

LIVING WORLD



Journal of the Trinidad and Tobago Field Naturalists' Club



2005



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 on natural history and to encourage and promote activities that would lead to an appreciation, preservation and conservation of our natural heritage.

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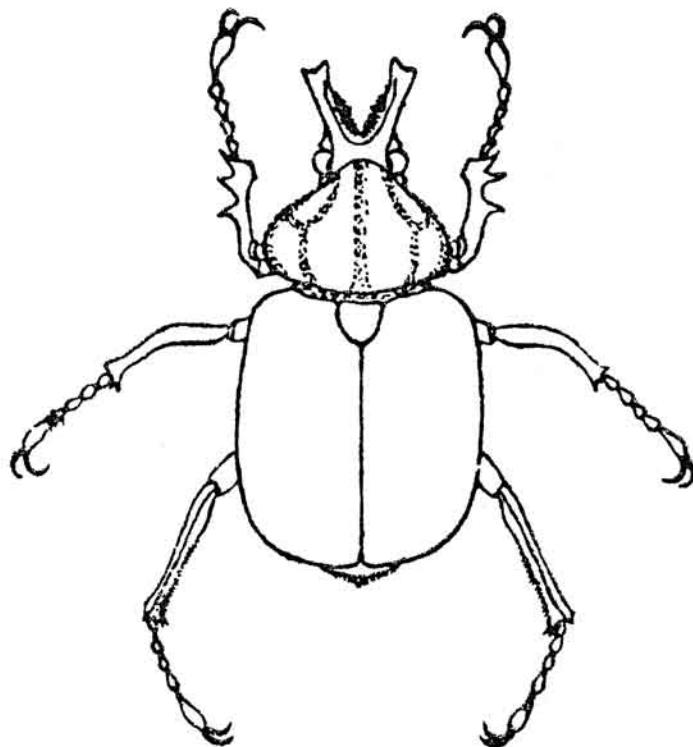
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Field Naturalists' Club
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Natura Maxime Miranda in Minimis

Published September, 2005

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ISSN 1029-3299

Acknowledgements

The Management Committee of the Trinidad and Tobago Field Naturalists' Club acknowledges with thanks the contributions made to the production of Living World 2005 by our Advertisers and the following Donor Companies:

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Special thanks to Michael E. Tikasingh for the design and layout of the front and back covers,
and to Calista Pierre and Rupert Mends for proofreading.

Editorial

Our environment is being degraded at an alarming rate and steps ought to be undertaken to address this situation as an emergency. To this end it is our intention to highlight environmental matters as seen by some of our noted and knowledgeable environmentalists. We are, therefore, pleased to have as our first Guest Editorialist Dr. Julien Kenny, a former professor of zoology, an author on books and articles on the environment and an ex-senator whose role in the Senate was to highlight environmental matters.

In this issue of the Journal, we have introduced a new section called “Published Elsewhere”. Some of our local as well as overseas scientists conduct studies on our local flora and fauna and publish their results in international journals. In order to call our naturalists’ attention to these publications, we will publish Authors’ abstracts of these papers with full citation on those articles that we think might be of interest to our members.

Checklists of plants and animals are important aspects in studies on biodiversity. D. Adams and Y. Baksh-Comeau present a list of plants on the small island of Chacachacare. They noted 244 species of plants including three species which are recorded for the first time for the island.

David Bass continues his series of freshwater macroinvertebrates on various Caribbean islands. In this issue, he writes about the macroinvertebrates on Antigua where he collected 41 species, all of which are reported for the first time from that island.

Whiteflies are mainly tropical and attack certain species of plants, particularly citrus. V. F. Lopez and her colleagues conducted field and laboratory studies on three species of *Aleurodicus* and present their results in this issue.

Matthew Cock continues with his series on skipper butterflies of Trinidad and Tobago. This paper is Part 13 (Hesperiinae) of the

series where he discusses 11 genera and 22 species. In a previous Living World, Matthew Cock mentioned an unidentified saturniid larva which he has now identified and reported as *Automeris libera*.

Jo-Anne Sewlal describes some defence mechanisms of the orb-weaving spider *Azilia vachoni*, while Victor Quesnel writes on the mating behavior of the skink *Mabuya nigropunctata*.

There are three Nature Notes: Charles Collins reports on the use of a nest site used for 40 years by Chestnut-collared Swifts. C. Starr writes about whirling behaviour in a Daddy-longlegs spider from Dominica and John Lum Young gives practical advice for handling the “Luminous Lizard”.

Bruce Cutler adds another spider family for Trinidad, Synotaxidae.

The third report of the Trinidad and Tobago Rare Bird Committee is written by Martyn Kenefick and lists 10 additional species to the Official List of Birds of Trinidad and Tobago. Aweeda Newaj-Fyzul and colleagues describe their attempts to re-float a Bryde’s whale stranded at La Brea, its death and subsequent autopsy.

In the new section, “Published Elsewhere,” there are three abstracts: One on the “Luminous Lizard” and two on butterflies.

Two book reviews are covered in this issue. One on “Butterfly Trails” by H. R. Roegner and reviewed by Matthew Cock tells of Roegner’s visit to Trinidad and elsewhere, while Christopher Starr reviewed “The Journals of the Trinidad Field Naturalists’ Club, 1892 – 1896” recently produced by the Club on two CDs.

EST

Cover Photograph

Opuntia wentiana, a member of the cactus family, is found growing on Chacachacare Island. It has not been recorded elsewhere on Trinidad or Tobago. The plant is spiny, erect 1-2 m and is much branched. Photo by Yasmin S. Baksh-Comeau.

State of the Environment: Guest Editorial

Once more our country is experiencing boom conditions driven largely by the exploitation of offshore natural gas resources and the increases in the market prices of gas and oil. How many members of the Club will recall the last energy boom and its effects, the drift away from the land to the cities and towns, and the wide range of funds set aside? Can any recall the special conservation fund, a sort of precursor to the current multi-million dollar Green Fund? And what became of it? It disappeared with the inevitable recession that followed the boom. Today we are again already experiencing in many ways comparable negative effects that were part of the last boom. The diversion of much of revenues on social relief programmes such as Unemployment Relief Programme (URP) and Community Environmental Protection and Enhancement Programme (CEPEP) has again made it difficult to obtain labour in agriculture or forestry, while regularization of squatting has made the phenomenon of squatting a permanent component of our culture. Increased consumption, both private and corporate, has also exacerbated the pollution problem.

At the same time we are, at least, in a better position to cope with the inevitable environmental degradation. We do in fact have a Ministry of the Environment although this is only one half of a larger one that includes Public Utilities. We also have a ten-year old Environmental Management Authority that in theory has overall charge of management of the environment, including, of course, the natural environment. The Authority does have a wide mandate but must manage according to legally laid down rules and procedures approved by Parliament. Few of these are actually on the books and it must rely on older existing legislation, usually with little impact. It does have the Certificate of Environmental Clearance procedures that have now come into effect while it has designated at least one Sensitive Area at Matura, and is proposing to designate others as well as Sensitive Species. But it is yet to have its draft vehicle emissions, air quality, effluents, and toxic and hazardous substances standards become law.

But there is a greater concern as the country enters the boom. This is the rapid industrialization based on the non-renewable resource of natural gas, driven by another Ministry, the Energy Ministry and the Prime Minister's Office, and a process that makes considerable demands on the resource of space, especially space that at present is arable land or mature secondary forest. Much of this industrialization will take place along the coast of the Gulf of Paria stretching from La Brea to as far as Icacos. And while full details are not yet available, the industrial estates at Union Estate of about 800 acres and at Cap de Ville Estate of 2000 acres alone represent a significant proportion of the South-western Peninsula, perhaps as much as ten percent. And we are informed that steps

are being taken to find similar acreages farther along and possibly through Cedros and Icacos. These estates require access to the sea via deepwater harbours. All this is actually happening without reference to Parliament or the citizenry.

The country has signed the United Nations Convention of Biological Diversity that does require it to conserve its major ecosystems. No one can dispute that the South-western Peninsula is a unique part of Trinidad. While its forests may not be of the same grandeur as those at Matura, or the Heights of Aripo, or the Trinity Hills, it is a part of the island that displays a diverse range of ecosystems from the cliffs and beaches of Chatham, Icacos and Columbus Bay, to the sedge swamps of the Fullerton Lagoon, the mangrove forests of Los Blanquizales Lagoon, and the many bouffes, some of which rise out of the sea at Chatham from time to time. There are also the islands of Los Gallos and Soldado Rock, a noted seabird-nesting site. There are a few scattered human settlements and small agricultural holdings. But there are also forests, including a forest reserve on the peninsula.

Perhaps, however, its biota makes it unique. With its proximity to the Macareo and Pedernales Rivers, and its traffic in human beings going back several millennia, many South American species are found there and nowhere else in Trinidad. This includes both plant and animal species. The Cedros Bee orchid, the Cedros balisier, the silver hatchet fish, the Cedros guabine, three frogs and at least one snake are examples. The peninsula is obviously an area of some dynamism in terms of movement of species from the Orinoco Delta to Trinidad, and this makes it worthy of declaration as a Sensitive Area under the Environmental Management Act, and under the UN Convention of Biological Diversity.

There will be a range of views on the subject of economic development. All must agree that there must really be some balance between development and environmental preservation, but one commonly held fear by biologists, Club members and conservationists generally, is that as we follow the current path, it is the environment that will suffer. There are, however, possible options that members of the Club, and indeed the public might pursue. The most important is public education, pressure on the political processes to plan carefully, to observe planning law and enact more effective laws and, above all, to honour the country's international treaty commitments.

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Checklist of the Vascular Plants of Chacachacare Island, Trinidad and Tobago

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ABSTRACT

Chacachacare Island is the most westerly of the islands off the north-west peninsula of the island of Trinidad. Most of the species listed are native; of these *Coccoloba nigrescens*, *Combretum trinitense*, *Lantana lockharti* are endemic to Trinidad. Three species, *Maytenus* sp., *Schaefferia frutescens* and *Bourreria cumanensis*, are new records for the island but unknown on the main islands of Trinidad and /or Tobago. This checklist records 244 species in 73 families.

Key words: Chacachacare Island, native, endemic, new records, families, species.

OBJECTIVE

To compile a comprehensive inventory of the vascular plants found on Chacachacare Island.

INTRODUCTION

This checklist of the flora of Chacachacare Island is a small extract from the major endeavour, in progress, to update the vascular flora of Trinidad and Tobago. The island is the largest of a group of islands off the western peninsula of Trinidad with botanical records from explorations starting in 1847 and 1861 with Herman Crueger, followed by Kirkman Finlay 1860–68, J. H. Hart and a few others up to 1900. From then on periodic collections continued throughout the last century by both amateur field naturalists and biologists. A preliminary expedition to the Salt Pond was undertaken by botanists from the National Herbarium of Trinidad and Tobago in 1992. This was followed by a serious and comprehensive study between 1993 and 1994, during which time about 20 visits to the island were made.

The island has a long history of human activity dating from pre-Columbian settlement right up to the present time. In 1797 the natural vegetation was cleared extensively for the commercial growing of cotton and tobacco, later other agriculture crops were introduced. Military occupation, commercial whaling and a leprosarium set up in the 1920's have all significantly influenced the natural vegetation. The last era of full-time human occupancy ended in 1985 with the closure of the leprosarium. Thus over the last two decades the island has had no permanent human presence and the vegetation has fully reverted to a dry scrubby mixture of epiphytes, shrubs, climbers and trees, all of which are well adapted to the harsh conditions that prevail.

Most of the species recorded are native and of these *Coccoloba nigrescens*, *Combretum trinitense*, *Lantana lockharti* are endemic to Trinidad. Three species, *Maytenus* sp., *Schaefferia frutescens* and *Bourreria cumanensis*, are new records for the island and not otherwise known on the main islands of Trinidad and /or Tobago. This checklist records 244 species distributed in 73 families. All the species in this checklist are linked to voucher collections housed at the National Herbarium of Trinidad and Tobago, unless otherwise stated.

METHODS

The checklist was developed from herbarium specimens in the National Herbarium of Trinidad and Tobago. The data from the specimen labels were then entered into an Access database. Data were also extracted from published Floras, journals, books and unpublished manuscripts in the herbarium. Extensive field surveys were undertaken in the following localities: the perimeter around the Salt Pond and Perruquier Bay and trail south of the bay; Lighthouse trail; Sanders Bay; Bulmers Bay and surrounding hillsides; Coco Bay east; Bande du Sud west and the near shore; and Rust Bay. A vegetation study done by Celeste Chariandy from October, 1998 – November, 1999 which produced plant lists for selected sites and a bibliography in an unpublished typescript were incorporated in this checklist.

GEOGRAPHICAL LOCATION

Chacachacare Island lies between 61° 49' and 61° 44' W and 10° 40' and 10° 42' N. It is the most westerly of the Bocas Islands off the north-west coast of Trinidad (Fig.1). It rises to 243.9 m (800 feet) and has a surface area of 392.6 ha (approx. 970 acres). The island is 'horseshoe shaped and very hilly. The hills slope towards the inside of the horseshoe. On the west side the hills are precipitous, descending abruptly to the Caribbean Sea. At the junction of the arms of the horseshoe, the land is flat and marshy (Carmichael 1961) (Fig. 2 and Plate 1).

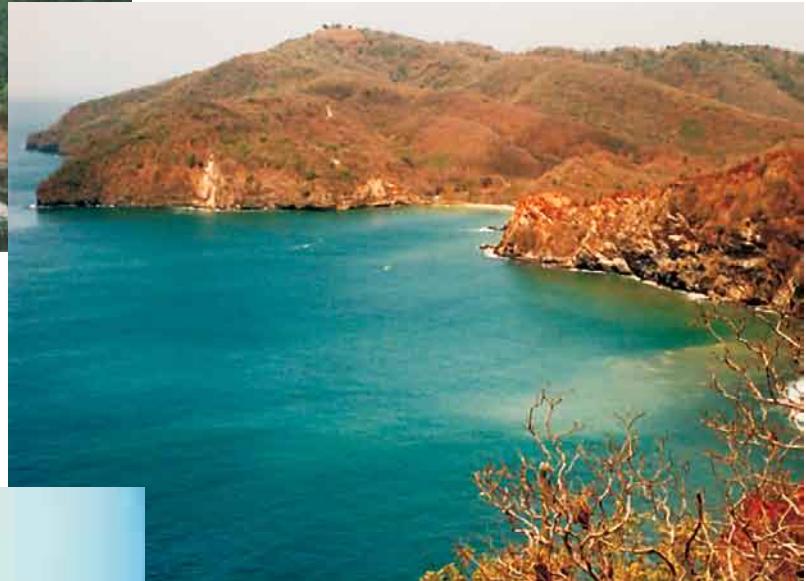


Fig.1. Chacachacare Island (arrow) in relation to Trinidad.
(Map modified from Philips Certificate Atlas for the Caribbean 3rd Ed. 1998)

* Deceased on 25 April, 2005.

PLATE I

1. Chacachacare in the wet season, October 1992.
(Photo: P. L. Comeau)



2. Chacachacare in the dry season, April 1993.
(Photo: P. L. Comeau)



3. View of the Salt Pond from the top of the lighthouse.
(Photo: Y. S. Comeau)



4. View of the Salt Pond from surrounding hills.
(Photo: P. L. Comeau)

PLATE II



5. *Bromelia humilis* forming a ground cover. (Photo: P. L. Comeau)



6. *Bromelia humilis* in flower.
(Photo: P. L. Comeau)



7. *Caularathron bicornutum*.
(Photo: J. S. Kenny)

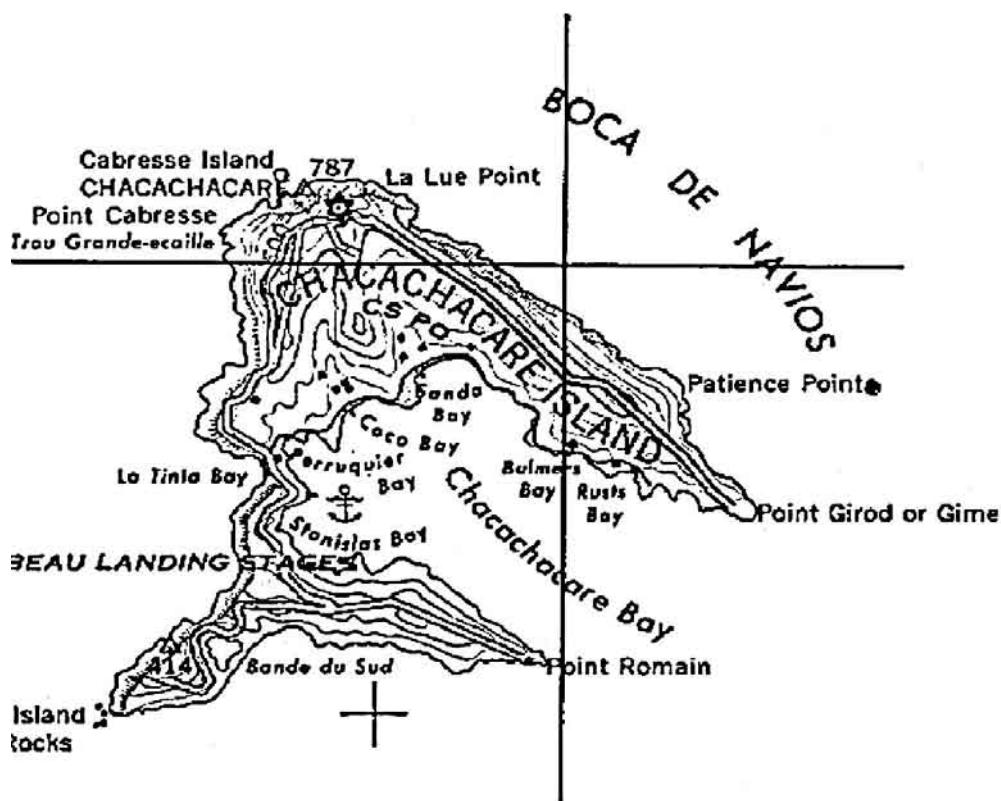


Fig. 2. Chacachacare Island showing the names of the main collecting sites.

PALAEOGEOGRAPHY

The island originated 'between 160 and 60 million years before the present' when 'the Trinidad area was a submerged continental shelf north of the ancient land mass of the Guyana Shield, and on it were deposited fine sands, clays and calcareous oozes' (de Verteuil 2002). Between 22 and 15 million years ago, the Northern Range, the most easterly extension of the Paria Peninsula in Venezuela, became a vertical upthrust above sea level extending to about 10 km. This eventually eroded and 'broke up into blocks due to faulting. Vertical movement and global rise in sea level resulted in submerged coasts separating Chacachacare from Trinidad' (de Verteuil 2002).

'In terms of rock types, there are two basic units, an unnamed quartz and quartz - mica schist in the north, and calcareous schist and metalimestone layers in the south (these probably correlate with rocks exposed along Lady Chancellor Road that we are calling the Chancellor schists and Kugler (1961) called the Chancellor beds). The contact between these two units dips gently (ca. 20° – 30°) to the south, as does the metamorphic layering (foliation) in the units themselves.' (John Weber 2001 pers. comm.).

CLIMATE AND VEGETATION

The climate is dry with an annual average rainfall of 44.91 ins (Beard 1946). During the dry season, which lasts for five months, the rainfall is less than two inches and drought conditions prevail. The steep topography combined with freely draining soil leads to arid habitats. Beard (1946) described the vegetation on Chacachacare as a Secondary Deciduous Seasonal Forest that has been altered by human interference. This community is not easily recognizable

at the present time and the only two relatively distinct communities are those of the upper beach community and the salt pond. The island is almost completely surrounded by cliffs on the south, west, north and north-east aspects. These have a few characteristic plants such as agaves, cacti and the bromeliad *Pitcairnia integrifolia* and the virgin orchid *Caularthon bicornutum* (Plate II). No attempt has been made in this study to identify communities of vegetation but instead focus is on its floristics. Future research may focus on population studies to determine dominant species or the status of endemic, rare, threatened and endangered species for purposes of conservation.

SPECIES LIST

A. The vascular plants included in this list are:-

Ferns – plants with erect or creeping stems and broad leaves, reproducing without flowers but by means of spores and independent gametophytes.

Conifers or Gymnosperms – plants with thick stems, small simple or large compound leaves, reproducing without flowers but by means of uncovered seeds usually arranged in cones.

Flowering Plants – plants reproducing by seeds enclosed in carpels.

Dicotyledons – flowering plants with two cotyledons.

Polypetalous Dicotyledons – flowering plants with corolla of separate petals.

Gamopetalous Dicotyledons – flowering plants with petals at least united at the base.

Monocotyledons – flowering plants with one cotyledon.

B. Explanation of type faces and special punctuation.

Names of families are in CAPITALS; some family names, see COMPOSITAE (ASTERACEAE), have a traditional form for which there is an alternative of equal standing, having the consistent ending 'aceae'.

Accepted names of species and their authors are in lower case letters.

Superceded names or synonyms are in *italics*. The names in italics have been used previously and some may be familiar. Those that are synonyms derive from situations either where the species has been transferred to a different genus or where the plant has been described unnecessarily on more than one occasion, for example, the plant which Urban described as *Capparis trinitensis*

had been described at an earlier date by Jacquin as *Capparis verrucosa*. A common type of synonym is where the original genus has been split up. One of the derivatives of this will carry the original species name – that is the basionym, e.g. *Polypodium aureum*. A misidentification occurs when the wrong name has been applied to the plant; in these cases the superceded name really belongs to a different plant, for example, *Alternanthera ramosissima*, as used by Simmonds in the Trinidad Flora in 1964, is not the Brazilian plant to which Martius and Chodat originally applied the name 'ramosissima' and our plant is really *Alternanthera flavescens* (see Amaranthaceae). Many little-used or obscure synonyms have been omitted from this list.

Names in square brackets [] refer to introduced species for food, commerce or ornament. Long-standing introductions which have naturalized are treated as native species.

List of Vascular Plants on Chacachacare Island**Ferns:**

SCHIZAEACEAE
PTERIDACEAE
POLYPODIACEAE

Lygodium venustum Sw.
Adiantum lucidum (Cav.) Sw.
Phlebodium aureum (L.) J. Sm.
Polypodium aureum L.

Gymnosperm:
CYCADACEAE

[*Cycas* sp.]

Flowering Plants**Polypetalous Dicotyledons:**

AIZOACEAE

Sesuvium portulacastrum (L.) L.
Trianthema portulacastrum L.
Achyranthes aspera L.
Achyranthes indica (L.) Mill.
Alternanthera caracasana Kunth
Alternanthera peploides (Willd. ex Roem. and Schult.) Urb.

AMARANTHACEAE

Alternanthera flavescens Kunth
Alternanthera ramosissima of authors, not (Mart.) Chodat
Iresine angustifolia Euphrasén
Iresine diffusa Humb. and Bonpl. ex Willd.

Iresine celosia L.

ANACARDIACEAE

Pfaffia iresinoides (Kunth) Spreng.
[*Mangifera indica* L.]
[*Spondias mombin* L.]
[*Annona squamosa* L.]
Ceiba pentandra (L.) Gaertn.
Bursera simaruba (L.) Sargent
Acanthocereus tetragonus (L.) Hummelinck

ANNONACEAE

Acanthocereus pentagonus (L.) Britton and Rose
Cereus hexagonus (L.) Mill.

BOMBACEAE

Hylocereus lemairei (Hook.) Britton and Rose

BURSERACEAE

Opuntia boldinghii Britton and Rose

CACTACEAE

Opuntia cochenillifera (L.) Mill.

CAPPARIDACEAE

Nopalea cochenillifera (L.) Salm-Dyck

Opuntia wentiana Britton and Rose

Pilosocereus lanuginosus (L.) Byles and Rowley

Cephalocereus moritzianus (Otto) Britton and Rose

Capparis cynophallophora L.

Capparis flexuosa (L.) L.

Capparis hastata Jacq.

Capparis cocclobifolia Mart. ex Eichler

Capparis odoratissima Jacq.

Capparis tenuisiliqua Jacq.

Capparis verrucosa Jacq. (Britton MSS. only)

Capparis trinitensis Urb.

Morisonia americana L.

CECROPIACEAE	<i>Steriphoma ellipticum</i> (DC.) Spreng. <i>Cecropia peltata</i> L.
CELASTRACEAE	<i>Maytenus floribunda</i> Reissek <i>Maytenus</i> sp. (Note: Tree 5–7 m; leaves alternate; flowers yellow-green; stamens 5; anthers brownish; fruit brownish-green; unnamed species.) <i>Schaefferia frutescens</i> Jacq. (Note: This species is widespread in the Caribbean area; it is a new record for Trinidad where the usual arid limestone habitat is poorly represented.)
COMBRETACEAE	<i>Combretum fruticosum</i> (Loefl.) Stuntz <i>Combretum trinitense</i> Britton <i>Conocarpus erectus</i> L. <i>Laguncularia racemosa</i> (L.) C. F. Gaertn.
CUCURBITACEAE	<i>Ceratosanthes palmata</i> (L.) Urb. <i>Psiguria umbrosa</i> (Kunth) C. Jeffrey <i>Anguria umbrosa</i> Kunth
ERYTHROXYLACEAE	<i>Erythroxylum havanense</i> Jacq. <i>Erythroxylum ovatum</i> Cav.
EUPHORBIACEAE	<i>Chamaesyce hypericifolia</i> (L.) Millsp. <i>Euphorbia glomerifera</i> (Millsp.) L. C. Wheeler <i>Euphorbia hypericifolia</i> L. <i>Chamaesyce serpens</i> (Kunth) Small <i>Euphorbia serpens</i> Kunth <i>Cnidoscolus urens</i> (L.) Arthur <i>Jatropha urens</i> L. <i>Croton guildingii</i> Griseb. <i>Croton niveus</i> Jacq. <i>Dalechampia scandens</i> L. <i>Ditaxis polygama</i> (Jacq.) L. C. Wheeler <i>Argythamnia polygama</i> (Jacq.) Kuntze <i>Euphorbia cotinifolia</i> L. <i>Euphorbia cotinoides</i> Miq. [<i>Euphorbia tirucalli</i> L.]
FLACOURTIACEAE	<i>Hippomane mancinella</i> L. <i>Jatropha gossypifolia</i> L. <i>Margaritaria nobilis</i> L. f. <i>Casearia guianensis</i> (Aubl.) Urb. <i>Casearia spinescens</i> (Sw.) Griseb. <i>Casearia zizyphoides</i> Kunth <i>Bauhinia glabra</i> Jacq. <i>Bauhinia cumanensis</i> Kunth
LEGUMINOSAE (CAESALPINIOIDEAE)	<i>Caesalpinia coriaria</i> (Jacq.) Willd. <i>Copaifera officinalis</i> (Jacq.) L. <i>Senna bacillaris</i> (L. f.) H. S. Irwin and Barneby <i>Cassia bacillaris</i> L. f. <i>Acacia retusa</i> (Jacq.) R. A. Howard
LEGUMINOSAE (MIMOSOIDEAE)	<i>Calliandra cruegeri</i> Griseb. <i>Piptadenia flava</i> (Spreng. ex DC.) Benth. <i>Pithecellobium unguis-cati</i> (L.) Mart. <i>Zapoteca formosa</i> (Kunth) H. M. Hern. <i>Calliandra marginata</i> Griseb. ex R. O. Williams
LEGUMINOSAE (PAPILIONOIDEAE)	<i>Canavalia rosea</i> (Sw.) DC. <i>Canavalia maritima</i> (Aubl.) Urb. <i>Coursetia caribaea</i> (Jacq.) Lavin <i>Cracca caribaea</i> (Jacq.) Benth. <i>Coursetia ferruginea</i> (Kunth) Lavin <i>Crotalaria spectabilis</i> Roth <i>Desmodium procumbens</i> (Mill.) Hitchc. <i>Dioclea guianensis</i> Benth. <i>Flemingia strobilifera</i> (L.) W. T. Aiton <i>Galactia lockhartii</i> Griseb. (Britton 2695 - K) <i>Galactia striata</i> (Jacq.) Urb. <i>Lonchocarpus punctatus</i> Kunth <i>Machaerium robinifolium</i> (DC.) Vogel <i>Rhynchosia minima</i> (L.) DC. <i>Sesbania sericea</i> (Willd.) Link <i>Sophora tomentosa</i> L. <i>Sophora occidentalis</i> L. <i>Vigna luteola</i> (Jacq.) Benth. <i>Vigna repens</i> (L.) Kuntze
MALPIGHIAEAE	<i>Heteropterys nervosa</i> A. Juss. <i>Banisteria nervosa</i> (A. Juss.) R. O. Williams [<i>Malpighia emarginata</i> DC. <i>Malpighia glabra</i> of authors, not L., 1753 <i>Malpighia punicifolia</i> of authors, not L., 1762.]

MALVACEAE	<i>Stigmaphyllon finlayanum</i> A. Juss. <i>Stigmaphyllon humboldtianum</i> of authors, not (DC.) A. Juss. <i>Stigmaphyllon tiliifolium</i> (Kunth) Nied. <i>Abutilon giganteum</i> (Jacq.) Sweet <i>Bastardia viscosa</i> (L.) Kunth <i>Cienfuegosia heterophylla</i> (Vent.) Garcke <i>Gossypium barbadense</i> L. Long Staple Cotton. <i>Gossypium hirsutum</i> L. Short Staple Cotton. <i>Malvastrum americanum</i> (L.) Torr. <i>Pseudabutilon umbellatum</i> (L.) Fryxell <i>Abutilon umbellatum</i> (L.) Sweet <i>Sida acuta</i> Burm. f. <i>Sida cordifolia</i> L. <i>Sidastrum multiflorum</i> (Jacq.) Fryxell <i>Thespesia populnea</i> (L.) Sol. ex Corrêa <i>Wissadula periplocifolia</i> (L.) C. Presl ex Thwaites, var. <i>gracillima</i> R. E. Fries
MELIACEAE	<i>Trichilia trifolia</i> L.
MENISPERMACEAE	<i>Cissampelos pareira</i> L. [<i>Ficus benjamina</i> L.]
MORACEAE	<i>Maclura tinctoria</i> (L.) D. Don ex Steud. <i>Chlorophora tinctoria</i> (L.) Gaudich. ex Benth.
MYRTACEAE	<i>Eugenia dussii</i> Krug and Urb. ex Urb. <i>Pseudanamomis umbellulifera</i> (Kunth) Kausel <i>Anamomis umbellulifera</i> (Kunth) Britton
NYCTAGINACEAE	<i>Psidium guajava</i> L. [<i>Bougainvillea</i> sp.]
OCHNACEAE	<i>Pisonia cuspidata</i> Heimerl
OLACACEAE	<i>Pisonia pacurero</i> Kunth
PASSIFLORACEAE	<i>Ouratea guildingii</i> (Planch.) Urb.
PHYTOLACCACEAE	<i>Ximenia americana</i> L.
POLYGALACEAE	<i>Passiflora serrulata</i> Jacq.
POLYGONACEAE	<i>Petiveria alliacea</i> L.
PORTULACACEAE	<i>Rivina humilis</i> L.
RHIZOPHORACEAE	<i>Bredemeyera lucida</i> (Benth.) Klotzsch ex Hassk.
RUTACEAE	<i>Securidaca diversifolia</i> (L.) S. F. Blake
SAPINDACEAE	<i>Coccocloba fallax</i> Lindau
STERCULIACEAE	<i>Coccocloba nigrescens</i> Lindau
TURNERACEAE	<i>Ruprechtia coriacea</i> (Karst.) S. F. Blake
VISCACEAE	<i>Talinum fruticosum</i> (L.) Juss. <i>Talinum triangulare</i> (Jacq.) Willd.
VITACEAE	<i>Talinum paniculatum</i> (Jacq.) Gaertn. <i>Rhizophora mangle</i> L. <i>Amyris ignea</i> Steyermark. <i>Amyris simplicifolia</i> of Karst., not Roxb. <i>Zanthoxylum fagara</i> (L.) Sarg. <i>Fagara pterota</i> L.
Gamopetalous Dicotyledons:	
ACANTHACEAE	<i>Urvillea ulmacea</i> Kunth <i>Helicteres baruensis</i> Jacq. <i>Waltheria indica</i> L. <i>Waltheria americana</i> L.
APOCYNACEAE	<i>Turnera odorata</i> Rich.
ASCLEPIADACEAE	<i>Phoradendron mucronatum</i> (DC.) Krug and Urb. <i>Phoradendron caerulescens</i> Trel. <i>Phoradendron ottonis</i> Eichler
AVICENNIACEAE	<i>Phoradendron trinervium</i> (Lam.) Griseb.
BIGNONIACEAE	<i>Cissus verticillata</i> (L.) Nicolson and C. E. Jarvis <i>Cissus sicyoides</i> L.
<i>Aphelandra pulcherrima</i> (Jacq.) Kunth	
<i>Dicliptera sexangularis</i> (L.) Juss.	
<i>Dicliptera vahliana</i> Nees	
<i>Justicia secunda</i> Vahl	
<i>Ruellia tuberosa</i> L.	
<i>Siphonoglossa sessilis</i> (Jacq.) D. N. Gibson	
<i>Justicia sessilis</i> Jacq.	
<i>Mandevilla subsagittata</i> (Ruiz and Pav.) Woodson	
<i>Metastelma parviflorum</i> (Sw.) R. Br.	
<i>Cynanchum parviflorum</i> Sw.	
<i>Sarcostemma clausum</i> (Jacq.) Schult.	
<i>Avicennia germinans</i> (L.) Stearn	
<i>Avicennia nitida</i> Jacq.	
<i>Anemopaegma karstenii</i> Bureau and K. Schum.	
<i>Anemopaegma carrerense</i> E. Arm.	

BORAGINACEAE

Macfadyena unguis-cati (L.) A. H. Gentry
Doxantha unguis-cati (L.) Miers
Mansoa verrucifera (Schltdl.) A. H. Gentry (R. A. Howard 10429, A)
Onohualcoa helicocalyx (Kunze) Sandwith
Tabebuia chrysanthia (Jacq.) G. Nicholson
Tabebuia rufescens J. R. Johnst.
Tabebuia serratifolia (Vahl) G. Nicholson
Tecoma stans (L.) Juss. ex Kunth
Bourreria cumanensis (Loefl.) O. E. Schulz
Cordia alliodora (Ruiz and Pav.) Oken (Marshall, 1934)
Cordia collococca L.

COMPOSITAE (ASTERACEAE)

Cordia curassavica (Jacq.) Roem. and Schult.
Cordia dentata Poir.
Heliotropium angiospermum Murray
Tournefortia volubilis L.
Acmella uliginosa (Sw.) Cass.
Spilanthes uliginosa Sw.
Bidens cynapiifolia Kunth
Calea solidaginea Kunth
Chromolaena odorata (L.) R. M. King and H. Rob.
Eupatorium odoratum L.
Condylidium iresinoides (Kunth) R. M. King and H. Rob.
Eupatorium iresinoides Kunth
Fleischmannia microstemon (Cass.) R. M. King and H. Rob.
Eupatorium microstemon Cass.
Isocarpha oppositifolia (L.) R. Br. ex Cass.
Launaea intybacea (Jacq.) Beauverd
Lactuca intybacea Jacq.
Piptocoma acuminata (Kunth) Pruski
Oliganthes condensata (Less.) Sch. Bip.
Piptocoma milleri (J. R. Johnst.) Pruski
Oliganthes milleri (J. R. Johnst.) Gleason
Pluchea carolinensis (Jacq.) G. Don
Pluchea odorata of Cheesman, not (L.) Cass.
Pluchea symphytifolia of authors, not (Mill.) Gillis
Trixis inula Crantz
Trixis radialis Kuntze
Wedelia calycina Rich.
Convolvulus nodiflorus Desr.
Jacquemontia nodiflora (Desr.) G. Don
Jacquemontia confusa Meisn.

CONVOLVULACEAE

Evolvulus tenuis Mart. ex Choisy,
 subsp. *longifolius* (Choisy) Ooststr.,
 subsp. *sericatus* (House) Ooststr.
Ipomoea nil (L.) Roth
Ipomoea rubens Choisy
Ipomoea riparia G. Don
Ipomoea tiliacea (Willd.) Choisy
Ipomoea violacea L.
Ipomoea tuba (Schltdl.) G. Don

EBENACEAE

LABIATAE (LAMIACEAE)

PLUMBAGINACEAE

RUBIACEAE

Merremia cissoides (Lam.) Hallier f.
Diospyros inconstans Jacq.
Hyptis pectinata (L.) Poit.
Plumbago scandens L.
Chiococca alba (L.) Hitchc.
Coutarea hexandra (Jacq.) K. Schum.
Genipa americana L.
Randia brevipes Steyermark. (Britton 2684, syntype NY; Howard 10424 cited in Steyermark, 1971)
Spermacoce verticillata L.
Borreria verticillata (L.) G. Mey.

SAPOTACEAE

SCROPHULARIACEAE

SOLANACEAE

Warszewiczia coccinea (Vahl) Klotzsch
Sideroxylon obtusifolium (Roem. and Schult.) T. D. Penn.,
 subsp. *buxifolium* (Willd. ex Roem. and Schult.) T. D. Penn.

Bumelia buxifolia Willd. ex Roem. and Schult.

Capraria biflora L.

Lycium americanum Jacq.

Lycianthes carolinianum of Baker and Simmonds, not Walter.

Lycianthes tweedianum Griseb. var. *chrysocarpum* (Urb. and Ekman) C. L. Hitchc.

[*Nicotiana tabacum* L.] (David Tindall 2001)

Solanum asperum Rich.

Solanum bicolor Willd. ex Roem. and Schult.

Solanum erianthum G. Don

Solanum ierense Britton

Solanum lanceifolium Jacq.

	<i>Solanum pseudocapsicum</i> L. [<i>Solanum karstenii</i> Dunal [<i>Solanum seaforthianum</i> Andrews]
THEOPHRASTACEAE	<i>Jacquinia armillaris</i> Jacq. [<i>Jacquinia barbasco</i> Mez
VERBENACEAE	<i>Lantana camara</i> L. <i>Lantana lockhartii</i> G. Don ex Sweet <i>Petrea volubilis</i> L. [<i>Petrea arborea</i> Kunth [<i>Petrea kohautiana</i> C. Presl.
	<i>Priva lappulacea</i> (L.) Pers. <i>Stachytarpheta jamaicensis</i> (L.) Vahl (Britton, Freeman and Brown 2775)
Monocotyledons:	
AGAVACEAE	<i>Agave evadens</i> Trel. <i>Agave</i> sp. (Britton 519, K)
ARACEAE	[<i>Sansevieria hyacinthoides</i> (L.) Druce]
BROMELIACEAE	<i>Anthurium pentaphyllum</i> (Aubl.) G. Don (Britton, Freeman and Brown 2766, NY495334) <i>Aechmea aquilega</i> (Salisb.) Griseb. [<i>Gravisia aquilega</i> (Salisb.) Mez
COMMELINACEAE	<i>Bromelia chrysantha</i> Jacq. <i>Bromelia humilis</i> Jacq. <i>Pitcairnia integrifolia</i> Ker Gawl. (Aitken 287, US) <i>Tillandsia flexuosa</i> Sw. <i>Callisia repens</i> (Jacq.) L. <i>Commelinina erecta</i> L. <i>Gibasis geniculata</i> (Jacq.) Rohweder <i>Tripogandra serrulata</i> (Vahl) Handlos
CYMODOCEACEAE	<i>Halodule beaudettei</i> (den Hartog) den Hartog
CYPERACEAE	<i>Cyperus ligularis</i> L. <i>Fimbristylis cymosa</i> R. Br. <i>Fimbristylis spadicea</i> (L.) Vahl <i>Scleria lithosperma</i> (L.) Sw. <i>Dioscorea polygonoides</i> Humb. and Bonpl. ex Willd. <i>Dioscorea trifoliata</i> Kunth
DIOSCOREACEAE	<i>Cenchrus echinatus</i> L. <i>Chloris barbata</i> Sw. [<i>Chloris inflata</i> Link
GRAMINEAE (POACEAE)	<i>Dactyloctenium aegyptium</i> (L.) Willd. <i>Eleusine indica</i> (L.) Gaertn. <i>Lasiacis anomala</i> Hitchc. <i>Leptochloa scabra</i> Nees (Finlay, K) <i>Leptochloa virgata</i> (L.) P. Beauv. <i>Panicum maximum</i> Jacq. <i>Pappophorum pappiferum</i> (Lam.) Kuntze <i>Schizachyrium microstachyum</i> (Desv.) Roseng., B. R. Arill. and Izag. <i>Setaria setosa</i> (Sw.) P. Beauv. (Hitchcock 10059, BM) [<i>Chaetochloa setosa</i> (Sw.) Scribn. <i>Sporobolus jacquemontii</i> Kunth [<i>Sporobolus indicus</i> of Hitchcock and Chase, not (L.) R. Br.
HYDROCHARITACEAE	<i>Sporobolus virginicus</i> (L.) Kunth <i>Urochloa fasciculata</i> (Sw.) R. D. Webster [<i>Panicum fasciculatum</i> Sw. <i>Halophila decipiens</i> Ostenf. <i>Thalassia testudinum</i> Banks and Sol. ex K. D. Koenig
ORCHIDACEAE	<i>Brassavola cucullata</i> (L.) R. Br. <i>Catasetum macrocarpum</i> Rich. ex Kunth <i>Caulanthron bicornutum</i> (Hook.) Raf. <i>Cyrtopodium punctatum</i> (L.) Lindl. <i>Oeceoclades maculata</i> (Lindl.) Lindl. <i>Sarcoglottis neglecta</i> Christenson [<i>Spiranthes acaulis</i> of authors, not (Sm.) Cogn.
PALMAE (ARECACEAE)	<i>Coccothrinax barbadensis</i> (Lodd. ex Mart.) Becc. [<i>Cocos nucifera</i> L.]
POTAMOGETONACEAE	<i>Ruppia maritima</i> L.
SMILACACEAE	<i>Smilax cumanensis</i> Humb. and Bonpl. ex Willd.

ACKNOWLEDGEMENTS

The authors would like to thank Winston Johnson, Doreen Jodhan, Kim Roberts, Ian Ramjohn, Surindra Maharaj, Hans Boos, Jalaludin Khan and Fr. Anthony de Verteuil for their invaluable assistance during this study, Dr. Amoy Lum Kong of the Institute of Marine Affairs (IMA) for inviting us to do this study and providing transport to and from the island and last but not least, the curators of the herbarium and the library staff at the Natural History Museum, London, England for allowing access to the plant collections and literature.

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A Survey of Freshwater Macroinvertebrates on Antigua, West Indies

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ABSTRACT

A survey of macroinvertebrates inhabiting the freshwater habitats of Antigua was conducted during June 1996. Qualitative collections were made by sweeping a dip net through the water column and by hand examination of submerged aquatic plants and debris in freshwater environments across the island. In addition, water temperature was recorded at each site. These collections yielded at least 41 species, all of which are reported for the first time from Antigua. Dominant taxa collected included gastropods, odonates, hemipterans, and coleopterans. Generally this macroinvertebrate fauna is sparse, most likely due to the oceanic origin of Antigua, the lack of freshwater habitat diversity, and disturbances to freshwater environments across the island.

INTRODUCTION

Antigua is located in the Leeward Islands of the Lesser Antilles. It is a small oceanic island comprising approximately 280 square kilometers. The south-western portion of this island is volcanic in origin, dating back at least 24 million years (Nagle *et al.* 1976) and rises to 402 m at Boggy Peak. Land to the north and east was formed as ocean sediments were thrust upward and primarily consists of limestones, marl, and calcareous sandstones. There are no permanent streams and only a few small springs exist. Many small water storage ponds having surface areas of <5 hectares were excavated in the past. Today several larger reservoirs have been constructed to supply water for domestic and agricultural uses. Much aquatic vegetation grows in shallow waters of these ponds and reservoirs. There appear to be no permanent bodies of fresh water above 150 m in elevation.

A limited amount of information regarding the freshwater invertebrates of the Lesser Antilles and other small Caribbean islands is available. Biodiversity surveys have been conducted on some islands including Barbados (Bass 2003a), St. Vincent (Harrison and Rankin 1975, 1976a, 1976b), St. Lucia (McKillop and Harrison 1980), Nevis (Bass 2000), Grenada (Flint and Sykora 1993; Bass 2004), Tobago (Nieser and Alkins-Koo 1991; Bass 2003b), and Trinidad (Hynes 1971; Alkins *et al.* 1981; Alkins-Koo 1990; Nieser and Alkins-Koo 1991), but similar published investigations are generally lacking for Antigua. While some invertebrate groups in the region have been studied, such as decapod crustaceans (Chace and Hobbs 1969; Hart 1980), odonates (Donnelly 1970), and trichopterans (Flint 1968, 1996; Botosaneanu and Alkins-Koo 1993; Flint *et al.* 1999), many others have yet to be surveyed.

The objectives of this investigation include: 1) to determine the species of aquatic macroinvertebrates inhabiting freshwater environments of Antigua; 2) to note microhabitat preferences of each species; 3) to determine the relative abundance of each species; and 4) to compare the Antiguan macroinvertebrates to those of other small Caribbean islands.

MATERIALS AND METHODS

Sixteen sampling sites were established in various freshwater habitats across Antigua during June 1996 (Fig. 1). Water temperature was measured with a centigrade thermometer at each site immediately prior to collecting efforts. Several methods of collecting were employed to ensure as many species as possible were captured. Submerged debris, primarily decaying plant material, was carefully examined and inhabitants were collected using forceps. A dip net was swept through aquatic vegetation and the water column to

capture macroinvertebrates occupying those microhabitats. The microhabitat where each specimen occurred was noted. These collecting methods were similar to those used in studies on other islands so comparisons of results could be made (Bass 2000, 2003a, 2003b, 2003c, 2004). 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 and the taxonomic name to which they could be identified was used. Sorenson's index of similarity (1948) was used to compare my collections in Antigua with similar endeavors on other small Caribbean islands.

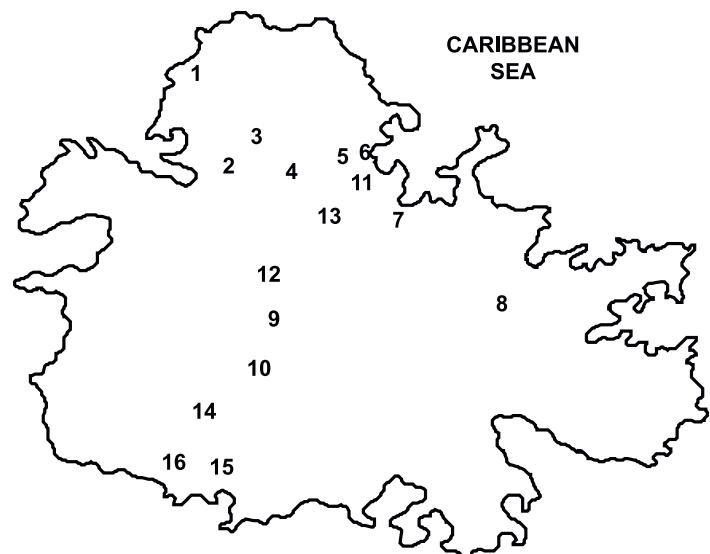


Fig. 1. Map indicating collecting sites in Antigua. Specific locations, dates, and approximate elevations of collections are listed below in Table 1.

RESULTS AND DISCUSSION

Water temperatures were warm, ranging from 27-32°C during the sampling period. Because Antigua is a relatively low-lying island, larger temperature differences due to changing elevations, such as those recorded on the more mountainous islands of St. Vincent (Harrison and Rankin 1975), St. Lucia (McKillop and Harrison 1980), Tobago (Bass 2003b), and Grenada (Bass 2004), were not observed.

A total of at least 41 species was collected from the freshwater habitats of Antigua (Table 1). This list is important because it represents the only collections of freshwater invertebrates currently known from Antigua. However, none of the species present was considered unexpected.

Oligochaeta

Only one species of oligochaeta was collected. *Limnodrilus udekemianus* was found in the muddy sediments of Cable and Wireless Pond. This eurytolerant species has been reported from similar microhabitats in Grenada (Bass 2004).

Gastropoda

Three species of snails were collected in freshwaters of Antigua. The introduced Asiatic snail, *Melanoides tuberculata*, and the native, air-breathing pond snail, *Physella cubensis*, are widespread on Caribbean islands (Bass 2003a, 2003b; Bass 2004). A third species, *Tropicorbis albicans*, was abundant across Antigua.

Cladocera

Simocephalus acutirostratus was found in large populations in two ponds near Old Road. Both ponds are shallow and contain high densities of aquatic vascular plants. Cladocerans often are planktonic and associate with submerged portions of vascular plants (Thorp and Covich 2001).

Ostracoda

A single species of ostracod was also collected from the two heavily vegetated ponds near Old Road. This species, *Chlamydotheca hummelinc*, occurred at high density and appeared to be epibiotic with the submerged portions of plants.

Amphipoda

The eurytolerant and widespread Holarctic amphipod, *Hyalella azteca*, was collected from submerged plant detritus in one small body of water. This species is abundant in ponds on other Caribbean islands (Bass 2003a, 2004), but seems to be generally lacking from those habitats in Antigua.

Decapoda

Several individuals of *Macrobrachium* were observed among roots and submerged debris beneath ledges in Fig Tree Creek. None was collected so a species determination could not be made.

Ephemeroptera

One genus of mayfly, *Callibaetis*, was collected from several locations on Antigua, typically on submerged decomposing leaves. These specimens were very immature and it was not possible to determine the exact species. Because all nymphs appear similar, they are to be assumed to belong to the same species.

Odonata

Eight species of odonates were collected. Of these, *Ischnura ramburii*, *Erythrodiplax umbrata*, and *Erythemis vesiculosa* were found at three or more sites. *Brachymesia furcata/herbida* was also found at more than one site but, due to the immaturity of the specimens collected, it was not possible to determine whether *B. furcata* or *B. herbida* was present. Only three of the sixteen sites lacked odonates. *I. ramburii* has been reported from freshwaters throughout the Caribbean (Harrison and Rankin 1976; Bass 2003b, 2003c, 2004).

Hemiptera

Hemipterans are one of the most common groups of insects in freshwaters of Caribbean islands (Bass 2003c). Eight species of hemipterans were found in these collections from Antigua. Although *Belostoma subspinosum* and *Mesovelia mulsanti* were the most common, all species, except for one, were found at more than one location. Only two sites lacked hemipterans. As observed on other

small Caribbean islands (Bass 2003c), populations of *M. mulsanti*, *Microvelia* sp., and *Pelocoris poeyi* possessed both winged and non-winged individuals. This loss of wings is a well-documented and widespread phenomenon observed among certain hemipterans occurring in isolated habitats (Schuh and Shlater 1995; Thorp and Covich 2001). It has been suggested an energy savings occurs if wings do not develop on individuals living in isolated habitats where suitable aquatic habitats are persistent (Roff 1990).

Coleoptera

Beetles are represented by 13 species and comprise the most diverse group of aquatic invertebrates in Antigua. This diversity is most likely due to the abundance of submerged aquatic vascular plants in ponds, a preferred microhabitat for many species of freshwater beetles. Of these, *Laccophilus subsignatus* and *Tropisternus lateralis* were the most frequently encountered. Coleopterans were absent at only one collecting site.

Diptera

Three taxa of freshwater dipterans were collected. The most common of these were larvae of the true midge, *Chironomus*. Members of this genus have hemoglobin in their blood that allows them to concentrate additional oxygen and occupy muddy sediments with low oxygen levels. *Chironomus* is widely distributed and its larvae have been reported from similar such habitats on other Caribbean islands (Harrison and Rankin 1976; Bass 2003a, 2003b). *Odontomyia* sp. and Tanyderidae were the two other dipteran larvae present, and both were uncommon on Antigua.

The number of macroinvertebrate species found in Antiguan freshwaters is less than half of that reported from Tobago (Bass 2003b), Grenada (Bass 2004), Barbados (Bass 2003a), and St. Vincent (Harrison and Rankin 1976b). Fewer species were expected because all four of those islands are larger than Antigua. In addition, Tobago, Grenada, and St. Vincent are mountainous and possess more aquatic microhabitats that allow more species to inhabit those islands.

It was interesting to note that trichopterans have not been found in Antigua although these aquatic insects are common on most other small Caribbean islands. As stated, Antigua is drier and has no permanently flowing water, a habitat preferred by many caddisflies species. This situation is similar to that occurring in Barbados where Flint (1993) reports only two species were present. Researchers have reported many more species are present on mountainous islands having permanent flowing waters, such as Tobago with 33 species (Flint 1996) and Grenada with 22 species (Flint and Sykora 1993; Flint *et al.* 1999; Botosaneanu 2002).

Similarity analysis indicated very little species overlap between Antigua and most of the other islands surveyed (Table 2). The highest similarity values were with Nevis (0.25) and St. Kitts (0.18). Both of these islands are relatively close to Antigua so it is not surprising that they show the greatest amount of faunal similarity. Although Barbados was much further away than most of the other islands, it had the third highest species similarity value (0.15). Again, this is most likely because the physical environments of Antigua and Barbados are somewhat alike. Most of the other islands to which Antigua is compared, except for the Caymans, are mountainous with very different physical environments resulting in different freshwater faunas (Bass 2003c). The limited species overlap between Antigua and the other islands included in this study makes it difficult to establish from where the Antiguan freshwater invertebrate fauna originated.

Much of Antigua has been impacted by both natural and

Table 1. List of freshwater macroinvertebrates, including collecting sites, life cycle stages present, relative occurrence, microhabitats, and proposed trophic relationships in Antigua during June 1996. Life cycle: A, adult; J, juvenile; L, larva; N, nymph. Occurrence: *** abundant, ** common, * uncommon.

Taxa	Collection Sites	Life Cycle	Occurrence	Microhabitat	Trophic Relationship ¹
Oligochaeta <i>Limnodrilus udekemianus</i>	3	A	*	Sediment	
Gastropoda <i>Tropicorbis albicans</i> <i>Melanoides tuberculata</i> <i>Physella cubensis</i>	2, 3, 4, 7, 9, 10, 13, 14, 15 4, 10, 12, 13, 14 4, 5, 9, 13, 14	J, A J, A J, A	*** ** **		
Cladocera <i>Simocephalus acutirostratus</i>	15, 16	J, A	**	Vascular hydrophyte	
Ostracoda <i>Chlamydotheca hummelinc</i>	15, 16	J, A	**	Vascular hydrophyte	
Amphipoda <i>Halella azteca</i>	1	A	*	Sediment	
Decapoda <i>Macrobrachium</i> sp.	14	A	*	Roots, Debris, Crevices	Predator
Baetidae <i>Callibaetis</i> sp.	5, 12, 13	N	*	Vascular hydrophyte	Collector
Odonata <i>Brachynesia furcata / herbida</i> <i>Ischnura ramburii</i> <i>Erythrodiplax umbrata</i> <i>Erythemis vesiculosa</i> <i>Lestes</i> sp. <i>Miathyria marcella / simplex</i> <i>Orthemis ferruginea</i> <i>Pantela flavescens</i>	7, 8 3, 4, 5, 7, 8, 9, 15, 16 5, 12, 15 4, 5, 10, 14 15 13 13 2, 3	N N N, A N N N N	* *** ** ** ** * * *	Sediment Vascular hydrophyte Vascular hydrophyte Sediment Vascular hydrophyte Vascular hydrophyte Sediment Sediment	Predator Predator Predator Predator Predator Predator Predator Predator
Hemiptera <i>Belostoma</i> sp. <i>Buenoa</i> sp. <i>Centrocoris nigripennis</i> <i>Hydrometra australis</i> <i>Limnogonus franciscanus</i> <i>Mesovelia mulsanti</i> <i>Microvelia</i> sp. <i>Pelocoris poeyi</i>	2, 10, 13, 14, 15, 16 12, 15, 16 15, 16 4 5, 11 3, 5, 8, 9, 12, 13, 16 13, 15 4, 7, 9, 12, 16	N, A N, A N N, A N, A N, A N, A N, A	** ** ** * ** *** ** **	Vascular hydrophyte Water column Water column Vascular hydrophyte Neuston Vascular hydrophyte Neuston Vascular hydrophyte	Predator Predator Predator Predator Predator Predator Predator Predator
Coleoptera <i>Berosus</i> sp. <i>Celina grossula</i> <i>Chrysomelidae</i> <i>Derallus rufid</i> <i>Enochrus pseuduchraceus</i> <i>Hydrophilus insularis</i> <i>Laccophilus subsignatus</i> <i>Mesonoterus</i> sp. <i>Pachydrus</i> sp. <i>Paracymus confusus</i> <i>Suphisellus</i> sp. <i>Thermonectus basilaris</i> <i>Tropisternus lateralis</i>	6, 9 2 15 2 1, 2, 14, 15 6, 8, 16 3, 5, 10, 12, 13, 15, 16 3 2 4, 5, 8, 10 2, 7, 16 12, 15, 16 4, 5, 6, 7, 8, 10, 12, 15, 16	A A A A A L, A L, A A A A A A L, A L, A	*	Vascular hydrophyte Vascular hydrophyte Vascular hydrophyte Sediment Sediment Sediment Vascular hydrophyte Vascular hydrophyte Vascular hydrophyte Sediment Vascular hydrophyte Sediment Vascular hydrophyte Vascular hydrophyte Sediment	Herbivore, collector, shredder Predator Herbivore, shredder Predator Predator Predator
Diptera <i>Chironomus</i> sp. <i>Odontomyia</i> sp. Tanyderidae ?	4, 5, 15, 16 1, 15 15	L, A L L	** * *	Sediment Vascular hydrophyte Sediment	Collector, shredder Collector

Trophic relationship¹ – Trophic relationships of insects taken from Merritt and Cummins (1996).

Collecting sites and approximate elevations: 1) Saline pool, Buccaneer Cove (2 m); 2) Woods Pond, Woods (15 m); 3) Cable and Wireless Pond, Woods (30 m); 4) Piggotts Creek, Piggotts (15 m); 5) Fitches Stream, Fitches (10 m); 6) Fitches Marsh, Fitches (7 m); 7) Blackmans Spring, Parham (5 m); 8) Collins Reservoir, Collins (12 m); 9) Fiennes Reservoir, Swetes (30 m); 10) Wallings Spring, Wallings (125 m); 11) Fitches Water Tank, Fitches (15 m); 12) Olivers Pond, Olivers (40 m); 13) Lightfoots Reservoir, Lightfoots (12 m); 14) Fig Tree Creek, Fig Tree Hill (12 m); 15) East Callaloo Pond, Old Road (5 m); 16) West Callaloo Pond, Old Road (5 m).

Table 2. Sorenson's Index of Similarity values comparing the freshwater macroinvertebrate fauna of Antigua to that of other small Caribbean islands, including approximate distances to those islands from Antigua and approximate island sizes. 0.00 = 0% common taxa and 1.00 = 100% common taxa.

Island	Approximate Distance (km)	Approximate Size (km ²)	Similarity Value
Montserrat	44	83	0.11
Nevis	70	93	0.25
St. Kitts	93	176	0.18
Saba	150	13	0.04
Dominica	154	751	0.08
St. Lucia	334	616	0.09
Barbados	466	430	0.15
Grenada	532	346	0.08
Tobago	642	300	0.08
Cayman Brac	1910	37	0.04
Little Cayman	1932	26	0.12
Grand Cayman	2028	197	0.05
Guanaja	2121	69	0.05

anthropomorphous factors. Most of the island has been settled and developed to some degree by humans. Many of the ponds on the island were constructed for water storage sites and subsequently colonized by aquatic life. Some ponds are surrounded by commercial and residential development resulting in sedimentation and pollution via runoff flowing into those ponds. Tropical storms and hurricanes periodically pass over Antigua and release large amounts of rainfall in short periods of time across the island.

Because Antigua is an oceanic island, its freshwater macroinvertebrate fauna had to colonize the island from elsewhere. These immigrants must have suitable dispersal mechanisms and be able to tolerate unfavorable conditions encountered while crossing ocean waters (Bass 2003c). No endemic freshwater invertebrates that may have evolved in isolation on Antigua have been discovered. However, as further studies are conducted in Antigua, additional species may be found and some of these might be unique to the island.

ACKNOWLEDGEMENTS

This research was conducted while the author was on sabbatical leave from the University of Central Oklahoma and serving as a Visiting Fulbright Professor and Research Fellow at the University of the West Indies. Kevel Lindsay and Lawrence Blackman assisted with some of the field work. The following individuals provided taxonomic assistance: M. J. Wetzel (Oligochaeta), G. T. Watters (Mollusca), C. J. Santos-Flores (Cladocera), L. D. Delorme (Ostracoda), M. Pescador (Ephemeroptera), R. W. Garrison (Odonata), J. T. Polhemus (Hemiptera), and P. J. Spangler (Coleoptera).

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Bioecological Studies on the Whiteflies (Hemiptera: Aleyrodidae) of Trinidad and Tobago

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ABSTRACT

Laboratory and field studies were carried out to elucidate the biology and ecology of indigenous species of *Aleurodicus* ((Hemiptera: Aleyrodidae) and other aleurodids in Trinidad and Tobago. Data are presented on the lifecycle of three commonly occurring whiteflies in Trinidad (*Aleurodicus cocois* (Curtis), *Aleurodicus pulvinatus* (Maskell) and *Aleurothrixus floccosus* (Maskell)) under constant temperature conditions in the laboratory. Males of all three species generally developed faster than females. *Aleurothrixus floccosus* developed faster than the two *Aleurodicus* spp. and oviposited the highest number of eggs per female. Egg hatch ranged from 85% in *A. floccosus* to 88% in *A. cocois*. Distinguishing features of the three species are described. During field surveys, several *Aleurodicus* species known to occur in Trinidad were encountered together with two undescribed aleurodicine species (*Aleurodicus* sp. and *Lecanoideus* sp.). One new country record (*Aleurotrachelus atratus* Hempel) and 13 new host plant records were also established. Contrary to expectations, the spiralling whitefly *Aleurodicus dispersus* Russell was not found either in Trinidad or Tobago. Whiteflies and their natural enemies were found throughout the year. A range of natural enemies appeared to keep whitefly populations in check. *Nephaspis* spp. were predominant among the predators, while *Encarsiella* spp. and *Encarsia* spp. were predominant among the parasitoids. Natural epizootics of the entomopathogenic fungus *Aschersonia aleyrodis* Webb were encountered only under persistent high humidity conditions.

Key words: Whitefly, Aleyrodidae, Aleurodicinae, Aleyrodinae, *Aleurodicus cocois*, *Aleurodicus pulvinatus*, *Aleurothrixus floccosus*, bioecology, Trinidad and Tobago.

INTRODUCTION

Many species belonging to the genus *Aleurodicus* (Hemiptera: Aleyrodidae: Aleurodicinae) are native to the New World tropics, occurring in Central and South America and the Caribbean. Several species in this genus have also become invasive, notably *Aleurodicus cocois* (Curtis) in Barbados (Cock 1985), *Aleurodicus dugesii* Cockerell in the United States (Zolnerowich and Rose 1996) and *Aleurodicus pulvinatus* (Maskell) in the Caribbean (Martin and Watson 1998). However, by far the most devastating is the spiralling whitefly, *Aleurodicus dispersus* Russell. This species was accidentally introduced to the Canary Islands in 1962 and to Hawaii in 1978 (Russell 1965; Paulson and Kumashiro 1985). Over the next two decades it spread widely to all the islands of the Pacific as well as to Asia, Australia and West Africa (Waterhouse and Norris 1989; Wijesekera and Kudagamage 1990; Kajita *et al.* 1991; Akinlosotu *et al.* 1993; Wen *et al.* 1994; Palaniswami *et al.* 1995; Alam *et al.* 1997; Lambkin 1999).

A considerable amount of literature exists on the biology of *Aleurodicus* spp., pertaining mostly to areas where *A. dispersus* has been introduced (Kumashiro *et al.* 1983; Waterhouse and Norris 1989; Wen *et al.* 1996; D'Almeida *et al.* 1998; Mani and Krishnamoorthy 2000). The present study was therefore undertaken to elucidate the biology of whitefly, particularly *Aleurodicus* spp. and their natural enemies in their native habitat in Trinidad since little is known beyond records of their presence on a few host plants (Mound and Halsey 1978). Even the presence of *A. dispersus* in Trinidad was debatable: this species was not reported from Trinidad in Mound and Halsey's (1978) catalogue of whitefly. However, natural enemies sent from Trinidad to Hawaii in 1979/80 (reportedly collected on *A. dispersus*) (Gordon 1982) were effective in controlling the whitefly not only in Hawaii, but also elsewhere where *A. dispersus* was accidentally introduced (Kumashiro *et al.* 1983; Waterhouse and Norris 1989; D'Almeida *et al.* 1998).

The study reported here formed part of a larger project, aimed at evaluating the predatory coccinellid, *Nephaspis bicolor* Gordon (Coleoptera: Coccinellidae), as a biological control agent

of Aleyrodidae, particularly *Aleurodicus* spp. (Lopez 2003; Lopez and Kairo 2003). One of the objectives of the study was to resolve the issue of whether *A. dispersus* was present in Trinidad or not. Three whitefly species consistently encountered during the surveys were later used for culturing, and studies on *N. bicolor*. These were *A. cocois*, *A. pulvinatus* (both subfamily Aleurodicinae) and *Aleurothrixus floccosus* (Maskell) (subfamily Aleyrodinae). The biology of the first two species has been little studied (Gondim and Sales 1981; Martin and Watson 1998). Although the woolly whitefly, *A. floccosus*, has been the subject of numerous studies, these have been almost exclusively on *Citrus* spp. hosts (Paulson and Beardsley 1986; Carvalho 1994). The opportunity was therefore taken to investigate the biology and ecology of these species. The field surveys aimed to establish the identity and host range of *Aleurodicus* spp. and other Aleyrodidae present in Trinidad and Tobago, and to obtain data on their population dynamics. Laboratory studies were aimed at elucidating the developmental and reproductive biology of *A. cocois*, *A. pulvinatus* and *A. floccosus*.

MATERIALS AND METHODS

Field studies

Trinidad and Tobago has two seasons: rainy season from June to December and dry season from January to May. The field surveys in Trinidad were begun in February 1996 and concluded in July 1997, thus encompassing two dry seasons (1996 and 1997) and one rainy season (1996). Surveys in Tobago were carried out in July and December 1996 and March and May 1997.

The areas surveyed in Trinidad were divided into eight zones for recording purposes (Fig. 1). Six areas were surveyed in Tobago, designated Zone 9. Zones 1, 3, 4 and 6, which had heavier infestations of *Aleurodicus* spp., were surveyed more regularly than the other zones.

At each survey location, potential host plants of *Aleurodicus* spp., namely guava (*Psidium guajava*), coconut (*Cocos nucifera*) and other palms, seagrape (*Coccoloba uvifera*), mango (*Mangifera indica*), citrus (*Citrus* spp.), cassava (*Manihot esculenta*), avocado

* deceased

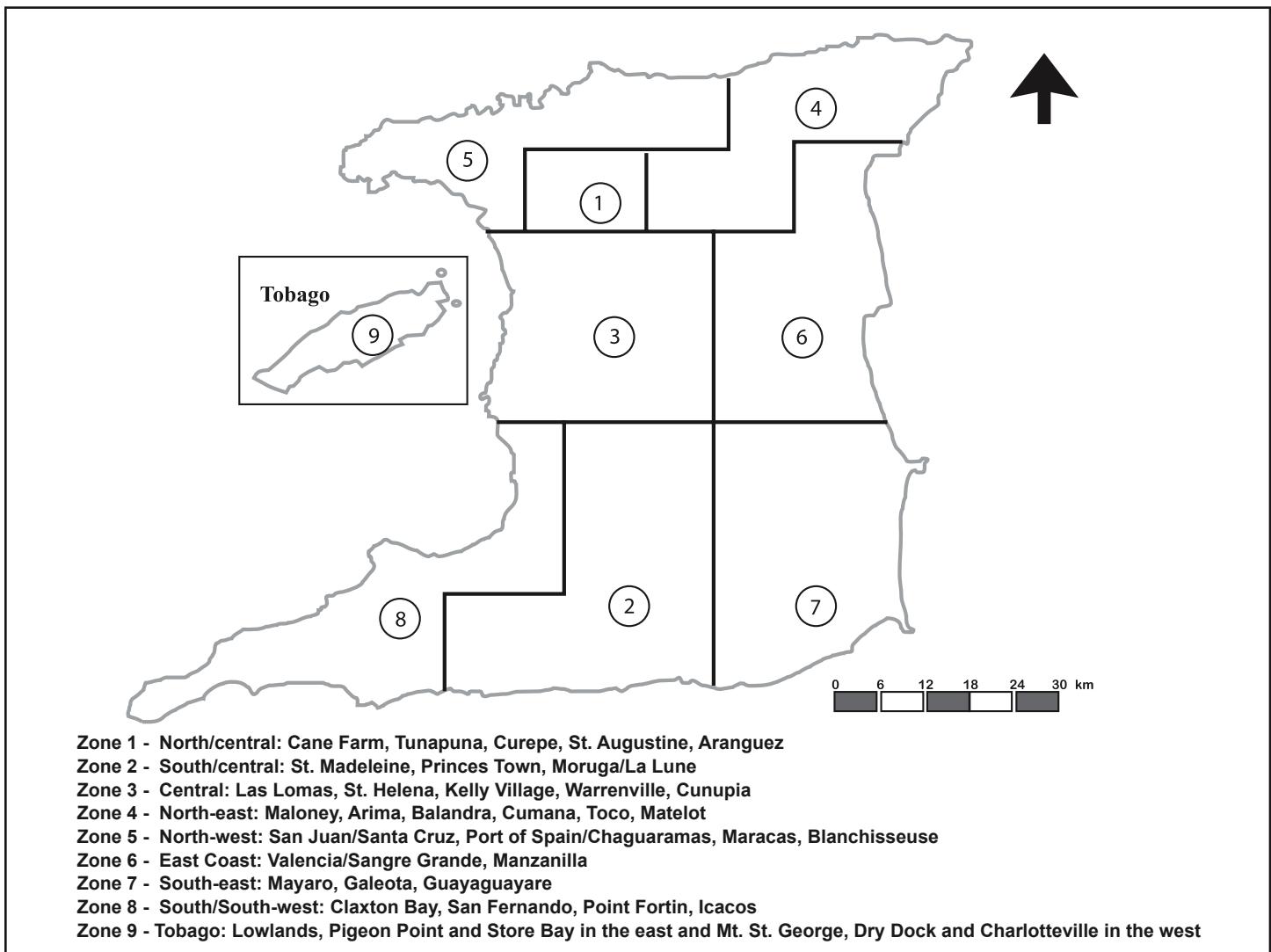


Fig. 1. Map of Trinidad and Tobago (inset) indicating areas surveyed under Zones 1-9.

(*Persea americana*), ficus (*Ficus benjamina*) and banana (*Musa* sp.), as well as surrounding trees/plants, were examined for the presence of whitefly and their natural enemies. When whitefly were encountered, an assessment of their population level was carried out using a qualitative scale as follows:

- 0 = no infestation;
- 1 = low infestation, <30% leaf surface/leaves infested;
- 2 = medium infestation, 30-70% leaf surface/leaves infested and
- 3 = high infestation, >70% leaf surface/leaves infested.

Associated natural enemies (*Nephaspis* spp. and other predators, parasitoids and microbial control agents) were also recorded. Wherever possible, samples of whitefly pupae were collected and brought to the laboratory for assessment. Coccinellid larvae/pupae in the sample were collected and reared for adults as well as for natural enemies (parasitoids/diseases). Percentage parasitism of whitefly was estimated by recording the number of parasitized pupae in batches of 100 randomly selected pupae. This was based on the colour of pupae, which are often covered in white wax and are black (pupa of parasitoid) or clear white (all contents fed upon) when parasitized but are pale greenish or yellow in unparasitized insects. At each location, 300-500 pupae were assessed and the average calculated to obtain percentage parasitism for that location on that sampling date.

Morphological characteristics of the live pupae (e.g. colour, size, shape of wax strands) of several whitefly species were recorded from a number of hosts. Field-collected leaf samples bearing the pupae were preserved in glass vials with 70% alcohol and sent for identification. Slides of pupae from several other hosts/locations were also prepared following the method outlined by Martin (1987). When authoritatively identified reference material was received, comparisons were made with the slide-mounted specimens to establish the identity of the whitefly.

Laboratory studies

Developmental biology

Four coconut plants, 40-50 cm tall each and with three open fronds, were used for the study on *A. cocois*. The fronds were examined carefully and all contaminants (e.g. scales, mealybugs and whitefly) removed. They were then wiped clean with a moist cloth and allowed to dry. The plants were placed on light frames in controlled-temperature laboratories (CT Rooms) maintained at $26\pm2^\circ\text{C}$. Each light frame consisted of a bank of 4-6 fluorescent lights and 2-4 incandescent bulbs suspended 20-30 cm above the cages. The lighting regime used was 12 h light and 12 h dark. Mated *A. cocois* adults were released on the middle leaf under sleeve cages for oviposition and were removed 24 h later. Egg size (length and

width) was measured for 30 randomly selected eggs. Observations were recorded daily on egg hatch. Once the eggs hatched and the crawlers had settled, 15-30 individuals were numbered on each plant and observed daily for change of instar, pupation and adult emergence. The size (length and width) of 30 randomly selected nymphs was measured immediately after change of instar and at pupation. The presence of moulted skin on the dorsal surface of the nymph indicated that the insect had changed instars overnight. This was recorded and the moulted skin was removed. The 4th instar was considered to have become a pupa when it stopped growing and retained a constant size over a 2-day period. By this time, the entire body usually became coated with a white powdery wax, and the wax patterns / strands that characterized each species also became distinct.

Four seagrape and guava plants were similarly prepared and used for studies on *A. pulvinatus* and *A. floccosus*, respectively. The plants, each 20-30 cm tall, were placed inside 40 cm x 40 cm x 40 cm mesh cages. All other experimental details and observations were the same as for *A. cocois* above.

Reproductive biology

Manipulation of whitefly adults with an aspirator often resulted

in high mortality. Therefore, to study the reproductive biology, five plants with leaves harbouring known numbers of pupae (approximately 15 per leaf) were individually isolated in sleeve cages prior to adult emergence. After emergence, the adults were allowed to remain on the same leaf and observed daily to record preoviposition period and mortality. Dead adults were carefully removed every day and their sex recorded. When all the adults were dead, the number of females per leaf was counted together with the number of eggs oviposited. Percent egg hatch was calculated based on the total number of eggs laid and total numbers hatched.

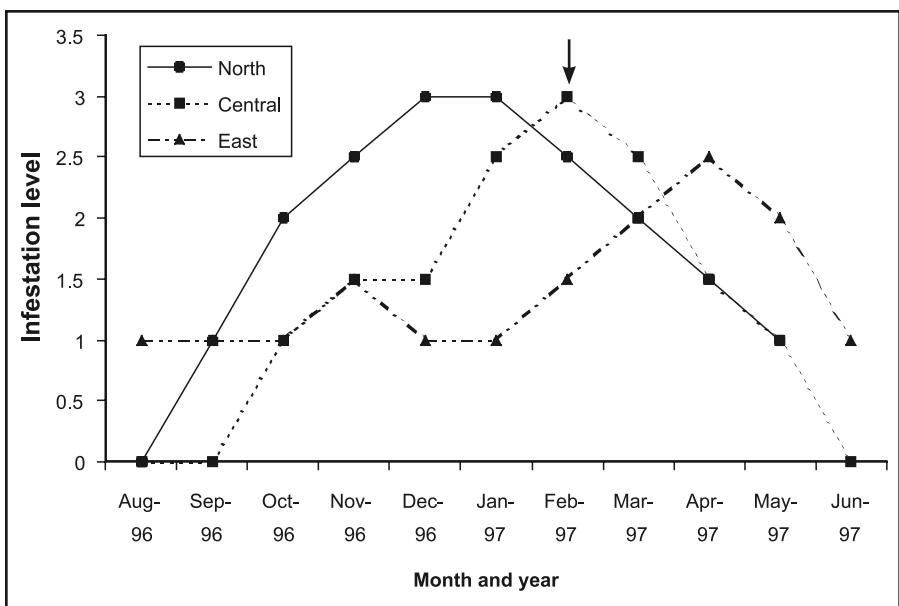
RESULTS

Field studies

Species of Aleyrodidae and their host plants recorded during field surveys are presented in Table 1. Several *Aleurodicus* spp. were encountered, but *A. dispersus* was not found on any of its known, common hosts such as guava, seagrapes and cassava. On guava, *A. maritimus* was the predominant species and *A. pulvinatus* was encountered occasionally, while *A. floccosus* was often found in association with both species. Seagrape was the main host plant for *A. pulvinatus*. Coconut and other palms, particularly the Manila palm, *Veitchia merrillii*, harboured mainly *A. cocois*, at least two

Table 1. Aleyrodidae and their host plants recorded in Trinidad and Tobago.

Species	Host plants	Remarks
<i>Aleurodicus capiangae</i> Bondar	Frangipani (<i>Plumeria</i> sp.) Plum (<i>Spondias</i> sp.)	New host record New host record
<i>Aleurodicus cocois</i> (Curtis)	Coconut (<i>Cocos nucifera</i>) Ficus (<i>Ficus benjamina</i>) Manila palm (<i>Veitchia merrillii</i>) Carat palm (<i>Sabal</i> spp.) Bamboo palm (<i>Chrysalidocarpus lutescens</i>)	New host record New host record New host record
<i>Aleurodicus maritimus</i> Hempel	Guava (<i>Psidium guajava</i>) Pigeon pea (<i>Cajanus cajan</i>)	
<i>Aleurodicus pulvinatus</i> (Maskell)	Coconut, Guava Seagrape (<i>Coccoloba uvifera</i>) Tropical almond (<i>Terminalia catappa</i>)	New host record New host record
<i>Aleurodicus trinidadensis</i> Quaintance and Baker	Coconut	
<i>Aleurodicus</i> sp.	Seagrape	Undescribed species
<i>Ceraleurodicus bakeri/moreirai</i> (Bondar)/Costa Lima	Coconut	New host record
<i>Lecanoideus mirabilis</i> (Cockerell)	Ficus Ashoka (<i>Polyalthia longifolia</i>)	New host record New host record
<i>Lecanoideus</i> sp.	Seagrape	Undescribed species
<i>Paraleyrodes urichii</i> Quaintance and Baker	Coconut	New host record
<i>Paraleyrodes</i> sp.	Coconut, Manila palm, Bamboo palm, Carat palm	
<i>Aleurothrixus floccosus</i> (Maskell)	Guava, Citrus (<i>Citrus</i> spp.) Pommecythere (<i>Spondias dulcis</i>)	New host record
<i>Aleurotrachelus atratus</i> Hempel	Coconut	New host and country record
<i>Aleurotrachelus trachoides</i> Back	Frangipani	New host record
<i>Aleurotrachelus</i> sp.	Coconut, Manila palm, Bamboo palm, Carat palm	
<i>Bemisia tabaci</i> biotype b	Pumpkin, Cabbage	



↓ = the first time that *Encarsiella noyesi* was encountered at this location.

Fig. 2. Infestation levels of *Aleurodicus cocois* on coconut at three locations in Central (Zone 3) and East Trinidad (Zone 6) and on Manila palm in North Trinidad (Zone 4).

species of *Paraleyrodes* (*Paraleyrodes* sp. and *P. urichii* Quaintance and Baker) and three species of *Aleurotrachelus* (*Aleurotrachelus* sp., *A. atratus* Bondar and *A. trachoides* Back). Several *Aleurodicus* species known to occur in Trinidad were recorded, together with two undescribed aleurodicine species. One new country record and several new host plant records were established (Table 1).

Whiteflies and their natural enemies were found throughout the year. Three factors, either alone or in conjunction with each other, appeared to play an important role in the observed population patterns of *Aleurodicus* spp. These were the phenology of host plants (populations on guava), local weather conditions (populations on coconut and seagrape) and the natural enemy complex (populations on all hosts / host plants). On guava, populations of *Aleurodicus* spp. and *A. floccosus* normally increased whenever there was new flush growth on the plants following periods of rainfall. During the dry season, however, new flush growth occurred only on trees that had a regular supply of water (e.g. near drains). Hence these species were encountered throughout the year at different locations. However, factors other than plant phenology were apparently more important in the case of *A. cocois* on coconut and other palms and *A. pulvinatus* on seagrape. During the rainy season, these species were present in low numbers even though the plants had new fronds and leaves. During dry periods, however, their populations increased very rapidly, indicating that lower rainfall and/or relative humidity favoured the development of these species.

Each generation of the whitefly took about one month for completion, and thus there were more than 12 overlapping generations annually. Peak populations occurred at different periods for different species e.g. populations of *A. cocois* and *A.*

pulvinatus on coconut and seagrape, respectively, remained low during the rainy season and peaked in the dry season. The influence of weather was particularly evident for *A. cocois* during the transition period between the rainy/dry season at two locations. Populations of this whitefly species in Central and North Trinidad began to increase in October / November 1996 when the rains declined and peaked around January / February 1997 (Fig. 2). On the other hand, persistent rains until January / February 1997 along the East Coast caused populations to remain low until March and then increase rapidly during April / May. At all locations, natural enemies caused a rapid decline in *A. cocois* populations within 4-6 weeks of the population peak, i.e. by April / May in Central and North Trinidad and by June in the East (Fig. 2). Population peaks of *A. maritimus*, *A. pulvinatus* and *A. floccosus* on guava, on the other hand, were related to the appearance of new flush growth, and peaked at different times on different trees (Fig. 3).

A range of natural enemies (mainly parasitoids and predators) accompanied even incipient whitefly populations. These appeared to be responsible for the rapid decrease or even annihilation of populations within a short period, often in just a few days to a few weeks. *Nephaspis* spp. were predominant among the predators and were encountered at most sites even when whitefly populations were low. The other predators (syrphids, chrysopids, spiders and ants) were more sporadic in distribution and numbers.

A total of fifteen species of parasitoids, including three hyperparasitoids, was recorded from various aleyrodid species and a summary based on Lopez and Kairo (2003) is provided in Table 2. Of these, one species each belonged to Platygasteridae (*Amitus*) and Eulophidae (*Entedononecrennus*), two to Encyrtidae (*Metaphycus*) and the remaining eight species to Aphelinidae (*Encarsiella*, *Encarsia*). Three species of the hyperparasitic genus *Signiphora* (*Signiphoridae*) were found at three locations; however, this group was not encountered in areas where high levels of whitefly

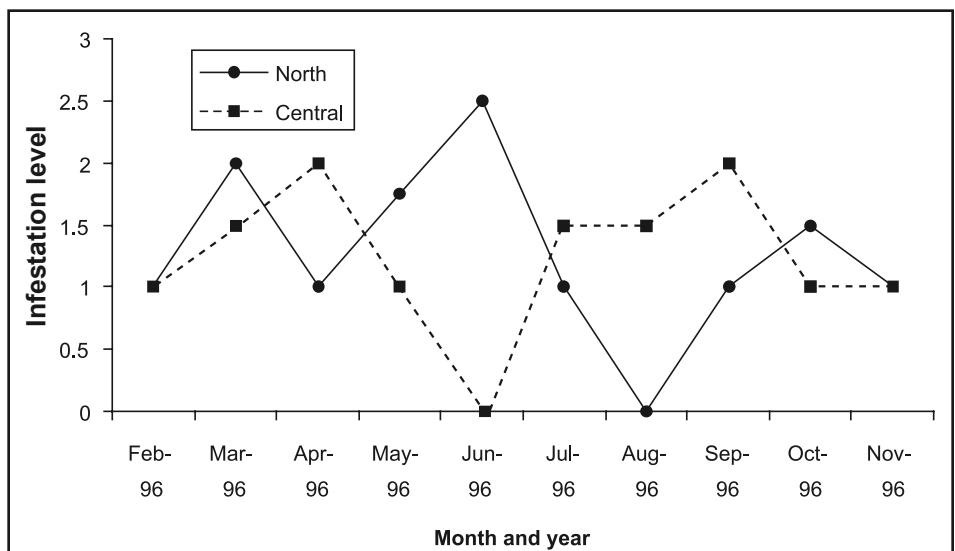


Fig. 3. Infestation levels of *Aleurodicus maritimus* on guava in North (Zone 1) and Central (Zone 3) Trinidad.

Table 2. Parasitoids of Aleyrodidae recorded in Trinidad and Tobago (based on Lopez and Kairo, 2003).

Species	Ex: host	Host plant
<i>Encarsia cubensis</i> Gahan	<i>Aleurothrixus floccosus</i>	Guava
<i>Encarsia guadeloupae</i> Viggiani	<i>Aleurodicus maritimus</i> <i>A. cocois</i> <i>A. pulvinatus</i> <i>Lecanoideus mirabilis</i>	Guava Manila palm Seagrape Ashoka tree
<i>Encarsia hispida</i> DeSantis	<i>Aleurothrixus floccosus</i>	Guava
<i>Encarsia</i> sp. nr. <i>meritoria</i> Gahan Sp. A.	<i>A. maritimus</i> <i>A. cocois</i> <i>Aleurothrixus floccosus</i>	Pigeon pea, Guava Manila palm <i>Spondias dulcis</i> , <i>Citrus</i> , Guava, <i>Pimenta</i> sp.
<i>Encarsia</i> sp. nr. <i>meritoria</i> Gahan Sp. B.	<i>A. cocois</i> + <i>Paraleyrodes</i> sp. <i>A. maritimus</i>	Coconut Guava
<i>Encarsia</i> sp. nr. <i>variegata</i> Howard	<i>Aleurothrixus floccosus</i>	Guava
<i>Encarsiella</i> sp. D.	<i>A. cocois</i> <i>A. maritimus</i> <i>A. pulvinatus</i>	Coconut Guava, Pigeon pea Seagrape
<i>Encarsiella noyesi</i> Hayat	<i>A. cocois</i> <i>A. maritimus</i> <i>A. pulvinatus</i>	Coconut Guava Seagrape
<i>Entedononecremnus</i> sp.	<i>Lecanoideus mirabilis</i>	Ficus
<i>Metaphycus</i> sp. 1	<i>Aleurotrachelus</i> sp.	Coconut
<i>Metaphycus</i> sp. 2	<i>A. cocois</i> <i>A. maritimus</i> , <i>A. floccosus</i>	Coconut Guava
<i>Amitus spiniferus</i> (Brèthes)	<i>A. floccosus</i>	Guava
<i>Signiphora xanthographa</i> Blanchard <i>Signiphora</i> spp.	<i>A. floccosus</i> ? <i>A. cocois</i> <i>Aleurotrachelus</i> sp.	Guava Coconut <i>Capsicum</i> sp.

populations were consistently encountered, and was apparently not very common.

Natural epizootics of the fungus *Aschersonia aleyrodis* Webb were encountered only on two occasions, the first on *A. floccosus* on guava and the second on *A. cocois* on coconut. Both were in high humidity conditions towards the middle of the rainy season and mostly older infestations on mature leaves were attacked. The fungus first appeared as small creamy white patches, later increasing in size considerably (often achieving 2-3 times the size of the whitefly host) and turning dark red to orange.

Laboratory studies

Developmental biology

The durations of development of the various life stages of *A. cocois*, *A. pulvinatus* and *A. floccosus* in the laboratory are presented in Table 3. For all three species, the egg stage had the longest duration followed by the pupal stage. The woolly whitefly *A. floccosus* developed slightly faster (28.3 days) than *A. cocois* (30.3) and *A. pulvinatus* (32.2 days). Males generally developed faster than females.

Sizes of the four instars and pupa are presented in Table 4. The first two instars were distinctly oval

in shape. The length to width ratios indicated a disproportionate increase in the width from the 1st to the 3rd instars in all three species, resulting in a more circular 3rd instar. All three species gradually regained their oval shape by the pupal stage. All stages of *A. floccosus* were smaller than the equivalent stages of the two *Aleurodicus* species. Eggs, 1st and 2nd instars of *A. cocois* and *A. pulvinatus* were very similar in size; however, during the later instars and the pupa stage, *A. cocois* became larger than *A. pulvinatus* (Table 4). For purposes of comparison, if pupal length and width of *A. cocois* is taken as 1 x 1, then the proportionate length and width of *A. pulvinatus* pupae were 0.87 x 1 and *A. floccosus* 0.56 x 0.58.

Among the several distinguishing morphological features of *A. cocois*, *A. pulvinatus* and *A. floccosus* were ovipositional patterns. Eggs of *A. cocois* were usually laid flat on the leaf surface, in perfect spirals particularly in the first generation on a new leaf. In later generations, this pattern tended to become irregular. The wax in the spirals was made up of thick strands, cut off into chain-like links. An extra layer

of wax was deposited around each egg, making it quite easy to distinguish these areas. Each spiral contained 12-26 eggs. In *A. pulvinatus*, first generation eggs on a new leaf were oviposited flat in a very orderly pattern in groups of 10-30 along the midrib and veins of the seagrape leaf. The eggs were placed very close to each other at almost equal intervals and covered with wax made up of characteristic thin strands, broken into fine chain-like links. Like

Table 3. Duration (in days) (mean±SE) of various life stages (males and females combined) of three whitefly species ($n = 4$ replications) in controlled-temperature ($26\pm2^\circ\text{C}$).

Life stage	<i>Aleurodicus cocois</i> on coconut	<i>Aleurodicus pulvinatus</i> on seagrape	<i>Aleurothrixus floccosus</i> on guava
Egg	10.5±0.09	10.7±0.27	9.6±0.10
1st instar	3.5±0.24	4.4±0.19	3.3±0.05
2nd instar	3.3±0.32	4.1±0.18	3.3±0.19
3rd instar	3.5±0.13	4.1±0.08	3.2±0.09
4th instar	3.9±0.14	2.3±0.04	3.4±0.15
Pupa	5.7±0.13	6.5±0.22	5.6±0.17
Total duration	30.3±0.14	32.2±0.15	28.3±0.07

Table 4. Sizes (in mm) (mean \pm SE) of various developmental stages of three whitefly species ($n = 30$ insects).

Life stage	<i>Aleurodicus cocois</i> on coconut	<i>Aleurodicus pulvinatus</i> on seagrape	<i>Aleurothrixus floccosus</i> on guava
Egg Length Width	0.35 \pm 0.003 0.13 \pm 0.002	0.34 \pm 0.003 0.12 \pm 0.001	0.21 \pm 0.002 0.08 \pm 0.001
1st instar length (l) width (w) ratio l/w	0.39 \pm 0.004 0.17 \pm 0.002 2.29	0.36 \pm 0.002 0.18 \pm 0.001 2.00	0.28 \pm 0.003 0.14 \pm 0.002 2.00
2nd instar length (l) width (w) ratio l/w	0.50 \pm 0.006 0.31 \pm 0.005 1.61	0.50 \pm 0.18 0.32 \pm 0.004 1.56	0.34 \pm 0.002 0.19 \pm 0.003 1.79
3rd instar length (l) width (w) ratio l/w	0.80 \pm 0.005 0.61 \pm 0.005 1.31	0.74 \pm 0.005 0.57 \pm 0.004 1.30	0.45 \pm 0.004 0.30 \pm 0.003 1.5
4th instar length (l) width (w) ratio l/w	1.17 \pm 0.006 0.75 \pm 0.008 1.56	1.03 \pm 0.007 0.72 \pm 0.008 1.43	0.68 \pm 0.006 0.41 \pm 0.006 1.66
Pupa Length (l) Width (w) Ratio l/w	1.30 \pm 0.005 0.80 \pm 0.006 1.63	1.13 \pm 0.004 0.80 \pm 0.005 1.41	0.73 \pm 0.006 0.46 \pm 0.005 1.59

A. cocois, the pattern of oviposition on the same leaf in the second generation was haphazard. Thus, nymphs often developed all over the leaf surface, either singly or in small groups. *Aleurothrixus floccosus* also oviposited eggs in a spiral, however, the eggs were usually laid upright or at a slanting angle. When a large number of adults oviposited on a leaf, the spirals often blended together and individual spirals were difficult to distinguish. A granular wax was deposited in an untidy, powdery mass all around the eggs, making them appear as flat, circular, grainy white areas.

The wax patterns on individual instars were also characteristic of each species. There was little or no wax on the first instar of all three species. Second-instar *A. floccosus* developed thin, thread-like wax strands that curled up into a woolly mass as development progressed. The pupae were often covered with a white woolly mat of wax that was several times thicker than the body of the insect (hence the common name ‘woolly whitefly’), together with deposits of clear honeydew. In older pupae, the honeydew deposits dried and turned brownish orange as they became contaminated with saprophytic fungi and other organisms. In *A. cocois* and *A. pulvinatus*, the wax pattern began to develop in the late 2nd / 3rd instar. More wax was deposited along the margins of the nymphs as development continued and single shiny filaments were often seen emerging from each compound pore. Fourth-instar *A. cocois* were particularly easy to distinguish since they had a thin layer of wax along the oval outline of the nymphs. When they pupated, the wax strands became thick and curled under, and appeared to radiate out along the margin of the pupa. In *A. pulvinatus*, on the other hand, the wax along the edges of the pupae was very thick. At times, eggs were laid so close together that the pupae in a sibling group appeared to be glued to each other and some of the faster developing nymphs crushed their slow developing siblings. In

addition, most older stages had two small patches, one on each side of the dorsal surface, which grew in size and became darker as the insect continued to develop. At pupation, the two dark patches were quite distinct and easily distinguished this species from others.

Reproductive biology

Data recorded on the reproductive parameters are summarized in Table 5. *Aleurothrixus floccosus* oviposited the highest number of eggs per female (89). Percentage egg hatch ranged from an average of 84.8% in *A. floccosus* to 88.4% in *A. cocois*.

DISCUSSION

Results from the laboratory studies on the life cycle of the whitefly conformed broadly to the previously recorded biology of *A. cocois* on several hosts and that of *A. floccosus* on *Citrus* spp. (Gondim and Sales 1981; Paulson and Beardsley 1986).

Field surveys revealed the presence of several previously recorded species from Trinidad and Tobago (Mound and Halsey 1978). Thirteen new host records, two new, undescribed species and one new country record were established. *Aleurodicus dispersus* was not found on any of its known hosts, confirming that this species does not occur on Trinidad and Tobago. Several other

Aleurodicus species were found, and it is likely that *Nephaspis indus* Gordon, reportedly collected on guava and coconut (Gordon 1982) was probably feeding on *A. maritimus* and/or *A. pulvinatus* and *A. cocois*, respectively. Of particular interest was the high level of adaptation exhibited by *A. cocois*, *Aleurotrachelus* spp. and *Paraleyrodes* spp. to the Manila palm, which is not native to Trinidad.

Under field conditions, a range of bioecological factors contributes to population levels of whitefly and their management. In several countries, humidity and/or temperature appeared to be important environmental parameters influencing the population dynamics of more than one species of *Aleurodicus*. In the Canary Islands, *A. dispersus* populations were distributed mostly along the coastal regions of Tenerife, Lanzarote and Gran Canaria (Manzano *et al.* 1995). Surveys for *Aleurodicus cocois anacardi* Carvalho, Arruda and Arruda (considered a food plant specific race of *A. cocois*) on cashew in the state of Ceara, Brazil, indicated that infestations were heaviest in areas with high humidity (coastal region) and decreased steadily as the relative humidity decreased with increasing distance from the coast (Melo and Cavalcante 1979). In Benin, D’Almeida *et al.* (1998) found that high humidity was conducive to the development of the immature stages of the exotic *A. dispersus*; however, heavy rainfall resulted in “wash down” of adults. Initially, very high populations of *A. dispersus* declined 80% in the three years following the presence of parasitoids. In India, where *A. dispersus* was introduced in the late 1990s, both temperature and humidity played a role in regulating the whitefly on guava in the absence of specific natural enemies (Mani and Krishnamoorthy 2000). However, in the presence of the parasitoid *E. guadeloupae* on banana, *A. dispersus* populations declined from 116.9 per 25 cm² leaf area in March 2000 to 1.1 per 25 cm² leaf area

Table 5. Reproductive biology of three whitefly species (mean \pm SE; n = 5 replications) in laboratory culture.

Parameter	<i>Aleurodicus cocois</i> on coconut	<i>Aleurodicus pulvinatus</i> on seagrape	<i>Aleurothrixus floccosus</i> on guava
Preoviposition period	2.8 \pm 0.37	2.6 \pm 0.25	1.6 \pm 0.25
Mean no. of eggs / female	35.7 \pm 4.33	41.5 \pm 5.07	89.1 \pm 7.61
Longevity of female	6.8 \pm 0.58	7.0 \pm 0.32	12.0 \pm 1.14
Mean no. of eggs / female / day	9.1 \pm 0.95	9.5 \pm 0.94	8.7 \pm 0.67
% egg hatch	88.4 \pm 2.65	87.7 \pm 3.10	84.8 \pm 2.52

in December 2001, with parasitism levels reaching 95.7% (Mani *et al.* 2004).

In Hawaii, natural enemies, rainfall and temperature were significant in regulating *A. dispersus* populations (Kumashiro *et al.* 1983). Studies on the performance of *N. indus* and *Encarsia ?haitiensis* Dozier in two distinct ecological zones revealed that the predator performed best in the lowlands where temperatures were higher and rainfall lower. It remained in high host density areas, with limited dispersal until host numbers declined. The parasitoid density, on the other hand, was high in both lowlands and highlands even when whitefly populations were low. This indicated either a lower food requirement or higher searching ability, allowing the parasitoid to thrive at lower host densities. It was concluded that the parasitoid was adaptable to both highland and lowland conditions (Kumashiro *et al.* 1983). In Costa Rica, a qualitative analysis of temperature and humidity indicated no effect on the population fluctuation of *A. dispersus* and its natural enemies; parasitoids, on the other hand, played an important role in regulating *A. dispersus* populations (Blanco-Metzler and Laprade 2000).

In the present study, whiteflies were recorded throughout the year in almost all areas of Trinidad and Tobago. Distribution patterns observed were either as a result of weather conditions (populations on coconut and seagrape), or phenology of the host plant (populations on guava). On all hosts, a range of natural enemies accompanied even incipient populations and appeared to be responsible for the rapid reduction or total annihilation of populations observed within a few weeks. This explained why the genus *Aleurodicus* has never been considered a serious or economically important problem despite occasional population outbreaks. It was noteworthy that many of the parasitic species (*Encarsia* spp. and *Encarsiella* spp.) attacked a range of aleyrodids belonging to both subfamilies (Aleyrodidae and Aleurodicinae). At least three hyperparasitic species were recorded, however, it seemed unlikely that they played a regulatory role in the overall ecology of the whitefly and their natural enemies since they were recorded infrequently and usually in areas where whitefly populations were low.

ACKNOWLEDGEMENTS

The contribution of the following persons in providing taxonomic identifications is gratefully acknowledged: Dr. Gillian Watson of Natural History Museum, London (NHM) – Aleyrodidae and Drs. Andrew Polaszek and John Noyes (NHM) – Aphelinidae and Encyrtidae, respectively; Drs. Robert Gordon (Northern Plains Entomology Research, Willow City, ND 58384, USA) and Roger

Booth (NHM) – *Nephaspis* spp. Voucher specimens were deposited at the NHM as follows: Whitefly – List numbers 2601 America (collection number 23456) and 7197 Europe (collection number 23511); Parasitoids – List number 2621 America (collection number 23542); *Nephaspis* spp. – List number 7146 Europe (collection number 23365).

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The Editorial Committee would like to thank the following individuals for their assistance in reviewing manuscripts for the 2005 issue of Living World:

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The Skipper Butterflies (Hesperiidae) of Trinidad.

Part 13, Hesperiinae, Genera Group K

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ABSTRACT

Details are given of the taxonomy, history, description, identification and biology of the 12 genera and 22 Trinidad and Tobago species of Genera Group K of the Hesperiidae (Lepidoptera). The female of *Enosis blotta* Evans is described for the first time. *Enosis achelous achelous* (Plötz) and *Damas clavus* (Herrich-Shäffer) are new records for Trinidad, and *Perichares deceptus fulvimargo* (Butler) is removed from the Trinidad list. *Moeros moeros* Möschler, known from Trinidad only from the holotype of its synonym *Argon casca* Bell, needs confirmation as a Trinidad species. One species, *E. blotta* Evans, has only been recorded from Trinidad and is a possible endemic. All 22 species are illustrated as adults, and the early stages are illustrated for *Ebusus ebusus ebusus* (Stoll), *Argon lota* (Hewitson), *Talides sergestus* (Cramer), *Talides sinois* (Hübner), *Telles arcalaus* (Stoll), *Cobalus virbius virbius* (Cramer), *Perichares philetis* (Gmelin), and *Orses cynisca* (Swainson). Three genera and three species also occur in Tobago; *Talides sergestus* was previously recorded from Tobago as *T. sinois*.

INTRODUCTION

Genera Group K (Evans 1955) is characterised by the broad “quadrantic” palpi, the inner side of the second segment longer than the side against the head, seen from above; the third segment usually a short, stout nipple. Antennae generally not constricted before the apiculus: nudum 10-16 segments, portion on club shorter than the long apiculus. Mid tibiae generally spined. Males generally with brands or a stigma UPF. Pronounced sexual dimorphism in some genera, especially *Carystus* and *Carystoides*.

Evans (1955) recognised 33 genera and 114 species of Group K from the Neotropical Region. Twelve genera and 22 species occur in Trinidad, while just three species of three different genera are recorded from Tobago. *Enosis achelous achelous* (Plötz) and *Damas clavus* (Herrich-Shäffer) are new records for Trinidad. *Talides sergestus* (Cramer) was previously erroneously recorded from Tobago as *T. sinois* (Hübner).

The known food plants of Group K are all Monocotyledons, a mixture of grasses, palms, and some Epigynae such as Musaceae and Heliconiaceae.

All specimens illustrated are in the author’s collection unless indicated otherwise. The following abbreviations are used to indicate other collections: AME – Allyn Museum of Entomology, Florida (now in the McGuire Center for Lepidoptera and Biodiversity, Gainesville, Florida); HEC – Hope Entomological Collections, Oxford University Museum; NHM – The Natural History Museum, (formerly British Museum (Natural History)); NMS – National Museums of Scotland (formerly Royal Scottish Museum); SAS – Mr. Scott Alston-Smith private collection; UWI – University of the West Indies, St. Augustine. In each figure of pinned adults, the UPS is shown on the left and the UNS on the right. The scale at the bottom of most figures of pinned specimens is in mm.

Enosis Mabille 1889

Four species of this genus are recorded from Trinidad; all seem quite uncommon. All are predominantly brown with reduced or no white hyaline spots, and the UNH plain brown with or without a few pale spots in spaces 2-6. Of those genera with this general appearance in Trinidad, *Enosis* are relatively large, and only superficially comparable to some species of *Cyneia*, *Eutychide* and *Euphyes*. Males of *Enosis* spp. in particular should be quite easy

to recognise because of the three part, curved, narrow stigma, from the base of space 2, below vein 2 and above vein 1. Females are most easily identified by associating them with their respective males, and that for *E. blotta* is described here for the first time. *Cyneia* (Group L) has a brand on vein 1 only; *Eutychide* (Group J) is larger, with more extensive white hyaline markings, and has a V-shaped brand at the base of space 2 and long brands under vein 2 and over vein 1; *Euphyes* (Group M) males lack the white hyaline spots altogether, and have a broad, straight brand from vein 3 to vein 1, interrupted at vein 2.

Of the four Trinidad species of *Enosis*, *E. achelous achelous* is most readily distinguished because it has no white hyaline markings F or spots UNH, and the UNS of the abdomen is pale. Its relatively large size, together with the strongly pointed F in the male should distinguish it from other plain brown species in Trinidad. *Enosis angularis* (Möschler) can be distinguished by the relatively truncate F, more rounded termen and broader wings. *Enosis blotta* Evans and *E. immaculata demon* Evans are rather similar: the males both have the F pointed as in *E. achelous*, and both have white hyaline markings in spaces 3, 6 and 7 F, and variable spotting UNH. *Enosis blotta*, however, has a dense, dark hair tuft in space 1B UPH, and a small yellow streak in space 1C UNH, neither character appearing in *E. immaculata*.

S. Alston-Smith (pers. comm.) considers all members of the genus to normally fly very close to the ground, so that they are easily overlooked. He suggests this behaviour may be associated with the use of short grasses as food plants.

196. K4/6 *Enosis blotta* Evans 1955

Figs. 1-2.

This species has only been recorded from Trinidad, and may be endemic. Evans (1955) described it from Trinidad on the basis of two males in the NHM, both collected at St. Ann’s by A. Hall, the type i-iii.1932, and the other xi-xii.1931 (Evans (1955) gives the type data as St. Ann, iii.1932). There is another male *E. blotta* in A. Hall’s collection in the Booth Museum taken in Arima District, i-iii.1932, labeled as *Metiscus atheas* (see discussion under next species). There are two more of A. Hall’s specimens of this species in W. J. Kaye’s collection in AME: a male from Maupertuis, 1939, and a male from St. Ann’s, i-iii.1932. The female has not hitherto been recorded.

Male UPS brown with a small, rounded white hyaline spot near the base of space 3, dots in spaces 6 and 7 (may be reduced to a trace), and sometimes a trace in 8. The type also has a small upper spot in space 2, which extends across space 2 UNF. UPH, a strong, dark brown hair-tuft along vein 1B covers much of space 1B to 3/4. UNH with a slight purple wash; dots in spaces 2 and 3, and weaker dots in spaces 5 and 6; a small yellow streak in space 1C close to vein 1B. The cilia H and space 2 F are paler than the ground colour. F male 17 mm.

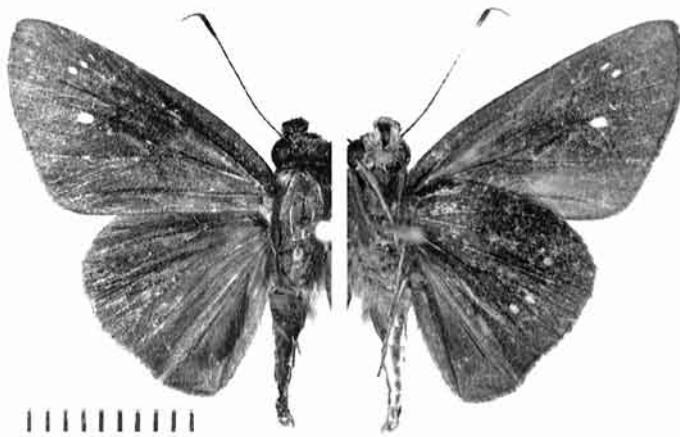


Fig. 1. *Enosis blotta* male, Morne Catharine, 12.ii.1980.

Female similar to male, but F less produced, and F a white hyaline spot in space 2 and a dot above vein 1 in line; UNF the distal half of space 1B pale. F female 16 mm.



Fig. 2. *Enosis blotta* female, Parrylands, 10.iii.1980.

This is an occasional species in Trinidad. Records of captures from Morne Catharine, Maracas Valley, Manzanilla Cocal, Maupertuis (A. Hall), Parrylands and Chatham (SAS) give no clear pattern of distribution. Six out of my seven records, and three of Hall's four specimens, were captured during the dry season (January – April), suggesting this species may be relatively more common then.

Life history and food plants apparently unknown.

197. K4/8 *Enosis immaculata demon* Evans 1955

Figs. 3-4.

Evans (1955) treats two subspecies: *immaculata* Hewitson, described from Colombia, and found from Mexico to Peru, and *demon* Evans, described from the Amazon, and found in Trinidad,

the Guyanas and at the mouth of the Amazon.

Kaye (1921) records *Metiscus atheas* Godman from Trinidad on the basis of a G. E. Tryhane specimen taken in St. Ann's Valley and at that time in the H. J. Adams collection. Evans (1955) treats *atheas* as a synonym of *Enosis achelous* (see next species). In Cock (1982b), I assumed that this record of *E. atheas* represented a misidentification for *E. immaculata demon*, which was undescribed when Kaye wrote. The Adams collection is now part of the NHM collection, and this includes a male *E. immaculata demon* from St. Anne's Valley [sic!]. I conclude that this is most probably the G. E. Tryhane specimen on the basis of which Kaye misidentified this species from Trinidad. However, there is a specimen of *E. blotta* in coll. A. Hall (Booth Museum) labelled *M. atheas*, so there was confusion over this genus amongst Trinidad collectors at that time.

Male as *E. blotta* except the hair tuft is much reduced and paler, and there is no yellow streak in space 1C UNH. F male 17-18 mm. I have not seen females from Trinidad, but illustrate one from Brazil (coll. NHM); it is plain brown with white hyaline spots.

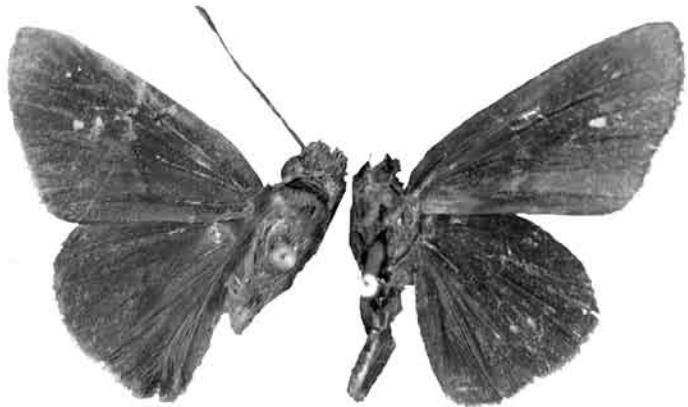


Fig. 3. *Enosis immaculata demon* male. Left UPS, St. Ann's Valley (specimen in NHM; note that the wings are not lying flat, and therefore look foreshortened); right UNS, Trinidad (specimen in NHM).



Fig. 4. *Enosis immaculata demon* female, Amazonas, Brazil (specimens in NHM).

There are two more males of this species in the NHM (Fig. 3): St. Ann's (i.1936 A. Hall) and one from the Saunders collection just labeled Trinidad. I have not taken this species, and the female seems not to have been captured from the island. I conclude it is an uncommon species, perhaps restricted to the north-west of the

island.

Moss (1949) does not include this species, but there is reared material of his in the NHM. The cast L5 head capsule is oval, narrower dorsally; it is covered with white waxy powder, but appears to be brown, paler adjacent to epicranial suture. The emerged pupa is pale translucent brown; the frontal spike is a small nub, bent downwards. The pupal shelter is formed in what appears to be a palm leaflet. There is similar material in AME from Ecuador (No. CH-18 A.C. Allyn): the emerged pupa is transparent, with the frontal spike a small nub, and the proboscis sheath not reaching the cremaster; the cast L5 head capsule is light brown, with a darker lateral stripe, the posterior margin narrowly dark, the clypeal sutures darker, and a narrow line down the centre of the clypeus.

197a. *Enosis achelous achelous* (Plötz 1882)

Fig. 5.

This species occurs from Mexico to Ecuador (TL Chiriquí, Panama). Evans (1955) lists *atheas* Godman (TL Mexico) as a synonym. This is a new island record for Trinidad, based on a male captured by S. Alston-Smith on Morne Catharine, iii.1986 (Fig. 5), a photo of which I compared with the NHM collection. S. Alston-Smith (pers. comm.) has subsequently collected this species from Bush Bush (male x.1999) and Chatham (male iv. 2002).

Wings plain brown UPS and UNS; costa and distal half UNF and all UNH with a ferruginous tint; abdomen UNS pale, with a brown central line. Evans (1955) notes that there may be spots in spaces 3 and 6 UNF and space 3 UNH, but these are not apparent in the single Trinidad male that I have examined. Some female specimens in the NHM also have a larger spot in space 2 F.



Fig. 5. *Enosis achelous achelous* male, Morne Catharine, iii.1986, S. Alston-Smith (specimen in SAS).

Life history and food plants apparently unknown.

198. K4/10 *Enosis angularis* (Möschler 1876)

Figs. 6-7.

Evans treated *angularis* as having two subspecies, *angularis* Möschler described from Suriname and reported from the Guyanas, Brazil, Peru and Bolivia, and *infuscata* Plötz described from Brazil, but occurring in Costa Rica, Venezuela and Ecuador (Evans 1955). However, Mielke (2004) treats *infuscata* as a synonym of *Papias subcostulata* (Herrick-Schäffer), and therefore *E. angularis* is monotypic.

Kaye (1940) records a specimen which he captured at Maracas, 24.xi.1920, as *Papias infuscata* (Plötz), which as noted above Evans (1955) treated as a second subspecies of *E. angularis*. There are no Trinidad specimens in the NHM. I have not located Kaye's specimen and there are no specimens of *E. angularis* from Kaye's collection in AME, so his specimen could well refer to another species.

Male UPS and UNS brown; F a small round white hyaline spot in space 3 and the trace of a dot in space 6; margin UNH slightly paler. Female similar, but with a narrow spot in space 2 parallel to the cell, and a very small spot in space 3 UNH. F male 16.5 mm, female 17 mm.

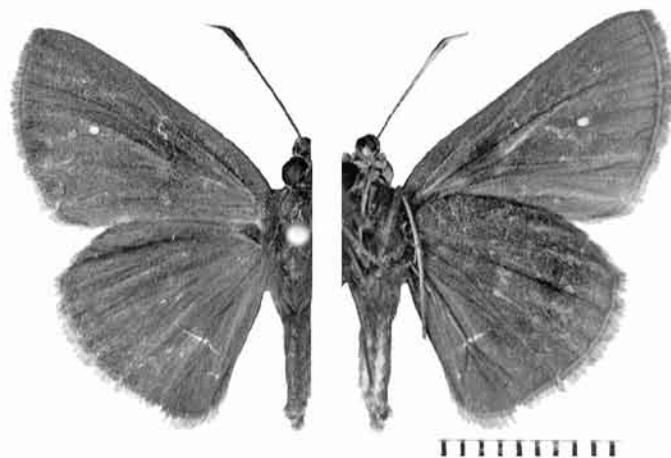


Fig. 6. *Enosis angularis* male, Nariva Swamp, milestone 46 1/4 track, 5.ii.1980.

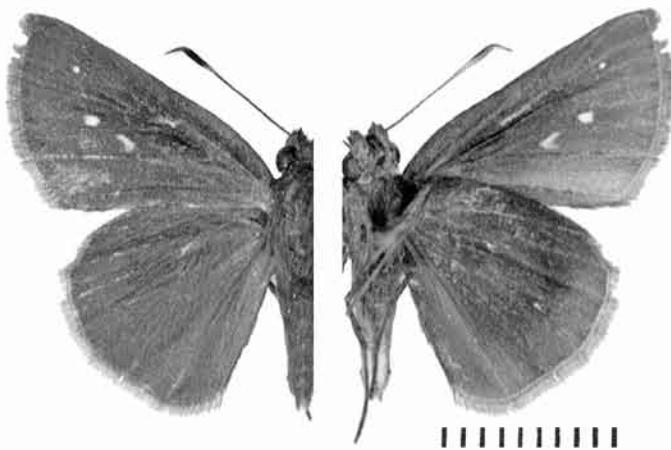


Fig. 7. *Enosis angularis* female, Las Lomas, Spanish Farm, 23.iii.1980.

This is an occasional species in Trinidad. The places of capture (Maracas, Nariva Swamp, Las Lomas, Palmiste) suggest a lowland distribution, and the months of capture (February – May) suggest a dry season flight period.

Janzen and Hallwachs (2001) have reared this species regularly from *Oryza latifolia* (Poaceae). They illustrate a yellowish larva; narrow dark dorsal plate on T1; rounded triangular head, indent at the vertex, shiny and rugose, brown with the lateral margins dark brown. The pupa is light brown, the spiracle T1 brown, and with a distinctive, short, dark, blunt, downward-pointed frontal spike. The life history and food plants have not been recorded from

Trinidad.

199. K6 *Ebusus ebusus ebusus* (Stoll 1780)

Figs. 8-10.

This distinctive species is the only member of its genus; it was described from Suriname, and occurs from Trinidad south to Peru and Bolivia (Evans 1955). Miller (1985) reviewed the genus and described a new subspecies from Mexico.

This species was first recorded from Trinidad by Crowfoot (1893) as *Entheus ebusus*. Kaye (1921) adds a record from Morne Diablo, 4.i.1916 by Sir Norman Lamont, treating the species as *Phanus ebusus*. In Kaye (1940), he treats it as *Carystus ebusus* and adds records from Tabaquite (14.i.1921, W. J. Kaye) and Fondes Amandes (male 17.v.1922, F. W. Jackson); these specimens are in Kaye's collection in AME, but the former is dated 18.i.1921 and the latter 17.iii.1922. Evans (1955) resolved the problem of the generic placement of this species by erecting the new genus *Ebusus* specifically for this distinctive species.

This large species, with extensive white markings UPH and UNH, can be mistaken for no other Trinidad skipper. As shown, the white markings are more extensive in the female. F male 20 mm, female 22 mm. Illustration in Lewis (1973, Plate 82.39, UNS).

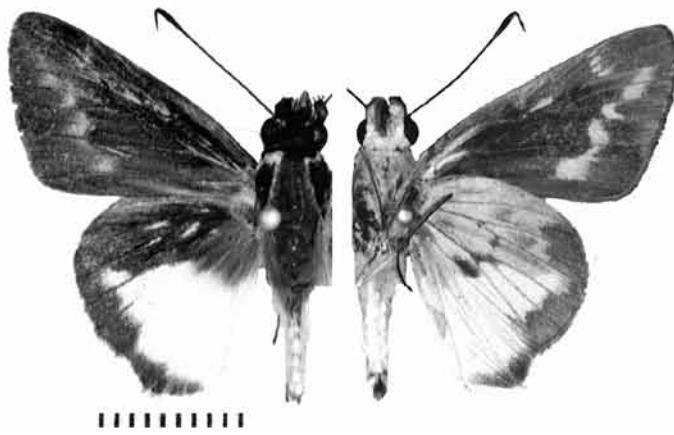


Fig. 8. *Ebusus ebusus ebusus* male, Parrylands, 16.x.1980 in cop.

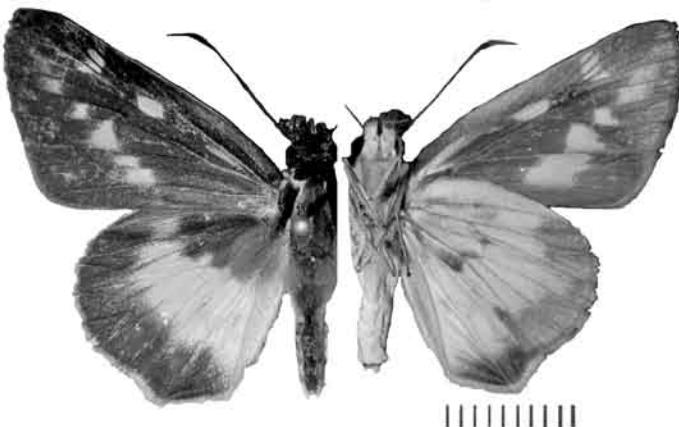


Fig. 9. *Ebusus ebusus ebusus* female, Parrylands, 16.x.1980 in cop.

This is not a common species, but probably collected disproportionately because of its large size and distinctive

colouring. In addition to the published records above from Morne Diablo, Tabaquite and Fondes Amandes, I have scattered records from Moreau, Parrylands, Palo Seco - Siparia Road and Rio Claro in the south, Sangre Grande and Tabaquite in central Trinidad, and Arima District, Fondes Amandes (200 ft.), "N. Hills", "Northern Mountains", Port of Spain and St. George's in the north. These records suggest this is a lowland forest species.

Moss (1949) records this species from assahy and pachiúba palms. The former is probably the species referred to as açaí, i.e. *Euterpe oleracea*, while the latter is *Socratea exorrhiza* (Henderson *et al.* 1995). *Euterpe oleracea*, known locally as manac is a likely food plant in Trinidad, but although known from the adjacent mainland, *S. exorrhiza* is not a Trinidad species (Henderson *et al.* 1995; Comeau *et al.* 2003). Moss's illustration of the larval head shows a dark ground colour with the clypeus and three streaks on each epicranium pale. A cast L5 head capsule in the NHM shows that the posterior portion of the head is dark, with a pale sub-dorsal sub-marginal line; the epicranial suture is narrowly dark, and the epicranium has pale sub-dorsal and lateral areas; the lower part of the head is covered with white waxy powder (hence only two of the three pale lines in Moss's plate are evident). The emerged pupa is transparent; the long frontal spike is curved upwards in a semi-circle; the proboscis sheath extends up to 10 mm beyond the cremaster. The pupa and pupal shelter are more or less devoid of white waxy powder.



Fig. 10. *Ebusus ebusus ebusus* ?L5, Parrylands, larva on wild palm, 20.i.1988.

I found a larva of this species on an unidentified palm in Parrylands, i.1988, in the same area that I caught three specimens in 1980; I photographed it (Fig. 10), and S. Alston-Smith subsequently reared it through. S. Alston-Smith (pers. comm.) has since then reared this species from picmoc (*Bactris major*) but I think the original larva was from a different palm.

200. K8 *Argon lota* (Hewitson 1877)

Figs. 11-14.

Evans (1955) described the genus *Argon*, for this species. For many years this species has been known as *Argon argus* (Möschler) (TL Colombia) (e.g. Evans 1955; Cock 1982b). Mielke and Casagrande (2002) examined the type of *lota* Hewitson (no locality data; in the Staudinger collection now in the Humboldt Museum, Berlin) and found it to be a female of the same species. Since Hewitson's name has precedence by one year, it must now be used for this species. Evans (1955) records specimens in the

NHM ranging from Argentina, north to Honduras, and it has been reported as far north as the state of Nayarit, Mexico (Llorente *et al.* 2004).

Kaye (1921 addenda) records two specimens taken by Sir N. Lamont on 17.i and 2.ii.1921 at Palmiste; both specimens are in NMS.

Sexes similar. UPF brown with white lower spot in 1B, white hyaline spots in 2, 3, 6, and sometimes 7; a lower and usually an upper cell spot. UNF apical area violet-grey with submarginal brown spots in spaces 4 and 5, and subapical brown spots in 6-8 around the white hyaline spots when present. UPH brown; UNH violet-grey with pale-edged brown spots in 2, 3 (normally with white pupil), across 4-5 displaced basally, 6 and near upper end cell. The arrangement and colouring of the spots UNH is distinctive in the Trinidad fauna. F male 18 mm, female 19 mm. Illustration in Lewis (1973, Plate 80.35 UNS).

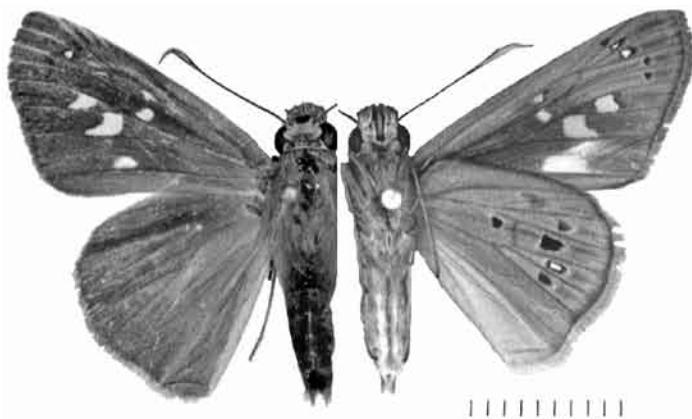


Fig. 11. *Argon lota* female. Left UPS, Curepe, ii.1979; right UNS Point Gourde, larva on coconut, 26.ii.1994, MJWC ref. 94/12.



Fig. 12. *Argon lota* adult female, St. Benedict's, larva on ornamental palm, ?*Chrysalidocarpus areca*, MJWC ref. 93/16B.

This is a widespread, occasional species, which could turn up almost anywhere in Trinidad, but is perhaps more likely to be found in lowland, disturbed habitats.

Moss (1949) reared this species from assahy palm (*Euterpe oleracea*), but gives no details; his preserved early stages (L5 head

capsule, pupae) match those described below. Janzen and Hallwachs (2001) have reared it from *Acrocomia aculeata*, and occasionally from *Bactris guineensis*.

I have reared this species from larvae on coconut (Caura Valley, MJWC ref. 81/23C; Pointe Gourde, MJWC ref. 94/12) and on an ornamental palm (St. Benedict's, MJWC ref. 93/16). The following is a composite of my notes from these rearings.

Pupa 25 mm; slender and elongate; frontal spike of 2.5 - 3 mm, sharply upturned at tip; proboscis sheath extends 2 mm beyond cremaster; light green with a yellow-green dorsal line; faint double white dorsal stripes become apparent on the thorax and abdomen as the pupa develops. No white waxy powder. Pupation in my rearing containers was always off the food plant, raising the possibility that this species does not pupate on the host plant.

The larval shelter is a tube made from a leaflet by pulling the edges together downwards. L5 34 mm; head rounded, about 3 mm high, by 2.5 mm wide towards base; very pale brown covered with white waxy powder, which may mask a paler patch on each side of the face. T1 concolorous with body. Body greenish white; dorsal line paler; loose white waxy powder strongest laterally and in posterior half, but whole body and head covered by the time it is mature; anal plate shield-shaped, with a fringe of long white setae. Legs concolorous. In the mature larva, wax glands develop ventro-laterally on A5-A6.

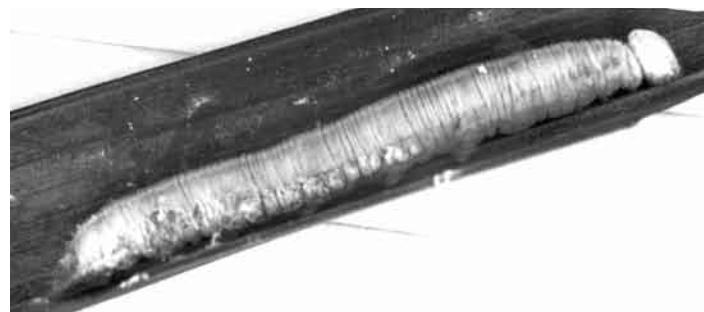


Fig. 13. *Argon lota* L5, St. Benedict's, larva on ornamental palm, ?*Chrysalidocarpus areca*, MJWC ref. 95/16.



Fig. 14. *Argon lota* L5, detail of head, as Fig. 13.

The head of the newly moulted L4 is light brown with a darker line down the face; subsequently covered with white waxy powder. Note that when newly moulted, the L4 has no white waxy powder, and this is probably true of all instars, the powder being produced anew each instar. L3 head brown, otherwise similar to later instars.

Moss's material in the NHM includes a parasitised pupa and an unidentified pinned ichneumonid.

201. K21 *Moeros moeros* (Möschler 1877)

Fig. 15.

Evans (1955) established the genus *Moeros* for the single species *moeros* Möschler, described from Suriname, and occurring in the Guyanas, Brazil and Bolivia as a rare species. *Argon casca* Bell was described from a Trinidad specimen (Bell 1959), but Mielke (2004) treats it as a synonym of *M. moeros*. As yet, the type of *casca* remains the only known specimen from Trinidad, so confirmation of this as a Trinidad species is desirable.

Male, based on photos of the type of *casca*, Bell (1959) and Evans (1955). UPF brown; apex broadly shining grey according to Evans (1955), but not Bell (1959); lower white spot in space 1B, white hyaline spots in spaces 2 (across width of space, elongated towards margin at lower corner), 3 (in line with spots in 1B and 2), 6-9 (that in space 6 displaced outwards), and a double cell spot, the upper displaced towards the apex, so that the cell spots and the spot in space 1B are in line. UNF repeats UPF markings but the spot in 1B is larger, apex shining violet-grey, and Evans (1955) notes dark spots in spaces 4 and 5, which are not present in the type of *casca*. UPH brown, with end cell darker; margin distinctly sinuate; cilia white. UNH brown with a slight violet suffusion; end of cell spot more pronounced, and although Bell (1959) doesn't mention it, the veins appear darker in the type of *casca*; Evans (1955) notes a small dark spot before end cell and on disc in spaces 2, 3, 4, 5, one or all of which may be absent. Abdomen below whitish with dark central line. F male 22 mm. Illustration in Lewis (1973, as *Moeris moeris*, Plate 83.50, UNS).

Female, based on Evans (1955). Similar to male, but UPF apex not broadly shining grey; spot in space 1B UNF larger; UNH greenish.



Fig. 15. *Argon casca* male UNS, holotype. Cascade Mountain Road, 12.iii.1933 (A. S. Pinkus) (specimen in American Museum of Natural History).

The large size (comparable to female *E. ebusus ebusus*), and arrangement of spots UPF – reminiscent of some females of *Carystus* spp. – should make this species easy to identify in Trinidad. The type of *casca* is labelled “Cascade Mountain Road, St. Anns, Trinidad” – B.W.I., 12.iii.1933, A. S. Pinkus). This species is a puzzle in Trinidad – apparently still only known from the original capture from a well-collected site, why has this distinctive large species never been caught again?

Moss (1949) reared this species from tucumá and murumurú palms. These names are applied to several *Asterocaryum* spp. including *A. aculeatum* for tucumá palm (Henderson *et al.* 1995). *Asterocaryum aculeatum* is the only palm of this genus that occurs

naturally in Trinidad, although it is restricted to the south-west (Comeau *et al.* 2003). Thus, if this skipper is a breeding resident in Trinidad, it is likely to be using palms of another genus in Trinidad. Moss (1949) refers to the pupa having a very long frontal spike, but gives no other details.

Talides Hübner 1819

This genus of six rather similar species (Austin 1998) is represented by two species in Trinidad: *T. sergestus* Cramer and *T. sinois* Hübner. The large size, arrangement of spots F and distinctive UNH of these two species should distinguish them from any other Trinidad skippers. Superficially the two species are rather similar and the differences, particularly in UNS markings, are most easily seen in the figures. In addition, males of *T. sergestus* have the H more rounded than *T. sinois* which, by comparison, has the H extended at the tornus; male *T. sinois* have the F spot in space 2 almost touching the spot in space 3 and the brand is more conspicuous and curved rather than straight in space 2.

There is a third species in the genus, *T. alternata* Bell, which occurs in Venezuela and the Guyanas, and might also turn up in Trinidad. Evans (1955) compares this species to *T. sinois*, but notes that in the male, the spot in space 2 is more basal compared to the spot in space 3, and there are usually additional spots in spaces 1B and 9. However, de Jong (1983) finds these characters and the male genitalia variable, and speculates that just one variable species is involved.

202. K13/1 *Talides sergestus* (Cramer 1775)

Figs. 16-21.

This species was described from Suriname, and is known from Mexico to southern Brazil (Evans 1955). Early illustrations, purportedly of this species, were actually of *T. alternata* (not known from Trinidad) or the species treated next, *T. sinois* (Evans 1955), and so Trinidad records of *T. sergestus* are quite likely to actually refer to *T. sinois*. A P. L. Guppy specimen from Tunapuna was Kaye's basis for the inclusion of this species in his first catalogue (Kaye 1904, 1921), but there are specimens from “Trinidad” (male, [18] 98, W. J. Kaye, AME; male, 20.xi.1920, W. J. Kaye, AME) and Fondes Amandes (male, 22.iii.1922, F.W. J[ackson], AME) in his collection.

There is a Frank D'Abadie male specimen from Roxborough in the NHM. Sheldon (1938) records *T. sinois* on the Tobago list (as *T. sinon*) almost certainly on the basis of this specimen (see under *T. sinois*). Evans (1955) didn't list this specimen as from Tobago, and so this record of *T. sergestus* from Tobago has not hitherto been correctly published.

Male. UPF brown, the basal half of the costa may be orange-brown when fresh; yellow hyaline spots in spaces 2 (very narrow, wider at lower, dorsum end; close to the base of vein 3), 3, 6-8, and a double cell spot, usually touching. Grey brand in two parts, one section across base of space 2 parallel to cell, the other across space 1B at an angle to the first part and displaced outwards slightly from the basal end of the part in space 2. UNF margin violet from apex to vein 3, widening from apex to reach spot in space 3; costa, costal half of cell, and apical UNF to space vein 4 chestnut, remainder of wing grey-black. UPH brown with a yellow hyaline spot towards base of space 3. UNH spaces 1B and 1C grey-brown; ground colour of remainder dark chestnut; a strong lilac band from 1/3 on vein

1B to apex; a lilac wash on upper part of cell and base of spaces 5 and 6; margin narrowly dark, with a strong lilac sub-marginal band within this, extending as a wash about halfway to the cell. The lilac band UNH and violet apex margin UNF line up when the butterfly is at rest (Fig. 18), creating a single line which may serve to disrupt the shape of the resting butterfly. Body brown above and orange brown below, with palpi and distal part of abdomen palest. F 24 mm. Illustration in Lewis (1973, Plate 87.19, male UNS).

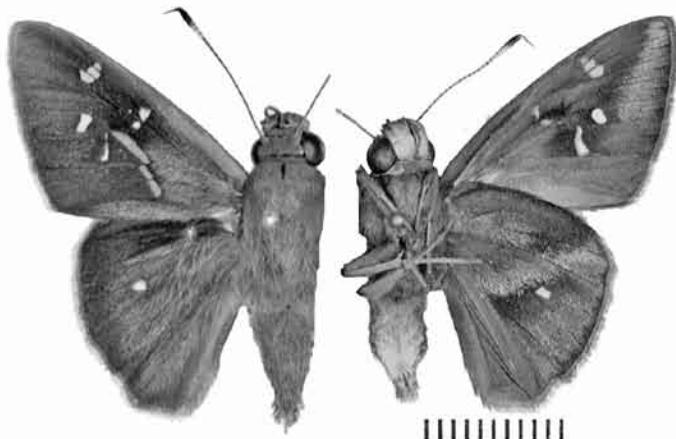


Fig. 16. *Talides sergestus* male. Left UPS, St. Benedict's, larva on ornamental *Heliconia* sp., MJWC ref. 95/34; right UNS, Plum Road, milestone 1/4, larva on *Heliconia* sp. 6.iv.1982, Ref 50B.

Female. UPF brown with yellow hyaline spots in spaces 1B (on vein 1 below inner margin of the spot in space 2), 2 (diagonal across space 2, the upper end very close to the cell spot), 3, 6-8, and a double joined cell spot. UNF as male, but the violet margin paler and extends to the base of the spot in space 3, and the spot in 1B UPF is extensive and pale. UPH as male. UNH similar to male, but the lilac area paler and more strongly and extensively marked, so that the ground colour is pale lilac, with the costal third UNH from base of space 1C to apex, and a short band from 1/3 on vein 1C to vein 4 including around spot in space 3 chestnut. F 23 mm, but this may be a small specimen.



Fig. 17. *Talides sergestus* female, St. Ann's, 9.xii.1978.

I think this species normally flies at dusk, or is crepuscular. I have caught three males in my mercury vapour light moth trap in Curepe (20.xi.1978, 16.ix.1979, 17.x.1979) but only rarely encountered it in the field. The larvae are found on *Heliconia* spp., and it probably occurs wherever its food plants occur, including

gardens, disturbed areas and forests. Because of its likely flight times, it is probably more frequently encountered in the north of the island. I have not seen this species come to flowers, but probably this reflects its crepuscular habits.



Fig. 18. *Talides sergestus* adult male, St. Benedict's, larva on ornamental *Heliconia* sp., MJWC ref. 95/34.

Moss (1949) reared this species and the preserved early stages in the NHM (cast L5 head capsules, emerged pupae) match those described below. Moss does not state the food plants, although it might be implied that they are the same as the next species, i.e. *Heliconia* and banana. Certainly, in Costa Rica it is found on *Heliconia latispatha* and banana (Janzen and Hallwachs 2001).

In Trinidad, I have found larvae occasionally on *Heliconia* spp., including an ornamental variety (St. Benedict's, MJWC ref. 95/34), *H. psittacorum* (Windbelt Reserve, MJWC ref. 88/9) and what was probably *H. bihai* (Plum Road, 0.25 milestone, MJWC ref. 82/50B). The following account is based largely on the first of these.

Pupa 38 mm; supported by a simple silk girdle behind A1; relatively plump, elongate posteriorly; short pale frontal spike; proboscis sheath extends 3 mm beyond cremaster; uniform pale green; all spiracles pale, inconspicuous. The area around the pupa is covered with white waxy powder, but not the pupa itself.



Fig. 19. *Talides sergestus* pupa, St. Benedict's, larva on ornamental *Heliconia* sp., MJWC ref. 95/34.

The larval shelters are made by making a long diagonal cut from the leaf margin and folding the distal flap over upwards, or downwards. Feeding is then towards the mid-rib basal to the shelter, or from the margin distal to the shelter.

The L5 grows to 55 mm; head rounded triangular, about 3 x 3 mm, truncate and indented at vertex; dark reddish brown with a broad, black stripe from posterior side of vertex, laterally to the white stemmata; posterior margin narrowly black; apices orange-brown on anterior side; an orange-brown patch anterior to the black lateral stripe, adjacent to the stemmata. T1 concolorous with body. Body smooth; dull translucent green, dorsal line slightly darker, due to presence of pale sub-dorsal subcutaneous fat bodies; white trachea and lateral tracheal line clearly visible; pale ventro-lateral ridge; male gonads conspicuous, pale yellow; anal plate semicircular, with margin whiter; legs and prolegs concolorous. The wax glands are formed ventrally and ventro-laterally in two patches, one on the posterior margin A7 and anterior margin A8, the other on the anterior margin of A9.



Fig. 20. *Talides sergestus* L5, St. Benedict's, larva on ornamental *Heliconia* sp., MJWC ref. 95/34.

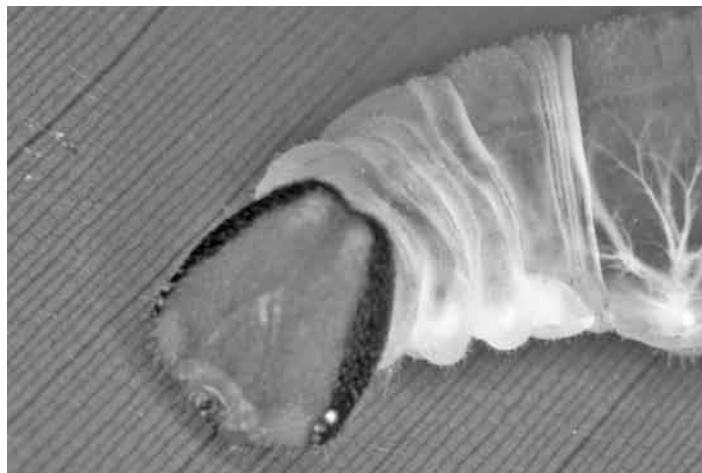


Fig. 21. *Talides sergestus* L5, detail of head, St. Benedict's, larva on ornamental *Heliconia* sp., MJWC ref. 95/34.

The L4, and probably also earlier instars, has a plain dark brown head.

One of two larvae collected at Plum Road (MJWC ref. 82/50B) had five white macrotype tachinid ova on its head; it subsequently died, and one tachinid larva completed its development in the carcass and pupated externally, but failed to emerge. Another larva from Windbelt Reserve (MJWC ref. 88/9) was parasitised by a gregarious *Apanteles* (s.l.) sp. wasp (Braconidae), which failed to emerge from the resultant cocoons. Wilkinson (1931) described *Apanteles talidicida*, a gregarious parasitoid of larvae of *T. sergestus* on a wild *Heliconia* sp. in Guyana, and subsequently (Wilkinson 1932) reported the same species from Trinidad attacking *Calpodes ethlius* Stoll (Cock 2003). This is likely to be the same species noted here from *T. sergestus* in Trinidad.

203. K13/2 *Talides sinois* Hübner [1819]

Figs. 22-28.

Evans (1955) treats this species as three subspecies: *cantra* Evans from Mexico to Venezuela, *sinois* from Trinidad, the Guyanas, Amazon, Peru and Bolivia, and *riosa* Evans from southern Brazil. All three are now considered valid species (Austin 1998; Mielke 2004). The name *Talides sinon* (Stoll) is widely used in the literature, but as Evans (1955) points out, it is an unavailable homonym.

Kaye (1921, 1940) does not include this as a Trinidad species. Kaye, like Sheldon and other workers, was confused between the two Trinidad species of *Talides* (Evans 1955). Thus, there is a specimen in his collection from St. Ann's Valley, 400 ft. (male, i. 1922, F.W. Jackson, AME), which he labelled as *Talides sergestus*. Hence, when Evans (1955) listed six males and three females from Trinidad in the NHM, this was the first published record of this species from the island.

Sheldon (1938) adds this species to the Tobago list (as *T. sinon*) on the basis of a specimen taken at Roxborough by Frank D'Abadie. There are no specimens of *T. sinois* from Tobago in the NHM, but there is a male *T. sergestus* collected by Frank D'Abadie from Roxborough, which almost certainly is the specimen to which Sheldon referred. Hence I conclude that *T. sinois* is not known from Tobago.

Male. UPF brown, the basal half of costa dark chestnut; a small yellow spot may be present in space 1B against vein 1; yellow hyaline spots in spaces 2 (close to inner margin of spot in space 3), 3, 6-8 and a double joined cell spot. Brand light grey, in two parts: one in space 2, the upper 1/3 under vein and adjacent cell, the lower 2/3 curved and angled away from cell, in line with the second part, which runs across space 1. UNF margin evenly violet from apex to space 2, not widening as in *T. sergestus*; costa, cell and apical area to space 2 chestnut; remainder grey-black apart from diffuse pale spot in 1B. UPH brown with a round yellow hyaline spot in space 3. UNH space 1B brown; ground colour of remainder chestnut, with an indistinct paler band from 1/3 on vein 1C to base of space 4, running basal to the spot in space 3. Body brown above, orange-brown below, head and abdomen lighter. F 25 mm.

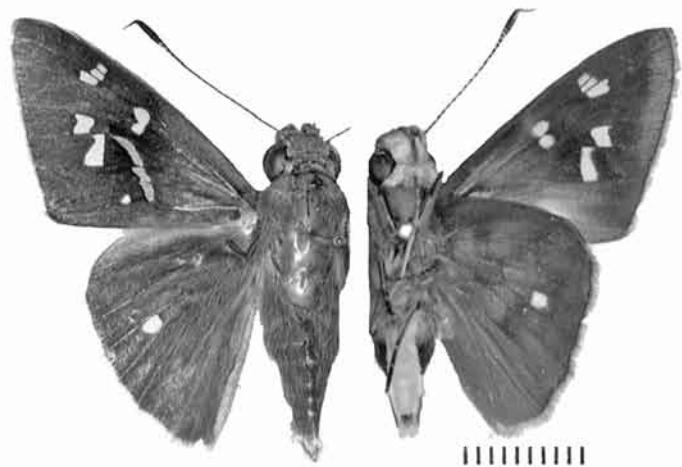


Fig. 22. *Talides sinois* male. Left UPS, Quare Road, 9.iii.1982; right UNS, Port of Spain Hilton, 13.x.1995.

Female. UPS brown, with spots as for *T. sergestus*, but slightly larger. UNF violet margin from apex to space 2, widening slightly

but not reaching spot in space 3; a rectangular lilac area in spaces 4 and 5 from end cell to just over half on vein 4, more sharply defined on distal margin, and separate from marginal band (not present in *T. sergestus*); upper cell, costa and apex to vein 4 otherwise chestnut; remainder of wing grey-black, except for large pale area in spaces 1A and 1B. UNH space 1B pale lilac-grey; ground colour of remainder pale lilac, with costal portion from base of space 1C to before apex suffused with brown; a diffuse brown band (wider than that of *T. sergestus*) from over half on vein 2 to vein 5 includes the yellow hyaline spot in space 3. F 27 mm.

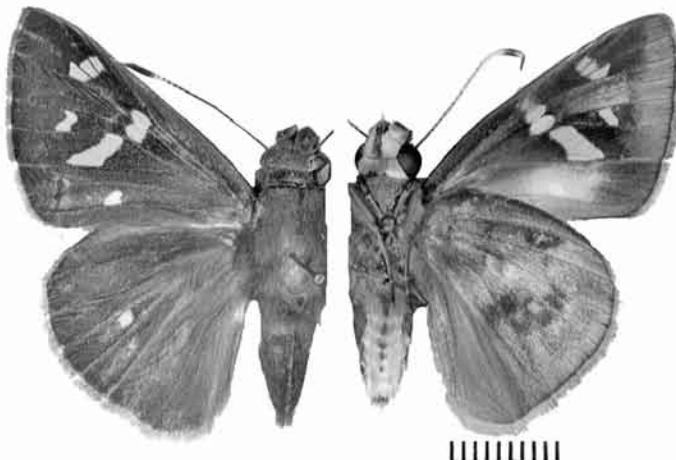


Fig. 23. *Talides sinois* female. Left UPS, Maracas Valley, Ortinola Estate, 11.x.1979; right UNS, El Tucuche, 2600 ft., 11.viii.1979.

This is an occasional species in Trinidad, and is not obviously crepuscular in its habits. Apart from one record near Moruga Bouffe, I have six records from the Northern Range or its foothills. I have a female from 2,600 ft on El Tucuche, showing that it probably occurs at all altitudes. I have not seen this species come to flowers.

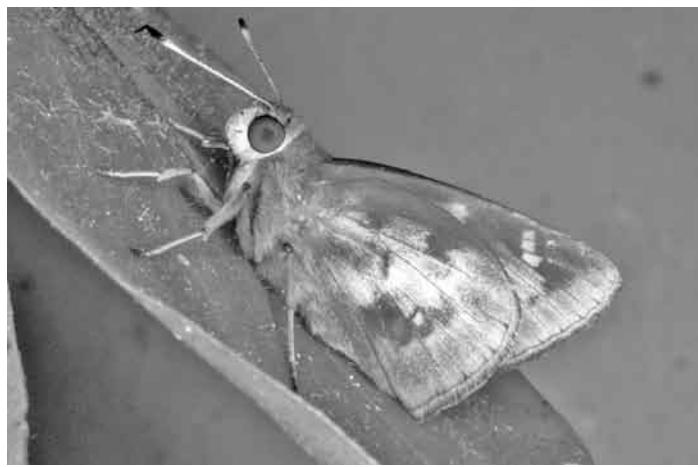


Fig. 24. *Talides sinois* adult female, Mt. Tamana, larva on *Heliconia bihai*, MJWC ref. 95/68.

The food plants reported for this species by Moss (1949, as *T. eudega*) are *Heliconia* and banana. Moss's preserved early stages in the NHM (cast L5 head capsules and emerged pupae) match those

described below. Janzen and Hallwachs (2001) found *T. cantra* on *Heliconia* spp. and banana in Costa Rica, but also occasionally on *Calathea insignis* (Marantaceae) and *Canna indica* (Cannaceae).

Like *T. sergestus*, the larvae of *T. sinois* feed on *Heliconia* spp. in Trinidad. I have found larvae on *H. bihai*¹ (Morne Catharine MJWC ref. 82/59B; Mt. Tabor, MJWC ref. 95/10; Parrylands, MJWC ref. 88/7; Trinity Hills, MJWC ref. 82/47B), *H. hirsuta* (behind St. Benedict's, MJWC ref. 94/22) and on an ornamental species (St. Benedict's, MJWC ref. 93/25). In captivity, larvae fed on *Calathea* and banana, and S. Alston-Smith (pers. comm.) has also found and reared this species on banana (Mt. Tamana, x.1999).

The pupa is formed in a leaf fold, with a silken pad for attachment of the cremaster, and a single strand girdle behind the thorax; the surface of the pupal shelter around the pupa is covered with white waxy powder for 15 - 20 mm in all directions. Pupa 49 mm; smooth and elongate but relatively plump; stout, blunt frontal spike of 1.5 - 2 mm, directed upwards at an angle of 30°; proboscis sheath extends 4 mm beyond cremaster; dull green, except frontal spike light brown distally; spiracles pale, inconspicuous; white waxy powder around cremaster and last two abdominal segments, but otherwise absent. As the pupa matures, a row of fine dots becomes apparent on the dorsal anterior edge of each abdomen segment. The pupal cuticle is very thin and transparent, and the development of adult colouring and wing markings can be clearly seen within; the empty pupal cuticle often collapses once the adult emerges.

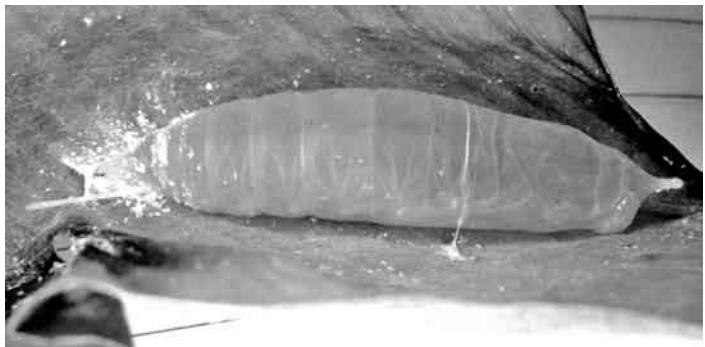


Fig. 25. *Talides sinois* pupa, Mt. Tamana, larva on *Heliconia bihai*, MJWC ref. 95/68.

L5 37 - 40 mm when mature. Head 4.5 x 3.5 mm high x wide; rounded triangular, truncate and indented at vertex; strongly rugose, shiny; scattered short, pale, inconspicuous setae; light brown; a short yellow-brown to pale brown streak from apex parallel to the epicranial suture; anterior to white stemmata an orange, orange-brown or light brown patch. T1 shiny, concolorous with body. Body dull translucent green; trachea clearly visible; spiracles pale, inconspicuous, except as the centre of a star of visible trachea; legs and prolegs concolorous; anal plate semi-circular, with white submarginal line and a fringe of short pale setae. The wax glands develop as two ventro-lateral patches, one on the posterior margin of A6 and the anterior margin of A7, and the other on the anterior margin of A8.

¹ This is the species I have referred to in earlier papers as *H. wagneriana*. However, the Trinidad species seems to be *H. bihai* L. (Berry and Kress 1991).

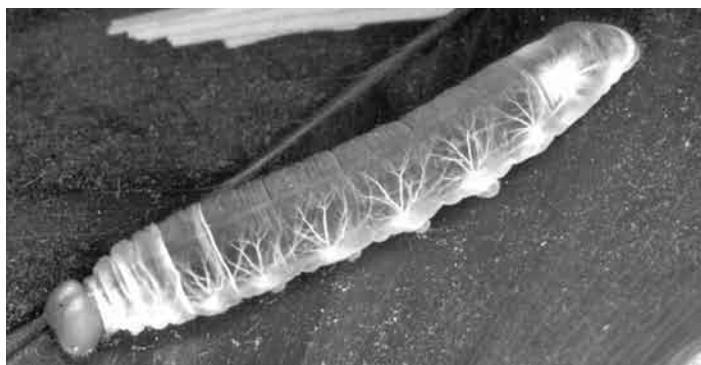


Fig. 26. *Talides sinois* L5, Mt. Tabor, larva on *Heliconia bihai*, MJWC ref. 95/10.



Fig. 27. *Talides sinois* L5, detail of head, Mt. Tamana, larva on *Heliconia bihai*, MJWC ref. 95/68.

L4 28 mm; head 3 x 2.5 mm high x wide; similar to L5, but the intensity of the yellow-brown apex markings and orange-brown markings anterior to the stemmata varies; in some individuals they are fully developed, while in most these areas are comparable with the ground colour, and the head is uniformly dull light brown. The L4 of two larvae of ssp. *cantra* that I reared in Colombia (Chinchiná, MJWC refs. 94/404, 96/101) had the head plain black, but the L5 and pupa matched that described here from Trinidad.

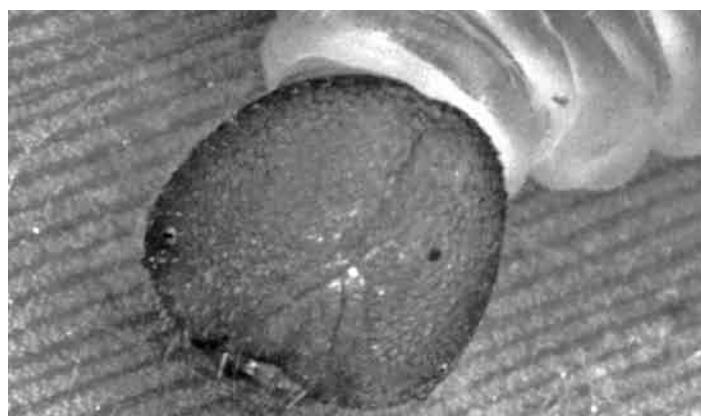


Fig. 28. *Talides sinois* L4, detail of head, Mt. Tabor, larva on *Heliconia bihai*, MJWC ref. 95/10.

L3 14-19 mm; head light brown, sometimes with the apices darker; stemmata and sutures darker; tracheal stars not obvious except on A8. The L3 can make a shelter from a whole small leaf, folding it down on either side of the mid-rib, and feeding from the distal part of the leaf.

L2 9 mm; head black; body translucent grey-green. One L2 was found in a shelter prepared by making a 20 mm oblique cut from edge of lamina, near base of leaf and folding the distal portion under to form a 6 mm wide flap. Another was found in a simple fold from the leaf margin, with the distal part of the small leaf eaten.

Young plants are used for oviposition, e.g. at the three leaf stage; this may be the preferred size of plant.

The larvae are attacked by a tachinid parasitoid, the fly larvae emerging from the host pre-pupa to pupate (e.g. MJWC ref. 82/47B, Trinity Hills). Moss's material in the NHM includes one pinned tachinid adult.

The larvae illustrated by Janzen and Hallwachs (2001) for ssp. *cantra* from Costa Rica differ from those described here from Trinidad. In the Costa Rican material, the head is bright chestnut brown, grading into a red eye spot anterior to the stemmata; there is a strong broad black line down the face, at least as wide as the clypeus, and there may also be a broad black posterior margin to the head. These differences are sufficiently striking to suggest specific differences rather than sub-specific differences.

***Carystus* Hübner 1819**

Three species of this genus are found in Trinidad; *C. jolus* (Stoll) and *C. ploetzi* Mielke and Casagrande are rare and *C. phorcus* (Cramer) is uncommon. The genus can be recognised in Trinidad by the relatively large size (F usually > 20 mm), presence of a double cell spot and a spot in space 4 F, and the pale, usually mottled UNH with dark veins.

204. K18/4 *Carystus jolus* (Stoll 1782)

Figs. 29-30.

This species is known from Trinidad, the Guyanas (TL Suriname) and Brazil (Evans 1955).

Kaye (1940) records a synonym, *C. bursa* (Hewitson), based on a specimen captured 25.iii.1923 at Siparia by Sir Norman Lamont; this specimen, a male, is in NMS (Fig. 29). This seems to be a rare species in Trinidad, and I can add only three more records – a female from St. Ann's (i-iii.1932, A. Hall, NHM; Fig 30), a male captured on the lower Morne Catharine trail, 27.ii.1982 by June and Floyd Preston, and a male collected by S. Alston-Smith at Talparo (iii.2001). There is another male in the Angostura-Barcant collection (Alston-Smith pers. comm.).

Male. UPF dark brown with white hyaline spots in 2 (large, near base of space, in line with cell spots), 3, 4, 6-8 (spot in space 6 displaced outwards), and a double cell spot (close together, the lower spot only separated from the spot in space 2 by the cubitus vein). UNF brown, apical area distal to cell as far as vein 2 diffuse whitish brown, veins dark; central area of space 1B a large diffuse whitish brown area. UPH dark brown with a very large round white discal spot in spaces 2-6 and end cell. UNH ground colour brown; space 1A white apart from margins; central part of space 1C, basal parts of spaces 2-5 and cell white, with veins dark except end cell and vein 5; spaces 6, 7 and 8 whitish brown with veins dark. Illustration in Lewis (1973, Plate 81.29, male UNS).



Fig. 29. *Carystus jolus* male, Siparia, 25.iii.1923, N. Lamont (specimen in NMS).

Female. UPF dark brown with white spot in space 1B (large, below inner margin of cell spots), 2 (large, inner margin in line with outer margin of cell spots), 3 (large as spot in 1B, midway between spots in spaces 2 and 4), 4-9 in an arc, only spots in 8-9 adjacent, double cell spot (close but not touching). UNF disk brown; basal and central part of costa and apical area from end cell to vein 2 whitish brown, with dark contrasting veins and margin; white spot in space 1B only slightly larger than UPS. UPH dark brown with a very distinctive, clear white streak in end cell and basal parts of spaces 4 and 5. UNH whitish brown with contrasting dark veins and margin; space 1B light brown; white streak with concolorous veins as UPS.

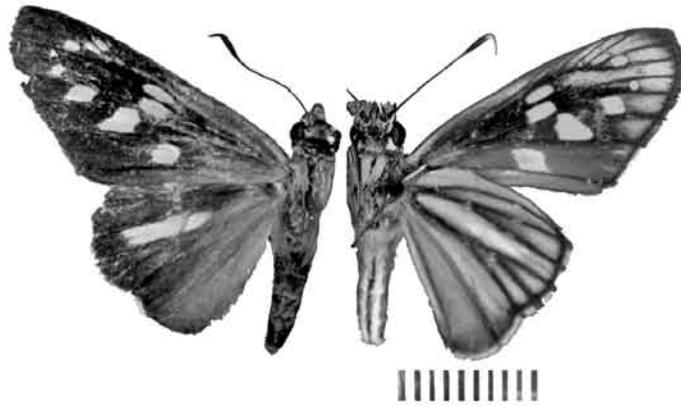


Fig. 30. *Carystus jolus* female. Left UPS, St. Ann's, i-iii.1932, A. Hall (specimen in NHM); right UNS, Brazil (specimen in NHM).

The male lacks the pre-apical white area seen in the other two species of the genus, while the white streak UPH in the female is unique in the Trinidad fauna.

The food plant in Belem is “jacatára palm” (Moss 1949). Three species of *Desmoncus* are known as jacatára or jacitara and recorded from Belem: *D. orthacanthos*, *D. polyacanthus* and *D. phoenicocarpus*, but only the first two are also known from Trinidad (Henderson *et al.* 1995; Comeau *et al.* 2003). Moss (1949) writes that “the pupa is heavily powdered and crossed with web”. Moss’s preserved early stages of this species in the NHM show that the pupal shelter is lined with a light silk cocoon and white waxy powder. The cast L5 head capsule is covered with white waxy powder, and appears to have a broad dark lateral stripe on a light brown background. The pupa is elongate, with a down-turned

cremaster, and a short straight pointed frontal spike; the proboscis sheath extends well beyond the cremaster.

205. K18/6 *Carystus ploetzi* Mielke and Casagrande 2002
Figs. 31-33.

Evans (1955), and hence Cock (1982b), treat this species as *Carystus senex* (Plötz). However, Mielke and Casagrande (2002) report that based on an examination of the type of *senex*, it is a junior synonym of *Panoquina peraea* (Hewitson). The species known as *C. senex* was undescribed, and so they named it *C. ploetzi* and illustrate the male holotype and female allotype from Pará, Brazil, and Iquitos, Peru, respectively. Evans (1955) reports additional specimens from Trinidad, the Guyanas, Brazil and Peru. Although Cock (1982b) suggested that Kaye’s (1940) reference to *C. claudianus* (Latrelle) might be in error for *C. senex* (i.e. *C. ploetzi*), I now think it more likely that Kaye applied this name to males only of *C. phorcus phorcus* (see next species account). The records in Evans (1955) are therefore the first published for *C. ploetzi* for Trinidad.

Male. UPS dark brown; white hyaline spots in space 2 (large, against distal half of lower cell spot), 3 (quadrate, midway between spot in space 2 and pale pre-apical area), double cell spot (the upper spot smaller and connected to the lower by a narrow bridge), a very small spot at the end of the cell (not present in type); a white pre-apical patch across spaces 4-8. UPH dark brown; a large round white discal spot in spaces 3-6, but not end cell. UNF costa and apical area beyond end cell to vein 2 pale lilac, veins dark; diffuse white patch from space 4-9, faint in spaces 4-5; disc blackish brown, fading to brown in spaces 1B and 1A. UNH space 1A brown; space 1B light brown; space 1C purple-brown; remainder of UNH pale lilac as apical UNF, veins dark; the white patch UPH shows UNH as only slightly paler than ground colour in spaces 4-6. UNS of abdomen white with dark ventral line.



Fig. 31. *Carystus ploetzi* male, Palmiste, iv.1936, N. Lamont (specimen in NMS).

Female. UPF dark brown; white spot in space 1 (elongate against vein 1, below inner margin of spot in space 2); white hyaline spots in space 2 (large, inner margin in line with outer margin of lower cell spot), 3 (midway between spots in spaces 2 and 4), 4 (small, not always present; not present in allotype), 6-9 (that in space 6 displaced towards margin), and a double, joined cell spot. UNF costa, upper cell and apical area to space 1B pale violet-brown with contrasting dark veins; disk brown; space 1A light brown. UPH brown, darker on margin and costa; indistinct pale suffusion across middle of spaces 4 and 5 (not present in allotype). UNH

ground colour pale violet-brown with contrasting dark veins and margin; spaces 1A, 1B and adjacent half of space 1C light brown with veins only slightly darker. F 22-23 mm.

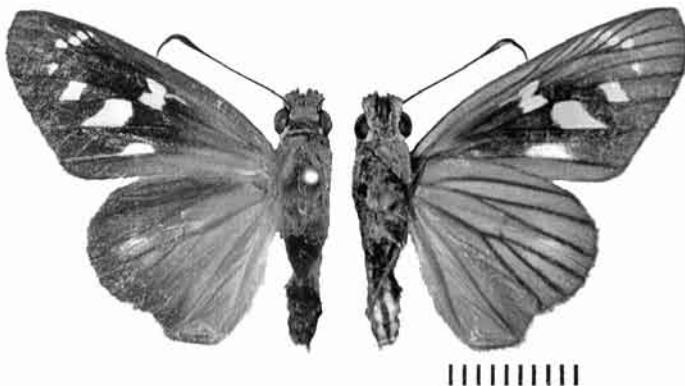


Fig. 32. *Carystus ploetzi* female, Curepe, 17.ii.1980.

The male is close to *C. phorcus*, but the cell spots are separated in that species and the spot in space 2 barely overlaps with the cell spot. The almost unmarked UPH and uniform UNH distinguish the female from the other *Carystus* spp. females.

This is a rare species in Trinidad, with no obvious habitat association. I have records from El Naranja at 2,300 ft. (female 9.i.1980), Curepe (female 17.ii.1980; Fig. 32), Los Bajos (male, SAS), Palmiste (male iv.1936, N. Lamont, NMS; Fig. 31), Inniss Field (3 male, 3 female, SAS), Guapo (female, SAS) and Parrylands (female, SAS).

Moss (1949) reared this species several times from lightly powdered larvae feeding on ground bamboo and palms: jacetára (rattan), tucumá, caraná, pachiúba and pupúnha palms, i.e. *Desmoncus* sp(p.), *Astrocaryum* sp(p.), *Mauritia carana*, *Socratea exorrhiza* and *Bactris gasipaes* (Henderson *et al.* 1995). Of these, only *M. carana* and *S. exorrhiza* are not reported from Trinidad (Henderson *et al.* 1995; Comeau *et al.* 2003). Moss's preserved emerged pupae in the NHM are elongate, tapered at the cremaster; the frontal spike is long, tapered and slightly upturned at apex; the proboscis sheath extends beyond the cremaster. The pupal chamber is lightly covered with white waxy powder. Moss's cast L5 head capsules appear to include at least two species; those associated with emerged pupae are covered with white waxy powder, but seem to be light brown in colour with variable dark markings on the epicranium.

S. Alston-Smith (pers. comm.) has reared this species from picmoc (*Bactris major*), and also found a pupa on an unidentified palm (near Moruga Bouffe, 24.iii.2003, MJWC ref. 03/223) on which the following is based.

The pupal shelter was made from a single leaflet, angled at the mid-rib, with the two sides of the lamina held open at an angle of about 75° with several stout strands of silk. The cremaster was securely inserted into a crossbar of silk and held by a silk girdle over the thorax. The leaflet under the pupa, and the pupa itself had a light coating of white waxy powder. Pupa 35 mm; elongate, smooth; frontal spike 2.5 mm, pale, tip up-turned; cremaster elongate, 4 mm, pale, with ridges along UPS margin; green with faint pale subdorsal line on A1-5.



Fig. 33. *Carystus ploetzi* pupa, near Moruga Bouffe, larva on unidentified palm, MJWC ref. 03/223).

206. K18/8 *Carystus phorcus phorcus* (Cramer 1777)

Figs. 34-35.

This species comprises two subspecies according to Evans (1955): *phorcus* (Cramer), described from Suriname, and found from Colombia to the Guyanas and the Amazon, and *claudianus* (Latreille) from southern Brazil and Bolivia.

Kaye (1940) adds this species to the Trinidad list based on a female he captured 12.i.1921 at Palmiste (specimen in AME). He also records captures of males of this species from Palo Seco (iv.1922, O. Latour; specimen in coll. Lamont, NMS) and St. Ann's (R. Dick) as *C. claudianus* (i.e. the other subspecies of *C. phorcus*). Since males of the two subspecies are similar, this interpretation is more likely than a misidentification for *C. senex* (i.e. *C. ploetzi*) which I suggested in Cock (1982b).

Male. UPS dark brown; white hyaline spots in space 2 (inner margin just overlapping with outer margin of lower cell spot), 3 (quadrate, midway between the spot in space 2 and pre-apical white patch) and double spot in cell (upper spot small, well separated from rounded lower spot); white pre-apical patch across spaces 4-8. UNF brown on disk; costal space and apical area from vein 4 to vein 9 light brown with contrasting dark veins; spaces 1A and 1B light brown with a diffuse pale spot in space 1B, below lower cell spot. UPH brown; a large white discal spot across spaces 3-6. UNH spaces 1A, 1B and adjacent half of space 1C light brown with concolorous veins, except basal half of vein 1A whitish; remainder of space 1C and basal half of spaces 6 and 7 whitish brown with dark veins; remainder of UNH light lilac-brown with dark veins and a diffuse darker band from end cell to 2/3 on vein 7. F 20 mm. Illustration in Lewis (1973, Plate 81.30, male, UNS).

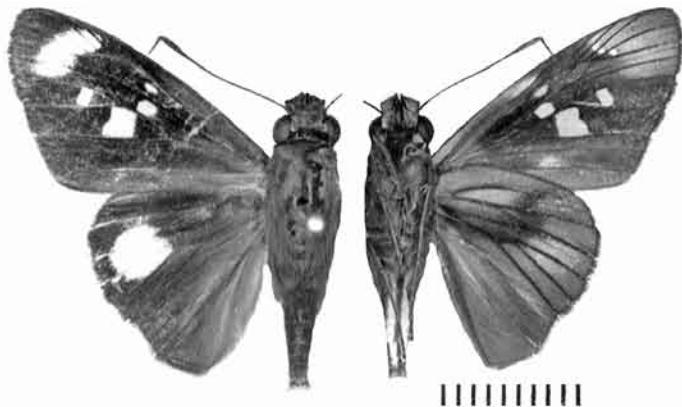


Fig. 34. *Carystus phorcus* male, Nariva Swamp, milestone 46 1/4 track, 5.ii.1980.

Female. UPF dark brown; white suffusion in middle part of space 1A; spot in space 1B (elongate, on vein 1, below lower cell spot); white hyaline spots in 2-4 (in line with spot in space 1B), 6-8 (that in space 6 slightly displaced towards margin), and a double cell spot (comparable in size, well separated from the spot in space 2).

UNF disk brown; costal space whitish brown; apical area from end cell to vein 3 pale lilac-brown with dark veins. UPH dark brown; strong white band across spaces 2-4 with dark veins; pale brown from white band, widening to whole of space 1A. UNH mottled with dark veins: space 1A, basal half of 1B, lower half of basal half of space 1C, a streak in basal half of spaces 2-4, upper half of cell white; remainder of spaces 1B, 1C, lower cell, and basal half of spaces 6 and 7 whitish brown; remainder of spaces 2-7 pale lilac-brown. Cilia white in space 1 F and spaces 1B and 1C H. F 20 mm.

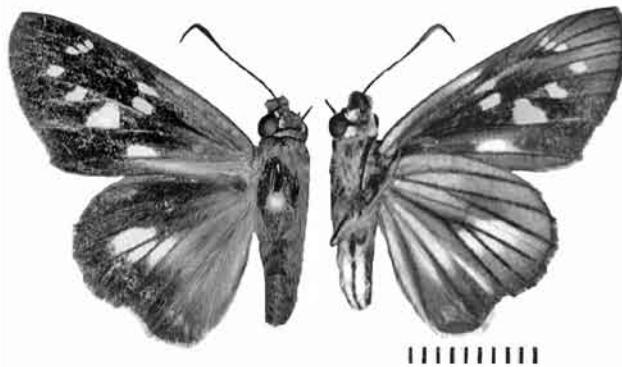


Fig. 35. *Carystus phorcus* female UNS, Andrew's Trace, 27.xi.1980.

The male is very close to that of *C. ploetzi*, but in that species the two cell spots F are linked and partially overlap with the spot in space 2. The evenly spaced spots F, and especially the white band UPH and UNH colouring make the female distinctive.

This species is commoner than the other two members of the genus in Trinidad, but still seems to be infrequently encountered. Many records are from lowland areas: lower Morne Catharine, Maraval, Curepe, Las Lomas, Nariva Swamp (Cock 1982a), Palmiste, Inniss Field, Moreau, Guapo, Parrylands and Rio Claro. However, I also have records from higher locations: North Post, Andrew's Trace, and Lalaja Ridge, showing that it could turn up anywhere.

A specimen that W. G. Sheldon captured at Scarborough is the basis of the inclusion of this species in the Tobago list (Sheldon 1938). This is probably the male labeled Tobago in the NHM, which came from the Sheldon collection.

Assahy palm (*Euterpe oleracea*) is the Belém food plant according to Moss (1949). In Costa Rica, however, it is normally found on *Acrocomia aculeata*, and occasionally on *Bactris guineensis* and *B. major* (Janzen and Hallwachs 2001). The larvae illustrated by Janzen and Hallwachs (2001) are very similar to those of *Argon lota* (above). Moss's preserved emerged pupae (no larval head capsules) in the NHM are similar to those of *C. ploetzi*. In Trinidad, Alston-Smith (pers. comm.) has reared this species from picmoc (*Bactris major*).

207. K19/1 *Telles arcalaus* (Stoll 1782)

Figs. 36-38.

This species is reported from Honduras to the Guyanas (TL Suriname), Amazon and Peru (Evans 1955).

Kaye (1925) described *Thespicus* (sic) *submarmorata* Kaye on the basis of a specimen captured at St. Ann's, 1300 ft, 15.iv.1922 by F.W. Jackson. Subsequently (Kaye 1940), he treats *submarmorata* as a synonym of *Telles arcalaus* and adds records from "Camuto Road, 100 ft." (28.v.1924, C. L. Collenette) and St. Ann's (R. Dick).

Sexes similar. UPF brown; basal half of costa orange-brown, lighter distally; pale yellow spot in space 1B; pale yellow hyaline spots in spaces 2, 3, 6-8, lower cell (basal to spot in space 2) and upper cell (at distal end of cell, above spot in space 2). UNF costa

yellow in central portion and in distal portion extending to space 6; apical part of UNF from end cell to space 4 otherwise chestnut; remainder of UNF black-brown. UPH brown; a row of yellow spots in spaces 2-5, larger yellow spot in space 6 and a diffuse yellow spot in space 7. UNH marked in yellow, brown, whitish brown and chestnut; a white spot on anterior margin of cell under origin of vein 5; yellow spots as UPH. F male 19 mm. Illustration in Lewis (1973, Plate 87.27, UNS).



Fig. 36. *Telles arcalaus* male. Left UPS, Morne Catharine, ex larva on *Heliconia hirsuta*, MJWC ref. 94/15; right UNS, Morne Catharine, larva on *Heliconia hirsuta*, 17.i.1988, Ref. 88/3.

This a very distinctive species due to the unusual arrangement of spots UPF and UPH and the striking and extensive yellow colouration UNS.

I have one specimen from my mercury vapour light moth trap in Curepe (male, 27.ix.1979) suggesting this species may have crepuscular tendencies. Further records from Aripo Savanna (male 12.viii.1979), Los Bajos (SAS), Guanapo Valley (SAS), Guapo (SAS), Maraval (male, ix.1891, NHM), Matura Forest (SAS), North Post (SAS), N. Hills (male, xi.1933-iii.1934, A. Hall, AME), Palmiste (male, 30.xii.1947, female, 23.iv.1949, male, 1.vi.1949, N. Lamont, UWI), Sangre Grande (SAS), and Valencia (SAS) suggest this species may be most frequent in lowland situations. As the larvae do not seem to be so uncommon, I suspect this is a crepuscular species and so, it is seldom encountered.



Fig. 37. *Telles arcalaus* adult male, Morne Catharine, larva on *Heliconia hirsuta*, MJWC ref. 94/15.

There is a specimen in coll. IIBC reared by F. J. Simmonds from *Heliconia psittacorum* (St Augustine, iv.1950). I have twice reared this species from larvae collected on *Heliconia hirsuta* on Morne Catharine (MJWC refs. 88/3, 94/15). In both cases the L5 larvae were found in shelters made from a whole leaf, the basal portion was folded downwards each side of the mid-rib and held with scattered silk strands, while the distal half had been eaten apart from the base of the mid-rib.

Pupa 25-26 mm; held by a single strand girdle running over the front of the thorax, with the attachment points on the substrate level with the back of the thorax; elongate, tapering from thorax to cremaster; frontal spike 1.5 mm, strongly curved upwards for distal half; uniformly light green.

One week before pupation, a L5 larva measured 23 mm; head rounded, wider towards base; slightly indented at vertex; light brown, with dark epicranial suture, and a dark spot around stemmata; entirely covered with white waxy powder. Body also covered with white waxy powder apart from a clear, and therefore darker, dorsal line.



Fig. 38. *Telles arcalaus* L5, Morne Catharine, larva on *Heliconia hirsuta*, MJWC ref. 94/15.

208. K22/1 *Cobalus virbius virbius* (Cramer 1777)

Figs. 39-44.

This widespread species is treated as five subspecies by Evans (1955). Ssp. *virbius* was described from Suriname, and occurs from Panama, through the Amazon Basin to Paraguay; ssp. *fidicula* (Hewitson) is the central American form, ssp. *hersilia* (Plötz) is from southern Brazil, and ssp. *hanta* Evans is based on a single specimen from Pernambuco, east Brazil. Ssp. *quadrum* (Mabille) from Colombia, Ecuador and Venezuela seems to overlap in range with ssp. *virbius*, so may well prove to be a distinct species.

This species was first recorded from Trinidad by Crowfoot (1893) as *Carystus virbius*. It seems likely that Trinidad collectors did not associate the males and females of this sexually dimorphic species, e.g. Lamont's three females in UWI (Cock 1982b) and two in NMS were curated as *Rhinthon cynea* (Hewitson) (= *Cyneia cynea*, not a Trinidad species), this species occasionally from *A. aculeata* only.

Male. UPS dark brown; white hyaline spots in spaces 2 (narrow, curved), 3 and a dot in 6. UNF brown, markings as UPF. UPH dark brown, with a broad white submarginal band from space 1B to space 4 or 5, narrower at space 1B, and with a narrow dark brown wedge at the margin in spaces 4 and 5. UNH space 1A and 1B brown; a broad white submarginal band as UPH; remainder of UNH with a strong purple flush. Cilia white in spaces 1B to 4 H. F 16 mm. Illustration in Lewis (1973, Plate 81.49, male UPS).

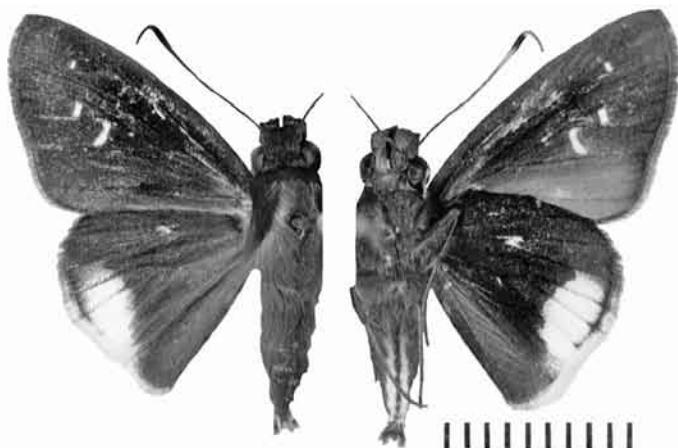


Fig. 39. *Cobalus virbius* male, St. Augustine, larva on *Veitchia merillii*, 1.xii.1999, D. Moore.

Female. UPF brown, with white hyaline spots as male but slightly larger, and extra spot in space 7. UNF brown; spaces 1A and 1B paler; a white spot in space 1B. UPH brown, slightly paler submarginally in space 1C. UNH spaces 1A, 1B and adjoining area of 1C brown-black; remainder of wing with slight purple suffusion; pale suffusion submarginally in space 1B, stronger than UPH. Cilia pale brown in spaces 1B to 2 H. F 17 mm.



Fig. 40. *Cobalus virbius* female UNS, Curepe, MVL, 1-10.ii.1982.

The male, with its white band UPH and UNH can be mistaken for no other Trinidad species. The female is superficially similar to several other species, especially in Group J, but the distinctive curved spot in space 2, the purple suffusion UNH, the pale submarginal suffusion in space 1B UNH and the pale cilia spaces 1B to 2 H should serve to identify this species in Trinidad.



Fig. 41. *Cobalus virbius* adult male, St. Benedict's, larva on ornamental palm, MJWC ref. 95/38C.

This species is occasionally encountered in both the north and the south of the island. I have one female taken in my mercury vapour light moth trap in Curepe (1-10.ii.1982; Fig. 40), and just one record of a male taken at flowers (eupatorium, Parrylands, 16.x.1980). Normally I have encountered this species in forest areas, usually within the forest itself. However, it must be more widespread than my observations imply, since larvae can be found in disturbed and garden habitats (e.g. St. Augustine, St. Benedict's) where they are associated with ornamental palms.

Moss (1949) often reared this species from assahy palm, *Euterpe oleracea*, and mucujá palm, *Acrocomia aculeata* (Henderson *et al.* 1995); he also found them on “the ornamental Carioca palm from Rio de Janeiro and on another unidentified palm.” He refers to the larvae and snouted pupae as elongate and light green with a light dorsal line. The preserved L5 remains in the NHM show the larvae to have a rounded head, narrower and flattened dorsally; the colour is light brown, with a heavy dark line down epicranial suture, across clypeus to mouth parts. In Costa Rica, Janzen and Hallwachs (2001) have reared this species occasionally from *A. aculeata* only.

I have reared this species from larvae collected on a narrow leaved ornamental palm (?*Phoenix* sp., St. Benedict's, MJWC ref. 95/38). The larvae form shelters by rolling the leaflets downwards. It has also been found on Manila palm, *Veitchia merrillii* (St. Augustine, 1.xii.1999, D. Moore, in coll. MJWC) and “forest palms” (S. Alston-Smith pers. comm.).

Pupa 22 mm; elongate and smooth; proboscis sheath extends 6 mm beyond wing cases, and 3 mm short of cremaster tip; pupa green with a thin white dorsal line on abdomen. Thin, straight, frontal spike 1.5 mm; black, at least at the tip, but the whole spike black in some specimens; directed upwards at an angle of 45° to body axis; tip bent back on itself in a tiny hook.



Fig. 42. *Cobalus virbius* pupa, St. Benedict's, larva on ornamental palm, MJWC ref. 95/38C.

L5 28 mm; head triangular in outline, rounded, but flattened dorsally and broadly indented at vertex; scattered, erect, pale setae; head covered with a heavy layer of white waxy powder except for a broad stripe down the centre of the face; under the powder, the head is pale apart from a large dark oval spot laterally on epicranium, the epicranial suture and the dorsal part of the clypeus, which is also dark; in one specimen this dark stripe continues across the clypeus to the mouth parts. T1 concolorous with body. Body greenish white, except for a dull green sub-dorsal line; laterally on A3-A8 a coating of white waxy powder, heavy on A7-A8; a few pale setae laterally on A8-A9; spiracles, legs and prolegs concolorous. The mature larva preparing to pupate becomes translucent with a white dorsal line and heavier white waxy powder.



Fig. 43. *Cobalus virbius* L5, St. Benedict's, larva on ornamental palm, MJWC ref. 95/38B.



Fig. 44. *Cobalus virbius* L5, detail of head, St. Benedict's, larva on ornamental palm, MJWC ref. 95/38B.

L4 15 mm; head dark, but paler each side of epicranial suture and in lower half of epicranium; head covered with white waxy powder apart from the clypeus. T1 concolorous with body which is grey-white, lightly covered with white waxy powder; white dorsal line; diffuse white sub-dorsal line. L3 has the head brown, lighter over the clypeus.

208a. K26 *Damas clavus* (Herrich-Shäffer 1869) Fig. 45-46.

This species was described without type locality, and occurs from southern Brazil to Guatemala (Evans 1955) and Mexico (Warren 2000). It has not previously been recorded from Trinidad. S. Alston-Smith (pers. comm.) has captured male specimens from Fondes Amandes (viii.1979; Fig. 45) and Chatham (ii.2001).

Evans (1955) notes that this is a very variable species, but insufficient Trinidad material is available to assess this. The two Trinidad males are brown UPS; a small yellowish spot in space 1B, yellow hyaline spots in spaces 2 (excavate on outer margin), 3 and 6 (dot) and an elongate spot in lower cell. Evans (1955) notes that the spot in space 1B is often absent and there may be further apical spots in spaces 7-9. There is a broad grey stigma at the base of space 3 alongside the cell, which is thicker basally, and a patch in space 2, below the base of the section in space 3. UNS paler brown, unmarked. In the female the UPF spots are larger and a small spot

may also be present in space 4; UNH a more or less straight row of white spots in spaces 3-5 and an inwardly displaced spot in space 6. F male 24 mm (Evans 1955). Illustration in Lewis (1973, Plate 82.23, female UNS).



Fig. 45. *Damas clavus* male, Fondes Amandes, viii.1979, S. Alston-Smith (specimen in SAS).



Fig. 46. *Damas clavus* female. Left UPS, French Guiana (specimen in NHM); right UNS, Belem, Brazil (specimen in NMH).

The size, arrangement of spots, male stigma, plain brown UNS in the male, and row of spots UNH in the female should serve to identify this species.

Janzen and Hallwachs (2004) have reared this species from two palms: *Astrocaryum alatum* and a *Bactris* sp., but do not illustrate the early stages. Recently, S. Alston-Smith (pers. comm. 2004) found and reared larvae of this species from an unidentified palm at Trinity Hills. He notes that the larva has a brown head, and is green with a yellow lateral stripe, while the pupa is green with a brown stripe. Based on three emerged pupae in the NHM reared by A. M. Moss in Para (Belem, Brazil), the emerged pupal case is about 25 mm long, flimsy and partially collapsed; almost transparent with a brown tint; the frontal spike is long and slender, with the dark tip hooked upwards; a narrow brown stripe runs from the tip of the cremaster to the tip of the frontal spike; the proboscis sheath extends beyond the cremaster for about 20 mm. Moss (1949) did not treat this species.

209. K28/1 *Carystoides basoches* (Latreille [1824])

Figs. 47-48.

This species was described from Brazil, and is recorded by Evans (1955) from Trinidad south to Paraguay. *Carystoides yenna* Evans (1955) was described as a ssp. of *basoches* from French Guiana and the Upper Putumayo and is much more variegated below; it is now treated as a separate species (Mielke 2004). *Carystoides basoches* was first recorded from Trinidad by Kaye (1904), mis-spelt as *C. basochesii*, based on a specimen he took in St. Ann's Valley in July 1901.

Male. UPF brown; white apical patch space 5-7, 2 mm wide; white hyaline spots in space 2 (large, against cubitus to base of vein 3), 3 (large, against cubitus to base of vein 4, almost completely overlapping cell spot) and cell (across width of cell, contiguous with spot in space 3 and only separated by dark vein). UNF costa brown; apical area (vein 2 to space 7) light brown; disk black-brown; vein 1 white; small dark spots in spaces 3-5. UPH brown; white hyaline spots in spaces 3-5 (the spot in space 3 smaller and separated by dark vein, the spots in spaces 4 and 5 joined). UNH light brown, basal area, space 1A and margin spaces 2-7 paler; spaces 1B and 1C black-brown. Antennal club white above. F 23 mm. Illustration in Lewis (1973, Plate 81.27, male UPS).

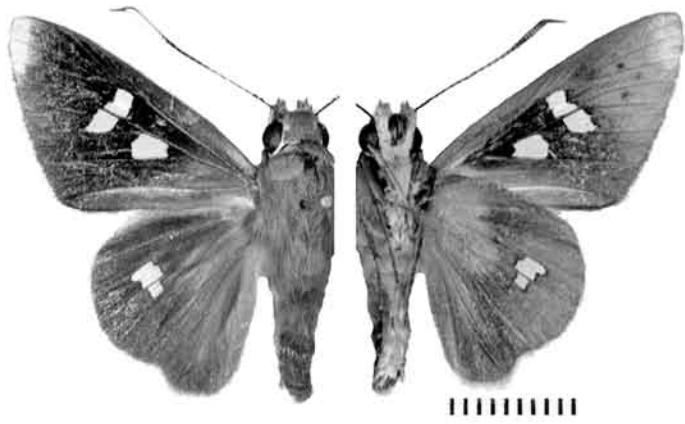


Fig. 47. *Carystoides basoches* male, Curepe, 20.viii.1978.

Female. UPF brown; light yellow spot in lower space 1B; pale yellow hyaline spots in spaces 2 (diamond shaped, the upper angle under the origin of vein 3, and partially overlapping, but separate from spot in cell), 3 (diamond shaped, well separated from spot in space 2), 6-7 (dots, that in space 6 closer to margin), cell (across width of cell, excavate on internal and external margins); no white apical patch. UNF colouring similar to male; dark spots in spaces 4 and 5, the hyaline spots in spaces 6-7 have a dark border; vein 1 concolorous. UPH brown; pale yellow hyaline spots in spaces 4-5 (partially overlapping, that in space 5 closer to margin). Evans (1955) refers to these spots extending into space 3, to distinguish *C. basoches* from *C. noseda*. This does not seem to be the case for females of *C. basoches* from Trinidad. De Jong (1983) comments that of the two females he examined from Suriname only one had a spot in space 3. It may be that Evans intended to refer to males rather than (by implication) both sexes in his key. UNH similar to male but paler; small dark spot in space 3 adjacent to the hyaline spot in space 4. Base of antennal club with a white ring. F 24 mm.

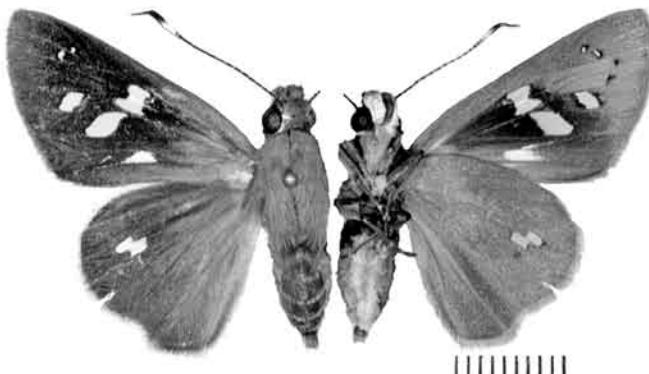


Fig. 48. *Carystoides basoches* female, above St. Benedict's, MVL, 26.v.1981.

The male with its white apical area and arrangement of spots could only be confused with the males of *C. noseda* and *C. sicania*. Whereas the male of *C. basoches* has rectangular white hyaline spots in spaces 3-5 H, in *C. noseda* the hyaline spot H is small, round and restricted to spaces 4-5, while in *C. sicania* the H spot is smaller and near the base of space 3. The female of *C. basoches* has rectangular pale yellow hyaline spots in spaces 4-5 H, and dark spots UNF in spaces 4 and 5, whereas the female of *C. noseda* has a white hyaline spot H which is smaller and circular, in space 5 only, and no dark spots UNF. The female of *C. sicania* has a strong white hyaline spot in space 6 F, and no dark spots UNF in spaces 4 and 5; the spots H are similar to those of *C. basoches*, but there is also a small spot in space 2 UNH.

This species is most frequently encountered when adults of either sex are attracted to light in the early evening; Sir Norman Lamont's collection includes 12 specimens from Palmiste which were probably caught in this way and I have occasional records from my house in Curepe. Other records (Inniss Field, Grande Ravine, Sangre Grande, Siparia, St. Ann's, St. Benedict's) suggest this species is widespread, but perhaps mainly encountered in lowland areas.

The larvae resemble those of *Cobalus [virbius]* according to Moss (1949) and he found them on tucumá and pachiúba palms (*Astrocaryum* sp(p). and *Socrates exorrhiza*), as well as a potted ornamental palm. Moss's material included three other *Carystoides* spp. including *C. noseda* and *C. sicania* (W. H. Evans' footnote in Moss 1949), and the early stages in the NHM are separated into these three species, although they are all very similar, and not that similar to *C. virbius*. The cast L5 head capsule is rounded in outline, flattened in front, and light brown. The pupal shelter is formed within a palm leaflet, and protected at each end of the shelter by a series of five distinctive reticulate nets of silk about 3-5 mm apart; the inside of the shelter is lightly covered with white waxy powder. The emerged pupa is smooth, stout, with no frontal spike and the proboscis sheath extends to the cremaster tip; light brown with spiracle T1 brown.

Chamaedorea tepejilote and *C. costaricana* are the regular food plants of this species in Costa Rica (Janzen and Hallwachs 2001), but it has also been reared occasionally from other palms: *Acrocomia aculeata*, *Bactris guineensis*, *B. major* and *Prestoea decurrens*. Janzen and Hallwachs (2001) illustrate two forms of the larva. One has a pale brown head, and a narrow lateral line from the vertex to the reddish mouth parts, and is comparable to

Moss's head capsules in the NHM. The other is darker brown with a heavy lateral line and another running down the centre of the face, with a short branch along the upper part of the adfrontal area. The mature larvae develop a layer of white waxy powder laterally on the head, and on the body, and only at this stage could be said to resemble *Cobalus virbius* (cf. comments in Moss (1949) referred to above).

The early stages have not been recorded in Trinidad, but the larvae can be expected to be found on ornamental and wild palms in lowland situations, probably including urban areas. S. Alston-Smith (pers. comm.) has reared this species in Trinidad from an unidentified palm. He notes that the large larvae of both this species and the next make a shelter by tying one leaflet on top of an adjacent one. The larva then consumes one of the leaflets only.

210. K28/2 *Carystoides noseda* (Hewitson 1866)

Figs. 49-50.

This species is not common in collections, with scattered records from Colombia, Trinidad, Suriname, Amazons (TL), Belém and Minas Geraes (Evans 1955).

Kaye (1921 addenda) lists two of Sir Norman Lamont's specimens from Palmiste taken 14.ii and 30.iv.1921 when he added this species to his catalogue. Neither specimen is in Lamont's UWI or NMS collections, and neither collection contains any material of this species. There is a female in the NHM collected by P. Lechmere Guppy without further data (Fig. 50), and I have a male collected at St. Benedict's (ix.1980) by David J. Hunt – probably at the lights of the Pax Guest House (Fig. 49).

Male. As male *C. basoches*, but smaller, the UNS light brown areas have a violet flush, the white hyaline spots H are smaller, and the spot in space 3 is absent. Evans (1955) states that the white apical patch is 3 mm wide in this species, but my Trinidad male has this patch 2 mm wide, the same as *C. basoches*.

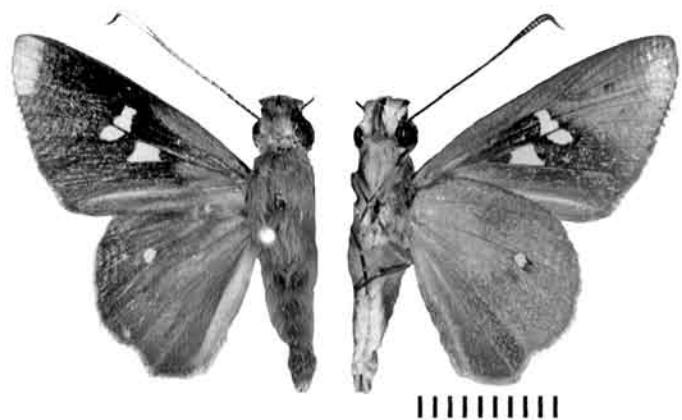


Fig. 49. *Carystoides noseda* male, St. Benedict's, ix.1980, D. J. Hunt.

Female. Similar to female *C. basoches*, but the white hyaline spot H is smaller and circular, in space 5 about one third of the distance from the end of the cell to the margin. The apical area UNF and UNH is paler brown than in *C. basoches*.

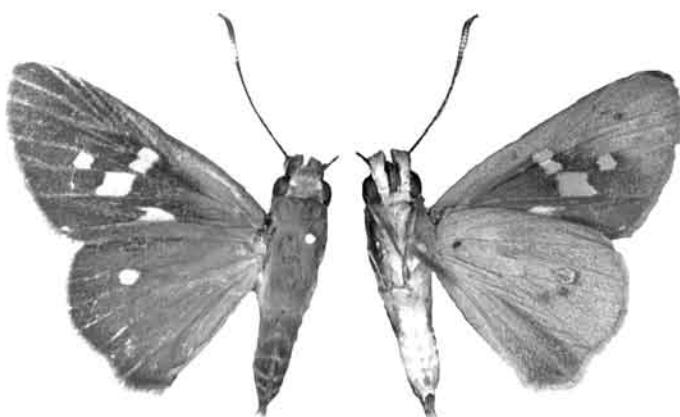


Fig. 50. *Carystoides noseda* female, Trinidad, P. Lechmere Guppy (specimen in NHM).

Moss's records of *C. basoches* from palms would seem to include material of this species too (see *C. basoches* above).

211. K28/10 *Carystoides sicania orbius* (Godman 1901) Figs. 51-52.

The nominate subspecies, *sicania* (Hewitson), is restricted to southern Brazil; ssp. *orbius* was described from Nicaragua but its range is the northern part of South America (Evans 1955).

Evans' (1955) listing of a male in the NHM is the first Trinidad record. This specimen is a male, labelled simply "Trinidad" (Fig. 51).

Male. Similar to *C. basoches* and *C. noseda*, but the hyaline spot H is smaller, and placed at the base of space 3. In addition, F hyaline spots are pale yellow; there is a white hyaline dot near the base of space 6 F in the Trinidad specimen; the F cell spot is almost divided into an upper and lower spot; UNH there is a second spot at the base of space 4; F the cell spot is more or less divided into an upper and lower spot; UPF costa to cell spot and UNF costa to end cell chestnut brown; UNH is strongly diffused with chestnut; and at least in the Trinidad specimen the abdomen UNS is plain white.



Fig. 51. *Carystoides sicania orbius* male, Trinidad (specimen in NHM).

Female similar to *C. basoches* and *C. noseda*, but F hyaline spot 6 well developed, only slightly smaller than that in space 3; very small spot in space 7, basal to that in space 6; F cell spot

almost divided into an upper and lower spot; UNF no dark spots in spaces 4 and 5; UPH with hyaline spot in space 5, adjacent to a white spot in space 4; a dot in space 3 distal to those in spaces 4 and 5; UNH spots as for UPH, but a dot in space 2, just basal to spot in space 3.



Fig. 52. *Carystoides sicania orbius* female UNS, Sangre Grande, viii.1990, S. Alston-Smith (specimen in SAS).

S. Alston-Smith (pers. comm.) has taken this species at scattered localities in Trinidad: Guanapo (male ix.1987), Mt. Tamana (female v.1993), Sangre Grande (male xii.1988, female viii.1990; Fig. 52), and Sans Souci (male vi.1993). It seems to be a generally scarce species.

As indicated under *C. basoches* (above), Moss's material of "*C. basoches*" reared from palms includes material of *C. sicania*.

212. K28/12 *Carystoides cathaea* (Hewitson 1866) Figs. 53-54.

The type locality of this species was not recorded, but it is found in the Guyanas and the Amazon Basin (Evans 1955).

Kaye (1921) reports this species from Trinidad based on a specimen taken in Fondes Amandes Valley. I have not seen this specimen, but I have a male taken in the forest near Moruga Bouffe, 23.v.1982 (Fig. 53). S. Alston-Smith (pers. comm.) has specimens from Aripo Savanna (male i.1982) and Sangre Grande (female viii.1989, female vii.1993; Fig. 54). This seems to be a rare species in Trinidad perhaps associated with damp lowland areas, although it may normally be crepuscular, and hence rarely encountered.

Sexes similar, except the male has vein 1 UNF white and the female has a narrow pale spot against vein 1 in space 1B F. UPS brown; margin from vein 2 to apex broadly paler; apical area palest at margin of spaces 4-5; white hyaline spots in spaces 2 (against cubitus and under origin of vein 3, lower external corner elongate), 3 (against cubitus and under origin of vein 3, outer margin excavate), and cell (across cell, lower outer corner meets upper inner corner of spot in space 3, well separated from spot in space 2). UNF costa brown; apical area to vein 2 light brown with lilac flush; spaces 1A and 1B light brown; disk black-brown. UPH brown. UNH with rays of different colours from the base: space 1A light brown with a violet tint; space 1B and lower half of 1C black-brown; upper half of space 1C light brown; cell (except upper margin) and spaces 2-4 brown with violet flush fading to light brown at margin of space 2; upper part of cell, base of space 6 and space 5 whitish brown; remainder of space 6 and space 7 brown with a violet flush. F male

23 mm.

The rayed appearance of the UNH is unique in the Trinidad fauna.

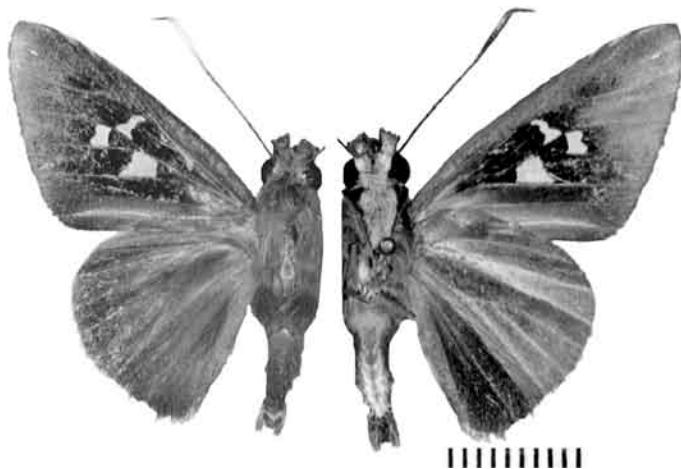


Fig. 53. *Carystoides cathaea* male, Nr Moruga Bouffe, 23.v.1982.

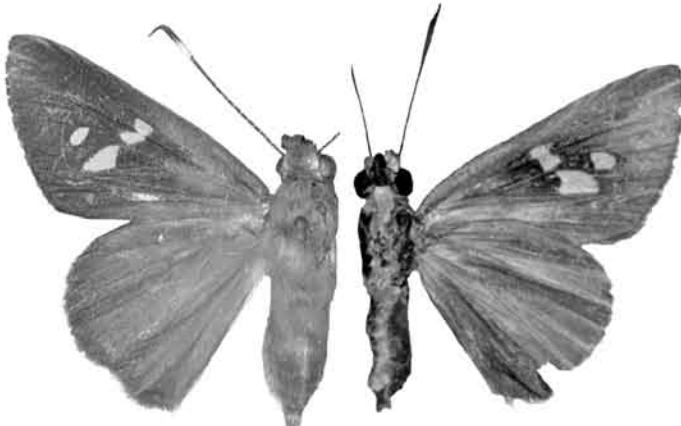


Fig. 54. *Carystoides cathaea* female. Left UPS, Para, Brazil (specimen in NHM); right UNS, Sangre Grande, vii.1993, S. Alston-Smith (specimen in SAS).

Moss (1949) notes the unusual behaviour of this species "haunting the house where it flits to and fro in quest of the most shady spot and then settles for a long while". Perhaps this too is a crepuscular or nocturnal species, like others of the genus.

Moss (1949) reared this species from four different species of palms. S. Alston-Smith (pers. comm.) has associated this species with picmoc, *Bactris major*, but not reared it.

213. K30/2 *Perichares philetes* (Gmelin [1790])

Figs. 55-61.

Evans (1955) treats *Perichares philetes* as four subspecies: *dolores* (Reakirt) from Mexico (TL) south along the Andean countries to southern Brazil, *philetes* (Gmelin) from the Greater Antilles (TL Jamaica), Guyanas, and Amazon, *aurina* Evans which may be just a variety of *dolores*, occurring from central America to Paraguay, and *limana* Evans based on an isolated population from coastal Peru. This species has also been referred to as *P. coridon* (Fabricius) (sometimes mis-spelt as *corydon*) and *P. phocion* (Fabricius), but both are unavailable homonyms (Evans 1955).

The first Trinidad record was that of Crowfoot (1893) as *Carystus corydon*.

Male. UPS brown; yellow hyaline spots in spaces 2 (narrow at vein 3, wider at vein 2), 3 (quadrate), cell (upper spot a distinctive elongate streak, lower spot small, against the basal end of the upper spot); a yellow spot is also sometimes present in lower space 1B (against vein 1, just distal to brand); broad grey brand, starting under vein 3 close to pointed end of spot in space 2, running to the cubitus and then curving away to vein 2 and straight across to vein 1. UNF brown, the apical area from the end of the cell and vein 4 mottled with light purple; a patch of yellow on the costa extends from the upper cell spot to the costa. UPH brown. UNH space 1A-1B brown; remainder of wing dark brown mottled with purple. Underside of abdomen orange-brown. Cilia pale 1B-6 F and 1B-7 H, with vein ends dark. F 23-24 mm. Illustrations in Brown and Heineman (1972, plate X, male but the brand is not evident), Lewis (1973, plate 85.7, male UNS) and Smart (1976, p.113, fig. 68, male UPS).

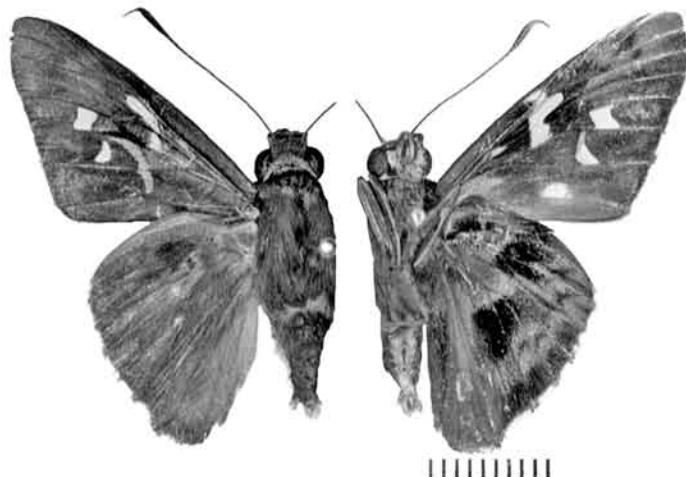


Fig. 55. *Perichares philetes* male, Curepe, 25.ix.1978.

Female similar to male, but UPF the spot in lower space 1B is normally present; there is a spot in upper space 1B, adjacent to the lower external margin of the spot in space 2; the two cell spots are usually joined. In one specimen (Fig. 57), the UPF upper cell spot is reduced to a small dash, and the lower cell spot is absent. F 26-28 mm. Illustration in Smith *et al.* (1994, plate 30.4, female).

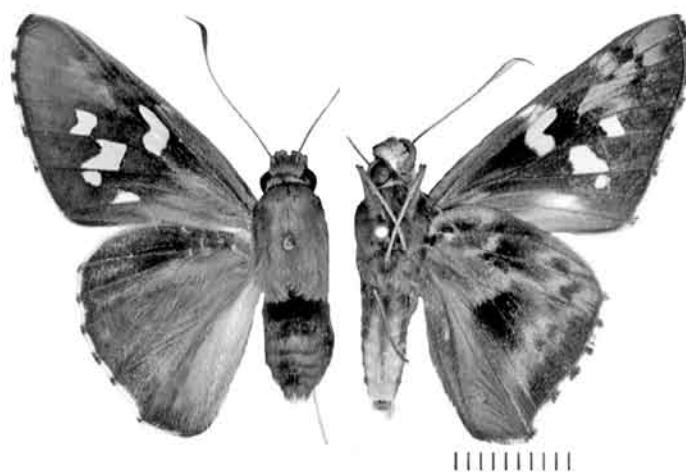


Fig. 56. *Perichares philetes philetes* female. Left UPS, Golden Grove, pupa on maize, xi.1980; right UNS, St. Benedict's, 12.x.1993.



Fig. 57. *Perichares philetes philetes* atypical female with reduced markings, Curepe, MVL 16.ix.1979.

There seems to be some variability in the presence and shape of the F spots in this species, and examination of more material will probably show greater variation than that mentioned here. The mottled purple UNS could only be confused with *P. lotus* below, but the F spotting of both sexes of *P. lotus* is very different.

This is a common and widespread species throughout lowland Trinidad, but does not seem to extend to any great altitude in the Northern Range, i.e. I have no records likely to be from above 1,000 ft. Sheldon (1936) records this species (as *Perichares corydon*) from Tobago citing his capture of a single specimen at Speyside; there is a pair of this species from the Sheldon collection in the NHM.

Brown and Heineman (1972) and Smith *et al.* (1994) both mention that although adults are active throughout the day, they are distinctly more active at dusk and dawn. Panton (1897) records that oviposition occurs "late in the evening". Since he was able to observe this while walking among some growing canes, the implication is that this was no later than at dusk. As a result of this flight time, adults are occasionally attracted to lights in the early evening. Thus, *P. philetes* used to come to my house lights and to my mercury vapour (MV) light moth trap in Curepe, occasionally but regularly. I have nine records of this behaviour from 1978-79, all from the months August to October, peaking in October, but did not record this behaviour thereafter. In the CABI Bioscience collection there are a further five specimens collected at light trap in Curepe in October 1972 which suggest this may be a consistent flight pattern at this time of year. Smith *et al.* (1994) report that adults occasionally come to flowers; reported nectar sources include coffee (Panton 1897), *Lantana*, *Bidens*, *Cordia* and *Jacquemontia* (Smith *et al.* 1994).

Panton (1897) provides a detailed account of the biology of this species in Jamaica (as *Carystus corydon*), including descriptions of all stages, and larval behaviour. This description has not since been bettered, and Brown and Heineman (1972) reproduce it verbatim. By the final instar the larva measures 53 mm; the head is relatively small, uniform light brown with dark stemmata; the body is described as clouded greenish-yellowish covered with "white downy hairs", and there is a broad greenish yellow dorsal stripe, which is dark green in the middle. Panton also refers to a "broad chalky-white blotch" on the undersurface of segment 4; this is the

wax gland ventrally on segment A1. The food plants reported by Panton are sugarcane, "indian corn" (i.e. *Zea mays*) and *Panicum maximum*.

There are records of *P. philetes* as a minor pest of sugar cane in Cuba, Haiti, Dominican Republic, Puerto Rico, Trinidad, Venezuela, British Guiana and Argentina (Box 1953). Additional food plant records from two bamboos, *Bambusa vulgaris* and *Cephalostachyum pergracile*, are given in Puerto Rico (1939). Wolcott (1951) adds a few details of the larva (as *Perichares phocion*), highlighting the "broad greenish-yellow dorsal stripe and long white hairs". Dethier (1942) records finding larvae of this species twice on sugarcane in Cuba, and refers to the larval head as "light yellow to green and unmarked, but covered with dense long colorless hairs".

In Guyana, *P. philetes* has been reported as a pest of coconut (Bodkin 1916) and sorghum (Sinha 1982). Although the larvae occasionally use jacetára palm (*Desmoncus* sp.) and *Hyospatha elegans* (Arecaceae), it is most commonly found on sugarcane at Belém (Moss 1949). The larva is very light yellow-green, glossy on the dorsal area and with recumbent light setae laterally. The pupa is green with a pair of dorsal lines, a prominent frontal spike and a long proboscis sheath. Smith *et al.* (1994) summarise the published accounts.

In Costa Rica, the larvae normally feed on grasses such as *Panicum maximum*, *Paspalum virgatum*, *Olyra latifolia* and *Rottboellia cochinchinensis*, but also can be found occasionally on palms, *Prestoea decurrens*, *Geonoma interrupta* and *Chamaedorea dammeriana* (Janzen and Hallwachs 2001).

I have reared this species once from a pupa collected on maize (Golden Grove, xi.1980) but did not record any details. S. Alston-Smith (pers. comm.) has reared *P. philetes* from "bull grass" and an unidentified palm in Trinidad. I have found a larva at Innis Field (MJWC ref. 04/23, 16.i.2004) on *Paspalum fasciculatum*, a large swampland grass. I am reasonably confident the larva was of this species, but unfortunately the resultant pupa died due to a fungal infection, so my identification needs confirmation. The fungus was identified by Dr. H.C. Evans as *?Paecilomyces reniformis* cf. The following description is based on this specimen.

Pupa 40 mm. Elongate, smooth; setae on eyes except central stripe, proboscis extends 5 mm beyond the wing cases, and 11 mm short of cremaster tip; frontal spike 2.5 mm, stout, blunt, rugose distally, pale brown; cremaster 2.5 mm, slender; pale green with narrow yellow sub-dorsal line; spiracles pale, inconspicuous.

L5 up to 50 mm or more. Head rounded, wider at base, indent at vertex; very pale green, almost white; stemmata black; mandibles dark; head covered with long, erect white setae, directed downwards and forwards. T1 pale green; translucent dorsal plate. Body dorsally and laterally yellowish with a green tint; diffuse yellow sub-dorsal line, more evident at a distance than when viewed close up; below spiracles and ventrally transparent green; body covered with scattered long, erect, white setae; posterior margin of segments T2-A8 with three folds in the cuticle. Legs and prolegs pale concolorous; spiracles white, inconspicuous; anal plate semi-circular. In the mature fifth instar, the wax glands develop as a single transverse patch on the posterior margin of A1 (cf. *Orses cynisca* below).

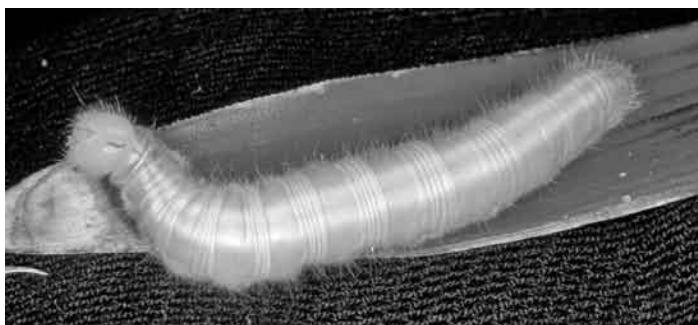


Fig. 58. *Perichares philetes philetes* L5, Inniss Field, larva on *Paspalum fasciculatum*, MJWC ref. 04/23.

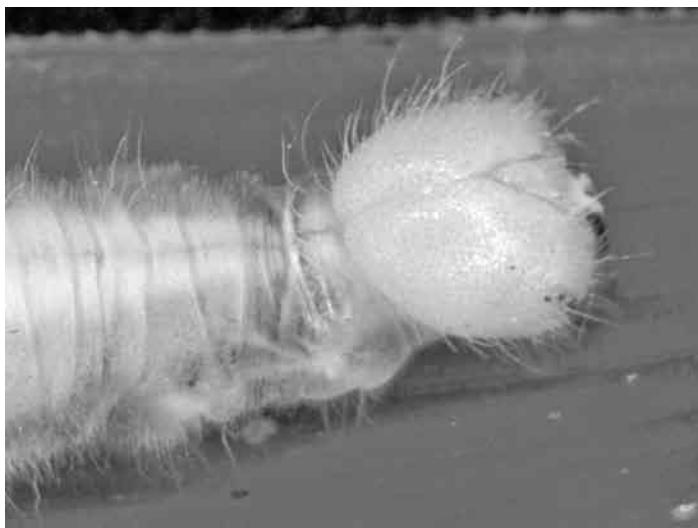


Fig. 59. *Perichares philetes philetes* L5, detail of head, Inniss Field, larva on *Paspalum fasciculatum*, MJWC ref. 04/23.

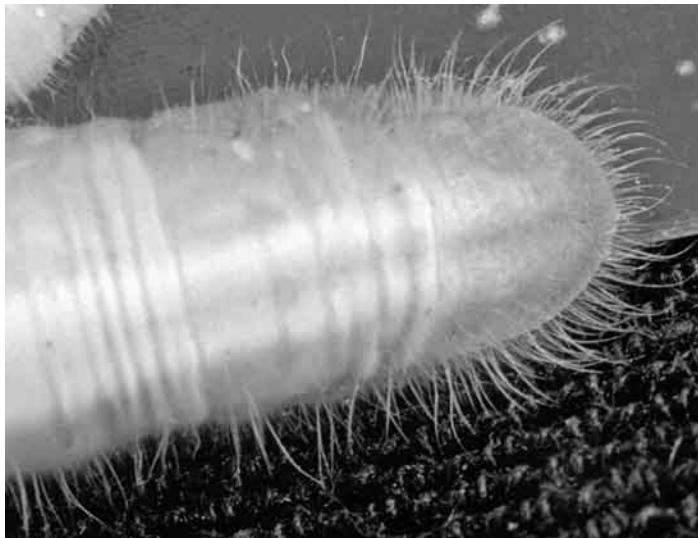


Fig. 60. *Perichares philetes philetes* L5, detail of anal plate, Inniss Field, larva on *Paspalum fasciculatum*, MJWC ref. 04/23.

L4 26 mm, seven days before moult to L5 completed. Head rounded, wider at base, slightly indent at vertex; bone white, mouth

parts dark; face with black speckles on clypeus, and in broad arc on epicranium. Body shiny, light green; sub-dorsal whitish line. Legs black; prolegs pale concolorous; spiracles pale.



Fig. 61. *Perichares philetes philetes* L4, detail of head, Inniss Field, larva on *Paspalum fasciculatum*, MJWC ref. 04/23.

Panton (1897) includes a description of one parasitism event which seems to refer to a gregarious euphorid attacking a young larva, but subsequent entomologists do not mention parasitism.

214. K30/3 *Perichares lotus* (Butler 1870)

Figs. 62-63.

This species is found from Mexico to Paraguay, TL Venezuela (Evans 1955).

Kaye (1904) described this species as *P. heroni* from a Trinidad specimen captured by Lady Broome, naming it after Mr. F. A. Heron of the NHM. Kaye does not mention the sex of his type specimen, but Evans (1955) notes that it is a male and held in the NHM. Thus Kaye and Butler described the two sexes as different species – an understandable error given the strong sexual dimorphism of this species. Subsequently, Kaye (1921) classifies his *P. heroni* as a synonym of *P. lotus*, a treatment also followed by Evans (1955). Curiously, Kaye (1904) also includes records of a male and female of *P. lotus* in his first list, commenting that the male is probably frequently mistaken for *P. corydon* (i.e. *P. philetes*). This information is repeated, together with the description of *P. heroni* under *P. lotus* in his catalogue (Kaye 1921).

Male. UPS brown, body and basal area UPH with green hairs. White hyaline spots in space 3 and across end cell; broad dark grey-black band, starting under vein 3 under inner margin of spot in space 3, running to the cubitus and then curving away to vein 2 and straight across space 1 to vein 1. UNF brown, the apical area mottled with light purple; disk blackish; dorsum pale brown; a yellow mark on the costa adjacent to the cell spot. UNH space 1A and 1B light brown; remainder brown, mottled with light purple. UNS of abdomen light yellow.



Fig. 62. *Perichares lotus* male, Siparia, x-xii.1920, A. Hall (specimen in NHM).

Female. UPF brown with light green-blue iridescence on thorax and basal part of wings; white hyaline spots in upper space 1B (against vein 2, partially overlapping with the spot in space 2), 2 (large, under basal part of vein 3), 4 (narrow) and cell (across width of cell, in line with spots in spaces 2 and 1B). UPH brown with light green-blue iridescence extending from base of wing to end cell and 2/3 in space 1B. UNF costa light brown with a pale patch extending cell spot to costa; apical portion from end cell and extending into space 3 brown, mottled with light purple; space 1A and distal half of lower 1B light brown; disk black-brown. UNH space 1B and adjacent half of space 1C light brown; remainder brown mottled with violet. F 25 mm. Illustration in Lewis (1973, Plate 85.6, female UPS).

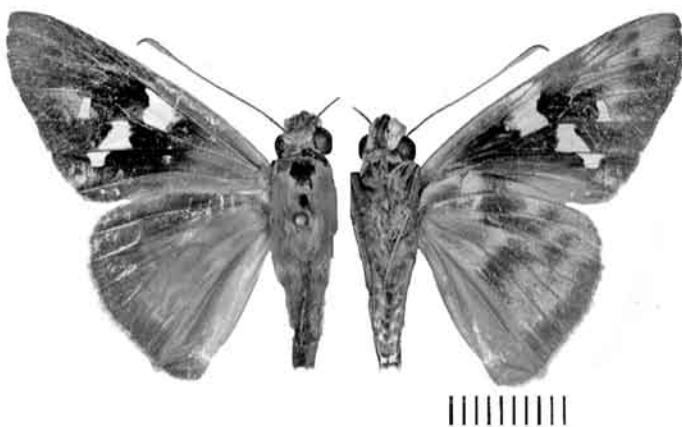


Fig. 63. *Perichares lotus* female, Curepe, 23.1-10.ii.1982, F. D. Bennett.

The mottled underside could only be confused with *P. philetetes* above, but the F spots in both male and female are very different in these two species.

This species is much less common than *P. philetetes*, and I have only a handful of records. Localities include Arima District (male xii.1931-i.1932, A. Hall, NHM), Caparo (male, NHM), Curepe (female 23.i-10.ii.1982; Fig. 63), Inniss Field (male i.1990, SAS; female iii.1985, SAS; female vii.1987, SAS), Maracas Valley, 600 ft. (female xii.1921, F.W. Jackson, AME), Maraval (female vii.1891, NHM), Moruga West (male xi.1988, SAS), Mt. Tabor (male 16.i.1982, J. and F. Preston), Parrylands (male i.1984, SAS), Siparia (male x-xii.1920, A. Hall, NHM; Fig. 62). My specimen

from Curepe was taken in my MV light trap, suggesting that this species too may have crepuscular habits.

Life history and food plants apparently unknown, but *P. lotus* is likely to feed on broad-leaved grasses.

[215. K30/5 *Perichares deceptus fulvimargo* (Butler 1873)]

Evans (1955) and Mielke (2004) treat this uncommon species under four subspecies: *deceptus* (Butler and Druce) from central America, *drina* Evans from Colombia and Peru, *fulvimargo* from Peru, Ecuador, Colombia and Venezuela (TL), and *luscinia* (Plötz) from southern Brazil. In my 1982 checklist (Cock 1982b) I assumed that the relevant subspecies for Trinidad would be *fulvimargo*.

Kaye (1921) records A. Hall's capture of a specimen of this species in November 1920 as *P. agrippa* Godman, a male synonym of *deceptus* (which was described from the female). There are no specimens of this species from Trinidad in the NHM (Evans 1955), and Kaye's record may be based on a male *P. lotus* collected x-xii.1920 by A. Hall in the Booth Museum.

Based on available evidence, I conclude that *P. deceptus* does not occur in Trinidad, and that it should be removed from the Trinidad list.

[216. K31/1 *Orses cynisca* (Swainson 1821)]

Figs. 64-71.

This widespread species was described from south Brazil and is known from Mexico to Paraguay (Evans 1955). Crowfoot (1893) included this species as *Carystus cynisca* in the first list of Trinidad butterflies.

Male. UPF brown; yellow hyaline spots in spaces 2 (beyond origin of vein 3, hourglass shaped), 3 (against vein 3, overlapping spot in space 2), and cell (broad spot across width of cell); brand grey and conspicuous, from upper inner angle of spot in space 2 to cubitus and then curving down into space 1B, in lower two thirds of space 1B becoming narrow and inconspicuous. Evans (1955) states that the three F spots are conjoined in the male, but in the Trinidad specimen before me, the cell spot is separated from the other two. UPH brown, narrowly yellow in apical part of space 7. UNF brown, with a yellow patch extending the cell spot to the costa. UNH ferruginous brown; narrowly pale yellow margin in spaces 3-7. Femora and tibiae orange; underside of abdomen pale yellow with a dark brown central line. F 24 mm. Illustration in Lewis (1973, Plate 84.27, male UNS).

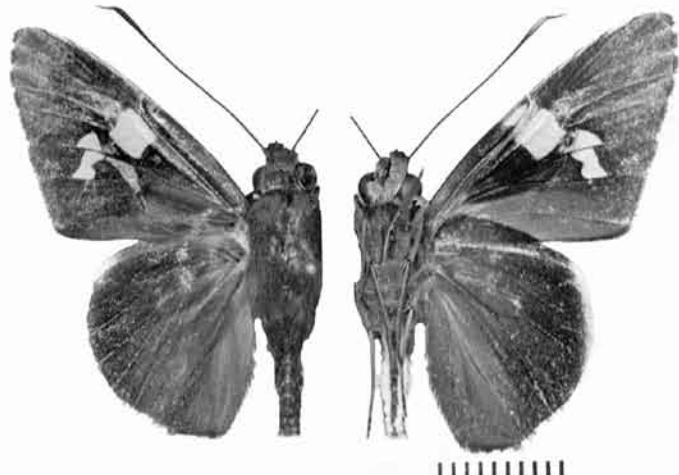


Fig. 64. *Orses cynisca* male, Mt Tabor, 22.xi.1981.

Female. UPF dark brown; white hyaline spots in space 1B, 2 and cell form a band across wing, divided only by dark veins. UPH dark brown; pale yellow marginal patch in spaces 6 and 7; cilia pale yellow in spaces 1C to 7. UNF brown; a pale yellow patch extends from the cell spot to the costa. In the resting position (Fig. 66) this spot aligns with the pale yellow margin UNH. UNH ferruginous brown; a broad pale yellow margin to the wing from space 2 to space 7. Legs and abdomen underside as male. F 25 mm.

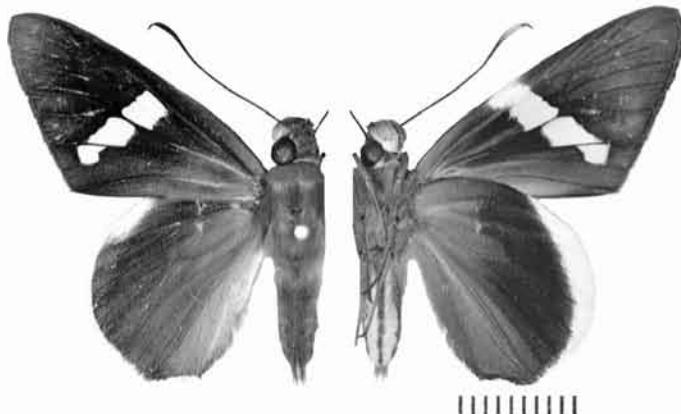


Fig. 65. *Orses cynisca* female, behind St. Benedict's, larva on *Olyra ciliatifolia*, MJWC ref. 94/38.

The male and female UPF markings and the female's broad pale yellow margin UNH are unique in the Trinidad fauna.



Fig. 66. *Orses cynisca* adult female, collected as larva behind St. Benedict's, on *Olyra ciliatifolia*, MJWC ref. 94/38.

This is an occasional and widespread species in Trinidad. Most records are from northern Trinidad where it can be found to at least 1,000 ft. in the Northern Range (Curepe, Las Lomas, Maraval, lower Morne Catharine, Mt. Tabor, Port of Spain, Quare Road, St. Ann's, St. Ann's Valley, St. Benedict's), but there are also records from central Trinidad (Caparo, female, F. Birch, NHM) and south Trinidad (Quinam, male, 27.xi.1916, Sir N. Lamont, NMS).

Moss (1949) reared this species from a larva on ground bamboo, but I cannot identify what plant this refers to, although in view of more recent records, it is likely to be an *Olyra* sp. Janzen and Hallwachs (2001) reared it repeatedly from *Olyra latifolia*, and rarely from *Lasiacis procerrima*, *L. sorghoidea* and *Panicum maximum* (all Poaceae).

I have found larvae once on a sedge, *Scleria latifolia* (Quare Road, MJWC ref. 82/51) and twice on *Olyra* spp.: *O. latifolia* (behind St. Benedict's, MJWC ref. 94/33), and *O. ciliatifolia* (Inniss Field, MJWC ref. 04/29). Twice I have found pupae (with associated feeding) on *O. ciliatifolia* (behind St. Benedict's, MJWC refs. 94/38, 94/44). The larva on *S. latifolia* was an L4 preparing to moult to L5; it had made a shelter by partially turning over one side of a leaf truncated by feeding, and it had spun a thin continuous film of silk so that the larva was entirely protected within this shelter. One field collected pupa was found fully exposed on the basal half of the terminal leaf of *O. ciliatifolia* – the distal half having been eaten.

Pupa 34-39 mm; smooth, slender, elongate; 1.5-2 mm frontal spike, tip dark, down-turned; cremaster slender, pointed; proboscis sheath extends 2 mm beyond cremaster in one specimen and 9 mm beyond wing cases, 6 mm short of cremaster tip in another; covered with inconspicuous short, pale setae on head, thorax apart from appendages, and abdomen; no white waxy powder. The pupal case is transparent and thin; covered with short, pale, erect setae; the colour through the cuticle is green, with a white sub-dorsal line from the front of the thorax to near the base of the cremaster, slightly diffuse on outer edge; a dorso-lateral white line from metathorax to A6. The thin cuticle of the pupa usually collapses after the adult has emerged.



Fig. 67. *Orses cynisca* pupa, behind St. Benedict's, larva on *Olyra ciliatifolia*, MJWC ref. 94/38.

L5 43 mm fully grown. Head wider at base, rounded, strongly indent at vertex; very pale brown, ventral quarter black; covered with short, pale, erect setae. Body shiny green (similar to the leaves of *Olyra ciliatifolia*); covered with short pale setae; spiracles pale, a well marked pale patch around spiracle A8, smaller patches around other spiracles; a diffuse dark spot anterior and dorsal to the white patch around spiracles A8. Legs black; prolegs pale concolorous. The wax glands of the mature larva are restricted to a ventral band on A1; the same character was noted in the larva of *Perichares philetis* above, but not thus far in other genera, confirmed the close relationship of the two genera.

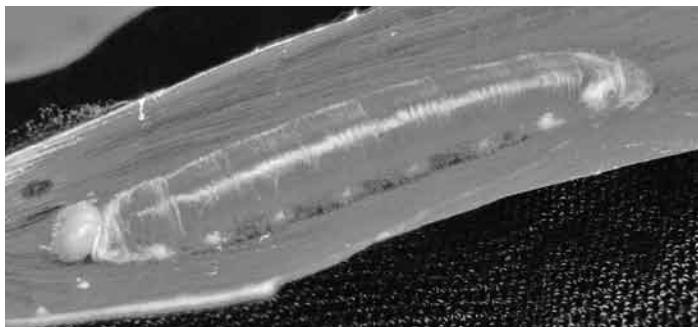


Fig. 68. *Orses cynisca* L5, Inniss Field, larva on *Olyra ciliatifolia*, MJWC ref. 04/29.

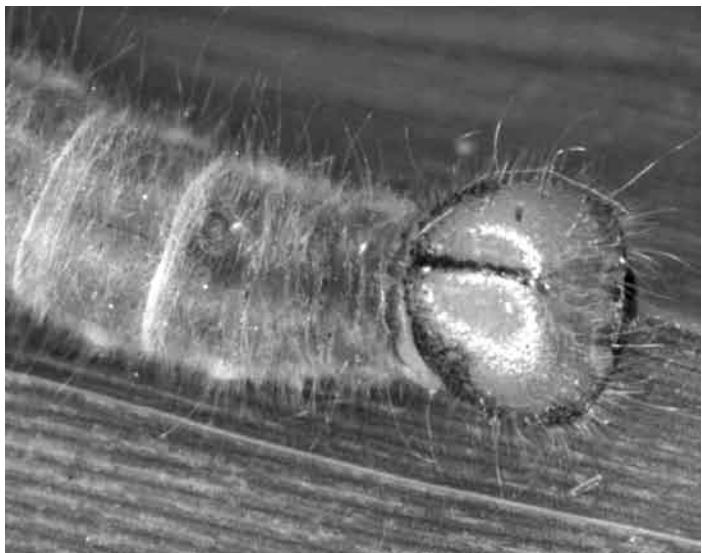


Fig. 71. *Orses cynisca* larva, fourth instar, detail of head, behind St. Benedict's, larva on *Olyra latifolia*, MJWC ref. 94/33.



Fig. 69. *Orses cynisca* L5, detail of head, Inniss Field, larva on *Olyra ciliatifolia*, MJWC ref. 04/29.

L4 head light translucent brown; posterior margin narrowly dark; a diffuse dark lateral marking from apex almost reaching stemmata; epicranial suture and mouth parts dark; one specimen has a small dash on epicranium close to and parallel to epicranial suture; head covered with long pale setae. T1 with a narrow black dorsal plate. Body dull dark green, with a pale sub-dorsal line; body covered with long pale setae; legs dark.

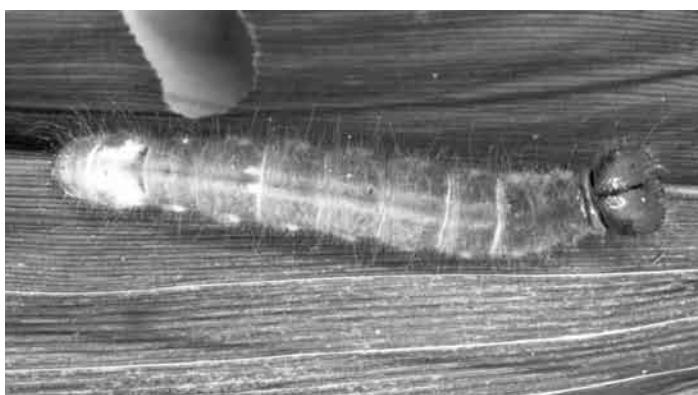


Fig. 70. *Orses cynisca* larva, fourth instar, behind St. Benedict's, larva on *Olyra latifolia*, MJWC ref. 94/33.

A tachinid larva emerged from one L5 larva collected as an L4 (behind St. Benedict's, MJWC ref. 94/33), but the resultant puparium failed to emerge. One pupa was found dead in the forest behind St. Benedict's (MJWC ref. 94/44) and had turned black. Subsequently fungus started to grow from the abdomen, and this was identified by Dr. C. Prior as the entomopathogenic fungus *Metarrhizium anisopliae* (IIBC No. I94-936).

ACKNOWLEDGEMENTS

The following have very kindly assisted in providing access to the collections in their care: Dr. George McGavin of the Hope Entomological Collections, Oxford University Museum (HEC), Dr. Phillip Ackery of the Natural History Museum (NHM) (formerly British Museum (Natural History)), Dr. Mark Shaw of the National Museums of Scotland (NMS), Mr. Scott Alston-Smith to his private collection (SAS), Professor Julian Kenny and Dr. Gene Pollard of the University of the West Indies, St. Augustine (UWI), Dr. Gerald Legg of the Booth Museum, Brighton, Drs. Lee and Jacqueline Miller of the Allyn Museum of Entomology, Sarasota, Florida (AME). I acknowledge with thanks that several of the species are illustrated with photographs of specimens held in the collections of NHM, SAS and NMS.

I reiterate my thanks to Dr. C. Dennis Adams, Dr. Yasmin Comeau, Mr. Bhorai Kalloo and Mr. Winston Johnson of the National Herbarium who identified the plants from which I reared Hesperiidae in Trinidad. I also thank Dr. Kurt Johnson, who provided the photographs of the type of *Argon casca* Bell from the American Museum of Natural History, Mr. Steve Steinhauer, AME, who identified a picture of *Damas clavus* for me, and Drs. Harry Evans and Chris Prior, who identified entomopathogenic fungi.

Don Sands nagged me into following the rule of the International Code of Zoological Nomenclature which states that when a species is placed in a genus other than that in which it was described, parentheses are placed around the original author's name which follows. I had not followed this rule, anticipating that an application to remove it would be successful, but this was not the case. I have therefore now used Beccaloni *et al.* (2004) to check

the original genus of all species names used and placed parentheses around author's names accordingly.

Once again, I especially thank Mr. Scott Alston-Smith who has read and commented on this paper, and provided additional records from his collecting, and observations and food plant records that have not previously been published.

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Automeris liberia (Cramer) (Lepidoptera: Saturniidae) in Trinidad

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ABSTRACT

The unidentified saturniid larva illustrated in Cock (2003, *Living World*, Plate 2, No. 12) which I photographed on a Convolvulaceae vine at Morne Bleu Textel, 18.i.1988 is now identified as a fifth instar *Automeris liberia* (Cramer), by comparison with images on the internet and written descriptions of Trinidad observations. The Trinidad literature referring to this species under at least three different names is summarised, and adult male and female moths are illustrated.

In Cock (2003, Plate 2, No 12) I illustrated an unidentified saturniid larva which I photographed on a Convolvulaceae vine at Morne Bleu Textel, 18.i.1988 (not 1985 as given in the plate legend). I have now identified the larva as a fifth instar *Automeris liberia* (Cramer), by comparison with images on the internet (Riekert 2004; Wenczel 2004; Wolfe 2004), and written descriptions of Trinidad observations (below). This note is to place this identification on record, but to also summarise the Trinidad literature referring to this species under at least three different names.

Guppy (1911) treats this species as “*Hyperchiria* sp.” noting incorrectly that *Automeris* is a synonym. Guppy refers in a footnote to H. F. Wilson captured a specimen of this moth at light in 1892, and included it in his list of butterflies and moths of Trinidad. In this paper, Wilson (1894) lists 29 moth species, and “*Hyperchiria* sp.” is the only Saturniidae species. Wilson comments “Taken at light in Woodford House; yellow forewings, reddish under wings with large eye.” This short description could apply to more than one *Automeris* sp., so it seems likely that Guppy had personal information in making his statement.

Kaye (1901) recorded this species from Trinidad as *Automeris erisichton* Boisduval, based on a specimen his brother, S. Kaye, captured at Verdant Vale (Arima Valley). Kaye and Lamont (1927) repeat this record and add new records from Guaico (18.iv.1915, N. Lamont) and Palmiste (1.ii., 17.iii., 4.iv.1922, N. Lamont). *Automeris erisichton* is a synonym of *A. liberia* (e.g. Lemaire 1996).



Fig. 1. *Automeris liberia* male, Arima Valley, Scott Quarry, at light, 28.x.1978 (M. J. W. Cock); scale bar 1 cm.

Subsequent collecting has shown this species to be widespread and quite common all over Trinidad, and there are identified specimens in various collections including the University of the West Indies, CABI Bioscience, the Natural History Museum (London), Oxford University Museum, etc. Adult specimens are shown as Fig. 1 (male) and Fig. 2 (female). The F is shades of light brown in both sexes, as is the margin H; the base and disc UPH is orange-brown, brighter in the male. This is a distinctive species in Trinidad, as the arrangement of the spots within the “eye” of the hind wing is unique.



Fig. 2. *Automeris liberia* female, Morne Bleu, Textel Installation, at light, 13.ix.1978 (M. J. W. Cock); scale bar 1 cm.

The first observations on the biology of this species in Trinidad are those of Guppy (1911) who as noted above refers to it as *Hyperchiria* sp. He describes larvae collected from coconut as “formidable looking light green caterpillars covered with numerous needlepointed branched spines, and there is a long narrow whitish stripe running along each side edged with reddish brown. The spiracles ... are dull yellow.” Urich (1915) clarifies that the species treated by Guppy was *A. liberia*. Lamont and Callan (1955) add *A. liberia* to the Trinidad list of moths, quoting Urich (1915).

Box (1953) includes a Trinidad record of *A. erisichton* from sugarcane in his list of sugarcane insects, but no details are provided. In his paper on Lepidoptera attacking cacao in Trinidad, Kirkpatrick (1954) found larvae of *A. erisichton* on cacao, but suggests that they normally feed on *Erythrina*, and drop onto the cacao beneath

and complete development. He records the larvae as 60 mm long, "bright grass green, the abdomen with a cream-coloured lateral stripe narrowly bordered above with crimson. Each segment with three pairs of bright green scoli bearing numerous urticating spines; the lateral scoli, situated just below the lateral stripe, smaller than the dorsal and subdorsal ones, which are nearly as long as the diameter of the body. Thoracic legs crimson, abdominal prolegs green with a crimson spot on the outer side just above the large slate-grey planta. Pupa in a rather thin but tough cocoon spun between leaves."

Thus, the published records for Trinidad show that this species is highly polyphagous, and potentially a minor pest on a variety of crops and trees.

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ADDENDUM

Synotaxidae, another Trinidadian Spider (Araneida) Family

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In Sewlal and Cutler (2003) on the spider families of Trinidad and Tobago, one family was inadvertently omitted.

Synotaxidae – Small to medium, pale green (in life), elongate spiders with long, thin, spineless legs. They resemble some Pholcidae and Theridiidae. Found in forests, they spin a very characteristic "chicken wire fence" web with rectangular mesh work. Webs are built in vegetation at least a half meter above the ground, and are built at night and taken down during the day.

See Anarsson (2003) for the latest reference.

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Defence Mechanisms of the Orb-Weaving Spider *Azilia vachoni* (Araneae:Tetragnathidae)

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ABSTRACT

Azilia vachoni (di Caporiacco) is an orb-weaving spider in the family Tetragnathidae. This species exhibited six secondary defence mechanisms in response to disturbance: walking away from the source of disturbance; dropping off the web; shifting its position in the hub; shaking the web; moving its body in a circular motion while walking in the web; and retaliation. The most frequent of these responses was walking away from the source of disturbance, which was regarded as a moderate response to disturbance by the spider.

Key words: defence mechanisms, *Azilia vachoni*, Tetragnathidae, Trinidad.

INTRODUCTION

The orb-weaver *Azilia vachoni* (di Caporiacco) of the family Tetragnathidae has been observed to occupy a wide variety of microhabitats in the understory vegetation of closed canopy forests. It was observed frequently in discrete patches of microhabitat referred to as buttress notches. This is the semi-open space between two buttress roots of a tree. The frequency of *A. vachoni* in this microhabitat lends itself readily to observation on aspects of its natural history, including secondary defence responses. This category of defence responses is only initiated by the animal when threatened by a predator (Edmunds 1974), noting that sometimes when an animal is disturbed one of its responses is to do nothing.

MATERIALS AND METHODS

This study was carried out in the Arena Forest Reserve, Trinidad, West Indies ($10^{\circ} 34'$ and $61^{\circ} 14'$ W). The ground is gently undulating with occasional short, steep slopes and an elevation varying from 22.9 m to 87.5 m (Bell 1980). A headlamp was used to facilitate detection and observation.

Web structure is described on the basis of 100 webs of both adults and juveniles during January – July 2003. Webs were dusted with talcum powder to highlight their structure. Using the terminology given in Zschokke (1999), features of the orb web were described. Some of the features included the placement of sticky and non-sticky silk, the presence of retreats, the use of camouflage and the orientation of the web.

Secondary defence responses of *A. vachoni* were elicited by disturbing subadults and adult individuals of this species in this experiment. A total of 52 *A. vachoni* was disturbed during September – December 2004 and January 2005. Disturbance consisted of two degrees: light followed by heavy. Light disturbance involved gently tapping any of the spider's legs with a thin, dry twig, while heavy disturbance involved striking the spider across the cephalothorax, again using a thin, dry twig. Heavy disturbance was repeated until the spider reached an end point. An end point was reached when the spider either dropped out of the web or walked to the periphery of the sheeting and touched the substrate. The response after each strike was recorded for both light and heavy disturbance. Care was taken not to disturb the web. We recognized that the orb web comprised three sections: (1) the hub; (2) the spiral; and, (3) the anchor threads. These areas of the orb web would be used to specify the location of each spider during the course of the disturbance experiment. *Azilia vachoni* are usually found in the resting position in the hub of their web. The resting

position consisted of the first and second pairs of legs stretched above the cephalothorax and the third and fourth pairs of legs angled behind the abdomen (Fig. 1). Therefore, *A. vachoni* found in this position and location on the web was considered to be at the starting point.

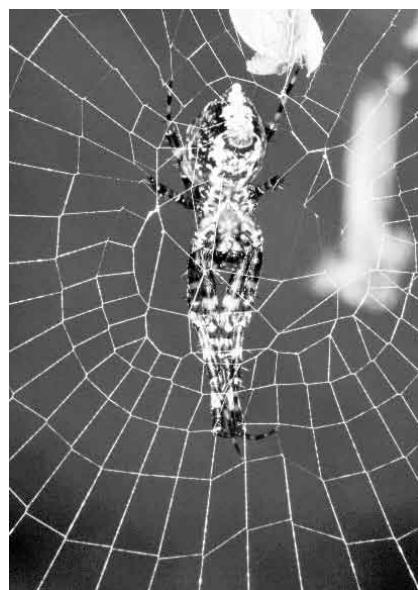


Fig. 1. *Azilia vachoni* in resting position in the hub of its web. Photo: John Abbott.

RESULTS

Webs built by *A. vachoni* can be thought of as consisting of three parts. The first is the hub, which is a roughly circular patch of non-sticky silk, comprising haphazardly arranged rectangles located in the centre of the web. The second part is the spiral, which is a set of concentric circles of sticky silk surrounding the hub. This feature is considered the most distinctive feature of the orb web (Zschokke 1999). Finally, there are the anchor threads which attach the spiral to the substrate. Both juveniles and adults utilize the same web design. Webs were built at angles varying between 0-90°.

This species does not construct retreats but utilize camouflage in their webs. The camouflage most likely consisted of material that had fallen or blown into the web. Some of the material that made

up this web feature included tiny pieces of bark held together by sticky silk. Smaller pieces of bark were held together by greater density of silk than larger pieces of bark or detritus. Other material found included tiny yellow flowers, dried leaflets of *Pentaclethra macroloba* (Willd.) and twigs. The material is approximately linearly placed starting from the hub and extending to the periphery of the spiral. Any material on the spiral was confined to this line which suggests that it was arranged by the spider. However, the use of camouflage by this species was not consistent since only 4 out of 31 webs sampled utilised it.

Azilia vachoni displayed six secondary defence mechanisms: (a) walking away from the source of disturbance; (b) shifting its position in the hub; (c) shaking the web; (d) moving its body in a circular motion while walking in the web; (e) retaliation; and (f) dropping off the web. Retaliation occurred when the spider bit the probe. The circular motion of the body and retaliation were observed by one of us (LD) during continuous heavy disturbance. Two of the spiders tested were holding a prey item when disturbed. Both individuals responded by abandoning their prey item in the hub, retreating to the end point and returning to it a few seconds later.

The secondary defence responses displayed by the spider (Table 1) can be classified as being: (a) non-threatening; (b) slight; (c) moderate; (d) severe; and (e) extreme. Utilizing this classification, a non-threatening response by this spider to disturbance is remaining

Table 1. The number of times each secondary defence response is exhibited by *Azilia vachoni* when exposed to both light and heavy degrees of disturbance.

Degree of Disturbance	Secondary Defence Response							Total
	Nothing	Shift position in hub	Walk	Drop from web	Retaliate	Shake web	Swirling circularly while moving in web	
Light	3	3	42	4	0	0	0	52
Heavy	5	4	77	16	1	2	3	108

stationary when touched with the twig. Shifting position in the hub of the web was regarded as a slight response by the spider. Walking away from the source of the disturbance is considered a moderate response, while dropping from the web is a severe response. Finally, retaliation, shaking the web and swirling circularly while moving in the web are extreme responses by the spider.

5.8% of the spiders that were lightly disturbed did nothing in response; 5.8% shifted their position on the hub; 80.8% walked toward another part of the web; 7.7% dropped out of the web; and none retaliated, shook or swirled in response to light disturbance. 4.6% of the spiders that were heavily disturbed did nothing in response; 3.7% shifted their position on the hub; 71.3% walked; 14.8% dropped from the web; 0.9% retaliated; 1.8% shook the web; and 2.8% swirled.

Regardless of whether the disturbance was light or heavy, a majority of the time *A. vachoni* walked away from the source of disturbance. However, it preferred to drop out of its web more often in response to heavy disturbance rather than light disturbance. No significant difference in the behaviours of *A. vachoni* was recorded when subjected to either light or heavy disturbance ($\chi^2=5.2$; $df=4$; $P=0.32$).

DISCUSSION

Spiders like most animals cannot totally rely on the features of their microhabitat to protect them from predators and have developed defence mechanisms. Animals display two types of defence mechanisms: primary and secondary. In this paper we are concerned with the secondary defence mechanisms exhibited by *Azilia vachoni*. As mentioned earlier, secondary defence mechanisms are only exhibited when the animal is disturbed. These mechanisms can range from the very simple and obvious, such as running away from the source of the disturbance, to displaying a specialised sequence of actions, for example, whirling. Based on a description of *Pholcus phalangioides* (Fuesslin), whirling involves the spider keeping its legs stationary on the web and swinging its body around (Lambright 1979; Jackson 1990; Jackson *et al.* 1990; Jackson 1992; Jackson *et al.* 1992). Whirling has so far only been described in species belonging to Pholcidae. One pholcid species that displays whirling in Trinidad is *Mesabolivar aurantiacus* (Mello-Leitão) (Sewlal 2005).

Some species may exhibit the same defence mechanisms, as seen with whirling in pholcids. Some species may also exhibit these defence mechanisms to a lesser extent or depending on how severe the animal rates the disturbance. Based on the data *Azilia vachoni* appears to utilize different defence mechanisms most likely depending on how it rates the severity of the disturbance (Table 1).

Some defence mechanisms may be taken as being straightforward, such as walking away from the source of the disturbance. However, variations such as walking away from the hub and then returning to it or erratic movement while walking, were displayed by the spiders. *Azilia vachoni* also displayed what we interpreted to be specialised defences such as shaking the web and, moving their bodies in a circular motion while walking on the web, the latter behaviour is similar to whirling. These defence mechanisms could be attempts to confuse the predator. The use of such defence mechanisms indicates that the predators of *A. vachoni* rely on their vision to catch prey.

Orb webs constructed by *Azilia vachoni* did not contain any special modifications to aid in the capture of prey. Their main function appeared to be the capture of prey via entanglement in the sticky silk of the spiral. The construction of a camouflage in the form of material incorporated into the web by some individuals, could be the result of recent disturbances or attacks by predators. However, the relationship between disturbance and construction of a camouflage by *A. vachoni* was not tested.

ACKNOWLEDGEMENTS

Many thanks to Christopher Starr for assisting with fieldwork and reviewing the manuscript. Thanks to Herbert Levi for identifying *Azilia vachoni*. Thanks to John Abbott for allowing us to use his photo of *Azilia vachoni*. Voucher specimens of *A. vachoni* collected by J. N. Sewlal and C. K. Starr in Trinidad, are deposited in the Museum of Comparative Zoology of Harvard University.

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NATURE NOTE

Defensive Whirling Behaviour in an Antillean Daddy-Longlegs Spider (Araneae: Pholcidae)

The Pholcidae are a worldwide family of about 950 known species of web-building spiders (B. A. Huber, pers. comm.). Most pholcids are characterized by extremely long, thin legs, giving rise to the English common name “daddy-longlegs spiders”.

When disturbed, the very widespread *Pholcus phalangioides* exhibits a conspicuous, distinctive response known as “whirling”, in which the spider hangs down from the web without moving its feet and swings its body around very rapidly in a horizontal circle or ellipse (Jackson 1990; Jackson *et al.* 1990; Lambright 1979). This frequently observed behaviour has given *P. phalangioides* and pholcids in general, the German common name “Zitterspinne”, or shaking spiders (Huber 2000). Whirling can be so rapid as to make the spider hard to see, and its value in anti-predator defense is experimentally demonstrated in *P. phalangioides* and two others, *Wugigara sphaerooides* and *Smeringopus pallidus* (Jackson 1992a; Jackson *et al.* 1990, 1992). Whirling is reported from several other species, including the neotropical *Coryssocnemis viridescens* (Huber 1998), *Mesabolivar eberhardi* (Eberhard and Briceño 1985) and *M. aurantiacus* (Sewlal 2005), and three *Modisimus* spp. (Eberhard and Briceño 1985). I report it here in an additional genus.

Although it is probably widespread in the family, whirling is not found in all pholcids (Huber 2000; Jackson 1992b; Jackson *et al.* 1993; Sewlal 2005). An especially striking exception is *Physocyclus globosus*. Like *P. phalangioides*, this tropical species is most commonly found in buildings, where it hangs motionless from the web by its long legs most of the time. However, despite many attempts to elicit it, whirling had not been observed in *P. globosus* (Sewlal 2005, pers. obs.) and is probably not part of its behavioural repertory.

Four species of pholcids are known from the Lesser Antilles (Huber 2000). *P. globosus* is probably introduced by humans and in my experience is found only in buildings. On the other hand, the closely-related *Mesolaesthus taino* (Guadeloupe and Dominica), *M. lemniscatus* (St. Vincent) and *M. nigrifrons* (St. Vincent) are undoubtedly native. In March 2005, I found *M. taino* to be common at two forest localities in Dominica: at sea level along the Indian River on the leeward side of the island, and at an elevation of about 500-600 m inland from the village of Grand Fond on the windward side. I took the opportunity to physically disturb a number of adult, and apparent subadult individuals in order to note their responses.

At the Indian River all nine disturbed spiders showed clear whirling, while above Grand Fond 23 of 35 (66%) did so. Many individuals also (or instead) included in their responses a rapid jerking of the body while walking about the web, a behaviour pattern prominent in disturbed *P. globosus* (pers. obs.).

Whirling is a well-defined behaviour pattern, so that there is little difficulty in saying whether a given individual exhibits it on a given occasion. However, not all whirling is equally pronounced. Jackson *et al.* (1992a) remarked that *W. sphaerooides* and *S. pallidus* whirl less

vigorously than *P. phalangioides*, and my own observations give the distinct impression that comparable disturbance elicits a more tentative whirling response from *M. taino* than either *P. phalangioides* or *M. aurantiacus*.

It seems intuitively obvious that whirling must be a very effective defense against both visually and tactiley-hunting predators, and there seems no reason why all long-legged pholcids that rest hanging down from their webs should not all be able to do it, equally well. The mystery, then, is not that many species do it, but that some others do it little or not at all. The present observations on *M. taino* contribute toward the eventual solution of this problem.

Thanks to Virginia Barlow and Chris Doyle for hospitality and facilitation in Dominica, and to Bernhard Huber for criticism of an earlier version of this nature note.

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Mating Behaviour of the Neotropical Skink *Mabuya nigropunctata* (Spix) in Trinidad, West Indies

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ABSTRACT

An account is given of mating behaviour in the neotropical skink *Mabuya nigropunctata* (Spix). The male tracks the female by scent, bites her tail first, and then at the end of a rapid series of bites along her flank, holds on to the upper arm on the side approached. The animals remain thus until sunset, with minor movements relative to one another, or changes in location seemingly initiated by the female. Copulation then occurs and lasts 2-5 sec. For most of the period of inactivity that follows initial contact, which may last as much as 10 h, the animals seem to be asleep. Eleven of thirteen matings were recorded in the months January - April, the dry season, with one each in June and August.

Key words: Mating behaviour, *Mabuya nigropunctata*, Trinidad.

INTRODUCTION

The only skink in Trinidad, formerly known as *Mabuya bistrigata* (Spix) (Murphy 1997), is now called *Mabuya nigropunctata* (Spix) (L. J. Vitt pers. comm.). It is one of about 15 species of *Mabuya* (Blackburn and Vitt 1992) distributed throughout the neotropical region. It is viviparous. Ovulation, placentation and embryonic development have been studied in some detail in Brasil (Vitt and Blackburn 1991), but mating behaviour seems, so far, to be undescribed.

Though Urich (1931) seems to have considered it a rare species, this is not my experience of it. My 18 locality records together with those in Murphy (1997) show it to be widespread and common, and it occurs in fair numbers in and around my home in Leotaud Trace near Talparo. Ten of the 13 observations reported below were made in the rooms of the house and the other three in the garage.

METHODS

I have done no experiments; I have simply written down everything I could observe when seeing the lizards attempting to mate. There is no obvious difference in appearance between the sexes and I have been forced to use behaviour as a guide to the sex of individuals. As will soon become evident, they copulate only in dim light, and on two occasions I have used a flashlight (torch) to see better what transpired. The time of sunset was determined from newspapers. Dates are given in the form day/month/year.

RESULTS

The behaviour may be divided into three phases: 1). The coming-together phase, 2). The immobile phase and 3). Copulation and separation.

I have seen the early part of mating behaviour only twice. On the first occasion, at about 1010 h on 19 February, 1999, a male skink followed the path taken by a female by frequently protruding its tongue. As he drew close enough to see the female, he jerked his head rapidly up and down several times with his mouth open and his tongue protruding, and moving up to a stationary female bit her near to the tip of her tail. With a long series of quick bitings up the tail and flank of the female he finally fastened on her right upper arm. By now the female was moving and seemingly trying to escape. They came to rest near a stack of newspapers where I saw them again at noon, but not at 1310 h, despite a careful search. I think it is more likely that they managed to hide in one of the many available hiding places than that they copulated and separated before 1310 h.

On the second occasion, at about 1445 h on 13 April, 1999 a male skink rapidly chased another who was running away. He soon caught the female by the base of her tail and transferred his bite to the upper arm. They then settled down, immobile, side by side. On this occasion I saw no preliminary tracking of the female by scent, but this may have happened before the female began to run away.

The period of immobility begins when the male bites the female's upper arm. Since copulation always occurred near sunset (Table 1), this period was sometimes long, sometimes short, depending on the time when the pair came together. The lizards, in fact, have seemed to be asleep during this time. My notes record the eyes being closed in one pair, and it has always been possible to approach extremely close (30 cm) without disturbing them. However, there have been movements during this period, and these are of two kinds: one in which the male adjusts his posture relative to the female, and the other in which the female moves taking the male with her.

I have seen the male lie to one side of the female (on the side of the bitten arm), overlie the female with his axis parallel to hers, and lie diagonally across the female, biting one arm and lying more or less on the other side. Shifts between these positions have occurred, breaking long periods of immobility. I have seen the male stroke the female's flank with his hand long before sunset. On one occasion (Table 1, No. 5) the female arched her tail slightly in seeming response to the male's stroking. I have also seen the male perform a side-to-side, rubbing motion of his pelvis across the female's rump (Table 1, No. 3). All these movements, however, have been momentary, lasting a few seconds within hours of immobility.

On the one occasion when the immobile phase was seen from start to finish, it lasted 3 h, 8 min. On the other four occasions when copulation was seen, the observed period ranged from 52 min. to 4 h, 35 min. Where copulation was not seen the immobile phase was measured from first observation to 22 min. before sunset, which was the earliest time observed (Table 1). In these the immobile phase ranged from a minimum of 29 min. to 9 h, 54 min.

On eight occasions the pairs moved after engaging. Pairs 3, 4 and 5 (Table 1) moved about 30 cm between first sighting and last sighting or copulation. Pair 2 moved about 2 m, and pairs 8 and 9 moved to hidden positions where I could not find them.

The five copulations that were witnessed all occurred near sunset, four from 5 to 22 minutes before sunset, 1-2 minutes after (Table 1). The duration of copulation has been exceedingly short, a matter of 2-5 seconds. Copulation has not always occurred from

Table 1. Mating behaviour of *M. nigropunctata* with special reference to the timing and duration of phases. Cop. = copulation; Cop-SS = difference between time of copulation and time of sunset (m); - = before sunset, + = after sunset (col.7); Obs. = observation; Imm. = Immobile; Transl. = translatory; R = right; L = left; h = hour; m = minute; s = second; M = male; F = female; NA = not available; NR = not recorded.

No.	Date	Rel. Size	Time			Duration			Arm bitten	Cop. from	Transl. move.
			1st Obs.	Cop.	Sunset	Cop-SS	Imm. Phase	Cop.(s)			
1	02.02.89	M >> F		NA	1808				NA		No
2	18.04.89	M >> F	1320	NA	1816		>4h 34m*		R		Yes
3	06.02.90	M = F	1003	NA	1810		>7h 45m		R		Yes
4	16.01.97	M < F	1645	1748	1800	-12	>1h 3m	<5	L	NA	Yes
5	01.04.97	M > F	0800	NA	1816		>9h 54m		L		Yes
6	09.08.97	M >> F	1531	NA	1826		>2h 33m		R		No
7	12.01.98	M = F	1701	1753	1758	-5	>52m	4	R	L	No
8	19.02.99	NR	1010	NA	1814		>7h 42m		R		Yes
9	14.03.99	M >> F	1734	NA	1816		>20m		R		Yes
10	13.04.99	M > F	1445	1753	1815	-22	3h 8m	3	R	L	Yes
11	20.06.99	M = F	1540	NA	1828		>2h 26m		L		No
12	04.04.00	M > F	1330	1805	1815	-10	>4h 35m	4-5	R	L	Yes
13	04.03.01	NR	1715	1817	1815	+2	>1h 2m	2	L	L	No

*Except for those cases where copulation was seen, all figures in this column are calculated as the elapsed time between first observation and twenty two minutes before sunset.

the side of the bitten arm; the male has sometimes adopted a “cross-over” position, biting one arm and copulating from the side of the other (Table 1, Nos. 7, 10, 12, and possibly No. 4 where the true position is uncertain).

On three occasions copulation began quite suddenly. On one occasion (Table 1, No. 7) the female's tail twitched, straightened and arched just before the male copulated. On the remaining occasion (Table 1, No. 12), when the male tried to copulate the female refused to cooperate, despite the long preliminary period of inactivity and the near approach of sunset. She seemed to be trying to escape from him and managed to move forward several centimetres. However, after 10-15 seconds with the male stroking her rump with his hand he managed to copulate. On disengaging, she attempted to bite him. He ran off with the female in pursuit. This was very atypical of disengagement. In all the others the female simply slid forward leaving the male immobile for a few seconds. In all five copulations the male never licked his hemipenis after disengaging.

DISCUSSION

Some elements of the behaviour recorded above appear in the mating behaviour of other lizards. Thus, biting by the male of the female's tail occurs in the mating behaviour of *Thecadactylus rapicauda*, *Anolis aeneus* and *Cnemidophorus lemniscatus* (Quesnel unpubl.). It is reported from many other species (Carpenter and Ferguson 1977). Stroking of the female's back, rump or flank by

the male occurs in *C. lemniscatus* (Quesnel unpubl.) and has been reported from other species including *Eumeces eggregius* (Scincidae) (Carpenter and Ferguson 1977). Physical movements such as these guide the course of courtship and mating in many species without the need for chemical cues. In the family Scincidae, on the other hand, chemical cues are important, and as the above account seems to show, pheromones guide the male *M. nigropunctata* to the female. Other species of Scincidae are known to make extensive use of them (Mason 1992).

However, the most extraordinary feature of the courtship of *M. nigropunctata* is the combination of inactivity after the pair has come together physically, with an extremely short period of copulation (2-5 sec.). Table 2 gives the information I could find in sources available to me on duration of copulation in lizards. It is immediately obvious that the range is very wide and that within a family and even within a genus there may be substantial differences. *Mabuya nigropunctata* has the shortest duration of all, with only *Cnemidophorus lemniscatus* and *Leiocephalus carinatus* close to it. The thought comes to mind, if some lizard species need only a few seconds for copulation, why do others need not only more, but much more time?

During the long period of immobility preceding copulation *M. nigropunctata* is very vulnerable to predators. However, in this it is not alone. *Gerrhonotus multicarinatus* may copulate for as long as 26 h (Table 2). As Smith (1946) remarked, “the mating animals are more or less oblivious to danger and a high mortality may thus be

Table 2. Duration of copulation in some species of lizards.
h = hour, m = minute, s = second.

Species	Family	Copulation	Reference
<i>Gerrhonotus multicarinatus</i>	Anguidae	12 – 26 h	Smith 1946
<i>Thecadactylus rapicauda</i>	Gekkonidae	63 s – 4 m	Quesnel unpubl.
<i>Anolis aenius</i>	Iguanidae	1 m – 1h	Schwartz and Henderson 1991
<i>Anolis argillaceus</i>	Iguanidae	2 – 5 m	Schwartz and Henderson 1991
<i>Anolis centralis centralis</i>	Iguanidae	2.7 m (mean)	Schwartz and Henderson 1991
<i>Anolis centralis litoralis</i>	Iguanidae	7.4 m (mean)	Schwartz and Henderson 1991
<i>Anolis garmani</i>	Iguanidae	25 m	Schwartz and Henderson 1991
<i>Anolis pumilus</i>	Iguanidae	2.3 – 13 m	Schwartz and Henderson 1991
<i>Anolis sagrei</i>	Iguanidae	105 s – 285 s	Schwartz and Henderson 1991
<i>Chamaeleolis barbatus</i>	Iguanidae	22.7 m (mean)	Schwartz and Henderson 1991
<i>Cyclura cornuta</i>	Iguanidae	1 – 2 m	Schwartz. and Henderson 1991
<i>Leiocephalus carinatus</i>	Iguanidae	a few s	Quesnel 1979
<i>Ameiva ameiva</i>	Teiidae	65 – 165 s	Smith 1946
<i>Cnemidophorus sexlineatus</i>	Teiidae	5 m	Schwartz. and Henderson 1991
<i>Cnemidophorus lemniscatus</i>	Teiidae	7 – 15 s	Quesnel unpubl.
<i>Eumeces egregius</i>	Scincidae	up to 90 m	Goin et al., 1978
<i>Eumeces fasciatus</i>	Scincidae	4 – 8 m	Smith 1946
<i>Eumeces obsolatus</i>	Scincidae	4 – 5 m	Smith 1946
<i>Mabuya nigropunctata</i>	Scincidae	2 – 5 s	This paper

expected during the mating season.” Nevertheless, in both species evolution has permitted this, suggesting that there are benefits to be revealed by further research. My search of the literature, admittedly incomplete, revealed no other lizard with comparable behaviour. Its function is obscure. Does it serve to synchronise copulation with ovulation? Is it somehow connected to viviparity?

There has sometimes been a large discrepancy in size between the male and female of a copulating pair. As Table 1 shows, on four occasions the male has been very much larger than the female. This circumstance is satisfactorily explained by the observations of Vitt and Blackburn (1991) that females as young as 2.5 months may ovulate, mate and begin gestation. Because the implanted ova grow hardly at all for the next four months, these small females can grow during this time to a size that can accommodate the fetuses when they begin to grow more rapidly. Their broods are always smaller (2–5 young) than those of larger females who have broods of 3–9 young (Vitt and Blackburn 1991).

M. nigropunctata at 10° S of the equator in Brasil (with the dry season May–Sept.) ovulated during the months August–November (Vitt and Blackburn 1991). Here in Trinidad, 10° N of the equator (with the dry season January–May), thirteen of the fifteen observed couplings (73%) occurred in the period January–April

with three in June and one in August. Therefore, in both localities the species prefers to breed in the dry season, but in Trinidad the breeding season seems to last longer than in Brasil.

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Third Report of the Trinidad and Tobago Rare Birds Committee: Rare Birds in Trinidad and Tobago in 2001 – 2003

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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 (Hayes and White 2000; White and Hayes 2002). The Committee has now assessed all records submitted during 2001, 2002 and 2003. In all 244 records were adjudged, representing 103 different species. As a result of these submissions, 10 additional species have been added to the official list of Birds of Trinidad and Tobago. Of those assessed, in only 19 cases (8%) 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 (AOU) 7th edition, 1998. Highlights of sightings submitted in 2002 have been published previously (Kenefick 2004).

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 list of those species considered by the TTRBC can be accessed together with our Photo Gallery from the home page of the TTFNC at <http://www.wow.net/ttfnc>.

RECORDS ACCEPTED

Cory's Shearwater, *Calonectris diomedea*. A single bird was flushed by the Trinidad-Tobago ferry, several km south of Scarborough on 10 May, 1998. (FH *et al.*). On 17 May, 1998, one was seen flying SE from Galera Pt. (FEH *et al.*). Tide-line corpses were found on 20 November, 2001 at Manzanilla (AA; RW) and on 4 April, 2002 in Blue Waters Bay, Tobago (RES). Finally, one was seen swimming close inshore at Manzanilla on 17 March, 2003 (DH). This rare seabird has been recorded less than once per annum. Many sightings are of tide-line corpses.

Manx Shearwater, *Puffinus puffinus*. Up to five were recorded between 5 October – 7 November, 2002 close inshore at Galera Pt. (MK). This is only the second record of this passage migrant in the last 10 years.

White-tailed Tropicbird, *Phaethon lepturus*. Sightings of single birds were made amongst the seabird colony on Little Tobago on 26 November, 2000 (MB *et al.*), 29 September, 2001 (PB *et al.*) and 3 February, 2003 (MK). It is likely that this is the same bird seen periodically since April 1998. There are undocumented reports of two birds present during 2003 engaged in behaviour indicative of a breeding attempt.

Rufescent Tiger-heron, *Tigrisoma lineatum*. On 1 August, 2001, an adult was flushed from a woodland stream at Cumuto (MK; HS). At the same site, a juvenile was seen on 25 January, 2003 (MK). An

adult was found close to the eastern edge of Nariva Swamp on 3 February, 2002 (GG) and a presumed different adult much further south in Nariva on 22 April, 2003 (GW). This is a rare and very localised resident of swamp forests in Trinidad.

Purple Heron, *Ardea purpurea*. A juvenile found on Caroni Rice Project on 24 September, 2002 remained until 10 October, 2002 (MK). This is the first record for Trinidad and Tobago and the second for South America.

Gray Heron, *Ardea cinerea*. A juvenile first found on 26 August, 2001 at Caroni Rice Project (FEH; NL *et al.*) remained until at least 26 September, 2001. The same individual was subsequently seen at Trincity Ponds on 27 September, 2001 (PD; BM *et al.*) and finally on 16 December, 2001 at Nariva (CR). This is the third record for Trinidad and Tobago.

Cocoi Heron, *Ardea cocoi*. A single bird was present at Buccoo Marsh from 25-29 June, 1998 (FEH *et al.*). This species is an uncommon dry season visitor to Trinidad, much rarer in Tobago.

Little Egret, *Egretta garzetta*. Single birds were found during the period under review as follows: 13 May, 1998 at Valsayn ricefields (FH *et al.*); 21-29 June, 1998 in Lowlands, Tobago (FH *et al.*); 11 July - 8 September, 1998 at Caroni Rice Project (FH *et al.*); 16 October, 2000 at Turtle Beach (FH *et al.*) and 24 May, 2001 at Caroni Rice Project (MK). The status of this species is now becoming clear. It is present in both islands, albeit in small numbers. To date, whilst suspected, no evidence of breeding has been found. In view of its regular occurrence, it is no longer considered a Review Species by TTRBC.

Western Reef-heron, *Egretta gularis*. A dark morph juvenile was first found close to Buccoo seafront, Tobago on 16 December, 2000 (MK). This represents the first record for Tobago; second for Trinidad and Tobago and second for South America. The bird remained in the Buccoo/Bon Accord area at least until 11 January, 2002.

Reddish Egret, *Egretta rufescens*. An extraordinary record of one bird found close to the mangrove at the Hilton complex, Lowlands on 21 July, 2003 (GeoW) unfortunately eluding a hundred or so ornithologists gathered for an international conference! This is only the fourth documented record of this species for Trinidad and Tobago.

White Ibis, *Eudocimus albus*. An adult was seen amongst a roosting flock of Scarlet Ibis at Caroni Swamp on 15 August, 1985 (GW). There have been no subsequent documented sightings to date. White Ibis are an extremely rare visitor, presumably from northern South America. Whilst birds in adult plumage are unmistakable in appearance, separating birds in juvenile plumage

from Scarlet Ibis is extremely difficult – indeed some authorities believe the two to be con-specific.

Glossy Ibis, *Plegadis falcinellus*. An adult was present on Caroni Rice Project between 1 July - 26 August, 2000 (MK). The same or a different individual was found at the same site between 28 December, 2000 - 8 January, 2001 (MK). A juvenile originally found on Caroni Rice Project, 10 October, 2002, moved to Valsayn rice fields on 22 November, 2002 (MK). An occasional visitor to Trinidad, Glossy Ibis are not recorded every year.

Jabiru, *Jabiru mycteria*. One was present on Buccoo Marsh, Tobago from 30 September - 5 October, 1998 (SW). This is only the third record for Trinidad and Tobago.

Maguari Stork, *Ciconia maguari*. A sub-adult found at Orange Valley on 17 August, 2001 (MK), remained until at least 23 September, 2001. This is the first record for Trinidad and Tobago.

Wood Stork, *Mycteria americana*. A single bird was seen briefly at Brickfields, on 18 October, 2000 (GW). Once no more than uncommon in occurrence, this species has now become extremely rare and there are no documented records for Tobago.

King Vulture, *Sarcoramphus papa*. An adult was found soaring low over Trinity Hills in south Trinidad on 9 October, 2003 (GG). This species remains a truly rare visitor to Trinidad usually with one sighting every 3-4 years.

Caribbean Flamingo, *Phoenicopterus ruber*. A flock, peaking at a phenomenal 137 birds was observed on the tidal mudflats close to Carli Bay from 9 - 12 August, 2003 (GW; MK). The previous largest group total in Trinidad has been six!

Comb Duck, *Sarkidiornis melanotos*. A flock of up to 21 birds, all in female or immature plumage, were regularly seen at the Caroni Rice Project between 13 - 31 August, 2000 (FH *et al.*). This constitutes the fourth record for Trinidad and Tobago. A further immature was seen briefly at the same locality on 1 October, 2000 (MK). An adult male showed well, again at Caroni Rice Project on 14 - 15 June, 2002 (MK).

American Wigeon, *Anas americana*. An immature male was present on Bon Accord sewage lagoons from 10 - 11 January, 2002 (MK) and on 5 February, 2003, another immature male was found at Lowlands lakes (MK). Formerly a rather common winter visitor, in recent times records have been few and far between.

Northern Shoveler, *Anas clypeata*. Two non-breeding plumaged adults were found at Lowlands lakes on 5 February, 2003 (MK). Unconfirmed reports of at least four birds in total have been received. This species remains a rare winter visitor.

Northern Pintail, *Anas acuta*. An adult female, seen between 9 - 13 June, 2001 at Caroni Rice Project (MK) constitutes the first record for Trinidad and Tobago. Subsequently, three females were found at Bon Accord on 14 December, 2003 (DT).

Ring-necked Duck, *Aythya collaris*. An adult male, commuting between Bon Accord and Lowlands, Tobago, was recorded from

26 November, 2002 - 5 February, 2003 (Rff; AJ; MK). With just four previous records, this duck is a rare winter visitor.

Lesser Scaup, *Aythya affinis*. An immature or female was seen at Cacandee Lagoon on 17 December, 2003 (MK). A very uncommon winter visitor. There have been just four records in the last eight years.

Hook-billed Kite, *Chondrohierax uncinatus*. An adult male circled over the Blanchisseuse Rd. on 26 March, 2002 (CS *et al.*) and another male was observed behind Blue Waters Inn, Tobago on 1 April, 2002 (CS *et al.*). An adult male flew low over a citrus estate at Tableland on 16 January, 2003 (MK; GW) and an adult female was seen perched on a tree on Chacachacare, 18 January, 2003 (MK). This is a decidedly uncommon raptor, seen about once per year.

Snail Kite, *Rostrhamus sociabilis*. An immature was found at Caroni Rice Project 19 May, 1998 (FH *et al.*). An immature female at the Caroni Rice Project first recorded 4 July, 2000 (Kenefick 2004) remained throughout 2002 and was joined by a sub-adult male 4 - 22 November, 2002 (MK). Despite these recent records, this species remains a very rare visitor from mainland South America.

Crane Hawk, *Geranospiza caerulescens*. A single bird recorded from Waller Field on 20 January, 2001 (RES *et al.*) represents the first documented account for Trinidad and Tobago. It is likely that the same individual was seen at Aripo Agricultural Stn. on 12 March, 2001 (CS *et al.*). Two adults were found close to the coast road at Nariva on 27 March, 2002 (CS *et al.*). On both 3 and 4 January, 2003, an adult was seen flying out from roost over Waller Field (CR; MK; GW). It is unclear whether this is the same individual recorded in January 2001.

Great Black-hawk, *Buteogallus urubitinga*. Two adults were seen displaying on 16 - 17 March, 2002 from the Saut d'Eau lookout (GG). This species remains a rare and very local breeding resident in Trinidad.

Swainson's Hawk, *Buteo swainsoni*. A light morph bird was seen soaring over Grande Riviere on 16 May, 1998. The same individual was relocated over Matelot, 10 km further west, the following day (FEH *et al.*). There have been only four previous documented records from Tobago of this long distance migrant. This is the first record for Trinidad.

Rufous Crab-hawk, *Buteogallus aequinoctialis*. An adult was seen over the high tide roost at Brickfields on 7 May, 2003 (MK; GW). There are several undocumented reports of the same individual, in the same area subsequently. The status of this species remains unclear. It may be a very localised resident, or more likely a casual visitor from mainland South America.

White-tailed Hawk, *Buteo albicaudatus*. An adult flew over San Francique, Penal on 6 June, 2001 (HK) and an immature at Caroni Rice Project 22 - 30 November, 2001 (AA; MK; RW). Finally an adult was found at Caroni Rice Project on 1 January, 2003 (GW). Historically, this species was resident in Trinidad. It is now just a casual visitor from the mainland.

Black Hawk-eagle, *Spizaetus tyrannus*. Two adults were found at Santa Flora on 18 June, 2002 (JW). On 16 Sept., 2003, two birds were seen circling the Toco Rd., just north of Cumana (MK). Formerly considered a rare visitor, increased sightings in recent years may be indicative of localised residents.

Crested Caracara, *Caracara plancus*. An adult was found perched on rocks at Galera Pt. on 10 August, 2000 (GW) and a sub-adult was seen close to the coast road at Nariva on 27 March, 2002 (CS *et al.*). On 14 March, 2003, an adult and a juvenile were found at Fullerton Swamp (MK; CR). Finally, on 11 June, 2003 an adult was caught in car headlights feeding on a road kill after dark on the M2 Ring Road (HK). Despite these recent records, this species remains a rare visitor from the mainland.

Eurasian Kestrel, *Falco tinnunculus*. A female was found hunting the grassy fields between the mangrove and Waterloo Rd., at Carli Bay on 17 December, 2003 (MK). It was last recorded on 1 January, 2004. This constitutes the first record for Trinidad and Tobago, second for the Caribbean and second for South America.

Aplomado Falcon, *Falco femoralis*. Records for the period are as follows: an adult on Caroni Rice Project 1 Sept., 2000 (MK); an immature hunting the same locality 28 July - 5 October, 2001 (MK); a sub-adult at Icacos at 12 December, 2001 (CR *et al.*); an immature was regularly seen at Caroni Rice Project between 31 August - 10 October, 2002 (MK); a second bird at the same locality on 30 October, 2002 (MK). In 2003, an immature hunted the high tide roost at Brickfields on 14 September, (MK). An immature at Lowlands lakes on 7 October, (BM) constitutes the first record for Tobago. Finally a sub-adult over Nariva Swamp on 8 October (BM). This species is becoming more regularly found in Trinidad, especially in areas holding flocks of migrating shorebirds.

Rufous-necked Wood-rail, *Aramides axillaries*. At least one, possibly two birds were found in the mangrove at Cacanee on 18 December, 2000 (MK; GW). Whilst shy by nature, this species remains a rare and very localised breeding resident in Trinidad.

Yellow-breasted Crake, *Porzana flaviventer*. One was heard calling from a shallow freshwater marsh at Louis D'or, Tobago on 22 December, 2002 (MK). It was subsequently seen and photographed on 22 February, 2003 (NG *et al.*) This is the first record for Tobago.

Paint-billed Crake, *Neocrex erythrops*. One was found, exhausted, in the Maraval Valley during March 1996. It was taken into care at the Emperor Valley Zoo, Port of Spain (per GG). Just before dawn on 16 September, 2001 one was dazzled in car headlights on a track through the Caroni Rice Project (MK). These are just the second and third records for Trinidad.

Spotted Rail, *Rallus maculatus*. An extremely secretive rare resident of freshwater marshland. The only record for the period is that of a road kill at Carapichaima on 6 July, 1997 (GW).

Azure Gallinule, *Porphyrrula flavirostris*. Two birds were found at the Caroni Rice Project on 10 May, 1999 (GW) and 22 August, 2000 (MK). The status of this species is still under review for any records away from their stronghold in Nariva Swamp.

American Coot, *Fulica americana*. Single adults were found on 24 March, 2001 at Bon Accord sewage lagoons (MK) and at Buccoo Marsh on 6 February, 2002 (MK) and 10 September, 2002 (R ff.). This species is a rare winter visitor to Tobago, with no documented records for Trinidad.

Caribbean Coot, *Fulica caribaea*. Single birds present at Buccoo Marsh, Tobago on 28 November, 2000 (MB) and 2 February, 2002 (RES *et al.*). The status of this species is unclear. Whilst it formerly bred in Tobago, it is essentially non-migratory and most recent records refer to casual visitors from other islands.

Killdeer, *Charadrius vociferous*. On 6 January, 2003, three Killdeer were seen in a dry field at Caroni Rice Project (CR; MK). At Nariva, one was found on 17 March, 2003 (DH). Once a fairly common winter visitor, these are the first documented records since 1995.

Upland Sandpiper, *Bartramia longicauda*. In the rather unusual setting of Brickfields, three were found on 14 September, 2001 (NL). A single bird fed on the short grass at Caroni Rice Project from 19 - 25 September, 2001 (MK) and on 26 October, 2001 one was found on Lowlands golf course (NH). One was seen amongst a large party of waders in a flooded field close to the highway at Trincity on 7 October, 2003 (BM). This species remains a decidedly uncommon passage migrant through Trinidad and Tobago, more likely seen in drier grassy areas than mudflats.

Long-billed Curlew, *Numenius americanus*. A single bird found at Buccoo Marsh on 30 September, 1999 (SW) constitutes the first record for Trinidad and Tobago.

Black-tailed Godwit, *Limosa limosa*. A single bird first found on Caroni Rice Project on 14 September, 2001 (FEH; MK) constitutes the first record for Trinidad and Tobago and South America. Extraordinarily, it was relocated on the tidal mudflats at Waterloo where it remained until at least 30 September, 2001.

Marbled Godwit, *Limosa fedoa*. A single adult was found at Brickfields at the high tide roost on 6 April, 2000 (MK); with another seen from 7 September - 12 October, 2000. (MK *et al.*). At the same site, up to two were present for an extended stay from 7 September, 2001 - 26 November, 2001 (MK *et al.*). This is still a very uncommon passage migrant and found exclusively on tidal mudflats.

Red Knot, *Calidris canutus*. A single bird was found at Speyside on 7 September, 2000 (R ff.). Whilst this species is a fairly common passage migrant to Trinidad, records from Tobago are extremely rare.

Curlew Sandpiper, *Calidris ferruginea*. An adult, moulting into breeding plumage was present at Caroni Rice Project from 1-5 May, 2002 (MK). This represents the first record of this species for Trinidad and Tobago.

Ruff, *Philomachus pugnax*. This species has probably historically been under recorded in Trinidad and Tobago. An immature found at Caroni Rice Project on 25 - 26 August, 2000 was only the fourth documented record for the island (MK). However, this sighting was

shortly followed by five more during this review period as follows: on 22 December, 2000, one at Lowlands lakes (FEH; GW); on 14 October, 2001 an adult male at Caroni Rice Project (MK); at the same locality an immature on 18 October, 2001 (MK) and an immature female, between 29 December, 2002 - 25 January, 2003 (MK). A single bird was regularly seen on Lowlands golf course from 23 - 28 October, 2003 (NH).

Buff-breasted Sandpiper, *Tryngites subruficollis*. At Valsayn ricefields, five birds were found on 3 May, 1998 (FEH *et al.*). During this review period the following birds were found on Caroni Rice Project: one on 24 May, 2000 (MK); up to three between 27 September and 2 October, 2000 (MK); one on 1 - 2 June, 2001 (MK); up to five between 19 September and 5 October, 2001 (MK) and two on 17 September, 2002 (MK). On 15 October, 2000 at least seven were found at dusk on Crown Point airfield. This is the first record for almost 100 years from Tobago. Another was found the following day at Speyside (FEH; MK). Finally one was seen at Lowlands golf course on 28 October, 2003 (NH). Recent trends show this species becoming a regular passage migrant to both islands favouring short grassy fields as opposed to mudflats.

Wilson's Phalarope, *Phalaropus tricolour*. On 1 October, 2000, after a period of high winds, two birds, an adult and an immature, were found in a flooded field at Caroni Rice Project (MK). This is just the third record for Trinidad and Tobago.

Pomarine Jaeger, *Stercorarius pomarinus*. Two adults passed Galera Pt., flying north on 30 April, 2002 (MK). There has been little northward seabird migration study in Trinidad and Tobago, hence the status of such birds is relatively unknown.

Lesser Black-backed Gull, *Larus fuscus*. A bird in first winter plumage was seen around the south-western peninsula of Tobago from 14 - 17 November, 2003 (EG). Whilst in recent years a small number of this species have been regularly seen in Trinidad, their occurrence in Tobago is much rarer.

Franklin's Gull, *Larus pipixcan*. On 3 December, 2000 a first winter plumaged bird was found amongst the Laughing Gull roost at Brickfields, constituting the third record for Trinidad and Tobago (MK). At Kings Wharf, San Fernando, two birds also in first winter plumage were found on 22 January, 2001 (MK). Finally on 22 April, 2001 a first summer individual was found at Kings Wharf. How many individuals involved is impossible to confirm – a minimum of two and a maximum of four. This gull is a rare winter visitor to Trinidad and may have been overlooked historically due to its close similarity in appearance to the abundant Laughing Gulls on our western coastline.

Black-headed Gull, *Larus ridibundus*. At Waterloo, up to two adults were occasionally seen between 1 March - 18 May, 2000 (GW; MK). On 26 February, 2003 a single bird moulting into adult plumage was reported from Brickfields (NL). From Tobago, a first winter plumaged bird was seen around the south-western shores on 21 November, 2003 (EG). This gull is a decidedly rare visitor to Trinidad and Tobago, recorded less than one per year.

Large-billed Tern *Phaetusa simplex*. On 15 May, 2001 an adult and an immature were found at Lowlands (RT). This is a common

visitor to Trinidad but reports from Tobago are extremely rare.

Yellow-billed Cuckoo, *Coccyzus americanus*. Records during the review period as follows. From Tobago, one record from Speyside on 19 October, 2002 (MW) and single birds at Bon Accord 21 December, 2002 (MK), 24 February, 2003 (BM), 12 October, 2003 (CD) and 2 December, 2003 (MK; R ff.). From Trinidad, one at Galera Pt. on 4 October, 2001 (MK; HS) and one at Cacandee on 2 November, 2003 (MK). Whilst numbers of this species have increased in recent years, it is still a very uncommon autumn passage migrant, possibly overwintering.

Mangrove Cuckoo, *Coccyzus minor*. One was seen flying across the sewage lagoons at Lowlands on 7 January, 2001 (MK). This species is a very localised and decidedly uncommon breeding resident to Trinidad. Its shy nature probably distorts its true abundance. There are far fewer records from Tobago.

Short-eared Owl, *Asio flammeus*. One bird of the sub-species *A. f. pallidicaudus* was found in a weedy field at Caroni Rice Project on 12 September, 2001. It was relocated a short distance away on the 16th, together with a second individual. This constitutes the first documented record of this species for Trinidad and Tobago (MK).

White-collared Swift, *Streptococne zonaris*. On 8 July, 2003, one was hawking insects over Grafton sanctuary (MK). On 7 October, 2003, at least five were seen flying over Gilpin Trace (BM). Whilst a frequent visitor to Trinidad, often encountered in large flocks, historically there is only one previous record from Tobago. Interestingly, the first bird ever recorded in Barbados was on 6 July, 2003.

Rufous-shafted Woodstar, *Chaetocercus jourdanii*. One, in immature or female plumage was found at Asa Wright on 28 August, 2000 (R ff.). Almost all records of this extremely rare visitor to Trinidad are from Asa Wright Nature Centre.

Scaled Antpitta, *Grallaria guatimalensis*. One bird heard calling from a densely forested steep slope close to Paria Junction on 5 September, 2002 (R ff.). In character, Antpittas are shy and elusive, hiding in the darkest and steepest areas of the forest. This species remains a rare and localised resident in Trinidad.

Spotted Tody-flycatcher, *Todirostrum maculatum*. A nest found close to Fullerton Swamp on 19 April, 1998 (FEH *et al.*), represents only the second documented nesting record for Trinidad.

Variegated Flycatcher, *Empidonax varius*. Single birds were found at Asa Wright Nature Centre on 18 November, 2001 (RW; RR); Arena Forest on 16 January, 2003 (MR) and from Blanchisseuse Rd. on 8 June, 2003 (MK; NH). A very uncommon Neotropical migrant whose true status may be confused due to its physical similarity to the much more common Piratic Flycatcher. These represent the first documented records since 1995.

Blue-backed Manakin, *Chiroxiphia pareola*. A female recorded on nest along Gilpin Trace on 12 April, 2000 (R ff.). This species is a locally common resident of Tobago. There are no documented records for Trinidad.

Black-whiskered Vireo, *Vireo altiloquus*. Single birds were found in Arena Forest on 19 February, 2001 (MK); at Teteron Bay on 28 April, 2001 (CR) and at the base of Morne Bleu on 12 March, 2003 (MK). This rare visitor may be overlooked due to its similar appearance to the much more common Red-eyed Vireo.

Caribbean Martin, *Progne dominicensis*. An adult male was seen flying amongst Grey-breasted Martins at Galera Pt. on 20 February, 2002 (MK). This common summer visitor to Tobago has, without doubt, been overlooked in Trinidad due to its close similarity in appearance to Gray-breasted Martins. Separating adult males is relatively straightforward, however, females are extremely difficult to specify.

White-winged Swallow, *Tachycineta albiventer*. At least two birds seen at Speyside between 5 - 11 September, 2000 constitute the first records for Tobago. (R ff; IB). There have been subsequent regular undocumented reports of several birds in the Plymouth area of the island.

Cliff Swallow, *Petrochelidon pyrrhonota*. Two birds were found at Caroni Rice Project from 22 - 29 April, 1998 (FEH *et al.*). Single immatures were at the same locality on 3 March, 2001 (MK) and 12 September, 2001 (MK); and an adult was seen amongst a mixed hirundine flock over Trincity ponds on 20 April, 2002 (MK *et al.*). This is a very uncommon passage migrant often found in association with large flocks of Barn Swallows.

Golden-winged Warbler, *Vermivora chrysoptera*. An adult at Kings Bay, Tobago on the extremely late date of 20 June, 2001 (JC) is only the fourth record for Trinidad and Tobago.

Chestnut-sided Warbler, *Dendroica pensylvanica*. On 30 December, 2000, a winter plumaged bird was found in Lopinot Valley (RN). On 17 December, 2001 an adult was seen along the Maracas coastal road (GW) and an adult, moulting into breeding plumage, was found close to the river at Montevideo, Grande Riviere on 28 February, 2002 (MK *et al.*). A rare passage migrant, possibly overwintering in Trinidad. There are to date no records from Tobago.

Cape May Warbler, *Dendroica tigrina*. On 25 December, 2000, an adult male was found in the grounds of the Coco Reef Hotel (NS). This is just the second record for Trinidad and Tobago in the last fifteen years. This is a very rare passage migrant, possibly overwintering.

Blackburnian Warbler, *Dendroica fusca*. A rare passage migrant, an adult male was found close to the Scatter Station on Morne Bleu, 26 March, 2001 (CR). The true status of this species in Trinidad and Tobago is unclear as we are aware of several undocumented reports.

Bay-breasted Warbler, *Dendroica castanea*. A male was found at Wallerfield on 20 January, 2002 (RES *et al.*). Whilst there are a number of historical records of this rare warbler, this is the only documented record in recent times.

Blackpoll Warbler, *Dendroica striata*. At least four immatures were observed at Galera Pt., 24 October, 2000 (MK) with two more at the same locality on 11 October, 2001 (MK; CR). On 28

December, 2002, a single immature was found at Lalaja (GW *et al.*). In view of its regular occurrence, especially during the period October - December, records are no longer assessed by TTRBC.

Cerulean Warbler, *Dendroica cerulean*. An adult male found beside a track north of Aripo Village on 22 November, 2000 (MB; CR) constitutes the first record for Trinidad and Tobago.

Black and White Warbler, *Mniotilla varia*. The only documented records for the period are of a female along Las Lapas Trace on 12 February, 2003 (MK; NH) and an immature by Gilpin Trace on 23 October, 2003 (NH). With less than one sighting per annum, this passage migrant warbler is still extremely uncommon in Trinidad and Tobago.

Summer Tanager, *Piranga rubra*. A first summer male seen on 28 January, and 13 February, 2002 at Las Lapas Trace (MK *et al.*). At the same location, an adult male was found on 12 February, 2003 (MK; NH). This species is a very uncommon winter visitor to Trinidad. True status is rather unclear as recent reports come from the Northern Range where its superficial similarity to Hepatic Tanager is a potential identification pitfall.

Scarlet Tanager, *Piranga olivacea*. All records during the period under review refer to single male birds as follows: on Morne Catherine, 28 April, 1998 (FEH); at Aripo Agriculture Stn., 18 April, 2000 (MK); in Arena Forest, 15 April, 2001 (CR); along Nariva Rd. 16 April, 2001 (CR) and at Asa Wright Nature Centre, 14 April, 2002 (SC). A rare spring migrant through Trinidad and Tobago with almost all records falling in the period 10 - 30 April.

Yellow-bellied Seedeater, *Sporophila nigricollis*. An adult male was seen briefly atop a ridge at Teteron Bay on 2 August, 2001 (MK). There is a regular late summer/autumn population on Chacachacare; elsewhere, species is rare indeed, due to the cage-bird trade.

Lesson's Seedeater, *Sporophila bouvronides*. An adult male was seen briefly close to the lighthouse on Chacachacare, 12 October 2003 (MK). Historically this species was a common resident in both islands. However, the cage-bird trade extirpated the resident population and it is now just a casual visitor from continental South America.

Bobolink, *Dolichonyx oryzivorus*. On 4 October, 1998, a single bird was seen and heard flying over Chacachacare (FEH *et al.*) and on 6 October, 2000, one flew over Galera Pt. (MK). All remaining Trinidad records come from the Caroni Rice Project as follows: up to 50 seen between 1- 20 October, 2000 (FEH; MK); a single bird on 28 December, 2000 (MK); up to 25 between 29 October - 5 November, 2001 (MK); up to 50 between 10 and 30 October, 2002 (MK); a single bird on 9 October, 2003 (BM). From Tobago, a single bird was found at Blue Waters Inn on 19 October, 2002 (MW). In recent years, this species has been recorded almost annually in autumn and early winter. All birds are in either immature or female plumage.

In addition to the above, acceptable records were received for a further 19 sightings of the following species whose status has already been established: Masked Booby, *Sula dactylatra*; White faced Whistling-duck, *Dendrocygna viduata*; Masked Duck, *Nomo-*

nyx dominicus; Green-throated Mango, *Anthracothorax viridigula*; Short-tailed Pygmy-tyrant, *Myiornis ecaudatus*; Bank Swallow, *Riparia riparia*; Ruddy-breasted Seedeater, *Sporophila minuta*; Moriche Oriole, *Icterus chrysocephalus*. Two records received, a Mallard, *Anas platyrhynchos* and a Collared Dove, *Streptopelia decao*, were considered to be of escaped or feral origin.

INCONCLUSIVE RECORDS

Records considered inconclusive were of Agami Heron, *Agamia agami*; Wood Stork, *Mycteria americana*; Caribbean Flamingo, *Phoenicopterus ruber*; Rufous Crab-hawk, *Buteogallus aequinoctialis*; Black Hawk-eagle, *Spizaetus tyrannus*; Herring Gull, *Larus argentatus*; Dark-billed Cuckoo, *Coccyzus melacoryphus*; Lesser Elaenia, *Elaenia chiriquensis*; Venezuelan Flycatcher, *Myiarchus venezuelensis*; Blackburnian Warbler, *Dendroica fusca*; Bay-breasted Warbler, *Dendroica castanea*; Slaty Finch, *Haplospiza rustica* and Gray Seedeater, *Sporophila intermedia* from Trinidad. From Tobago, Gray Hawk, *Asturina nitida*; Short-tailed Hawk, *Buteo brachyurus*; Black-headed Gull, *Larus ridibundus*; Common Nighthawk, *Chordeiles minor*; Blue and White Swallow, *Pygochelidon cyanoleuca* and Tropical Parula, *Parula pitayumi*.

ACKNOWLEDGEMENTS

Records and contributions were received from the following: Andy Adcock, Mike Bowen, Ian Broadbent, Jay Caplin, Steve Cooper, Phil Davis, Carl Deabreu, Richard ffrench, Phil Davis, Ernest Garcia, Newton George, Geoffrey Gomes, Nigel Hacking, Floyd Hayes, Dave Holman, Alvaro Jaramillo, Martyn Kenefick, Howard Kilpatrick, Nigel Lallsingh, Bill Murphy, Roger Neckles, Mike Rogers, Courtenay Rooks, Rose Rowlett, Bob Scott (RES), Hema Seeramsingh, Chris Sharpe, Roopnarine Singh, Nigel Stocks, Roger Taylor, David Tomlinson, George Wallace (GeoW), Rob Wardle (RWa), Simon Warry, Richard Webster (RWe), Graham White (GW), Mark Wilson, Jerry Wittet.

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NATURE NOTE

On the Heat Sensitivity of the “Luminous Lizard” *Proctoporus shrevei*



Proctoporus shrevei (Photo: Graham L. White)

Proctoporus shrevei is a Trinidad endemic lizard found in the Northern Range at altitudes mostly above 600 m though there have been a few reports of some at lower altitudes. Usually called the “Luminous Lizard”, its body length is about 50 mm and tail about 85 mm. Adult males have a row of five or six ocelli on each side of the body and these have been reported as luminous by the discoverer of the lizard, Ivan Sanderson (1939). Since then others have failed to duplicate Sanderson’s original observations, but the lizard continues to attract attention from scientists and the general public.

On 12 April, 2004 the writers caught a male *P. shrevei* on the edge of a stream at an elevation of about 700 m on the route to Soho Cave in the Aripo Valley. It remained enclosed in the palm of the hand less than two minutes but went into a comatose state and had to be revived by pouring some cold water over it from the stream. It survived the return trip and was subsequently kept in captivity for several months.

Recently, Knight *et al.* (2004) reported that *P. shrevei* typically occupies a microclimatic range of 20-23°C and will die if kept at temperatures above 24°C. Trials by one of us (VQ) have shown that a thermometer bulb grasped in the hand will record a

temperature rise from 30.3 to 35.2°C in one minute. If, however, the hand had been immersed in water at 26.1°C for two minutes, the temperature on holding the thermometer will dip and return to near 30°C in one minute. Thus, it would seem that our lizard when held in the hand went into heat-stroke, and this result should serve as a warning to others to handle captured lizards of this species as little as possible, if they are to remain alive.

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Attempted Re-Floating and Subsequent Necropsy of a Bryde's Whale, *Balaenoptera edeni* at La Brea, Trinidad and Tobago

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ABSTRACT

An adult, male, Bryde's whale (*Balaenoptera edeni*) was stranded in shallow water at La Brea, Trinidad, in May 2004. It was assessed clinically by a team from UWI's School of Veterinary Medicine (SVM) and several attempts were made to return it to the sea. Three days later, the whale was found dead five metres from where it had been stranded. A group from the SVM carried out a partial post-mortem examination. Valuable morphometric and other data were collected together with a selection of tissue samples for laboratory investigation. No specific cause of death has yet been diagnosed but tests are still in progress or pending. The case illustrates the need for a concerted approach to strandings of live or dead cetaceans and the value of an input by scientists from UWI and elsewhere. The establishment of a regional stranding network is essential.

INTRODUCTION

Whales of various species are found throughout the oceans of the world and the waters surrounding Trinidad and Tobago are no exception. Around the turn of the last century, there was a small-scale whaling industry centered on the islands of North Western Trinidad which caught up to 25 animals per season (Reeves *et al.* 2001).

Over the past six years there have been at least nine incidents of marine mammals being stranded on Trinidad and Tobago's shores. Between April and October 1999, there were five separate incidents of pilot whale *Globicephala macrorhynchus* strandings in Trinidad (Trinidad Express Newspaper April 28, 1999 and October 15, 1999). In 2002, a porpoise had beached in Chaguaramas on Trinidad's north-western coast. In January 2003, yet another pilot whale was temporarily stranded: at Waterloo on Trinidad's western coast (White and Gosine 2003). In 2004, three marine mammals were reported as stranded: a Bryde's whale *Balaenoptera edeni* in La Brea on Trinidad's south-western coast in May 2004 (Trinidad Express Newspaper May 11, 2004), the subject of this article; and two dolphins in Mayaro on Trinidad's south-eastern coast in September 2004. Unfortunately, in the latter case, by the time help arrived, the dolphins had already been slaughtered and shared among villagers (Newaj-Fyzul and Cooper, unpublished data). On the morning of Sunday May 9, 2004, a La Brea resident discovered a floundering, "40-foot" whale, approximately one km east of Pt. Sable, La Brea. Over the following 36 hours, some villagers poured buckets of water on the animal and attempted to coax the whale into deeper water. Other people allegedly sought to do harm to the animal by cutting out portions of the blubber and inscribing their names and the date into the animal's skin with penknives.

THE CASE

On the morning of Tuesday May 11, 2004, a request was received at the School of Veterinary Medicine (SVM), University of the West Indies (UWI), for assistance with the stranded animal. A coastguard helicopter was dispatched to transport a team that included Professor John E. Cooper, Dr. Carla Phillips and Dr. John Watkins to the site. From the helicopter, many people, several small boats and a commercial tug were spotted with the whale in about 1 – 2 m of water about 100 m offshore on the gently sloping beach. At the site of the beaching, the team of veterinarians was assisted by officials of the Environmental Management Authority (EMA), the Institute of Marine Affairs (IMA) and the Forestry Division.

The animal was now positively identified as a Bryde's whale *Balaenoptera edeni* (see later). Although the whale was mostly submerged, it could easily be seen to be a 'large one' and it was pointing out to sea – possibly a positive sign. After taking aerial pictures, the UWI representatives landed on the beach and waded out to the animal. It was estimated to be approximately 15 m long. The team divided forces, with a veterinarian at the head, body and tail. Physical examination following standard procedures (Barnett and Robinson, 2003) was not easy because of strong waves, but it was concluded that the whale was not seriously sick or grossly injured externally. It was breathing regularly. It was not possible, because of the circumstances (an almost totally submerged whale and large waves), to carry out tests of sensibility or vitality on the lines suggested by Butterworth *et al.* (2004) but the animal appeared to be very aware of stimuli and was definitely 'vital'.

Interviews with people present revealed that one attempt was made earlier in the day to tow the whale into deeper water using small boats and ropes, but this failed. The team, with stronger ropes and a tug, decided to try again to translocate the whale out to sea. This decision was not taken lightly and was one of Herculean proportions as large cetaceans are never easy patients. This is in marked contrast to the smaller species which are relatively easily manipulated and can even be taken into care (Townsend 1999). In view of the whale's apparent healthy state, other options, such as tending the animal where it was first stranded or even leaving it to die were not realistic and in any case would have been futile because of the impossibility of providing protection for the whale, 24 hours a day.

After a small mishap with the rope slipping off on the first attempt, a second try was made with the strap and rope replaced around the body, just behind the fins and the whale was very gently and slowly towed some 3 - 4 km out to sea in deeper water, where it displayed dives in a very encouraging way.

Whilst debating how best to release the whale from the straps and tow rope – which was some 30 m long – the whale divested itself of them and headed out to sea.

The tug and some other small boats then patrolled up and down the shore for about half an hour, making lots of noise and with engines running hard in an attempt to discourage the whale from a possible return. A very optimistic team returned to the SVM, feeling that a job had been well done.

The next day, however, the whale was in a similar position on shore. It was returned by the tug to deeper water three times. On

the third tow it was reported that the whale was either dead or in very poor condition, but no further reports were received for three days until Friday May 14, 2004, when the dead whale washed ashore some five kilometres to the west on Guapo Beach.

On Saturday May 15, 2004, a team from the SVM again visited the site, this time to conduct a post-mortem examination to ascertain the possible cause of death and to investigate any underlying pathology. This team included Professor John Cooper, Mrs. Margaret Cooper, Dr. Carla Phillips, Dr. John Watkins, Mrs. Aweeda Newaj-Fyzul and Mr. Anthony Bastaldo. Professor C. F. Brownie, an External Examiner at the SVM and Dr. Sham Bissessar of the Veterinary Public Health Unit, as well as a number of veterinary students, later joined the group.

POST-MORTEM EXAMINATION

A team effort was needed to carry out the post-mortem (necropsy) examination on the whale, which started at 0950 h. The beach area was fenced off, creating a "clean" area where onlookers and assistants could stand, and a "dirty" area for those appropriately dressed and protected who were performing the necropsy. The work was hampered by the fact that the whale was in water, albeit on the edge of the beach, and that the tide was rising. Also there was a time restriction in that the Solid Waste Management Company Limited (SWMCOL) wanted to dispose of the whale's carcass by 1400 h. Therefore only a limited necropsy could be performed.

The necropsy technique broadly followed the recommendations of the European Cetacean Society (Kuiken and Hartmann 1991) with modifications based on the authors' experiences and the particular features of the case.

The animal was confirmed as a male, with a conspicuous penis that measured 59 cm in length. The total length of the whale was 11.33 m. Other measurements were: mandible – snout 26 cm; girth cranial to dorsal fin 158 cm; girth at pectoral fin 230 cm.

Gross post-mortem findings were minimal and complicated by decomposition. There was contusion (bruising) of skin and subcutaneous tissues, much of which was recent and probably attributable to damage when the whale was stranded and when attempts were made to re-float it. No parasites were detected. Various bacteria were isolated from internal organs but did not appear to include significant pathogens. A wide range of tissues, collected for histopathological investigations are still being processed: initial examination of some of these has shown no microscopical changes suggestive of infectious disease but there are traumatic and inflammatory lesions. All samples have been retained and catalogued at the SVM, as the start of a UWI Reference Collection.

THE SPECIES INVOLVED

The Bryde's whale *Balaenoptera edeni*, belonging to the order Cetacea Sub-order Mysticeti and Family Balaenopteridae, is easily recognised by the three parallel longitudinal ridges on the head which is unique to the species. The head is very large. There are twin blowholes with a low splashguard to the front. This whale has no teeth, but has the most extravagant baleen apparatus. The two rows of baleen plates consist of about 250-410 short plates each.

The skin on the back and upper surface of the whale is usually grey, but may appear mottled with circular scars, because of parasitic infection or Cookie cutter shark bites. (Our whale was very dark grey). There are slender, short, pointed tip flippers with a broad flattened tailstock. The underside of the whale is purple-grey, blue-grey or creamy, while the underside of the tail fluke may

appear dirty white.

The average length at sexual maturity is about 12.5 m for a female, which is usually larger than the male (12.2 m). The female reaches sexual maturity at around 10 years while the male averages 9 to 13 years. The gestation period is one year and lactation may be less than a year. The female gives birth every two years and the calves are about four metres in length.

These whales prefer tropical, sub-tropical and some warmer temperate waters and are present most commonly in areas between 30 degrees North and 30 degrees South latitude. They feed all year round and their diets consist of euphausiids, schooling fish, especially anchovies, herring and mackerel. Some Bonito and smaller sharks may also be eaten (Ellis R. 1980).

Bryde whales do not employ sophisticated underwater "sonar" system (echolocation) to supplement their knowledge of the surrounding environment (none of the mysticete species has been shown capable of echolocation). These whales may dive for about ten minutes and average four to seven blows with a long dive. They swim in loose groups or singly and spread over several kilometres. They rarely show the top of their heads; however, they often expose their backs and dorsal fin before a long dive and their diving sequence is irregular.

DISCUSSION

Analysis of the medical aspects of this case are still being worked on and will be presented at a later date. The incident is reported here in order to provide a record of the stranding, of the species involved and of the basic steps taken first to attempt to save the live whale and, subsequently, to obtain maximum scientific value from the animal's carcass.

Strandings of cetaceans in the Caribbean are likely to continue to occur and there is a need for an organised response to such incidents. Collaboration between government bodies, UWI and Non-Governmental Organisations – with an input from local people and concerned, knowledgeable naturalists – is essential if best practice is to be followed in future. Advice and assistance from experienced people overseas, especially in North America and Europe, will also be required, and at the time of writing, discussions are underway with a view to establishing a stranding network on Trinidad and Tobago. In the long term it is important that Trinidadians and other Caribbean nationals gain the necessary expertise and, in this respect, the 2004 incident, although disappointing in its outcome, was educational and provided very useful lessons for all those involved.

ACKNOWLEDGEMENTS

We are grateful to the Director, staff and students of the SVM for their help and support for this venture and for assistance with diagnostic and research samples. Our thanks are due to Petrina Shepherd and Deborah Daniel for typing this manuscript. The encouragement of the Principal of UWI is much appreciated.

The various governmental bodies – Wildlife Section (Forestry Division), EMA, IMA, Coastguard, Police and SWMCOL – all provided essential support and advice. Individual officers from these organizations were painstaking in their concern for the whale and in their willingness to help. In the same vein, thanks are due to those local residents of La Brea who did their best to protect the whale when it was first located and to the tug owners who made their boats available for the operation.

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NATURE NOTE

Traditional Nest-site Use by Chestnut-collared Swifts

It is well known that birds may return to nest year after year at the same site. Long-term use of a particular nest site or colony site has been termed "traditional nest-site use" (Dobkin *et al.* 1986). Many seabird breeding colonies have been documented as being at the same location for decades or even longer. Gannets *Sula bassanus* have nested on Scotland's Bass Rock since 1447 (Nelson 1978). Physical stability of the nest site and continued reproductive success are thought to be important factors contributing to the return of successive generations to breed at the same location (Austin 1949; McNicholl 1975). Protection from predators, a nearby food supply and scarcity of other suitable nest sites may also be important (Blancher and Robertson; Dobkin *et al.* 1986).

In Trinidad, the presence of nesting colonies of Yellow-rumped Caciques *Cacicus cela* in the centre of Sangre Grande and Cumuto for many years are graphic examples of this. Individual nest sites as well as colony sites may also be occupied for extended periods; this seems to be characteristic of many species of swifts (Lack 1956; Snow 1962; Collins 1968; Dobkin *et al.* 1986; Collins and Foerster 1995). This may be particularly true for the Chestnut-collared Swift *Cypseloides niger* and other members of the subfamily Cypseloidinae, which have particular nesting habitat requirements that may be in short supply. These swifts nest on damp, dark rock surfaces near or over water and often behind waterfalls (Lack 1956; Knorr 1961; Snow 1962; Collins 1968). In Trinidad, Chestnut-collared Swifts have been reported nesting in the same Guacharo Gorge (= Dunstan Cave) for about 70 years. This site, in upper Arima Valley on the grounds of the Asa Wright Nature Centre, was first mentioned by Belcher and Smooker (1936) and the swifts nesting there were extensively studied by Snow (1962) and Collins (1968, 1974). Snow recorded one particular Chestnut-collared Swift nest used in four successive years and, after being washed away, rebuilt the following year near the original position. My observations between 1961 and 1967 similarly recorded individual nests to be present at the same positions in the gorge for up to six years, albeit relined with some fresh material each year. On a visit to the centre in October 2004, I observed one Chestnut-collared Swift nest on an overhanging ledge near the mouth of the Dunstan Cave which was the exact site of a nest during my 1961-1967 studies 40 years ago! I had also noted a nest at this site on a later visit in 1972. R. ffrench (pers. com.) informed me that one has been observed there consistently for the past 18 years. Discussions with the nature centre naturalists indicated that 2-3 more of the sites lower in the cave where David Snow and I observed swift nests years ago still had

active nests in 2004. Although Chestnut-collared Swifts have a low adult mortality rate and some individuals may live in excess of 20 years (Collins 1974), it is almost certain that these nests have been utilized by a sequence of different individuals over the years.

These observations serve to reinforce the earlier suggestion (Dobkin *et al.* 1986) that traditional nest-site use is widespread in the Apodidae and is to be expected in the Chestnut-collared Swift in particular. It is important to note that this pattern of traditional use also extends to specific individual nest placements and not just colony sites involving several to many individual nests in one more generalized location.

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PUBLISHED ELSEWHERE

ABSTRACTS

Shedding Light on the Luminous Lizard (*Proctoporus shrevei*) of Trinidad: A Brief Natural History

C. Michael Knight, William H. N. Gutzke and Victor C. Quesnel

Caribbean J. of Science, 40(3): 422-426. 2004.

A herpetological debate lasting 70 years regarding the so-called luminous lizard, *Proctoporus shrevei*, of Trinidad is addressed. Published natural history accounts from the 1930's suggested that the males of the species possess the capability of producing light. Despite the potential significance of such a trait in a terrestrial vertebrate, no direct studies of *P. shrevei* were conducted and findings from indirect studies were equivocal. To resolve the debate, a field investigation was conducted in May 2001 and 2002 with

adult *P. shrevei* in Trinidad. Evidence supported the hypothesis that the lizard's scales are highly reflective and, when combined with fluctuations in dermal pigmentation, this produces an optical illusion consistent with early natural history observations. No evidence for bioluminescence was found. However, despite being a tropical organism, *P. shrevei* displays intolerance to heat and life history adaptations to relatively cold, cave-entrance microhabitats.

A Synopsis of the Castniidae (Lepidoptera) of Trinidad and Tobago

J. M. González and M. J. W. Cock

Zootaxa, 762: 1-19. 2004.

Current knowledge of the Castniidae of Trinidad and Tobago is summarized based on literature, museum specimens, and personal observations. Two new synonyms are proposed: *Aciloa palatinus pallida* Lathy = *Athis palatinus palatinus* (Cramer), and *Haemonides cronis urichi* Lathy = *Haemonides cronis cronis* (Cramer). One new combination is proposed: *Telchin syphax syphax* (Fabricius). *Erythrocastnia* Houlbert is a new subjective synonym of *Telchin* Hübner. Eleven species are now recorded from Trinidad, six of which are remarkably uncommon in collections: *Synpalamides phalaris* (Fabricius), *Eupalamides cyparissias cyparissias* (Fabricius), *Athis fuscorubra* (Houlbert), *Feschaeria amycus* (Cramer), *Castnia invaria trinitatis* Lathy, *Castniomera atymnii* (Dalman) and *Telchin syphax syphax*. *Athis palatinus* occurs occasionally on the ridges of the Northern Range. *Haemonides*

cronis is found occasionally on the ridge tops and hill tops of the Northern Range and the Central Range. *Telchin licus* is the most common and widespread castniid in Trinidad. It is a pest of sugar cane, and we critically review the literature on its other host plants. *Xanthocastnia evalthe evalthe* (Fabricius) is a forest-dwelling species of the Northern Range. *Feschaeria amycus amycus* is the only species known from Tobago, based on a single specimen.

EDITOR'S NOTE

The above paper has just been published in the electronic journal Zootaxa (www.mapress.com/zootaxa/). Anyone interested in receiving a .pdf file of this paper, which includes a colour plate illustrating adults of all Trinidad and Tobago castniids, is welcome to contact the second author by e-mail: m.cock@cabi.org

Immature Stages of *Calydna venusta morio* (Riodinidae) from Trinidad

M. J. W. Cock and J. P. W. Hall

J. of the Lepidopterists' Society, 58: 51-53. 2004.

Calydna venusta morio Stichel (Riodinidae), was first found in Trinidad in 1984 by S. Alston-Smith at Point Gourde, on the north-western peninsula of Trinidad. On 16 May, 1999, MJWC found several fourth and fifth instar riodinid caterpillars in shelters on a single bush of *Ximenia americana* L. (Olacaceae) at Point Gourde; three of these were reared. The L4, L5 and pupa are briefly described and illustrated, as well as a living adult female. *Ximenia*

americana is recorded from only one locality in Trinidad, on the beach between Erin and Chatham, i.e. on the south coast. However, more recent herbarium records include Erin Beach, Quinam Beach and Chacachacare Island. It seems likely that *C. venusta* will eventually be found on Chacachacare Island, and perhaps at the South Coast localities for *X. americana*.

BOOK REVIEWS

Butterfly Trails

H. R. Roegner

Xlibris Corporation, USA. 2003. 208 p.

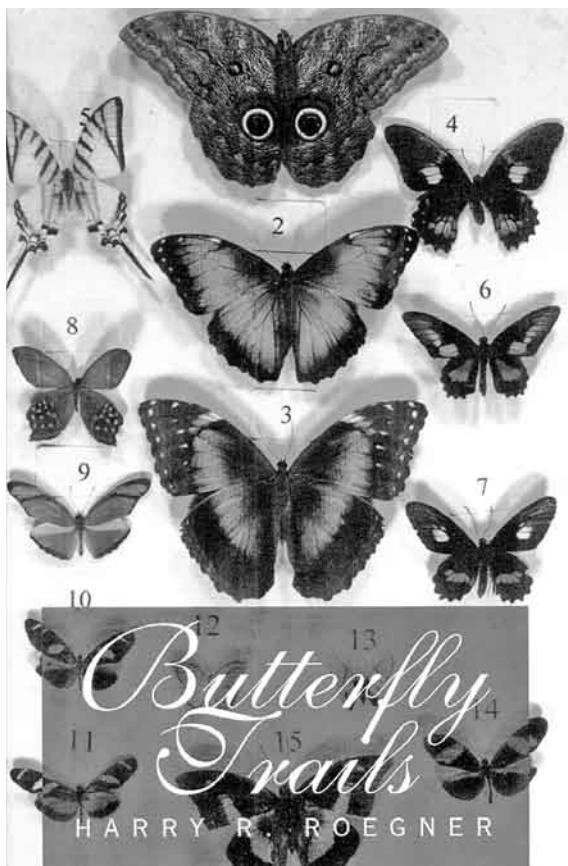
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Harry R. Roegner travelled in Asia, Africa and Latin America as an international businessman and dedicated butterfly collector for more than 40 years. In this slim volume he has compiled six vignettes of his experiences in Peru, China, Costa Rica, Liberia, Trinidad and Ivory Coast. Having been to all these places except Liberia, and also having collected in them, at least in passing, I found this an interesting, entertaining and easy read. For those without at least a passing interest in and knowledge of butterflies, there is plenty of human interest – Harry Roegner has taken his chances while collecting.

The vignette of particular interest to this readership is the chapter entitled “Trinidad-Barcant.” Malcolm Barcant is the author of Trinidad’s only butterfly field guide, based on his 50 years collecting here (Bancant 1970). Inspired by Barcant’s book and reports that Barcant had been prohibited from taking his collection with him when he emigrated (leading to its acquisition by Angostura), Roegner made four visits to Trinidad between 1979 and 1984 to try and recreate Barcant’s comprehensive collection outside the island. He achieved 250 out of his target of 400 butterflies other than Hesperiidae; 15 of these illustrate the front of the book’s dust cover. This chapter describes his second visit, made in 1980, the most memorable in terms of species and events.

There are interesting observations on butterflies, including



anecdotal behavioural observations on emperors, cattlehearts, preponas, lady’s slipper, the bee, caligos, etc. During his short visit, Roegner also encountered a Cuban agent, an obeah man, a marijuana field guarded by a trip-wire shotgun, and lobbied a government agent on the need to take steps to preserve the Angostura-Barcant collection from neglect. It seems to be a feature of this book that this sort of thing happens to Harry Roegner on his butterfly collecting travels.

There are a couple of observations worth picking up on. Firstly, Roegner captured the southern cattleheart (*Parides sosostris*) behind Maracas Bay, and suggests that whereas this species had been restricted to the south of Trinidad and prevented from moving north by swamps and plantations, development of swamp areas and closure of some plantations had created avenues for it to spread north. I have not caught the southern cattleheart in the area, but I have caught the rare brown glass-wing (*Ceratinia nise*) behind Las Cuevas Bay. Both these species are associated with lowland forest in Trinidad, predominantly in the south, so that although the Northern Range is not suitable habitat, patches of lowland close to the North Coast are suitable and I suspect may maintain isolated populations.

Particularly in light of a return visit in 2000, Roegner also comments on the impact of slash and burn agriculture destroying forest, especially around Port of Spain and its surrounding sprawl. He goes on to suggest that one reason that he only achieved 250 butterfly species out of Barcant’s 400 total is that habitat destruction has led to extinction of some species on the island. While it is certainly true that there has been significant habitat destruction on the island, I think this destruction has been far less than it might have been, thanks partially to the efforts of groups such as the TTFNC. My personal opinion is that very few, if any, species that were truly indigenous 100 years ago (i.e. excluding vagrants and migrants) have become extinct on the island as yet. I propose to make a more detailed analysis of this question in consultation with local collectors, and hope to be able to present this at a later date.

If you are interested in a snapshot of Trinidad’s social history from a visitor’s perspective in 1980 combined with natural history observations on butterflies, then it is worth reading this chapter. If you would enjoy five similar snapshots then buy the book. Details of the publisher are given above, although I bought my copy from an internet bookseller – for about TT\$120.

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The Journals of the Trinidad Field Naturalists' Club, 1892-1896

CD published by the Trinidad and Tobago Field Naturalists' Club, 2004.

TT\$200 or US\$35

The Trinidad Field Naturalists' Club was founded in 1891 as a manifestation of the strong British amateur tradition in natural history (Starr 2004). After a vigorous early period, it fell into inactivity in 1907, with only intermittent activity until 1954, after which it has continued without interruption (Carr 1991; Quesnel 1991; Quesnel et al. 1956; Rooks 1991).

The importance of communication among members and with the wider public was understood from the outset, and in April 1892 the Club began publication of its journal. This continued through two volumes, each of 12 numbers, and then abruptly stopped, to all appearances, in 1896. The possibility remains that a few numbers appeared after this – readers with access to relevant archives in Britain or India are cordially invited to look into this question – but all indications are that vol. 1 no. 12 in February 1896 was the last until it was revived in 1956 (Quesnel 1991).

The reasons for the journal's demise after just four years are something of a mystery. The Club's membership had risen rapidly within a year from the initial eight to about 50, and the journal appeared to be doing very well. From a very respectable initial press run of 150, it quickly went to 300 and above, and the regularity with which it appeared was a sign of good health. The effective dissolution of the Club in 1907 appears to have been quite a separate event, and one is left with the mundane conjecture that a loss of one or two key members of the editorial committee robbed the journal of its impetus. There is no direct evidence of this, but small organizations are inherently unstable.

In the Club's founding period, a majority of members resided in Port of Spain and could presumably attend meetings. Still, there was the critical problem of maintaining contact with other naturalists outside of the city and abroad in an age before telephones and e-mail, and when road conditions made it difficult to move about in even so small a territory as Trinidad. Accordingly, the early journal served many more purposes than its modern counterpart, the *Living World*.



In addition to research reports and nature notes, it included material that today would go into the minutes of meetings, committee reports and the quarterly newsletter, as well as excerpted papers from other journals. In short, it was a proceedings journal typical of its time.

The early journal gave special attention to problems of economic biology, alongside the more basic concerns of naturalists then and now. The members recognized the value of a good floristic/faunistic groundwork, so that species lists appeared from time to time. Beyond this, there are some notable biases that undoubtedly arose from the particular interests of those members who happened to be most active. Most strikingly, there was virtually no attention to marine life. And there was much more about animals – especially amphibians, reptiles and birds – than about plants and fungi. Birds received much less attention then than now.

Numbers of the post-1956 revived journal have been reasonably accessible, at least in Trinidad, to those determined to find them, but until now those from 1892-96 have effectively been hidden from most of us. This very convenient CD will thus be welcomed by many. It comprises 11 files readable in Acrobat. The first of these is an introduction and table of contents compiled by the editors. The entire pages of volumes 1-2 are divided in sequence among the remaining 10 files. Each volume comprises a little over 300 pages and includes its own subject/taxonomic index, useful in searching for particular topics.

The files were produced by scanning an original set of the journal. Not surprisingly, the available numbers were not always in prime condition after all these years, so that the print is not modernly crisp. Even so, one can read every passage without undue effort. This handsomely-produced set of the early *Journal of the Trinidad Field Naturalists' Club* is a bargain for local naturalists, archivists, libraries, and others who understand along with William Faulkner that "The past is not dead; in fact, it is not even past."

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Reviews of the CD “Bird Song of Trinidad and Tobago” and DVD “Wild T&T”

- a. The CD set is priced at TT\$300.00 and is available at the Asa Wright Nature Centre, Trinidad and at both Cuffie River Nature Resort and The Adventure Farm in Tobago.
- b. The DVD is available from “RIK Books” and “Just CD’s” chain of stores and priced at \$250 + VAT. VHS versions are available via Caribbean Discovery Tours via
Email: caribdis@wow.net or Tel. 620-1989.

Bird Song of Trinidad and Tobago The terms “birding” and “bird-watching” embrace a wide spectrum of interests and intensities. These hobbies are aided by an ever growing library of support material, suitable for all levels of ability and now include DVD, Video and CD ROM.

“Bird Song of Trinidad and Tobago - an aid to identification” is a 3 CD set recording, the work of John Hammick and Richard ffrench, assisted by Dave Ramlal. Accompanying is an index booklet naming each track and allowing cross reference to the picture and written account in Richard ffrench’s 2nd edition of his “Guide to the Birds of Trinidad and Tobago”.

Birding is often about what initially you hear, rather than see. There follows a filter process which basically asks two questions of the noise heard; (a) is it a bird (rather than insect, mammal or amphibian)? If the answer is “yes” (b) then what species is it? Here these CD’s become invaluable. Whilst not a visual aid that can be easily used in the field, I know of more than one birder who use their vehicle CD systems on the drive out to and back from birding locations.

To a general audience, the selection is extremely comprehensive covering 179 species, including representatives from every bird family occurring in our twin islands. These CD’s put to rest the misconception that an individual species only makes “one kind of noise”. Individual recordings are generous in the coverage not only of familiar vocalizations, but also include a variety of sub-song and contact calls. Obviously selection of species is a very personal thing. As an ardent seeker of secretive and elusive birds, I would have welcomed inclusion of more of our resident crakes and rails – birds we frequently hear and rarely see. Again personally, I find the vocalizations of “pigeons and doves” frustratingly similar. Gray-fronted and White-tipped Doves are admirably handled, if only the rarer Ruddy and Lined Quail-doves had been included!

On a more technical note, the absence of introductory titles or numbering to announce individual tracks on the CD’s themselves is irritating and could easily have been incorporated.

Nevertheless, these criticisms are minor and should not in any way detract from what is a major work of excellent

quality. Whilst it may have a rather limited audience, I can thoroughly recommend it as an essential reference for any resident or visiting birder to Trinidad and Tobago.

Wild T&T Departing from the exclusivity of birds, “Wild T&T” is a 45 minute long film produced by Pearl & Dean (Caribbean) Ltd. in association with Caribbean Discovery Tours; available on both VHS and DVD. Whether your interest is in birds or butterflies, spiders or snakes, frogs or lizards, mammals or fish, plants or trees, there is plenty here for everyone. The highest compliment I can pay to the photography is to call it “BBC quality”. The narration is both informative and pleasing to the ear, without detracting our attention from what is being filmed.

Personal favourites are many, especially the sequences of the Wolf Spider devouring a frog twice its size; the dance of the Blue - backed Manakins; the troop of Red Howler monkeys stretching and yawning in the hot afternoon sun and the Silky Anteater actually dropping off to sleep. However, without doubt the social interaction of the White - fronted Capuchin monkey family takes pride of place for me.

The advantage of a DVD version is its flexibility. In addition to the film, there are options available for a captioned rolling slide show featuring every species depicted; copy of the script; a useful bibliography and a series of location maps. My only minor criticism is restricted to the captioning. The trogon depicted is a female Violaceous, not White-tailed Trogon and there are several spelling and punctuation mistakes.

Not only do I wholeheartedly recommend this film to everyone with an interest in the animal and plant life of our islands, I urge all parents and school teachers alike to show this to the children; the generation who can truly help to save what otherwise is in danger of being lost forever.

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Articles can be forwarded on diskettes or CDs along with one hard copy to: Elisha S. Tikasingh, 12 Newbury Hill, Glencoe, Trinidad and Tobago. Files up to 500kb may be sent as e-mail to: elisha@rave-tt.net, g-white@tstt.net or linusp47@hotmail.com.

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Nature Notes is a section allowing contributors to describe unusual observations on our flora and fauna. Notes should not exceed one Journal page.

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Some examples:

1. Journals:

Snow, D. W. 1962. A field study of the Black and White Manakin in Trinidad. *Zoologica*, 47: 65-104.

Quesnel, V., Farrel, T. F., Hilton, A., Hilton, J. and Zuniaga, L. 1996. The revegetation of the McClean Monument. *Living World, J. of the Trinidad and Tobago Field Naturalists' Club*, 1995-1996: 9-12.

2. Titles of **Foreign Language Journals** should be given in full. e.g. *Tijdschrift Voor Entomologie*.

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Barcant, M. 1970. Butterflies of Trinidad and Tobago. London: Collins. 314 p.

4. Citation from Books and Monographs with Editors:

Collins, C. T. 2002. Notes on the biology of the Band-rumped Swift in Trinidad. p.138-143. In **Floyd E. Hayes and Stanley A. Temple**, eds. Studies in Trinidad and Tobago's Ornithology Honouring Richard ffrench. St. Augustine, Trinidad and Tobago: Depart. of Life Sciences, Univ. of the West Indies, Occasional Paper No. 11.

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**Deadline for submission of articles for the 2006 issue of Living World –
1 February 2006.**

CONTENTS

The Trinidad and Tobago Field Naturalists' Club	Inside Front Cover
Acknowledgements	ii
Editorial	iii
Cover Photograph	iii
State of the Environment: Guest Editorial.....	iv
 Research Papers	
Checklist of the Vascular Plants of Chacachacare Island, Trinidad and Tobago	1
<i>C. D. Adams and Y. S. Baksh-Comeau</i>	
A Survey of Freshwater Macroinvertebrates on Antigua, West Indies	11
<i>D. Bass</i>	
Bioecological Studies on the Whiteflies (Hemiptera: Aleyrodidae) of Trinidad and Tobago.....	15
<i>V. F. Lopez, M. T. K. Kairo, P. Bacon and A. Khan</i>	
The Skipper Butterflies (Hesperiidae) of Trinidad. Part 13, Hesperiinae, Gencra Group K	23
<i>M. J. W. Cock</i>	
Automeris liberia (Cramer) (Lepidoptera: Saturniidae) in Trinidad.....	48
<i>M. J. W. Cock</i>	
Defence Mechanisms of the Orb-Weaving Spider <i>Azilia vachoni</i> (Araneae: Tetragnathidae)	50
<i>J. N. Sewlal and L. Dempewolf</i>	
Mating Behaviour of the Neotropical Skink <i>Mabuya nigropunctata</i> (Spix) in Trinidad, West Indies	53
<i>V. C. Quesnel</i>	
 Reports	
Third Report of the Trinidad and Tobago Rare Birds Committee: Rare Birds in Trinidad and Tobago in 2001-2003	56
<i>M. Kenefick</i>	
Attempted Re-floating and Subsequent Necropsy of a Bryde's Whale, <i>Balaenoptera edeni</i> at La Brea, Trinidad and Tobago.....	62
<i>A. Newaj-Fyzul, C. Phillips, J. D. Watkins and J. E. Cooper</i>	
 Nature Notes	
Defensive Whirling Behaviour in an Antillean Daddy-Longlegs Spider (Araneae: Pholcidae)	52
<i>C. K. Starr</i>	
On the Heat Sensitivity of the "Luminous Lizard" <i>Proctoporus shrevei</i>	61
<i>J. Lum Young, P. Comeau, A. Hailey, D. Jaggernauth, B. Oumdath and V. Quesnel</i>	
Traditional Nest-site Use by Chestnut-collared Swifts.....	64
<i>C. T. Collins</i>	
 Addendum	
Synottaxidae, another Trinidadian Spider (Araneida) Family	49
<i>B. Cutler</i>	
 Published Elsewhere	65
 Book Reviews	
Butterfly Trails by H.R. Roegner	66
<i>M. J. W. Cock</i>	
The Journals of the Trinidad Field Naturalists' Club, 1892-1896	67
<i>C. K. Starr</i>	
 Reviewers for Living World, 2005	22
 Notes to Contributors	Inside Back Cover