LIVING WORLD

Journal of The Trinidad and Tobago Field Naturalists' Club

2018

THE TRINIDAD AND TOBAGO FIELD NATURALISTS' CLUB

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

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

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Editorial

The 2018 issues of Living World was initially published online as separate papers, followed by the overall issue. We anticipate that this would shorten the period between submission and publication of articles and indeed as of the next issue we plan to publish the submission and publication dates. Articles for Living World can now be submitted online via our open access journal platform. (See https://ttfnc.org/livingworld/index.php/lwj/about/submissions#onlineSubmissions).

We are pleased to include our Guest Editorial on the importance of and recent activities to increase our knowledge of our bat communities. Unlike birds, which are regularly observed and documented, our knowledge of the diversity, distribution and habits of bats is poor. Yet they represent 70% of our mammalian fauna and are of tremendous ecological importance. What is particularly encouraging is the corporation between agencies in pushing the bat research and conservation agenda. We are highlighting these activities, both on our cover and within the pages of this Living World, with the expectation that work will continue. Indeed in this issue C.F. Loughrey provides an account of the bat communities at three contrasting locations in Tobago.

The other papers in this issue of Living World are quite variable. M.J.W. Cock provides a comprehensive account of the sphingid moths of Trinidad, all 81 species with illustrations of both adults and larvae. There are two Nature Notes targeting the larvae of Saturnid moths; a caterpillar of *Arsenura beebei* by M. Kelly and M.J.W. Cock and one on *Rothschildia vanschaycki* by D.S. Huggins, K. Sookdeo and M.J.W. Cock. J.N. Sewlal concludes her account of the orb-weaving spider diversity within the Eastern Caribbean in a summary paper which includes all previous surveys. A more intimate association between harvestmen and cyanobacteria is highlighted by V.A. Young, M.K. Moore and V. R. Townsend Jr.

Representing the Amphibia, we have a Research Paper recording the apparent absence of chytrid infection of frogs in northeast Tobago, by R. Thomson, P.A. Hoskisson, S. Brozio and J. R. Downie and a Nature Note on potential case of cannibalism in the tadpoles of *Mannophryne trinitatis* by R.J. Auguste and N.F. Angeli. This note highlights how much we still don't know about this phenomenon and the ecological implications within this species. Finally for the Arachnida/Amphibia R. J. Auguste, S. Maraj and R. Deo share their observations on the capture of a *Leptodactylus validus* by the spider *Ancylometes bogotensis.*

We have five Nature Notes in this issue. In addition to the four already mentioned we have a report of a new species of mussel in Trinidad and new locations for a previously recorded species.

The report of the Trinidad and Tobago Bird Status and Distribution Committee presents 152 records submitted in 2017. Martyn Kenefick points out that this represents the highest number of submissions and the highest number of "reportable species" since the formation of the Committee 23 years ago.

This year G.A. Rivas has provided a book review of the Reptiles and Amphibians of Trinidad and Tobago. The Trinidad and Tobago Field Naturalists' Club is particularly proud of this publication as the wide list of authors are predominantly, if not all, members of the Club and regularly contribute to Living World. The fruitful collaboration is no doubt due to the activity of the TTFNC.

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Cover Photograph

This Common Tent-making Bat, *Uroderma bilobatum* is demonstrating the important role that bats play in dispersing forest fruit, in this case a Ficus fruit. The photo was taken by Merlin Tuttle, and enhanced by Edward Rooks.

Guest Editorial

Bats: Magnificent and Mysterious

It is indeed an honour to be granted the opportunity to write in the Living World Journal on a topic I hold dear. In this guest editorial, I highlight the importance of bats in our ecosystems, reflect on the diversity of bats in Trinidad and Tobago, highlight some of the research taking place in Trinidad and Tobago, and advocate for continued research into these marvellous creatures.

Whenever I am given the opportunity to present on the importance of bats, I start by asking the audience what they believe to be the importance of birds. Depending on the audience, I may get a few people answering that their plumage or songs are appealing. With some prompting, finally, members of the audience speak of pollination, seed dispersal, and insect control. Bats are the night shift for these services. One study on the pollination services of new world phyllostomid bats found that they pollinate the flowers of 360 species of plants of 159 genera and 44 families. Another study found that neotropical bats disperse the fruits of at least 549 species of plants of 191 genera and 62 families. Their role in maintaining our forest ecosystems is profound, and is well demonstrated by the cover photo where a Common Tent-making Bat, *Uroderma bilobatum* is dispersing a Ficus fruit. With respect to fruit dispersal, bats are cited as essential for recolonisation in forest clearings since many of the seeds they disperse are adapted for growth in disturbed areas. These early successional plants include those of the Jumbie Candle, *Piper sp.* and Bois Canot, *Cecropia peltata*. Bats are especially good at helping to repair fragmented forests since they are described as mobile foragers, traversing these open areas and dispersing seeds into forest patches. Without insectivorous bats, the food resources we as humans depend upon would likely be more expensive. It has been estimated, for example, that the value of bats to agriculture in the continental United States is $22.9 billion/year with respect to insect control, thereby reducing the need for pesticide applications. In Thailand, a single species of bat has been found to prevent the loss of about 2900 tonnes of rice per year. The benefits of bats in the control of insect populations may also extend to their consumption of mosquitoes and other vectors of disease, which means they have a critical role to play in human health as well.

In light of the many ecosystem services provided by bats, the Minister of Agriculture, Land and Fisheries, Senator the Honourable Clarence Rambarrat, has recognised the importance of these creatures, going so far as to join the Trinidad and Tobago Bat Conservation and Research Unit (also known as Trinibats) on an evening of mist netting at the Asa Wright Nature Centre in the Arima Valley on October 12th, 2018. The bats cooperated fully this evening, with 185 bats of 19 species being captured and safely released back into the night. This was the largest catch rate for the entire 2018 Trinibats expedition, and we were able to highlight a wide array of feeding guilds to the Honourable Minister. Bats comprise over 20% of the world's mammalian fauna, and 70% locally. In Trinidad and Tobago there are roughly 70 species of bat, and this list is likely to grow given the fact that molecular techniques used to differentiate species have not been conducted on most of the species present. Using such techniques, the only endemic species of mammal in Trinidad and Tobago was recently found in Tobago, Sir David Attenborough's Myotis, *Myotis attenboroughi*. The rich diversity we are fortunate to have in Trinidad and Tobago can be discussed in several ways. In terms of Family diversity, there are nine families of bat, with the Phyllostomidae dominating with five subfamilies and 38 of the roughly 70 species. Each of these families have their own unique characteristics. The Emballonuridae, for example, are characterised by having glandular sacs on their wings, used to mark their territories and attract mates. The Thyropteridae, consisting of one species, Spix's Disk-winged bat, *Thyroptera tricolor* is adapted to roost in the rolled up leaves of heliconia and banana using suction cups on its heels and thumbs. In terms of size, the smallest bat in Trinidad is the Riparian Myotis, *Myotis riparius,* with a forearm between 32-38mm, while the largest is the Spectral Bat, *Vampyrum spectrum*, with a forearm between 98-110mm.

Perhaps the best way to illustrate our bat diversity, however, is by feeding guild. The Spectral Bat is the largest bat in the New World, and the largest carnivorous bat in the world, feeding on birds and small mammals. There are several gleaning animalivores, such as the Little Big-eared Bat, *Micronycteris megalotis.* These can find and consume insects perched on a leaf in the dark within forested habitats, no easy task. Nectar feeding bats, such as Geoffrey's Hairy-legged Bat, *Anoura geoffroyi*, have spectacular acrobatic displays, hovering at flowers for short periods while they stick out their long tongues to consume the nectar therein. Large generalist fruit bats like the Great Fruit-eating Bat, *Artibeus lituratus*, can be seen dispersing a wide array of fruit, including Figs, Hog Plum, and Sapodilla. There are also several species of high and fast flying insectivorous bats, such as the Ghost-faced Bat, *Mormoops megalophylla*, that fly above the canopy feeding on moths, beetles and flies. There is one species of bat which specialises on fish, the Greater Fishing Bat, *Noctilio leporinus*, extending its long feet with large sharp claws to gaff fish at the water's surface. Finally, in Trinidad we possess two of the three species of vampire bat, the Common Vampire Bat, *Desmodus rotundus*, which feeds on mammalian blood, and the White-winged Vampire Bat, *Diaemus youngi*, which feeds on avian blood.

The diversity of bats we see in Trinidad and Tobago makes this a fertile ground for research. The William Beebe Tropical Research Centre at Simla in the Arima Valley was used by Dr Donald Griffin in the 1960s to conduct some of his seminal work on echolocation in bats, helping uncover the feeding ecology of the Greater Fishing Bat. It was Dr Griffin who coined the term "echolocation" in 1944 to describe the method used by microbats navigate and forage in the dark. The reproductive ecology of bats has also been the subject of very interesting and ongoing research. Seba's Short-tailed Fruit Bat, *Carollia perspicillata,* has been used as a model organism to help understand some of the serious problems found in human pregnancy. They are ideally suited to this task since they usually carry a single embryo in a simplex uterus, similar to that seen in humans. In understanding the reproductive ecology of this species, scientists such as Dr John Rasweiler IV have helped us understand some of the processes which lead to implantation of human embryos. Some of the pioneering work on paralytic rabies was carried out in Trinidad, where the link between bats and this form of the disease was made in 1931 during a multi-species rabies epidemic which killed 73 people, and thousands of livestock. Today, research continues on mimicking the anticoagulant properties of enzymes in the saliva of the Common Vampire Bat. Though the Vampire Bat has a sordid history in Trinidad, it is hoped that in harnessing the special properties found in their saliva humans may benefit from novel drugs for stroke victims. The community of bats we find in the forests of Trinidad have themselves been shown to be indicators of forest health, with gleaning animalivores having higher abundance in primary forests.

Throughout the world, bats continue to perform their tasks under cover of darkness. They perform many ecosystem services which we take for granted, have spectacular adaptations to perform these tasks, and continue to be important subjects of research. More recently, research on their behavioural and feeding ecology continues with the University of the West Indies (UWI), in conjunction with Trinibats. Research on the efficacy of batbox use in Trinidad is ongoing, where the use of bat boxes in attracting bats and alleviating bat human conflict is the focus. Bat boxes have been installed at the Asa Wright Nature Centre, along with bat acoustic recorders, in keeping with the pioneering work carried out in Trinidad on echolocation. A comprehensive treatise of the bats of Trinidad and Tobago has also been published by Geoffrey Gomes and Fiona Reid, an essential companion to novices and experts alike. Trinibats continues in our efforts to educate the public of the importance of bats, encouraging research and conservation. Beyond the research carried out by the UWI, Trinibats, and other entities, in more recent times we are pleased to see the removal of most bat species from the vermin list in the Conservation of Wildlife Act. Support from the Government of Trinidad and Tobago and the Minister of Agriculture, Land and Fisheries in the protection of roosting habitat for bats is also vital. One such location which houses a massive population of bats is the old World War II bunker in Cumuto called the "Icehouse". We do hope that structures such as these will be protected in perpetuity for these bats. Bats deserve our respect and protection. I hope that I've highlighted their importance, and the need for their continued protection.

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Orb-weaving spiders of the Eastern Caribbean

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ABSTRACT

The Eastern Caribbean represents a poorly studied region in terms of arthropod biodiversity, in particular spiders. This paper reviews studies on the biodiversity of orb-weaving spider families on seven islands in the Eastern Caribbean, sampled between January 2006 and August 2010. Specimens were collected using two main methods; visual search and sweep-netting, and supplemented by material collected from the nests of the spider hunting wasp *Sceliphron* sp. Sampling efforts yielded 33 species distributed among six families. Biodiversity was quantified by examining the observed species richness, diversity indices, species abundance models, and multidimensional scaling plots. Factors such as geographic location and habitat classification were also examined in this study as possible factors influencing orb-weaver biodiversity. No significant difference among the islands was found in terms of species richness, diversity, evenness and dominance. St. Lucia possessed the most distinct orb-weaver species composition, while the faunas of St. Kitts and Nevis and of Grenada and Montserrat were closely associated.

Key words: Anapidae, Araneidae, Mysmenidae, Symphytognathidae, Theridiosomatidae and Tetragnathidae, orb-webs

INTRODUCTION

Spiders are regarded as one of the most speciose animal orders on the planet (Coddington and Levi 1991; Foelix 1996; Nyffeler 2000) and high ranking predators in multiple habitat types (Cardoso *et al.* 2008; Oxbrough *et al.* 2005; Sharma *et al.* 2010; Stratton *et al.* 1979; Wise 1993). Spiders also make excellent candidates for biodiversity studies due to their abundance as well as relative ease to identify and be efficiently sampled compared to other invertebrates (Hsieh and Linsenmair 2011; Oxbrough *et al.* 2005). Finally they occupy middle trophic levels in terrestrial food webs acting as prey for organisms in higher tropic levels (Oxbrough e*t al.* 2005) as well as predators (Cardoso *et al.* 2008; Stratton *et al.* 1979; Wise 1993) which makes them highly regarded with respect to ecosystem stability (Coyle 1981) and arthropod control (Enders 1975; Moulder and Reichle 1972; Riechert 1974; Turnbull 1973).

The neotropics have long been declared a region rich in biodiversity but the literature contains scattered references to the spiders, particularly concerning the islands of the Lesser Antilles. Many islands in the region lack species lists and those lists that do exist tend to be based on surveys that were conducted 80 or more years ago, for example, the survey of Antigua by Bryant (1923). As a result, biodiversity data is either unavailable or unreliable for most islands and existing lists fail to document the relation of species composition and richness to the habitat from which it is recorded.

Habitat has been consistently cited as one of the most important factors affecting arthropod biodiversity influencing multiple facets including abundance, species richness (Halaj *et al.* 1998; Hatley and MacMahon 1980; Peres *et al.* 2007; Stratton *et al.* 1979) and species composition (Uetz 1991). This is achieved by the presence of more diverse microclimates (Uetz 1991) produced by the varying amounts of rain and light that reach the lower strata of forests (Loyola and Martins 2009). Web-building spiders in particular are highly dependent on the vegetation present in an area to provide them with suitable points of attachment for web construction (Riechert and Gillespie 1986) and for protection from the elements and predators (Enders 1974, 1976, 1977; Hodge 1988).

In the Eastern Caribbean there are 15 web-building spider families recorded, out of which six construct orb-webs; Anapidae, Araneidae, Mysmenidae, Symphytognathidae, Theridiosomatidae and Tetragnathidae. I chose to limit my study to orb-weaving spiders as their characteristic web design ensures they are relatively thoroughly sampled in each locality selected. They also have a uniform lifestyle and literature is available to identify them, which makes detection of new species and changes in the ecology between families and species and differences between habitat types easier and faster.

This paper focuses on the orb-weaving spider families collected on seven islands between January 2006 and February 2008. Sampling was conducted on the islands of Nevis (Sewlal and Starr 2007), St. Kitts (Sewlal 2008), Anguilla (Sewlal and Starr 2010), Antigua (Sewlal 2009a), Grenada (Sewlal 2009b), Montserrat (Sewlal 2010) and St. Lucia (Sewlal, 2011). Sampling on all of these islands was done with the aim of documenting the spider species found in as a broad variety of habitats as possible. This paper serves to collectively examine the results of the islands sampled, and looks at the relationship between habitat heterogeneity and species diversity with respect to orb-weaving spiders

METHODOLOGY

Across the seven islands in this study (Fig. 1), a total of 110 localities and 27 different habitats were sampled with some habitats not found on every island sampled (Table 1). Brief descriptions of the habitat types are given Table 2. Each island in this study was sampled for a uniform period of two weeks.

Localities for sampling were selected through consulting with government ministries and obtaining maps or reports done that contained vegetation classifications. The classification from the first island to be sampled - Nevis – was used as a guide to maintain consistency in habitat descriptions and thus the selection of habitats for sampling in subsequent islands that were sampled. Care was taken not to damage produce or flowers when sampling some habitats such as farmland used for cultivation of crops or ornamental plants. Precautions included questioning owners about the period between the last treatments with pesticides, and in determining if the habitat in some localities were to be classified as natural or disturbed such as secondary forests, in terms of when was it last used for commercial purpose.

Data from each island were collected using a combination of the visual search and sweep-netting methods, both of which are effective with respect to rapid collection of the species present in an area. Visual search involved walking around in the selected habitat and collecting what was seen from ground level to arm's length above the collector's head. Microhabitats most likely to yield cryptic species were searched using this method, such as under logs, inside rotting logs, inside holes, under bark and rocks. Sweep-netting involved sweeping the vegetation with a tough canvas insect net. This method collected diurnal and nocturnal species in retreats or resting in the vegetation. Sampling concluded if no individuals of new species were found after 15 minutes of the last new species recorded for that locality. The main goal of this study was to survey a single locality of each of the major vegetation types on each island sampled, but where time and resources permitted up to four localities in each major vegetation type was sampled (Table 2). After identifying specimens down to species level, they were transferred and stored in glass vials in 96% alcohol.

There are many different ways to separate organisms into categories to allow for easier study. One such method is by placing them into what are known as what are known as functional guilds. These are defined by Whitmore *et al.* (2002) as groups that contain species that "potentially compete for jointly limited resources". In this study

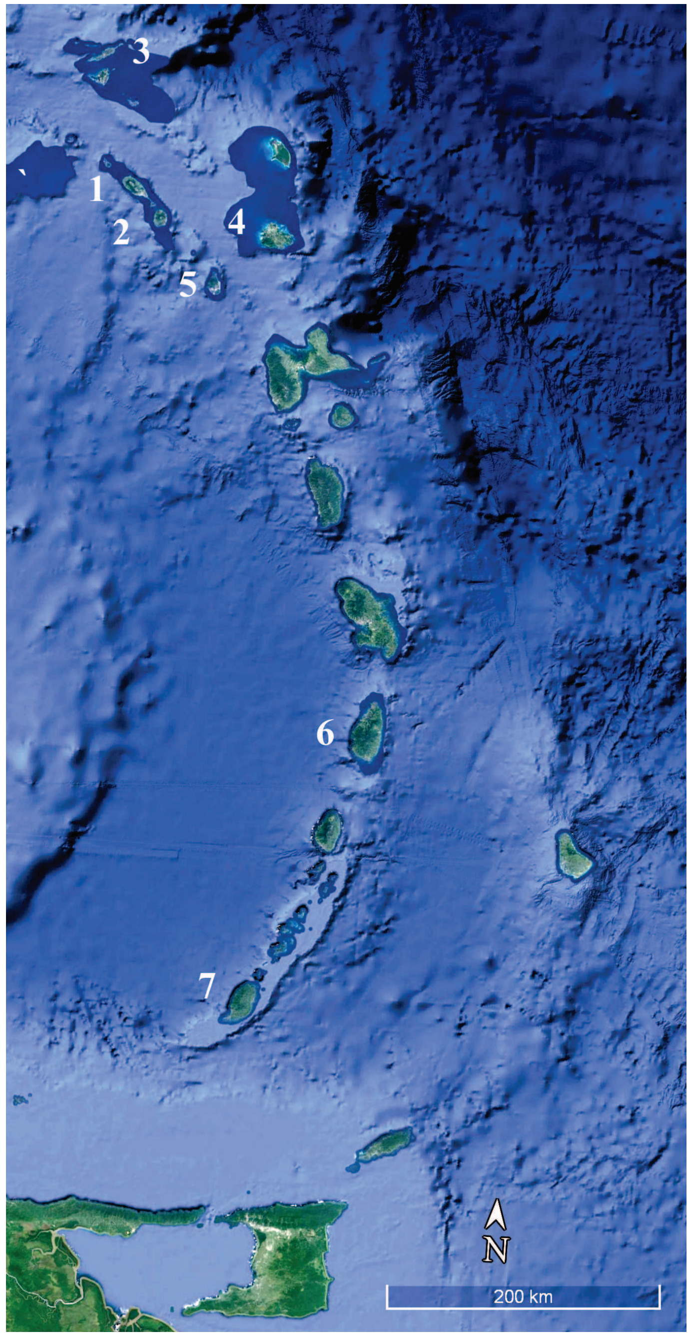

Fig. 1. Map of Eastern Caribbean showing islands sampled; St Kitts (1), Nevis (2), Anguilla (3), Antigua (4), Montserrat (5), St. Lucia (6) and Grenada (7).

web-building spiders, specifically orb-weaving species, were collected. Spiders are generally separated into web-builders, plant wanderers and ground wanderers. As their name suggests, the web-builders depend on their webs to capture prey whereas with the other two functional groups the spiders do not construct webs, but stalk and ambush their prey. The difference between the last two groups is that one is predominantly found wandering on the vegetation, hence the term plant wanderers, while members of the other group walks on the forest floor thereby referred to as ground wanderers. The use of functional groups can allow

Table 1. Number of localities sampled in each habitat according to island for spider surveys of Eastern Caribbean. Shaded sites are human-influenced habitats.

Island	Garden	In and on buildings	Abandoned buildings	Farmland	Roadside	Pastureland	Sec forest	Deciduous forest	Lower montane	Montane	Palm brake	Humid Valley Forest	Dry Forest	Vegetation around salt ponds	Mangrove	Littoral Woodland	Elfin woodland	Riparian Vegetation	Semi-evergreen forest	Evergreen woodland	Inland scrub	Rainforest	Dry evergreen forest	*Scelphron* nests	Coastal veg	Cactus scrub
St. Kitts	2	2	2	2	4	1	1	0	0	0	1	0	1	1	0	1	1	0	0	0	0	1	2	1	0	0
Nevis	4	3	0	1	2	0	3	0	0	1	1	0	0	0	0	2	1	0	0	0	3	0	0	0	0	0
Anguilla	1	2	3	0	2	0	0	0	0	0	0	0	2	1	0	0	0	0	0	1	0	0	0	2	0	1
Antigua	3	4	3	0	4	2	0	0	0	0	0	2	3	3	0	0	0	3	0	0	0	0	0	0	3	0
Montserrat	3	2	1	2	3	0	0	0	0	1	1	0	2	0	3	2	1	0	1	0	0	0	0	0	1	0
St. Lucia	3	1	0	2	2	0	3	2	2	0	0	0	0	0	1	2	0	1	1	0	0	0	0	0	1	0
Grenada	1	2	3	2	2	0	1	0	0	2	1	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0

one to gain valuable insight into the microhabitat, vegetation preferences as well as responses to habitat change of each group (Haddad *et al.* 2009; Hsieh *et al.* 2003).

Trends in biodiversity in this study were limited to web-building species and determined by examining species richness, diversity indices and species composition, and calculating the three main diversity indices; Shannon-Weiner Index (*H'*), reciprocal of the Simpson Index (1/*D*) and Berger-Parker (*d*) which looked at species diversity, evenness and dominance respectively (Magurran 2004), using the following formulas; $H' = -\Sigma p_i \ln p_i,$ where $p_i = n_i / N$ (the abundance of species *i* at a site as a proportion of the total sample at that site), 2. $D = 1/y$, where $y = \Sigma(n_i (n_i -1) / N(N-1))$ and $d = n_{max} / N$, where n_{max} represents the number of individuals of the most common species. The Shannon index has been used in numerous biodiversity studies (Begossi1996) giving it the reputation as a benchmark measure for biological diversity (Magurran 2004), allowing the comparison of diversity with other studies. The Shannon index is sensitive to sample size (Magurran 2004) and to changes in the importance of rare species (Peet 1974). Much ecological information can be obtained from the value of the Shannon index. High Shannon values indicate high species richness and thus the presence of diverse communities and species that are evenly distributed (Hsieh *et al.* 2003; Peet 1974), while a zero value indicates the presence of a single species (Peet 1974). Therefore Shannon gives information on the distribution of species abundance in the community or sample (Peet 1974). The interpretation of the results of the Shannon index with respect to comparing sites is tricky due to sources of error as it is sensitive to relative species abundance and richness (Magurran 2004). Multiple diversity indices were used to better describe the differences in diversity between habitats.

The reciprocal of the Simpson index was calculated as recommended by Downie *et al.* (1995) and Magurran (2004) to obtain a measure expressing diversity in addition to evenness. Data analysis involved determining the abundance, observed species richness, species diversity, evenness and dominance for each island as a whole and per habitat. However, because of the lack of independence among these indices an ANOVA using Statistix was only conducted on observed species richness to determine if this varied significantly among habitats on the islands sampled.

The community structure of the spider fauna was determined by fitting the rank-abundance curve generated for all the islands as a whole, to four main species abundance models given in Magurran (2004) which give additional information on the communities in question such as main ecological trends. Lastly species composition was analysed through the use of a MDS (multidimensional scaling) plot generated using Primer 5 software (Clarke and Warwick 2001).

RESULTS

One way of examining the results is to split the habitats found in more than one island into 'naturally occurring habitats' and 'habitats that have developed as a result of human activities'. Overall, the two most speciose habitat types are roadside and garden vegetation containing 17 and 15 species respectively, with both being considered to belong to the latter mentioned group. Pastureland was the least speciose with five species. Within natural habitats, the most species-rich were littoral woodland the vegetation surrounding salt ponds with 11 species each. The lowest species richness found in palmbrake and elfin woodland

Table 2. Habitat types sampled during the course of this study and their descriptions.

Habitat	Description
Garden	Lands landscaped and maintained at private residences, hotels or for public viewing.
Inside and around dwellings	Inside and around buildings occupied by humans
Abandoned buildings	Stone and wooden structures that have not been occupied or used for a minimum of two years
Farmland	Land that is utilised for cultivation of crops
Roadside	Vegetation up to 30m from either side of the road
Pasture land	This habitat exists in areas once cleared for cultivation and have been abandoned. Current use of this habitat may be as pasture land for grazing livestock.
Secondary vegetation	Lands once cleared for agriculture disturbed for firewood or timber extraction
Deciduous Seasonal Forest	This vegetation type experiences the same conditions as semi-evergreen seasonal forest. The canopy layer reaching 3-9 m in height with an emergent layer 12-18 m. Buttressing is again not a feature of the trees in this vegetation type. Palms are absent while lianes and epiphytes are rare.
Lower Montane Rainforest	This habitat type experiences a high evaporation rate. The canopy is closed and reaches heights up to 21-30 m. The lower level consists of small tree ferns while the ground cover is extremely sparse. Again buttressing is not exhibited by the trees. Palms, lianes and epiphytes are rare in this vegetation type.
Montane Forest	Land has steep topography, with shallow, leached and often water-logged soils. High precipitation is characteristic of this habitat (200-254cm per annum).
Palm brake	This habitat type is comprised almost entirely of *Prestoea montana*, with a lower stratum of immature trees and palms, with ferns and heliconias comprising the understory vegetation. The palms vary from 3 m in exposed areas to 12 m in sheltered areas.
Humid Valley forest	This habitat type is found in small areas in the south-western volcanic regions of the island of Antigua. The dominant species in this habitat type consist of *Ceiba pentandir*, *Ficus* spp., and *Delonix regia*. There is a low concentration of vines, epiphytes and palms.
Dry Forest	Vegetation is of moderate height, with many shrubs and vines. Trees such as *Ceiba pentandra* and *Ficus citrifolia* may exceed 9 m.
Vegetation around salt ponds	This includes Red Mangrove (*Rhizophora mangle*).
Mangrove	Mangrove and vegetation under its canopy found along the banks of rivers or lakes or in dry coastal areas.
Littoral woodland	These areas are near the sea and confined to the north and east coasts of the island. They are exposed to sea-blast which refers to the fine salt spray deposited on the vegetation. They seldom extend inland from the coast for more than approximately 60 m. The vegetation also exhibits the mechanical effect of the wind, where they are streamlined into tables and domes.
Elfin Woodland	Characterised by small trees and shrubs stunted by constant wind exposure. The high humidity is ideal for epiphytes, like bromeliads, orchids, ferns and mosses.
Riparian Vegetation	Vegetation found along the banks of rivers or lakes
Semi-evergreen seasonal forest	This vegetation type is not exposed to violent winds. However, it does experience a drought period of five months. The canopy layer occurs at a height of 6-12 m, with a discontinuous emergent layer reaching 18-24 m. The lower level is dominated by palms. Buttress roots are not common in this habitat but, lianes and epiphytes are frequent.
Evergreen woodland	The vegetation in this habitat type seldom exceed 9m in height and consist of trees and shrubs with small leathern leaves. Native species include *Pisonia fragrans*, *P. subcordata Burgera simaruba* and *Tabebuia pallida*. Non-native species include *Haematoxylum campechianum*, *Leucaena leucocephala* syn. *L. glauca* and *Acacia* spp. succulent species such as *Agave karatto*, *Cephalocereus royeni* and *Opuntia* spp. are also found.
Inland scrub	This exists in areas once cleared for cultivation and have been abandoned. The areas around many of the abandoned sugar plantations exhibit this habitat. Patches of scrub vegetation usually spiny, are found dispersed in the grassland.
Rainforest	This vegetation type usually consists of broad-leaved trees and has a continuous canopy, commonly 30–36 m in height as well as emergent trees, 60 m or taller. The canopy layer comprises of trees of many different sizes, including pygmies, which reach only a metre.
Dry Evergreen forest	Bushes and gnarled little trees with hard evergreen leaves that form low woodland 3-9 m in height.
Sclephron sp. nests	Cells of the solitary mud wasp *Sceliphron* sp.
Coastal Vegetation	Vegetation comprises mainly of sea grapes (*Coccoloba uvifera*). Most vegetation is stunted and wind sculpted where wind exposure is high.
Coastal/Cactus Scrub	Found in areas of shallow and stony soil with an average annual rain-fall of 76 to 102 cm. Besides cacti, trees which grow in this habitat are stunted and wind sculpted if wind exposure is high.

Table 3. Showing species composition for the orb-weaving families, according to habitat for spider surveys of Eastern Caribbean. Key: 1 – St. Kitts; 2 – Nevis; 3 – Anguilla; 4 – Antigua; 5 – Montserrat; 6 – St. Lucia 7 – Grenada.

	Garden	In and on Buildings	Abandoned buildings	Farmland	Roadside	Pastureland	Secondary Forest	Deciduous forest	Lower montane	Montane	Palm brake	Humid Valley Forest	Dry Forest	Vegetation around salt ponds	Mangrove	Littoral Woodland	Elfin woodland	Riparian Vegetation	Semi-evergreen	Evergreen woodland	Inland scrub	Rainforest	*Scelphron* nests	Coastal veg	Cactus scrub
Anapidae																									
Sp. A					6																				
Araneidae																									
Acacesia cf *hamata*																			6						
nr *Alpaida* sp.																							3		
Araneus sp. A																				3					
Araneus sp. B																				3					
Araneus sp. C														4											
Araneus sp. D	5															5								5	
Argiope argentata	3;4;5;6	1;2;6;7	1;3;7	6;7	1;3;4;5;6;7	4	2;6	6		7			3;4;7	3;4	5;6	1;2;4;5;7		4;6;7	5	3	2		3	5;6	3
Argiope trifasciata														4		1									
Chrysometa sp A				1							2											1			
Cyclosa caroli	6						6		6			4						6	6						
Cyclosa walkenari	4;2;5	4	3	2	1;2;3;5								4							3	2				
Eriophora sp.					2																				
Eustala anastera	4;5;2;1	7	4;1		5		2	6		5		4	5		5;6	7			5;6				3	6	
Eustala fuscovittata				1;6		4																			
Gasteracanta cancriformis	1;2;4	1;4	1;4;5	1;2;5	1;2;3;7		2;6			5	2		1;3;4;5;7	1	5	5;7		4;6	5	3	1;2		3	5	
Kapogea sp.					1																				
Mangora sp.	2																								
Metepeira compsa	1;2;3;4;6	1;2;6	1	1;2	1;2;3;7								4	1;3;4	5	1;4;5;6	7	4	5	3	2		3	5;6	3
Neoscona neothesis				6	6																				
Neoscona cf oaxcensis	2;4	2		5	1;3;4	4								4	5	1;5					2		3		
Spilasma sp.										5															
Wagneriana sp.																	7								
Mysmenidae																									
Sp A																			6						
Symphytognathidae																									
Sp A															6										
Tetragnathidae																									
Alcimosphenus lincinus					6		2	6	6			4													
Leucauge argyra	2;4;5;6	2;4;7	5;7	1;5;6	1;2;3;4;5;6;7	1	2;6			5;7	5			1;3;4		4	5	4;6;7			2				
Leucauge regnyi	1;2;3;7	2;7	1;7	1;5;7	2;3;5;6	1	1;2;6;7	6	6	5;7	1	4	1;3;4;7		5;6	1;5;7	1;7	4;6	5;6	3	2	1		5	
Tetragnatha nitidens					4;5									3;4;5			1	4;5;6	6						
Tetragnathid sp A																			5						
Theridiosomatidae																									
Sp A.					6		6																		
Sp B.														4				4							

Table 4. Showing the total island sample and mean per site for; abundance (N), observed species richness (S), species diversity (*H′*), species evenness (1/*D*) and dominance (*d*) per habitat for Grenada, Montserrat, Nevis, St. Kitts, St. Lucia Antigua and Anguilla sampled between January 2006 and August 2010.

Island	$N_{(Act.)}$	$N_{(Mean)}$	$S_{(Act.)}$	$S_{(Mean)}$	$H'_{(Act.)}$	$H'_{(Mean)}$	$1/D_{(Act.)}$	$1/D_{(Mean)}$	$d_{(Act.)}$	$d_{(Mean)}$
Grenada	110	13.8	8	2.5	1.98	0.8	5.59	3.04	0.39	0.06
Montserrat	313	24.1	13	3.3	2.38	0.9	10.67	2.9	0.35	0.06
Nevis	311	25.5	12	4.1	1.87	1	5.61	2.9	0.34	0.05
St. Kitts	380	31.7	12	3.4	2.32	0.8	7.89	2.5	0.28	0.04
St. Lucia	358	22.4	16	4.3	2.06	1	6.41	4.1	0.45	0.05
Antigua	220	14.7	15	4.5	2.09	1	7.55	3.3	0.15	0.05
Anguilla	258	21.5	12	4.1	1.48	1	3.19	3.9	0.25	0.05

habitats with four and five species respectively (Table 3).

Sampling yielded a total of 33 species from six families for this region. Grenada was found to contain the lowest species richness (Table 4) while St Lucia and Antigua had the highest and second highest values. Notably Nevis, St. Kitts and Anguilla have the same species richness values. However, single factor ANOVA test observed species richness ($F_{6,72}$ = 1.47; P = 0.201), was not significantly different among the islands included in this study.

The rank-abundance curve produced (Fig. 2) fitted only the log series model (D = 0.151; $D_{0.05}$ = 0.154).

In terms of the similarity of species composition among the islands, analysis (Fig. 3) showed three distinct groups. Antigua, St Kitts and Nevis formed one cluster with Montserrat, Anguilla and Grenada forming a second cluster with Montserrat, with Montserrat and Anguilla being more similar to each other than either to Grenada. St. Lucia contained the most distinct assemblage of species.

DISCUSSION

The results revealed that in natural habitats, highest species richness was found in littoral woodland and the vegetation around salt ponds, while lower species richness was exhibited in high altitude habitats such as, palmbrake and elfin woodland. This result was not surprising since these low diversity habitats are found at very high altitudes for example in in Nevis (Sewlal and Starr 2007), St. Kitts (Sewlal 2008), Montserrat (Sewlal 2010) and Grenada (Sewlal 2009b). Few species can withstand the harsh conditions present such as sea blast, salt and hurricanes. Although both littoral woodland and coastal vegetation experience similar conditions, the coastal habitat contains fewer species than littoral woodland with 11 and six species respectively. This is possibly due to the lack of study vegetation in coastal habitat which does not provide adequate support for webs. Most of the individuals present were found on the side facing inland, rather than that facing the ocean, indicating that this location provided the spiders with protection from elements such as wind.

The high species richness exhibited by both garden and roadside habitats is not consistent with previous studies, which indicate that both of these habitats provide ideal conditions for spiders. For example, they contain gaps in the vegetation for flying prey which can be blown into or fly into the webs of orb-weavers. The variety of vegetation means many suitable points of attachment for web construction. Also the presence of artificial lighting attracts

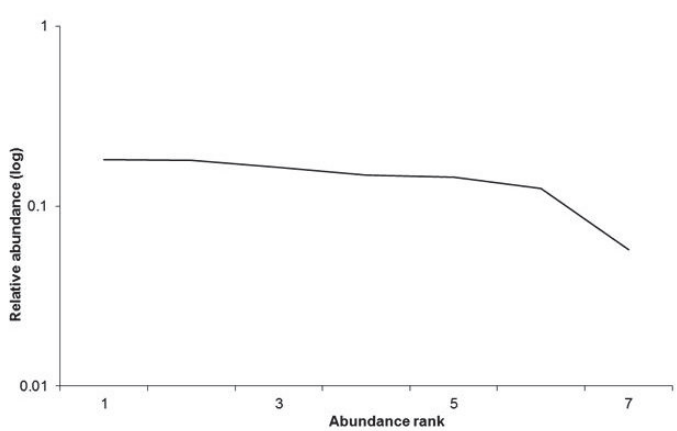

Fig. 2. Rank abundance curves for average abundances of all islands sampled (Montserrat, Nevis, St. Kitts, St. Lucia Antigua and Anguilla).

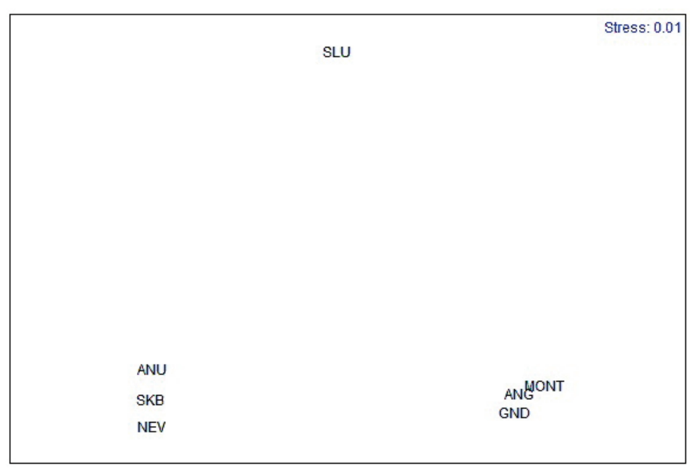

Fig. 3. Multidimensional scaling plot showing the species composition similarity for Anguilla (ANG), Grenada (GRN), Montserrat (MONT), Nevis (NEV), St. Kitts (SKB), St. Lucia (SLU) and Antigua (ANU).

flying insects thus providing a relatively steady food supply to nocturnal as well as diurnal species.

The low level of species richness exhibited by altered habitats such as pastureland can also be explained by the high level of disturbance caused by grazing, little protection from the elements and lack of stable structures for web construction. Although farmland is considered disturbed habitat, like the pastureland it exhibited a higher species richness, most likely as it provides a good food source for spiders since many agricultural pests are insects. It is important to note that the low species richness in certain habitats, such as dry evergreen forest, cactus scrub, low montane forest and rainforest, were most likely a by-product of these habitats only being present on a single or few islands.

Few species were also found on buildings (both occupied and abandoned). This is expected since most of the species found here were also found in the neighbouring garden habitat (Table 1). As with the garden habitat, these area often have artificial light, which will attract a relatively constant supply of insects thus providing a stable source of food. However, the exterior of these manmade structures did not provide many suitable points of attachment for web placement.

The similarity among St. Kitts, Nevis and Antigua in terms of species composition (Fig. 3) is expected as they are relatively close to each other (Fig. 1) (Sewlal and Starr 2010), of similar size and share similar habitats. Montserrat, Anguilla and Grenada also have similar species compositions (Fig. 3). Although these islands are fairly far apart geographically (Fig. 1), they have all experienced high disturbance events. Hurricanes have profound effects on web-building spiders, for example causing a decrease in population densities (Spiller and Schoener 2007). Grenada has experienced two hurricanes successively in recent years; Hurricanes Ivan and Emily hit the island in 2005 and 2006 respectively resulting in a change in the understory vegetation structure. For example, in the montane forest on Mount Qua Qua the natural vegetation has been replaced with dense stands of razor grass (*Scleria secans*). This indicates that this habitat is going through primary succession, providing a habitat for generalist species (Sewlal 2009b), which may explain the lowest observed species richness here (Table 4). Hurricane damage to vegetation is a major influence on the orb-weaver fauna of this island, as indicated by the high species richness found in the dry forest habitat which exhibited little damage from the hurricanes (Sewlal 2009b). Anguilla has also experienced hurricane damage with the most recent being Hurricane Lenny in 1999. This island is also quite flat with a maximum elevation of 65m (Sewlal and Starr 2010); most of the vegetation is short and subject to disturbance by wind and rain. However, it has more time to recover in terms of its biodiversity. Montserrat has also experienced disturbance but in this case due to the constant activity of the Soufriere Hills volcano which has rendered approximately two-thirds of the island uninhabitable by people and explaining why it yielded the second lowest observed species richness (Table 4).

Sampling in St. Lucia was concentrated in the South and East of the island as they had the largest areas of natural habitats to sample (Sewlal 2011). Also some of the forested habitat sampled comprised of secondary vegetation which accounted for the high species richness. The disturbance in this habitat caused by commercial logging has created new niches, therefore possibly containing both specialist and generalist species (Sewlal 2011). St. Lucia is also the largest of the seven islands sampled, so this coupled with the mixture of natural and disturbed habitats could account for the more habitats and microhabitats and, in turn, the distinct species composition found on this island.

The community structure of spiders on these islands was found to fit the log series abundance model indicating that the species that make up this community arrived at random intervals (May 1975), which makes sense as these are oceanic islands. Oceanic islands have volcanic origins therefore all of the fauna found there was brought over by humans or naturally, such as on floating mats of vegetation or migration from continental land masses, depending on their distance from the island or nearby islands. It also implies that the community has a simple ecology (May 1975) dominated by a few factors (Magurran 2004; May 1975). Some of the advantages of this model are that it is not influenced by sample size or the abundance of the most common species (Taylor 1978).

Orb-weavers occupy a wide range of habitats, and Araneidae was consistently the most ecologically diverse family in all islands sampled (Sewlal and Starr 2007; Sewlal 2008, 2009a, 2009b, 2010, 2011). It was followed by Tetragnathidae in terms of family diversity, except when it was replaced by Oxyopidae in St Lucia (Sewlal 2011) and Salticidae in Montserrat (Sewlal 2010). However, the preference of certain species for specific habitats is not unusual especially with respect to orb-weavers.

Two big orb-weaver species (*Araneus* and *Eriophora*) were recorded from the islands. However, *Nephila clavipes* belonging to Nephilidae was absent from despite being present on nearby islands like Trinidad and Tobago (Sewlal 2013) and the Greater Antilles (World Spider Catalogue 2016). For future work, continental islands like Trinidad and Tobago can be compared with that of the females of this species are quite large, measuring between 24 to 40 mm in length, producing webs often spanning a metre in width. In the available habitats it was observed that members of *Leucauge* constructed web up to a metre in width so that they vegetation can support and facilitate webs of this size. Therefore the noted absence of very large orb-weaving species on the islands of the Eastern Caribbean may be related to their size in that the habitats available on these islands cannot facilitate webs of that size and provide enough prey to sustain spiders of this size.

For future work, I would recommend that similar studies be carried out on other spider groups, such as plant and ground wandering species. Also the results from these studies can be compared with continental islands such as Trinidad and Tobago.

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Hawk-moths (Lepidoptera: Sphingidae) of Trinidad, West Indies: an illustrated and annotated list

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ABSTRACT

An illustrated and annotated catalogue is presented of 84 species of Sphingidae confirmed to occur in Trinidad. *Adhemarius daphne* (Boisduval), *Aleuron chloroptera* (Perty), *Nyceryx stuarti* (Rothschild) and *Erinnyis impunctata* Rothschild & Jordan are new records for Trinidad. In addition, five prior species records have not been confirmed, and seven reported species are considered to be in error. Images of living adults of 33 species and the early stages of six species are included. Very little has been recorded regarding food plants and early stages in Trinidad, but known food plants from elsewhere in the Neotropics are tabulated, as are data of the months of capture and localities in suburban and forested localities in Trinidad.

Key words: catalogue, distribution, food plants, hornworms, phenology, Tobago

INTRODUCTION

Of all the moth families in Trinidad, Sphingidae, popularly known as hawk-moths and hornworms have been most studied. They are large, colourful and conspicuous, easily recognised and frequently seen by naturalists and the public, most frequently when attracted to house lights. Globally, their taxonomy is well understood (at least compared to nearly all other moth families), and they have been used as model groups for biological and ecological studies in several areas of the tropics (Moss 1912, 1920; Janzen 1986, Kawahara *et al*. 2013; Schreiber 1978; Stradling *et al*. 1983; Tuttle 2007).

As discussed by Cock (2003), the moths of Trinidad have been documented by W.J. Kaye in a preliminary catalogue (Kaye 1901) and a catalogue (Kaye and Lamont 1927), to which there is a short supplement (Lamont and Callan 1950). Kaye (1904) was reprinted in the *Proceedings of the Agricultural Society of Trinidad and Tobago* of 1914 (Kaye 1914a), with occasional supplementary information mainly relating to common names, probably added by P.L. Guppy. There has been relatively little published on the Trinidad hawk-moths since then, apart from an intensive light trapping study on Sphingidae by Stradling *et al*. (1983), which provides an important resource for what follows. I have recently published a checklist of the moths of Tobago (Cock 2017b), which included 26 hawk-moth species. Treatments are available for Trinidad Castniidae (González and Cock 2004), Mimallonidae (St Laurent and Cock 2017) and Sematuridae (Cock 2016), but these are all relatively small families in Trinidad (Cock 2003). This illustrated catalogue of the Sphingidae of Trinidad is the first of the medium sized families to be treated, and it is hoped that other families will be tackled in the future.

Nomenclature and classification.

Nomenclature follows Kitching and Cadiou (2000) and Kitching (2017), and where this has changed since Kitching and Cadiou (2000) an explanation is provided. Accordingly species names follow the original spelling and do not show gender agreement in the case of Latin and Greek adjectival species names. Some authors have recognised forms in two of the Trinidad species (*Erinnyis lassauxii* (Boisduval), *Erinnyis obscura* (Fabricius)). These are infraspecific, have no taxonomic standing, and are synonyms of the given species (see e.g. Kitching and Cadiou 2000). However, inasmuch as the names of forms can be conveniently used to refer to particular phenotypes of polytypic species, they are useful. Thus, it is easier to refer to '*Erinnyis obscura* f. *domingonis* (Butler)' and thereafter 'f. *domingonis*' than to repeatedly refer to 'a form of *Erinnyis obscura* with dark forewing markings'.

Kawahara *et al*. (2009) examined the phylogeny of the Sphingidae based on five nuclear genes, demonstrating that more work is needed to clarify the natural groups of Sphingidae, particularly below the subfamily level. Although their work indicates some problems relating to subfamilies as presently defined, this is not an issue when applied to the Trinidad fauna, and so the three subfamilies Smerinthinae, Sphinginae and Macroglossinae are used here without reservations. The tribes they recognised can be applied to the limited Trinidad fauna with little difficulty (Table 1). However, since then Kitching (2017) has built on their phylogeny and used subtribes to encompass the diversity Kawahara *et al*. (2009) showed, although this has not been formally published yet. Here I use Kitching's tribes and subtribes, and incorporate the species groups evident in Kawahara *et al.* (2009) as shown in Table 2.

Identification.

When working with pinned specimens in good condition, all of the Trinidad species can be identified by careful examination and comparison with the images provided here. Diagnostic features are pointed out in the text which should help with similar species. Many naturalists are now taking photographs rather than specimens in support

Table 1. Provisional classification of the Trinidad Sphingidae, based on Kawahara *et al*. (2009). The group names within Dilophonotini are not used in Kawahara *et al*. (2009), but are based on their phylogenetic tree.

Subfamily	**Tribe**	**Group**	**Genera reported from Trinidad (and number of Trinidad species)**
Smerinthinae	Ambulycini		*Adhemarius* (3), *Protambulyx* (2)
Sphinginae	?	*Cocytius* group	*Cocytius* (1), *Amphonyx* (2), *Neococytius* (1)
	Sphingini	Sphingini *sensu stricto*	*Manduca* (10)
	Acherontiini		*Agrius* (1)
Macroglossinae	Dilophonotini	*Pachylia* group	*Pachylia* (2)
		Nyceryx group	*Callionima* (4), *Nyceryx* (4), *Perigonia* (2), *Eupyrrhoglossum* (1), and *Aellopos* (5)
		Erinnyis group	*Oryba** (2), *Pachylioides* (1), *Madoryx* (3), *Hemeroplanes* (1), *Erinnyis* (7), *Isognathus* (2), *Pseudosphinx* (1), *Phryxus* (1)
		Aleuron group	*Aleuron* (2), *Unzela* (1)
		Enyo and *Eumorpha* group*	*Enyo* (3) *Eumorpha* (9)
		Pachygonidia group	*Pachygonidia* (1)
	Choerocampini		*Hyles* (1), *Xylophanes* (12)

* Weakly supported groups or placements in Kawahara *et al*. (2009).

Table 2. Classification of the Trinidad Sphingidae, after Kitching (2017), including the genera groups of Kawahara *et al*. (2009)

Subfamily	**Tribe**	**Subtribe**	**Genera reported from Trinidad (and number of Trinidad species)**
Smerinthinae	Ambulycini		*Adhemarius* (3), *Protambulyx* (2)
Sphinginae	Sphingini	Cocytiina	*Cocytius* (1), *Amphonyx* (2), *Neococytius* (1)
		Sphingina	*Manduca* (10)
		Acherontiina	*Agrius* (1)
Macroglossinae	Dilophonotini	Dilophonotina	*Pachylia* group: *Pachylia* (2) *Nyceryx* group: *Aellopos* (5), *Callionima* (4), *Eupyrrhoglossum* (1), *Nyceryx* (4), *Perigonia* (2) *Erinnyis* group: *Erinnyis* (7), *Hemeroplanes* (1), *Isognathus* (2), *Madoryx* (3), *Oryba** (2), *Pachylioides* (1), *Phryxus* (1), *Pseudosphinx* (1)
		Philampelina	*Aleuron* group: *Aleuron* (2), *Unzela* (1) *Enyo* and *Eumorpha* group*: *Enyo* (3) *Eumorpha* (9) *Pachygonidia* group: *Pachygonidia* (1)
	Macroglossini	Choerocampina	*Hyles* (1), *Xylophanes* (12)

* Weakly supported groups or placements in Kawahara *et al*. (2009).

of their observations. With experience, images of living moths can also be readily identified, and I have included such images as are available to me to facilitate this (Figs. 1-38). However, some of the better diagnostic features of the hindwings and abdomen may be obscured in images of living specimens in natural resting positions. This can be resolved by taking additional images to show these features (e.g. Fig. 5 *Protambulyx strigilis* (Linnaeus) female, Fig. 15 *Agrius cingulata* (Fabricius)), or more careful examination and comparison of the visible features. Further images of pinned adults, genitalia, diagnostic details, and literature references can be found on the *Sphingidae Taxonomic Inventory* website (Kitching 2017) and images of adults and early stages can be found in the websites of Janzen and Hallwachs (2017) and Oehlke (2017).

Sources of records

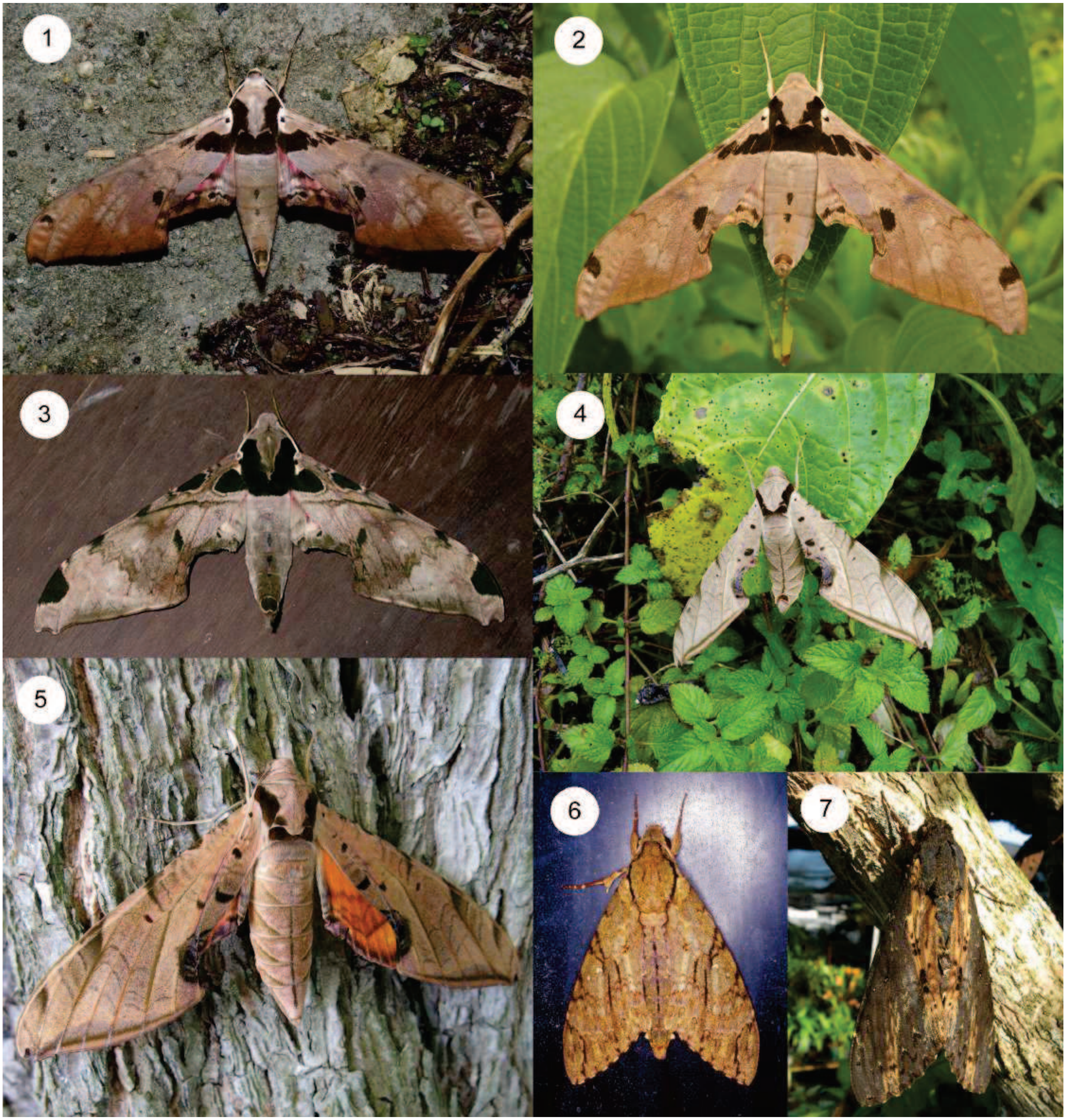
The basis of this checklist is the published work of Kaye and Lamont (1927), Lamont and Callan (1950), Schreiber (1978) and Stradling *et al*. (1983), together with my collecting while resident in Trinidad, 1978-1982 and on subsequent visits. I have supplemented these sources with records and images from numerous colleagues and contacts, and records from museums and collections as follows:

MGCL - McGuire Center for Lepidoptera and Biodiversity, which includes W.J. Kaye's collection (only selected records confirmed and included)

MJWC - the private research collection of M.J.W. Cock, UK (records from all specimens and unpublished notes compiled and collated)

NHMUK - Natural History Museum, London, UK, which contains much historical material collected by F. Birch, S.M. Klages and others (only selected records confirmed and included)

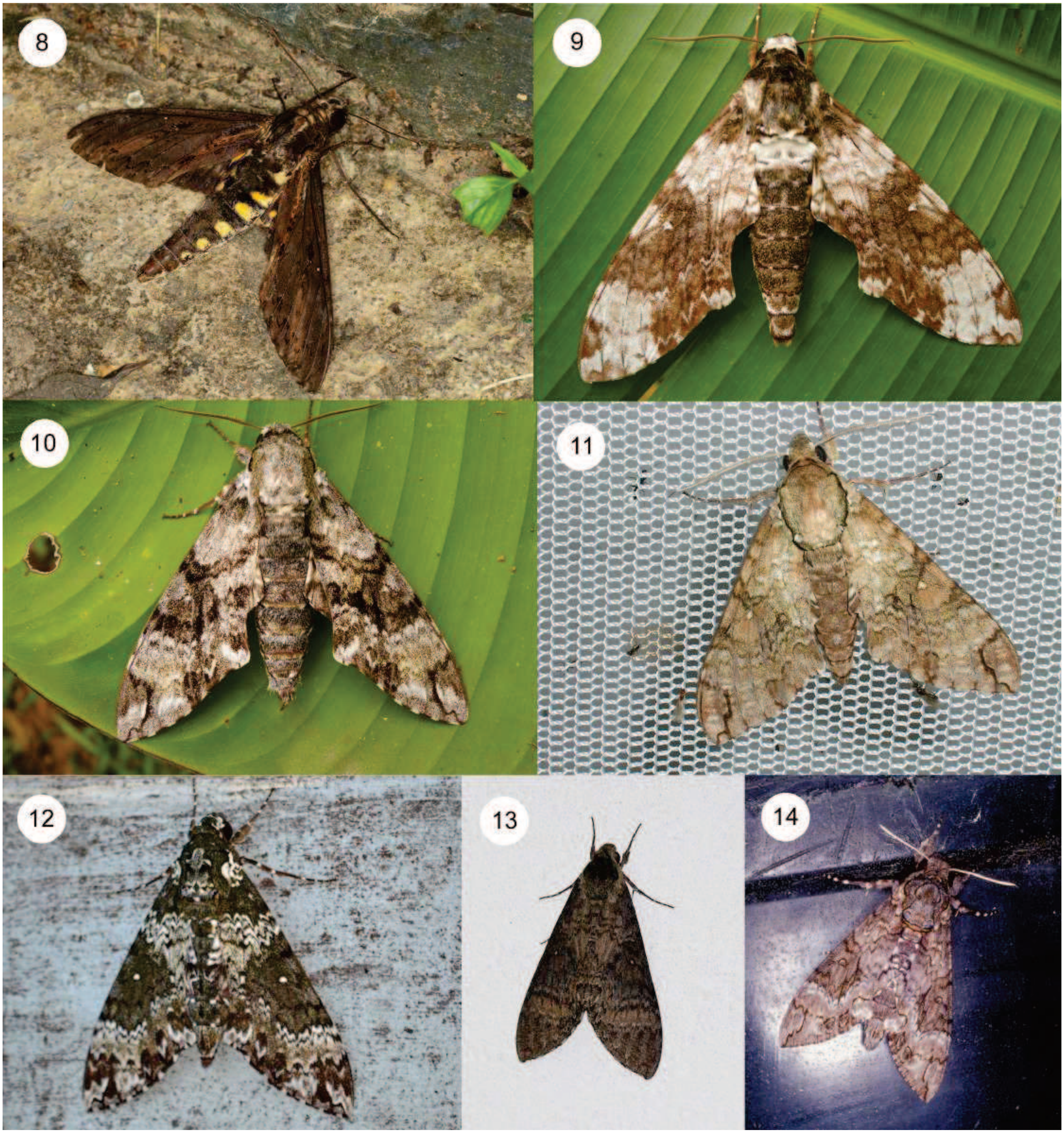
NMSE - National Museum of Scotland, Edinburgh, UK, which includes the balance of the collections of Sir Norman Lamont and D.J. Stradling (records from Lamont's specimens compiled and collated, but only selected records from Stradling's material are included).



Figs. 1-7. Living adults of Trinidad Sphingidae (1). **1**, *Adhemarius gannascus* male, Morne Bleu, 28 December 2014 (K. Sookdeo photo). **2**, *Adhemarius daphne* male, Brasso Venado, 27 July 2014 (K. Sookdeo photo). **3**, *Adhemarius palmeri* male, Asa Wright Nature Centre, 1 March 2009 (J. Morrall photo). **4**, *Protambulyx strigilis* male, Morne Bleu, 2 January 2011 (K. Sookdeo photo). **5**, *Protambulyx strigilis* female, Penal, 5 September 2009 (K. Sookdeo photo). **6**, *Cocytius lucifer* male, Brigand Hill, 28 March 2003 (M.J.W. Cock photo). **7**. *Neococytius cluentius* female, Cat's Hill, 24 June 2009 (K. Sookdeo photo).

OUNHM - Oxford University Natural History Museum, which includes material collected by R.M. Farmborough and others (records from many, but perhaps not all, specimens compiled and collated).

UWIZM - University of the West Indies Zoological Museum, St. Augustine, Trinidad and Tobago, which includes part of the Sir Norman Lamont collection, F.D. Bennett's collection and part of D.J. Stradling's collection (records from all specimens compiled and collated).

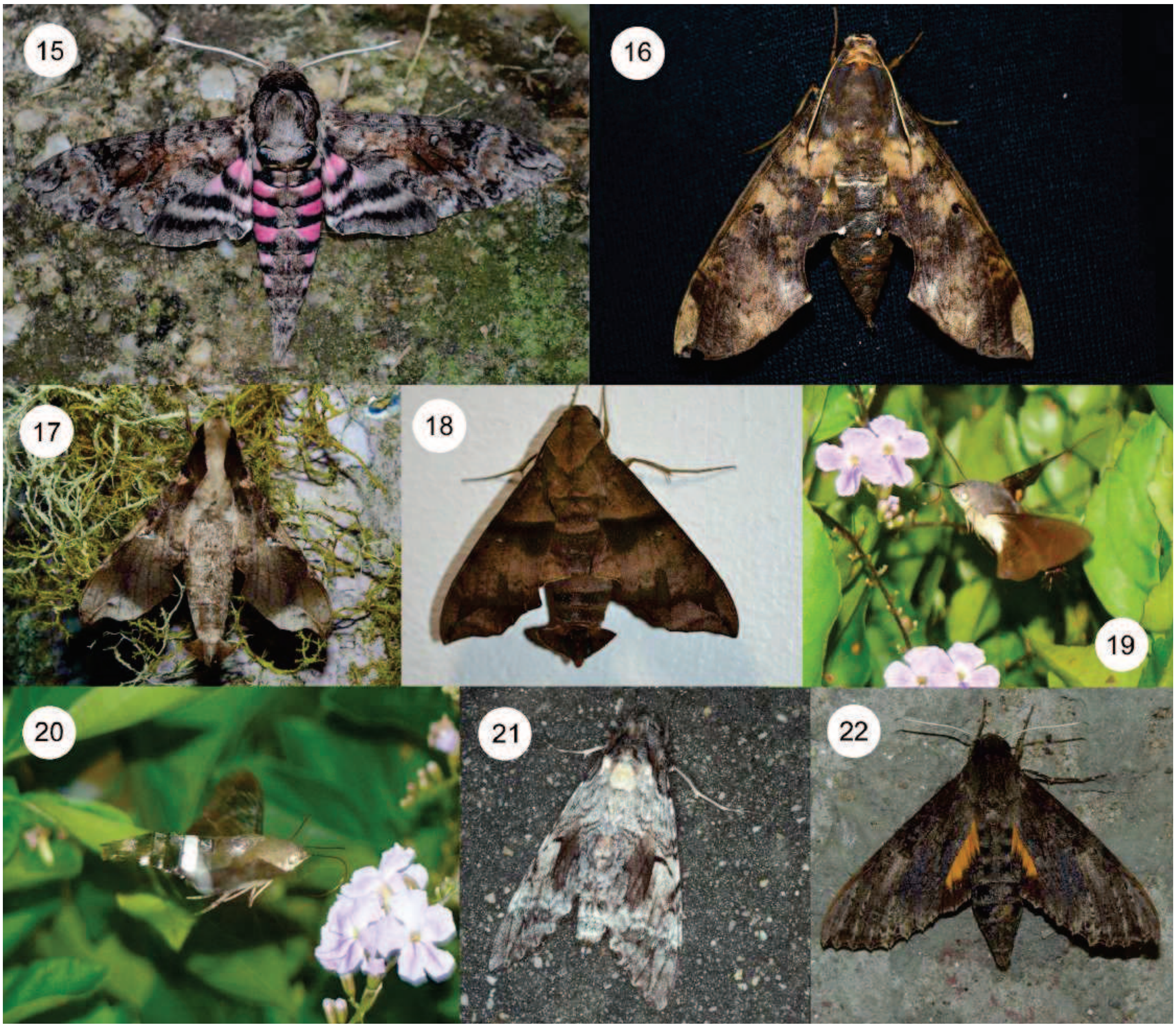


Figs. 8-14. Living adults of Trinidad Sphingidae (2). **8**, *Neococytius cluentius* male, Asa Wright Nature Centre, 23 March 2015 (S. Nanz photo). **9**, *Manduca albiplaga* male, Brasso Venado, 27 July 2014 (K. Sookdeo photo). **10,** *Manduca huascara*, Brasso Venado, 27 July 2014 (K. Sookdeo photo). **11,** *Manduca florestan*, Simla Nature Lodge, 16 June 2006 (M.S. Botham photo). **12**, *Manduca rustica rustica*, Morne Bleu, 29 December 2013 (K. Sookdeo photo). **13**, *Manduca diffissa tropicalis*, South Oropouche, August 2010 (T.P. Maharaj photo). **14**, *Agrius cingulata* male, Brigand Hill, 28 March 2003 (M.J.W. Cock photo).

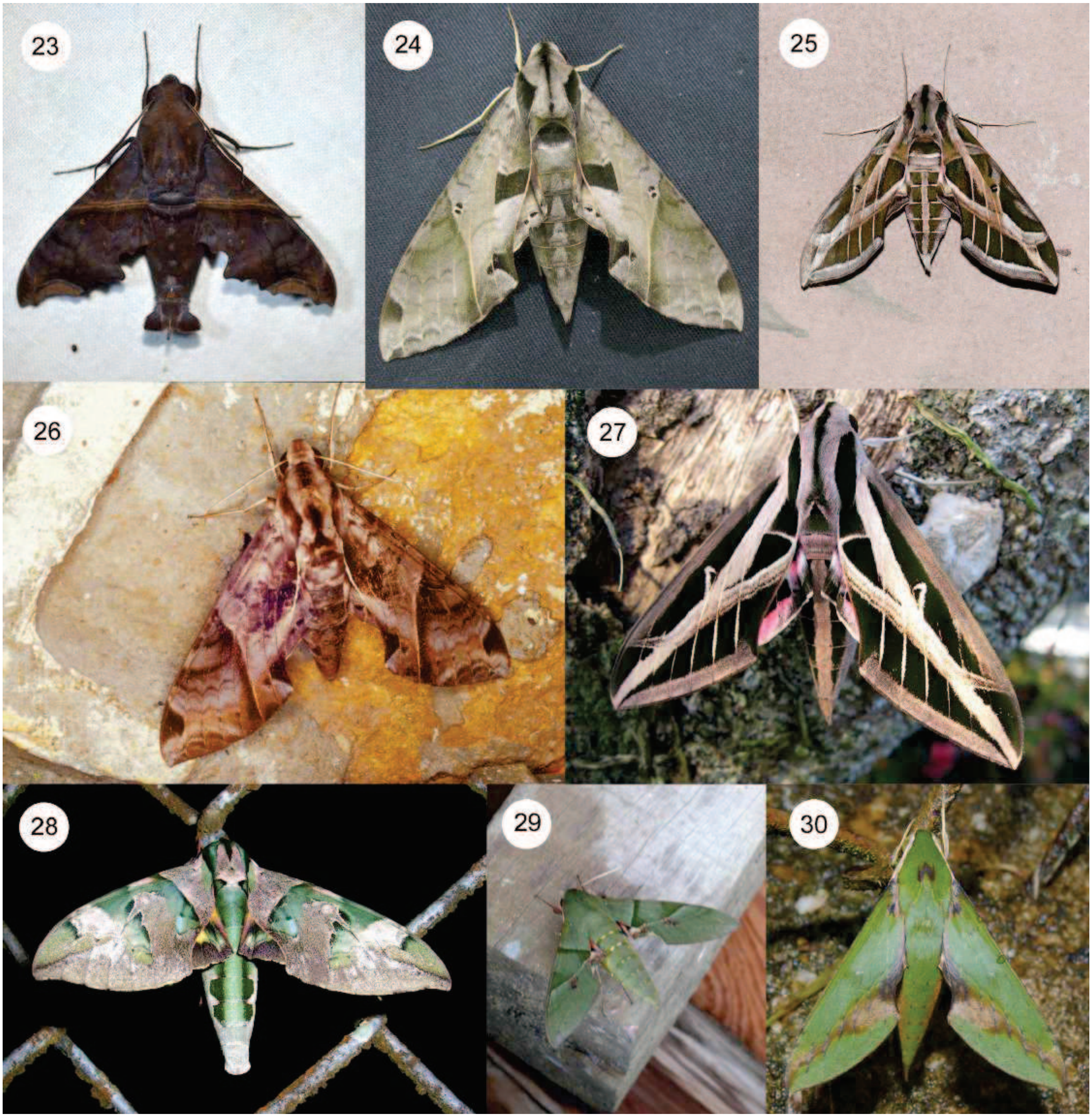
Images of adults

Images of pinned adults are provided life size under each species entry. Recognising that these may not be used in hard copy, a 5cm scale bar is included on each page. Male and female specimens are both shown where sexual dimorphism is significant, and at least one species for each genus is shown as both male and female (where material is available). Ventral (underside) views are shown where there are useful diagnostic features, or space would otherwise be wasted.

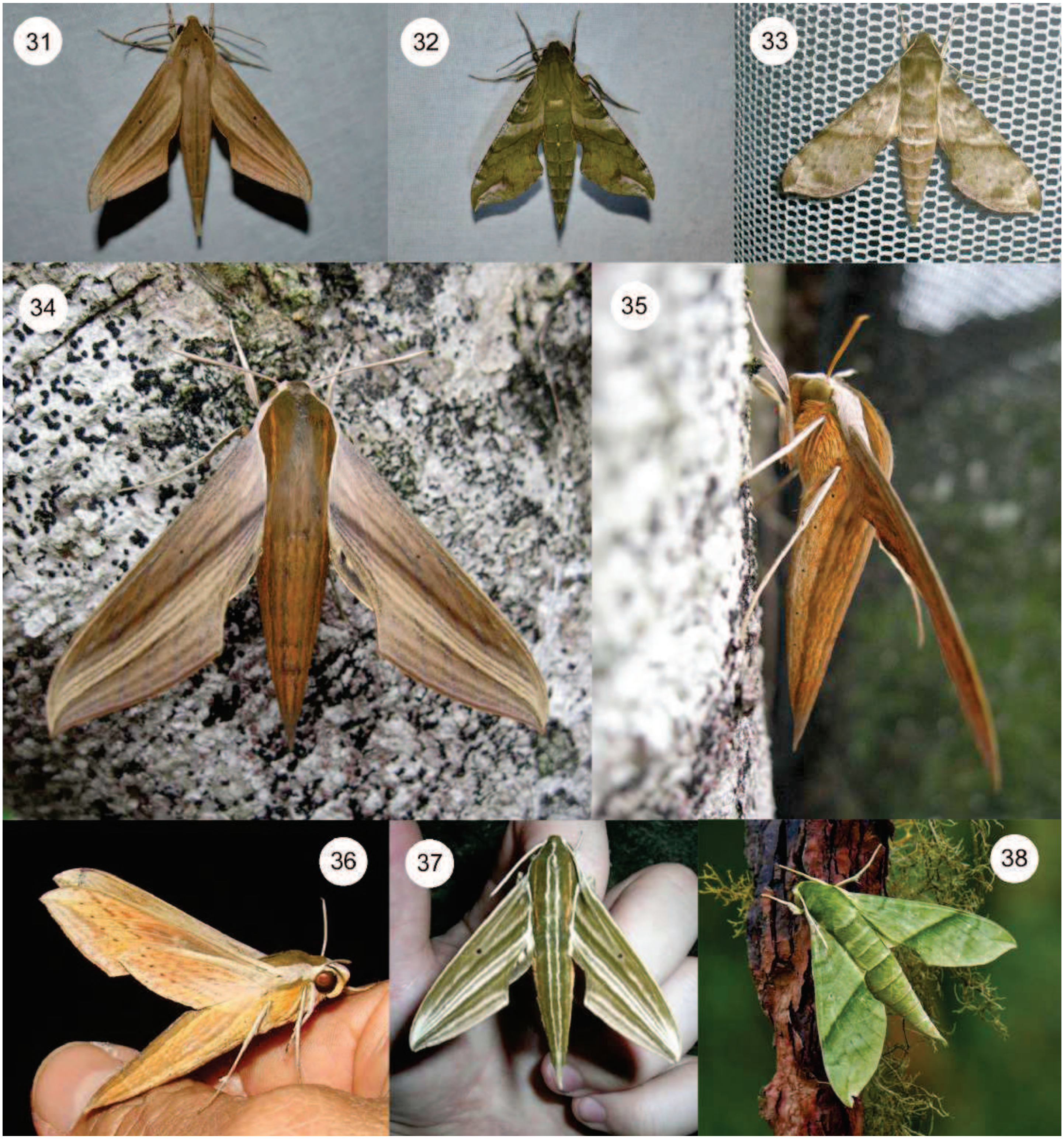
Figs. 1-38 of living adult moths show typical resting positions to facilitate the identification of images of living moths. These are deliberately not representative, but are simply images that I have accumulated from my own work and images generously shared by resident and visiting naturalists. For none of these images is a scale available, although these can be derived from the images provided of pinned specimens.



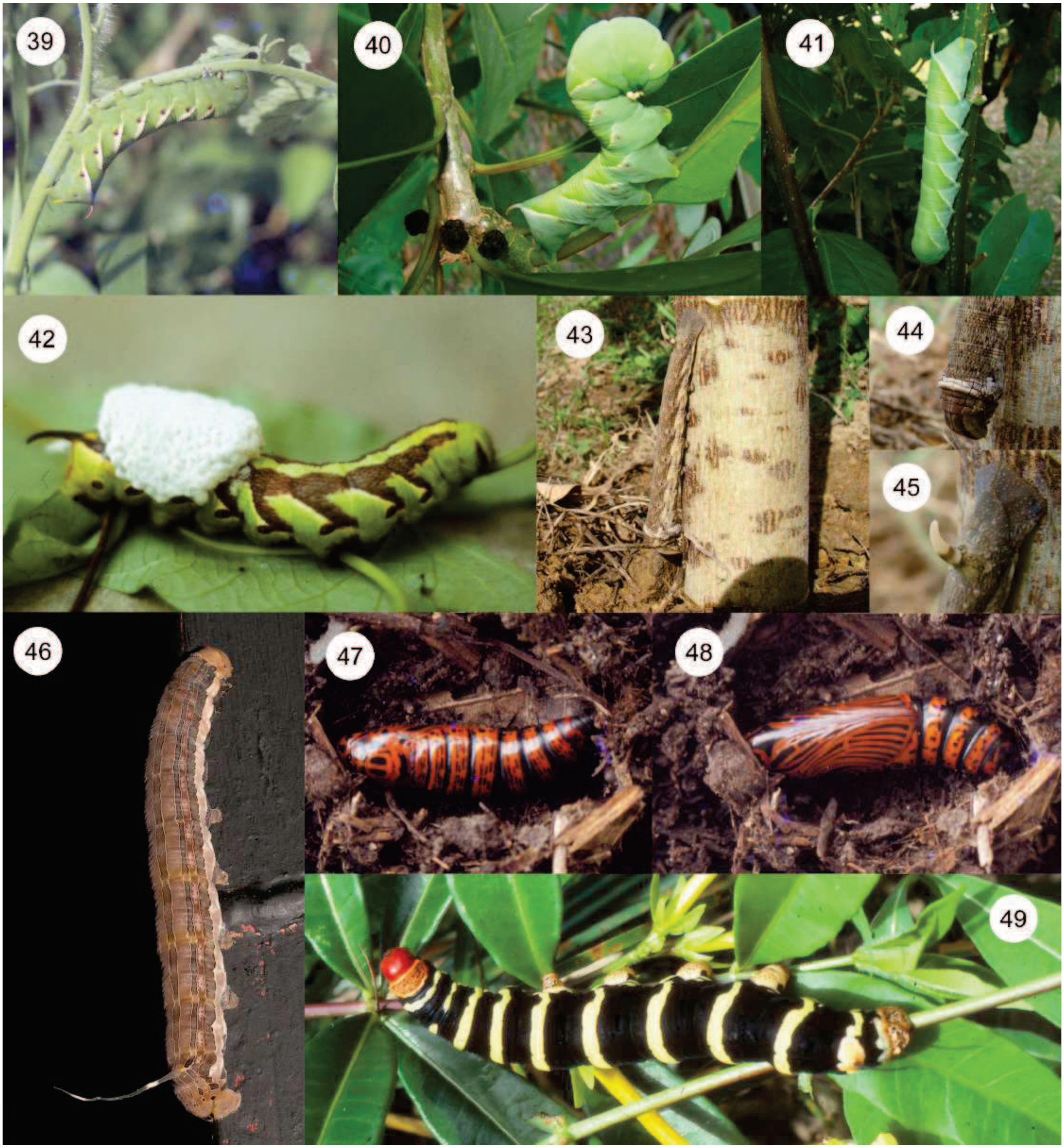
Figs. 15-22. Living adults of Trinidad Sphingidae (3). **15**, *Agrius cingulata* female, Morne Bleu, 21 September 2013 (K. Sookdeo photo). **16**, *Pachylia ficus*, Penal, 24 November 2013 (K. Sookdeo photo). **17,** *Callionima pan pan*, Morne Bleu, 28 December 2014, (K. Sookdeo photo). **18,** *Perigonia lusca lusca* male, Brasso Seco, 11 January 2014 (K. Sookdeo photo). **19**, *Aellopos ceculus*, Tobago, Englishman's Bay, 14 March 2013 (M. Kelly photo). **20**, *Aellopos clavipes clavipes*, Tobago, Englishman's Bay, 17 February 2009 (M. Kelly photo). **21**, *Pseudosphinx tetrio* male, Mt. St. Benedict's, 12 October 1993 (M.J.W. Cock photo). **22**, *Isognathus scyron*, Aripo Savanna, 28 September 2014 (K. Sookdeo photo).



Figs. 23-30. Living adults of Trinidad Sphingidae (4). **23**, *Enyo ocypete* male, Penal, 20 June 2014 (K. Sookdeo photo). **24,** *Eumorpha satellitia licaon*, Penal, 9 July 2010 (K. Sookdeo photo). **25,** *Eumorpha vitis vitis*, South Oropouche, 22 December 2009 (T.P. Maharaj photo). **26,** *Eumorpha anchemolus* female, Brigand Hill, 28 March 2003 (M.J.W. Cock photo). **27,** *Eumorpha fasciatus fasciatus* male, Penal 18 March, 2009 (K. Sookdeo photo). **28,** *Eumorpha capronnieri*, Morne Bleu, 14 June 2006 (M.S. Botham photo). **29,** *Eumorpha labruscae* male, South Oropouche, 8 July 2008 (T.P. Maharaj photo). **30**, *Xylophanes chiron nechus* male, Morne Bleu, 29 December 2013 (K. Sookdeo photo).



Figs. 31-38. Living adults of Trinidad Sphingidae (5). **31,** *Xylophanes loelia*, Penal, 4 February 2014 (K. Sookdeo photo). **32,** *Xylophanes pluto*, Penal, 20 June 2014 (K. Sookdeo photo). **33,** *Xylophanes pistacina*, Penal, 27 November 2008 (K. Sookdeo photo). **34-35,** *Xylophanes tersa tersa*, Penal, 27 November 2008 (K. Sookdeo photo). **36,** *Xylophanes tersa tersa*, Tobago, Englishman's Bay, 1 March 2009 (M. Kelly photo). **37**, *Xylophanes titana* male, Simla Nature Lodge, June 2006 (M.S. Botham photo). **38**, *Xylophanes tyndarus tyndarus* male, Morne Bleu, 30 May 2017 (T.P. Maharaj photo).



Figs. 39-49. Early stages of Trinidad Sphingidae. **39,** *Manduca sexta paphus* mature caterpillar, Aranguez Gardens, on tomato (Solanaceae), undated (M.J.W. Cock photo). **40-41,** *Manduca sexta paphus* mature caterpillar (not reared), Tobago, Englishman's Bay, on ornamental *Brugmansia* sp. (Solanaceae), 19 January 2011 (M. Kelly photo). **42**, *Agrius cingulata* caterpillar, Arima Valley, Simla, on *Ipomoea* sp. (Convolvulaceae), parasitized by unidentified Microgasterinae (cocoons), January 1980 (M.J.W. Cock photo). **43-45**, *Erinnyis alope alope* caterpillar (not reared), Tobago, Englishman's Bay, on papaya, 16 January 2011 (M. Kelly photo). **46**, *Isognathus scyron* mature caterpillar, South Oropouche, August 2010 (T.P. Maharaj photo). **47-48**, *Isognathus scyron* pupa reared from *Allamanda cathartica* (Apocynaceae), Curepe, undated (M.J.W. Cock photo). **49**, *Pseudosphinx tetrio* mature caterpillar, on *Allamanda cathartica*, Tobago, Argyll Bay, 28 February 1981 (C.D. Adams photo).

Vagility

Some species of hawk-moths are well known to disperse by flying great distances, often as regular migrants (Hodges 1971, Tuttle 2007), and in Costa Rica many species move long distances into drier forests during the rainy season (Janzen 1986). However, there is little information regarding this behaviour in Trinidad, and it may be that some species recorded from the island are not resident, e.g. *Hyles lineata* (Fabricius) (see below). Writing about the Caribbean species, Cary (1951) lists *Agrius cingulata*, *Manduca rustica* (Fabricius), *Cocytius antaeus* (Drury), *Protambulyx strigilis*, *Erinnyis ello* (Linnaeus), *E. alope* (Drury), *Pachylia ficus* (Linnaeus), *Pachylioides resumens* (Walker), *Eumorpha satellitia* (Linnaeus), *E. vitis* (Linnaeus), *E. fasciatus* (Sulzer) and *E. labruscae* (Linnaeus) as likely to disperse over wide stretches of water. In passing, Cock and Boos (2007) reported that Julius O. Boos had collected specimens of *Callionima falcifera* (Gehlen) and *Enyo lugubris* (Linnaeus) 'at light on an oilrig in the sea between Venezuela and the island of Trinidad'. I checked these specimens, now in UWIZM, while preparing the present account. They are labelled 'Trintes Platform B, East of Mayaro Beach' August 1978, i.e. to the east of Trinidad. Trintes B was deployed in the Galeota Marine Field, east of Mayaro, from June 1978 (MPM 1981), and is 8-9km offshore, northeast of Point Galeota (Petroleum Economist 2015), so Cock and Boos (2007) referring to the platform as between Trinidad and Venezuela is misleading. Further records from offshore rigs would add to our insight regarding the species involved, and frequency and scale of the movement of these moths.

Immature stages

There is very little recorded regarding the life histories of the Sphingidae in Trinidad, so an overview is provided of food plant records from other parts of the Americas (Appendix Table 1). Several of the sources listed include images of caterpillars and pupae, notably Moss (1912, 1920), Dyer and Gentry (2002), Dyer *et al*. (2017), Janzen & Hallwachs (2017), and Oehlke (2017). In the following species accounts, only literature and information specific to Trinidad and Tobago is included. The few images available of early stages of Trinidad hawk-moths are shown as Figs. 39-49. Hawk-moth caterpillars have a distinctive and characteristic horn or tail on the posterior end of the body (hence the common name hornworms). Although this tail may be greatly reduced in mature caterpillars of some species, its presence will normally serve to distinguish hawk-moth caterpillars from those of other families for the Trinidad fauna (but not necessarily elsewhere). Pupation is generally in a cell in the soil. Rearing methods are not treated here, as information can be found on-line (e.g. https://breedingbutterflies.com/general-information/, http://sphingidae-haxaire.com/index.php/study/livestock/). There is considerable scope for documenting the life histories of Trinidad and Tobago's hawk-moths (and indeed other Lepidoptera), e.g. Cock (2007, 2008).

Collecting

Most collecting of hawk-moths in Trinidad, at least in the last 50 years, has been by using lights, particularly mercury vapour lights (MVL) with a strong ultra-violet component, to attract nocturnal adults. Based on this collecting method, Stradling *et al*. (1983) recorded all Sphingidae for nearly 4000 light trap nights at Curepe and used these data to examine patterns of flight in relation to rainfall and the lunar cycle, and how species frequency and diversity has varied over time.

As an aside, it may be noted that CAB International (CABI) staff (including F.D. Bennett, R.E. Cruttwell, the author, etc.) have labelled material as from Curepe, when actually it is from St. Augustine (based on the outlines shown for Curepe and St. Augustine on Google maps). The reasons for this are twofold: (1) although the part of Gordon Street where the CABI premises are situated is in St. Augustine, the CABI office uses the Curepe post office, and hence the postal address is Curepe, and (2) in those days, data labels were hand written or hand printed using a small hand-printing press, and the attraction of writing or preparing hundreds of data labels with the short 'Curepe' rather than the long 'St. Augustine' is obvious.

This body of data from Curepe (= St. Augustine) is complemented by records from collecting at light in forested areas, most notably at the Morne Bleu Textel Installation and at Simla in the Arima Valley, but with observations from many parts of Trinidad (Cock 2003). However, these represent dozens of evenings collecting compared to the thousands of nights trapping in St. Augustine. The intensive collecting at Curepe (St. Augustine) has resulted in five species being only recorded from there: *Erinnyis impunctata* Rothschild & Jordan, *Pachylia syces syces* (Hübner), *Callionima inuus* (Rothschild & Jordan), *Aleuron chloroptera* (Perty), and *Hyles lineata* (Appendix Table 2). However, when other habitats are better collected, this exclusivity to Curepe is expected to disappear; indeed, two further species were removed from this list as this paper was being finalized.

In Appendix Table 2, I have attempted to classify species as being commonly (+++), occasionally (++), rarely (+), or effectively never (-) associated with (i.e., collected in) suburban habitats and forested areas. However, the aforementioned intensive collecting in Curepe is expected to have led to a corresponding overemphasis on suburban habitats in this analysis.

The hummingbird hawk-moths, *Aellopos* spp., fly by day and feed at flowers, resembling small humming-birds, and have been occasionally caught using nets by butterfly collectors or photographed hovering at flowers. While I was resident in Trinidad, malaise traps were run at several locations, to collect flying insects into ethanol. I sorted some of these catches from Curepe and the Aripo Valley to record the Sphingidae, but found only small numbers of a few species by this collecting method.

There is a group of genera that are poorly documented from Trinidad, because they are not readily attracted to light: *Nyceryx* Boisduval (four species), *Perigonia* Herrich-Schaffer (two species), *Aellopos* Hübner (four species), *Oryba* Walker (two species), *Aleuron* Boisduval (two, possibly four species), *Unzela* Walker (one, possibly two species), and *Pachygonidia* Fletcher (one, possibly two species) (Haxaire 1992, 1996a, 1996b, 2005). As noted above, *Aellopos* spp. are primarily day-flying, though they continue to feed until dusk; the remaining species primarily fly at dusk and dawn and are hardly attracted to lights, apart from *Perigonia lusca* (Fabricius), which is regularly caught at light. All these species are most likely to be seen and collected when coming to flowers. The flowers that are most attractive include species of *Calliandra* and *Inga* (Fabaceae, Mimosoideae) (Haxaire 1992, 1996b). *Eupyrrhoglossum* Grote (one species) and *Enyo* Hübner (three species) are also attracted to flowers at dusk, but then come to light later in the night (Haxaire 1992, 1996c). Thus, for the species that only fly at dusk, there are very few records and specimens, and several species of this group have been recorded from Trinidad by Schreiber (1978) for which I have not seen specimens. It seems likely that before collecting at light came to predominate, collectors in the late 19th and early 20th centuries were aware of this behaviour and exploited it to collect specimens of these genera. Certainly, it would merit investigation in Trinidad today to better understand the hawk-moth fauna.

SPECIES ACCOUNTS

In the checklist that follows, the currently accepted name of each species (and where appropriate subspecies) recorded from Trinidad is followed by a list of all names used for the species in the literature relating to Trinidad. There follows brief notes on (1) taxonomic issues (if any), (2) identification, (3) biology in Trinidad (if anything is known), and (4) status in Trinidad. For the last, an indication is given as to how rare or common the species is in Trinidad, based on the number of records known to the author: rare <5, uncommon 5-10, occasional 11-19, quite or rather common 21-49, and common >50. For rare species, the individual records are listed. I also give an indication of the habitats in which species have been found, but rarely differentiate more than suburban (as exemplified by Curepe / St. Augustine) and forested, although where there seems to be a pattern, the latter is characterised by altitude or the part of the island. Additional information on months and localities of captures is summarised in Appendix Tables 2 and 4.

Species entries for 84 species which I can confirm as occurring in Trinidad follow below. These are followed by sections on species recorded from Trinidad which I have not been able to confirm (5 species), and species recorded from Trinidad, which I consider to be errors (7 species).

The Sphingidae of Trinidad

Family: Sphingidae
Subfamily: Smerinthinae
Tribe: Ambulycini

The five Trinidad species of two genera are easily recognised by the elongate forewings with an apical notch, and the coloured dorsal hindwings: orange in *Protambulyx* Rothschild and Jordan and pink in *Adhemarius* Oiticica Filho.

1. *Adhemarius gannascus* (Stoll, 1790) (Figs. 1, 50-51)
Amplypterus gannascus (Stoll): Kaye (1914b), Kaye and Lamont (1927), Cary (1951)
Amplypterus gannascus gannascus (Stoll): Schreiber (1978), Stradling *et al*. (1983)
Adhemarius gannascus (Stoll): Vaglia & Haxaire (2005)

Identification. Three species of *Adhemarius* are recognised from Trinidad. *Adhemarius palmeri* (Boisduval) is easily separated from the other two, for example, by the dark diagonal line beyond the basal band of the forewing; when seen in life, the lines of the two wings are aligned. *Adhemarius gannascus* and *A. daphne* (Boisduval) below are similar, but the dark mark on the forewing costa just before the apex is consistently narrow in *A. gannascus* and wider in *A. daphne*.

Biology in Trinidad. According to Haxaire and Rasplus (1987a), the food plants are *Ocotea* sp. (Lauraceae), based on the work of D.H. Janzen and colleagues (Janzen and Hallwachs 2017). Recently, Janzen and Hallwachs (2016) clarify that they have not reared *A. gannascus* itself, although it flies in their study area, and these earlier records are all referable to cryptic species that had been confused with *A. gannascus*. Thus, at this time, the food plants and biology of *A. gannascus* are unknown.

Status in Trinidad. A fairly common forest species. Most records are from the north, but Kaye and Lamont (1927) report it from Fyzabad (R.M. Farmborough).

2. *Adhemarius daphne daphne* (Boisduval, [1875]) (Figs. 2, 52)

Taxonomic issues. This species is identified based on the treatment by Vaglia and Haxaire (2005). There may be a further cryptic species based on DNA barcoding (Janzen and Hallwachs 2017; I.J. Kitching pers. comm. 2017). *Adhemarius daphne* has not hitherto been separated from *A. gannascus* in publications relating to Trinidad, but the author has long been aware that two species are present with different genitalia, and in the past I have incorrectly referred to the present species as *A. dentoni* (Clark). Based on material in UWIZM, I find that some specimens were treated as *A. gannascus* by Stradling *et al*. (1983).

Identification. As discussed under *A. gannascus* above.

Status in Trinidad. An occasional forest species.

3. *Adhemarius palmeri* (Boisduval, [1875]) (Figs. 3, 53)

Amplypterus palmeri (Boisduval): Kaye (1914b), Kaye and Lamont (1927), Schreiber (1978), Stradling *et al*. (1983)

Identification. *Adhemarius palmeri* is easily separated from the other two species of *Adhemarius* spp., for example, by the dark diagonal line beyond the basal band of the forewing.

Status in Trinidad. An occasional species, found in suburban areas and forested areas, but not recorded from higher areas

4. *Protambulyx eurycles* (Herrich-Schäffer, [1854]) (Fig. 54)

Protambulyx eurycles (Herrich-Schäffer): Schreiber (1978), Stradling *et al*. (1983)

Identification. This distinctive species might only be confused with the much commoner *P. strigilis* below, but that species lacks the strong wavy parallel lines on both wings, the dark forewing margin and the strong dark marking on the basal part of the forewing dorsum.

Status in Trinidad. I only know of three records, two from lowland forest, and one from a suburban situation.

50

Fig. 50. *Adhemarius gannascus gannascus* (Stoll) male, Morne Bleu, Textel Installation, at light, 26 July 1978 (M.J.W. Cock) [MJWC].

51

Fig. 51. *Adhemarius gannascus gannascus* (Stoll) female, Morne Bleu, Textel Installation, at light, 13 September 1978 (M.J.W. Cock) [MJWC].

Curepe, MVL: ♂ 10 September 1979 (M.J.W. Cock) [UWIZM CABI.7042]
Parrylands Oilfield, MVL: ♂ 25 July 1981 (M.J.W. Cock) [UWIZM CABI.7043]
Valencia Forest, MVL: ♂ 5 August 1981 (M.J.W. Cock) [MJWC] (Fig. 54)

52

Fig. 52. *Adhemarius daphne daphne* (Boisduval) male, Morne Bleu, Textel Installation, at light, 29 March 1979 (M.J.W. Cock) [MJWC].

53

Fig. 53. *Adhemarius palmeri* (Boisduval) male, Hollis Reservoir, at pump house lights, 2 November 1978 (M.J.W. Cock) [MJWC].

54

Fig. 54. *Protambulyx eurycles* (Herrich-Schäffer) male, Valencia Forest, MVL, 5 August 1981 (M.J.W. Cock) [MJWC].

5. *Protambulyx strigilis* (Linnaeus, 1771) (Figs. 4-5, 55-56)

Ambulyx strigilis (Linnaeus): Kaye (1901), Kaye (1914a)

Protambulyx strigilis (Linnaeus): Rothschild and Jordan (1903), Kaye (1914b), Kaye and Lamont (1927), Cary (1951)

Protambulyx strigilis strigilis (Linnaeus): Schreiber (1978), Stradling *et al*. (1983), Cock (2017b)

Taxonomic issues. Janzen and Hallwachs (2017) indicate that there may be two cryptic species present under this name in Costa Rica, but this possibility has not been investigated elsewhere.

Identification. A distinctive species readily separated from its congener, *P. eurycles*, above.

Status in Trinidad. A common and widespread species, found in suburban and forest habitats.

Subfamily: Sphinginae
Tribe: Sphingini
Subtribe: Cocytiina

This group of four Trinidad species in two genera is basal to the two other recognised subtribes of Sphingini treated below. They are large species with yellow basally on the hindwing and yellow lateral spots on the anterior abdomen. Several species of *Manduca* Hübner have the latter character, but not the former. All Trinidad species feed on Annonaceae and are notable for their long proboscides.

6. *Cocytius duponchel* (Poey, 1832) (Figs. 57-58)

Cocytius duponchel (Poey): Schreiber (1978), Stradling *et al*. (1983)

Taxonomic issues. Eitschberger (2006) placed this species in the genus *Amphonyx*, but this has not been widely accepted (e.g. Kitching 2017).

Identification. See under *C. antaeus* below.

Biology in Trinidad. Reported Annonaceae food plants include *Annona muricata* (soursop, introduced), *A. reticulata* (custard apple, introduced) and *A. squamosa* (sugar apple, introduced), but there are no reports of this species as a pest in Trinidad.

Status in Trinidad. An occasional but widespread species in Trinidad, found in both suburban and forest habitats.

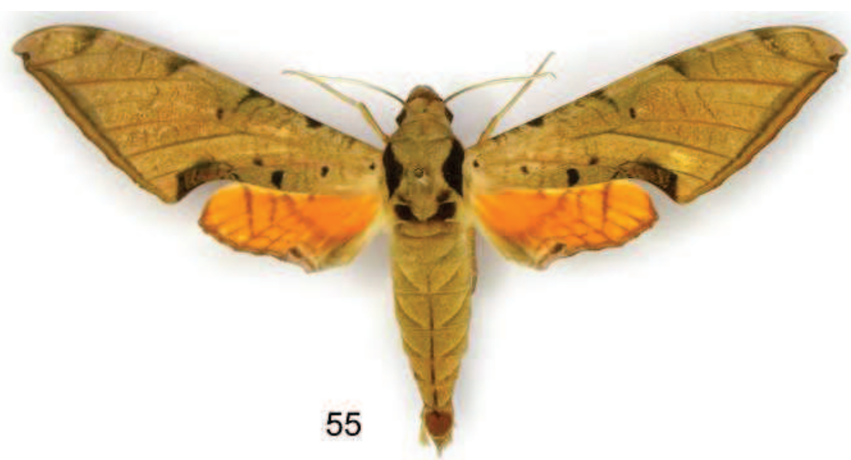


Fig. 55. *Protambulyx strigilis* (Linnaeus) male, Morne Bleu, Textel Installation, at light, 29 September 1978 (M.J.W. Cock) [MJWC].

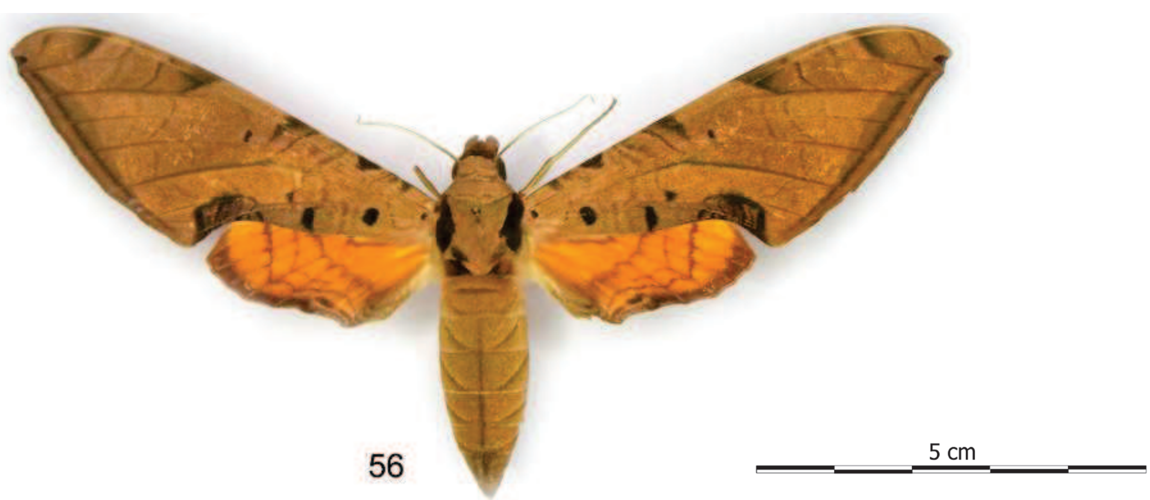


Fig. 56. *Protambulyx strigilis* (Linnaeus) female, Morne Bleu, Textel Installation, at light, 29 September 1978 (M.J.W. Cock) [MJWC].

7. *Cocytius lucifer* Rothschild and Jordan, 1903 (Figs. 6, 59)

Cocytius lucifer Rothschild and Jordan: Lamont and Callan (1950), Schreiber (1978)

Cocytius lucifer lucifer Rothschild and Jordan: Stradling *et al*. (1983)

Amphonyx lucifer (Rothschild and Jordan): Eitschberger (2006)

Taxonomic issues. As for the last species, Eitschberger (2006) placed this species in the genus *Amphonyx*, but this has not been widely accepted (e.g. Kitching 2017). There are two cryptic DNA barcode species under this name in Costa Rica (Janzen and Hallwachs 2011), but this has not been investigated elsewhere.

Identification. See under *C. antaeus* below.

Status in Trinidad. An occasional species in forest habitats.

8. *Cocytius antaeus* (Drury, 1773) (Fig. 60)

Cocytius antaeus medon [*sic*] (Stoll): Kaye (1914b) [misspelling of *medor*, a synonym of *antaeus*]

Cocytius antaeus medor (Stoll): Kaye and Lamont (1927), Cary (1951) [*medor* is a synonym of *antaeus*]

Cocytius antaeus antaeus (Drury): Schreiber (1978)

Cocytius antaeus (Drury): Eitschberger 2006

Identification. This large species resembles the previous two, *C. duponchel* and *C. lucifer*. Pinned specimens are easy enough to distinguish: the hyaline discal area of the hindwing has the veins dark in all three species, but only in *C. antaeus* is there a parallel dark line in the distal part of each hyaline space. This character is hidden when living adults are photographed, and so only characters of the forewing can be used: the forewings of *C. antaeus* and *C. duponchel* are more mottled than the rather evenly coloured forewing of *C. lucifer*; and furthermore *C. antaeus* has a

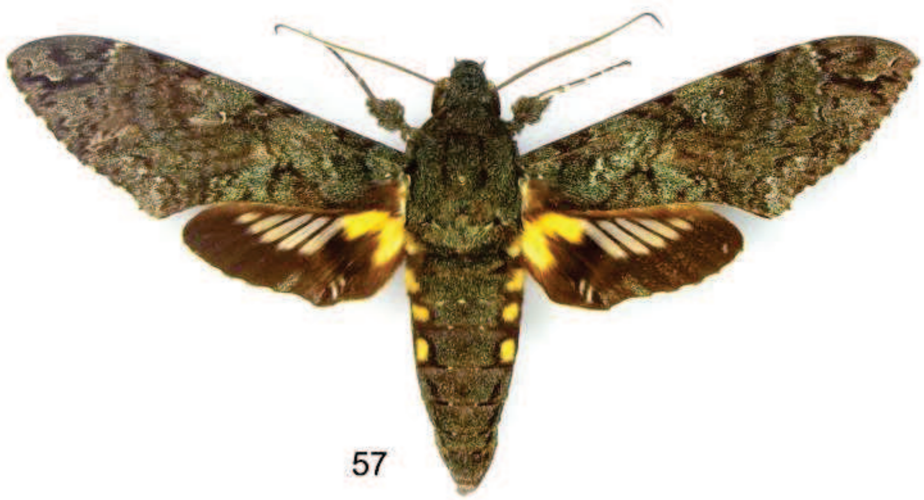


Fig. 57. *Cocytius duponchel* (Poey) male, Morne Bleu, Textel Installation, at light, 29 September 1978 (M.J.W. Cock) [MJWC].

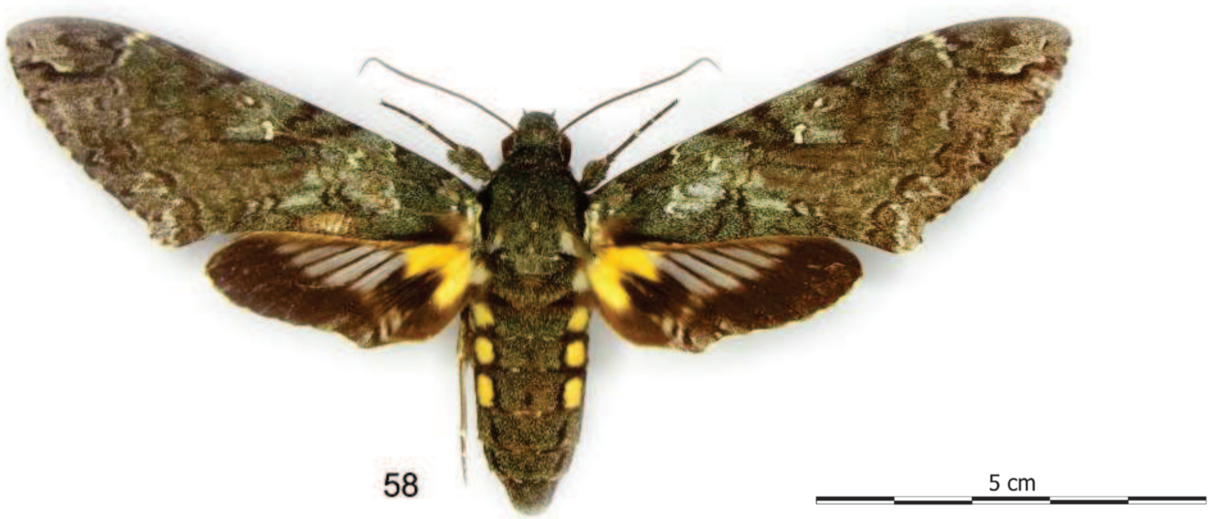


Fig. 58. *Cocytius duponchel* (Poey) female, Valsayn Park, at light, 22 September 1978 (M.J.W. Cock) [MJWC].

single black streak in the discal area, *C. lucifer* has two, and *C. duponchel* has at most a weak streak.

Biology in Trinidad. As for *C. duponchel*, although the Annonaceae food plants include *A. muricata* (soursop, introduced), *A. reticulata* (custard apple, introduced) and *A. squamosa* (sugar apple, introduced), there are no reports of this species as a pest in Trinidad.

Status in Trinidad. An occasional species in suburban habitats, rarely found in forested areas.

9. *Neococytius cluentius* (Cramer, 1775)
(Figs. 7-8, 61-62)

Cocytius cluentius (Cramer): Kaye and Lamont (1927)
Neococytius cluentius (Cramer): Stradling *et al*. (1983)

Identification. The females of this species probably have the greatest wing spans of any Trinidad hawk-moth, up to 18cm. Adults are superficially similar to the last three species, but the forewing is much darker, and the lateral yellow spots on the abdomen extend further distally. Photographs of living adults with the yellow markings of the hindwing and abdomen potentially hidden may be confused with the smaller *Erinnyis alope* (and size is not always evident in an image). When at rest, the adult of *N. cluentius* holds its wings more tightly against the body (Fig. 7) like *Erinnyis* spp. but unlike *Cocytius* spp. (e.g. Fig 6). The weak pale marking of the forewing of *N. cluentius* are closer to the base of the wing, and *E. alope* has a dark stripe dorsally the length of the thorax, and a strong crest that can be seen in lateral view and sometimes in dorsal view.

Biology in Trinidad. The Annonaceae food plants reported include *A. muricata* (soursop, introduced), *A. reticulata* (custard apple, introduced), but there are no reports of this species as a pest in Trinidad.

Status in Trinidad. An uncommon species, primarily in forest habitats.

Subfamily: Sphinginae
Tribe: Sphingini
Subtribe: Sphingina

This tribe is represented by the genus *Manduca*, with ten species in Trinidad. Kawahara *et al*. (2013) conducted a multi-gene phylogenetic analysis of *Manduca*, and recognised (1) a basal group, the *lefeburii* complex, and three well supported groups referred to here as: (2) the *florestan* complex, (3) the *sexta* complex, and the (4) *occulta* complex.

The *lefeburii* complex of *Manduca*

This is the basal group of the genus in the phylogeny of Kawahara *et al*. (2013).

10. *Manduca lefeburii* (Guérin-Méneville, [1844])
(Figs. 63)

Protoparce lefeburei [*sic*] (Guérin-Méneville): Kaye (1914b), Kaye and Lamont (1927)
Protoparce lefeburei lefeburei [*sic*] (Guérin-Méneville): Schreiber (1978), Stradling *et al*. (1983)

Identification. A very distinctive species in Trinidad, although there are similar species in South America.

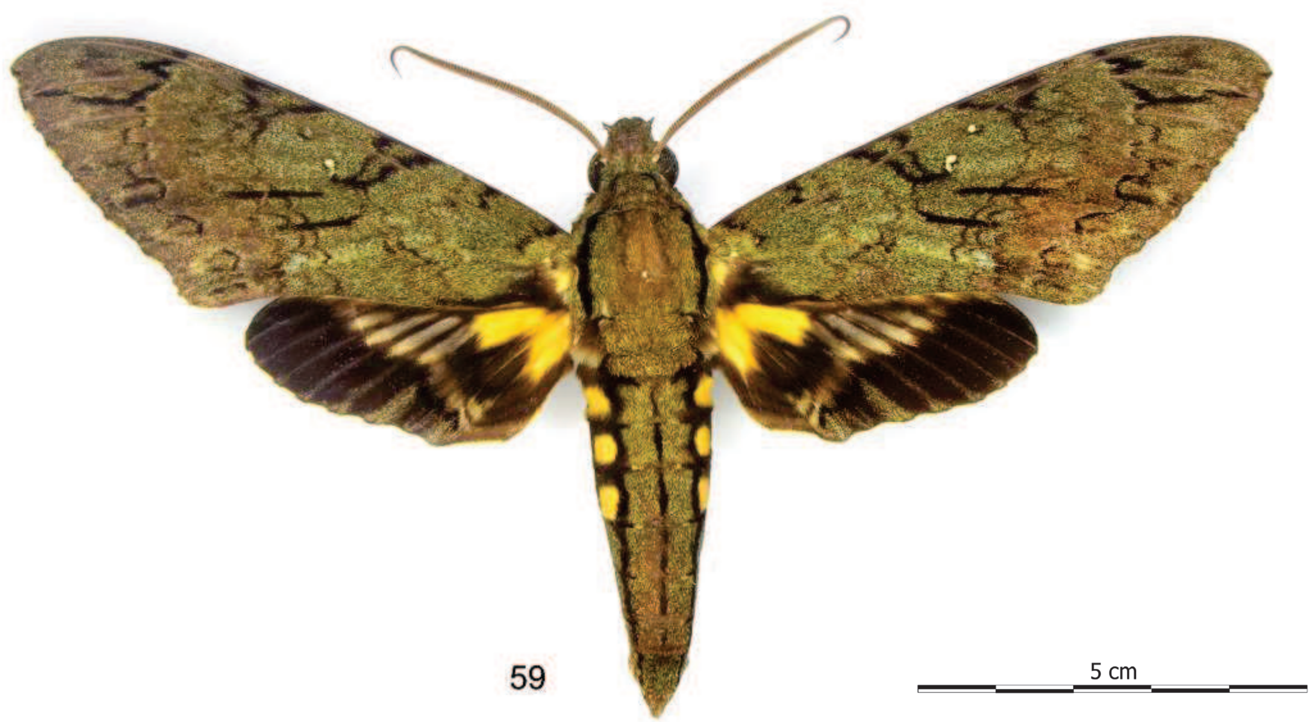


Fig. 59. *Cocytius lucifer* Rothschild and Jordan male, Brigand Hill, lighthouse security MVL lights, 24 March 2003 (M.J.W. Cock) [MJWC].

Status in Trinidad. An uncommon species, found in suburban and disturbed habitats, but not forested.

11. *Manduca albiplaga* (Walker, 1856) (Figs. 9, 64)
Protoparce albifuga [*sic*] (Walker): Kaye (1914b)
Protoparce albiplaga (Walker): Kaye and Lamont (1927)
Manduca albiplaga (Walker): Cary (1951)
Manduca albiplaga albiplaga (Walker): Schreiber (1978), Stradling *et al*. (1983)
Identification. This is the largest *Manduca* species in Trinidad, and can be further recognised by the white discal and apical bands of the forewing.
Status in Trinidad. An occasional species, predominantly in forested areas, especially on the ridges of the Northern Range.

The *florestan* complex of *Manduca*
The three species treated in this group do not have yellow markings laterally on the abdomen. *Manduca franciscae* (Clark) and *M. huascara* (Schaus) were not included in Kawahara *et al*.'s (2013) study, but are placed here based on their obvious similarity.

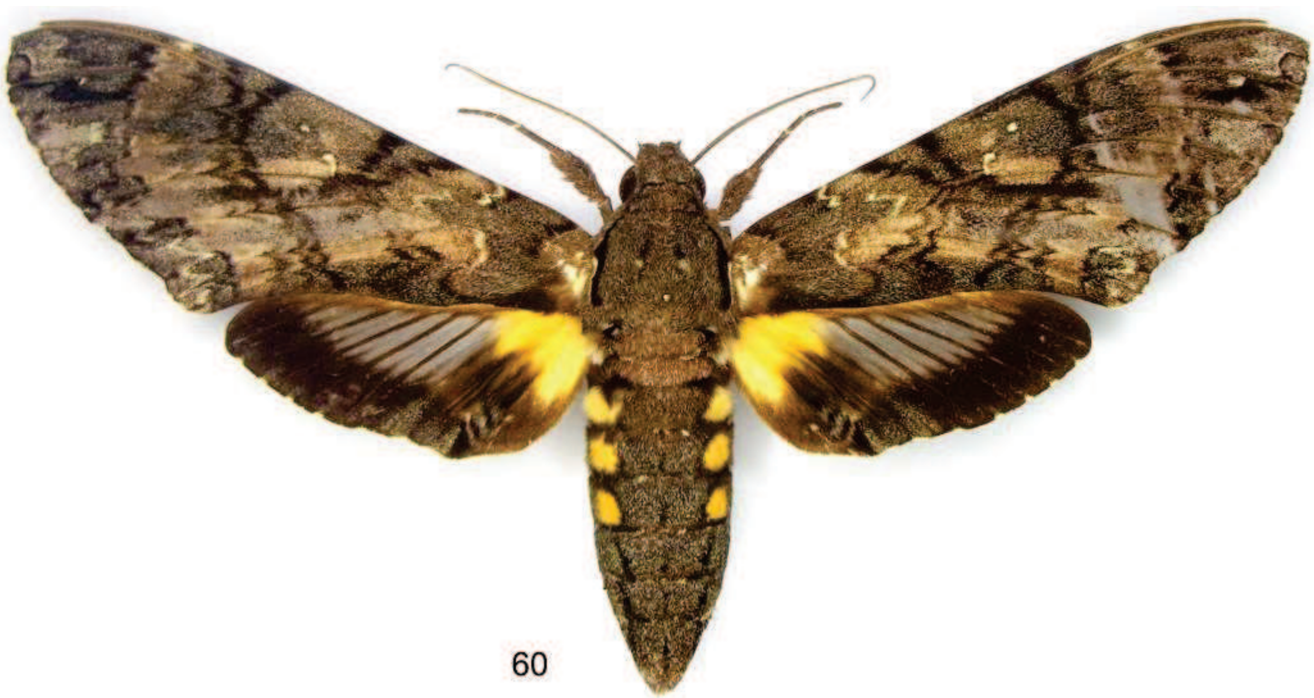


Fig. 60. *Cocytius antaeus* (Drury) female, St. Augustine, MVL, September 1978 (F.D. Bennett) [MJWC].

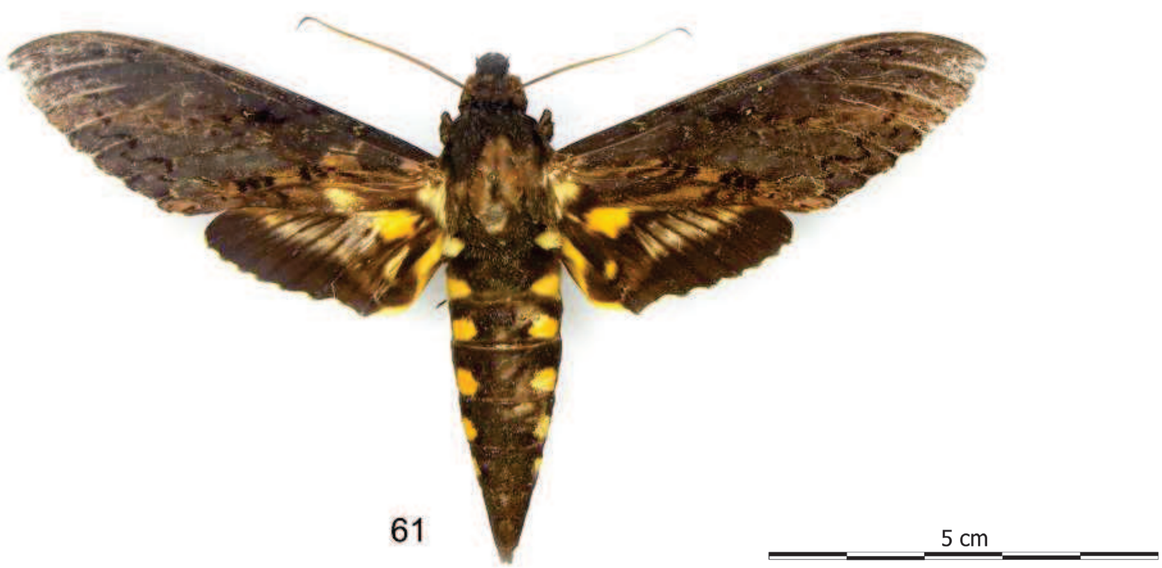


Fig. 61. *Neococytius cluentius* (Cramer) male, Parrylands Oilfield, MVL, 25 July 1981 (M.J.W. Cock) [MJWC].

12. *Manduca franciscae* (Clark, 1916) (Fig. 65)
Manduca franciscae (Clark): Stradling *et al*. (1983)
Identification. This rare species might easily be overlooked as a pale *M. florestan*, but it is slightly smaller, the colouring is significantly paler, and the hindwing of *M. florestan* (Stoll) is more uniformly brown. Separation of images of the two could be difficult without voucher material.
Status in Trinidad. I know of just two records, from Arima Valley and Palmiste.
Arima Valley, Simla, MVL: ♂ 3 May 1981 (M.J.W. Cock) [MJWC] (Fig. 65)
Palmiste: ♀ 11 June 1948 [N. Lamont] [UWIZM. 2013.13.2346]

13. *Manduca huascara* (Schaus, 1941) (Figs. 10, 66-67)
Protoparce corallina: Kaye (1914b) [probable mis-identification]
Manduca lichenea (Burmeister): Cary (1951) [misidentification]
Manduca fosteri (Rothschild and Jordan): Stradling *et al.* (1983) [misidentification]
Taxonomic issues. This medium sized *Manduca* species has been misidentified in Trinidad collections in the past as *M. fosteri* (Rothschild and Jordan) and *M. lichenea* (Burmeister), which are not Trinidad species. Based on appearances, I suspect that this is also the species which Kaye (1914b) referred to as *M. corallina*, although curiously, he does not refer to this species in Kaye and


62

Figs. 62. *Neococytius cluentius* (Cramer) female, Parrylands Oilfield, MVL, 25 July 1981 (M.J.W. Cock) [MJWC].

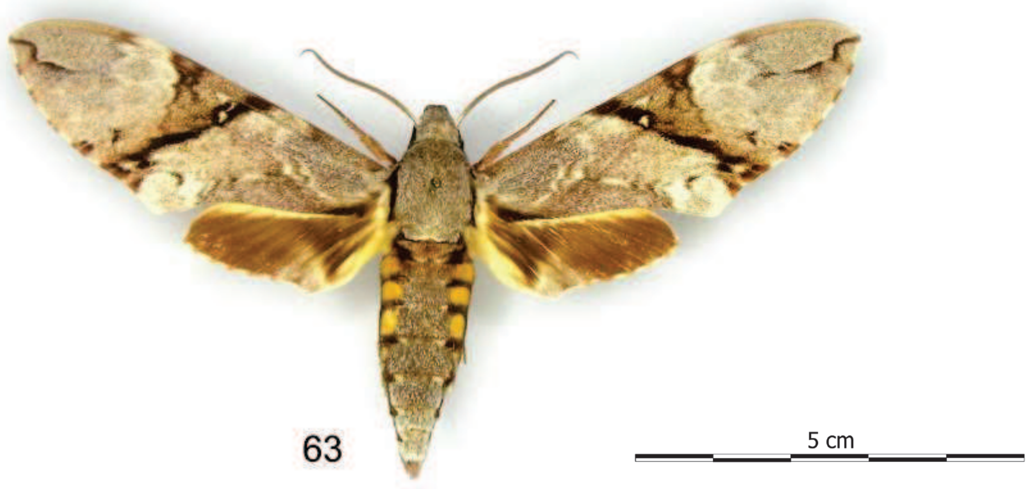


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Fig. 63. *Manduca lefeburii* male, Manzanilla, at light, 3 June 1979 (M.J.W. Cock) [MJWC].

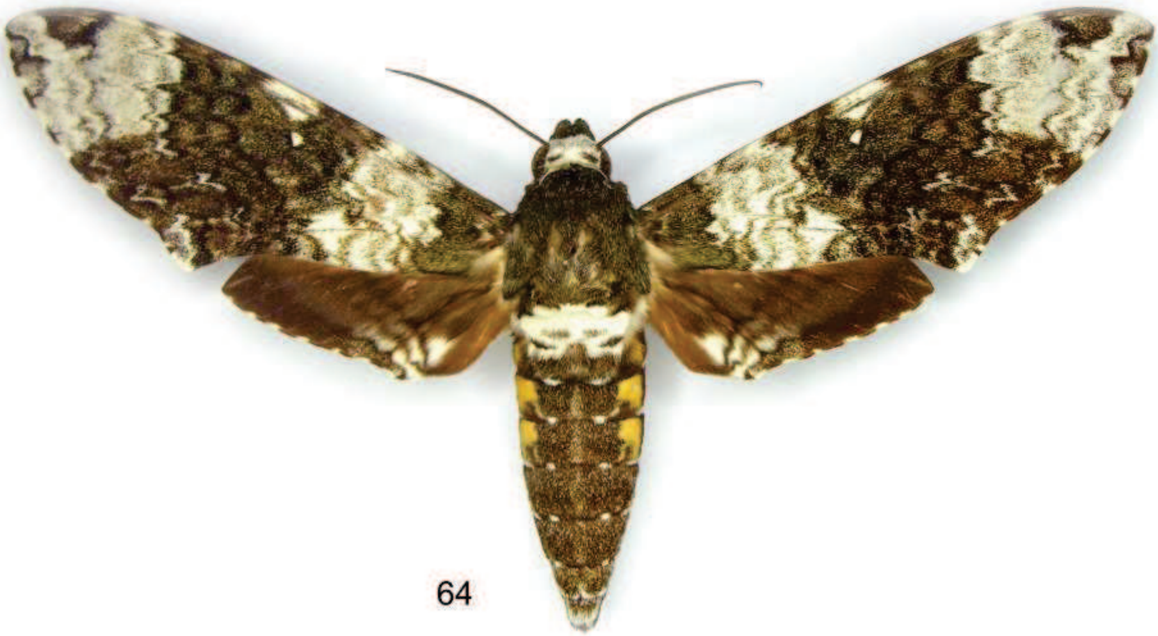


Fig. 64. *Manduca albiplaga* (Walker) male, Morne Bleu, Textel Installation, at light, 10 May 1981 (M.J.W. Cock) [MJWC]

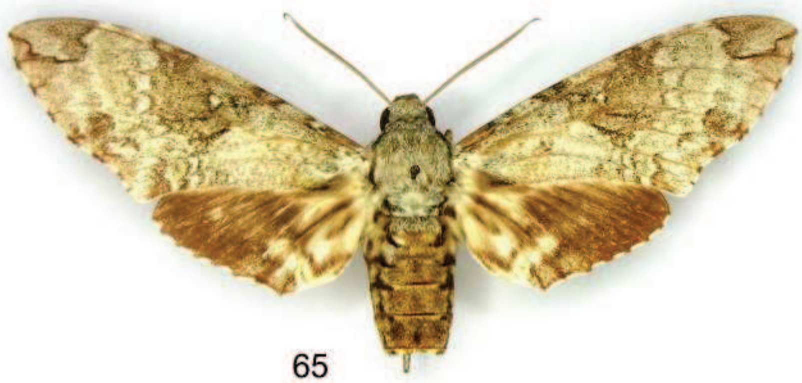


Fig. 65. *Manduca franciscae* (Clark) male (dissected), Arima Valley, Simla, MVL, 3 May 1981 (M.J.W. Cock) [MJWC].

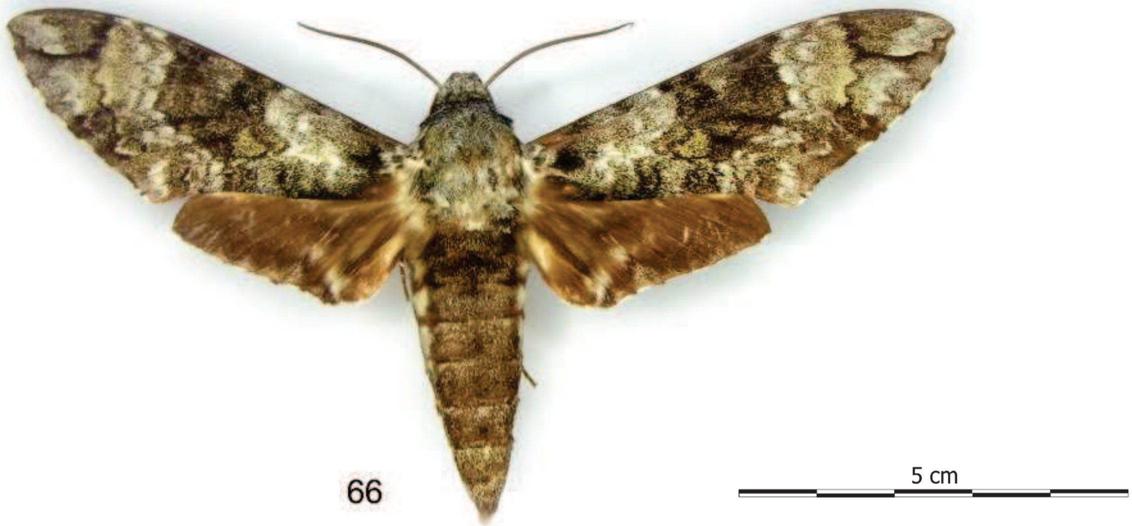


Fig. 66. *Manduca huascara* (Schaus) male, Arima Valley, Simla, MVL, 28 February 1981 (M.J.W. Cock) [MJWC].

Lamont (1927). It was confused with the common *M. florestan* (below) by Stradling *et al*. (1983).

Identification. This is a reasonably distinctive species within the Trinidad fauna: *M. florestan* is a more evenly coloured and greener species, with a diagnostic contrasting light brown patch at the end of the forewing cell (although care is needed as this patch can be weakly or very weakly expressed in some individuals). Images of living adult *M. huascara* might be confused with *Agrius cingulata* or *Pseudosphinx tetrio* (Linnaeus), but careful examination of the details of the forewing markings should separate them.

Status in Trinidad. An occasional widespread species, more common in forested areas, but not from the higher parts of the Northern Range.

14. *Manduca florestan* (Stoll, 1782) (Figs. 11, 68)

Diludia florestan (Stoll): Kaye (1901, 1914a)

Protoparce florestan (Stoll): Rothschild and Jordan (1903), Kaye (1914b), Kaye and Lamont (1927)

Manduca floristan [*sic*] (Stoll): Cary (1951)

Manduca florestan florestan (Stoll): Schreiber (1978), Stradling *et al*. (1983)

Manduca florestan (Stoll): D'Abrera ([1987]), Cock (2017b)

Identification. This species might be confused with the last two as discussed above.

Status in Trinidad. A common and widespread species in forested areas.

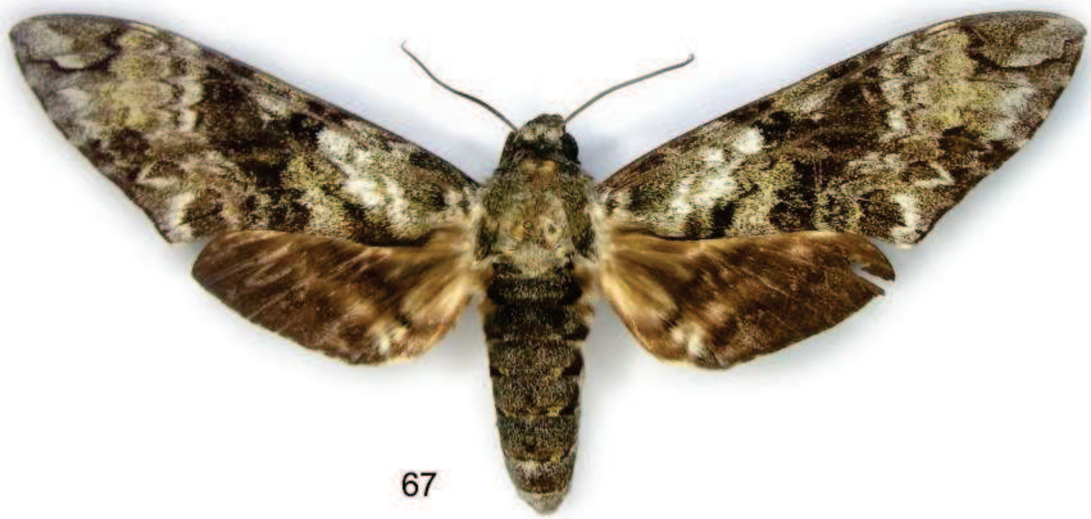


Fig. 67. *Manduca huascara* (Schaus) female, Brigand Hill, lighthouse security MVL lights, 25 March 2003 (M.J.W. Cock) [MJWC].

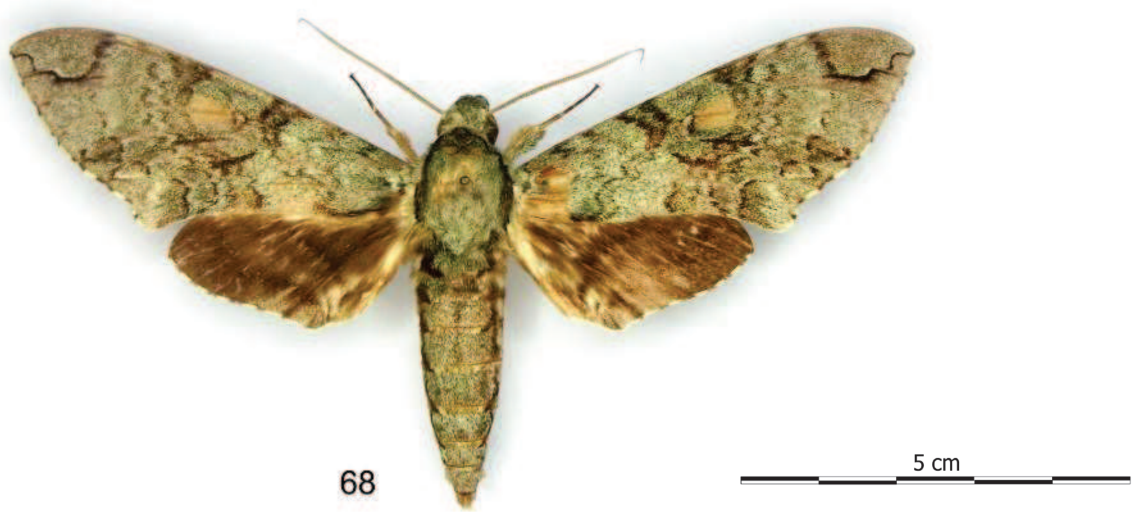


Fig. 68. *Manduca florestan* (Stoll) male, Morne Bleu, at light, 13 September 1978 (M.J.W. Cock) [MJWC].

The *sexta* complex of *Manduca*

15. *Manduca rustica rustica* (Fabricius, 1775) (Figs. 12, 69)

Macrospila sp.: Guppy (1893)

Protoparce rustica (Fabricius): Kaye (1901, 1914a, 1914b)

Protoparce rustica rustica (Fabricius): Rothschild and Jordan (1903), Kaye and Lamont (1927)

Manduca rustica rustica (Fabricius): Schreiber (1978), Stradling *et al*. (1983), Cock (2017b)

Identification. The fine grained mottling of the wings and strong white spot in the forewing cell should serve to recognise this species in Trinidad.

Biology in Trinidad. Guppy (1893) describes rearing a '*Macrospila* sp.' which he found on 'heliotrope', which may well have been the polyphagous *Manduca rustica*.

Status in Trinidad. A fairly common and widespread species in both suburban and forest habitats.

16. *Manduca sexta* (Linnaeus, 1763) *paphus* (Cramer, 1779) (Figs. 39-40, 70)

Protoparce paphus (Cramer): Kaye (1901), Guppy (1914), Kaye (1914a)

Protoparce sexta (Linnaeus): Guppy (1911a, 1911b)

Protoparce sexta paphus (Cramer): Rothschild and Jordan (1903), Kaye (1914b), Kaye and Lamont (1927) , Cock (2017b)

Protoparce sp.: Topper (1943)

Manduca sexta paphus (Cramer): Cary (1951), Schreiber (1978), Stradling *et al*. (1983)

Manduca sexta jamaicensis (Butler): Schreiber (1978), Stradling *et al*. (1983) [misidentification or error]

Manduca sexta (Linnaeus): CABI (2002c)

Taxonomic issues. There appears to be at least two cryptic taxa under this name in Costa Rica (Janzen and Hallwachs 2017), but only a single species in South America based on the barcodes in BOLD (http://boldsystems.org/index.

69

Fig. 69. *Manduca rustica rustica* (Fabricius) male, Morne Bleu, Textel Installation, at light, 29 September 1978 (M.J.W. Cock) [MJWC].

70

Fig. 70. *Manduca sexta paphus* (Cramer) male, Curepe, MVL, 25 July 1978 (M.J.W. Cock) [MJWC].

php, 24 October 2017). Schreiber (1978) records both *M. sexta jamaicensis* and *M. sexta paphus* from Trinidad; the former is restricted the Caribbean islands, including the Lesser Antilles, but I have seen no evidence that it also occurs in Trinidad.

Identification. This medium sized hawk-moth has the forewings rather uniformly grey, and although there are other similar species in South America, this is the only one of this appearance known from Trinidad. Photographs of living adults might be confused with *Agrius cingulata* as discussed above, or the darker *M. diffissa* (Butler) below.

Biology in Trinidad. In Trinidad, Guppy (1911b) notes caterpillars on tobacco, tomato and peppers, and Kaye and Lamont (1927) refer to this species as the tobacco hawk-moth.

Status in Trinidad. A fairly common species in suburban habitats, but hardly recorded from forests.

The *occulta* complex of *Manduca*

This group is based on *M. occulta* (Rothschild and Jordan), a species closely related to *M. diffisa* Butler, which does not occur in Trinidad. Kawahara *et al*. (2013) did not include *M. ochus* (Klug) in their study, and its placement is uncertain.

17. *Manduca diffissa* (Butler, 1871) *tropicalis* (Rothschild and Jordan, 1903) (Figs. 13, 71)

Protoparce diffusa [*sic*] *tropicalis* (Rothschild and Jordan): Kaye (1914b) [misspelling]

Protoparce diffissa tropicalis (Rothschild and Jordan): Kaye and Lamont (1927), Cary (1951), Schreiber (1978), Stradling *et al*. (1983)

Manduca occulta occulta Rothschild and Jordan: Schreiber (1978) [misidentification or error]

Taxonomic issues. Schreiber (1978) lists *Manduca occulta occulta* Rothschild and Jordan from Trinidad, but this is the Central American equivalent of *Manduca diffissa,* and not a South American species**.**

Identification. This species is darker than the superficially similar *M. sexta* above. In living specimens the slightly paler postdiscal lines align across the two wings.

Status in Trinidad. A fairly common, widespread species found in both suburban and forested habitats.

18. *Manduca hannibal hannibal* (Cramer, 1779) (Fig. 72)

Protoparce hannibal (Cramer): Rothschild and Jordan (1903), Kaye (1914b), Kaye and Lamont (1927)

Manduca hannibal (Cramer): Cary (1951)

Manduca hannibal hannibal (Cramer): Schreiber (1978), Stradling *et al*. (1983)

Taxonomic issues. There seems to be at least two cryptic species in Costa Rica (Janzen and Hallwachs 2017) but this has not been evaluated elsewhere.

Identification. A distinctive species; note the orange dorsal markings on the abdomen, and the relatively uniform brown dorsal forewing, with a broad blackish post-discal band and narrow submarginal white

Biology in Trinidad. Kaye and Lamont (1927) give '*Frombeta* (Solanaceae)' as a food plant, but this is an error for *Trombeta*, incorrectly transcribed from Moss (1912).

Status in Trinidad. An uncommon species found in suburban and forested situations.

19. *Manduca ochus* (Klug, 1836) (Fig. 73)

Protoparce ochus (Klug): Kaye (1901), Rothschild and Jordan (1903), Kaye (1914a, 1914b), Kaye and Lamont (1927)

Manduca ochus (Klug): Cary (1951), Schreiber (1978), Stradling *et al*. (1983)

Identification. A very distinctive species; the combination of rich brown and blackish costal markings on the forewing cannot be mistaken.

Status in Trinidad. A rare species, from both suburban and forest areas.

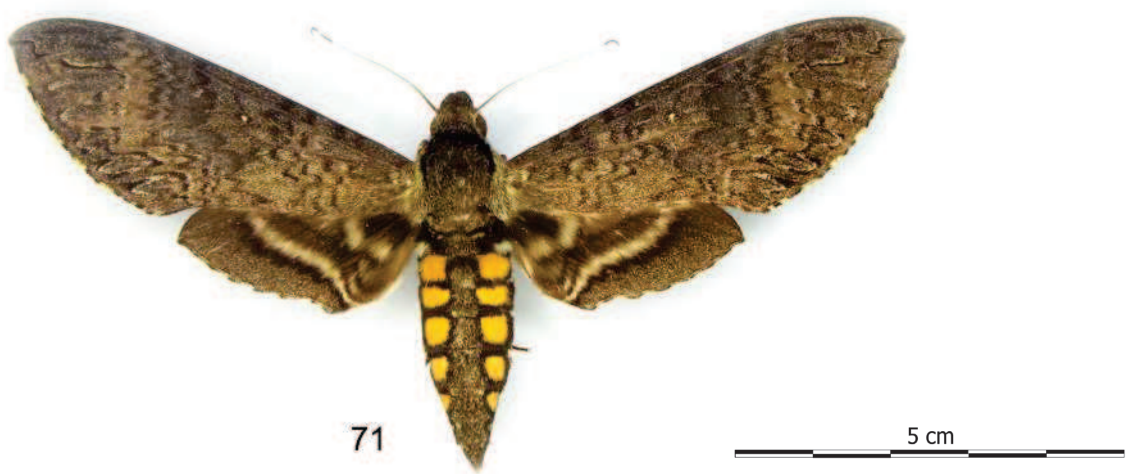


Fig. 71. *Manduca diffissa tropicalis* (Rothschild and Jordan) male, Morne Bleu, Textel Installation, at light, 10 May 1981 (M.J.W. Cock) [MJWC].

Subfamily: Sphinginae
Tribe: Sphingini
Subtribe: Acherontiina

This mostly Old World subtribe is represented by just one species in Trinidad: *Agrius cingulata*. It is unique in the Trinidad fauna in having pink markings on the abdomen.

20. *Agrius cingulata* (Fabricius, 1775)
(Figs. 14-15, 41, 74-75)

Herse cingulata (Fabricius): Kaye (1914b), Kaye and Lamont (1927), Pollard (1984)

Agrius cingulata (Fabricius): Cary (1951)

Agrius cingatulus [*sic*] (Fabricius): Schreiber (1978), Stradling *et al*. (1983)

Identification. The pink markings on the dorsal hindwing and abdomen are distinctive. Slight sexual dimorphism, the male typically has more contrasting forewing markings. Images of resting adults do not show the pink markings normally, and they must be identified by comparison of the markings with similar species such as *Pseudosphinx tetrio* and *Erinnyis* spp.

Biology in Trinidad. The Convolvulaceae food plants include sweet potato (*Ipomoea batatas*), on which the caterpillar are an occasional, minor pest in Trinidad (Pollard 1984).

Status in Trinidad. An occasional species found in both disturbed and forest habitats.

Subfamily: Macroglossinae
Tribe: Dilophonotini
Subtribe Dilophonotina

For ease of comparison, the sequence in Kawahara *et al* (2009) is followed here, using group names for convenience based on the obvious clades on their phylogeny. Thus, I refer to the *Pachylia* group (two species of *Pachylia* Walker), the *Nyceryx* group (16 species of five genera), the *Erinnyis* group (17 species of seven genera), and the *Aleuron* group (three species of two genera).

Fig. 72. *Manduca hannibal hannibal* (Cramer) female, Curepe, MVL, 28 November 1978 (M.J.W. Cock) [MJWC].

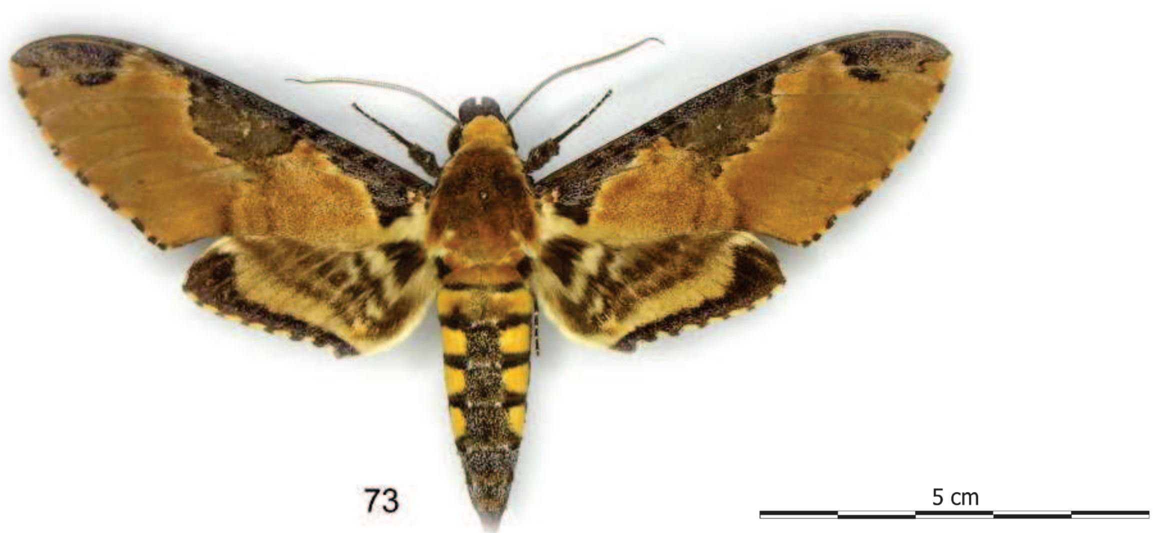


Fig. 73. *Manduca ochus* (Klug) male, Morne Bleu, Textel Installation, at light, 26 July 1978 (M.J.W. Cock) [MJWC].

***Pachylia* group**

Two species of *Pachylia* are reported from Trinidad. Both feed on *Ficus* (Moraceae).

21. *Pachylia ficus* (Linnaeus, 1758) (Figs. 16, 76-77)

Pachylia ficus (Linnaeus): Rothschild and Jordan (1903), Kaye (1914b), Kaye and Lamont (1927), Cary (1951), Schreiber (1978), Stradling *et al*. (1983), Cock (2017b)

Identification. This species can be recognised by the mottled brown dorsal forewings with a distinct pale brown apical patch. The rare *P. syces* is darker and has a pale brown patch on the forewing costa as well.

Status in Trinidad. Kaye and Lamont (1927) considered *P. ficus* one of the commonest of the Sphingidae, but observations since the 1970s show that it is only an occasional species, mostly recorded from suburban areas.

22. *Pachylia syces syces* (Hübner, [1819]) (Fig. 78)

Pachylia syces syces (Hübner): Schreiber (1978), Stradling *et al*. (1983), Cock (2017b)

Biology. Adults have been collected at flowers of Mimosoideae (*Inga* sp., *Callliandra* sp., etc.) at dusk in French Guiana (Haxaire and Rasplus 1987a). It may be that this is primarily a dusk or crepuscular flier, rarely attracted to light.

Identification. The dorsal forewings are fairly uniformly dark brown with pale brown patches on the costa and apex.

Status in Trinidad. A rare species in Trinidad that I have not personally encountered. Stradling *et al*. (1983) note just three records, and I have seen images of two further females from Tobago (Cock 2017b).

Curepe, light trap: ♀ 25 November 1970 (F.D. Bennett) [UWIZM CABI.1984] (Fig. 78); ♂ 20 September 1973 [F.D. Bennett] [NMSE, ex D.J. Stradling collection]

***Nyceryx* group**

This group comprises the following genera from Trinidad: *Callionima* Lucas (four species), *Nyceryx* (four species), *Perigonia* (two species), *Eupyrrhoglossum* (one species), and *Aellopos* (five species). *Callionima* spp. can be readily recognised by the silver distorted Y-shape on the dorsal forewing; *Madoryx* spp. and *Hemeroplanes triptolemus*

Fig. 74. *Agrius cingulata* (Fabricius) male, Caura Valley, Nr. Caura, MVL, 24 September 1978 (M.J.W. Cock) [MJWC].

Figs. 75. *Agrius cingulata* (Fabricius) female, Brigand Hill, lighthouse security MVL lights, 28 March 2003 (M.J.W. Cock) [MJWC].

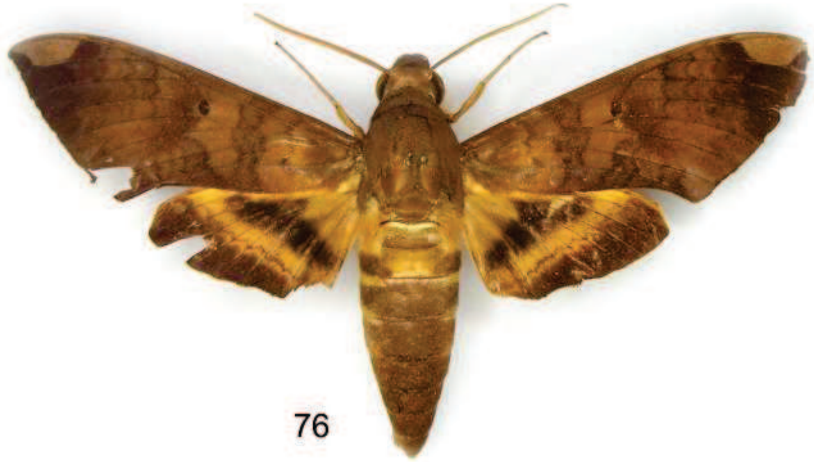


Fig. 76. *Pachylia ficus* (Linnaeus) male, St. Augustine, MVL, 29 August 1978 (F.D. Bennett) [MJWC].

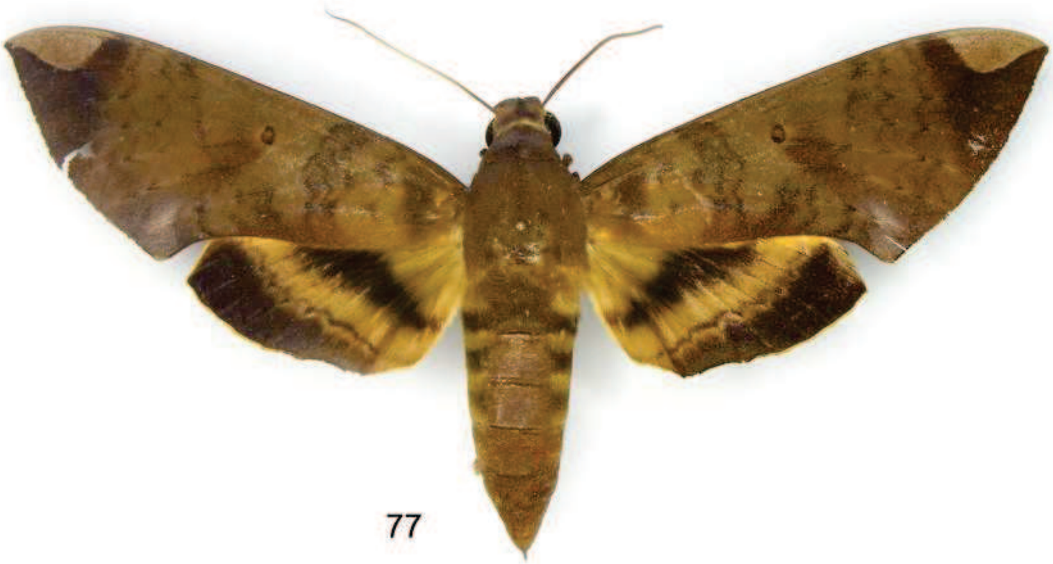


Fig. 77. *Pachylia ficus* (Linnaeus) female, Brigand Hill, lighthouse security MVL lights, 28 March 2003 (M.J.W. Cock) [MJWC].

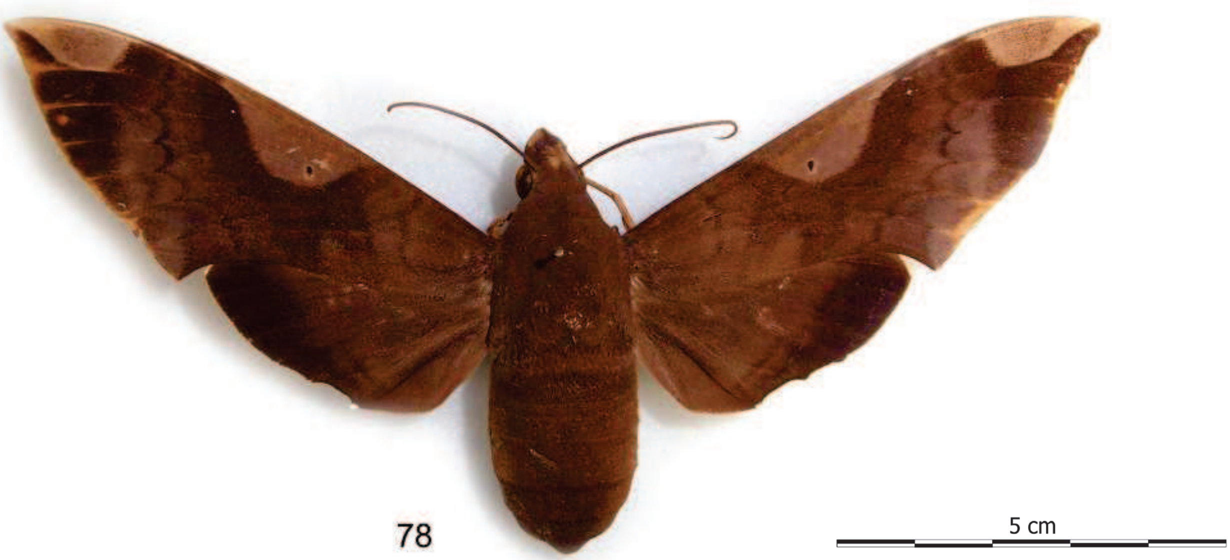


Fig. 78. *Pachylia syces syces* (Hübner) female, Curepe, light trap, 25 November 1970 (F.D. Bennett) [UWIZM CABI.1984].

(Cramer) also have one or two silver spots, but not in a Y-shape. The inclusion of *Callionima* is weakly supported, but the remaining genera appear to be a monophyletic group.

23. *Callionima pan pan* (Cramer, 1779) (Figs. 17, 79-80)
Callionima pan (Cramer): Stradling *et al*. (1983)
Identification. The slightly truncate forewing apical margin should help separate *C. pan* from the other *Callionima* spp. found in Trinidad.
Status in Trinidad. An uncommon species in Trinidad with records from a suburban area (Curepe, four records including three noted by Stradling *et al*. (1983)) and a forested area (Morne Bleu four records).

24. *Callionima calliomenae* (Schaufuss, 1870) (Figs. 81-82)
Hemeroplanes calliomenae (Schaufuss): Kaye (1914b), Kaye and Lamont (1927),
Callionima calliomenae (Schaufuss): Schreiber (1978), Stradling *et al*. (1983)
Identification. The variable olive-grey-brown forewing dorsal colouring and denticulate margin, and the yellow rather than orange dorsal hindwing when visible, will distinguish this common species from others of the genus.
Status in Trinidad. A common species in suburban areas, but not recorded from forested areas.

25. *Callionima inuus* (Rothschild and Jordan, 1903) (Figs. 83-84)
Callionima inuus Rothschild and Jordan: Stradling *et al*. (1983)
Identification. This species is superficially similar to *C. falcifera* (below), but can be recognised by the more elongate, and less falcate forewing and the more contrasting dorsal forewing subapical reticulate pale orange patch, which has a curved outer margin.
Status in Trinidad. An occasional species, recorded only from a suburban area (Curepe).

26. *Callionima falcifera* (Gehlen, 1943) (Figs. 85-86)
Callionima parce parce (Fabricius): Schreiber (1978), Stradling *et al*. (1983) [misidentification]
Callionima falcifera (Gehlen): Stradling *et al*. (1983), Cock and Boos (2007)
Taxonomic issues. A population from Mexico was recognised as a separate subspecies in Kitching and Cadiou 2000), but this has now been sunk, so no subspecies name is needed (Kitching 2017). This species was identified by dissection and comparison with the illustrations in Soares (1993). Trinidad specimens are quite variable in colour, some being orange-brown in general colour (Fig. 85) and others darker (Fig. 86). I have dissected an example of both and found no significant differences.
Identification. The sharply falcate forewing, variable

Figs. 79-80. *Callionima pan pan* (Cramer) male, Curepe, MVL, 13 February 1980 (M.J.W. Cock) [MJWC]. **79**, dorsal. **80**, ventral.

Figs. 81-82. *Callionima calliomenae* (Schaufuss). **81**, male, Curepe, MVL, 11 September 1979 (M.J.W. Cock) [MJWC]. **82**, female, Curepe, MVL, 2 September 1978 (M.J.W. Cock) [MJWC].

orange-brown dorsal forewing and pale subapical reticulated patch with a straight outer margin should serve to distinguish this species.

Status in Trinidad. A common species in suburban areas, but only occasionally caught in lowland forested areas.

27. *Nyceryx coffaeae* (Walker, 1856) (Figs. 87-88)

Nyceryx coffeae [*sic*] (Walker): Kaye and Lamont (1927), Schreiber (1978), Stradling *et al*. (1983)

Identification. This small hawk-moth is readily distinguished from the larger *N. maxwelli* (Rothschild) and the other two *Nyceryx* spp., which have denticulate wing margins, but might be confused with *Perigonia lusca*. *Nyceryx coffaeae* has two yellow patches on the dorsal hindwing (diagnostic for this species in Trinidad), where *P. lusca* has only one.

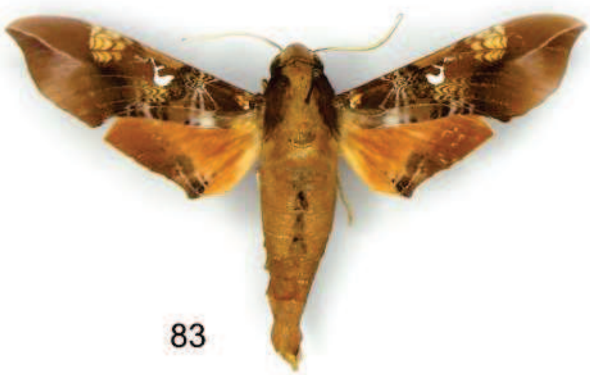
Status in Trinidad. An uncommon species, all records are from a suburban area (Curepe).

28. *Nyceryx maxwelli* (Rothschild, 1896) (Figs. 89-90)

Taxonomic issues. This species has not previously been reported from Trinidad. My identification was confirmed by I.J. Kitching (pers. comm. 2004) from dorsal and ventral images, and from Haxaire & Cadiou (1999).

Identification. The relatively large size, forewing shape and markings, and extensive yellow basal-discal area of the dorsal hindwing will help to identify this species.

Status in Trinidad. *Nyceryx maxwelli* is only known



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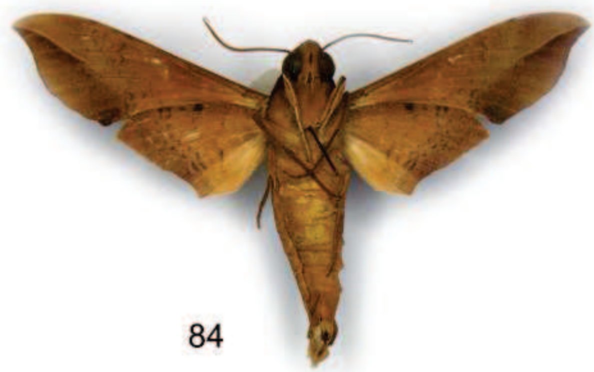
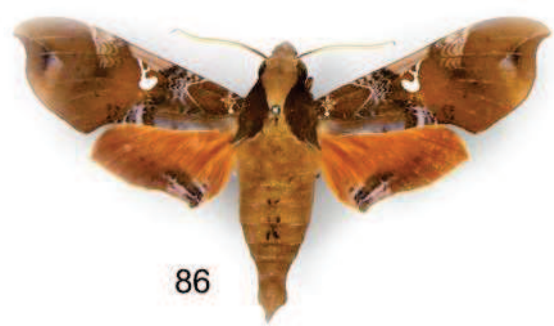


84

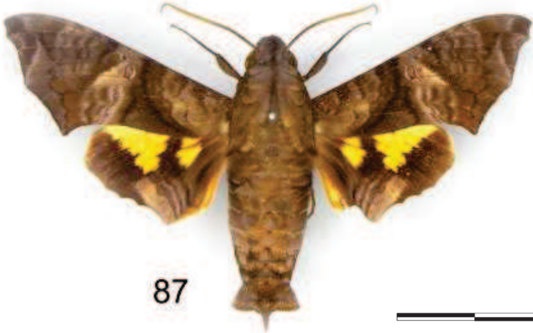
Figs. 83-84. *Callionima inuus* (Rothschild and Jordan) male, Curepe, light trap, 7 October 1969 (F.D. Bennett) [MJWC]. **83**, dorsal. **84**, ventral.

85



86

Figs. 85-86. *Callionima falcifera falcifera* (Gehlen) male. **85**, Curepe, MVL, 25 May 1979 (M.J.W. Cock) [MJWC]. **86**, Curepe, MVL, 12 September 1979 (M.J.W. Cock) [MJWC].



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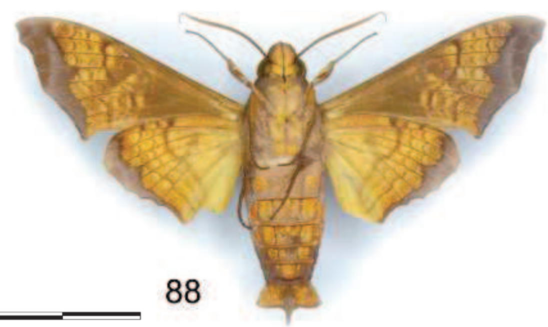
5 cm



88

Figs. 87-88. *Nyceryx coffaeae* (Walker) male, Curepe, MVL, 14 January 1980 (M.J.W. Cock) [MJWC]. **87**, dorsal. **88**, ventral.

from Trinidad from one record, collected near Chatham, southwest Trinidad, by Mary Alkins-Koo.

Chatham: ♂ 7 January 1985 (M. Alkins) [UWIZM. 2014.9.1289] (Figs. 89-90)

29. *Nyceryx riscus* (Schaus, 1890) (Figs. 91, 93-94)

Nyceryx riscus (Schaus): Schreiber (1978), Stradling *et al*. (1983)

Taxonomic issues. Haxaire (2013) reports that there is a significant 3% barcode difference between the Central American and South American populations of *N. riscus*. The South American population may require a new name as *N. riscus* was described from Mexico.

Identification. The reddish brown dorsal forewing with a dark marginal band and the denticulate margin of both wings will separate this species and *N. stuarti* (Rothschild) (below) from other Trinidad hawk-moths. The dark marginal area is angled towards the tornus in *N. stuarti* (Fig. 91), but almost straight in *N. riscus* (Fig. 92).

Status in Trinidad. This species was first reported from Trinidad by Schreiber (1978) and Stradling *et al*. (1983). It is uncommon, but occurs in both suburban and forested areas. There are no records from the south of Trinidad, from where a very similar species, *N. stuarti* is reported below.

30. *Nyceryx stuarti* (Rothschild, 1894) (Figs. 91, 95-97)

Taxonomic issues. This species has not previously been reported from Trinidad. The two specimens reported below were confused with *N. riscus* (above) until I identified them from Haxaire (1996b, 2005) when preparing this catalogue. I have subsequently checked all material in MJWC, NMSE and UWIZM as *N. riscus* without finding additional specimens of *N. stuarti*.

Identification. See under *N. riscus* above.

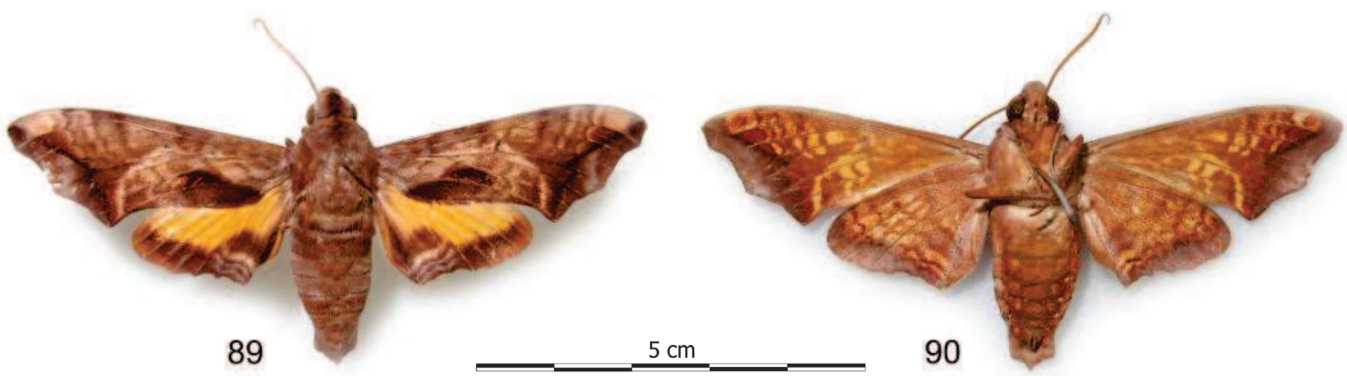
Status in Trinidad. To date, this species in Trinidad is only known from a pair taken at light in Parrylands, February 1980, by the late Julius O. Boos. It seems likely that *N. stuarti* is associated with lowland forest, perhaps restricted to the south or southwest of Trinidad.

31. *Perigonia pallida* Rothschild and Jordan, 1903 (Figs. 98-99)

Perigonia pallida Rothschild and Jordan: Kaye and Lamont (1927)

Perigonia pallida pallida Rothschild and Jordan: Schreiber (1978), Stradling *et al*. (1983)

Identification. This hawk-moth is unlikely to be confused with any other Trinidad species, being recognisable by its small size and the large yellow discal area of the dorsal hindwing.



Figs. 89-90. *Nyceryx maxwelli* (Rothschild) male, Chatham, 7 January 1985 (M. Alkins) [UWIZM]. **89**, dorsal. **90**, ventral.

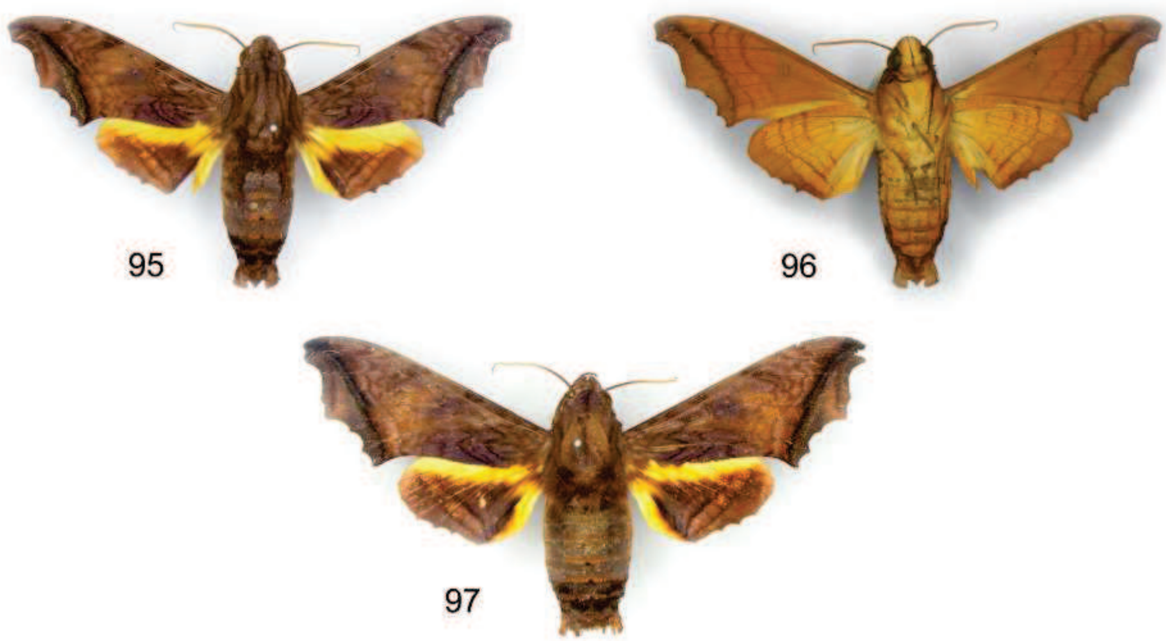
Figs. 91-92. Diagnostic characters for *Nyceryx stuarti* (91) and *N. riscus* (92). (Not to scale)

Status in Trinidad. An uncommon species, only recorded from suburban areas (Port of Spain, Curepe).

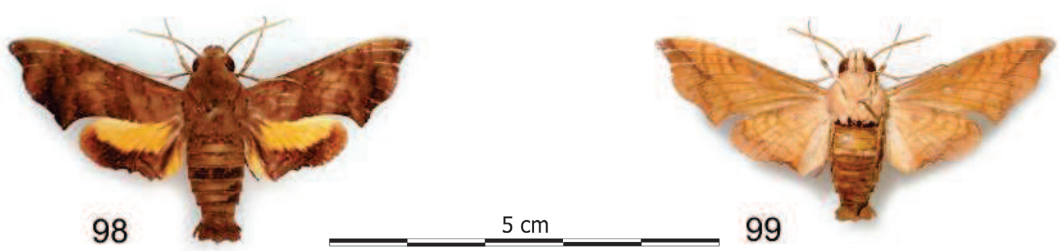
32. *Perigonia lusca lusca* (Fabricius, 1777)
(Figs. 18, 100-103)
Perigonia lusca (Fabricius): Kaye (1914b), Kaye and Lamont (1927)
Perigonia interrupta (Walker): Schreiber (1978), Stradling *et al*. (1983) [synonym]
Perigonia lusca restituta (Walker): Stradling *et al*. (1983) [synonym]
Perigonia lusca tenebrosa (C. Felder and R. Felder): Stradling *et al*. (1983) [synonym]
Perigonia lusca lusca (Fabricius): Cock (2017b)

Taxonomic issues. This is a variable species with several named forms, which have sometimes been treated as subspecies in the Trinidad literature. Here they are treated as a single subspecies which is variable in the extent of yellow dorsal hindwing markings. This interpretation is supported by DNA barcoding (I.J. Kitching pers. comm. 2017).

Figs. 93-94. *Nyceryx riscus* (Schaus) male, Brigand Hill, lighthouse security MVL lights, 28 March 2003 (M.J.W. Cock) [MJWC]. **93**, dorsal. **94**, ventral.



Figs. 95-97. *Nyceryx stuarti* (Rothschild). **95**, male, Parrylands, at light, February 1980 (J.O. Boos) [MJWC]. **96**, as Fig. 95, ventral view. **97**, female, Parrylands, at light, February 1980 (J.O. Boos) [MJWC].



Figs. 98-99. *Perigonia pallida* Rothschild and Jordan male, Curepe, at light, 8 July 1977, D.J. Stradling [UWIZM.2014.9.1408] (photo UWIZM). **98**, dorsal. **99**, ventral.

Identification. This is a fairly distinctive, small species. It might be confused with *Nyceryx coffaeae* (above), under which species differences are highlighted. *Perigonia ilus* Boisduval is a confusingly similar species found on the adjacent mainland that could well occur in Trinidad. It can be most readily distinguished by the dorsum of the ventral hindwing being yellow rather than dull brown as in *P. lusca* (Fig. 103). In preparing this paper, I re-examined 29 specimens previously identified as *P. lusca*, and there were no *P. ilus* amongst them.
Status in Trinidad. A fairly common species found in suburban and forested areas.

33. *Eupyrrhoglossum sagra* (Poey, 1832) (Figs. 104-106)
Eupyrrhoglossum sagra (Poey): Kaye and Lamont (1927), Schreiber (1978), Stradling *et al*. (1983), Cock (2017b)
Identification. This is one of two Trinidad species of hummingbird hawk-moths that have yellow markings on the dorsal hindwing and adjacent thorax, the other being *Aellopos ceculus* (Cramer), which follows. The yellow hindwing markings are narrower in *E. sagra*, the detail of the dorsal forewing markings differ, and the ventral forewing has some areas mottled with orange, whereas that of *A. ceculus* is uniformly dark apart from the white subterminal spot.
Biology in Trinidad. F.D. Bennett has collected *E. sagra* coming to flowers of *Lantana montevidensis* at 18.00 h (Curepe, January 1977), but this species is most often collected when attracted to light.
Status in Trinidad. An uncommon species, with records from suburban and lowland forest areas.

***Aellopos* Hübner, [1819]**
This is a genus of day-flying hummingbird hawk-moths, of which five species have been recorded from Trinidad, but only four are accepted here. The first, *A. ceculus,* has a yellow band on the dorsal hindwing and yellow laterally on the abdomen, while the three remaining confirmed

Figs. 100-103. *Perigonia lusca lusca* (Fabricius). **100**, male, Curepe, MVL, 31 December 1980 (M.J.W. Cock) [MJWC]. **101**, female, Curepe, MVL, 1 June 1979 (M.J.W. Cock) [MJWC]. **102**, female, Curepe, MVL, 4-10 June 1981 (M.J.W. Cock) [MJWC]. **103**, as Fig. 100, ventral view.

Figs. 104-106. *Eupyrrhoglossum sagra* (Poey). **104**, Left, male, Aripo Valley, Rapsey Estate, malaise trap, 14-21 August 1978 (R.M. Baranowski) [MJWC]. **105**, female, Curepe, MVL, 5 September 1978 (M.J.W. Cock) [MJWC]. **106**, as Fig. 105, ventral.

species are dark with a white band on the abdomen: *A. clavipes* (Rothschild and Jordan), *A. titan* (Cramer) and *A. fadus* (Cramer). Records of the fifth species, *A. tantalus* (Linnaeus) (Kaye 1901, Kaye and Lamont 1927), are here considered a misidentification of *A. clavipes*, as discussed below. However, *A. tantalus zonata* (Drury) occurs in the Caribbean as far south as Grenada, and so could turn up in Tobago or Trinidad. Hodges (1971), D'Abrera ([1987]) and Tuttle (2007) present diagnostic characters of the dorsal and ventral forewing surfaces to separate the four species. *Aellopos fadus* and *A. titan* both have on the ventral forewing, a double row of white spots from the inner margin to the cell; they also have an outer band of white spots from the tornus to about two-thirds along costa, single in *A. titan* and partially double in *A. fadus*; further, on the dorsal surface, *A. titan* has a strong dark spot at the end of the cell that is obscure or missing in *A. fadus*. In contrast, *A. tantalus* and *A. clavipes* lack the double row of white spots from the inner margin to the cell, and the outer band is reduced to three irregular spots in M_3-Cu_1 to M_2-M_3 (spaces 3-5), and on the dorsal surface both have a dark spot at the end of the cell. *Aellopos tantalus* and *A. clavipes* can be most readily separated by the presence in *A. clavipes* of two (sometimes one) narrow streaks on the underside in Cu_1-Cu_2 (space 2), although with complete specimens to hand, the swollen foretarsus of *A. clavipes* compared to the normal foretarsus of *A. tantalus* reliably distinguishes the two.

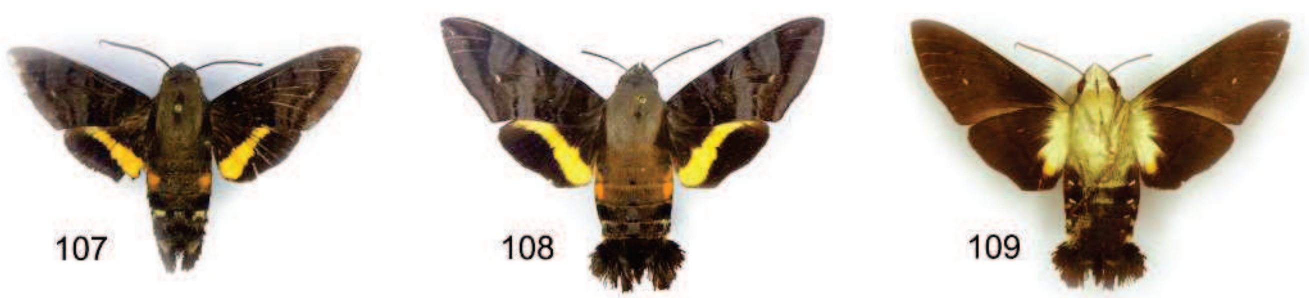
34. *Aellopos ceculus* (Cramer, 1777) (Figs. 19, 107-109)
Eupyrrhoglossum ceculus (Cramer): Kaye (1901, 1914a)
Sesia ceculus (Cramer): Kaye (1914b), Kaye and Lamont (1927), Cary (1951)
Aellopos ceculus (Cramer): Schreiber (1978), Stradling *et al*. (1983), Cock (2017b)

Identification. With its yellow markings, *A. ceculus* can only be confused with *Eupyrrhoglossum sagra*, above, under which differences are discussed.

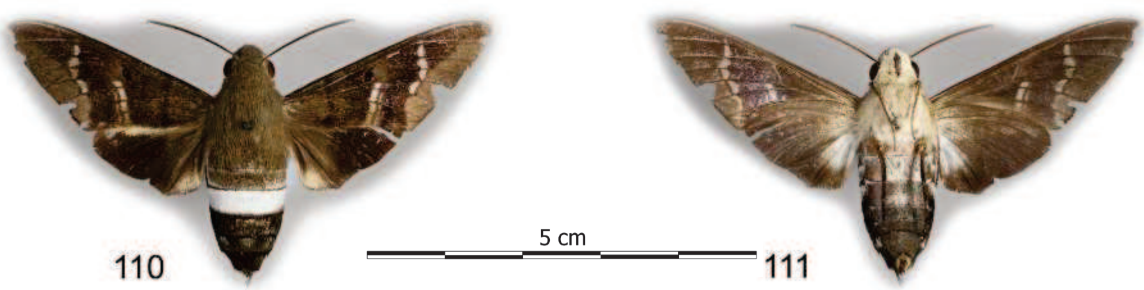
Biology in Trinidad. This is normally a day-flying species, although it comes rarely to light. F.D. Bennett has collected two specimens coming to flowers of *Lantana montevidensis* at 18.00 h (Curepe, January 1977).

Status in Trinidad. An occasional species found in both suburban and forest habitats.

35. *Aellopos clavipes clavipes* (Rothschild and Jordan, 1903) (Figs. 110-111)
Aellopus [*sic*] *sisyphus* (Burmeister): Kaye (1901), Kaye (1914a) [synonym of *A. tantalus*, misidentification]
Sesia tantalus (Linnaeus): Kaye (1914b), Cary (1951) [misidentification]
Sesia tantalus tantalus (Linnaeus): Kaye and Lamont (1927) [misidentification]
Aellopos tantalus (Linnaeus): Schreiber (1978) [assumed misidentification]
Aellopos clavipes clavipes (Rothschild and Jordan): Schreiber (1978), Stradling *et al*. (1983), Kelly (2011), Cock (2017b)



Figs. 107-109. *Aellopos ceculus* (Cramer). **107**, male, Grande Ravine Reserve, (J. Boos) [MJWC]. **108**, female, Curepe, black light trap, 1-20 March 1982 (F.D. Bennett) [MJWC]. **109**, as Fig. 108, ventral view.



Figs. 110-111. *Aellopos clavipes clavipes* (Rothschild and Jordan) female, Fort George, 1000 ft.: January 1922 (F.W. Jackson) [MGCL] (photo R. St Laurent, MGCL). **110**, dorsal. **111**, ventral.

Identification. See under *Aellopos* above.

Status in Trinidad. A rare species, with just one specimen located from Trinidad, although another is known from the Gulf of Paria, 3½ miles offshore (I.J. Kitching pers. comm. 2017). The early records of *A. tantalus* are thought to be misidentifications of *A. clavipes*, as set out in the section on species not recognised from Trinidad. There are two recent photographic records from Tobago (Cock 2017b).

Fort George, 1000 ft. [305 m]: ♀ January 1922 (F.W. [Jackson]) [MGCL] (Figs. 110-111)

36. *Aellopos titan titan* (Cramer, 1777) (Figs. 112-113)

Sesia titan (Cramer): Kaye and Lamont (1927)

Aellopos titan titan (Cramer): Schreiber (1978), Stradling *et al*. (1983)

Identification. See under *Aellopos* above.

Status in Trinidad. Known from just one record, a female captured by Sir Norman Lamont at Morne Diable, 1 July 1917 – not 1918 as stated by Kaye and Lamont (1927).

Morne] Diable: ♀ 1 July 1917 [N. Lamont] [NMSE] (Figs. 112-113)

37. *Aellopos fadus* (Cramer, 1775) (Figs. 114-115)

Sesia fadus (Cramer): Kaye and Lamont (1927), Cary (1951)

Aellopos fadus fadus (Cramer): Schreiber (1978), Stradling *et al*. (1983)

Identification. See under *Aellopos* above. A specimen in Lamont's collection in UWIZM had been misidentified as *A. titan*.

Biology in Trinidad. Usually seen and collected feeding at flowers.

Status in Trinidad. An uncommon species with records from both suburban (Curepe) and forest areas.

Curepe, light trap: ♀ 11 August 1975 (F.D. Bennett) [UWIZM CABI.2161]

Curepe, CIBC Station: ♀ 10 July 1989 (T. Cassie) [UWIZM CABI.2162]

Curepe, malaise trap: ♀ 27 June 1978 [MJWC]

Grande Ravine reserve, at flowers: ♂ September 1977 (J.O. Boos) [MJWC] (Figs. 114-115)

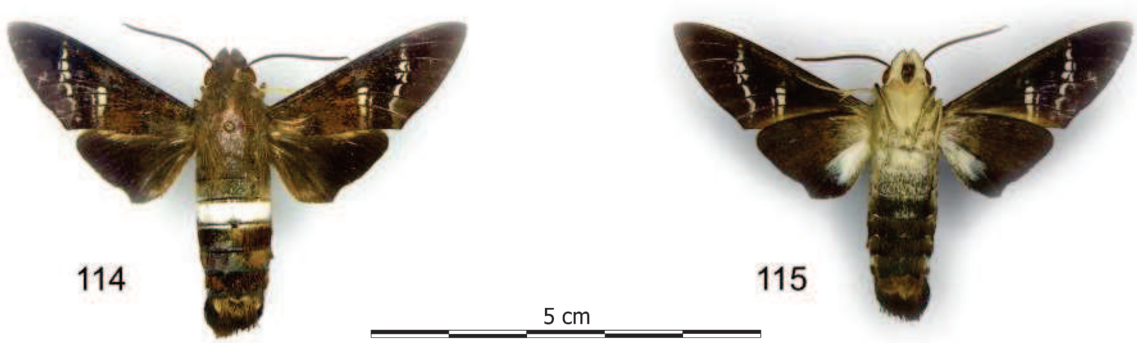
San Fernando: ♀ 20 April 1947 [N. Lamont] [UWIZM.2013.13.2301]

Trinidad: ♂ (Miller coll.) [MGCL]

***Erinnyis* group**

In Trinidad, the *Erinnyis* group of Kawahara *et al*. (2009) comprises *Oryba* (two species), *Pachylioides* Hodges (one species), *Madoryx* Boisduval (three species), *Hemeroplanes* Hübner (one species), *Erinnyis* Hübner (seven species), *Isognathus* C. Felder and R. Felder (two species) and *Pseudosphinx* Burmeister (one species). It is assumed that *Phryxus* Hübner (one species), which Kawahara *et al*. (2009) do not include, also belongs here

Figs. 112-113. *Aellopos titan titan* (Cramer) female, M[orne] Diable, 1 July 1917 [N. Lamont] [NMSE]. **112**, dorsal. **113**, ventral. (Photos A. Whiffin, NMSE).



Figs. 114-115. *Aellopos fadus* (Cramer) male, Gran Ravine reserve, at flowers, September 1977 (J.O. Boos) [MJWC]. **114**, dorsal. **115**, ventral.

given the similarity to *Erinnyis* and *Isognathus*. The inclusion of *Oryba* in the clade is not strongly supported, although the remaining genera seem to be a monophyletic clade, with *Erinnyis*, *Isognathus*, *Pseudosphinx* and *Phryxus* forming a tight group, and so the group is referred to by its most species-rich genus, *Erinnyis*.

Erinnyis, *Isognathus, Phryxus* and *Pseudosphinx* are noteworthy in that the adults rest with their forewings almost parallel with the body, rather than at an acute angle to each other as is the case with the other tribes found in Trinidad. This should help separate images of superficially similar species, apart from *Neococytius cluentius* which also holds its wings almost parallel with the body (Fig. 7).

38. *Oryba kadeni* (Schaufuss, 1870) (Fig. 116)

Oryba kadeni (Schaufuss): Kaye and Lamont (1927), Schreiber (1978), Stradling *et al*. (1983)

Identification. This species might only be confused with *O. achemenides* (Cramer) below. The two are obviously different, as shown in the figures, but this is based on relative width, colour and contrast of the markings, rather than a single diagnostic character. Rothschild and Jordan (1903) highlighted that the distal marginal area of the dorsal forewing is much narrower than the space between this and the discal line beyond the cell in *O. achemenides*, but equally broad in *O. kadeni*. However, they are best separated by the conspicuous narrow green discal band bounded by brown lines or bands on the dorsal hindwing in *O. kadeni* that is missing in *O. achemenides*. There is quite strong sexual dimorphism in *O. kadeni*, along the lines shown for *O. achemenides* (Figs. 117-118), but I have not seen any male *O. kadeni* from Trinidad to illustrate this, although published images from elsewhere are available (Kitching 2017, Oehlke 2017).

Status in Trinidad. A rarely collected species, very occasionally attracted to light. Haxaire (1996a) indicates that adults fly extremely rapidly at dusk, which may reflect why it is seldom collected in Trinidad. The few records to date are from Curepe.

Curepe, MVL: ♀ 21 August 1978 (M.J.W. Cock) [MJWC]

St. Augustine: ? December 1979 (Stradling *et al*. 1983)

South of Valencia, 10.633N 61.195W, mist-netting: ♀ 5 September 2014 (M.G. Rutherford photo) [https://www.inaturalist.org/observations/11142177]

Trinidad: ? (F.W. Urich) (Kaye and Lamont 1927)

39. *Oryba achemenides* (Cramer, 1779) (Figs. 117-118)

Oryba achemenides (Cramer): Kaye and Lamont (1927), Schreiber (1978), Stradling *et al*. (1983), Cock (2017b)

Identification. See under *O. kadeni* above; this is a generally darker species.

Status in Trinidad. An uncommon species in Trinidad and Tobago, with scattered records at light in suburban and forested areas.

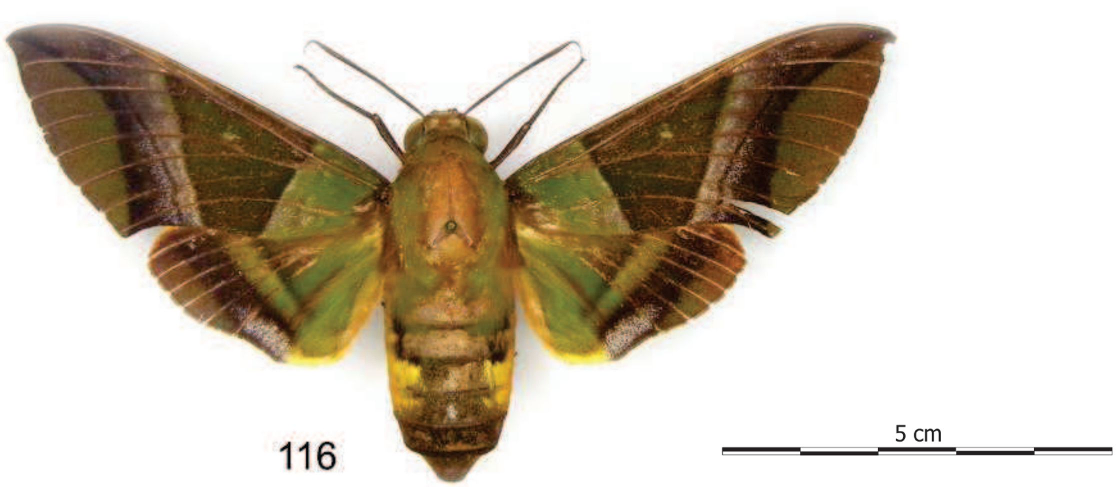
40. *Pachylioides resumens* (Walker, 1856) (Figs. 119-120)

Pachylia resumens Walker: Kaye and Lamont (1927), Cary (1951)

Pachylioides resumens (Walker): Schreiber (1978), Stradling *et al*. (1983), Cock (2017b)

Identification. This species is superficially similar to *Pachylia* spp., but lacks the pale costal marking at the apex of the dorsal forewing of the two Trinidad species.

Status in Trinidad. An occasional species, recorded from both suburban and forested areas.



Figs. 116. *Oryba kadeni* (Schaufuss) female, Curepe, MVL, 21 August 1978 (M.J.W. Cock) [MJWC].

41. *Madoryx oiclus oiclus* (Cramer, 1779)
(Figs. 121-122)

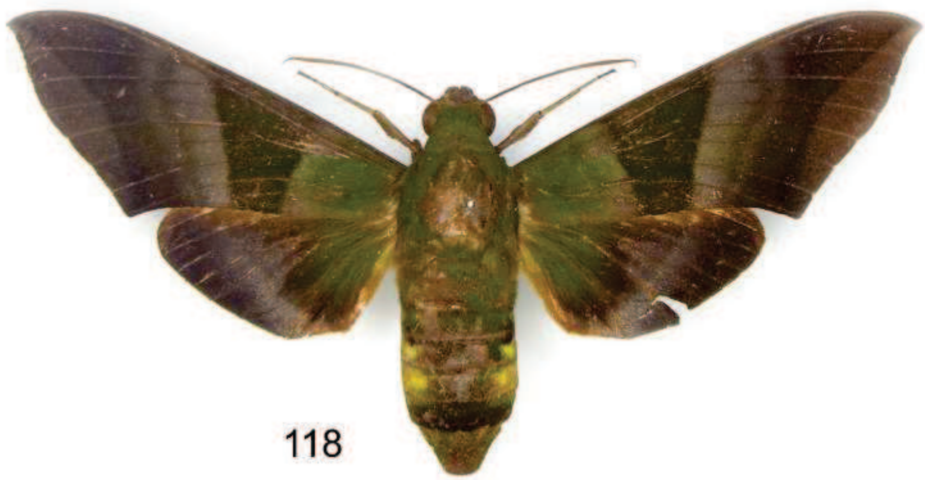
Madoryx oiclus (Cramer): Kaye (1914b), Kaye and Lamont (1927), Cary (1951), Schreiber (1978), Stradling *et al*. (1983), D'Abrera ([1987]), Cock (2017b)

Identification. The two silvery discal spots of the dorsal forewing separate *Madoryx* spp. from other genera in Trinidad. The spot closest to the costa is an elongate angled dash in *M. oiclus* whereas that of *M. plutonius* (Hübner) is reduced to a dot and that of *M. bubastus* (Cramer) is round.

Status in Trinidad. A common species, primarily in suburban situations.

117

Fig. 117. *Oryba achemenides* (Cramer) male, Brigand Hill, lighthouse security MVL lights, 17 January 2004 (M.J.W. Cock) [MJWC].



118

Figs. 118. *Oryba achemenides* (Cramer) female, Curepe, MVL, 31 October 1979 (M.J.W. Cock) [MJWC].

119

Fig. 119. *Pachylioides resumens* (Walker) male, Valsayn Park, at light, 22 September 1978 (M.J.W. Cock) [MJWC].

42. *Madoryx plutonius plutonius* (Hübner, [1819]) (Fig. 123)

Madoryx pluto pluto (Cramer): Schreiber (1978), Stradling *et al*. (1983) [unavailable homonym]

Identification. See under *M. oiclus* above.

Status in Trinidad. A rare species, only recorded from forested areas of the Northern Range.

Cumaca Road, 4.6 miles, MVL: 2♂ 18 July 1981 (M.J.W. Cock) [MJWC; UWIZM CABI.2036]; ♂ 21 October 1982 (M.J.W. Cock) [UWIZM CABI.2037]

Lalaja Ridge, MVL: ♂ 3 September 1982 22.00-24.00h (M.J.W. Cock) [MJWC notes]

43. *Madoryx bubastus bubastus* (Cramer, 1777) (Figs. 124-125)

Madoryx bubastus (Cramer): Kaye (1914b)

Madoryx bubastus bubastus (Cramer): Kaye and Lamont (1927), Cary (1951), Schreiber (1978), Stradling *et al*. (1983)

Identification. See under *M. oiclus* above.

Status in Trinidad. An uncommon species, with records from both suburban and forested areas.

44. *Hemeroplanes triptolemus* (Cramer, 1779) (Figs. 126-127)

Leucorhampha triptolemus (Cramer): Rothschild and Jordan (1903), Kaye (1914b), Kaye and Lamont (1927), Cary (1951)

Hemeroplanes triptolemus (Cramer): Schreiber (1978), Stradling *et al*. (1983), Cock (2017b)

Identification. The elongate white discal spot and the narrow yellow bands on the abdomen should serve to recognise this species.

Status in Trinidad. A fairly common species, primarily recorded from suburban areas.

45. *Phryxus caicus* (Cramer, 1777) (Figs. 128-129)

Phryxus caicus (Cramer): Lamont and Callan (1950), Schreiber (1978), Stradling *et al*. (1983)

Identification. The long white and black line across the

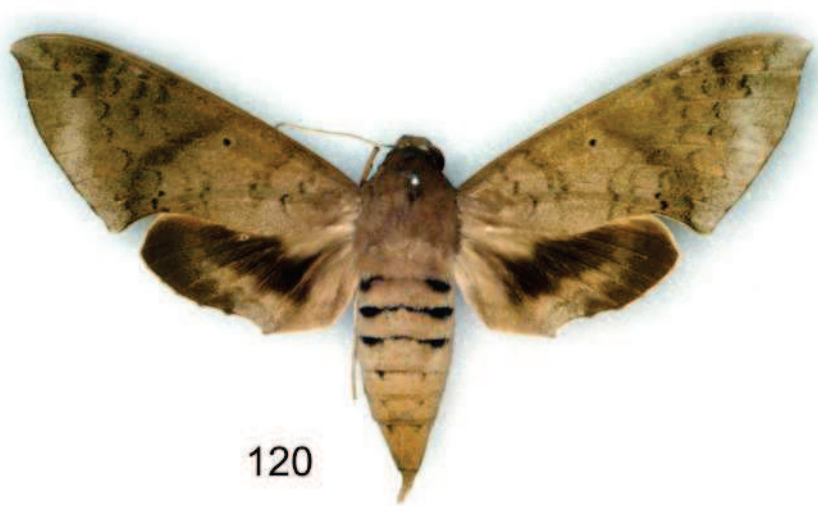


Fig. 120. *Pachylioides resumens* (Walker) female, Fyzabad, April 1917 - June 1918 (R.M. Farmborough) [OUNHM].

Figs. 121-122. *Madoryx oiclus oiclus* (Cramer). **121**, male, Valsayn Park, at light, 4 August 1978 (M.J.W. Cock) [MJWC]. **122**, female, Curepe, BLT, 21-28 February 1982 (F.D. Bennett) [MJWC].

dorsal forewing, orange-brown dorsal hindwing with dark marginal lines along the veins, and black and grey banded abdomen make this a distinctive species.

Status in Trinidad. An uncommon species, recorded from suburban and disturbed areas, but not from primarily forested areas.

***Erinnyis* Hübner, [1819]**

Seven species of *Erinnyis* are recognised from Trinidad. They can be divided into two groups based on the abdominal markings: *Erinnyis alope*, *E. lassauxii* (Boisduval), *E. impunctata* and *E. ello* have the abdomen banded with black and light grey, whereas *E. oenotrus* (Cramer), *E. crameri* (Schaus) and *E. obscura* (Fabricius) have the abdomen uniformly brown. In the first group, *E. alope* has the basal and discal dorsal hindwing yellow, *E. impunctata* and *E. ello* have it dull orange (brighter in female *E. ello*) and *E. lassauxii* has just the basal area orange, almost completed obscured in the typical form (although there is another form of *E. lassauxii* that

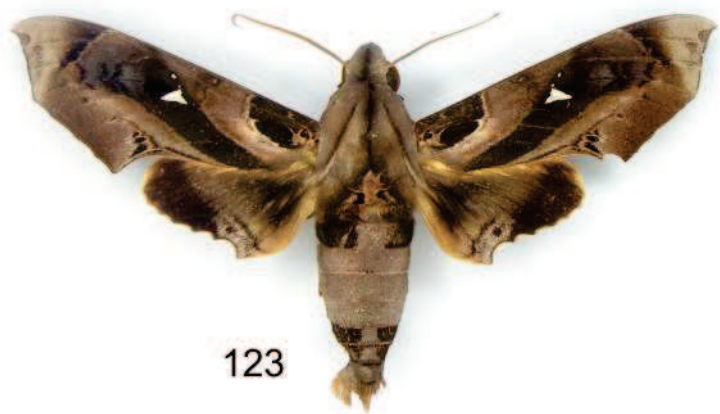
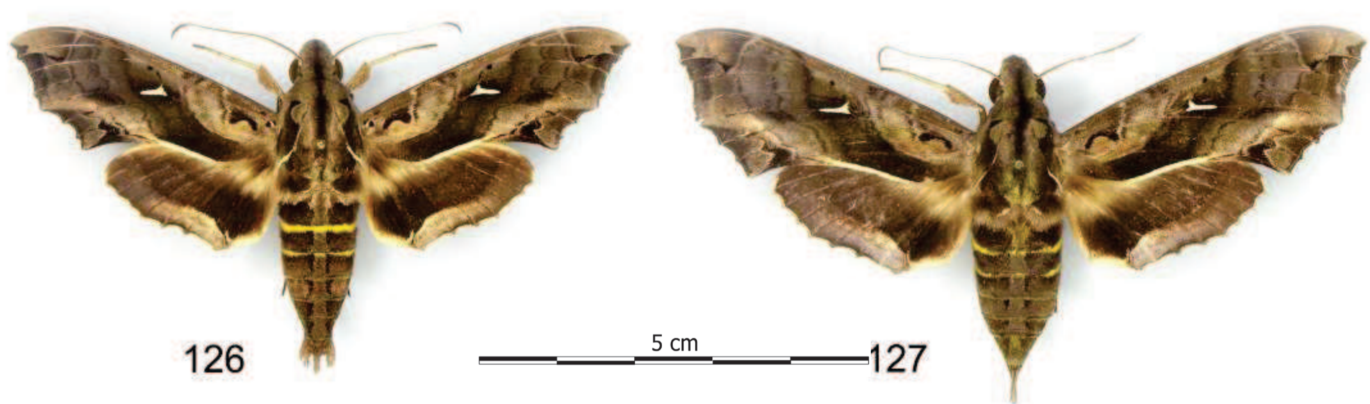


Fig. 123. *Madoryx plutonius plutonius* (Hübner) male, Cumaca Road, 4.6 miles, MVL, 18 July 1981 (M.J.W. Cock) [MJWC].

Figs. 124-125. *Madoryx bubastus bubastus* (Cramer). **124**, male, Parrylands Oilfield, at light, 22 February 1980 (J.O. Boos) [MJWC]. **125**, female, Curepe, MVL, 8-14 December 1981 (M.J.W. Cock) [MJWC].



Figs. 126-127. *Hemeroplanes triptolemus* (Cramer). **126**, male, Curepe, MVL, 9 October 1978 (M.J.W. Cock) [MJWC]. **127**, female, Curepe, MVL, 26 June 1979 (M.J.W. Cock) [MJWC].

closely resembles *E. impunctata* but has not been found in Trinidad); *E. impunctata* and *E. ello* can be separated by the dark brown dorsal forewing of *E. impunctata* (similar to male *E. crameri*), the uniformly pale grey forewing of the female of *E. ello* and the irregular dark streak from base to apex on the grey forewing of male *E. ello*. In the second group, *E. obscura* is much smaller than the others, the forewing reminiscent of male *E. ello*, and the hindwing dull orange, only narrowly darker at the margin; the female of *E. oenotrus* is grey with two darker patches on the costa, the one just before mid-costa extending irregularly to just above tornus; male *E. oenotrus* and both sexes of *E. crameri* resemble each other, but the hindwing margin of *E. oenotrus* is even with a diffuse internal border, whereas that of *E. crameri* is uneven, extending basally along the veins and with a sharp internal border. *Erinnyis* spp. might also be confused with *Isognathus* spp., of which two are known from Trinidad: the common *I. scyron* (Cramer) has similar colouring to *E. alope*, but the wings are broader, and the grey bands on the abdomen are narrower and not interrupted dorsally; the rare *I. caricae* (Linnaeus) has the hindwing yellow, with a minimal dark margin and dark veins extending at least halfway to the base of the wing. Given that several of these diagnostic characters relate to the dorsal hindwing, identification of images of living moths with this feature covered will be more difficult and rely on a careful comparison of the forewing characters. Hence, identification will be facilitated if images are also taken to show the hindwing.

46. *Erinnyis alope alope* (Drury, 1773)
(Figs. 42-44, 130-131)

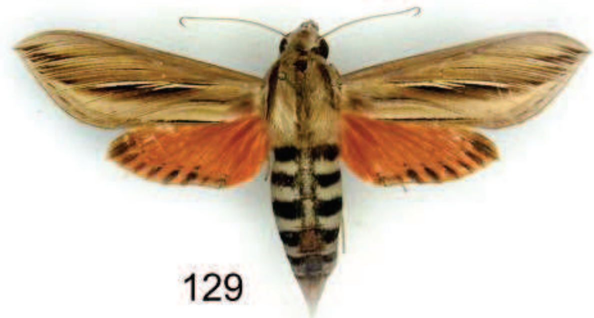
Erinnyis alope (Drury): Kaye and Lamont (1927), Cary (1951), CABI (2002b)

Erinnyis alope alope (Drury): Schreiber (1978), Stradling *et al*. (1983), Cock (2017b)

Biology in Trinidad. Although food plants include papaya, *Carica papaya*, this species has not been reported as a pest in Trinidad.

Identification. See under *Erinnyis* above.

Status in Trinidad. A common species in both suburban and forested areas.



Figs. 128-129. *Phryxus caicus* (Cramer). **128**, male, Curepe, MVL, 22 November 1978 (M.J.W. Cock) [MJWC]. **129**, female, Maraval, 18 June 1977 (J.O. Boos) [MJWC].

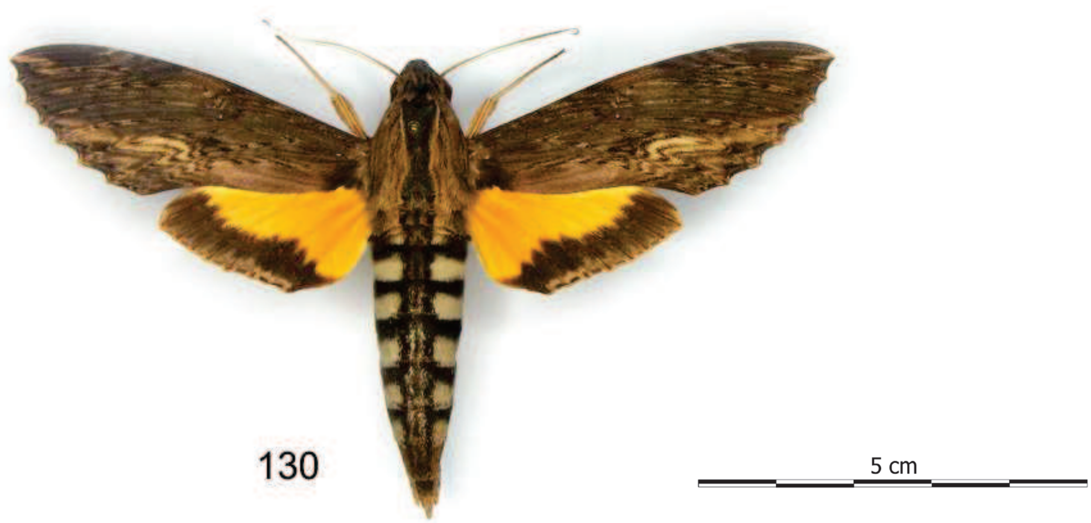


Fig. 130. *Erinnyis alope alope* (Drury) male, Morne Bleu, Textel Installation, at light, 26 July 1978 (M.J.W. Cock) [MJWC].

47. *Erinnyis lassauxii* (Boisduval, 1859) (Figs. 132-134)
Erinnyis lassauxi [*sic*] (Boisduval): Kaye (1914b), Kaye and Lamont (1927)
Erinnyis lassauxi [*sic*] (Boisduval) ssp.: Cary (1951)
Erinnyis lassauxii (Boisduval): Schreiber (1978), Stradling *et al*. (1983), Cock (2017b)

Identification. See under *Erinnyis* above. Three forms of *E. lassauxii* have been recognised (Rothschild and Jordan 1903, D'Abrera [1988]): f. *lassauxii* (dorsal hindwing dark with the orange colour much reduced; Fig. 134), f. *omphaleae* (Boisduval) (dorsal hindwing with extensive orange area and a broad dark margin; Fig. 132) and f. *merianae* Grote (similar to f. *omphaleae*, but the orange more extensive and the dark margin correspondingly narrower). These names have no taxonomic standing, being infra-specific, but they are a useful tool to refer to the forms of a polytypic species . I have seen no specimens of the last-named form from Trinidad. Were f. *merianae* to occur, specimens might be confused with *E. impunctata* below (which Rothschild and Jordan (1903) and D'Abrera [1988] treat as a fourth form of *E. lassauxii*), but *E. impunctata* lacks the dark spots on the ventral surface of the abdomen (Fig. 136), which are found in all forms of *E. lassauxii* (Fig. 133). In the material that I have seen from Trinidad, males of *E. lassauxii* are usually f. *omphalae* (Fig. 132) and females are usually f. *lassauxii* (Fig. 134).

Status in Trinidad. A fairly common species in both suburban and forested areas.

48. *Erinnyis impunctata* Rothschild and Jordan, 1903 (Fig. 135-136)
Erinnyis oenotrus (Cramer): Stradling *et al*. (1983) [partial misidentification, see below]

Taxonomic issues. This species not previously been recorded from Trinidad. When compiling records for this catalogue, two specimens in F.D. Bennett's series of *E. oenotrus* in UWIZM were found. They would have been combined with that species in the Stradling *et al*. (1983) dataset.

Identification. See under *Erinnyis* above. This species

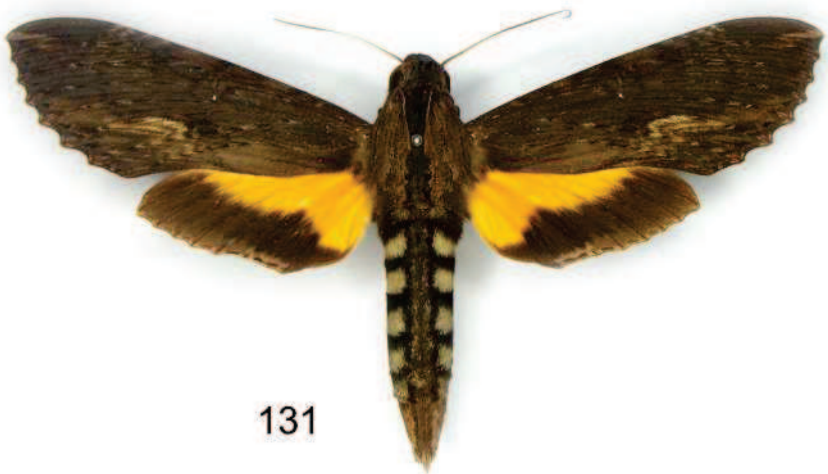


Fig. 131. *Erinnyis alope alope* (Drury) female, Morne Bleu, Textel Installation, at light, 10 August 1978 (M.J.W. Cock) [MJWC].

Figs. 132. *Erinnyis lassauxii* (Boisduval) f. *omphaleae* (Boisduval) male, Morne Bleu, Textel Installation, at light, 29 September 1978 (M.J.W. Cock) [MJWC].

differs from *E. oenotrus* and *E. crameri* in having grey bands on the abdomen, like those of *E. ello*, *E. lassauxii* and some other species of *Erinnyis*. It is closest in appearance to *E. lassauxii* f. *merianae* as noted under that species, but this form has not been reported from Trinidad.

Status in Trinidad. Just two records from Curepe. This seems to be a rare species, but would have been overlooked.

Curepe, MVL: ♂ 1 January 1969 (F.D. Bennett) [UWIZM CABI.1935]; ♂ 12 February 1971 (F.D. Bennett) [UWIZM CABI.1933]

49. *Erinnyis ello ello* (Linnaeus, 1758) (Figs. 137-138)

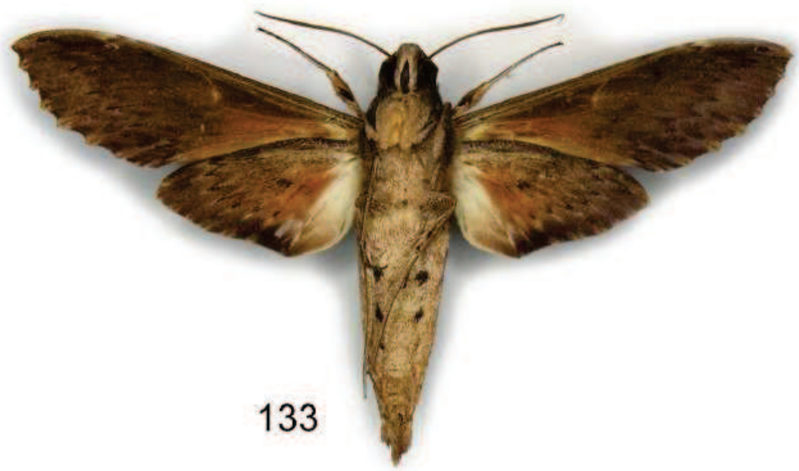
Dilophonota ello (Linnaeus): Kaye (1901), Guppy (1911a, 1911b), Kaye (1914a)

Erinnyis ello (Linnaeus): Rothschild and Jordan (1903), Kaye (1914b), Urich (1915), Kaye and Lamont (1927), Cary (1951), Winder (1976), Des Vignes (1986), CABI (2002a), MFPLMA (2010)

Erinnyis ello ello (Linnaeus): Schreiber (1978), Stradling *et al*. (1983), Cock (2017b)

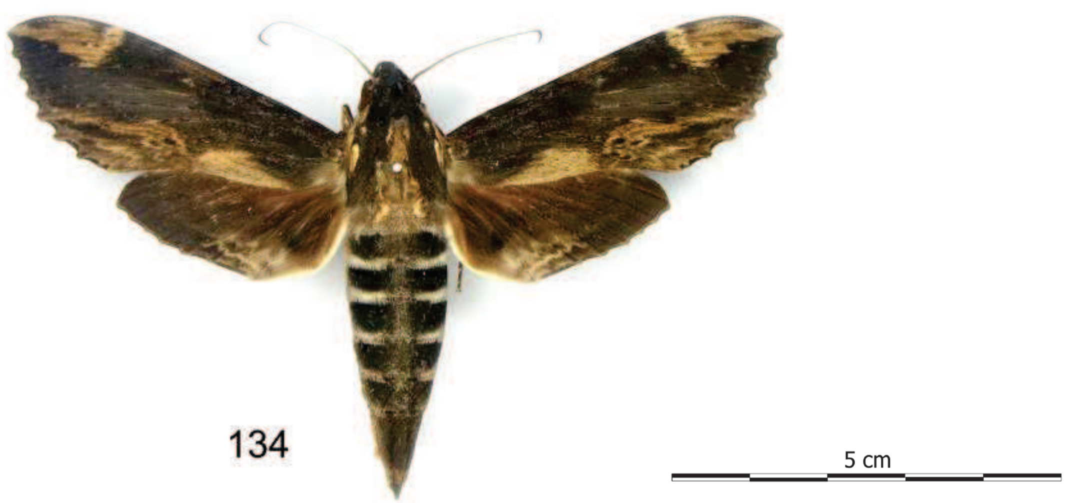
Taxonomic issues. Barcoding of the material reared by Janzen and Hallwachs (2017) suggests that caterpillars of what appears to be *E. ello* reared from *Manilkara chicle* (Sapotaceae) in Costa Rica are a separate species, with matching barcodes from Mexico to the Amazon (Belém) (I.J. Kitching pers. comm. 2017). *Manilkara chicle* does not occur in Trinidad, but *M. bidentata* (known locally as balata) is occasional in Trinidad forests and more common in coastal areas (Hill and Sandwith 1947). It would be worth looking for caterpillars of *E. ello* on this tree in Trinidad, and experimental studies could clarify the status and biology of the two barcode groups.

Biology in Trinidad. In Trinidad, Guppy (1911b) notes caterpillars on rubber and cassava. Urich (1915) notes it as a pest of cassava, usually kept in check by natural enemies: *Telenomus* sp. (Scelionidae) attacking eggs, and at least one species of Microgasterinae parasitic on the caterpillars. Kaye and Lamont (1927) refer to this species as the cassava hawk-moth. In recent decades there have been periodic outbreaks reported on cassava (Des Vignes



133

Fig. 133. *Erinnyis lassauxii* (Boisduval) f. *omphaleae* (Boisduval) male, as Fig. 132, ventral.



134

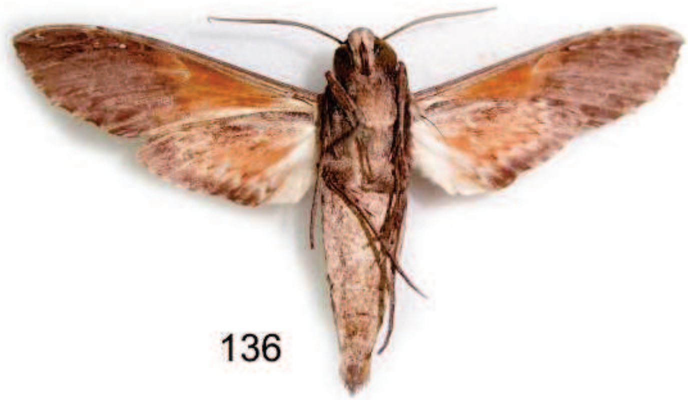
Fig. 134. *Erinnyis lassauxii* (Boisduval) f. *lassauxi* (Boisduval) female, Brigand Hill, lighthouse security MVL lights, 17 January 2004 (M.J.W. Cock) [MJWC].

1986, MFPLMA 2010). While living in Trinidad, 1978-1982, I also observed occasional outbreaks on planted patches of introduced rubber trees, *Hevea brasiliensis* (Euphorbiaceae) at Fishing Pond, Arima Valley (between Simla and Asa Wright), and Southern Main Road (not far from Pitch Lake). These scattered patches of planted rubber trees are not obvious when the trees are mature, as in Arima Valley and on Southern Main Road, and the outbreaks were first noticed because the mature caterpillars had descended to the ground and were walking on the road. It was the popping noise made by inadvertently driving over them that drew the outbreak to my attention – in those days, as was the case with most cars, we did not have air-conditioning!

Identification. See under *Erinnyis* above.

Status in Trinidad. One of the commonest species everywhere, occasionally abundant.

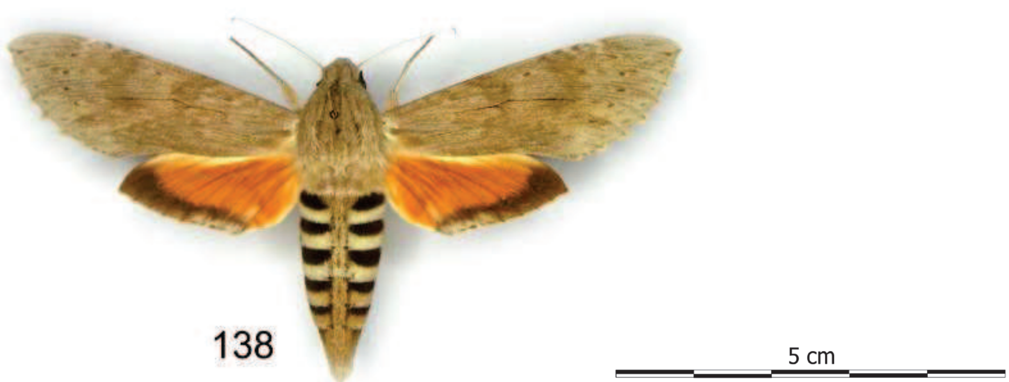

135


136

Figs. 135-136. *Erinnyis impunctata* Rothschild and Jordan male, Curepe, MVL, 12 February 1971 (F.D. Bennett) [UWIZM CABI.1933]. **135**, dorsal. **136**, ventral.


137

Fig. 137. *Erinnyis ello ello* (Linnaeus) male, Morne Bleu, Textel Installation, at light, 26 July 1978 (M.J.W. Cock) [MJWC].



138

Fig. 138. *Erinnyis ello ello* (Linnaeus) female, Curepe, caterpillar on cassava, emerged 28 July 1978 (M.J.W. Cock) [MJWC].

50. *Erinnyis oenotrus* (Cramer, 1780) (Figs. 139-140)
Erinnyis oenotrus (Cramer): Kaye (1914b), Kaye and Lamont (1927), Cary (1951), Schreiber (1978), Stradling *et al*. (1983)
Identification. See under *Erinnyis* above.
Status in Trinidad. A fairly common species, recorded from both suburban and forested areas

51. *Erinnyis crameri* (Schaus, 1898) (Figs. 141-142)
Erinnyis crameri (Schaus): Rothschild and Jordan (1903), Kaye (1914b), Kaye and Lamont (1927), Cary (1951), Schreiber (1978), Stradling *et al*. (1983)
Identification. See under *Erinnyis* above.
Status in Trinidad. A common species in both suburban and forested situations.

52. *Erinnyis obscura obscura* (Fabricius, 1775) (Figs. 143-144)
Erinnyis obscura obscura (Fabricius): Cary (1951), Schreiber (1978), Stradling *et al*. (1983)
Erinnyis domingonis (Butler): Stradling *et al*. (1983) [synonym]
Taxonomic issues. For many years, *E. domingonis* was considered a valid species, resembling *E. obscura* but darker, although doubts had been expressed about its validity (Kitching and Cadiou 2000, Haxaire and Herbin 2000). Tuttle (2007) showed that both species could be reared from the same female and accordingly made *E. domingonis* a junior subjective synonym of *E. obscura*. The name *domingonis* may be useful to refer to the dark form, i.e. *E. obscura* f. *domingonis*. Stradling *et al*. (1983) record two males as *E. domingonis* from 3,767 trap nights in the St. Augustine area, 1969-1977. These specimens are now in NMSE and one is shown here as Fig. 144.
Identification. See under *Erinnyis* above.
Status in Trinidad. A common species in suburban areas, with rather few records from forested areas.

53. *Isognathus scyron* (Cramer, 1780)
(Figs. 22, 45-46, 145-146)
Unnamed caterpillar: Guppy (1893)
Anceryx scyron (Cramer): Kaye (1901), Kaye (1914a)
Isognathus scyron (Cramer): Rothschild and Jordan (1903), Kaye (1914b), Cary (1951), Schreiber (1978), Stradling *et al*. (1983), D'Abrera ([1987])
Identification. See under *Erinnyis* above. There is slight sexual dimorphism: the male has two dark dashes on the discal cell of the dorsal forewing; these are absent in the female, which is darker than the male but has a more

Figs. 139-140. *Erinnyis oenotrus* (Cramer). **139**, male, Morne Bleu, Textel Installation, at light, 3 July 1978 (M.J.W. Cock) [MJWC]. **140**, female, Curepe, MVL, 15 January 1980 (M.J.W. Cock) [MJWC].

Figs. 141-142. *Erinnyis crameri* (Schaus). **141**, male, Morne Bleu, Textel Installation, at light, 26 July 1978 (M.J.W. Cock) [MJWC]. **142**, female, Valsayn Park, at light, 30 June 1978 (M.J.W. Cock) [MJWC].

conspicuous light brown area beyond the end of the cell of the dorsal forewing, and the grey bands on the abdomen are more obvious.

Biology in Trinidad. The caterpillars are a common sight on the introduced ornamental *Allamanda cathartica* (Apocynaceae), often noticed by naturalists and the public.

Status in Trinidad. Very common in suburban areas, but also regularly found in forested areas, indicating that other food plants must also be used.

54. *Isognathus caricae* (Linnaeus, 1758) (Fig. 147)

Isognathus caricae (Linnaeus): Lamont and Callan (1950), Schreiber (1978), Stradling *et al*. (1983)

Identification. See under *Erinnyis* above. The yellow dorsal hindwing with dark veins is unique in Trinidad.

Status in Trinidad. A rare species, with records from Palmiste (Lamont and Callan 1950), and Curepe (Stradling *et al*. 1983).

Curepe, light trap: ♀ 26 September 1969 (F.D. Bennett) [UWIZM CABI.1877]; ♂ 23 July 1977 (D.J. Stradling) [NMSE]

Palmiste: ♀ 22 April 1934 [N. Lamont] [NMSE]; ♀ 25 April 1934 [N. Lamont] [NMSE] (Fig. 148)

55. *Pseudosphinx tetrio* (Linnaeus, 1771) (Figs. 21, 47, 148-149)

Macrospila tetrio (Linnaeus): Caracciolo (1890)

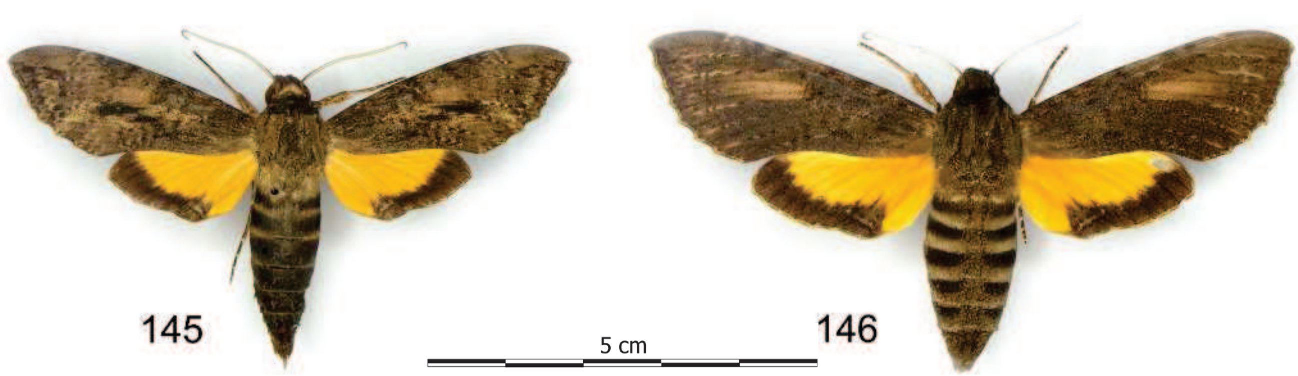
Pseudosphinx tetrio (Linnaeus): Kaye (1901), Rothschild and Jordan (1903), Kaye (1914a, 1914b), Kaye and Lamont (1927), Cary (1951), Schreiber (1978), Stradling *et al*. (1983), Cock (2003, 2008), Cooper and Cooper (2009), Cock (2017b)

Identification. The mottled grey dorsal forewings, dark dorsal hindwings and grey banded abdomen should distinguish this species in Trinidad. There is modest sexual dimorphism: the dorsal forewing markings of males are more contrasting, with an extensive dark area adjacent to the tornus, whereas the larger females are more uniformly pale grey.

Biology in Trinidad. Kaye and Lamont (1927) refer to this species as the frangipani hawk-moth and note that it is a 'constant pest on frangipani (*Plumeria*); the large voracious larvae completely stripping a tree of its leaves in a few days'. Cock (2008) illustrates the early stages in Trinidad and discusses this species in Trinidad and Tobago. The caterpillars in Trinidad have been observed almost exclusively on the naturalised frangipani, *Plumeria rubra* (Apocynaceae), but may also use the garden ornamental *Allamanda cathartica* (Apocynaceae) occasionally.

Status in Trinidad. A fairly common species that could turn up anywhere. Caterpillars are more conspicuous than adults, and more frequently observed by members of the public.

Figs. 143-144. *Erinnyis obscura obscura* (Fabricius). **143**, male, Curepe, MVL, 15 January 1981 (M.J.W. Cock) [MJWC]. **144**, male f. *domingonis*, St. Augustine, at light, February 1977 (D.J. Stradling) [NMSE] (photo A. Whiffin, NMSE).



Figs. 145-146. *Isognathus scyron* (Cramer). **145**, male, Curepe, MVL, September 1978 (M.J.W. Cock) [MJWC]. **146**, female, St. Augustine, from caterpillars on *Allamanda cathartica*, emerged 12 July 1978 (M.J.W. Cock) [MJWC].

***Aleuron* group**

In the Trinidad fauna, *Aleuron* (two species) and *Unzela* (one species) form a small, isolated group that is rarely collected.

56. *Aleuron carinata* (Walker, 1856) (Figs. 150-151)

Aleuron carinata (Walker): Schreiber (1978), Stradling *et al*. (1983)

Identification. A small, rather plain species, generally brown, but with distinctive banding on the anterior part of the abdomen.

Status in Trinidad. A rare species in Trinidad collections with only three records. Haxaire (1992) states that the genus can be caught coming to flowers at dusk (18.45-19.00h in French Guiana) and very rarely come to light, so different collecting methods should show this species to be more common in Trinidad than light trap records indicate.

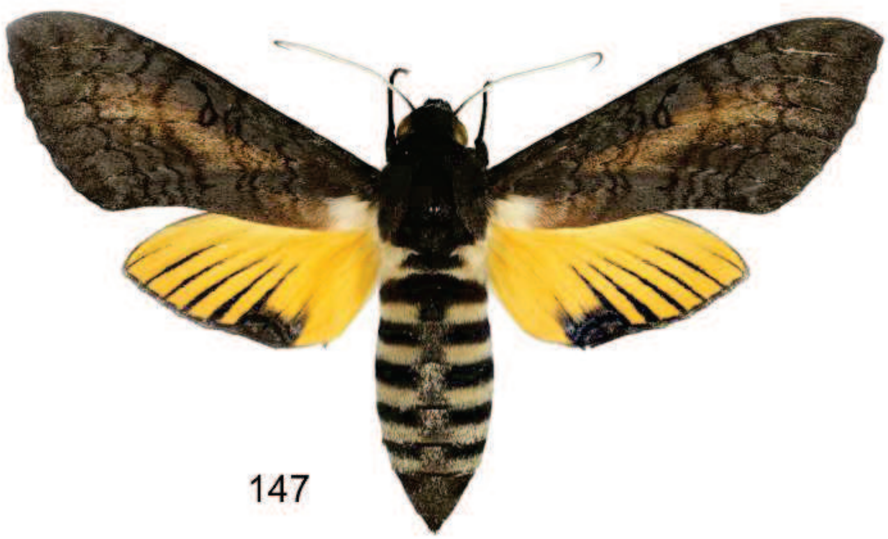
Arima Valley, Asa-Wright Nature Centre: ? 6 October 2017 (tlaloc27, poor photo) [https://www.inaturalist.org/observations/8552081]

Curepe, light trap: ♂ January 1977 (F.D. Bennett) [NHMUK]; ♂ 23 January -10 February 1982 (F.D. Bennett) [MJWC]

57. *Aleuron chloroptera* (Perty, [1833]) (Fig. 152)

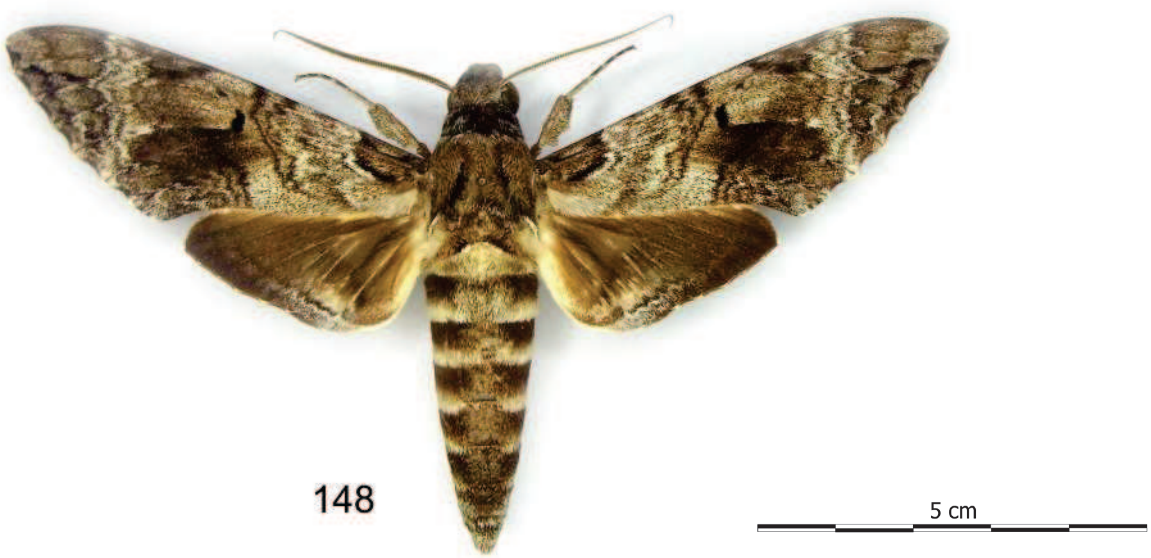
Identification. Th greenish colour of this distinctive small hawk-moth rapidly fades to olive-brown (as in Fig. 152); it has a broad dark margin to the dorsal hindwing, and the forewing is distinctly hooked at mid-termen.

Status in Trinidad. There is just one record of this species from Trinidad. Although this specimen was taken at light, *A. chloroptera* is more likely to be found feeding



147

Fig. 147. *Isognathus caricae* (Linnaeus) female, Palmiste, 25 April 1934 [N. Lamont] [NMSE] (photo A. Whiffin, NMSE).



148

Fig. 148. *Pseudosphinx tetrio* (Linnaeus) male, Morne Bleu, Textel Installation, at light, 26 July 1978 (M.J.W. Cock) [MJWC].

at flowers at dusk or as caterpillars.

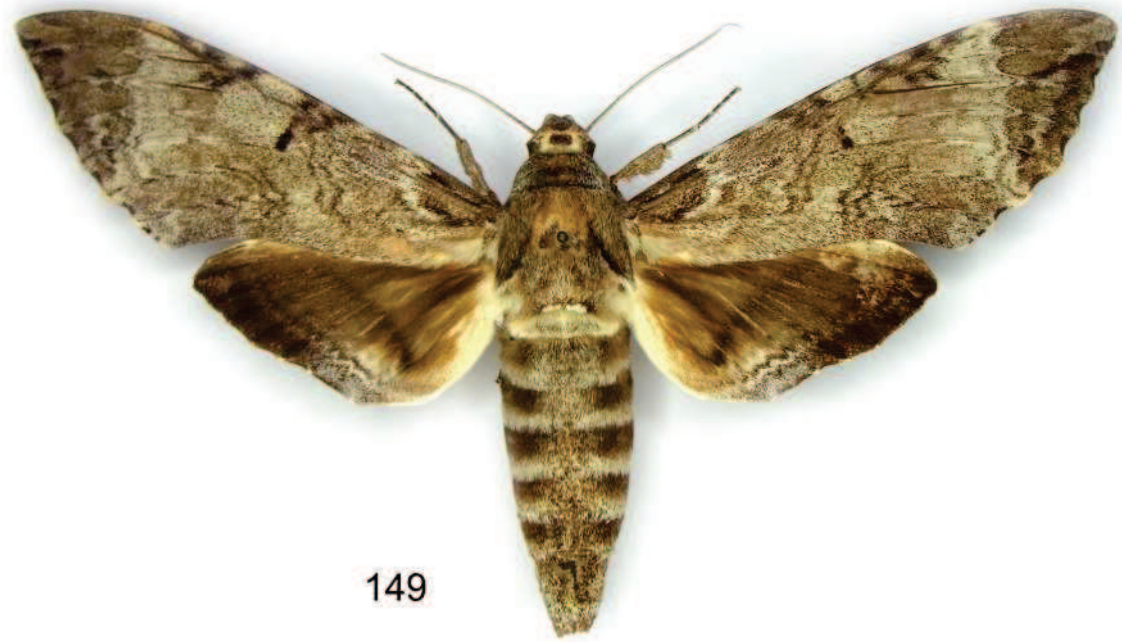
Curepe, black light trap: ♂ 6 September 1976 (F.D. Bennett) [UWIZM CABI.2094]

58. *Unzela japix japix* (Cramer, 1776) (Figs. 153-155)

Enyo japix japix (Cramer): Rothschild and Jordan (1903), Schreiber (1978), Stradling *et al*. (1983)

Identification. The white ventral body, narrow white band on the abdomen and wing markings will all help to recognise this small hawk-moth.

Status in Trinidad. This species has been rarely collected in Trinidad. There is an old, undated specimen in NHMUK,



149

Figs. 149. *Pseudosphinx tetrio* (Linnaeus) female, Port of Spain, 12 July 1978 (W. de Voogd) [MJWC].

150 151

Figs. 150-151. *Aleuron carinata* (Walker) male, Curepe, black light trap, 23 January -10 February 1982 (F.D. Bennett) [MJWC]. **150**, dorsal. **151**, ventral.

152

Fig. 152. *Aleuron chloroptera* (Perty) male, Curepe, black light trap, 6 September 1976 (F.D. Bennett) [UWIZM].

and recently one was photographed attracted to light in the Arima Valley.

Arima Valley, Asa Wright Nature Centre: ?♂ 22 March 2015 (S. Nanz photo , http://www.stevenanz.com/Main_Directory/Trips/2015_Trinidad_Tobago/Trinidad_Tobago_Leps/source/img_3286.htm) (Figs. 153-155).

Trinidad: ♂ [NHM]

Subfamily: Macroglossinae
Tribe: Dilophonotini
Subtribe Philampelina

Based on the phyllogentic tree in Kawahara *et al*. (2009, Figure 3), this subtribe comprises two groups: the *Enyo* and *Eumorpha* group (three species of *Enyo* and nine of *Eumorpha* Hübner), and the *Pachygonidia* group (one species of *Pachygonidia*).

***Enyo* – *Eumorpha* group**

The three Trinidad species of *Enyo* form a weakly supported group with *Eumorpha*.

59. *Enyo lugubris lugubris* (Linnaeus, 1771) (Figs. 156-158)

Enyo lugubris (Linnaeus): Kaye (1901), Kaye (1914a), Cock and Boos (2007)

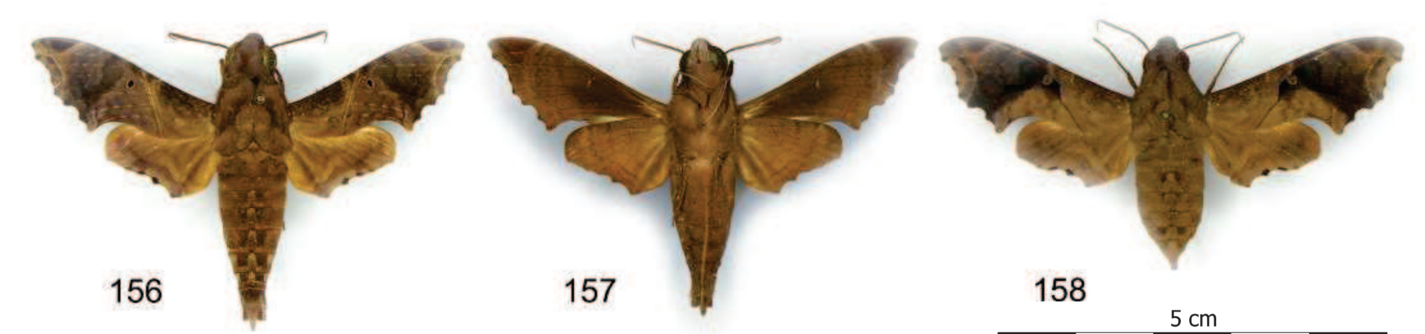
Epistor lugubris lugubris (Linnaeus): Rothschild and Jordan (1903), Kaye and Lamont (1927)

Epistor lugubris (Linnaeus): Kaye (1914b), Cary (1951)

Enyo lugubris lugubris (Linnaeus): Schreiber (1978), Stradling *et al*. (1983)

Identification. A sexually dimorphic species. The male might only be mistaken for *E. ocypete* (Linnaeus) (below), but that species has a very conspicuous yellow-white patch on the dorsal hindwing dorsum that is absent in *E. lugubris*. However, this feature is not visible in images of the living moths, and the discal spot at the end of the cell should be examined – dark in *E. lugubris*, faint or pale in *E. ocypete*. The female of *E. lugubris* is less colourful than that of *E. ocypete*, and the dorsal forewing discal line extends to the dorsum as a weakly distinguished line, whereas in *E. ocypete* it extends to the dorsum as the sharply contrasting inner border of a broad dark band.

Figs. 153-155. *Enyo japix japix* (Cramer), Arima Valley, Asa Wright Nature Centre, 22 March 2015 (photos S. Nanz). **153**, dorsal view. **154**, lateral view. **155**, ventral view. (Not to scale)



Figs. 156-158. *Enyo lugubris lugubris* (Linnaeus). **156**, male, Curepe, MVL, 23 May 1979 (M.J.W. Cock) [MJWC]. **157**, as Fig. 156, ventral view. **158**, female, Curepe, MVL, 20 September 1978 (M.J.W. Cock) [MJWC].

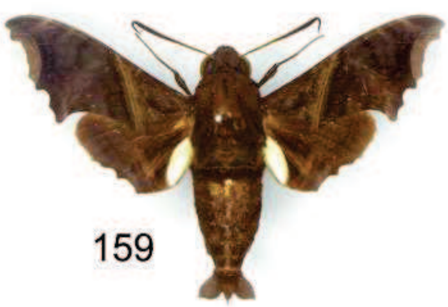
Status in Trinidad. A common species almost exclusively found in suburban areas.

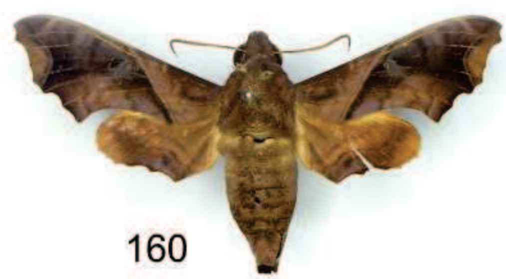
60. *Enyo ocypete* (Linnaeus, 1758) (Figs. 23, 159-160)
Enyo ocypete (Linnaeus): Schreiber (1978), Stradling *et al*. (1983), Cock (2017b)
Identification. A strongly sexually dimorphic species. Diagnostic features to distinguish *E. ocypete* from *E. lugubris* are discussed under that species.
Status in Trinidad. Not as common as *E. lugubris* in Trinidad, but *E. ocypete* is also a common species. It is found in both suburban and lowland forested areas.

61. *Enyo gorgon* (Cramer, 1777) (Figs. 161-162)
Enyo gorgon (Cramer): Kaye (1901), Kaye (1914a)
Epistor gorgon (Cramer): Rothschild and Jordan (1903), Kaye (1914b), Kaye and Lamont (1927)
Epistor gorgon gorgon (Cramer): Schreiber (1978), Stradling *et al*. (1983)
Identification. A strongly sexually dimorphic species. The male is distinctive due to the arrangement of three shades of brown on the dorsal forewing, and the bulging costa. The female superficially resembles those of other members of the genus, but the contrasting shades of brown and the distinct discal eye spot of the dorsal forewing make it easily recognisable.

Status in Trinidad. An uncommon species in Trinidad, with all records from suburban areas.

***Eumorpha* Hübner, [1807]**
This genus has nine Trinidad species. It was previously been placed in a separate tribe Philampelini, but is clearly nested within Dilophonotini in Kawahara *et al*.'s (2009) phylogeny. Ponce *et al*. (2015) discuss the phylogeny of the genus and the development of a dorsal posterior eye spot on the caterpillars, grouping species into six provisional groups (referred to as clades I–VI). Their phylogeny indicates that *E. phorbas* (Cramer), *E. capronnieri* (Boisduval) and *E. labruscae* form the basal clade I of the genus, although the inclusion of the last-named is not strongly supported. The remaining Trinidad species form two groups based on adult markings, *E. vitis* and *E. fasciatus* in one and the remaining species, *E. obliquus* (Rothschild and Jordan), *E. megaeacus* (Hübner), *E. satellitia* and *E. anchemolus* (Cramer) in the other. However, the phylogeny of Ponce *et al*. (2015) indicates that although the last two species are very close, the others are spread across separate clades that do not match adult markings; thus, *E. fasciatus* and *E. megaeacus* are in clade IV whereas *E. vitis* is in clade VII with *E. anchemolus*, while *E. obliquus* is in clade II and *E. satellitia* in clade VI.





Figs. 159-160. *Enyo ocypete* (Linnaeus). **159**, male, Curepe, MVL, 19 January 1980 (M.J.W. Cock) [MJWC]. **160**, female, Curepe, MVL, 15 September 1979 (M.J.W. Cock) [MJWC].

5 cm

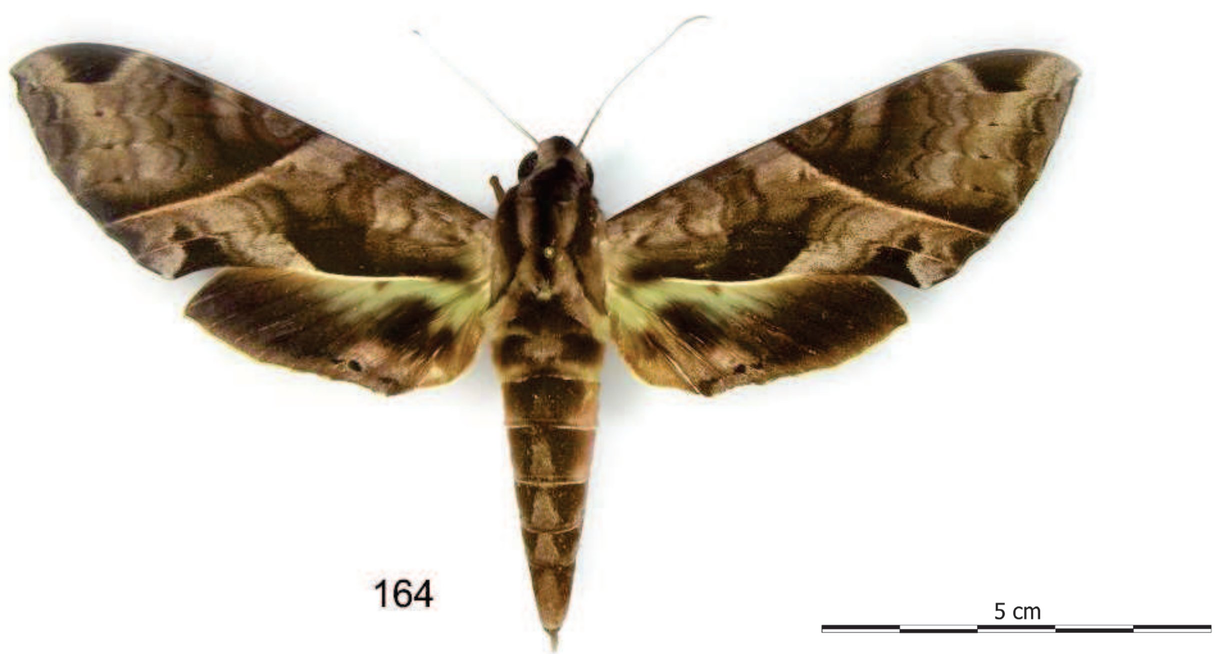
Figs. 161-162. *Enyo gorgon* (Cramer). **161**, male, Valsayn Park, at light, 3 August 1979 (M.J.W. Cock) [MJWC]. **162**, female, Curepe, light trap, 20 July 1970 (F.D. Bennett) [UWIZM CABI.4777] (photo UWIZM).

62. *Eumorpha anchemolus* (Cramer, 1779)
(Figs. 26, 163-164)
Pholus anchemolus (Cramer): Rothschild and Jordan (1903), Kaye (1914b), Kaye and Lamont (1927)
Eumorpha anchemolus (Cramer): Cary (1951)
Eumorpha anchemola [*sic*] (Cramer): Schreiber (1978), Stradling *et al*. (1983), D'Abrera ([1987])
Eumorpha triangulum (Rothschild and Jordan): Cock (2003) [misidentification]

Identification. The first four species of *Eumorpha* treated here are all rather similar: *E. anchemolus*, *E. satellitia*, *E. obliquus* and *E. megaeacus*. *Eumorpha anchemolus* and *E. obliquus* are distinctly larger than *E. satellitia* and *E. megaeacus* (which is not helpful when working from an image with no scale). Characters of the dorsal forewing can be used as follows to separate the four species. There is a darker area running from the base of the forewing along the dorsum to about the mid-point where it either ends in a sharply demarcated, pointed wedge (*E. satellitia*, *E. obliquus*, *E. megaeacus*), or a diffuse area spreading further into the forewing disc (*E. anchemolus*). In *E. satellitia*, the basal side of this wedge is also sharply demarcated and pointed, in *E. obliquus*, a dark subdiscal line runs from the upper inner corner of the wedge to the


163

Fig. 163. *Eumorpha anchemolus* (Cramer) male, Morne Bleu, Textel Installation, at light, 20 August 1978 (M.J.W. Cock) [MJWC].


164

5 cm

Figs. 164. *Eumorpha anchemolus* (Cramer) female, Brigand Hill, lighthouse security MVL lights, 25 March 2003 (M.J.W. Cock) [MJWC].

costa, and in *E. megaeacus* the basal side of the wedge is barely differentiated from the wedge and forms part of a continuous dark band from the base of the forewing to the end of the wedge, the band being sharply demarcated by a pale stripe above it from the base of the wing.

Males of *E. anchemolus* from Trinidad generally have a reddish tone (Fig. 163), whereas the three females examined lack this (Fig. 164). Cock (2003) misidentified two females from Brigand Hill as *E. triangulum*. *Eumorpha anchemolus* and *E. triangulum* can be separated by the shape of the subapical costal patch on the forewing upperside: in *E. anchemolus* this is cut off by Rs4 (vein 6), making it quadrate as in *E. satellitia* and the other species, whereas in *E. triangulum* the inner, basal corner is elongated downwards across about half the wing width (Kitching 2017).

Status in Trinidad. An occasional species in Trinidad, rarely found in suburban areas and normally found in forested areas, most commonly at Morne Bleu.

63. *Eumorpha satellitia* (Linnaeus, 1771) *licaon* (Cramer, 1775) (Figs. 24, 165)

Pholus satellitia licaon (Cramer): Kaye (1914b), Kaye and Lamont (1927)

Pholus satellitia lichaon [*sic*] (Cramer): Cary (1951)

Eumorpha satellitia satellitia (Linnaeus): Schreiber (1978), Stradling *et al*. (1983) [Jamaican subspecies]

Eumorpha satellitia licaon (Cramer): Cock (2017b)

Identification. See under *E. anchemolus* (above).

Status in Trinidad. A rather common and widespread species in Trinidad, more frequent in forested areas than suburban areas

64. *Eumorpha obliquus* (Rothschild and Jordan, 1903) (Figs. 166-167)

Pholus obliquus Rothschild and Jordan: Kaye and Lamont (1927)

Eumorpha obliquus (Rothschild and Jordan): Cary (1951), Cock (2017b)

Eumorpha obliquus obliquus (Rothschild and Jordan): Schreiber (1978), Stradling *et al*. (1983)

Taxonomic issues. Kitching & Cadiou (2000) treated *E. obliquus* as having three subspecies, but Eitschberger (2011) raised *E. orientis* (Daniel) and *E. guadelupensis* (Chalumeau & Delplanque) to species level, leaving *E. obliquus* with no subspecies.

Identification. See under *E. anchemolus* (above).

Status in Trinidad. An uncommon species in Trinidad, recorded from Morne Bleu and Curepe, but rare in suburban areas.

65. *Eumorpha megaeacus* (Hübner, [1819]) (Fig. 168)

Eumorpha eacus (Cramer): Stradling *et al*. (1983) [unavailable homonym]

Identification. See under *E. anchemolus* (above).

Status in Trinidad. A rare species in Trinidad with just two records. The food plants are particular species of *Ludwigia* spp. (Onagraceae) (Appendix Table 1). Janzen & Hallwachs (2017) found it almost entirely on *L. leptocarpa* and *L. octovalvis*, rather than other *Ludwigia* spp. in Costa Rica. These two species are particularly associated with freshwater swamps and riparian habitats (CABI 2015, University of Florida 2017), which are under-collected habitats in Trinidad, and may explain why there are not more records of *E. megaeacus*.

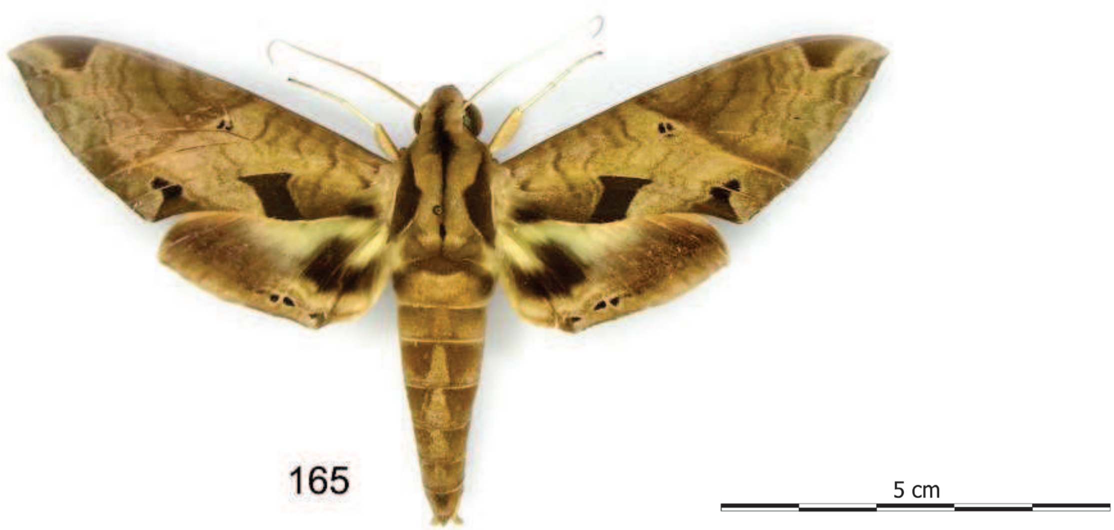


Fig. 165. *Eumorpha satellitia licaon* (Cramer) male, Morne Bleu, Textel Installation, at light, 26 July 1978 (M.J.W. Cock) [MJWC].

Cushe Village, Cunapo Southern Main Road, approximately mid-way between Biche and Rio Claro: ?♀ 14 September 2017 (K. Mahabir photo)

Hollis Reservoir, at pump house lights: ♂ 2200-2300 h 5 September 1978 (M.J.W. Cock) [MJWC]

66. *Eumorpha vitis vitis* (Linnaeus, 1758) (Figs. 25, 169)

Pholus vitis vitis (Linnaeus): Kaye and Lamont (1927)

Eumorpha vitis vitis (Linnaeus): Cary (1951), Schreiber (1978), Stradling *et al*. (1983), Cock (2017b)

Identification. The broad white stripe from the base (or near) to the apex of the dorsal forewing separates *E. vitis*, *E. fasciatus* and *Hyles lineata* (below) from other Trinidad hawk-moths. Both *Eumorpha* spp. have an additional transverse stripe from mid-dorsum to costa, just before apex. The margin of the dorsal hindwing is broadly pink in *E. fasciatus* and narrowly pale brown in *E. vitis* making these species easy to separate. However, when this character is not visible in images of living moths, they can be separated by the double discal spot in *E. vitis*,

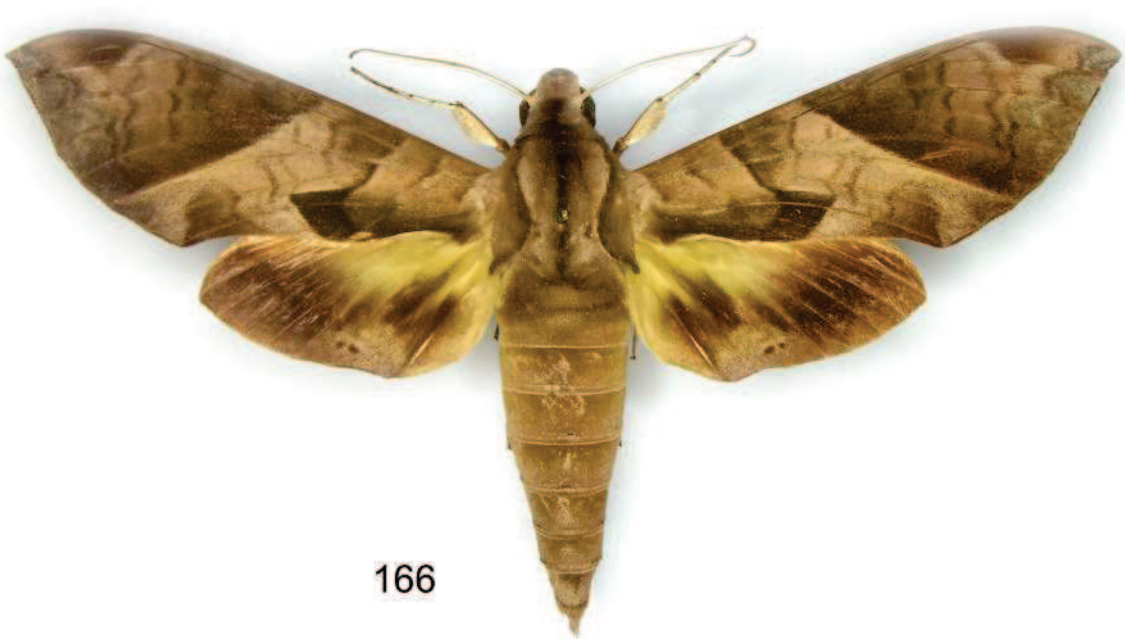
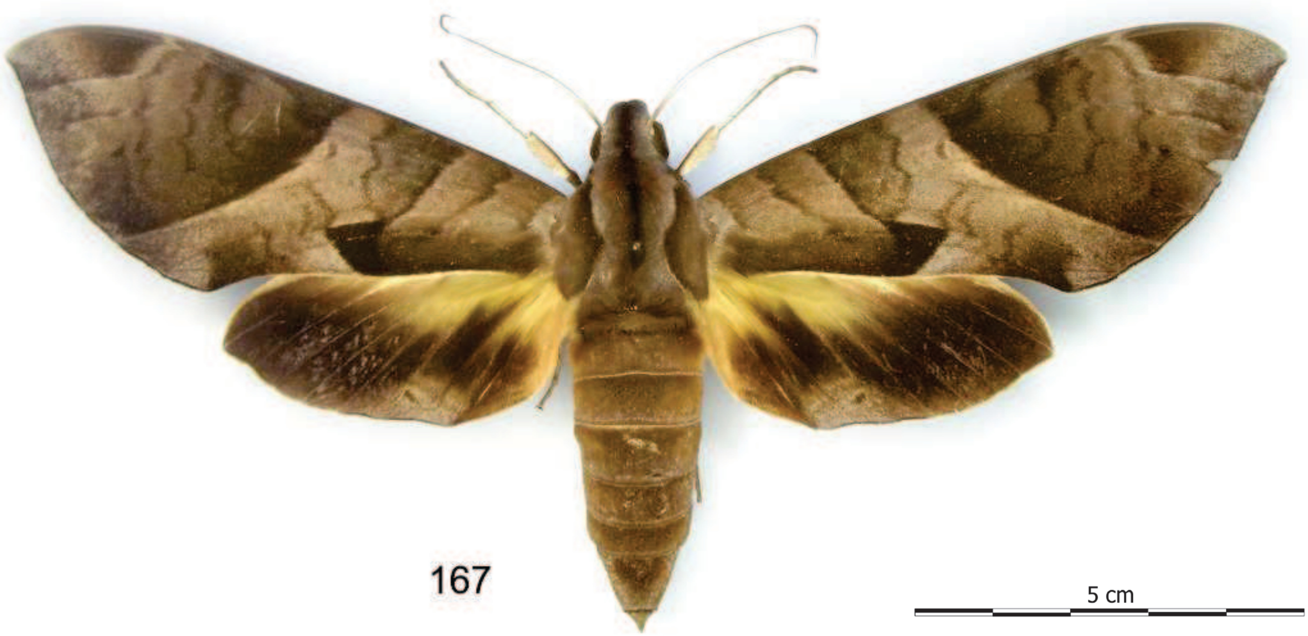


Fig. 166. *Eumorpha obliquus* (Rothschild and Jordan) male, Morne Bleu, Textel Installation, at light, 27 August 1978 (M.J.W. Cock) [MJWC].



Figs. 167. *Eumorpha obliquus* (Rothschild and Jordan) female, Morne Bleu, Textel Installation, at light, 13 September 1978 (M.J.W. Cock) [MJWC].

which is single in *E. fasciatus*, and by the narrow, pale line from just before mid-dorsum to the main white stripe at right angles to the dorsum in *E. fasciatus* and the less well marked, broader, double line in the same area, but nearer the wing base and at an angle to the dorsum in *E. vitis*.

Status in Trinidad. A common species, particularly in suburban and disturbed areas.

67. *Eumorpha fasciatus fasciatus* (Sulzer, 1776) (Figs. 27, 170)

Pholus fasciatus (Sulzer) (*vitis*): Kaye (1914b),

Pholus fasciatus (Sulzer): Kaye and Lamont (1927)

Eumorpha fasciata fasciata [*sic*] (Sulzer): Schreiber (1978), Stradling *et al*. (1983)

Identification. See under *E. vitis* above.

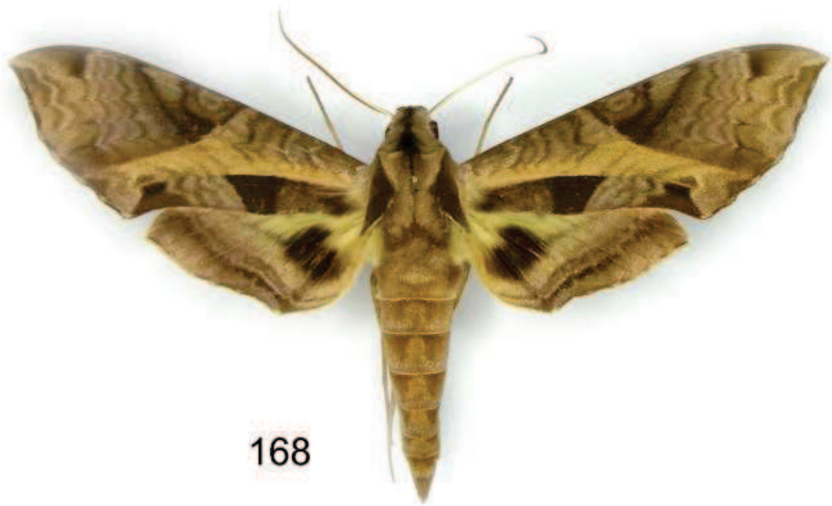


Fig. 168. *Eumorpha megaeacus* (Hübner) male, Hollis Reservoir, at pump house lights, 22.00-23.00h 5 September 1978 (M.J.W. Cock) [MJWC].

Fig. 169. *Eumorpha vitis vitis* (Linnaeus, 1758) male, St. Augustine, MVL trap, 10 August 1978 (F.D. Bennett) [MJWC].

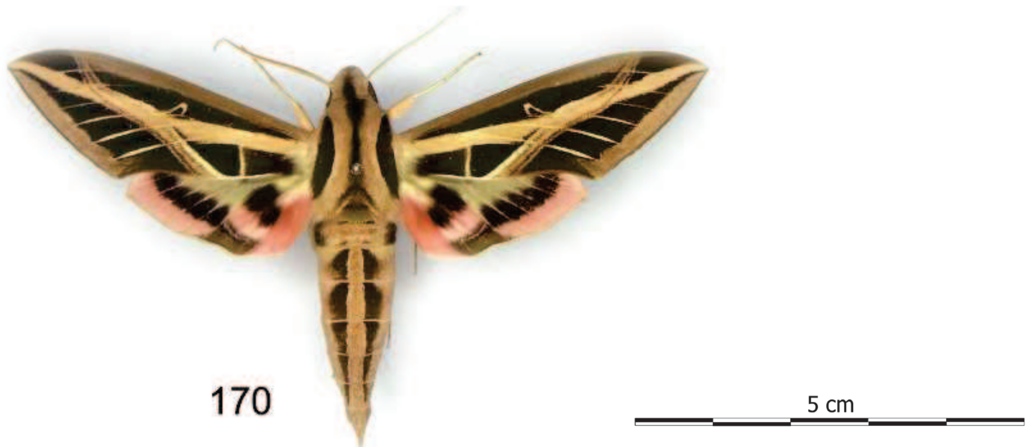


Fig. 170. *Eumorpha fasciatus fasciatus* (Sulzer) male, Curepe, MVL, 28 December 1979 (M.J.W. Cock) [MJWC].

Status in Trinidad. An occasional species, recorded from suburban and disturbed areas, but not forests.

68. *Eumorpha phorbas* (Cramer, 1775) (Fig. 171)
Pholus phorbas (Cramer): Rothschild and Jordan (1903), Kaye (1914b), Kaye and Lamont (1927)
Eumorpha phorbas (Cramer): Schreiber (1978), Stradling *et al*. (1983)
Identification. The mottled dark green dorsal forewing should serve to recognise this species. *Eumorpha capronnieri* is similar in markings, but most of the forewing is pale brown. *Eumorpha labruscae* is uniformly green, but lighter in colour and with straight discal lines across the wing, and a small brown patch centrally; when the hindwings are visible, the unusual blue markings are very distinctive.
Status in Trinidad. A fairly common species in all forested areas, but rare in suburban areas.

69. *Eumorpha capronnieri* (Boisduval, [1875]) (Figs. 28, 172)
Pholus capronnieri (Boisduval): Kaye and Lamont (1927)
Eumorpha capronnieri (Boisduval): Schreiber (1978), Stradling *et al*. (1983), Cock (2017b)
Identification. The brown and green dorsal forewings are very distinctive.
Status in Trinidad. An occasional species in forested areas.

70. *Eumorpha labruscae* (Linnaeus, 1758) (Figs. 29, 173)
Pholus labruscae (Linnaeus): Kaye (1914b), Kaye and Lamont (1927), Cruttwell (1974)
Eumorpha labruscae labruscae (Linnaeus): Schreiber (1978), Stradling *et al*. (1983)
Taxonomic issues. Kitching & Cadiou (2000) included a subspecies from Galapagos, but this is sunk by Kitching (2017).
Identification. The red, yellow and blue markings of the

Fig. 171. *Eumorpha phorbas* (Cramer) male, Morne Bleu, Textel Installation, at light, 10 August 1979 (M.J.W. Cock) [MJWC].

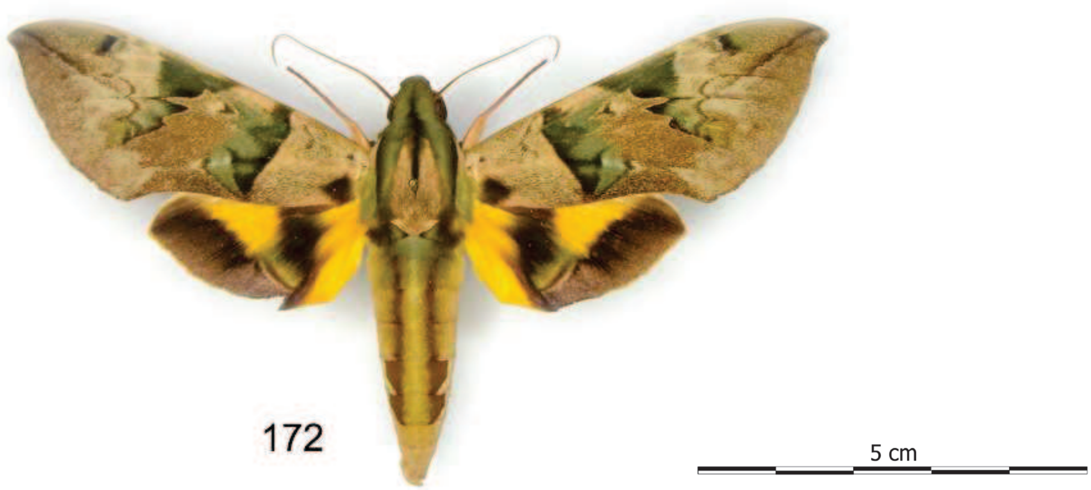


Fig. 172. *Eumorpha capronnieri* (Boisduval) male, Rio Claro-Guayaguayare Road, milestone 6.5, MVL, 30 September 1978 (M.J.W. Cock) [MJWC].

dorsal hindwings are very unusual, but the rather uniform green dorsal forewing with straight discal lines is also distinctive.

Status in Trinidad. A common species in Stradling *et al*.'s (1983) study, but it seems to have been much less common in subsequent years. Most records are from suburban areas.

Pachygonidia group

This genus, with one record of one confirmed Trinidad species forms a separate group, most closely related to several Old World genera (Kawahara *et al.* 2009, Fig. 3).

71. *Pachygonidia caliginosa* (Boisduval, 1870) (Fig. 174)
Pachygonia [*sic*] *caliginosa* (Boisduval): Schreiber (1978), Stradling *et al*. (1983)
There is a specimen in Lamont's collection in UWIZM with no data, erroneously labelled *Eupyrrhoglossum sagra* (Poey). It is probably a Trinidad specimen, taken by Lamont prior to 1915, most likely at Palmiste (I have observed that material of this vintage from Palmiste listed by Kaye and Lamont (1927) is unlabelled in UWIZM).

Identification. This medium sized, brown species, with two discal lines on the dorsal hindwing can only be confused with *P. subhamata* (Walker), which has the apex of the forewings truncate rather than falcate. *Pachygonidia subhamata* is recorded from Trinidad by Schreiber (1978) but I have not seen any specimens.

Status in Trinidad. Just one poorly documented record from early last century. This is another genus that flies at dusk (and probably also dawn) and is best captured at flowers (Haxaire 1996b).

[Palmiste]: ♀ undated [N. Lamont] [UWIZM.2013.13.2300

Subfamily: Macroglossinae
Tribe Macroglossini
Subtribe: Choerocampini

Two genera of Macroglossini are found in Trinidad: the Old World genus *Hyles* with a single representative, and the New World genus *Xylophanes* with 12 species. The latter are quite easy to recognise by virtue of the resting position with the wings held horizontal at an angle of about 60° and the long, relatively thin body.

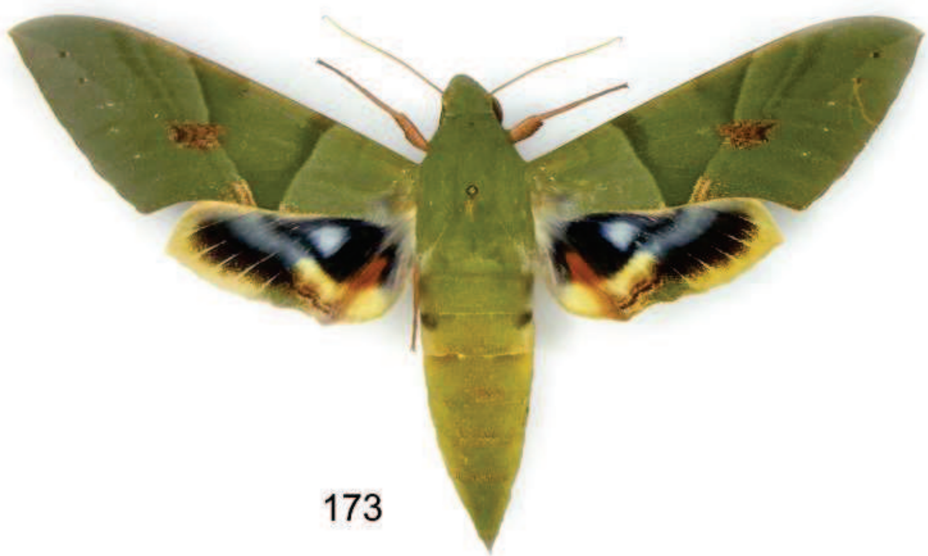


Fig. 173. *Eumorpha labruscae* (Linnaeus) female, Valsayn Park, at light, 29 September 1978 (M.J.W. Cock) [MJWC].

Fig. 174. *Pachygonidia caliginosa* (Boisduval), female, [Trinidad], [N. Lamont] [UWIZM.2013.13.2300] (photo UWIZM).

72. *Hyles lineata* (Fabricius, 1775) (Fig. 175)
Celerio lineata (Fabricius): Cary (1951)
Hyles lineata lineata (Fabricius): Stradling *et al*. (1983)
Taxonomic issues. *Hyles lineata* is a New World species (introduced in Hawai'i) that could be confused with the very similar Old World species, *H. livornica* Esper, which has been reported from French Guiana (Haxaire 1993). The identification of the single known specimen from Trinidad (below) was confirmed using the diagnostic characters set out in Haxaire (1993) and Eitschberger and Steiniger (1976).
Identification. The broad white stripe from base to apex of the forewing is superficially similar to *Eumorpha vitis* and *E. fasciatus*, but both those species have a transverse stripe from mid-termen to costa just before apex. Any future Trinidad specimens should be checked against *H. livornica*.
Status in Trinidad. Only known from a single specimen taken by light trap at Curepe. Given that this is a vagile species, it may be that it is not normally resident in Trinidad. Curepe, light trap: ♂ 25 July 1970 (F.D. Bennett) [UWIZM CABI.4988]

73. *Xylophanes anubus* (Cramer, 1777) (Fig. 176)
Xylophanes anubus (Cramer): Kaye and Lamont (1927), Cary (1951), Schreiber (1978), Stradling *et al*. (1983)
Identification. The larger size and relatively uniform beige coloured dorsal forewings should distinguish this species from other *Xylophanes* spp.
Status in Trinidad. This species is quite common in forested areas, particularly in the Northern Range, but rare in suburban and disturbed areas.

74. *Xylophanes ceratomioides* (Grote and Robinson, 1867) (Fig. 177)
Xylophanes ceratomioides (Grote and Robinson): Schreiber (1978), Stradling *et al*. (1983)
Identification. A very distinctive species in the Trinidad fauna; the arrangement of the brown and pinkish areas of the dorsal forewing are like no other species, although

Fig. 175. *Hyles lineata* (Fabricius) male, Curepe, light trap, 25 July 1970 (F.D. Bennett) [UWIZM CABI.4988] (photo UWIZM).

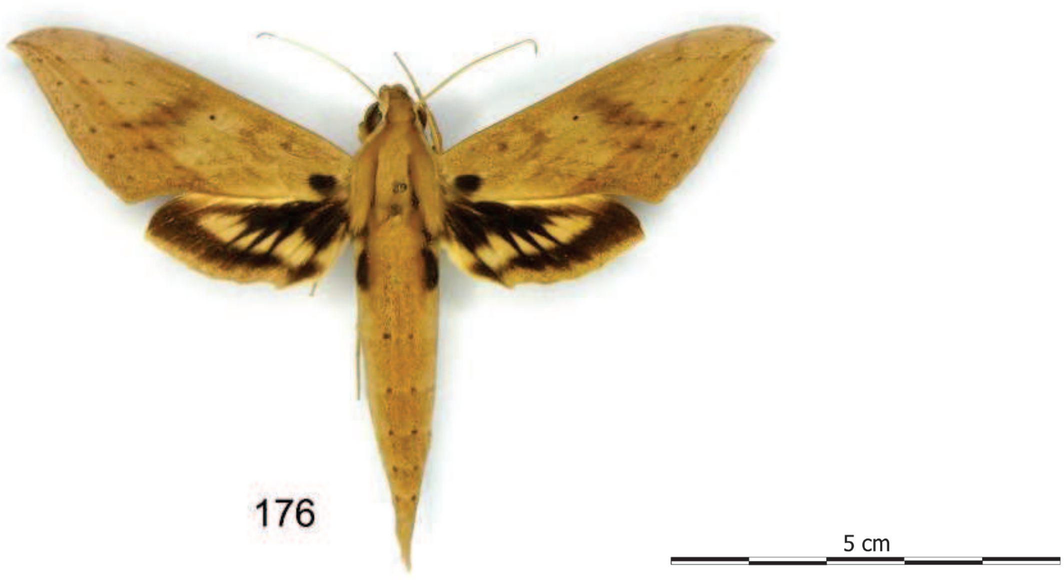


Fig. 176. *Xylophanes anubus* (Cramer) male, Morne Bleu, Textel Installation, at light, early November 1978 (M.J.W. Cock) [MJWC].

there are other superficially similar *Xylophanes* spp. on the mainland (D'Abrera 1987).
Status in Trinidad. A fairly common species in forested areas, but rare in suburban and disturbed areas.

75. *Xylophanes chiron* (Drury, 1773) *nechus* (Cramer, 1777) (Figs. 30, 178-179)
Xylophanes chiron nechus (Cramer): Kaye and Lamont (1927), Cary (1951), Schreiber (1978), Stradling *et al*. (1983)
Identification. A very distinctive species in the Trinidad fauna.
Status in Trinidad. This is a common, sometimes very common, species in forested areas, and is also occasionally found in suburban and disturbed areas.

76. *Xylophanes loelia* (Druce, 1878) (Figs. 31, 180-181)
Xylophanes loelia (Druce): Schreiber (1978), Stradling *et al*. (1983), Vaglia *et al*. (2008)
Identification. This is the least common of three medium sized species with slightly contrasting brown dorsal forewings, the other two being *X. neoptolemus* (Cramer) and *X. tersa* (Linnaeus). The latter has yellow markings on the dorsal hindwing whereas the other two are pinkish red, but this character is not evident in images of the living adults. Quite subtle differences can be seen comparing the dorsal forewings, but the body colouring and markings are also helpful. In *X. tersa*, the base of the dorsal forewing is pale, sharply contrasting with the adjacent thorax (Figs. 34-36), whereas there is little colour difference between the wing base and adjacent thorax for *X. loelia* and *X. neoptolemus*. In addition, *X. tersa* has golden dorso-lateral longitudunial bands on the abdomen (Figs 34, 190), not present on the other two species. The dorsal thorax and body of *X. loelia* is paler than in *X. neoptolemus*, and *X. loelia* has a faint thin brown dorsal line on the abdomen but not the thorax, whereas *X. neoptolemus* has three parallel brown dorsal lines on the abdomen and one on the thorax.
Status in Trinidad. This is an occasional species in suburban and disturbed areas. It may have been overlooked as the common *X. neoptolemus* by Stradling *et al*. (1983).

Fig. 177. *Xylophanes ceratomioides* (Grote and Robinson) male, Toco, at light, 3 June 1978 (M.J.W. Cock) [MJWC].

Figs. 178-179. *Xylophanes chiron nechus* (Cramer). **178**, male, Cumaca Road, 4.6 miles, MVL, 18 July 1981 (M.J.W. Cock) [MJWC]. **179**, female, Morne Bleu, Textel Installation, at light, 26 June 1978 (M.J.W. Cock) [MJWC].

77. *Xylophanes neoptolemus* (Cramer, 1780) (Figs.182-183)

Choerocampa neoptolemus (Cramer): Kaye (1901), Kaye (1914a)

Xylophanes neoptolemus (Cramer): Rothschild and Jordan (1903), Kaye (1914b), Kaye and Lamont (1927), Kitching and Cadiou (2000), Vaglia *et al*. (2008)

Xylophanes neoptolemus trinitatis Closs: Closs (1917), Schreiber (1978), Stradling *et al*. (1983)

Xylophanes neoptolemus trinitatas [*sic*] Closs: Cary (1951)

Identification. See under *X. loelia* (above).

Status in Trinidad. A common and widespread species.

78. *Xylophanes pistacina* (Boisduval, [1875]) (Figs. 33, 184-185)

Xylophanes pistacina pistacina (Boisduval): Schreiber (1978), Stradling *et al*. (1983)

Identification. The mixture of pastel green-grey colours and a simple discal line on the dorsal forewings make this species distinct.

Status in Trinidad. An occasional species in suburban and forested areas.

79. *Xylophanes pluto* (Fabricius, 1777) (Figs. 32, 186-187)

Xylophanes pluto (Fabricius): Kaye (1914b), Kaye and Lamont (1927), Schreiber (1978), Stradling *et al*. (1983), Cock (2017b)

Identification. The dorsal green forewing, infused with white and multiple discal lines should separate this species from others even if the vivid orange hindwing is not visible.

Status in Trinidad. A fairly common species in both suburban and forested areas.

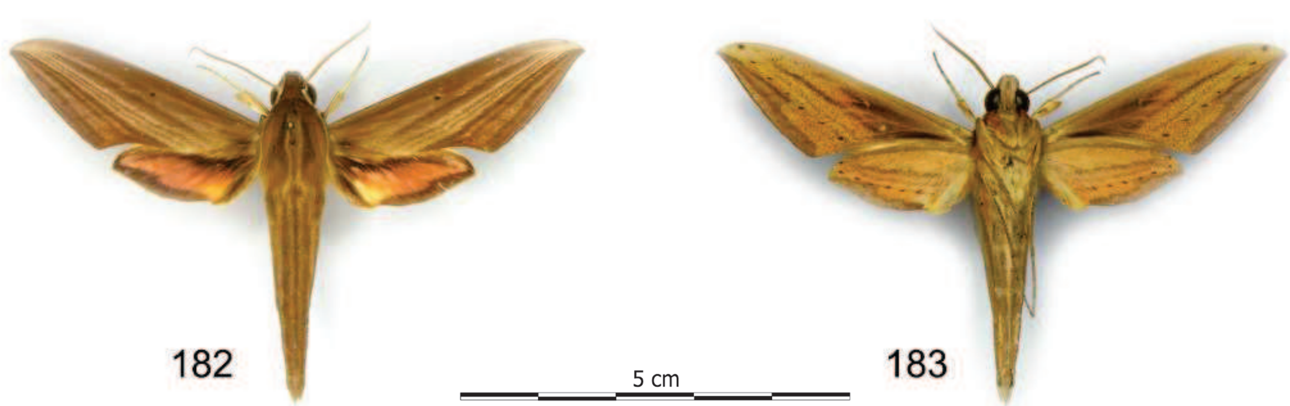
80. *Xylophanes porcus* (Hübner [1823]) *continentalis* Rothschild and Jordan, 1903 (Figs. 188-189)

Xylophanes porcus continentalis Rothschild and Jordan: Schreiber (1978), Stradling *et al*. (1983)

Identification. This plain brown species is unlikely to be confused with any other at present, but there are cryptic species under this name in mainland South America (I.J. Kitching pers. comm. 2017).

Status in Trinidad. An occasional species in forested areas.

Figs. 180-181. *Xylophanes loelia* (Druce) male, Curepe, MVL, 17 September 1979 (M.J.W. Cock) [MJWC]. **180**, dorsal. **181**, ventral.



Figs. 182-183. *Xylophanes neoptolemus* (Cramer) male, Morne Bleu, Textel Installation, at light, 10 July 1978 (M.J.W. Cock) [MJWC]. **182**, dorsal. **183**, ventral.

81. ***Xylophanes tersa tersa*** **(Linnaeus, 1771)** (Figs. 34-36, 190-191)
Choerocampa tersa (Linnaeus): Kaye (1901, 1914a)
Xylophanes torsa [*sic*] (Linnaeus): Kaye (1914b)
Xylophanes tersa (Linnaeus): Rothschild and Jordan (1903), Kaye and Lamont (1927)
Xylophanes tersa tersa (Linnaeus): Schreiber (1978), Stradling *et al*. (1983), Cock (2017b)

Identification. See under *X. loelia* (above).

Status in Trinidad. The commonest hawk-moth in Trinidad, occurring in all habitats sampled.

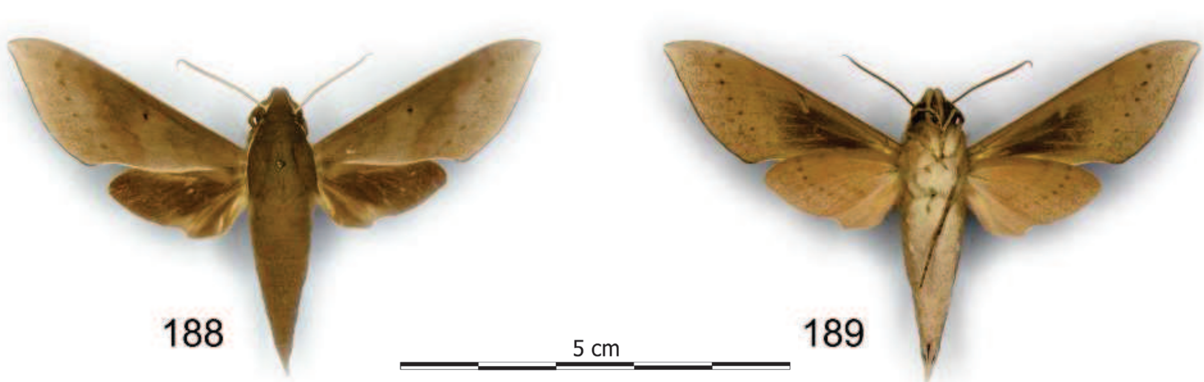
82. ***Xylophanes thyelia thyelia*** **(Linnaeus, 1758)** (Figs. 192-195)
Xylophanes thyelia (Linnaeus): Kaye (1914b), Kaye and Lamont (1927), Cary (1951)
Xylophanes thyelia thyelia (Linnaeus): Schreiber (1978), Stradling *et al*. (1983)

Identification. A very distinctive species in the Trinidad fauna, due to its small size, pale line from base to apex of the dorsal forewing, and rich colouring ventrally.

Status in Trinidad. An uncommon species, primarily found in forested areas, but occasionally in suburban areas.

Figs. 184-185. *Xylophanes pistacina* (Boisduval, [1875]). **184**, male, Curepe, MVL, 14 June 1979 (M.J.W. Cock) [MJWC]. **185**, female, Arima Valley, Simla, MVL, 3 May 1981 (M.J.W. Cock) [MJWC].

Figs. 186-187. *Xylophanes pluto* (Fabricius) male, St. Augustine, MV Trap, 10 August 1978 (F.D. Bennett) [MJWC]. **186**, dorsal. **187**, ventral.



Figs. 188-189. *Xylophanes porcus continentalis* Rothschild and Jordan male, Morne Bleu, Textel Installation, at light, until 23.30h 29 September 1978 (M.J.W. Cock) [MJWC]. **188**, dorsal. **189**, ventral.

83. *Xylophanes titana* (Druce, 1878) (Figs. 37, 196-197)
Xylophanes titana (Druce): Stradling *et al*. (1983), Cock (2007)

Biology in Trinidad. Cock (2007) illustrates the adult and early stages from a caterpillar collected on *Endlichera umbellata* (Rubiaceae) on Morne Catherine.

Identification. Images of living adults of this species might be confused with *X. tersa*, but *X. titana* is larger, the dorsal forewing is darker and more contrasting and the abdomen and thorax have two pale dorsal lines

Status in Trinidad. An occasional species in forested areas.

Figs. 190-191. *Xylophanes tersa tersa* (Linnaeus) male, Curepe, MVL, 5 August 1978 (M.J.W. Cock) [MJWC]. **190**, dorsal. **191**, ventral.

Figs. 192-195. *Xylophanes thyelia thyelia* (Linnaeus) males. **192**, Morne Bleu, Textel Installation, at light, 22.00-02.00h 29 March 1979 (M.J.W. Cock) [MJWC]. **193**, as Fig. 192, ventral view. **194**, Cumaca Road, 4.6 miles, MVL, 21 October 1982 (M.J.W. Cock) [MJWC]. **195**, as Fig. 194, ventral view.

Figs. 196-197. *Xylophanes titana* (Druce) male, Morne Bleu, Textel Installation, at light, until 23.30h 29 September 1978 (M.J.W. Cock) [MJWC]. **196**, dorsal. **197**, ventral.

84. *Xylophanes tyndarus tyndarus* (Boisduval, [1875]) (Figs. 38, 198-199)

Choerocampa tyndarus (Boisduval): Kaye (1901, 1914a)

Xylophanes tyndarus (Boisduval): Rothschild and Jordan (1903), Kaye (1914b), Kaye and Lamont (1927), Cary (1951), Cock (2017b)

Xylophanes tyndarus tyndarus (Boisduval): Schreiber (1978), Stradling *et al*. (1983)

Taxonomic issues. Haxaire (2013) described a new subspecies for Central America, whereas the nominotypical subspecies is restricted to South America, including Trinidad.

Identification. This plain green species, slightly darker beyond the discal line, should not be confused with any other Trinidad species.

Status in Trinidad. An occasional species in forested areas, rare in suburban areas.

Species not confirmed from Trinidad:

The following species have been recorded as occurring in Trinidad by Schreiber (1978) and Stradling *et al*. (1983), but I have been unable to confirm them from specimens, photographs or recent records, and there are no specimens known to I.J. Kitching (pers. comm. 2017) in the NHMUK or elsewhere. Schreiber (1978) based his distribution table on a review of 17 museums and private collections in Europe and USA containing nearly 75,000 labelled Neotropical specimens. At the time, Schreiber (1978) lists 22,815 Neotropical records from the NHMUK, but the NHMUK Sphingidae holdings have been doubled by the addition of the J.-M. Cadiou collection. Of the collections checked by Schreiber, I have only checked the NHMUK (partly in person, but completely by consultation with I.J. Kitching), and the implication is that voucher specimens for some of Schreiber's records are held in one or more of the museums or collections that I have not seen. Having said that, there is also the possibility of errors – in labelling, in curation, in identification, in the interpretation of labels ('Trinidad' occurs in several Neotropical collecting localities in diverse countries), and even transcription errors. Although Stradling *et al*. (1983) also list these species, this is purely on the basis of the distribution reported by Schreiber (1978) and not on new observations. Nevertheless, the first four of these species are dusk and dawn flower feeders unlikely to be captured at light (see introduction), and the fifth could be overlooked for the common *X. tersa*, so in principle there is no reason to say that their presence in Trinidad will not be confirmed in the future.

***Aleuron iphis* (Walker, 1856)**

Aleuron iphis (Walker): Schreiber (1978), Stradling *et al*. (1983)

This rare dusk flower-feeder occurs in French Guiana (Haxaire and Rasplus 1987b) and so might be a Trinidad species.

***Aleuron neglectum* Rothschild and Jordan, 1903**

Aleuron neglectum neglectum Rothschild and Jordan: Schreiber (1978), Stradling *et al*. (1983)

Same comments as for the preceding *A. iphis*.

***Pachygonidia subhamata* (Walker, 1856)**

Pachygonia [sic] subhamata (Walker): Schreiber (1978), Stradling *et al*. (1983)

Given that this is a dusk flower-feeder, and has been recorded from coastal Venezuela (I.J. Kitching pers. comm. 2017), it may yet be found to occur in Trinidad.

***Unzela pronoe pronoe* Druce, 1894**

Enyo pronoe pronoe (Druce): Schreiber (1978), Stradling *et al*. (1983)

This dusk flower-feeder occurs in French Guiana (Haxaire and Rasplus 1987b), so could be a Trinidad species.

Figs. 198-199. *Xylophanes tyndarus tyndarus* (Boisduval) male, Morne Bleu, Textel Installation, at light, 10 May 1981 (M.J.W. Cock) [MJWC]. **198**, dorsal. **199**, ventral.

***Xylophanes turbata* (Edwards, 1887)**

Xylophanes turbata (Edwards): Schreiber (1978), Stradling *et al*. (1983)

Schreiber (1978) includes this species from Trinidad in his distribution table, but not in his distribution map. It has been recorded from coastal Venezuela (I.J. Kitching pers. comm. 2017) and so it is possible that it could occur in Trinidad. It resembles *X. tersa*, but the dorsal hindwing is pale brown (D'Abrera [1987]), so it is unlikely to have been overlooked in Stradling *et al*.'s (1983) comprehensive light trapping at Curepe. It just might be worth watching out for this species in the dry northwest peninsular or Bocas Islands.

Species recorded from Trinidad, but considered to be errors

See comments under 'Species not confirmed from Trinidad:' above. However, in contrast to the species treated in that section, there are arguments for thinking that the following species are unlikely to occur in Trinidad as set out below.

***Adhemarius ypsilon* (Rothschild and Jordan, 1903)**

Amplyterus ypsilon Rothschild and Jordan: Schreiber (1978), Stradling *et al*. (1983)

Although recorded from Mexico to Peru, this species is not known from northern Venezuela (I.J. Kitching, pers. comm. 2017) and is unlikely to occur in Trinidad.

***Manduca occulta* (Rothschild and Jordan, 1903)**

Manduca occulta occulta (Rothschild and Jordan)*:* Schreiber (1978), Stradling *et al*. (1983)

Schreiber (1978) lists *Manduca occulta occulta* from Trinidad, but this is the Central American equivalent of *Manduca diffissa,* and not a South American species**.**

***Manduca sexta jamaicensis* (Butler, 1875)**

Manduca sexta jamaicensis (Butler): Schreiber (1978), Stradling *et al*. (1983)

Schreiber (1978) records both *M. sexta jamaicensis* and *M. sexta paphus* from Trinidad; the former is restricted the Caribbean islands, including the Lesser Antilles, and I have seen no specimens to indicate that it also occurs in Trinidad.

***Isognathus rimosa* (Grote, 1865)**

Isognathus rimosa (Grote): Cary (1951)

Cary (1951) lists this species as perhaps occurring in Trinidad ('Trinidad (?)'), but I know of no records.

***Aellopos tantalus tantalus* (Linnaeus, 1758)**

Aellopus [*sic*] *sisyphus* (Burmeister): Kaye (1901) [synonym of *A. tantalus*]

Sesia tantalus (Linnaeus): Kaye (1914b), Cary (1951)

Sesia tantalus tantalus (Linnaeus): Kaye and Lamont (1927)

Aellopos tantalus (Linnaeus): Schreiber (1978), Stradling *et al*. (1983)

Kaye (1901) included this species in his provisional list of the Trinidad moths as its synonym as *Aellopus sisyphus* (Burmeister), referring to a specimen in 'Coll. Schaus'. The bulk of William Schaus's collection is now held in the USNM although some is in NHMUK and other major collections (Heinrich and Chapin 1942). This specimen has not been found in USNM (J.W. Brown pers. comm. 2017) or NHMUK (I.J. Kitching pers. comm. 2017). Kaye and Lamont (1927) list this species from Trinidad based on a record from Fort George (1,000 ft.) [305 m] January 1922 (F.W. Jackson). The specimen was located in MGCL and found to be *A. clavipes*. Early last century, *A. clavipes* was considered to be a subspecies of *A. tantalus*, following the treatment of Rothschild and Jordan (1903), which probably explains the use of the name *A. tantalus* from Trinidad. Schreiber (1978) included records from Kaye and Lamont (1927) so it is reasonable to suggest that his inclusion of this species from Trinidad is based on that source. I conclude that these early records refer to *A. clavipes* and not *A. tantalus*.

***Eumorpha cissi* (Schaufuss, 1870)**

Eumorpha cissi (Schaufuss): Stradling *et al*. (1983)

Stradling *et al*. (1983) list one specimen of this species from Trinidad, but I have failed to locate a specimen in UWIZM or NMSE. It is not impossible that they were misled by the slight sexual dimorphism shown by *E. anchemolus*, and mistook the darker, less red female for a separate species (as the present author also did initially). *Eumorpha cissi* is an Andean species extending into western Venezuela, and found above 1500m (5,000ft) (D'Abrera [1987]), and unlikely to occur in Trinidad, and so this record is not accepted.

***Xylophanes crotonis* (Walker, 1856)**

Xylophanes crotonis (Walker): Schreiber (1978), Stradling *et al*. (1983)

Schreiber (1978) includes this species from Trinidad in his distribution table, but not in his distribution map. It appears to be an Andean species (I.J. Kitching pers. comm. 2017) and unlikely to occur in Trinidad.

DISCUSSION

I have recorded 84 species of Sphingidae from Trinidad, plus 12 unconfirmed records, of which five are considered possible and seven are considered likely to be errors. This compares with 54 recorded by Kaye and Lamont (1927), 81 recorded by Schreiber (1978), and 77 recorded by Stradling *et al*. (1983) out of a total possible list of 94 including published records that they had not substantiated. Comparing my list of 84 species with Stradling *et al*.'s (1983, Appendix 1) 75 confirmed records, they treat *Erinnyis domingonis* as a separate species whereas here it is treated as a synonym of *E. obscura*, I reject their record of *E. cissi*, and they do not include *Adhemarius daphne,* the four species of *Aellopos*, *Aleuron chloroptera*, *Erinnyis impunctata*, *Pachygonidia caliginosa*, *Nyceryx stuarti* and *Unzela japix*. Of these, *Adhemarius daphne, Aleuron chloroptera*, *N. stuarti* and *Erinnyis impunctata* are here recorded from Trinidad for the first time.

Of the 84 species accepted, six (7%) are based on single records (*Aellopos clavipes, A. titan*, *Aleuron chloroptera*, *Hyles lineata*, *Nyceryx maxwelli*, *Pachygonidia caliginosa*), a slightly higher rate than for Lycaenidae in the recent analysis by Cock & Robbins (2016), where six out of 131 Lycaenidae (5%) are known only from single specimens. This percentage of records based on single specimens suggests that further collecting will reveal more new records for Trinidad.

Comparing the records from suburban habitats and forest habitats (Appendix Tables 2 and 3), it can be seen that despite the totally disproportionate investment in collecting in suburban habitats (Curepe / St. Augustine), there are many species that were collected as frequently or more frequently in forest habitats (Appendix Table 2). I have categorised 23 species as relatively frequent in suburban habitats and 23 as relatively frequent in forest habitats. Six species are frequently collected in both: *Erinnyis alope*, *E. ello*, *E. crameri*, *Eumorpha satellitia*, *Xylophanes neoptolemus* and *X. tersa*. There has been an even larger bias towards collecting in the northern half of Trinidad than in the south, and not surprisingly, although all bar one of the 84 Trinidad species have been recorded from the north, only 51 have been recorded from the south (Appendix Table 2). Further collecting and observations in the south is likely to show that most or all species also occur there.

Cock (2017b) listed 26 Sphingidae from Tobago (Appendix Table 2), representing 31 % of the 84 species recorded here from Trinidad. This is significantly higher than 20% for all butterflies (Cock 2017a), reflecting the greater mobility of adult hawk-moths compared to other families of Lepidoptera. All species recorded from Tobago are known from Trinidad and can be identified using the images provided here.

The table of captures in forested areas (Appendix Table 4) indicates that hawk-moths are collected in significant numbers in every month, but the amount of collecting effort in each month is uneven, so more detailed analysis is not justified. Of the collecting sites shown in Appendix Table 3, the area lumped together under 'Morne Bleu' is on the ridge tops of the northern range at the head of the Arima Valley at about 600–700 m (2,000–2,300 ft.), whereas the remainder are all at significantly lower elevations. There is no hint that any species are only found at the higher elevation sites, although a significant number of less common species have yet to be recorded from the high elevation sites. On balance, there is little evidence of species being restricted by elevation rather than by habitat.

This illustrated checklist of Trinidad hawk-moths should enable adults of all known species to be identified, and it is my hope that this will stimulate interest in this charismatic group in Trinidad and Tobago. Using this checklist, identifications can now be reliably made, and further studies on distribution and frequency, adult feeding habits, food plants and life history studies, etc., can all be readily taken up.

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Appendix Table 1. Overview of the main food plants of Sphingidae found in Trinidad based on records from elsewhere.

	Species	Food plants	Sources
1	*Adhemarius gannascus*	Apparently unknown	
2	*Adhemarius daphne*	Lauraceae (*Ocotea*)	Janzen and Hallwachs (2017), Oehlke (2017)
3	*Adhemarius palmeri*	Apparently unknown	
4	*Protambulyx eurycles*	Probably Anacardiaceae and Simaroubaceae	Oehlke (2017)
5	*Protambulyx strigilis*	Anacardiaceae (*Anacardium*, *Astronium*, *Spondias*, *Schinus*, *Tapirira*, *Simarouba*)	Dyer and Gentry (2002), Tuttle (2007), Janzen and Hallwachs (2017), Oehlke (2017)
6	*Cocytius duponchel*	Annonaceae (*Annona*, *Rollinia, Guatteria*, *Xylopia*)	Moss (1920), Dyer and Gentry (2002), Janzen and Hallwachs (2017), Oehlke (2017)
7	*Cocytius lucifer*	Annonaceae (*Annona*, *Desmopsis*)	Janzen and Hallwachs (2017), Oehlke (2017)
8	*Cocytius antaeus*	Annonaceae (*Annona*, *Rollinia*)	Moss (1912, 1920), Tuttle (2007), Janzen and Hallwachs (2017), Oehlke (2017)
9	*Neococytius cluentius*	Annonaceae (*Annona*), Piperaceae (*Piper*)	Moss (1920), Dyer and Gentry (2002), Janzen and Hallwachs (2017)
10	*Manduca lefeburii*	Salicaceae (*Casearia*, *Zuelania*)	Haxaire and Rasplus (1987a), Janzen and Hallwachs 2017), Oehlke (2017)
11	*Manduca albiplaga*	Annonaceae (*Annona*, *Rollinia*) and Lamiaceae (*Aegiphila*); perhaps also Cordiaceae	Moss (1920), Janzen and Hallwachs (2017), Oehlke (2017)
12	*Manduca franciscae*	Apparently unknown	
13	*Manduca huascara*	Apparently unknown	
14	*Manduca florestan*	Polyphagous on at least 11 families, particularly Bignoniaceae and Lamiaceae, but also Boraginaceae, Cordiaceae, Rubiaceae, Verbenaceae, etc.	Moss (1920), Dyer and Gentry (2002), Janzen and Hallwachs (2017), Oehlke (2017)
15	*Manduca rustica*	Polyphagous, including Bignoniaceae, Convolvulaceae, Cordiaceae, Lamiaceae, Malvaceae, and Verbenaceae	Moss (1912), Janzen and Hallwachs (2017), Oehlke (2017)
16	*Manduca sexta*	Mainly Solanaceae (*Capsicum*, *Datura*, *Nicotiana*, *Solanum*); also Lamiaceae (*Aegiphila*), Martyniaceae (*Martynia*, *Proboscidia*) and Petiveriaceae (*Rivina*)	Moss (1912,1920), Tuttle (2007), Dyer and Gentry (2002), Janzen and Hallwachs 2017), Oehlke (2017)
17	*Manduca diffissa*	Solanaceae (*Nicotiana*, *Solanum*)	Moss (1912,1920)
18	*Manduca hannibal*	Solanaceae (*Cestrum*, *Datura*, *Solanum*), Lamiaceae (*Aegiphila, Clerodendrum*)	Moss (1912,1920), Dyer *et al*. (2017), Janzen and Hallwachs 2017), Oehlke (2017)
19	*Manduca ochus*	Solanaceae (*Cestrum*)	Janzen and Hallwachs 2017)
20	*Agrius cingulata*	Convolvulaceae (*Convolvulus*, *Ipomoea*, *Merremia*)	Moss (1912, 1920), Tuttle (2007), Janzen and Hallwachs (2017), Oehlke (2017)
21	*Pachylia ficus*	Moraceae (*Brosimum*, *Castilla*, *Ficus*, *Maclura)*	Moss (1912, 1920), Tuttle (2007), Dyer and Gentry (2002), Janzen and Hallwachs (2017), Oehlke (2017)
22	*Pachylia syces*	Moraceae (*Ficus*, *Artocarpus*), Urticaceae (*Cecropia*)	Moss (1912, 1920), Dyer and Gentry (2002), Janzen and Hallwachs (2017), Oehlke (2017)
23	*Callionima pan*	Apparently unknown	
24	*Callionima calliomenae*	Apparently unknown	
25	*Callionema inuus*	Apocynaceae (*Ambelania*)	Moss (1920)
26	*Callionima falcifera*	Apocynaceae (*Stemmadenia*)	Janzen and Hallwachs (2017), Oehlke (2017)
27	*Nyceryx coffaeae*	Rubiaceae (*Calycophyllum*, *Uncaria*)	Janzen and Hallwachs (2017), Oehlke (2017)
28	*Nyceryx maxwelli*	Apparently unknown	
29	*Nyceryx riscus*	Bignoniaceae (*Xylophragma*)	Janzen and Hallwachs (2017), Oehlke (2017)
30	*Nyceryx stuarti*	Rubiaceae (*Uncaria*)	Janzen and Hallwachs (2017)

Appendix Table 1 Continued. Overview of the main food plants of Sphingidae found in Trinidad based on records from elsewhere.

	Species	Food plants	Sources
31	*Perigonia pallida*	Apparently unknown	
32	*Perigonia lusca*	Rubiaceae (*Calycophyllum*, *Coffea*, *Guettarda*, *Ourouparia*, *Uncaria*), Aquifoliaceae (*Ilex*)	Moss (1920), Tuttle (2007), Janzen and Hallwachs (2017), Oehlke (2017)
33	*Eupyrrhoglossum sagra*	Rubiaceae (*Chomelia*, *Guettarda*, *Sabicea*)	Moss (1920), Janzen and Hallwachs (2017), Oehlke (2017)
34	*Aellopos ceculus*	Rubiaceae (*Ourouparia*, *Sabicea*)	Moss (1920), Dyer and Gentry (2002), Janzen and Hallwachs (2017)
35	*Aellopos clavipes*	Rubiaccae (*Randia*)	Moss (1920), Tuttle (2007), Janzen and Hallwachs (2017), Oehlke (2017)
36	*Aellopos titan*	Rubiaceae (*Alibertia*, *Genipa*, *Guettarda*, *Randia*)	Moss (1920), Tuttle (2007), Janzen and Hallwachs (2017), Oehlke (2017)
37	*Aellopos fadus*	Rubiaceae (*Alibertia*, *Augusta*, *Genipa*)	Moss (1920), Janzen and Hallwachs (2017), Oehlke (2017)
38	*Oryba kadeni*	Rubiaceae (*Cosmibuena*, *Isertia*, *Palicourea*, *Remijia*)	Moss (1920), Dyer and Gentry (2002), Janzen and Hallwachs (2017), Oehlke (2017)
39	*Oryba achemenides*	Rubiaceae (*Ourouparia*, *Uncaria*)	Moss (1920), Janzen and Hallwachs (2017)
40	*Pachylioides resumens*	Apocynaceae (*Echites*, *Forsteronia*, *Zschokkea*)	Moss (1920), Janzen and Hallwachs (2017), Oehlke (2017)
41	*Madoryx oiclus*	Bignoniaceae (*Tecoma*), Verbenaceae (*Rehdera*)	Haxaire and Rasplus (1987a), Janzen and Hallwachs (2017), Oehlke (2017)
42	*Madoryx plutonius*	Aquifoliaceae (*Ilex*), Melastomataceae (*Conostegia*, *Miconia*), Vochysiaceae (*Erisma*, *Vochysia*)	Moss (1920), Janzen and Hallwachs (2017), Oehlke (2017)
43	*Madoryx bubastus*	Rubiaceae (*Calycophyllum*, *Guettarda*)	Janzen and Hallwachs (2017), Oehlke (2017)
44	*Hemeroplanes triptolemus*	Apocynaceae (*Amblyanthera*, *Echites*, *Fischeria*, *Mesechites*, *Zschokkea*)	Moss (1920), Dyer and Gentry (2002), Janzen and Hallwachs (2017), Oehlke (2017)
45	*Phryxus caicus*	Apocynaceae (*Mesechites*)	Janzen and Hallwachs (2017), Oehlke (2017)
46	*Erinnyis alope*	Euphorbiacae (*Hevea*, *Manihot*), Caricaceae (*Carica*)	Moss (1912, 1920), Haxaire and Rasplus (1987a), Tuttle (2007), Dyer and Gentry (2002), Janzen and Hallwachs (2017), Oehlke (2017)
47	*Erinnyis lassauxii*	Apocynaceae (*Gonolobus*, *Morrenia*)	Moss (1912, 1920), Janzen and Hallwachs (2017), Oehlke (2017)
48	*Erinnyis impunctata*	Apparently unknown	
49	*Erinnyis ello*	Euphorbiaceae (*Euphorbia, Manihot*, *Poinsettia, Sebastiania*), Caricaceae (*Carica*); also Apocynaceae, Sapotaceae (*Bumelia*, *Chrysophyllum*, *Manilkara*)	Moss (1912, 1920), Tuttle (2007), Dyer and Gentry (2002), Janzen and Hallwachs (2017), Oehlke (2017)
50	*Erinnyis oenotrus*	Apocynaceae (*Forsteronia*, *Echites*, *Zschokkea*)	Moss (1920), Janzen and Hallwachs (2017), Oehlke (2017)
51	*Erinnyis crameri*	Apocynaceae (*Rauvolfia*, *Stemmadenia*)	Janzen and Hallwachs (2017), Oehlke (2017)
52	*Erinnyis obscura*	Apocynaceae (*Blepharodon*, *Cynanchum*, *Gonolobus*, *Sarcostemma*)	Moss (1920), Tuttle (2007), Janzen and Hallwachs (2017), Oehlke (2017)
53	*Isognathus scyron*	Apocynaceae (*Allamanda*). See text	Oehlke (2017)
54	*Isognathus caricae*	Apocynaceae (*Allamanda*, *Himatanthus*)	Oehlke (2017)
55	*Pseudosphinx tetrio*	Apocynaceae (*Plumeria*)	Moss (1912), Janzen and Hallwachs (2017), Oehlke (2017)
56	*Aleuron carinata*	Dilleniaceae (*Curatella*, *Doliocarpus*)	Janzen and Hallwachs (2017), Oehlke (2017)
57	*Aleuron chloroptera*	Dilleniaceae (*Curatella*, *Davilla*)	Janzen and Hallwachs (2017), Oehlke (2017)
58	*Unzela japix*	Dilleniaceae (*Curatella*, *Davilla*, *Doliocarpus*, *Pinzonia*, *Tetracera*)	Moss (1920), Dyer and Gentry (2002), Janzen and Hallwachs (2017), Oehlke (2017)
59	*Enyo lugubris*	Vitaceae (*Cissus*), Dilleniaceae (*Doliocarpus*)	Moss (1920), Tuttle (2007), Janzen and Hallwachs (2017), Oehlke (2017)

Appendix Table 1 Continued. Overview of the main food plants of Sphingidae found in Trinidad based on records from elsewhere.

	Species	Food plants	Sources
60	*Enyo ocypete*	Dilleniaceae (*Curatella*, *Davilla*, *Doliocarpus*, *Tetracera*), Onagraceae (*Ludwigia*), Vitaceae (*Cissus*)	Moss (1920), Dyer and Gentry (2002), Janzen and Hallwachs (2017), Oehlke (2017)
61	*Enyo gorgon*	Vitaceae (*Cissus*, *Vitis*)	Moss (1920) , Janzen and Hallwachs (2017), Oehlke (2017)
62	*Eumorpha anchemolus*	Dilleniaceae (*Davilla*, *Doliocarpus*), Vitaceae (*Ampelopsis*, *Cissus*)	Moss (1912, 1920), Janzen and Hallwachs (2017), Oehlke (2017)
63	*Eumorpha satellitia*	Vitaceae (*Ampelopsis*, *Cissus*)	Moss (1912, 1920), Tuttle (2007), Janzen and Hallwachs (2017), Oehlke (2017)
64	*Eumorpha obliquus*	Marcgraviaceae (*Schwartzia*), Vitaceae (*Cissus*)	Moss (1920), Janzen and Hallwachs (2017)
65	*Eumorpha megaeacus*	Onagraceae (*Ludwigia*)	Moss (1920), Janzen and Hallwachs (2017), Oehlke (2017)
66	*Eumorpha vitis*	Vitaceae (*Cissus*, *Vitis*)	Moss (1920), Tuttle (2007), Dyer and Gentry (2002), Janzen and Hallwachs (2017), Oehlke (2017)
67	*Eumorpha fasciatus*	Onagraceae (*Ludwigia*)	Moss (1912, 1920), Tuttle (2007), Janzen and Hallwachs (2017), Oehlke (2017)
68	*Eumorpha phorbas*	Marcgraviaceae (*Schwartzia*)	Janzen and Hallwachs (2017)
69	*Eumorpha capronnieri*	Apparently unknown	
70	*Eumorpha labruscae*	Vitaceae (*Ampelopsis*, *Cissus*)	Moss (1920), Tuttle (2007), Dyer and Gentry (2002), Janzen and Hallwachs (2017), Oehlke (2017)
71	*Pachygonidia caliginosa*	Apparently unknown; other species of *Pachygonidia* feed on Dilleniaceae, Rubiaceae, Vitaceae	Janzen and Hallwachs (2017)
72	*Hyles lineata*	Polyphagous including Melastomataceae, Nyctaginaceae, Onagraceae, Portulacaceae	Tuttle (2007), Janzen and Hallwachs (2017), Oehlke (2017)
73	*Xylophanes anubus*	Rubiaceae (*Palicourea*, *Psychotria*)	Moss (1920), Dyer and Gentry (2002), Janzen and Hallwachs (2017), Oehlke (2017)
74	*Xylophanes ceratomioides*	Rubiaceae (*Hamelia*, *Margaritopsis*, *Psychotria*)	Dyer and Gentry (2002), Janzen and Hallwachs (2017), Oehlke (2017)
75	*Xylophanes chiron*	Many Rubiaceae (*Coussarea*, *Faramea*, *Margaritopsis*, *Morinda*, *Palicourea*, *Psychotria*, *Rudgea*, *Spermacoce*), Melastomataceae (*Miconia*), Vochysiaceae (*Vochysia*)	Moss (1920), Dyer and Gentry (2002), Dyer *et al*. (2017), Janzen and Hallwachs (2017), Oehlke (2017)
76	*Xylophanes loelia*	Rubiaceae (*Spermacoce*); also Onagraceae (*Ludwigia*)	Moss (1920), Janzen and Hallwachs (2017)
77	*Xylophanes neoptolemus*	Apparently unknown	
78	*Xylophanes pistacina*	Rubiaceae (*Psychotria*)	Oehlke (2017)
79	*Xylophanes pluto*	Erythroxylaceae (*Erythroxylon*), Rubiaceae (*Augusta*, *Hamelia*, *Manettia*, *Margaritopsis*, *Morinda*)	Moss (1912), Haxaire and Rasplus (1987b), Tuttle (2007), Dyer and Gentry (2002), Janzen and Hallwachs (2017), Oehlke (2017)
80	*Xylophanes porcus*	Rubiaceae (*Hamelia*, *Margaritopsis*, *Palicourea*, *Psychotria*)	Moss (1920), Dyer and Gentry (2002), Janzen and Hallwachs (2017), Oehlke (2017)
81	*Xylophanes tersa*	Rubiaceae (*Diodia*, *Hamelia*, *Margaritopsis*, *Pentas*, *Richardia*, *Spermacoce*)	Moss (1912, 1920), Tuttle (2007), Dyer and Gentry (2002), Janzen and Hallwachs (2017), Oehlke (2017)
82	*Xylophanes thyelia*	Apparently unknown	
83	*Xylophanes titana*	Rubiaceae (*Manettia*)	Janzen and Hallwachs (2017), Oehlke (2017)
84	*Xylophanes tyndarus*	Rubiaceae (*Faramea*)	Janzen and Hallwachs (2017), Oehlke (2017)

Appendix Table 2. Overview of the frequency of capture, distribution and habitat of Sphingidae in Trinidad and Tobago. **Curepe 1969-1976** is the total number of each species recorded by Stradling *et al.* (1983) with the three light traps in Curepe (St. Augustine) over 3767 trap nights. **Curepe 1978-1982** is based on my irregular light trap records over these years in my garden in Curepe (St. Augustine). **Other records** encompasses all records not from Curepe (note that records from Curepe / St. Augustine that are not included in the first two datasets are not included in these numbers). **Suburban species** and **Forest species** gives a subjective indication of the relative frequency in these habitats based on 1-3 + signs, or – for almost or completely absent. **Recorded from South Trinidad:** the south of Trinidad is treated as south of the Central Range; there are no records from the strip south of Tabaquite and north of San Fernando. **Recorded from Tobago** is taken from Cock (2017b).

	Species	Curepe 1969-1976	Curepe 1978-1981	Other records	Suburban species	Forest species	Recorded from South Trinidad	Recorded from Tobago
1	*Adhemarius gannascus*	3	1	49	+	+++		
2	*Adhemarius daphne*	0	1	5	-	+++	X	
3	*Adhemarius palmeri*	14	0	5	++	++	X	
4	*Protambulyx eurycles*	0	1	2	-	++	X	
5	*Protambulyx strigilis*	133	11	29	++	++	X	X
6	*Cocytius duponchel*	44	3	6	++	+	X	
7	*Cocytius lucifer*	3	0	9	+	+++	X	
8	*Cocytius antaeus*	62	0	3	++	+	X	
9	*Neococytius cluentius*	3	1	4	+	+	X	
10	*Manduca lefeburii*	7	2	4	++	-		
11	*Manduca albiplaga*	9	1	29	+	+++		
12	*Manduca franciscae*	0	0	2	-	+		
13	*Manduca huascara*	?	1	18	+	+++		
14	*Manduca florestan*	369[2]	1	44	+	+++	X	X
15	*Manduca rustica*	51	1	11	++	++	X	X
16	*Manduca sexta*	468	11	12	+++	-	X	X
17	*Manduca diffissa*	543	11	23	++	++	X	
18	*Manduca hannibal*	13	1	7	+	+	X	
19	*Manduca ochus*	2	0	6	+	++	X	
20	*Agrius cingulata*	79	1	28			X	
21	*Pachylia ficus*	17	0	17	++	++	X	X
22	*Pachylia syces*	0	0	0	+	-		X
23	*Callionima pan*	0	1	4	-	+		
24	*Callionima calliomenae*	59	9	1	+++	-		
25	*Callionema inuus*	12	0	0	+++	-		
26	*Callionima falcifera*	572	27	16	+++	++	X	
27	*Nyceryx coffaeae*	7	2	0	+++	-		
28	*Nyceryx maxwelli*	0	0	1			X	
29	*Nyceryx riscus*	11	3	2	++	+		
30	*Nyceryx stuarti*	0	0	2		++	X	
31	*Perigonia pallida*	11	1	0	+++			
32	*Perigonia lusca*	58	15	7	+++	+	X	X
33	*Eupyrrhoglossum sagra*	8	2	7	++	++	X	X
34	*Aellopos ceculus*	0	0	7	++	++	X	X
35	*Aellopos clavipes*	0	0	1				X
36	*Aellopos titan*	0	0	1		+	X	
37	*Aellopos fadus*	0	0	6	+	+		
38	*Oryba kadeni*	1	1	1	++	+		
39	*Oryba achemenides*	2	1	3	++	++		X
40	*Pachylioides resumens*	12	0	4	++	+	X	X
41	*Madoryx oiclus*	105	7	3	+++	+	X	X
42	*Madoryx plutonius*	0	0	5		++		

Appendix Table 2 Continued. Overview of the frequency of capture, distribution and habitat of Sphingidae in Trinidad and Tobago.

	Species	Curepe 1969-1976	Curepe 1978-1981	Other records	Suburban species	Forest species	Recorded from South Trinidad	Recorded from Tobago
43	*Madoryx bubastus*	3	1	3	++	++		
44	*Hemeroplanes triptolemus*	31	3	7	+++	+	X	X
45	*Phryxus caicus*	14	1	3	++		X	
46	*Erinnyis alope*	344	3	26	+++	+++	X	X
47	*Erinnyis lassauxii*	44	0	12	++	++	X	X
48	*Erinnyis impunctata*	2[3]	0	0	+			
49	*Erinnyis ello*	1023	26	111	+++	+++	X	X
50	*Erinnyis oenotrus*	19[3]	1	6	++	+		
51	*Erinnyis crameri*	107	3	14	+++	+++		
52	*Erinnyis obscura*	201[4]	3	5	+++			
53	*Isognathus scyron*	1740	118	37	+++	+	X	
54	*Isognathus caricae*	0	0	4	+		X	
55	*Pseudosphinx tetrio*	18	5	18	++	++	X	X
56	*Aleuron carinata*	1	0	0	+			
57	*Aleuron chloroptera*	0	0	0	+			
58	*Unzela japix*	0	0	1		+		
59	*Enyo lugubris*	183	43	16	+++		X	
60	*Enyo ocypete*	84	8	9	+++	+	X	X
61	*Enyo gorgon*	5	1	4	++			
62	*Eumorpha anchemolus*	6	0	18	+	+++	X	
63	*Eumorpha satellitia*	27	8	25	+++	+++	X	X
64	*Eumorpha obliquus*	4	0	7		+++		X
65	*Eumorpha megaeacus*	0	0	2		+		
66	*Eumorpha vitis*	160	5	26	+++	+	X	X
67	*Eumorpha fasciatus*	12	8	5	+++	+	X	
68	*Eumorpha phorbas*	5	0	27	+	+++	X	
69	*Eumorpha capronnieri*	1	0	9		+++	X	X
70	*Eumorpha labruscae*	57	2	10	+++		X	
71	*Pachygonidia caliginosa*	0	0	?1				
72	*Hyles lineata*	1	0	0	+			
73	*Xylophanes anubus*	1	0	27		+++	X	
74	*Xylophanes ceratomioides*	5	0	26	+	+++	X	
75	*Xylophanes chiron*	29	3	84	++	+++	X	
76	*Xylophanes loelia*	0	2	4	+			
77	*Xylophanes neoptolemus*	205	2	68	+++	+++	X	
78	*Xylophanes pistacina*	1	1	3	+	+	X	
79	*Xylophanes pluto*	356	21	23	+++	+	X	X
80	*Xylophanes porcus*	2	0	25		+++		
81	*Xylophanes tersa*	1472	259	43	+++	+++	X	X
82	*Xylophanes thyelia*	3	1	8	+	+++	X	
83	*Xylophanes titana*	1	0	19		+++		
84	*Xylophanes tyndarus*	3	0	10	+	+++	X	X
	Total	8848	645	1131				
	Number of species	65	50	77	23[1]	23[1]	51	26

[1]This is the number of species allocated +++; six species are rated +++ in both habitats.
[2]*Manduca huascara* and *M. florestan* were mixed together as *M. florestan.*
[3]Two specimens of *Erinnyis impunctata* were included under *E. oenotrus.*
[4]Including two specimens identified by Stradling *et al*. (1983) as *E. domingonis.*

Appendix Table 3. The main collecting sites for Trinidad Sphingidae from non-suburban sites. Morne Bleu includes the Morne Bleu Textel Installation, as well as sites along the Arima-Blanchisseuse Road from the base of the road to Morne Bleu Textel Installation to the end of Las Lappas Trace, and Lalaja Ridge. Palmiste was Sir Norman Lamont's Estate near San Fernando; although it is a housing development now, when Lamont collected from around 1913 to the 1940s the species he collected indicates it must have been mixed estate with some garden and some forest fragments. Arima Valley includes observations from the Asa Wright Nature Centre, Simla and Sir Norman Lamont's St. Patrck's Estate adjacent to Simla. Cumaca represents one specific sight on the Cumaca Road where I ran a mercury vapour light on two occasions. 'Other' includes material from diverse parts of Trinidad including Inniss Field, Balandra, Sangre Grande, Hollis Reservoir, Rio Claro – Guayaguare Road, Maturita, and Penal, for each of which at least ten records are included, as well as 20 sites with fewer records.

	Species	Morne Bleu	Palmiste	Arima Valley	St. Benedicts	Parrylands	Brigand Hill	Aripo Valley	Cumaca	Other
1	*Adhemarius gannascus*	40		10					2	8
2	*Adhemarius daphne*	4		3		1				1
3	*Adhemarius palmeri*	1		5		1			1	4
4	*Protambulyx eurycles*					1				1
5	*Protambulyx strigilis*	25	5	1						3
6	*Cocytius duponchel*	3	1	2		3				3
7	*Cocytius lucifer*	7	1							0
8	*Cocytius antaeus*	1	2							1
9	*Neococytius cluentius*			1	1	2				1
10	*Manduca lefeburii*	1								1
11	*Manduca albiplaga*	22		4	6					1
12	*Manduca franciscae*		1	1						
13	*Manduca huascara*	4		9			8			1
14	*Manduca florestan*	22	2	12	1	2	2			10
15	*Manduca rustica*	6	3	3			1			
16	*Manduca sexta*		6							1
17	*Manduca diffissa*	10	5	2	1	1				2
18	*Manduca hannibal*	2		3						
19	*Manduca ochus*	1	2		1					
20	*Agrius cingulata*	15	7				2			1
21	*Pachylia ficus*		7	2			2			2
22	*Pachylia syces*									
23	*Callionima pan*	4								
24	*Callionima calliomenae*				1					
25	*Callionema inuus*									
26	*Callionima falcifera*		1	2	1	1	1			4
27	*Nyceryx coffaeae*									
28	*Nyceryx maxwelli*									1
29	*Nyceryx riscus*			1			1			
30	*Nyceryx stuarti*					2				
31	*Perigonia pallida*									
32	*Perigonia lusca*	1	1		2		1			1
33	*Eupyrrhoglossum sagra*			1		1		1		1
34	*Aellopos ceculus*	1	1							3
35	*Aellopos clavipes*									2
36	*Aellopos titan*									1
37	*Aellopos fadus*									1
38	*Oryba kadeni*									1
39	*Oryba achemenides*	1					1			1
40	*Pachylioides resumens*			1		1				

Appendix Table 3. Continued. The main collecting sites for Trinidad Sphingidae from non-suburban sites.

	Species	Morne Bleu	Palmiste	Arima Valley	St. Benedicts	Parrylands	Brigand Hill	Aripo Valley	Cumaca	Other
41	*Madoryx oiclus*						1			
42	*Madoryx plutonius*	1							3	
43	*Madoryx bubastus*					1				1
44	*Hemeroplanes triptolemus*		2			1				1
45	*Phryxus caicus*		1							1
46	*Erinnyis alope*	13	3		1			1		1
47	*Erinnyis lassauxii*	5	1	2		1	2			
48	*Erinnyis impunctata*									
49	*Erinnyis ello*	31	6	10	6			1		3
50	*Erinnyis oenotrus*	1	2	3						1
51	*Erinnyis crameri*	6	4	1						
52	*Erinnyis obscura*				1					1
53	*Isognathus scyron*	2	11							2
54	*Isognathus caricae*		4							
55	*Pseudosphinx tetrio*	6	2							2
56	*Aleuron carinata*			1						
57	*Aleuron chloroptera*									
58	*Unzela japix*			1						
59	*Enyo lugubris*		7		1					
60	*Enyo ocypete*				2	3				3
61	*Enyo gorgon*									
62	*Eumorpha anchemolus*	10			3		3			2
63	*Eumorpha satellitia*	8	7	1	2		1		1	7
64	*Eumorpha obliquus*	7								
65	*Eumorpha megaeacus*									1
66	*Eumorpha vitis*		11		1					1
67	*Eumorpha fasciatus*		4							1
68	*Eumorpha phorbas*	14		3					5	6
69	*Eumorpha capronnieri*	4							2	3
70	*Eumorpha labruscae*		3	1						2
71	*Pachygonidia caliginosa*									
72	*Hyles lineata*									
73	*Xylophanes anubus*	15							4	7
74	*Xylophanes ceratomioides*	8		8		2	1			7
75	*Xylophanes chiron*	64	3	1		2			2	1
76	*Xylophanes loelia*									3
77	*Xylophanes neoptolemus*	2	3	13	2	7	1	17		13
78	*Xylophanes pistacina*			2						1
79	*Xylophanes pluto*	9	5	2	1					3
80	*Xylophanes porcus*	12		2					2	1
81	*Xylophanes tersa*	10	9				1	8		5
82	*Xylophanes thyelia*	4							2	2
83	*Xylophanes titana*	15		1						
84	*Xylophanes tyndarus*	5	1		1					1
	Number of records	423	134	115	35	33	29	28	24	140
	Number of species	43	35	34	19	18	16	5	10	56

Appendix Table 4. The months of capture for Trinidad Sphingidae from non-suburban sites.

	Species	January	February	March	April	May	June	July	August	September	October	November	December	Total
1	*Adhemarius gannascus*	1	3	11		3	1	4	7	22	2	4	2	**60**
2	*Adhemarius daphne*	1		3				3		1	1			**9**
3	*Adhemarius palmeri*	1		3	1	1		1	1		3	1		**12**
4	*Protambulyx eurycles*							1	1					**2**
5	*Protambulyx strigilis*	3		2				3	2	15	1	4	4	**34**
6	*Cocytius duponchel*							4	2	2	3	1		**12**
7	*Cocytius lucifer*	1		1						5			1	**8**
8	*Cocytius antaeus*	1								2	1			**4**
9	*Neococytius cluentius*			1		1	1	2						**5**
10	*Manduca lefeburii*						2							**2**
11	*Manduca albiplaga*			1		11	3	3	5	10				**33**
12	*Manduca franciscae*					1	1							**2**
13	*Manduca huascara*	3	3	10		1		1	3	1				**22**
14	*Manduca florestan*		1		5	22	8	3		10	2			**51**
15	*Manduca rustica*	1		3		1				4	1	2	1	**13**
16	*Manduca sexta*				2	2			1				2	**7**
17	*Manduca diffissa*	2		4		3	1	3	2	3		1	2	**21**
18	*Manduca hannibal*	1				1			1			2		**5**
19	*Manduca ochus*	1				1		1				1		**4**
20	*Agrius cingulata*	2	1	10	1	1		2	2	4		1	1	**25**
21	*Pachylia ficus*	1	1	4		1			1	1		2	2	**13**
22	*Pachylia syces*													
23	*Callionima pan*				1			1		1			1	**4**
24	*Callionima calliomenae*					1								**1**
25	*Callionema inuus*													
26	*Callionima falcifera*			1		1				5		3		**10**
27	*Nyceryx coffaeae*													
28	*Nyceryx maxwelli*	1												**1**
29	*Nyceryx riscus*			1	1									**2**
30	*Nyceryx stuarti*		2											**2**
31	*Perigonia pallida*													
32	*Perigonia lusca*	1		1		2				1			1	**6**
33	*Eupyrrhoglossum sagra*							1	2		1			**4**
34	*Aellopos ceculus*	1		1						2		1		**5**
35	*Aellopos clavipes*		2											**2**
36	*Aellopos titan*							1						**1**
37	*Aellopos fadus*									1				**1**
38	*Oryba kadeni*									1				**1**
39	*Oryba achemenides*	1				1							1	**3**
40	*Pachylioides resumens*	1						1						**2**
41	*Madoryx oiclus*	1												**1**
42	*Madoryx plutonius*							2		1	1			**4**
43	*Madoryx bubastus*		1										1	**2**

Appendix Table 4 Continued . The months of capture for Trinidad Sphingidae from non-suburban sites.

	Species	January	February	March	April	May	June	July	August	September	October	November	December	Total
44	*Hemeroplanes triptolemus*							1		1	1	1		**4**
45	*Phryxus caicus*						1					1		**2**
46	*Erinnyis alope*					1		1	3	9	3	2		**19**
47	*Erinnyis lassauxii*	2		2			1	1		4	1			**11**
48	*Erinnyis impunctata*													
49	*Erinnyis ello*	2	1	32	1	7	2	3	2	4	1	2		**57**
50	*Erinnyis oenotrus*		1	3	1			1				1		**7**
51	*Erinnyis crameri*		1	3				3			2	1	1	**11**
52	*Erinnyis obscura*							1	1					**2**
53	*Isognathus scyron*	1	3	1	1			1	2	3	1	1	1	**15**
54	*Isognathus caricae*				4									**4**
55	*Pseudosphinx tetrio*	2		4				1				1	2	**10**
56	*Aleuron carinata*										1			**1**
57	*Aleuron chloroptera*													
58	*Unzela japix*			1										**1**
59	*Enyo lugubris*	1	1			1				1	1	1	2	**8**
60	*Enyo ocypete*					2	1		2	3				**8**
61	*Enyo gorgon*													
62	*Eumorpha anchemolus*	1		3	1	4			4	4	1			**18**
63	*Eumorpha satellitia*			1		9	6	6	1	2		1	1	**27**
64	*Eumorpha obliquus*								4	3				**7**
65	*Eumorpha megaeacus*									1				**1**
66	*Eumorpha vitis*	1		2		2				1	2		5	**13**
67	*Eumorpha fasciatus*		2						1		1		1	**5**
68	*Eumorpha phorbas*			2			1	7	5	6	2	3	2	**28**
69	*Eumorpha capronnieri*	1			3		1	2	1	1				**9**
70	*Eumorpha labruscae*							1	1	2	1	1		**6**
71	*Pachygonidia caliginosa*													
72	*Hyles lineata*													
73	*Xylophanes anubus*	1				1		2	3	11	5	3		**26**
74	*Xylophanes ceratomioides*	1		2			2	4	6	8		2	1	**26**
75	*Xylophanes chiron*	2					2	4	3	50	5	4	3	**73**
76	*Xylophanes loelia*			1	1		1							**3**
77	*Xylophanes neoptolemus*	1	2	5		2	1	3	24	1	6	9	4	**58**
78	*Xylophanes pistacina*					2								**2**
79	*Xylophanes pluto*	1	5			1	2			10		1		**20**
80	*Xylophanes porcus*				1	1			3	6	6			**17**
81	*Xylophanes tersa*		2	9				3	9	4		3	3	**33**
82	*Xylophanes thyelia*	1		1					1	1	2	2		**8**
83	*Xylophanes titana*					1	1		2	8	2	2		**16**
84	*Xylophanes tyndarus*					5	2						1	**8**
	Number of records	42	32	129	24	94	41	82	108	235	60	65	46	**960**
	Number of species	33	17	32	14	32	21	36	33	44	29	33	24	**75**

Annex Table 5. Index of species by numerical sequence, by genus and by species

	Numeric sequence		Alphabetical sequence by genus		Alphabetical sequence by species
1	*Adhemarius gannascus*	2	*Adhemarius daphne*	39	*achemenides, Oryba*
2	*Adhemarius daphne*	1	*Adhemarius gannascus*	11	*albiplaga, Manduca*
3	*Adhemarius palmeri*	3	*Adhemarius palmeri*	46	*alope, Erinnyis*
4	*Protambulyx eurycles*	34	*Aellopos ceculus*	62	*anchemolus, Eumorpha*
5	*Protambulyx strigilis*	35	*Aellopos clavipes*	8	*antaeus, Cocytius*
6	*Cocytius duponchel*	37	*Aellopos fadus*	73	*anubus, Xylophanes*
7	*Cocytius lucifer*	36	*Aellopos titan*	43	*bubastus, Madoryx*
8	*Cocytius antaeus*	20	*Agrius cingulata*	45	*caicus, Phryxus*
9	*Neococytius cluentius*	56	*Aleuron carinata*	71	*caliginosa, Pachygonidia*
10	*Manduca lefeburii*	57	*Aleuron chloroptera*	24	*calliomenae, Callionema*
11	*Manduca albiplaga*	6	*Cocytius duponchel*	69	*capronnieri. Eumorpha*
12	*Manduca franciscae*	7	*Cocytius lucifer*	54	*caricae, Isognathus*
13	*Manduca huascara*	25	*Callionema inuus*	56	*carinata, Aleuron*
14	*Manduca florestan*	24	*Callionima calliomenae*	34	*ceculus, Aellopos*
15	*Manduca rustica*	26	*Callionima falcifera*	74	*ceratomioides, Xylophanes*
16	*Manduca sexta*	23	*Callionima pan*	75	*chiron, Xylophanes*
17	*Manduca diffissa*	8	*Cocytius antaeus*	57	*chloroptera, Aleuron*
18	*Manduca hannibal*	61	*Enyo gorgon*	20	*cingulata, Agrius*
19	*Manduca ochus*	59	*Enyo lugubris*	35	*clavipes , Aellopos*
20	*Agrius cingulata*	60	*Enyo ocypete*	9	*cluentius, Neococytius*
21	*Pachylia ficus*	46	*Erinnyis alope*	27	*coffaeae, Nyceryx*
22	*Pachylia syces*	51	*Erinnyis crameri*	51	*crameri, Erinnyis*
23	*Callionima pan*	49	*Erinnyis ello*	2	*daphne, Adhemarius*
24	*Callionima calliomenae*	48	*Erinnyis impunctata*	17	*diffissa, Manduca*
25	*Callionema inuus*	47	*Erinnyis lassauxii*	6	*duponchel, Cocytius*
26	*Callionima falcifera*	52	*Erinnyis obscura*	49	*ello, Erinnyis*
27	*Nyceryx coffaeae*	50	*Erinnyis oenotrus*	4	*eurycles, Protambulyx*
28	*Nyceryx maxwelli*	62	*Eumorpha anchemolus*	37	*fadus, Aellopos*
29	*Nyceryx riscus*	70	*Eumorpha capronnieri*	26	*falcifera, Callionema*
30	*Nyceryx stuarti*	67	*Eumorpha fasciatus*	67	*fasciatus, Eumorpha*
31	*Perigonia pallida*	70	*Eumorpha labruscae*	21	*ficus, Pachylia*
32	*Perigonia lusca*	65	*Eumorpha megaeacus*	14	*florestan, Manduca*
33	*Eupyrrhoglossum sagra*	66	*Eumorpha obliquus*	12	*franciscae, Manduca*
34	*Aellopos ceculus*	68	*Eumorpha phorbas*	1	*gannascus, Adhemarius*
35	*Aellopos clavipes*	63	*Eumorpha satellitia*	61	*gorgon, Enyo*
36	*Aellopos titan*	66	*Eumorpha vitis*	18	*hannibal, Manduca*
37	*Aellopos fadus*	33	*Eupyrrhoglossum sagra*	13	*huascara, Manduca*
38	*Oryba kadeni*	44	*Hemeroplanes triptolemus*	48	*impunctata, Erinnyis*
39	*Oryba achemenides*	72	*Hyles lineata*	25	*inuus, Callionema*
40	*Pachylioides resumens*	54	*Isognathus caricae*	58	*japix, Unzela*
41	*Madoryx oiclus*	53	*Isognathus scyron*	38	*kadeni, Oryba*
42	*Madoryx plutonius*	43	*Madoryx bubastus*	70	*labruscae, Eumorpha*
43	*Madoryx bubastus*	41	*Madoryx oiclus*	47	*lassauxii, Erinnyis*
44	*Hemeroplanes triptolemus*	42	*Madoryx plutonius*	10	*lefeburii, Manduca*
45	*Phryxus caicus*	11	*Manduca albiplaga*	72	*lineata, Hyles*
46	*Erinnyis alope*	17	*Manduca diffissa*	76	*loelia, Xylophanes*
47	*Erinnyis lassauxii*	14	*Manduca florestan*	7	*lucifer, Cocytius*
48	*Erinnyis impunctata*	12	*Manduca franciscae*	59	*lugubris. Enyo*
49	*Erinnyis ello*	18	*Manduca hannibal*	32	*lusca, Perigonia*
50	*Erinnyis oenotrus*	13	*Manduca huascara*	28	*maxwelli, Nyceryx*
51	*Erinnyis crameri*	10	*Manduca lefeburii*	65	*megaeacus, Eumorpha*
52	*Erinnyis obscura*	19	*Manduca ochus*	77	*neoptolemus, Xylophanes*
53	*Isognathus scyron*	15	*Manduca rustica*	64	*obliquus, Eumorpha*
54	*Isognathus caricae*	16	*Manduca sexta*	52	*obscura, Erinnyis*
55	*Pseudosphinx tetrio*	9	*Neococytius cluentius*	19	*ochus, Manduca*
56	*Aleuron carinata*	27	*Nyceryx coffaeae*	60	*ocypete. Enyo*
57	*Aleuron chloroptera*	28	*Nyceryx maxwelli*	50	*oenotrus, Erinnyis*
58	*Unzela japix*	29	*Nyceryx riscus*	41	*oiclus, Madoryx*
59	*Enyo lugubris*	30	*Nyceryx stuarti*	31	*pallida, Perigonia*
60	*Enyo ocypete*	39	*Oryba achemenides*	3	*palmeri, Adhemarius*
61	*Enyo gorgon*	38	*Oryba kadeni*	23	*pan, Callionima*
62	*Eumorpha anchemolus*	71	*Pachygonidia caliginosa*	68	*phorbas, Eumorpha*
63	*Eumorpha satellitia*	21	*Pachylia ficus*	78	*pistacina, Xylophanes*
64	*Eumorpha obliquus*	22	*Pachylia syces*	79	*pluto, Xylophanes*
65	*Eumorpha megaeacus*	40	*Pachylioides resumens*	42	*plutonius, Madoryx*
66	*Eumorpha vitis*	32	*Perigonia lusca*	80	*porcus, Xylophanes*
67	*Eumorpha fasciatus*	31	*Perigonia pallida*	40	*resumens, Pachylioides*
68	*Eumorpha phorbas*	45	*Phryxus caicus*	29	*riscus, Nyceryx*
69	*Eumorpha capronnieri*	4	*Protambulyx eurycles*	15	*rustica, Manduca*
70	*Eumorpha labruscae*	5	*Protambulyx strigilis*	33	*sagra, Eupyrrhoglossum*
71	*Pachygonidia caliginosa*	55	*Pseudosphinx tetrio*	63	*satellitia, Eumorpha*
72	*Hyles lineata*	58	*Unzela japix*	53	*scyron, Isognathus*
73	*Xylophanes anubus*	73	*Xylophanes anubus*	16	*sexta, Manduca*
74	*Xylophanes ceratomioides*	74	*Xylophanes ceratomioides*	5	*strigilis, Protambulyx*
75	*Xylophanes chiron*	75	*Xylophanes chiron*	30	*stuarti, Nyceryx*
76	*Xylophanes loelia*	76	*Xylophanes loelia*	22	*syces, Pachylia*
77	*Xylophanes neoptolemus*	77	*Xylophanes neoptolemus*	81	*tersa, Xylophanes*
78	*Xylophanes pistacina*	78	*Xylophanes pistacina*	55	*tetrio, Pseudosphinx*
79	*Xylophanes pluto*	79	*Xylophanes pluto*	82	*thyelia, Xylophanes*
80	*Xylophanes porcus*	80	*Xylophanes porcus*	36	*titan, Aellopos*
81	*Xylophanes tersa*	81	*Xylophanes tersa*	83	*titana, Xylophanes*
82	*Xylophanes thyelia*	82	*Xylophanes thyelia*	44	*triptolemus, Hemeroplanes*
83	*Xylophanes titana*	83	*Xylophanes titana*	84	*tyndarus, Xylophanes*
84	*Xylophanes tyndarus*	84	*Xylophanes tyndarus*	66	*vitis, Eumorpha*

Apparent lack of chytrid infection in northeast Tobago's frogs

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ABSTRACT

Six species of Tobago frogs (including the stream frog *Mannophryne olmonae*) from 11 sites across the northeast of the island were tested in 2016 for the presence of the pathogenic chytrid fungus *Batrachochytrium dendrobatidis*. No chytrid was detected in any of the 176 samples (20-39 frogs per species). These results contrast with a 2006 survey which found chytrid in 25% of the *M. olmonae* individuals sampled, though none in smaller samples of four other species. Together with similar results from Trinidad, our findings indicate that the infection may have died out or be at a very low level in Trinidad and Tobago. However, there is a need to sample from the south of Tobago and from two threatened species not yet assessed.

Key words: amphibians, Caribbean, chytridiomycosis, Tobago

INTRODUCTION

The infectious disease chytridiomycosis whose aetiological agent is the fungus *Batrachochytrium dendrobatidis* (Bd) has been identified as one cause of the widespread population declines afflicting the World's amphibians (Stuart *et al*. 2004; Kilpatrick *et al*. 2010). In recent years it has become apparent that amphibian species vary widely in their susceptibility to the disease, with some acting as carriers while themselves remaining asymptomatic, whilst others suffer high mortality rates (Venesky *et al*. 2014).

In Trinidad and Tobago, Alemu *et al*. (2008,2013) reported the occurrence of Bd infection in both of the endemic aromobatid species, *Mannophryne olmonae* (Tobago) and *M. trinitatis* (Trinidad) although they saw no signs of clinical disease in either species. Greener *et al*. (2017) and Shepherd *et al*. (2016) carried out new surveys for chytrid in Trinidad, re-sampling *M. trinitatis* but also testing other species, both from single-species sites and from multi-species assemblages. Greener *et al.* found no chytrid infected individuals in a sample of 116 *M. trinitatis* from six sites, including some sites where Alemu *et al.* (2013) collected chytrid-positive samples. Shepherd *et al*. found no chytrid in 245 frogs from a further 15 species sampled across nine widely separated sites, both single and multi-species assemblages. In the light of these findings, it seemed worthwhile to re-test Tobago's frogs for chytrid, ten years after the previous assessment. We report on the results of these tests here.

METHODS

Site and species selection

Chytrid swabbing was conducted in Tobago between June and August 2016. A total of eleven sites were visited and six species sampled (Table 1; Figure 1), all in the north-east of the island. At two sites, only *Mannophryne olmonae* was sampled. At the other eight sites 1-4 species were sampled. Table 1 lists only the species that were sampled at each site, not the complete list of species detected at each site. *M. olmonae* is a day active frog, so sampling occurred during daylight hours. The other five species are active and were sampled at night. Scientific names follow Frost (2017).

Sampling methods

Frogs were caught by hand or with the aid of a small hand-net, and were transferred to individual polythene bags. The collection team were all trained in frog identification by JRD and had Murphy (1997) available to check any doubtful identifications. Where possible, chytrid sampling took place at the capture site and frogs were released once all had been swabbed. On occasion, when the number of frogs captured was very large, or the weather too wet for reliable swabbing, the frogs in their bags were transferred to our base in Charlotteville, swabbed there and returned to their capture site next morning. Swabbing was all carried out by RT to ensure uniform technique, and followed the standard protocol (Brem *et al*. 2007), as used also in Trinidad by Greener *et al*. (2017) and Shepherd *et al*. (2016). Gloves were routinely used for frog handling and discarded after each use, as were the polythene bags, to avoid any cross contamination. In addition, nets were disinfected with bleach after use. Clinical grade sterile Deltalab swabs were used to sample the skin of each frog. They were stored in sterile 1ml vials with 0.5 ml ethanol added to preserve the collected DNA, and sealed with a screw cap. Vials were stored in our base freezer and later transferred to the UK by air in a cool bag.

Each site was sampled only once per species, to avoid

Fig. 1. Map of northeast Tobago showing the sites sampled for this study.

any risk of sampling the same individuals more than once. The exception to this was Dead Bay pond where ten *Leptodactylus validus* were sampled one night early during the study, and then a further 25 were sampled six weeks later; the intention was to test whether there was any evidence of a change in chytrid occurrence over time, given the multi-species breeding assemblages at this site.

Sample analysis

DNA was extracted using Bioline genomic extraction kit and standard PCR carried out as described by Shepherd *et al*. (2016). The positive control DNA for Bd was supplied by Professor Andrew Cunningham, Institute of Zoology, London.

RESULTS

A total of 188 frogs were sampled, with the smallest species sample size being 27 (Table 2). DNA could not be extracted from 12 samples, so the total number of analysed samples was 176. No sample tested positive for chytrid. As insurance that we had performed the assay correctly, our negative control showed no DNA and our positive controls with low and higher amounts of chytrid DNA both showed positive. Since no Tobago sample gave positive results, there was no basis for a comparison between the two *Leptodactylus validus* samples collected from Dead Bay pond at different times, so they are all presented together in Table 2. Of the 12 samples which lacked extractable DNA, ten were from the Tobago glass frog, *Hyalinobatrachium orientale* (reducing the number of that species that could be tested to 20). During the fieldwork, no frogs were observed with clinical symptoms of chytrid infection. A few frogs did look unhealthy e.g. a few *Boana xerophylla* (previously *Hypsiboas crepitans*) had green growths on their hands and feet, but this is not a symptom normally associated with chytridiomycosis.

DISCUSSION

Alemu *et al*. (2008) carried out their survey during June-September 2006. They sampled 84 *Mannophryne olmonae* from five northeast rivers (Argyle, Bloody Bay, Doctor's, King's Bay and Louis d'Or) and three Northside Road streams, but caught most of these frogs (64) at Doctor's. At Doctor's, they found 29.7% positive for chytrid; chytrid was also detected at two other sites (Argyle and one of the Northside Road streams), giving 25% positives for the whole sample. They also tested four other species: two each of *Leptodactylus validus*, *Pristimantis charlottevillensis* and *Hyalinobatrachium orientale*, and 34 *Rhinella marina,* all of which were negative for chytrid. None of the chytrid-positive frogs showed clinical signs of disease.

Our survey, ten years after that of Alemu *et al*., covered several of the same sites (Argyle, Louis d'Or, Doctor's) and therefore provides a direct comparison. The difference in results could relate to sample size (Alemu

Table 1. Descriptions of the eleven sites, with the frog species sampled from each. Site names are as on local maps, except where such names are lacking and have been given by University of Glasgow expeditions e.g 'Mystery' river. Abbreviations for frog names: OL, *Mannophryne olmonae*; VA, *Leptodactylus validus*; PU, *Engystomops pustulosus*; BX, *Boana xerophylla*; CV, *Pristimantis charlottevillensis*; HO, *Hyalinobatrachium orientale*. GPS co-ordinates differed slightly at different locations within each site; for simplicity, we give only one set of co-ordinates for each site.

Site name and GPS co-ordinates	Species collected	Site characteristics
Hermitage N11.31435, W060.57454	HO,CV,BX, VA	Medium to high vegetation with *Heliconia* and ferns.Canopy closed where glass frogs were located, and stream running constantly. Elsewhere, canopy open, stream intermittent. Substrate rocks and pebbles.
Cambleton N11.31667, W060.55733	CV,VA	Medium to high vegetation with *Heliconia* and some bamboo. Canopy closed, stream intermittent. Substrate: leaf litter.
Merchiston N11.28638, W060.54179	OL, BX, CV	Medium height vegetation, mostly small plants. Canopy open, stream intermittent. Substrate: leaf litter.
Louis d'Or 'original' N11.27180, W060.56355	CV	High vegetation with *Heliconia* and ferns at some points, elsewhere, bamboo, ferns and open canopy. Stream constant. Substrate: leaf litter, rocks, pebbles.
Louis d'Or 'new' N11.27049, W060.56311	OL, CV	Medium height vegetation with *Heliconia*, ferns and small plants. Closed canopy, stream intermittent. Substrate: leaf litter.
Main Ridge N11.28667, W060.59545	HO,CV	High palms and ferns. Canopy closed, stream constant. Substrate: rocks, silt, mud.
'Mystery' N11.31566, W060.62614	OL	High ferns and small plants with canopy partly closed. Stream constant. Substrate: leaf litter, rocks, pebbles.
Argyle Waterfall N11.25953, W060.58602	OL	Low ferns, canopy open. Major river. Substrate: rocks and pebbles.
Doctor's river N11.31104, W060.53991	OL, HO, CV	High *Heliconia* and ferns where glass frogs were found. Elsewhere, smaller plants including low ferns, canopy open, stream constant. Substrate: leaf litter, rocks, pebbles.
Dead Bay river N11.29070, W060.63354	HO, CV, VA	High *Heliconia* and ferns where glass frogs were found, canopy open, stream constant. Substrate: leaf litter, rocks, pebbles.
Dead Bay pond N11.29152, W060.63214	BX,VA,PU	Pond surrounded by low vegetation; open canopy. Edges part concrete, part grass. Bottom of pond muddy with rotting timber.

Table 2. The number of individual frogs of each species sampled at each site. *= no DNA extracted. Species name abbreviations as in Table 1.~=additional sample 6 weeks later than the first.

Site	Numbers of each species					
	HO	OL	VA	PU	BX	CV
Hermitage	6(*1)	0	2	0	1	6(*1)
Cambleton	0	0	1	0	0	2
Merchiston	0	18	0	0	5	2
Louis d'Or original	0	0	0	0	0	2
Louis d'Or new	0	2	0	0	0	2
Main Ridge	11(*5)	0	0	0	0	5
Mystery	0	4	0	0	0	0
Argyle Waterfall	0	4	0	0	0	0
Doctor's	4	3	0	0	0	3
Dead Bay river	9(*4)	0	1	0	0	5
Dead Bay pond	0	0	10(~25)	30(*1)	25	0
TOTALS	30	31	39	30	31	27

et al. caught 64 at Doctor's alone, while our *M. olmonae* sample was 31 in total from five sites). However, if chytrid was going to take hold in Tobago, it would be expected to spread in the ten years since the first survey and possibly to affect other species. Instead, we found no chytrid in *M. olmonae* or in substantial samples of five other species. Of these, three (*P. charlottevillensis*, *B. xerophylla* and *H. orientale*) were found at the same sites as *M. olmonae* and therefore might have been expected to have become infected. Research elsewhere (Scheele *et al.* 2017) shows that asymptomatic infections in one species can amplify the harmful effects on a susceptible species where the two co-occur. The Dead Bay pond we surveyed is used as a breeding site by several species in very large numbers (*Trachycephalus typhonius* and *Dendropsophus minutus* in addition to those we surveyed: JRD, personal observations) and would therefore be expected to act as a place where chytrid, if present, could easily spread. Our conclusion therefore is that chytrid, while present in at least one species ten years ago, is now absent or at very low levels or in very restricted locations.

One deficiency in our results was the lack of DNA in 12 of our samples. Ten of these cases were from *H.orientale* (Table 2), suggesting that the failures may relate more to the species than to our technique overall. These are very small delicate frogs and it may be that in some individuals, our swabbing was too gentle to extract an adequate sample.

One of Alemu *et al.*'s concerns was that they had found chytrid in one of Tobago's endemic species. At that time, IUCN rated *M. olmonae* as Critically Endangered, so the discovery of chytrid in the population was particularly worrying. Since then, following work by Lehtinen *et al.* (2016), the conservation status of *M. olmonae* has been softened to Vulnerable. When added to our findings on chytrid, Lehtinen *et al*.'s results provide a more hopeful view of the future of this species.

Both of the investigations into chytrid's status in Tobago's frogs have been conducted in the northeast of the island. This is justifiable since the northeast is the principal location of Tobago's endemic and threatened species (Murphy 1997). However, not all of the threatened species (IUCN 2016) have been assessed for chytrid: *Pristimantis turpinorum* is a Tobago endemic with a very restricted range, an IUCN rating of Vulnerable, and should be assessed; *Flectonotus fitzgeraldi* occurs in Tobago, Trinidad and Venezuela, but has an IUCN rating of Endangered- the problem is that its habits make it extremely difficult to capture in adequate numbers to assess properly.

The occurrence and impact of chytrid in the Caribbean has been patchily reported. Olson *et al.* (2013) provided maps of chytrid's distribution up to 2011. Caribbean islands positive for chytrid were Cuba, Hispaniola (Dominican Republic), Puerto Rico, Dominica and the British Virgin Islands, whilst those showing no chytrid were Jamaica, Montserrat, Barbados and Grenada. Other islands appeared not to have been assessed, although Olson *et al.*'s dataset omitted Alemu *et al*.'s (2008) Tobago study. Since then, Greenhawk *et al*. (2017) and Sabino-Pinto *et al*. (2017) have confirmed the presence of chytrid at low levels of prevalence in Puerto Rico and Cuba respectively. In contrast, Hudson *et al.* (2016) reported the devastating effects on the Critically Endangered endemic mountain chicken (*Leptodactylus fallax*) of the arrival of chytrid first in Dominica and later in Montserrat. Rodriguez-Brenes *et al.* (2016) discussed the importance of studying chytrid prevalence in low altitude tropical locations where the infection can be asymptomatic but act as a reservoir for spread to cooler, wetter, often montane habitats where mortality occurs. Our findings give some grounds for optimism concerning Tobago's frogs, but regular monitoring is advisable.

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Influence of forest disturbance on bat community diversity in northeast Tobago, West Indies

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ABSTRACT

Bat assemblages were sampled at three habitats of varied disturbance within northeast Tobago over a 10-week period. Overall 995 individuals, representing 15 species, were caught through the use of mist nets. Community diversity, evenness, abundance, and feeding guild composition across sites were recorded. Our analysis showed lower species diversity and richness within the site experiencing ongoing disturbance. Results from the secondary forest suggest diversity can recover to natural levels if this disturbance ends. However, some species were only located within primary forest, which may be a result of specific ecological requirements.

Key words: Chiroptera, mist-netting, diversity

INTRODUCTION

Anthropogenic disturbance has reduced the quality, size, and number of forest habitats within the Neotropics, consequently impacting the animal species residing within them (Chapin III *et al.* 2000, Gibson *et al.* 2011). Different bat species show different levels of sensitivity to environmental change, in some cases leading to local extinctions and consequently shifts in community composition (Fenton *et al.* 1992, Medellín *et al.* 2000). This response to disturbance can differ between feeding guilds, for example gleaning animalivore numbers may decrease while frugivores benefit (Clarke *et al.* 2005). It is important to assess the effect of disturbance on bat communities within the tropics as they provide a variety of important ecosystem services such as pollination, seed dispersal, and pest control (Medellín *et al.* 2000).

The country of Trinidad and Tobago has recorded 68 species of bats, 24 of which are found in Tobago (Gomes and Reid 2015). While studies have previously been carried out in Tobago to assess the bat fauna present, there is currently no literature assessing the composition of habitat-specific bat communities on the island. Tobago's natural landscape supports a variety of forest habitats, containing lower montane, lowland and xerophytic rainforest, semi-evergreen and deciduous seasonal forest, dry evergreen forest and forested wetland. In recent history a fluctuating agricultural industry has left secondary forest covering the majority of the landscape, as sites have been left to recover and regenerate when plantations were abandoned (Helmer *et al.* 2012). Within the centre of the landmass, a smaller area of the primary montane forest remains, protected since 1776 as part of the Main Ridge Forest Reserve. Small towns surround the forested area, situated along the coastal road (Helmer *et al.* 2012, UNESCO).

The impact of landscape disturbance has been observed to affect multiple aspects of bat diversity and community structure within the Neotropics. Decreased species richness and diversity has been found within deforested areas of tropical forests (Brosset *et al.* 1996, Fenton *et al.* 1992). Selective logging in Trinidad was determined to have altered feeding guild abundance in comparison to primary forest (Clarke *et al.* 2005), while local-scale fragmentation of Neotropical forests was found to reduce species richness in Panama (Meyer *et al.* 2008). This paper presents the results of mist-net sampling of bat communities from three sites in northeast Tobago; an urban area, secondary forest and primary forest.

METHODS

Surveys were conducted over a ten week period from 21 June to 17 August 2016 using mist nets at ground and sub-canopy level. A total of 18 nights of sampling took place at three locations within northeast Tobago, six sample nights for each site. The sites consisted of an urban area experiencing frequent anthropogenic disturbance (Charlotteville Village, N11.32148, W060.55398) a secondary forest undergoing succession following previous disturbance (Dead Bay River, N11.29115, W060.63352), and a primary forest containing the mature climax vegetation of the island (Main Ridge Forest Reserve, N11.27832, W060.58253) (Fig.1). Detailed forest maps of Tobago allowed accurate identification of forest type and land cover (Helmer *et al.* 2012).

To determine the community composition at each site, individuals were caught and identified to species level through the use of field keys (Gomes and Reid 2015, Reid 2009). Three nylon mist nets were placed at ground level (2 x 12m, 1 x 9m) (monofilament 0.08mm , height 2.4m) and two nets at sub-canopy level (2 x 9m) to intercept potential flight paths along natural corridors. Nets were opened at sunset for four hours each night, typically from 1830h to 2230h, and checked every 15 minutes. Upon capture, each individual was weighed using Pesola Spring Balances

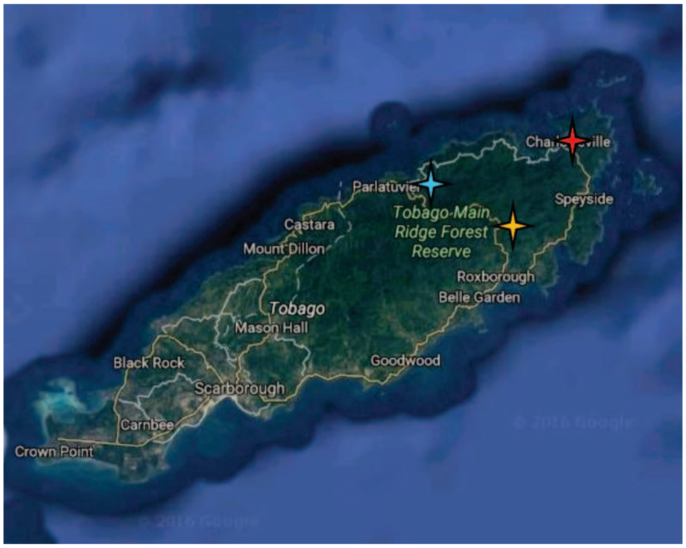

Fig. 1. Map of Tobago showing location of study sites (Urban Site: red, Secondary Site: blue, Primary Site: yellow) T

and forearm size was measured using 0-150mm Dialmax Vernier Dial Callipers (to the nearest 0.1mm) to assist in species identification (Gomes and Reid 2015, Reid 2009).

Data were analysed using programme R and package "vegan" (Oksanen *et al*. 2018). Calculation of mist net hours (MNH) assessed the capture rates between sites, and Pearson's Chi-square Test was used to evaluate statistical significance. The number of individuals caught of each species was recorded (abundance). Whittaker's Rank Abundance Plots were applied to represent the relative abundances per site against species rank. This allowed comparison between sites, despite differences in size and species composition (Magurran and McGill 2011). To allow improved comparison of species richness between sites, sample based accumulation curves were fitted for species richness at each site. An asymptote for abundance data was estimated using first order Jackknife estimators. Macgurran and McGill (2011), found that non-parametric measures (Chao 1, Chao 2, Jackknife) performed better in comparison to parametric measures as more precise, efficient, and less biased. In this study Jackknife was chosen against Chao 1 and Chao 2, as both Chao estimators calculated species richness to be lower than our observed species richness. Beta diversity was calculated using the Whittaker Index (βw), assessed pairwise over the three sites (Whittaker 1960). Whittaker's index of beta diversity was used as it is an effective index of species turnover (Koleff *et al.* 2003). Simpson's Reciprocal Index and Simpson's Evenness were used to evaluate the species diversity and species dominance respectively within each test site (Simpson 1949). Simpsons Index (1/D) was divided by species richness (S) to find Simpsons Evenness. One-way analysis of variance (ANOVA, F) was conducted on these two measures to determine if the differences across habitats was statistically significant. Power analysis of this ANOVA calculation ($f=1.6$, $p= 0.01$, power = 0.9) recommended a minimum of 4.013 samples nights per site, which confirmed our six sample nights per site as adequate. Where statistical significance was detected, additional post hoc Tukey Tests were carried out to assess the sites pairwise. Analysis of individual abundance per feeding guild were compared between sites using Pearson's Chi-Squared Test.

RESULTS

Sampling Effort: A total of 375.5 mist net hours were carried out over 18 sample nights. The overall capture rate was found to be 2.8 bats net^{-1} h^{-1}. Capture rate was 1.9 bats net^{-1} h^{-1} at the urban site and 2.4 bats net^{-1} h^{-1} at the secondary site. The most successful capture rate was found at the primary site at 4.1 bats net^{-1} h^{-1} (Table 1). This difference in individuals caught was shown to be statistically significant ($\chi 2= 116.14$, $p<0.005$).

Species Composition & Abundance: A total of 995 bats were sampled, representing 15 species from four families (Table 2). The Phyllostomidae accounted for the majority of bats caught (94.7%), followed by Vespertilionidae (3.3%), then Molossidae (1.5%) and Emballonuridae (0.5%). Individual species counts were dominated by species from the Phyllostomidae family

Table 1. Summary of total number of individuals sampled (n), mist net hours, and rate of capture per net per hour, as defined by the different nets used for each site.

Site	**Ground Nets**			**Triple High Nets**			**Total**		
	n	**MNH**	**Bats net^{-1} h^{-1}**	**n**	**MNH**	**Bats net^{-1} h^{-1}**	**n**	**MNH**	**Bats net^{-1} h^{-1}**
Urban	64	48.5	0.8	158	72	2.2	223	120.5	1.9
Secondary	138	47	2.9	146	72	2	284	119	2.4
Primary	221	44.5	5	267	73.5	3.6	488	118	4.1
Total	424	140	3	572	217.5	2.6	995	357.5	2.8

- *Artibeus jamaicensis* (60.3%), *Carollia perspicillata* (15.6%), and *Artibeus cinereus* (11.8%). All other species were present at relatively low numbers (2.6% - 0.2%). The urban site contained 46.7% of the total species caught, the secondary site contained 86.7%, and the primary site contained 93.3%. Six species were shared among all habitats sampled (*C. perspicillata, Glossophaga longirostris, Artibeus lituratus, A. jamaicensis, A. cinerus and Myotis attenboroughi*). Three species were found exclusively within the primary site (*Saccopteryx leptura, Micronycteris megalotis, and Centurio senex*). One individual of the species *Anoura geoffroyi* was captured at the secondary site, and one individual at the primary site. Whittaker rank abundance plots (Fig. 2) depict the relative abundance of species within each sample site. At all three sample sites, the majority of species are found to be rare while a small number of species are abundant in high numbers, indicating a low species evenness.

Species Richness & Diversity: Species accumulation curves achieved a near asymptote for both the urban and primary site. A slightly lower rate of accumulation is present for the secondary site and while the curve levels out slightly, no clear asymptote was reached (Fig. 3). Regression analysis for total species richness (Fig. 4) estimated the asymptote would occur at 8.1 for the urban site, 15.5 for the secondary site, and 14.8 for the primary site. This indicates sampling detected close to the total estimated species for the urban and primary site, while at the secondary site 3 - 4 species remained unrecorded.

The beta diversity across all sites was 0.36. The lowest beta diversity value was found between the secondary and primary site ($\beta w = 0.15$), followed by the urban and secondary site ($\beta w=0.26$). The highest beta diversity value was found between the urban and primary site ($\beta w =0.42$). Bat species diversity as calculated through Simpsons Index (1/D) showed a significant difference between the study sites (one-way ANOVA, $F (2, 15) =15.52$, $p=0.0002$). The urban site showed statistically significant differences from both secondary and primary sites ($p=0.0001$, $p=0.005$ respectively). As $p>0.05$ between the secondary site and the primary site, there was no significance difference between bat species diversity at the two sites. No significant difference was present for Simpson's Evenness between any of the survey sites (Table 3).

Table 2. Bat species captured within the study, along with their respective family and sub-family, feeding guild, total sample abundance and sample abundance found within each Site. See table 4 for feeding guilds.

Taxon			Guild	Site			Total
Family	Subfamily	Species		Urban	Secondary	Primary	
Emballonuridae		*Saccopteryx leptura*	AI	0	0	5	5
Molossidae		*Molossus molossus*	AI	13	2	0	15
Phyllostomidae	Carolliinae	*Carollia perpicillata*	F	14	52	79	145
	Glossophaginae	*Anoura geoffroyi*	N	0	1	1	2
		Glossophaga longirostris	N	1	4	2	7
	Phyllostomianae	*Micronycteris megalotis*	GA	0	0	2	2
		Phyllostomus hastatus	O	0	3	6	9
	Stenodermatinae	*Artibeus lituratus*	F	3	11	8	22
		Artibeus jamaicensis	F	185	131	284	600
		Artibeus cinereus	F	6	44	66	116
		Chiroderma villosum	F	0	9	2	11
		Centurio senex	F	0	0	2	2
		Sturnira lilium	F	0	9	17	26
Vespertilionidae		*Eptesicus brasiliensis*	AI	0	11	11	22
		Myotis nigricans	AI	1	7	3	11
			Total	223	284	488	995

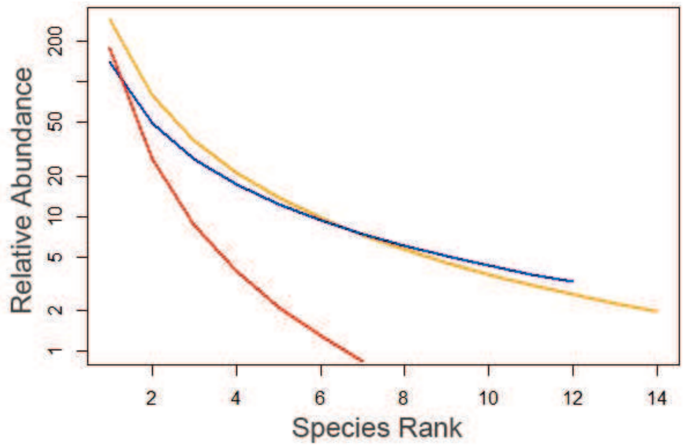

Fig. 2. Log relative species abundance for a) urban site, b) secondary site, c) primary site

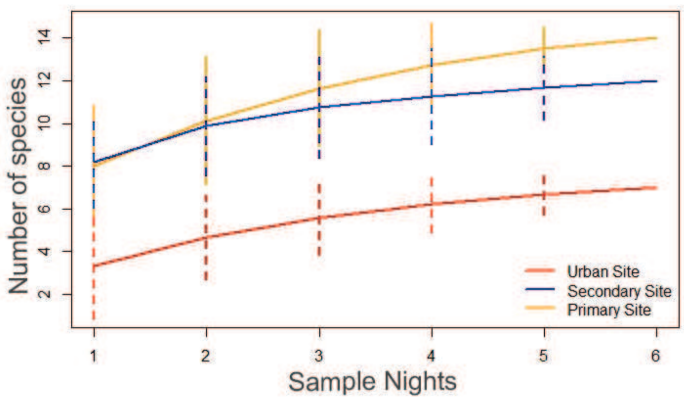

Fig. 3. Sample-based species accumulation curve for each site sampled.

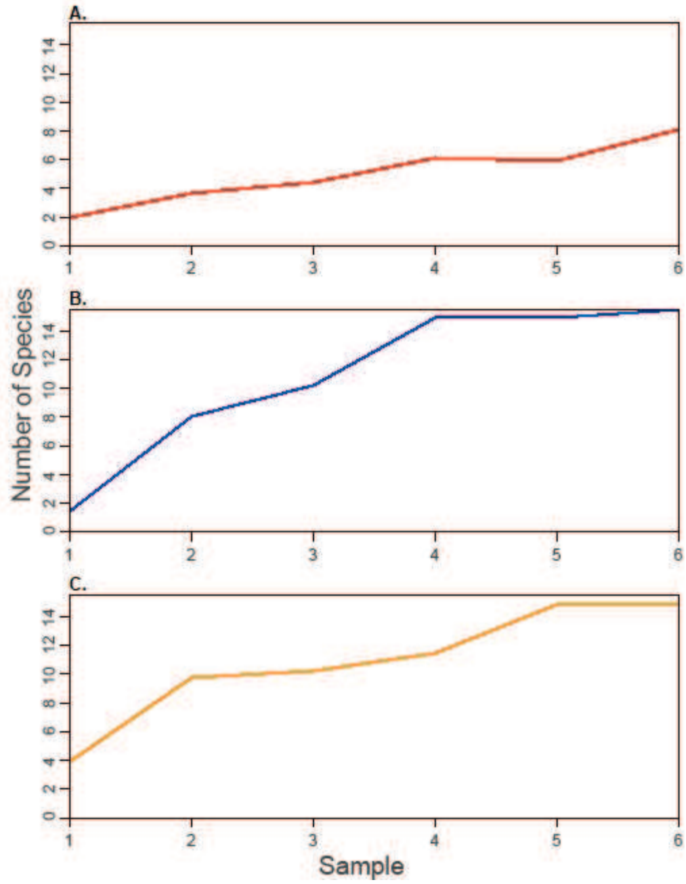

Fig. 4. Estimated species richness using first-order jackknife for A. urban site, B. secondary forest site, C. primary forest site.

Feeding Guilds: Trophic analysis for number of individuals captured showed frugivores dominated all habitats, representing over 90% of individuals at any site sampled. Aerial insectivores were the next most common guild, averaging over 5% of total number captured. Nectarivores, omnivores and gleaning animalivores all fell beneath 1% of captures. (Table 4). Gleaning animalivores and omnivores were represented by just one species each, *Micronycteris megalotis* and *Phyllostomus hastatus* respectively (Table 1). In addition, the gleaning animalivorous guild was only present within the primary site. No statistical significance was found for differences in feeding guild abundance between sample sites.

DISCUSSION

The three bat communities sampled were found to differ in terms of species abundance, species diversity, and species richness. Both diversity and richness were significantly lower in the urban site, which suffers from continuous anthropogenic disturbance. The secondary site was indicated to contain the highest species diversity and estimated richness. The highest abundance of individuals was recorded at the primary site, which was also home to three species not detected in either of the other two habitats. Higher bat species turnover occurs between the urban site and the primary site, where habitat variation lowers the proportion of species shared between two sites (Estrada and Coates-Estrada 2002). Both the beta diversity and alpha diversity values agree with our assumption of a disturbance gradient affecting the habitats, from the urban to secondary site then primary site.

One trait that appears to be shared by all bat assemblages sampled in Tobago is domination of community composition by a small number of species, as seen in the Whittaker rank abundance plots and species evenness calculations. This is a typical characteristic of island habitats and tropical rainforest communities (Meyer and Kalko 2008, Stevens and Willig 2002). In this study, *A. jamaicensis* is the predominant species found at all sites. As a generalist frugivore capable of undertaking prolonged flights, *A. jamaicensis* is able to exploit human modified landscapes avoided by more sensitive species (Ortega and Castro-Arellano 2001).

The urban site used within our study suffers from light pollution, sound pollution, human activity and reduced vegetation, and subsequently provides fewer ecological niches (Brosset *et al.* 1996, Hourigan *et al*. 2006). The low species diversity and richness recorded at this site corresponds with other studies noting lower diversity in deforested habitats (Clarke *et al.* 2005, Fenton *et al.* 1992). Four out of the seven species caught within the urban area had previously been identified as the first species to colonise a disturbed area (*A. jamaicensis*, *A. cinereus*, *C. perspicillata*, *M. molossus)* (Brosset *et al.* 1996). The disturbances affecting this habitat may prevent reforestation from occurring, thus reducing the ability of other, less resilient, bat species to persist here.

The Phyllostominae sub-family of bats, represented here by *M. megalotis* and *P. hastatus*, show sensitivity to disturbance and are often only present in pristine landscapes (Bobrowiec and Gribel 2010, Medellín *et al.* 2000). *M. megalotis* was located solely within the primary site. This habitat restriction may be a consequence of dietary specialisation as a gleaning animalivore, hunting arthropods and vertebrates from surfaces in narrow space, rendering the species unable to adapt to anthropogenic disturbance (Clarke *et al.* 2005). *P. hastatus* is a large omnivorous predator that avoids areas where habitat modification is present (Schulze *et al.* 2000). The presence of *P. hastatus*within the secondary site indicates the site has recovered to a significant degree from previous disturbance.

Frugivores accounted for over 90% of individuals captured within the study, and the resulting seed dispersal carried out by various species allows multiple stages of succession to occur. Bats are responsible for the dispersal of pioneer flora species following habitat disturbance. Upon maturing, this initial vegetation provides more favourable conditions for specialised bat species that frequent later stages of succession, until the seeds of climax flora can be dispersed (Gomes and Reid 2015). However, as is the case with *M. megalotis*, the absence of *C. senex* within the secondary site may show conditions are still not suitable for rarer species that require climax vegetation. *C. senex* has adapted to feed upon mature canopy fruits, and so is less involved in the reforestation of disturbed areas than species such as *C. perspicillata* and *A. jamaicensis* (Gomes and Reid 2015).

The interaction of multiple frugivorous species with their environment can create a more heterogeneous habitat. Species diversity was highest in the secondary site, and our analysis estimates that this site contains the highest number of species. The species accumulation curve (Fig. 3) indicates there may still be a small number of species to be discovered given further sampling effort. The primary site contained more of the specialist species, but with increased disturbance in the secondary forest, the secondary site may be able to support a wider range of species. Both forest specialists and generalists, and edge and open ecosystem species can find suitable habitat here

Table 3. Diversity analysis. Species richness (S), total number of individuals caught, Simpsons Index (1/D, and Simpsons evenness index (1/D/S) between each sample site.

Site	Number of Species (S)	Number of Individuals	Simpson Index (1/D)	Simpsons Eveness Index 1/D/S)
Urban	7	223	1.435	0.205
Secondary	12	285	3.623	0.302
Primary	14	488	1.592	0.185

Table 4. Feedings guilds present at each site, by individuals captured and percentage of total sample

Site	Urban		Secondary		Primary		Total	
Feeding Guild	**Number Captured**	**Percent**	**Number Captured**	**Percent**	**Number Captured**	**Percent**	**Number Captured**	**Percent**
Frugivore	208	93.27%	256	90.14%	458	93.85%	922	92.66%
Nectarivore	1	0.45%	5	1.76%	3	0.61%	9	0.90%
Aerial Insectivore	14	6.28%	20	7.04%	19	3.89%	53	5.33%
Gleaning Animalivore	0	0.00%	0	0.00%	2	0.41%	2	0.20%
Omnivore	0	0.00%	3	1.07%	6	1.23%	9	0.90%

(Castro-Luna *et al.* 2007a, Connell 1978).

The primary site showed the highest capture rate, contrasting with results from Trinidad (Clarke *et al.* 2005), French Guiana (Brosset *et al.* 1996), and Mexico (Medellín *et al.* 2000). Tobago's primary forest has been protected since 1776 when the Main Ridge was established as a Forest Reserve, preventing rainforest fragmentation, which has affected abundance in other Neotropical sites (Meyer *et al.* 2008). The importance of maintaining conservation efforts and protecting areas such as the Main Ridge Forest Reserve is evident, as it allows the persistence of specialised species and guilds sensitive to disturbance while supporting high numbers of individuals.

The use of mist nets within this study may have potentially under-sampled aerial insectivores. Families such as Molossidae and Vespertilionidae include species that possess the ability to detect and avoid mist nets while feeding, although these families do not typically show significant responses to disturbance (Castro-Luna *et al.* 2007b). Mist nets are extremely efficient for sampling the Phyllostomidae family, which is the most species-rich bat family present in the Neotropics. However, additional sampling methods such as acoustic sampling or harp traps could identify previously undetected species (Ochoa *et al.* 2000) and build a more complete community inventory for Tobago. The secondary site has an elevation of around 600m, double the height of both the urban and primary sites. Previous publications in the tropics have found bat species diversity to typically decrease with increasing elevation, and a peak richness occurs at around 300m elevation (McCain 2007). We can therefore exclude this factor as an alternative explanation to our results. Future studies may still benefit from sampling multiple forest sites at differing levels of elevation to identify any relationship between elevation and species diversity within Tobago. Tobago has large expanses of secondary forest, and the ability of the forest to recover from previous disturbance has allowed bat community diversity to recover. As the majority of bat species within our study are frugivores, a suggestion for further research would be to assess the role of bats in forest regeneration on the island.

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Epizoic cyanobacteria associated with harvestmen (Arachnida: Opiliones) from Tobago, West Indies

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ABSTRACT
On Tobago, there is a species of sclerosomatid harvestman (*Prionostemma* sp.) that serves as a host to a variety of cryptogams. In the living condition, the exterior of the harvestmen is light blue in appearance, which quickly fades to a bluish-green following preservation in ethanol. Observations of specimens with scanning electron microscopy (SEM) revealed the occurrence of several types of epizoic organisms, including prokaryotic cells (several sizes of bacilli and cocci) and at least two species of fungi. Moreover, using PCR with specific primers, we confirmed the presence of at least one species of epizoic cyanobacterium occurring on the tegument of the harvestmen. The tegument of the carapace and abdomen of *Prionostemma* sp. is full of numerous small pits that may facilitate colonisation and survival by epizoic organisms.

Key words Camouflage, Cryptogam, Fungi, Sclerosomatidae, Tegument

INTRODUCTION

Epizoic organisms attach to the external surfaces of animals, living as either commensals or mutualists (reviewed by Machado and Vital 2001). Among terrestrial vertebrates, examples include lichens that dwell on the shells of giant tortoises in the Galapagos Islands (Hendrickson and Weber 1964), bryophytes and algae growing on the heads of lizards in Mexico (Gradstein and Equihua 1995) and algae occurring on the hairs of Neotropical sloths (Thompson 1972). Epizoic organisms have also been observed on terrestrial arthropods, including bryophytes growing upon millipedes in Colombia (Martínez-Torres *et al.* 2011), liverworts and lichens that dwell on mantids in Costa Rica (Lücking *et al.* 2010), and cryptogams and their associated microfaunas (e.g., oribatid mites, rotifers and nematodes) occurring on weevils in New Guinea (Gressitt and Sedlacek 1967; Gressitt *et al.* 1968). Among arachnids, in particular, interactions involving epizoic organisms are known to occur in harvestmen (Order Opiliones), which may carry cyanobacteria, liverworts, and nonpathogenic fungi (Machado *et al.* 2000; Machado and Vital 2001; Proud *et al.* 2012; Townsend *et al.* 2012). Only three species of harvestmen representing two families, Gonyleptidae (suborder Laniatores) and Sclerosomatidae (suborder Eupnoi), have been observed to have relationships with epizoic cyanobacteria or bryophytes (Machado and Vital 2001; Proud *et al.* 2012; Townsend *et al.* 2012).

Machado and Vital (2001) noted variation in the colonisation frequencies of gonyleptid harvestmen by epizoic cryptogams in different types of forests and also noted several similarities shared by arthropod hosts that are inhabited by cryptogams. In both weevils and harvestmen, the surfaces of the exoskeletons feature pits, tubercles and granulations, traits that may facilitate colonisation and survival of the epizoites at early life stages. In addition, arthropod hosts tend to be slow-moving, survive for multiple years and inhabit moist habitats. Machado and Vital (2001) also observed that colonising cryptogams are generally common and widespread taxa, rather than specialists, and also have the ability to colonise ephemeral habitats and grow quickly. Observations of epizoic organisms have generally been made only for harvestmen that occur in moist, tropical environments.

In this study, we used scanning electron microscopy and molecular techniques to investigate further the relationship between epizoic organisms on the carapace and abdomen of an unidentified species of sclerosomatid harvestman from Tobago, West Indies. Specifically, we used SEM to survey the diversity of microorganisms on the external surface of the exoskeleton and molecular techniques to confirm the presence of cyanobacteria among the observed types of cryptogams.

METHODS

Adult sclerosomatid harvestmen, identified as *Prionostemma* sp. 6 by Townsend *et al.* (2012), were collected by hand from the leaf litter and vegetation along the trail connecting the Speyside Overlook to Pigeon Peak from 10-14 August 2010 in Tobago (Townsend *et al.* 2012). The primary habitat in this area (11N 17.845 60W 32.934 at 405 m in elevation) is lower montane rainforest, and *Prionostemma* sp. 6 is one of the most commonly species, with individuals often observed moving across the forest floor at night (Townsend *et al.* 2012). In contrast to their syntopic congeners, the individuals of *Prionostemma* sp. 6 with epizoic cyanobacteria that we observed had a distinct light denim blue colour on their dorsum that faded to bluish-green following preservation in 70% ethanol.

We prepared multiple adults (n = 5) for SEM by dehydrating them in an ethanol ladder and chemically drying them with hexamethyldisilazane. Individuals were mounted on aluminium stubs using carbon adhesive strips, sputter coated with gold for 2 min and examined with a Hitachi S-3400 VP SEM at accelerating voltages of 5-15 kV in the SEM laboratory on the campus of Virginia Wesleyan University. Voucher specimens are deposited in the American Museum of Natural History (AMNH) arachnological collection.

Several techniques were used to remove cyanobacterial cells from the preserved individuals in order to isolate the genomic DNA from the bacteria. Surface films of epizoic cyanobacteria were removed from the harvestmen by applying a piece of tape to their body, and then either scraping or washing the tape into a test tube (following the protocol described by Proud *et al.* 2012). In addition to the scotch tape technique, cyanobacterial cells were also scraped off the harvestmen into a 70% ethanol solution and entire bodies of the harvestmen were added to a 70% ethanol solution and agitated with forceps and scissors to dislodge the bacterial cells. Dislodged cells from these preparations were pelleted in a microcentrifuge tube at 13,000 rpm for 2 min. DNA was isolated using the GE Healthcare Illustra Bacteria Genomic Mini Spin Kit (#28-9042-58), following Protocol 5.3 for purification of genomic DNA from gram-positive bacteria. The cyanobacteria *Oscillatoria* (Carolina Biological Supply) was used as a positive control, as it contains the phycocyanin operon from which the IGS primers can amplify a ~700 base pair PCR product. Both an IGS forward primer (5'-GGCTGCTTGTTTACGCGACA-3') and an IGS reverse primer (5'-CCAGTACCACCAGCAACTAA-3') were used to amplify the IGS with PureTaq RTG PCR beads (GE Healthcare; Proud *et al.* 2012). The PCR settings were: 94^{o} C for 5 min followed by 40 cycles of 94^{o} C for 20 seconds, 60^{o} C for 30 seconds, and 72^{o} C for 1 min. PCR products were analysed by gel electrophoresis.

RESULTS

The tegument of the carapace and abdomen of *Prionostemma* sp. 6 are covered in numerous small pits (Figs. 1, 2A-B). Using SEM, we observed that many of these pits were filled with a mixture of soil particles and other detritus (Fig. 2C). In addition, we observed the occurrence of prokaryotic organisms (Fig. 2C) in many of the pits on the carapace and abdomen. Bacteria included several types of cocci (Fig. 2D) and bacilli (Fig. 2D-F). We also observed the occurrence of larger, eukaryotic cells including leaf-shaped structures (Fig. 2E) that resemble the thalli of Laboulbeniales fungi as well as those that may represent fungal hyphae (Fig. 2F). The results of our analysis of the surface films that we removed from the harvestmen revealed the presence of a distinct band of 700 base pairs, a positive result that confirms the presence of cyanobacteria (Fig. 3).

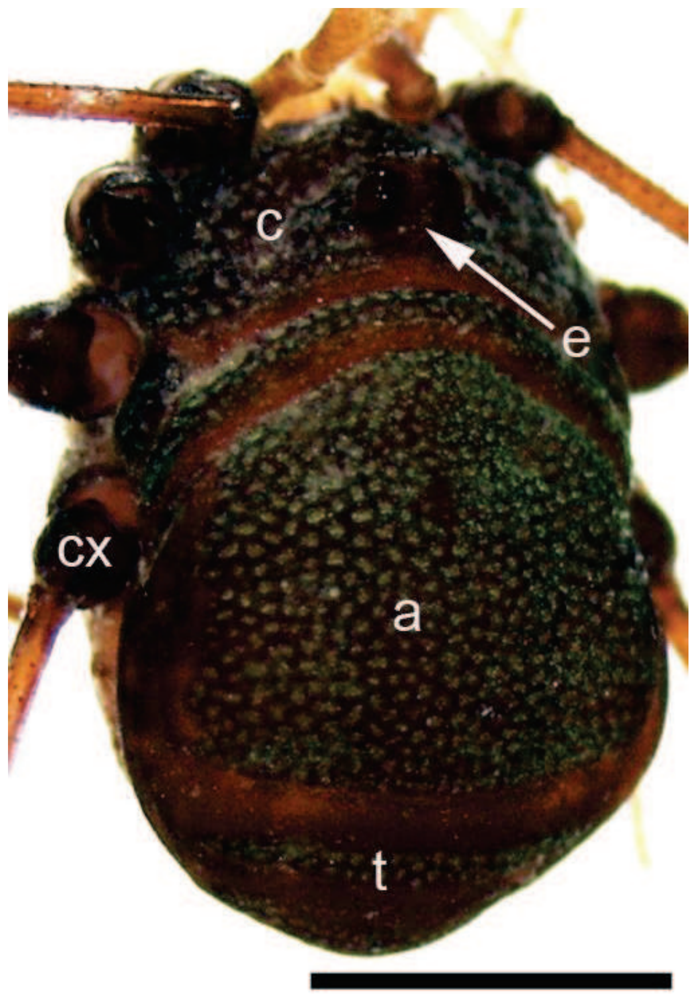

Fig. 1. Photograph of the dorsal habitus of the sclerosomatid harvestman *Prionostemma* sp. 6 with bluish-green cyanobacteria on the dorsal surface. a = abdomen; c = carapace; cx = coxa; e = eye mound (ocularium); t = free tergite. Scale bars = 1.5 mm.

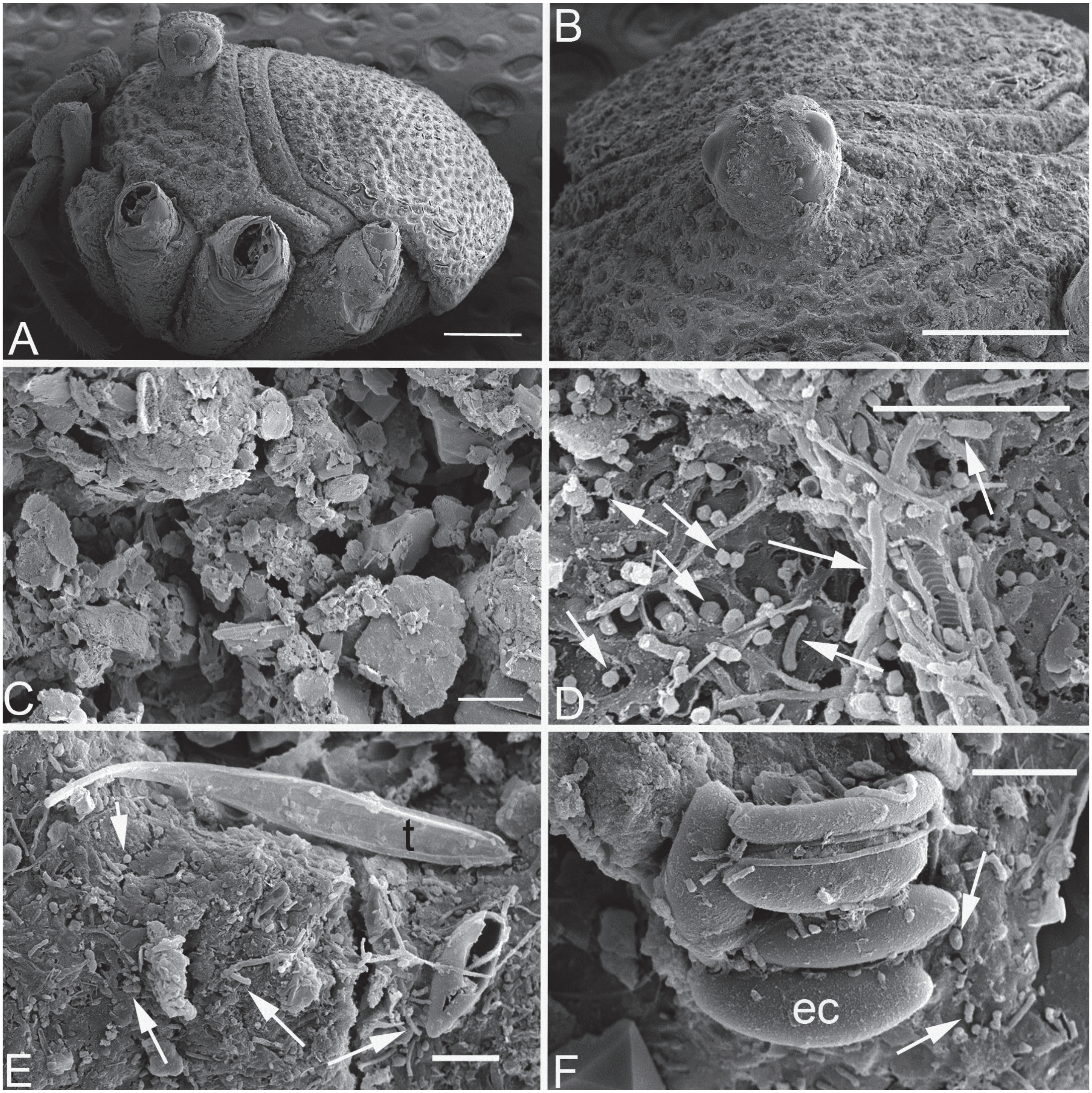

Fig. 2. SEM micrographs showing the mixture of detritus and microorganisms on the tegument of the sclerosomatid harvestman *Prionostemma* sp. 6. Lateral (A) and anterior (B) views of the dorsal scutum revealing the density and distribution of pits on the tegument. C). Detritus from a pit on the posterior region of the body. D) Arrows indicate bacteria (bacilli and cocci) from a pit on the carapace. E) Bacteria (arrows) and a fungal thallus (t) from a pit. F) Large eukaryotic cells (ec) with smaller prokaryotic cells (arrows). Scale bars = 500 μm for A –B and 5 μm for C –F.

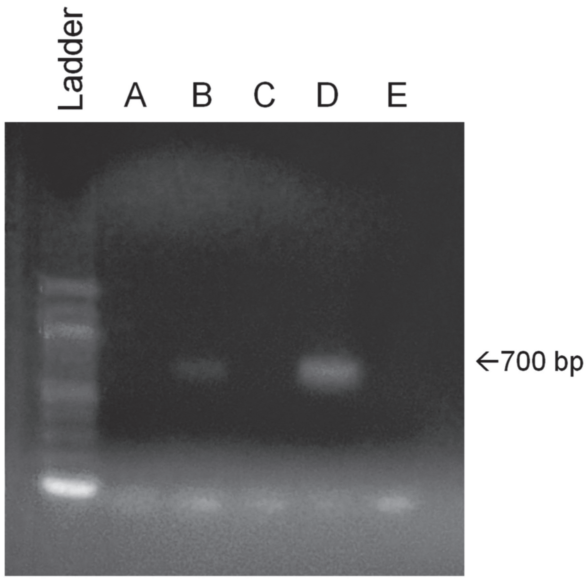

Fig. 3. Gel showing PCR products following amplification of the intergenic sequence of the PC operon within cyanobacteria. DNA from scraping tape applied to the body of an individual of *Prionostemma* sp. 6 (Lane B), and DNA removed from washing the tape applied to the harvestmen body (Lane C) were compared with positive control DNA from *Oscillatoria* (Lane D) and a negative control of no DNA (Lane E). All lanes were compared with the 100 base pair DNA Ladder (New England BioLabs #N3231S). The similar bands on Lane B and Lane D at the 700 base pair region (indicated by arrow) confirm that the cells collected from the tegument of the *Prionostemma* sp. 6 were cyanobacteria.

DISCUSSION

Our confirmation of cyanobacteria living on the dorsal tegument of the carapace and abdomen of adults of the harvestmen *Prionostemma* sp. represents only the third documented case of a epizoic interaction between photosynthetic prokaryotes and harvestmen. Interestingly, all three instances involve host species that live in moist Neotropical environments (Fig. 4). In addition, the species of harvestmen serving as hosts have a tegument dominated by small pits or tubercles, providing suitable habitats for colonisation by epizoic organisms. One striking difference between the cyanobacteria observed by Machado and Vital (2001) and Proud *et al.* (2012) and the cyanobacteria that occurs on the tegument of the harvestman studied here is colour. The specimens that we studied were not green, but rather a distinct blue. We believe that this difference in coloration probably reflects interspecific variation in the pigments used by different species of cyanobacteria. In addition, the epizoic cyanobacteria observed by Proud *et al.* (2012) were generally similar in size to those that we observed on the specimens studied here. However, the epizoites that Proud *et al.* (2012) observed were aggregated in dense patches across most of the dorsal surface of the carapace and abdomen. In contrast, the epizoic cyanobacteria that we observed here occurred generally in a thin film with the most of the small, prokaryotic cells occurring predominantly as dense clusters in the pits on the tegument of the host.

The nature of the epizoic relationship that exists between cryptogams and harvestmen (i.e., commensalism or mutualism) remains to be empirically investigated. The cyanobacteria on the dorsum of the harvestmen are photosynthetic and relatively small. They are probably unable to penetrate the cuticle of the host and, thus, are certainly not parasitic. On the bases of our field observations of harvestmen with cryptogams, the hosts do not appear to be encumbered by the biomass of epizoic organisms that they carry. To the contrary, our observations indicate that individuals with epizoic organisms move normally and are not lethargic.

From the perspective of the epizoic organisms, the body of the host is an unusual microenvironment that supports few, if any, potential competitors for light or other limiting resources. Thus, monotypic colonies of epizoic cyanobacteria can thrive on the tegument of their hosts. However, the benefit, if any, to the host is not as clear. Harvestmen do not appear to be capable of feeding

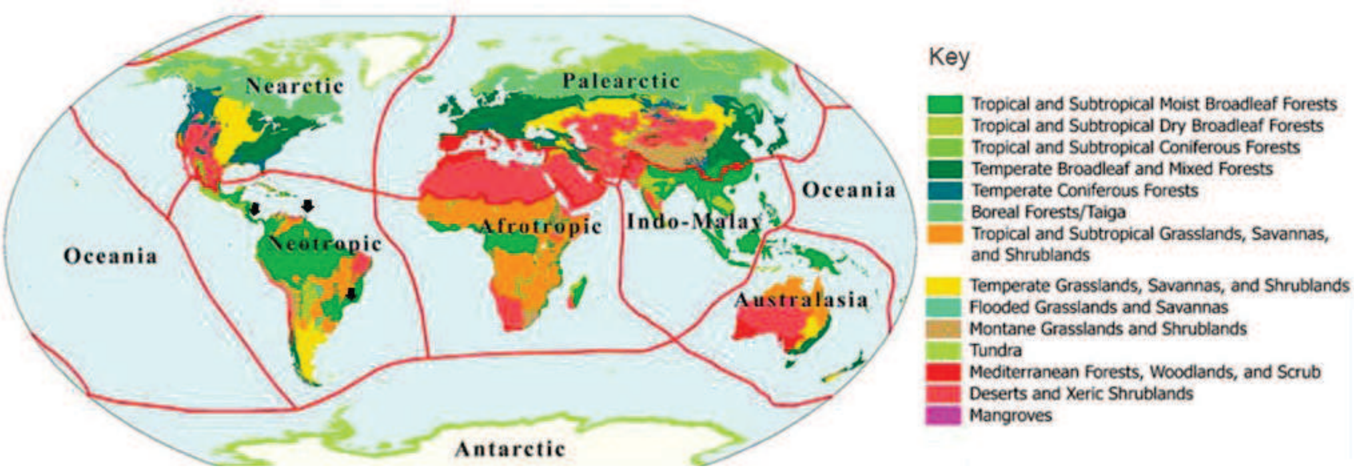

Fig. 4. Arrows indicate the three locations from which harvestmen associated with cyanobacteria have been captured. Map modified from Olson *et al.* 2001.

upon epizoic organisms that live on their dorsum. While harvestmen pass their distal leg segments between the chelicerae in a behaviour known as "grooming", they simply cannot reach the surfaces of the dorsal scutum nor do they have the anatomy necessary (i.e., chelate tarsi) to remove epizoic organisms from the dorsal surfaces of their bodies.

Gressitt *et al.* (1968) hypothesised that the presence of mosses on the dorsal surfaces of weevils in New Guinea conferred crypsis and thus enabled hosts to avoid predators, especially diurnal predators that rely upon visual cues to find their prey. Habitat use and circadian activity patterns of several species of Neotropical *Prionostemma* spp. have been studied (Donaldson and Grether 2007; Grether and Donaldson 2007; Wade *et al.* 2011). In these harvestmen, adults generally are more active in the leaf litter at night, spending the day, occupying perches on tree trunks, buttresses and the exposed surfaces of leaves in the understory. If host species with epizoic cyanobacteria exhibit similar habits, it may be that individuals with cryptogams have better camouflage and are less obvious to visually oriented predators. Unfortunately, the behavioural ecology of *Prionostemma* p. 6 or that of its congeners in Costa Rica has not yet been examined.

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Nature Notes

Is this the caterpillar of *Arsenura beebei* (Lepidoptera: Saturniidae)?

We report here on a very distinctive caterpillar and suggest its likely identity. M.K. and Dr Feroze Omardeen encountered it on 11 March 2018 along Martinez Trace, just north of Brasso Seco in the Northern Range of Trinidad, West Indies. The approximate coordinates were: 10°44'00.00" N, 61°18'08.08" W. The caterpillar was stationary on a rotting leaf stalk of *Cecropia peltata* L. (Urticaceae) on the ground, so there was no evidence as to what the food plant was. The caterpillar was striking. It was black with 10 bright blue bands and 7.5-8.0cm in length (Fig. 1).

Although the caterpillar was not reared, we can deduce its identity with some confidence. Its large size indicates an uncommonly large adult moth. The cuticle surface is smooth apart from small subdorsal scoli on the three thoracic segments and segments 8–10 of the abdomen, and it has very large, conspicuous spiracles. These characters suffice to place it in only one genus among the large moths recorded from Trinidad: *Arsenura* (Saturniidae, Arsenurinae) (Lampe 2010, Janzen and Hallwachs 2018). The young caterpillars of *Arsenura* spp. have long, thin scoli, often 2–3 times the body width, which become relatively shorter as the caterpillars grow until they resemble those seen in Fig. 1, or are absent altogether (Lampe 2010, Janzen and Hallwachs 2018).

Two species of *Arsenura* are known from Trinidad: *A. armida* (Cramer) and *A. beebei* (Fleming) (Kaye and Lamont 1927, Cock 2003). *Arsenura armida* has been treated as a widespread polytypic species (Lemaire 1980), but it is now clear that it is more appropriate to treat it as a complex of species, most of which is yet to be worked out (e.g. Brechlin and Meister 2010). The caterpillars of at least some populations of this complex are known. When mature, caterpillars of a population from Carabobo Province, northern Venezuela, are dark brown-black with irregular yellow-brown bands, strongest on abdominal segments 1–7, and no wider than 1/3 of the segment width, and in the final instar the subdorsal scoli are absent (Lampe 2010). The Central American population, now known as *A. arianae* Brechlin and Meister, has the head and anal segment brown and a pale, broad, diffuse lateral line, linked by irregularly diffuse pale transverse bands (Costa *et al.* 2001, Janzen and Hallwachs 2018). Both these reports are of gregarious species, although it is not out of the question that the apparently solitary blue caterpillar had strayed from a social group and/or was looking for a pupation site. We note that there are very few records of *A. armida* from Trinidad, all from the southern part of the island (Kaye and Lamont 1927), and there has been only one record since 1918 (M.J.W. Cock unpublished).

Fig. 1. Final instar caterpillar of presumed *Arsenura beebei.*

The caterpillar of *A. beebei* has not previously been reported, as far as we are aware. In contrast to *A. armida*, *A. beebei* has been regularly collected in the Northern Range of Trinidad, with more than 30 records extending from Port of Spain to Toco (M.J.W. Cock unpublished) (Fig. 2). Given this geographic pattern and the lack of any close resemblance of the specimen in question to known caterpillars of the *A. armida* complex, we can consider it very likely that the caterpillar of *A. beebei* is now known and is strikingly distinct in colouration.

Fig. 2. *Arsenura beebei* male from high in the central part of the Northern Range (Morne Bleu Textel installation, 20 January 2007). Wingspan 14 -15 cm. Photo by J. Muddeman (Spainbirds Nature Tours, www.spainbirds.com).

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The caterpillar of *Rothschildia vanschaycki* (Lepidoptera, Saturniidae), a little known silk moth from Trinidad, W.I.

On 9 March 2018, one of us (DSH) found and photographed a large, strikingly colourful caterpillar (Fig. 1) at Guapo Beach, near Point Fortin (approximately 10.19N, 61.67W), on a species of mangrove growing on land. The caterpillar was large, at least 6 cm long so probably in the final instar. It was stationary on a stem about 1.5m off the ground, and we presume that it was on its food plant since there were few other potential food plants nearby, and it wasn't actively searching for a pupation site. Based on this image, the food plant is either white mangrove (*Laguncularia racemosa* (L.) Gaertn. f., Combretaceae) or red mangrove (*Rhizophora mangle* L., Rhizophoraceae), but key diagnostic features are not visible (Y. Baksh-Comeau pers. comm.).

The size and arrangement of spined scoli indicate that it is a species of Saturniidae. Comparison of the image with published images of Saturniidae caterpillars (e.g. Lampe 2010, Janzen & Hallwachs 2018) showed that *Rothschildia* is the only genus from Trinidad which shows this configuration of short-spined, small subdorsal, dorsolateral and lateral scoli on all thoracic and abdominal segments. *Rothschildia* is a genus of New World atlas moths, with at least 25 species distributed primarily in the Neotropical Region (Lemaire 1978, 1996). In recent years, several new species have been described, and some subspecies have been revised to species (e.g. Brechlin and Meister 2012). There are only three species of *Rothschildia* known from Trinidad: *R. erycina erycina* (Shaw), *R. aurota aurota* (Cramer) and *R. vanschaycki* Brechlin and Meister (Kaye & Lamont 1927, Brechlin and Meister 2012, M.J.W. Cock unpublished data). The mature caterpillar of *R. erycina erycina* is black with white bands and partial orange-red bands, and that of *R. aurota aurota* is yellow-green dorsally, blue green ventrally, with a pale lateral line, small red scoli, red spiracles and no bands (Lampe 2010). As the specimen in question is very different from both of these, we infer that it is the hitherto unknown caterpillar of *R. vanschaycki*. Caterpillars of some subspecies of the closely related *R. lebeau* (Guerin-Méneville) are known (Lampe 2010, Janzen & Hallwachs 2018). Lemaire (1978, 1996) treated the widespread *R. lebeau* as having six subspecies, some of which are now treated as valid species (Brechlin and Meister 2012). Two subspecies might be found in Trinidad: *R. lebeau lebeau* is found in northern Venezuela to the west of Trinidad, while *R. lebeau amacurensis* Lemaire is known from the Orinoco Delta to the south of Trinidad, with one doubtful record from Trinidad (Lemaire 1978) which may prove to be the recently described *R. vanschaycki*. The caterpillar of the latter is unknown, but that of *R. lebeau lebeau* from Carabobo Province, northern Venezuela, is illustrated by

Fig. 1. Presumed final instar caterpillar of *Rothschildia vanschaycki*.

Lampe (2010, plate 231). In the penultimate instar the body is fairly uniformly green darker ventrally, with small red scoli, yellow-brown spiracles and bands of grey (anteriorly) and white (posteriorly) on the dorsal and lateral parts of the abdominal segments. The final instar is similar, but the red scoli are missing. In some characters the Guapo Beach caterpillar is close to those of *R. lebeau lebeau*: the rather uniform green ground colour, small red scoli, absence of a lateral line and the presence of transverse bands. However, it also differs significantly, as the transverse bands of the abdomen are much more striking, being white anteriorly in the dorsal half, red posteriorly from the subdorsal scolus on one side dorsally to the other side, and black from the subdorsal scolus to the bottom of the prolegs, which have a red spot laterally, and the spiracles in the black band are concolourous. Unfortunately the head of the Guapo Beach caterpillar is not visible in the photo.

Rothschildia vanschaycki was recently described from Trinidad based on a single specimen collected at Port of Spain (Brechlin and Meister 2012). MJWC had been aware of this as a rare species in Trinidad, but identified it as *R. lebeau*. In addition to the type specimen, there are two further specimens known to us from Trinidad: a male collected at Valpark Shopping Plaza, Valsayn South (10.633N 61.418E, 26 June 1978, M.J.W. Cock) and a female from ‘Trinidad’ (no other data) in the Natural History Museum, London. Further, KS has photographed an adult male about 3km from Valsayn South at the Caroni Swamp Visitor Centre, on the eastern side of Caroni Swamp (10.605N 61.434W, 2 November 2014; Fig. 2), and at least three images of males from the same area have been posted on the internet: late June 2011 (What’s that Bug? 2011), 30 May 2016 (Rutherford 2016), 4 November 2017 (rainingrainers 2017). It is a rarely encountered species in Trinidad, and the places where it has been seen suggest an association with coastal swamps, which this provisional mangrove food plant association supports.

Fig. 2. Living *Rothschildia vanschaycki* male, Caroni Swamp Visitor Centre, 2 November 2014 (K. Sookdeo).

Although we are confident of our identification of this striking caterpillar, it would be desirable to locate additional specimens to rear through to confirm this and the food plant. Its distinctiveness supports Brechlin and Meister’s (2012) decision to treat *R. vanschaycki* as a separate species rather than as a subspecies of *R. lebeau*.

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First report of the freshwater mussel *Mytilopsis leucophaeata* (Family Dreissenidae) in Trinidad W.I. and a new locality record of the native *Anodontites crispata* (Family Unionidae)

Freshwater mussels have been documented within Trinidad since the 1800s (Guppy 1866) with two species of the Unionidae family; *Anadontitis crispata* (Bruguiere 1792) and *Mycetopoda* sp. identified. In this note we record a new location for *A. crispata* and a new species record *Mytilopsis leucophaeata* (Conrad 1831) for Trinidad.

During a survey of freshwater biota in water courses in northeast Trinidad in August 2015, a population of the mussel *Mytilopsis leucophaeata* (Conrad 1831) was discovered in the small river immediately north east of the Rio Seco/Salybia River bridge on the Toco Main Road (UTM 20N 716200, 1184191). The density of mussels was estimated at between 20 to 100 individuals per square metre. They were clustered on both rock and driftwood substrate. No individuals were observed in the Rio Seco River or any other watercourse that was surveyed.

Specimens were collected and sent to Miramar Zeemuseum, Netherlands for confirmation of the identification. Live specimens were also housed in a freshwater aquarium at The University of the West Indies, St. Augustine for up to 24 months after collection.

Mytilopsis leucophaeata (Conrad 1831), (Dark false mussel or Conrad's false mussel) is a member of the Dreissenidae family native to North America. *M. leucophaeata* has a thick, usually dark periostracum covering the shell and a maximum length of 2cm. (Fig.1). Juveniles may also be striped. The ventral margin of the shell is fairly straight. Internally, there is a septum near the umbo, and partly covered by this is a small triangular apophysis. This characteristic septum is absent in the Mytilidae or true mussels.

This species has also been reported within suitable habitats in Martinique (Delannoye *et al.* 2015), Guadeloupe in 1980 and 2012 (GBIF 2018), Margarita, Nueva Esparta, and Boca Chavez, Anzoategui in Venezuela (GBIF 2018), and as far south as French Guiana (Massemin *et al.* 2011). Its range is suspected to be underestimated (Pointier 2015).

There have been several instances of the species being responsible for bio-fouling in European and temperate regions (Dziubińska 2015, Holeck *et al.* 2004, Therriault *et al.* 2004), and the initial expansion to these more southerly locations are thought to be the result of transport by watercraft and not necessarily natural dispersal (Holeck *et al.* 2004).

It is possible that subsequent natural spread to Trinidad may have occurred through planktonic drift influenced by the Orinoco discharge plume, or transport via birds or possibly a direct introduction from its natural range via ballast water discharge.

Whilst there is no documentation of this species forming dense colonies that out compete native bivalves in the other Caribbean countries, monitoring of the spread of this species and any negative impact on other species in Trinidad, is important. *Mytilopsis leucophaeata* could potentially compete with native mollusc species such as the *Neritina* sp., which was also found in low densities at the site. No predation of *M. leucophaeata* was observed at the collection site. In captivity however, the native freshwater prawn, *Macrobrachium crenulatum* did actively attack and feed on it. We suspect this prawn could be a natural predator as they also occur at the collection site.

Our second new finding refers to the native species *Anodontites crispata.* This species was first recorded by Guppy from the Caroni flood plains (Guppy 1866). Bacon recorded the species at Cuche River and Nariva Swamp in 1978 (Bacon 1979) and since then shells of *A. crispata* (=A. cf. *irisans*) were collected from Poole and Caparo drainages in 2007 (Mohammed *et al.* 2008) (Table 1). In addition mussels (> 2cm in length) were observed by Dr Mary Alkins-Koo in freshwater areas of the Carlisle River, south Chatham in the early 1980s. Although these were not identified, it is suspected they could be members of the Unionidae family. Here we document a new location for *A. crispata* in southern Trinidad within the South Oropuche drainage where a tributary crosses Mulchan Road (UTM 20N 672341, 1119862). The site has a muddy substrate, with slow moving turbid water and riparian vegetation, a habitat known to be favoured by the species (Huehner 1987, Gagnon *et al.* 2006) and similar to that where Mohammed *et al.* (2008) documented shells in 2007. The species is also known to be sensitive to low dissolved oxygen concentrations and the family does not tolerate any salinity (Huehner 1987, Gagnon *et al.* 2006).

The unionids fulfil important ecosystem functions and are one of the most threatened freshwater taxa globally (Zieritz *et al.* 2016). Unlike *M. leucophaeata*, which has planktonic free swimming stage in their life cycle, the Unionids planktonic stage relies on fish gills as primary host for both support and nutrition (Williams *et al.* 1993). Juveniles move upstream via their fish host. Subtle changes in habitat and /or extraction of their fish host can lead to loss of this taxon. This species may be a candidate as an indicator species indicating well aerated slow moving nutrient poor streams with intact fish populations.

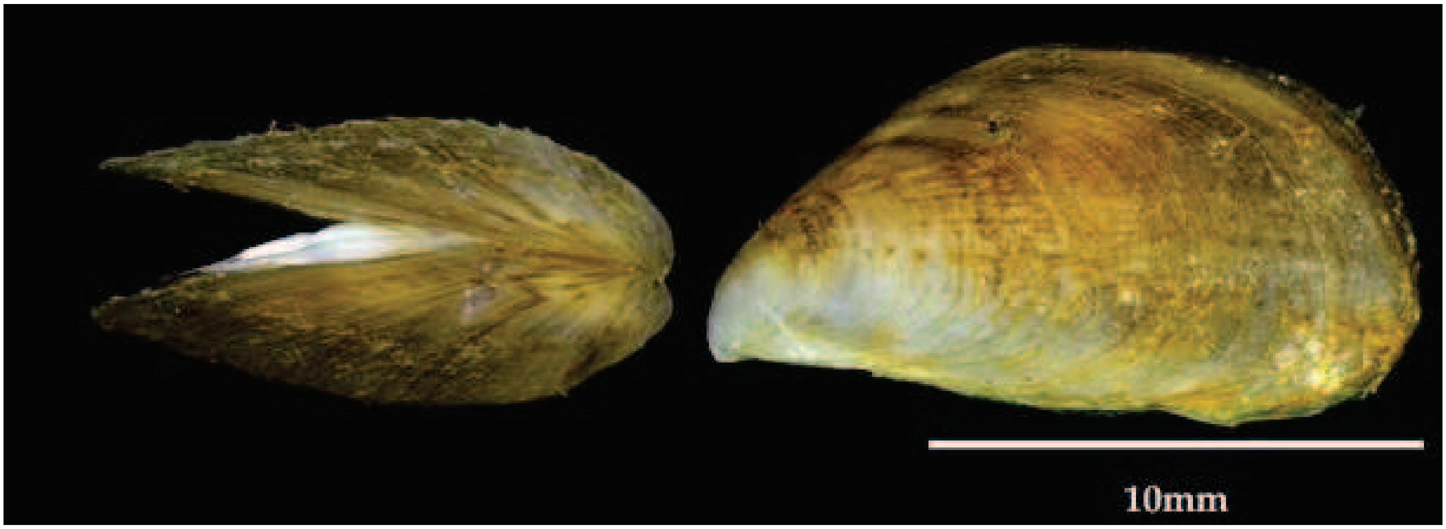

Figure 1. *Mytilopsis leucophaeata* collected in North East near Rio Seco River, Trinidad. Photo credits- Robert Vink, The Netherlands.

Table 1 Occurrences of freshwater mussels in Trinidad. *See location description in text

Species	Location	Sighting Date	Publication
Anodontites crispata	Caroni flood plains	na	Guppy, 1866
	Cuche River	May 1978	Bacon *et al.* 1979
	Nariva	August 1978	Bacon *et al.*1979
	Nariva	August 1988	Smithsonian via I.W. Ramnarine, 1988
	Poole River	May 2007	Mohammed *et al.* 2008
	Caparo River	November 2007	Mohammed *et al.* 2008
	Mulchan Trace, Penal Rock Road	September 2014	current paper
Mycetopoda sp.	Nariva	August 1988	Bacon *et al.* 1979
	Ortoire	May 2007	Mohammed *et al.* 2008
Mytilopsis leucophaeata	NE of Rio Seco River*	August 2015	current paper

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Field observations of potential cannibalism among tadpoles of the Trinidad stream frog *Mannophryne trinitatis* (Anura: Aromobatidae)

Cannibalistic behaviour has been reported among tadpoles and is potentially influenced by food availability and conspecific density (Jefferson *et al*. 2014). Cannibalism involves killing and feeding on an individual of the same species (Fox 1975), not to be confused with scavenging, which involves feeding on already dead individuals. Cannibalism offers direct benefits to tadpoles in the form of a meal, and also provides other direct and indirect benefits such as shortened development time (Crump 1990) and reduced competition in some populations (Jefferson *et al*. 2014). Conversely cannibalism may pose selective disadvantages. For example, it may increase the risk of contracting chytridomycosis (Altig *et al.* 2007), or there may be inclusive fitness costs of killing close relatives. Observation and investigation across more species is required to further understand how common cannibalism is among tadpoles (Fox 1975, Altig *et al.* 2007).

Mannophryne trinitatis (Garman 1887) of the family Aromobatidae (formerly Dendrobatidae) are small frogs (males 29mm, females 30mm snout to vent length) which are distributed across the Northern Range and Central Range of Trinidad (Murphy *et al*. 2018). Cannibalism among large *M. trinitatis* tadpoles has been reported by Downie *et al*. (2001) mainly under laboratory conditions and briefly in the field. We report on a field observation of potential cannibalistic behaviour in tadpoles of *M. trinitatis* in Trinidad and suggest further research.

On 6 August 2018 at 1810h, RJA and NFA observed seven to eight tadpoles of *M. trinitatis* consuming a single conspecific individual. We were unable to determine if the individuals were scavenging on an already dead conspecific, or whether this was a case of intraspecific predation, or cannibilism as defined by Fox (1975). Most tadpoles detached from the dead tadpole when we moved leaves and shone our LED torches to gain a better view. But one of the larger tadpoles appeared more aggressive than the others and stayed feeding, finally moving the dead tadpole into an overhanging rock crevice apart from the others (Figure 1). The site was along the Lopinot Rd., Trinidad just south of Lopinot Village (UTM 20N 682925, 1181345). The microhabitat consisted of an isolated pool of water, within a rock gully, less than 10m from the roadside. The ephemeral pool was on a slightly inclined rock surface surrounded by dense canopy cover with an almost dried up stream flowing nearby. The pool had leaves in it covering more than 50% of the surface of the water, and macrofauna consisted solely of *M. trinitatis* tadpoles. The tadpoles were visually identified using the local field guide (Murphy *et al*. 2018) and we also observed *M. trinitatis* adults near the pool with no other amphibian species observed nearby.

Similar observations have been made before. Downie *et al*. (2001) reported on larger *M. trinitatis* tadpoles attacking and sometimes eating smaller conspecific tadpoles which were introduced to their pool. This behaviour was observed in the laboratory, and under natural conditions at a location similar to that of the present observation. Jowers and Downie (2005) also reported *M. trinitatis* tadpoles killing and feeding on their conspecifics under laboratory settings. Our additional observation of *M. trinitatis* tadpoles eating conspecifics under natural conditions is therefore not surprising. However it does highlight an area for further study.

Do tadpoles of *M. trinitatis* regularly kill and eat other tadpoles of their own species or are they usually only scavenging on individuals who have died for other reasons? If they are just feeding on dead individuals, then does this help keep the water clean? Alternatively, if individuals do regularly kill conspecifics, what are the factors that influence this behaviour? Cannibalism may provide a source of nutrition or reduce competition in resource-poor environments (Crump 1990), and the small isolated pools where the *M. trinitatis* tadpoles were observed were heavily shaded and likely to have low primary productivity. Alternatively do plentiful food sources modulate individual aggressiveness and boldness and lead to reduced cannibalism? Ultimately does cannibalism in the species offer any fitness benefits and do they cannibalise related individuals?

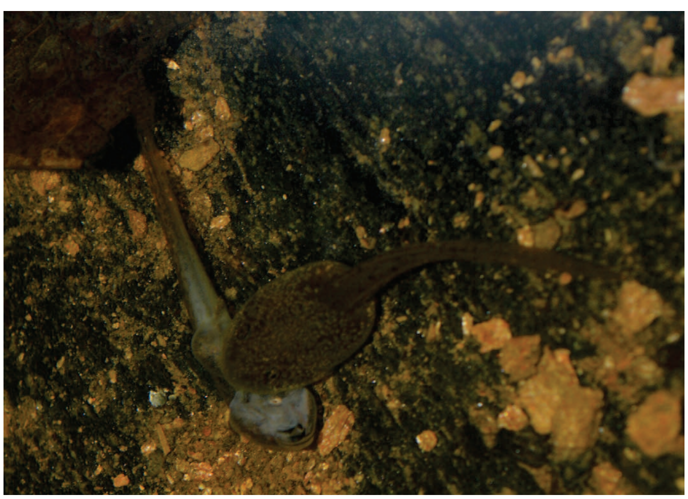

Fig. 1. *Mannophryne trinitatis* tadpole feeding on a conspecific individual.

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Possible predation on the frog *Leptodactylus validus* (Anura: Leptodactylidae) by the spider *Ancylometes bogotensis* (Ctenidae) in Trinidad, W.I.

Spiders are known to feed on a variety of species, including reptiles (Correy 1988), fish (Deacon *et al*. 2015), crustaceans (Bhukal *et al*. 2015), and amphibians (White 2015). Indeed, predation on amphibians by spiders has been recorded quite frequently, and encompasses a variety of species of amphibians (Menin *et al*. 2005; Toledo 2005). In the Neotropics, the family Ctenidae has been reported as one of the dominant groups of spiders predating on amphibians (Menin *et al*. 2005; Barbo *et al*. 2009; Pinto and Costa-Campos 2017). Although these predation reports highlight species of frogs belonging to a variety of families, including Leptodactylidae, none, as far as we are aware of, include the species *Leptodactylus validus* (Garman 1888).

On 18 November 2017, at 1900h, while conducting a herpetofauna field trip in the Bush Bush Wildlife Sanctuary, Nariva Swamp, Trinidad (UTM 20N 714726, 1148978) at an elevation approximately 15–25 m above sea level), we witnessed possible predation on the frog *L. validus* by the spider *Ancylometes bogotensis* (Keyserling 1877) (Figure 1). We did not observe the initial capture of the frog by the spider, but we stayed to observe the behaviour for about ten minutes. The spider appeared to have had its fangs gripped onto the rear end of the frog, between its hind legs. The frog was active and appeared to be trying to escape, thus we believe the capture of the frog probably occurred just prior to our initial observation. The frog was able to move a few centimetres but it was unable to break free of the spider. The apparent predation took place along a trail that had leaf litter on the forest floor, with mostly closed canopy above. There was a tree stump on the trail and a two-foot-wide ditch of water nearby where the attack occurred. The trail was approximately 3 m across. The forest type in Bush Bush Wildlife Sanctuary consists of seasonal evergreen forest (Beard 1946). We observed many other *L. validus* in the leaf litter nearby and along the trail, and we speculate that *A. bogotensis* may be commonly predating on this species in the area.

We identified *L. validus* based on the description in Murphy (1997) and Murphy *et al*. (2018), and the identification was subsequently confirmed by John Murphy from the photograph. *Leptodactylus validus* is a medium-sized terrestrial frog attaining a maximum snout-to-vent length of 50 mm which is widespread throughout Trinidad and has been recorded in Bush Bush Wildlife Sanctuary prior to our observation (Murphy 1997). The tympanic fold of *L. validus* extending to the shoulder, lack of a white lateral blotch bordered by a more dorsal dark stripe, and a lack of a mid-dorsal stripe on the dorsum will readily distinguish it from other Leptodactylidae species on Trinidad, including *Adenomera* and *L. nesiotus* (Murphy *et al*. 2018). We noted the similarity of *A. bogotensis* by comparing our photographs to those in other recent publications of the spider predating on a variety of species in Trinidad (Bhukal *et al*. 2015; Deacon *et al*. 2015; White 2015). This identification was confirmed by Dr Höfer of the State Museum of Natural History Karlsruhe in Germany who added that the spider was a female *Ancylometes*. *Ancylometes bogotensis* is found throughout the Neotropical region from Bolivia to Nicaragua, and is the only species from this genus known from Trinidad (Höfer and Brescovit 2000). We did not collect any specimens, as an additional permit is required to collect within the Wildlife Sanctuary. As such, we did

Fig. 1. *Ancylometes bogotensis* with captured *Leptodactylus validus*. Photo Renoir J. Auguste

not gather measurements of the frog and the spider, nor did we stay long enough to witness *A. bogotensis* consuming the *L. validus*. We postulate that our report further adds to the literature that spiders are important predators to a variety of amphibian species.

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Fifteenth report of the Trinidad and Tobago Birds Status and Distribution Committee Records submitted during 2017

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INTRODUCTION

The Trinidad and Tobago Birds Status and Distribution Committee (TTBSDC) was established in 1995 to assess, document and archive the occurrence of rare or unusual birds in Trinidad and Tobago and thus provide reliable long-term monitoring of our rarer species.

The official list of the birds of Trinidad and Tobago together with the list of species considered by the committee and details of all records accepted by the Committee can be accessed on-line at http://rbc.ttfnc.org. Previous reports of the committee were prepared by Hayes and White, (2000); White and Hayes (2002) and Kenefick (2005, annually 2007-2017). Archived records including photographic submissions number 1369 at the end of 2017.

The Committee has assessed all records submitted during 2017. In all 152 records were adjudged, representing 56 different species. This represents the highest number of submissions and the highest number of "reportable species" since the formation of the Committee. This illustrates both the continued growth and popularity of birdwatching nationally. We also wish to commend the quality of photographic submissions by so many observers and urge observers to continue to document and report their sightings to us.

Of the submissions assessed, in only nine cases did the Committee find the identification inconclusive. However the year coincided with a number of identification challenges for the Committee, principally with submissions of smaller *Elaenias* and immature *Ardea* herons. Currently five *Elaenia* submissions remain outstanding and a working party within the Committee aims to create a template to both scrutinise same and create a template to simplify the process for the future. Concurrent to that, a similar template is being worked upon to clarify proven differences between immature plumage of the three *Ardea* heron species known to occur.

Records presented below follow the revised nomenclature and taxonomic order of the South American Classification Committee as at June 2018 (Van Remsen *et al.* 2018).

The Committee comprises the following members: Martyn Kenefick (Secretary), Geoffrey Gomes, Nigel Lallsingh, Bill Murphy, Kris Sookdeo and Graham White. Again, there are instances where we have benefited from supporting international expert knowledge to assist us with certain identification issues. We wish to acknowledge the valuable assistance provided by Bill Clark, Jon Dunn, Dr Kamal Islam, Michael O'Brian David Sibley, James Smith and Scott Weisensaul (USA) and Robin Restall (UK) during 2017. All recorded sightings summarised below occurred in 2017 unless otherwise stated.

Records accepted

A presumed pair of **White-faced Whistling-Duck, *Dendrocygna viduata*** found along an irrigation channel within farmland at Orange Grove on 13 May, increased to four birds on the 27 May (JF *et al*.). Almost all sightings of this austral wanderer occur between mid-May and mid-October.

A juvenile or adult female **Muscovy Duck, *Cairina moschata*** was photographed flying over Sumaria trace, Charlieville on 1 October (RA, MB). Whilst we remain concerned over provenance of this species in the south-west peninsula of Trinidad, all indications are that this bird could well be of wild origin.

A pair of **American Wigeon, *Mareca americana*** was found in Caroni Rice Project on 4 March (DN,JR). This is the first documented record of this species for the island of Trinidad in the last 22 years. On 8 March an adult female was photographed at Bon Accord sewage lagoons, Tobago (MKe). These constitute the latest dates for this migrant duck, previous latest being 21 February 2005.

Two **Northern Shoveler, *Spatula clypeata*** likely both females were found at Bon Accord sewage lagoons, Tobago on 2 November, remaining until the 25 November at least (LK). This is just the third documented account of this species in the last 22 years.

Two pairs of **Lesser Scaup, *Aythya affinis*** were photographed swimming on Arena Reservoir on 14 January (MKe, FO). This species is one of our more regular migrant ducks, having been found in seven of the last 17 years.

An adult **American Flamingo, *Phoenicopterus ruber*** *w*as seen flying over Caroni Swamp on 18 March (MK *et al*.). Over the course of the next two months, numbers increased to a maximum of 75 birds on 7 May, with one remaining until at least 7 June.

An immature **Scaly-naped Pigeon, *Patagioenas squamosa*** was photographed perched in roadside mangrove south of Manzanilla on 25 October (BR). Whilst this species has now colonised Little Tobago island and the adjacent Tobago headlands, this is the first documented sighting for Trinidad.

A pair of **Blue Ground Dove, *Claravis pretiosa*** were found on the Chaguaramas peninsula on 4 March (JF,FO) and subsequently seen and heard by many observers. Whilst this remains an uncommon and localised resident of dry Trinidad scrub and forest, it's wary and secretive nature may belie its true abundance

A **Dark-billed Cuckoo, *Coccyzus melacoryphus*** was found in scrub bordering Caroni Rice Project on 8 August (NL). On subsequent days at least three birds were seen by many observers, with two still present on 13 August. All documented sightings of this austral wanderer in the last 22 years have occurred between 24 July and 31 August.

On 17 June 2013, a moulting adult male **Rufous-shafted Woodstar, *Chaetocercus jourdanii*** was photographed at Asa Wright Nature Centre (SG). Whilst the identification of Woodstars sometimes represents a challenge for the Committee, this is the first documented individual to show its unique tail shape and pattern. There have now been five confirmed sightings of this erratic austral wanderer with all records from early May to late August

Single **Amethyst Woodstars, *Calliphlox amethystina*** were documented as follows :- an immature male at Surry village, Lopinot on 29 April (GW); an immature at Asa Wright on 2 May (DP); an adult male at Yerette on 24 May (TF) and another immature at Asa Wright on 8 June (MK). Since first found back in 2015, there have now been eight documented sightings of this wandering hummingbird from mainland South America, all occurring between 29 April and 26 July.

An **American Coot, *Fulica americana*** was found in a flooded field within Caroni Rice Project on 25 July (RA). The extent of white on the blaze, reaching the top of the head, together with the date show this to be a wandering *F a caribaea*, probably from the Lesser Antilles, formerly known as Caribbean Coot and now considered conspecific with American Coot.

A record-breaking total of four individual **Double-striped Thick-Knees, *Burhinus bistriatus*** were found in widely separate localities during the year as follows :- at Waller Field on 6 July (KF,DR); alongside a golf course at Trincity on 10 July (MK,RJ); in Caroni Rice Project on 30 July (NL) and finally in the unusual location of Queens Park Savanna, Port of Spain on 22 August (FO). Of interest, this last locality is the site of the very first record of this species in Trinidad, back in 1983. Now documented in four of the last six years, these sightings have all occurred within the expected date range of early July to early September.

An **Upland Sandpiper, *Bartramia longicauda*** was photographed, also on Queens Park Savanna, Port of Spain on 29 August (JF). This brings to 13, the total number of sightings of this rare southbound migrant from continental North America in the last 22 years with all but one birds occurring between 29 August and 26 October.

A basic plumaged adult **Curlew Sandpiper, *Calidris ferruginea*** was photographed at Brickfield on 16 December 2014 (NL). There have now been three documented records of this Eurasian shorebird in Trinidad, others being in May 2002 and September 2016.

Two **Buff-breasted Sandpiper, *Calidris subruficollis*** were found in agricultural fields north of Waterloo Main Rd. on 30 September, one remaining until 15 October at least (NL)(Fig. 1). All 18 documented records of this southbound migrant shorebird in the last 22 years, have been between 17 September and 28 October.

Fig. 1. Buff-breasted Sandpiper, *Calidris subruficollis*, Waterloo, October 2017. Photo Nigel Lallsingh.

Up to three **Franklin's Gulls, *Leucophaeus pipixcan*** first found on 4 December 2016 (see Kenefick 2017) remained through to 16 February at least. An adult found at Pigeon Pt. Tobago on 3 April (RL) is the first documented record for the island. Elsewhere a late northbound adult was photographed at Brickfield on 5 May (NL) and an early arriving bird in first winter plumage found at the same site on 1 August (NL).

The **Audouin's Gull, *Ichthyaetus audouini*** first found in December 2016 (see Kenefick 2017) was again present at Brickfield on 14 January (NL) and from 30 March to 3 April (many observers) and finally further north at Invaders Bay on 17 August (WR). This record has now been accepted by the South American Classification Committee of the American Ornithologists Union as the first confirmed sighting for South America.

An adult **White-tailed Tropicbird, *Phaethon lepturus*** was seen from the lookout on Little Tobago island on 12

January (KB, DJ)(Fig. 2). Subsequent reports confirmed a breeding pair which successfully raised one chick (many observers). Whilst long anticipated, this is the first confirmed breeding of this species in Trinidad and Tobago.

Fig. 2. White-tailed Tropicbird, *Phaethon lepturus,* Little Tobago island on 12 January 2017 photo Nigel Hacking.

A **Cory's Shearwater, *Calonectris diomedea*** was seen flying south along the coast at Manzanilla on 2 January (TJ). This remains a rare migrant seabird to local waters, with almost all sightings coming from the winward coast of Tobago and Trinidad's eastern coastline from November to May.

An immature **Agami Heron, *Agamia agami*** was found in flooded lowland forest east of Brasso Seco during early March (CF)(Fig. 3). This is the first documented record of this shy and elusive wanderer from mainland South America since 1961

Fig. 3. Agami Heron, *Agamia agami,* Brasso Seco, March 2017. Photo Carl Fitzjames.

The **Gray Heron**, ***Ardea cinerea*** first found at Bon Accord, Tobago on 28 December 2016 (see Kenefick 2017) was reported until 6 April. Similarly, the individual first found at Brickfield on 18 December 2016 (see Kenefick 2017) remained throughout the year. Additionally, a bird in first winter plumage was photographed at Waterloo on 8 July (NL).

At least one of the **Glossy Ibis, *Plegadis falcinellus*** first found on 27 November 2015 at Bon Accord, Tobago (see Kenefick 2016, 2017) remained until 1 February at least. Additionally single birds were photographed at Caroni Rice Project on 31 July (NL) and Satnurine trace, Penal on 14 August (RG). Once a rare wanderer from the mainland, they now occur annually and have been found in most months of the year

An adult male **Snail Kite, *Rostrhamus sociabilis*** was photographed on Caroni Rice Project on 21 March. Later joined by two birds in immature/female plumage they remained until 11 April at least (JF, JG,KM). On 23 April, a male was photographed at farmland in Aranguez (JF) and a further male was at Orange Grove on 13 May. It is possible that only three birds in total were involved. Formerly a very rare wanderer from the mainland, they have now occurred during the period March-May in four of the last seven years.

A bird of prey which puzzled many observers for a long while was eventually identified as a hybrid **White-tailed Hawk, *Geranoaetus albicaudatus*** x **Savanna Hawk, *Buteogallus meridionalis***. It was first found on 26 July (RA *et al.*)(Fig. 4) and remained present until the year end. This is the first ever documented report of such hybridisation in Trinidad.

Fig. 4. Hybrid White-tailed Hawk, *Geranoaetus albicaudatus* x Savanna Hawk, *Buteogallus meridionalis.* Caroni Rice Project 2017. Photo Jerome Foster.

In each of the last five years, a pair of **Brown-throated Parakeet, *Eupsittula pertinax*** has been observed inspecting/excavating holes in termite nests in the Aripo savanna area. On 5 December, three birds were found together, indicative of successful breeding (EC, ES).

Two White-eyed Parakeet, *Psittacara leucophthalmus* were photographed close to Talparo on 27 February (FO).

In south-west Trinidad a flock of approximately 20 were seen flying into roost in Mango trees at Pleasantville, San Fernando on 9 June (RL) with varying numbers being seen in the general area on a number of dates subsequently (many observers). The feral flock, based in the northern suburbs of Port of Spain has been reported as far east as San Juan.

A **Small-billed Elaenia, *Elaenia parvirostris*** was found at Orange Grove on 23 May (JF) and two different birds were photographed at Carlsen Fields on 4 June and 10 June respectively (NL). Thereafter up to four birds were present in a small agricultural area alongside Caroni Rice Project on 10 August with at least one remaining until the 14 August (NL *et al.*). These sightings fall within the newly established pattern of sightings in Trinidad. In all since 2007, 25 birds have been found; all but one between 11 May and 5 September.

A **Lesser Elaenia, *Elaenia chiriquensis*** was photographed at Baboonia trace, Charlieville on 24 August (JF). Currently five other submissions are still under review by the Committee. This remains a scarce resident of Trinidad lowland scrub. The complexity of *Elaenia* flycatcher identification may mask its true abundance.

During the year, five sightings of **Black-whiskered Vireo, *Vireo altiloquus*** were as follows :- at Gran Couva on 12 February (JF); Poole on 24 March (FO); Carlsen Field on 16 June (JF); Caroni swamp on 16 September (WR) and Morne Bleu on 7 October (FA). This species is a partial or short-distance migrant, breeding both on many of the Lesser Antilles and also islands off of the Venezuelan coastline. Of the 37 documented records in the last 22 years, all but one reflect non-breeding dispersal. However we now have a June sighting. The question remains as to whether this is merely a delayed migrant, or whether the species may now become resident.

Southern Rough-winged Swallow, *Stelgidopteryx ruficollis* is a common and widespread Trinidad resident species, but in Tobago it is rare. One found over Bon Accord sewage lagoons on 11 January (DJ) is just the fourth documented record for the island.

A **Bank Swallow, *Riparia riparia*** was found at Bon Accord sewage lagoons on 3 November (CH, RH). Still a distinctly rare migrant to Tobago, all four records this century have been from this location.

Northbound migrant **Cliff Swallows, *Petrochelidon pyrrhonota*** were observed on Caroni Rice Project on 4 March (NL), 28 March (JF), 11 April (JF) and 27 April (JF). Returning southbound birds were found at Trincity on 11 September (MK, NL) and at Brickfield on 28 October (NL). This is by far the largest ever number of sightings in Trinidad. It is, however, uncertain whether this reflects increased observer coverage, increased observer awareness of *hirundine* identification or a true change in migration distribution.

A pair of **Lesson's Seedeaters, *Sporophila bouvronides*** were found in St. Joseph on 21 October (CC, JF). On the same date, a male was photographed in farmland at El Socorro (RJ, SR). The date pattern suggests natural wanderers from the mainland, however escapees from the pet trade cannot be eliminated. No reports were received this year from the historic breeding site in south Trinidad.

Single male **Yellow-bellied Seedeater, *Sporophila nigricollis*** were found at Orange Grove on 5 May (JF), Morne Catherine on 24 September (FO) and Mt. St. Benedict on 9 October (MC, JR). This follows the now anticipated trend of sightings from the north-west peninsula and farmlands and grasslands at the southern base of the Northern Range. Of the 22 documented records archived since the formation of this Committee, all but two were from these geographical areas.

An adult male **Scarlet Tanager, *Piranga* olivacea** was photographed at Asa Wright Nature Centre on 9 April (PD *et al.*) and again seen on 16 April (BR). Of the 11 documented, northbound migration records of this species, all but one have occurred from 8 to 28 April.

A returning adult female **Black and White Warbler, *Mniotilta varia*** was found once again in a patch of mangrove close to Carli Bay on 13 October (NL) for its fourth successive winter.

For the second year running, what we assume to be the same **Tennessee Warbler, *Leiothlypis peregrina*** was photographed feeding in a line of trees adjacent to Brickfield Fishing Depot on 9 December (NL). First documented in Trinidad as recently as 2014, there have now been five sightings of this southbound migrant, in three years.

A female **Cerulean Warbler, *Setophaga cerulea*** found on 4 December at Gran Couva remained until the year end at least (JF *et al.*), although its preference for feeding in the tops of an extremely large Samaan tree precluded positive identification for some while. Considered "vulnerable" by the International Union for the Conservation of Nature, and known to have suffered a decrease in population by more than 70% in the last 50 years, this is the fourth documented sighting for Trinidad and Tobago and the only individual known to be present for more than one day.

The **Bay-breasted Warbler, *Setophaga castanea*** first found at Carli Bay on18 December 2016 (see Kenefick 2017) remained until at least 31 January. Another was found at Talparo on 22 January (KM, FO). Since first found in 2014, they have been documented every year since; but not, as yet, from Tobago.

A **Chestnut-sided Warbler, *Setophaga pensylvanica*** in basic plumage was found at Bon Accord, Tobago on 15 February (MKe). This is the first documented record for Tobago in the last 22 years. Whilst still considered a very rare southbound migrant, five have been found in the last seven years.

A female **Canada Warbler, *Cardellina canadensis*** was found in mangrove adjacent to Bon Accord sewage lagoons on 8 February (MKe). This constitute the first documented sighting for Tobago and just the second nationally of this migrant warbler which has a wide wintering distribution throughout northern South America

A female **Baltimore Oriole, *Icterus galbula*** was found at Asa Wright Nature Centre on 13 May (RD,AG,LN)(Fig. 5). This is just the third documented sighting of this northbound migrant in the last 23 years.

Fig. 5. Baltimore Oriole, *Icterus galbula,* Asa Wright Nature Centre, May 13 2017. Photo Ashley Grove

A flock of 11 **Bobolink, *Dolichonyx oryzivorus*** was found inside Caroni Rice Project on 23 October (MC, JR). This southbound migrant from continental North America is now found almost annually with 18 out of the last 20 documented sightings being from 1 October to 22 November.

Additional records

Acceptable records were also received for a further 67 sightings of the following species whose status has been established but who's distribution continues to be monitored by the Committee. **Scaled Dove***, Columbina squammata;* **Rufous-necked Wood-Rail**, *Aramides axillaris;* **Rufescent Tiger-Heron**, *Tigrisoma lineatum;* **Hook-billed Kite**, *Chondrohierax uncinatus;* **Black Hawk-Eagle**, *Spizaetus tyrannus;* **Rufous Crab-Hawk**, *Buteogallus aequinoctialis;* **Crane Hawk,** *Geranospiza caerulescens;* **Little Egret,** *Egretta garzetta***;** **Crested Caracara,** *Caracara cheriway* (Fig. 6); **Aplomado Falcon,** *Falco femoralis;* **Variegated Flycatcher**, *Empidonomus varius;* **Summer Tanager,** *Piranga rubra.*

Fig. 6. Crested Caracara, *Caracara cheriway* adult with nestling. Nesting of this species was first documented in March-April 2017, location withheld. Photo Rishi Goordial.

Escaped cage and aviary species

We are aware of a reintroduction project involving **Muscovy Ducks** *Cairina moschata* from Point a Pierre Wildfowl Trust. Sightings of this species from the south-west peninsula of Trinidad may involve birds from this scheme. **Village Weavers**, *Ploceus culcullatus* remain in small numbers on Caroni Rice Project and **Tricolored Munias**, *Lonchura malacca* are spreading thoughout western and central Trinidad. Elsewhere, exotic parrot species continue to be reported. **Painted Parakeet***, Pyrrhura picta* has been photographed in both Princes Town and Port of Spain; **Red-shouldered Macaw**, *Diopsittaca nobilis* from Waterloo; **Red and Green Macaws,** *Ara chloropterus* from La Brea, Palo Seco, Vessigny, Quinam, Santa Flora, Las Cuevas, Blanchisseuse, Cumuto and Moka and a **Military Macaw**, *Ara militaris* from south Valsayn. A **Blue Bunting**, *Cyanocompsa parellina* at Orange Grove and a **Venezuelan Troupial,** *Icterus icterus* in Carlsen Fields are also presumed to be a loss to cage-bird owners .

The provenance of seedeater and seed-finch species continues to be a problem. The Committee has taken a decision that, unless there is supporting evidence to the contrary, all sightings will be considered under this category and that assessment will be on identification alone. **Chestnut-bellied Seed-Finch**, *Oryzoborus angolensis* was reported from South Oropouche and Carli Bay; an adult male **Lesson's Seedfinch**, *Sporophila bouvronides* from Nariva and a **Chestnut Munia**, *Lonchura atricapilla* was photographed at Caroni Rice Project.

Inconclusive records

Submissions of the following species were deemed inconclusive :- **Green Heron**, *Butorides virescens* (Trinidad*)*; **Gray Heron**, *Ardea cinerea;* **Lesser Elaenia**, *Elaenia chiriquensis;* **Cliff Swallow**, *Petrochelidon pyrrhonota;* **Louisiana Waterthrush***, Seiurus motacilla* **Blackburnian Warbler,** *Setophaga fusca.*

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Book Review

A Field Guide to the Amphibians & Reptiles of Trinidad & Tobago. Trinidad & Tobago Field Naturalists' Club

by J.C. Murphy, J.R. Downie, J.M. Smith, S. M. Livingstone, R.S. Mohammed, R.M. Lehtinen, M. Eyre, J.N. Sewlal, N. Noriega, G.S. Casper, T. Anton, M.G. Rutherford, A.L. Braswell and M.J. Jowers.

(R.J. August, Managing Editor; Foreword by R.A. Thomas) 2018

Twenty years ago, I bought 'Amphibians and Reptiles of Trinidad and Tobago', published by the North American Krieger becoming, with 'Turtles of Venezuela' by Peter Pritchard and Pedro Trebbau, one of the first herpetofauna books in my personal library. Then, I was amazed by the similitude of the herpetofauna of these two island and adjacent islets with coastal Venezuela, separated by barely 15km from the Venezuelan Paria Peninsula. When I received the book, my impression was that everything one needed to know was already there, there were only few topics to investigate; but on the other hand, it also motivated me to investigate the Venezuelan area that is the most similar to those islands: the isolated Paria Peninsula. I was able to publish a note on the reptiles of Sucre State one year late (Rivas and Oliveros 1997 "1998"). Coming back to Pritchard and Trebbau (1984), I noted a picture of a mata mata turtle that arrived to the coast of Trinidad with some barnacles in its carapace, due to its permanence in blackish water. What I read surprised me, how the waters from the Orinoco can carry masses of floating vegetation with reptiles to the coast of Trinidad. That picture also called my attention because the photographer, Hans Boos, had the same surname as a farm ubiquitous in northeastern Venezuela (decades later I noticed this farm have belonged to an uncle of H. Boos).

Years later, in March 2014, travelling with my colleague Tito Barros to Florida, USA, to visit Peter Pritchard to work on the book 'Venezuela y sus Tortugas', we made a brief stop in Trinidad and took the opportunity to meet Mr Boos. Once in the airport, Boos invited us to visit the Emperor Valley Zoo and later visit his home to see his personal library. Then, he showed us his slide collection and I was surprised to see that mata mata picture I had seen 20 year earlier in Pritchard and Trebbau's and Murphy's books. That is how my life history has become what it is, it was written and visualised by those photos that appeared in those two books. That sort of circle, is closed today as I write this modest review. Since then I have been always interested in the herpetofauna of Trinidad and Tobago, and of course of that of the Paria Peninsula. A few years ago, I do not remember who contacted who, John and I started an online friendship, so thatI was looking forward to A Field Guide to the Amphibians & Reptiles of Trinidad & Tobago published by the renowned Trinidad & Tobago Field Naturalists' Club, which fills the gap after Murphy (1997), and surely as it happened with me, it would motivate a new generation of researchers in herpetology. This new Field Guide will certainly be a valuable source of information to understand and preserve this unique biota, shared in part with northeastern Venezuela.

The guide contains information provided by 20 investigators, directed by John Murphy, and edited by Renoir Auguste, a promising young herpetologist from Trinidad. With 336 pages, A Field Guide to the Amphibians & Reptiles of Trinidad & Tobago starts with a list of all authors and their current affiliations, a foreword by Robert Thomas, notable herpetologist from the US, who has worked in South America. These are followed by a preface, acknowledgments, how to use this book, introduction the environment conservation, folklore, measurements & identifying features, waifs & questionable species, amphibian species accounts, reptile species accounts, six appendixes, glossary of terms, list of references cited in the text and finally an index of common names.

We can read in the preface about Anne, a pregnant green anaconda, found in Trinidad and shipped to the Bronx Zoo and how her babies were distributed to many other zoos, or the discovery of a luminous lizard found a cave by Ivan Sanderson, among other histories, being a source of motivation to a next generation of individuals interested in herpetology.

The first part of the Introduction described briefly but precisely the rate of discoveries of new species of amphibians and reptiles, lack of information, how the geographers consider Trinidad & Tobago a biodiversity hub, the relationships of these islands with the surrounding land masses and features and diversity of the herpetofauna that can be found.

The section of conservation is really useful for all researchers, tourists, as well as hunters that need to know the legislation of the country as well as the laws that protect the wildlife and organisation to grant the permits. In the folklore chapter, the authors mention that Trinidad and Tobago is biologically and culturally very diverse, with a variety of influences, including African, Chinese, Indian and European immigrants and colonisers. This rich cultural mosaic is reflected in folklore and superstitions, including folk medicine. Measurement and characteristics of the different groups, shows the main characteristics to identify the species. Profusely illustrated with drawings, albeit some of the drawings taken from other publications; however, the objective is met. In waif and questionable species, the authors have reviewed all available information and with provide new evidence about the species wrongly cited for the Republic of Trinidad and Tobago.

The species accounts make up the bulk of this treatise, including information on 129 species of amphibians and reptiles (35 frogs, 30 lizards, 11 turtles, two species of crocodiles, and 51 snakes). Ten of them had an exotic origin: the frogs *Eleutherodactylus jonhtonei* and *Scarthyla vigilans*, seven lizards (*Hemidactylus mabouia*, *Anolis aeneus*, *A. extremus*, *A. richardii*, *A. sagrei*, *A. trinitatis* and *A. wattsi*) and a fresh water turtle (*Trachemys scripta elegans*). Each species account contains its previous known name, common name, size, identification, similar species, distribution, habitat and biology, a dot map with different colours dots according to the time of the record, and finally profusely illustrated with many pictures and drawing of the species and their habitat, most of them taken directly from the country, except few taken on outside such as *Anolis extremus*, an exotic species.

Six appendices are provided: the first is on Trinidad frog reproductive modes: spawn, hatching stages, and tadpoles (appendix I), followed by Handling Amphibians and Reptiles (appendix II), Amphibian chytridiomycosis, (appendix III) Snakebite (appendix IV), Herpetological Collections in Trinidad & Tobago (appendix V) and Research Stations and Lodging for Ecotourists (appendix VI). The glossary of biological terms is really useful for all those people familiar or not with biodiversity issues. How it reads on page 3 "the design of this field guide allows ready access to the Trinidad and Tobago herpetofauna. The vocabulary may be most familiar to naturalists, scientists and amateur herpetologists, but for the novice we have supplied a glossary and some detailed explanations". Finally, a wider list of bibliographical references and an index of common names finish the masterpiece.

The team of authors of A Field Guide to the Amphibians & Reptiles of Trinidad & Tobago have provided us with a useful tool to know and preserve the life of the amphibians and reptiles from these islands. This guide complements those of Kenny (1969), Murphy (1997), and Boos (2001) and those books edited by Hailey *et al.* (2011a,b). I will recommend it to everyone interested in knowing the biodiversity of amphibians and reptiles of Trinidad and Tobago, the Antilles and northern South America.

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