout to vent length (SVL), with a tail 1.8 times the SVL. They are quite colourful possessing a red-brown dorsum often interspersed with yellow spots and streaks outlined in black on the head, with a yellow collar outlined in black anterior to the forelimbs. Females are somewhat smaller and have a less colourful mottled appearance (Murphy 1997). The gecko is typically associated with humid rain forest habitats.

Early on the afternoon of 29 July, 2006 while exploring the mouth of a limestone sinkhole near the path to the World War II guns at Point Baleen, Gaspar Grande Island, the author located and captured a male *Gonatodes ceciliae* in a small nook in the cave wall a few metres from the lip of the sinkhole. The animal was placed in a plastic receptacle and brought to the surface for photography. The species is known to be easily heat stressed (Murphy 1997) and as such was kept out of direct sunlight and when handled, it was grasped by its thigh to minimize heat transfer from the author's hand (Lum Young *et al.* 2005). The animal was then returned to the point of capture and released unharmed.

After a careful review of the herpetological literature of the small Boca Islands off Trinidad's northwestern peninsula and conversations with those most familiar with the herpetofauna of the area, this observation of *Gonatodes ceciliae* was confirmed as the first record of the species for the island of Gaspar Grande. Gaspar Grande is a very dry island of scrub vegetation and is not at all typical of the type of humid rain forest habitat associated with this species. The lizard has been recorded in fairly moist areas supported by small seasonal streams on two of the other Boca Islands (Monos and Chacachacare) (Boos 1984a).

The sinkhole terminated several metres underground in a saltwater pool assumed to be fed by some underground passage from the sea. The sheltered nature of the mouth of the sinkhole may serve to some extent to trap water vapour evaporating from the saltwater pool below. A relatively cool and humid microhabitat at the mouth of the sinkhole is thus maintained allowing *Gonatodes ceciliae* to inhabit the otherwise quite warm, dry island. Gaspar Grande is in large part, a limestone island riddled with such sinkholes to saltwater pools. These sinkholes on Gaspar Grande and the small seasonally stream-fed areas on Monos and Chacachacare are microhabitat oases for a number of reptile species (Boos 1984a, b) and are worthy of continued exploration and study. It is crucial that those responsible for the management of the land in the Boca Islands seek to regulate human activity in these areas so as to preserve the species so dependent upon them for survival.

I am grateful to Dr. Victor C. Quesnel for providing advice and background literature, Mr. Hans E. A. Boos for advice, Mr. Stephen Smith for assistance in observing the animal in the field and Mr. Paul Budgen for his photography of the animal.

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BOOK REVIEWS

The Trinidad and Tobago Field Naturalists' Club Trail Guide

Second Edition

Paul L. Comeau, I. Reginald Potter and **Prudence K. Roberts** (Editors)
The Trinidad and Tobago Field Naturalists' Club, Trinidad and Tobago, 2006. 364 p.
ISBN 978-976-8194-78-2

"A second edition of anything should show improvements". That is the opening sentence of the preface to the second edition of The Trinidad and Tobago Field Naturalists' Club Trail Guide, so I propose to tell you about them. The book is substantially larger than the first edition with 364 pages instead of 276 pages. This increase results from the inclusion of six new trails and the provision of a map for each trail, old and new. This new feature is important because it gives an idea of the trail as a whole with some sense of the overall direction and the twists and turns involved. GPS readings are given for the start of every trail and many waypoints between there and the destination. If you have a working GPS instrument you should never be lost. It is important to check your instrument to make sure that the reading it gives for the start of the trail is the same as that given in the book. If it isn't, there may be a systematic error to correct for every waypoint as well.

The plan of the book is the same as the plan for the earlier edition. Two prefaces, three preliminary chapters, a table and two maps precede the main section which runs from p. 26 to p. 349, and this section is followed by references, a glossary and a list of emergency telephone numbers. Chapter 1 (Environment) gives information about the geology of our two islands and the forests that cover them. It is basically unchanged. However, I warn the reader that the section on geology is full of technical terms many of which do not appear in the glossary. Here is my list: andesite, argilline, argellite, calcareous, foraminiferal, marl, phyllites, pyroxene, quartz, quartzite, ultramafic and finally, porphyroblastic albite-epidote-sericite. How did that monstrosity slip past the editors without comment? Fortunately, one can enjoy the trails without knowing what any of them means.

Chapter 2 (again unchanged) tells the novice the do's and don'ts of hiking, how to dress, what equipment to take, what to do if he or she gets lost, what to do about bites and stings etc. Surprisingly, though snakes are mentioned and snakebite said to be rare, there is nothing on how to treat snakebite if it happens. To remedy this omission I suggest that every reader of this book should read as well the chapter on snakebite in "The Snakes of Trinidad and Tobago" by Hans E. A. Boos.

Chapter 3 describes how to use the Trail Guide and it is followed by a table which lists their length, their degree of difficulty etc. This chapter advises "Be sure to read the whole description before you start hiking". It is good advice; follow it.

I have not hiked all these trails myself for the purpose of this review, but I have hiked most of them at some time or another. The descriptions I have read for the ones I know well seem more than adequate and I know that they have been tested for accuracy by Club members other than the describers. So, with good descriptions and GPS waypoints, all those using this book should get to their destinations and find their way back quite easily. However, I am not fond of counting paces. I know perfectly well that there are few permanent landmarks in a forest so counting paces may be unavoidable, but doing this means that there is less time for biological studies or simply enjoying the forest scenery. If one member of a group is willing to do the counting, the others, of course, are free for other activities, but it seems to me fairer for the members of a group to share this chore.

I have left the best for last. All the photographs are new and all are good with some being truly impressive. The covers are beautiful and the painting of Tucuche from the north has caught the mood of majesty and serenity. How often have I passed this way and admired this unusual view of Tucuche where the little 'tooth' to the west seems higher than the summit itself! Maureen Ottier's painting has caught another phenomenon that has puzzled me, the 'tooth' wreathed with cloud while the summit itself is clear. This I have seen often enough to encourage the speculation that there must be some difference in the vegetation of the two sites.

Trail No. 8 in the Trail Guide describes a route from Maracas Valley over the ridge to Las Cuevas Bay. There is a photograph of the site of Sister Beatrice's tapia house at the ridge and the statement: "Reportedly, there is a steep route up Tucuche from this area..." The existence of such a route is (or was) fact, not fiction. On 17 March, 1996, with four other persons, I hiked to the 'tooth' and then to

the summit itself. I can confirm that the route was then passable and not particularly steep, though there were two dangerous spots. I can confirm, too, that there was a difference in vegetation. My notes record: "Vegetation at the tooth was indeed a little different from (that of) Tucuche itself. The ground cover was almost entirely young *Prestoea* with the trees *Clusia tucuchensis* and *Didymopanax glabratum* being the commonest".

We live in a beautiful country. May all who use this informative and beautiful book help to keep it so.

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Flowers of Trinidad and Tobago

Julian Kenny

Prospect Press, Maraval, Trinidad and Tobago. 2005. 140 p.
ISBN 976-95057-8-1

At first sight "Flowers of Trinidad and Tobago" by Professor Emeritus Julian Kenny looks like a coffee table book, full of pretty photographs for visitors to browse through while their hosts attend to a domestic emergency. However, those who read the text very soon realise that this is a serious, if succinct, scientific overview of a wide variety of both native and introduced flowering plants of Trinidad and Tobago, albeit for the amateur naturalist.

Touching briefly on the uses man has made of flowers in religious ceremonies, Professor Kenny begins by posing the question "What is a flower?" and proceeds to answer it himself by describing the evolution of flowering plants in a few short sentences and giving the reader an introduction into basic floral anatomy, stressing the reproductive function of every flower.

The second chapter gives the reader some idea of the wealth of flowering plants, from the tallest trees to the smallest herb, to be found in Trinidad and Tobago. Each of the next seven chapters highlights a particular habitat – or rather, habitats, since in the chapter headed "forests" habitats range from swamp to elfin forests, each with very different species demanding specialised ecosystems for survival.

Streams and rivers, wetlands, savannas and the dramatic variety of coastal habitats (from the sun, sea and sands of Tobago to the mangrove swamps of Trinidad) and flowering plants to be found in these locations are the subjects of the next four chapters. Apart from the flowering plants, these chapters include information on the geology and micro-climates preferred by the flora in each habitat.

Agriculture, the eighth chapter, has had the greatest impact on ecosystems and consequently, the flowering plants growing in these disturbed areas, and secondary growth forest. Professor Kenny touches very briefly on the barren (where flowering plants are concerned) landscapes of sugar cane and rice-growing, contrasting them with plantations of citrus, cocoa and coffee that provide an ideal ecosystem for shade-loving plants.

Man-made habitats conclude the survey of ecosystems in this book. Perhaps the greatest surprise is the diversity of flowering plants to be found around landfills. Given some rain and allowed to settle without further disturbance, seeds of flowers transported with the material germinate, grow and flower on land filled for housing or industry.

As one would expect from any serious work on flora, the last four sections of the book are headed, respectively: bibliography, appendix– families, glossary, and index to species.

The illustrations are lavish; texts accompanying each photographed flower note the scientific name, common name, family, times of flowering and where it can be found.

Photographers will be interested in Professor Kenny's notes on digital photography in the Preface, in which he stresses that his book "is NOT a guide to identification." That "It simply seeks to illustrate the remarkable diversity and beauty of floral form in a tiny fraction of Trinidad and Tobago's plant life."

There's no doubt in the minds of those who have already read this book that he has succeeded in making the wider public aware of the wealth of beauty in the flowering plants – and where to find them.

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