LIVING WORLD

Journal of The Trinidad and Tobago Field Naturalists' Club

2017

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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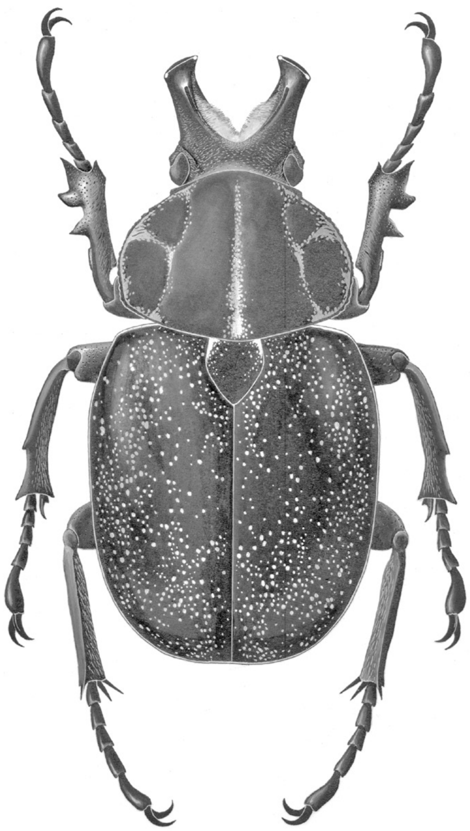

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Editorial

The Paris Agreement on climate change was adopted at the end of 2015. This year we are honoured to receive a Guest Editorial from John Agard describing our national responsibility to reduce carbon emissions. Professor Agard describes our national approach and what institutions like the Trinidad and Tobago Field Naturalists' Club should be doing. We learn that we are the second highest emitter of carbon dioxide per capita in the world at about 38.2 metric tons/person. Fortunately we also learn that we know what to do, we have publicized this to the world and now need to get on with the job.

In addition to the Guest Editorial, the 2017 Living World contains nine research papers, six nature notes, one report and a book review. This year we start with a paper on the freshwater algal species *Chara*, which the authors, Julian Duncan and Judy Rouse-Millar, point out is an unfamiliar element in our biodiversity. We were pleased to receive a paper on shark and mobulid species recorded in Tobago submitted by Lanya Fanovich and co-authors. The publication of citizen-based observations are a valuable source of information on our biodiversity and is in keeping with the philosophy of the Journal. Indeed, this the first paper on sharks in Living World. The marine theme continues with a paper on fibropapilloma tumours on green turtles by Michelle Cazabon-Mannette and Carla Phillips. Matthew Cock, Scott Alston-Smith and Kris Sookdeo add to our knowledge of our Lepidoptera in three research papers; one on new additions to the butterfly list of Trinidad, one on the moths of the Five Islands and one on the Lepidoptera of Huevos. Switching to fish, Ryan Mohammed and his co-authors describe the assemblages of fish in streams in northeastern Tobago. Kerresha Khan and co-authors ask whether an ocelot's origin can be determined from its coat pattern. Finally Chris Starr and Shane Ballah describe the ant fauna of urban Port of Spain.

Our nature notes are dominated by range expansion of species, both native and exotic. Roger Downie and co-authors provide an update of the spread of the introduced frog *Eleutherodactylus johnstonei* in both islands. Adam Fifi and Renoir Auguste describe new locations for the introduced *Anolis wattsi*. Renoir also gives an update of the distribution of the native frog *Adenomera* cf *hylaedactla* and questions whether we may have more than one species of *Adenomera*. Ryan Mohammed and co-authors provide sightings of the introduced Red-eared Slider (a terrapin), and discuss their potential invasive status. Finally we have two new island records: Rakesh Bhukal together with Chris Starr describe the first record of the wasp *Trypoxylon albitarse* for Tobago. Rakesh also records the dragonfly *Erythemis attala* on Trinidad for the first time.

During 2016 three new species were added to the Trinidad and Tobago bird list. These include Eurasian Wigeon, Slender-billed Kite and Audouin's Gull. The report of the Trinidad and Tobago Bird Status and Distribution Committee highlights 2016 as having the highest number of reported sightings since the formation of the Committee. This not only illustrates the growth of birdwatching nationally but the contribution birdwatchers make to our understanding of the status of each species.

The book The Dragonflies & Damselflies of Trinidad & Tobago by John Michalski became available at the end of 2015. Rakesh Bhukal provides a review of this attractive book which makes this important group of insects accessible to a wider audience.

In 2016 Living World was published online in a fully searchable webpage format. Thirty-two issues of the Club's journal, dating back to 1961, are now available online and freely accessible as pdfs. Earlier editions will be uploaded during the course of the coming year. It is the editorial committee's intention to eventually make all of these editions available in the HTML format as well.

Building on our move to an online journal, we are pleased to announce the introduction of a 'continuous publication' workflow for Living World. In 2018, we will publish each research article online as soon as it has passed the peer-review process and is accepted for publication. At the end of each year, the content, together with nature notes and reports will be compiled into one issue, which will be available as 'print on demand' for those who wish to order a hard copy. The obvious advantage of this change for authors is that the submission-to-publication time will be considerably reduced, and findings disseminated in a more timely fashion. It also means that manuscripts may be submitted for consideration at any point in the year. For readers, it allows the option of engaging with the articles one by one or in an annual 'package'. Adopting this model brings us in line with the majority of journals internationally, who already practice continuous publication for the reasons listed above. Whether an author, a reader, or both, we hope that this change enhances your enjoyment of the Journal and, as always, we appreciate your feedback.

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Cover Photograph

Green Turtles were once thought to feed exclusively within areas of turtle grass. We now know that they also feed on algae associated with rocky reefs around both Trinidad and Tobago. This individual, and others, were regularly seen off the coast of Blanchisseusse in northern Trinidad. Photo Graham White.

Guest Editorial

Trinidad and Tobago and Climate Change. Are we rising to the Challenge?

Trinidad and Tobago is a signatory to the Paris Climate Change Agreement. With this, we have indicated that we support worldwide efforts to reduce carbon dioxide emissions thus reducing the effects of climate change. We acknowledge that anthropogenic climate change is in fact occurring, and that we must do our part to reduce carbon dioxide emissions which have steadily risen since the industrial revolution in the late 1800s and early 1900s due to the combustion of fossil fuels. That the Earth's temperature rises with increasing levels of greenhouse gases is a fact that we have known for a long time, Arrhenius documenting this in his famous paper of 1896 entitled "On the influence of carbonic acid in the air upon the temperature of the ground". The effect he documented is unfolding exactly as he predicted. Human beings have added a tremendous amount of carbon dioxide and other greenhouse gases to the atmosphere, adding to the peak of the natural warming process. We are now in unchartered territory, and are, in fact, already seeing the effects of anthropogenic climate change. How do we mitigate and adapt to these changes, especially in light of the fact that we in the Caribbean form a series of small island states which are especially vulnerable? In 2017, we saw Maria, a category 5 hurricane form in record time. The islands in Maria's path have been utterly devastated. The latest climate models project between a 1-3 % increase in average global temperatures by the year 2100 if we do nothing, and this will have devastating effects worldwide. We will not be immune to these effects. Sea level monitors in Port of Spain, Point Fortin, Galeota and Scarborough are all online and accessible, and support models showing that sea level rise is taking place at the rate of about 2.7mm/year +/- 0.4mm. If we have a high tide while rains fall in Port of Spain, there is the inevitable flood. It is frightening to think what may happen to Trinidad and Tobago should we be hit by even a category 1 hurricane. You can ignore the scientific facts at hand, but it will be to your peril. Climate change is happening, but is Trinidad and Tobago doing its part to mitigate against the effects of global climate change?

The available data shows that Trinidad and Tobago is in the unenviable position of being the second highest emitter of carbon dioxide per capita in the world at about 38.2 metric tons/person, being surpassed only by Qatar, at 40.3 metric tons/person (we may have surpassed them by now). This isn't surprising given that we are one of the few small island developing states that are net exporters of energy. We export oil and natural gas products, and have six of the largest ammonia plants in the world. We as a country have gotten rich using our fossil fuel wealth, but with these riches comes tremendous responsibility. Our response to the per capita carbon statistic is usually that we shouldn't be looking at the per capita emissions, but the total emissions by country, in which case Trinidad and Tobago perhaps contributes less than 1% of the global total, which officials tout as being tame by comparison. This is an abdication of our responsibility to the world, especially our Caribbean neighbours. It is irresponsible for us to cite the overall contribution and we ought to take the necessary steps to reduce this, especially in light of the fact that the population of Trinidad and Tobago is predicted to decline over the next ten years, thus increasing our per capita carbon emission value if we take a business as usual attitude.

Trinidad and Tobago knows what to do, and we have publicized this to the world. As a signatory to the Paris Climate Agreement, Trinidad and Tobago has submitted to the UN its Nationally Determined Contribution or NDC (available online). This document is meant to show the world what each country plans to do to contribute to the overall reduction of their greenhouse gas emissions. For example, Trinidad and Tobago has committed itself to a 20% reduction in greenhouse gas emissions in the public transportation sector by 2030. The NDC for Trinidad and Tobago is based in large part on a 2015 study done in Trinidad and Tobago entitled "Strategy for reduction of carbon emissions in Trinidad and Tobago, 2040", available online on the Ministry of Planning and Development's website. This was funded by a grant to Trinidad and Tobago from the Inter-American Development Bank. All of the calculations for mitigation of GHG emissions for Trinidad and Tobago were done in this study, including cost benefit and cost efficiency analyses, prioritizing those strategies which would be most cost effective for us to accomplish. At the top of this list are those strategies which are categorized as having negative cost efficiency, meaning that we would not only reduce our GHG emissions, but also make money, a win-win. At the top of the list, is the promotion of vehicle energy efficiency and fuel switching in maxi-taxis followed by buses. We have already started working on these strategies, and these have led to our saving millions of dollars in fuel costs in buses in Trinidad and Tobago. We have no excuse. The studies have been carried out, and many of the highlighted strategies will make us money. We are not short on policy documents, but where is the action? We don't have an adaptation plan to date, though this is currently being undertaken through a European Union funded project. The current administration has stated that they want to generate 10% of the country's electricity using renewables by 2021 but we are yet to see what the plans are with respect to renewables. Are we going to put up wind farms? Photovoltaics?

The government of Trinidad and Tobago has a vital role to play in helping us reach our NDCs, but they are by no means the only entity to contribute. What role does corporate T&T have in helping drive a change in the country to help reduce GHG emissions and mitigate the effects of climate change? There is growing consensus among corporations that making money alone is not good enough, with many corporations adhering to the triple bottom line - money, people, and environment. Some companies are leading in this vein. Atlantic LNG, for example, has calculated its carbon footprint, based on all of their activities, in an effort to offset their emissions of GHGs. All cars that Volvo makes from 2019 onwards will either be electric or hybrid, signalling a move away from fossil fuels. BP no longer stands for British Petroleum, but for Beyond Petroleum, acknowledging the need to diversify away from petroleum products. Indeed, if they wish to be the providers of energy needs in the future, they see the imperative to invest into renewable energy industries, with growing recognition that fossil fuel industries are on the way out. More and more companies are realising that it is not only good PR to switch to renewables, but it's also profitable.

What can organisations like the Trinidad and Tobago Field Naturalists' Club do in their efforts to reduce our carbon emissions? For starters, they can work to educate people about the issue of climate change, the fact that Trinidad and Tobago has policies and plans in place to reduce our carbon emissions, and to put pressure on the government to fulfil the commitments made in the NDC. We can all educate one another about energy conservation using such devices as activity sensors, conduct energy audits to assess how we can each save energy, and demand that new policies be enacted by government to help us not only meet our commitments, but surpass them. With respect to new policy, at the moment we have no feed-in-tariffs legislation. Feed in tariffs are policy instruments which allow people who have invested in renewable energy technologies to be rewarded for all the electricity they generate and provide back to the electricity grid. Imagine never having to pay electricity bills for the rest of your life, and instead getting money for generating more energy than you consume. Several countries in the Caribbean have feed in tariffs, including Barbados, Jamaica and Dominica. Why don't we have these in Trinidad and Tobago? One of the reasons this hasn't been pursued in Trinidad and Tobago is that we have one of the cheapest electricity rates in the world, which means there is little incentive to take advantage of some of the subsidies for renewable energy technologies which the government has put in place. We should not only be investing in renewable energy as individuals, but we as a country should be manufacturing the technology. With our abundance of cheap energy, and an abundance of suitable sandy raw materials to manufacture photovoltaics on our doorstep in our neighbour Guyana, this would appear to be a missed opportunity. The government has already signalled that they may be looking at revised utility rates in the not too distant future. Would this perhaps prompt more people to switch to renewables? Would this then prompt us to enact feed-in-tariffs?

Each of us contributes in our own way to the carbon emissions of Trinidad and Tobago. It is each individual doing their little bit to reduce these carbon emissions which will help us resolve this problem. The more people that take this challenge on, the better it will be for all mankind. The government of Trinidad and Tobago has policies in place to help reduce our GHGs and also mitigate against climate change, but we need them to act faster to the challenge at hand. We need to demand better of them, educate the population of the issues, and lobby for new policies such as the enactment of feed-in-tariffs to help us reach our goals. Climate change is one of the biggest challenges to face humanity. I have no doubt that together we can overcome this challenge.

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Chara sp. an Unfamiliar Algal Element in our Biodiversity

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ABSTRACT

Chara, is a freshwater, green algal genus with cosmopolitan distribution, a species of which can be found in abundance in the limestone ponds at Mayo, central Trinidad. The alga, a member of the Charophyta – a group considered to be ancestral to land plants - has many features of interest, among which are a protective jacket around the reproductive organs (a feature of land plants); true oogamous reproduction; a highly differentiated thallus; and the capacity to deposit calcium carbonate in the water in which it grows. It is also known to produce a substance that is toxic to mosquito larvae.

Key words: Charophyta, limestone ponds, Trinidad, biological control, calcium carbonate

INTRODUCTION

The term alga refers to a diverse group of predominantly aquatic, chlorophyll-containing autotrophic organisms which are not necessarily closely related, and is thus polyphyletic. The group was originally placed in the Kingdom Plantae. However, all algal groups - except the green algae - are currently classified as Protoctista - any eukaryotic organism that is not an animal, plant or fungus - because they possess features which are not shared with land plants such as diversity of life cycles, morphology, cellular organisation and accessory pigments present along with chlorophyll. These additional pigments mask the presence of the chlorophyll, rendering the alga brown, yellow/brown or red.

The green algae which include two divisions, Chlorophyta and Charophyta, are now classified with land plants in the Kingdom Plantae or Chlorobionta. They possess features such as tropisms, circadian rhythms, osmoregulation, cell polarity, basic mating types and plant hormones inherited from a eukaryotic ancestor which make them suitable ancestors as land plants (The Green Plant BAC library project 2017). In fact, a group of green freshwater algae (Charophytes) is believed to be the ancestors of land plants, based on evidence gathered from cell ultrastructure, biochemistry and molecular biology of living members. Thus, green algae in particular the Charophytes, of which the genus *Chara* discussed in the article, is an example, are related by common ancestry to land plants. Classification of organisms is in constant flux but the evidence which identifies the relatedness of green algae and land plants is quite strong and well accepted by the scientific community.

While there is a comprehensive record of the marine elements of our algae (Duncan and Lee Lum 2006), the same does not hold for freshwater species, thus very little is known locally of the genus *Chara*, a representative of which is found in the ponds at Mayo , in the limestone area in central Trinidad.

Distribution and habitat of the genus

The genus is reported as occurring from as far north at 69 degrees in Norway and to about 49 degrees south in the Kerguelen Islands (Pal *et al.* 1962) as cited by Sharma (1986).

In Europe, members of the genus are found growing in lakes and ponds in limestone areas, a habitat referred to as H3140, characterised as hard oligotrophic water, in which the concentration of calcium carbonate ($CaCO_3$) is high, making the water very alkaline. Water in which the level of $CaCO_3$ is above 120 mg/L is regarded as being hard. Some species of the genus are found in slow running water while others grow in different habitats, such as *C. hatei* S. C. Dixit, which grows trailing on the soil, *C. nuda* B. S. Pal and *C. grovesii* B. P. Pal, found on mountains, and *C. wallichii* A. Braun, found in plains (Neelesh 2013). The brackish water charophyte *Chara canescens* Loiseleur, widely distributed in the coastal regions of the Northern Hemisphere (Winter and Kirst 1991) is intermediate between the freshwater species *Chara vulgaris* L. which exhibits adaptability to slightly brackish lake water (Kirst *et al.* 1988) and the euryhaline charophytes in terms of salt tolerance (Winter and Kirst 1991). *Chara buckellii* G. O. Allen, a giant-celled alga is found in a salt lake in Saskatchewan (Hoffmann and Bisson 1990).

Locally, *Chara* is found in the limestone ponds at Mayo in central Trinidad, where the water is very alkaline and the level of $CaCO_3$ is of the order of 343mg/L. The plants are often encrusted with $CaCO_3$, which renders them brittle and rough to the feel; the metabolic processes associated with this deposition often give them an unpleasant smell of hydrogen sulphide. On account of the encrustation they are known as stoneworts.

The plants are anchored in the substrate by rhizoids; these bind the soil particles together, stabilising the bottom sediments thereby preventing muddy water. The water is usually very clear (Fig. 1).

Fig. 1. Limestone pond at Mayo, showing growths of *Chara* sp. beneath the surface of the clear water

Fig. 2. Terminal portion of main axis, a – node, b- branch of unlimited growth, c – branch of limited growth (leaf), d- internode

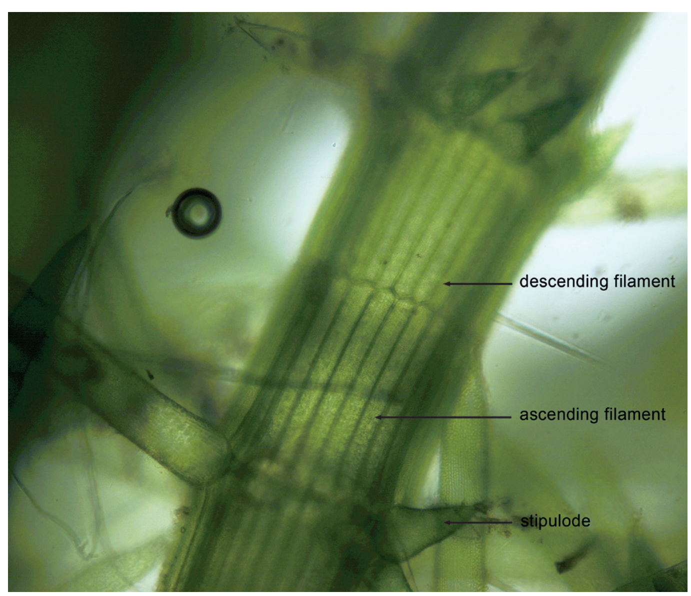

Fig. 3. An internode above and below which stipulodes are seen; ascending and descending corticating filaments are also seen.

Structure

The thallus of *Chara* is branched, multicellular and macroscopic. Most species grow to a height of 30cm, but some grow as tall as 1m. However, structurally, there is a main axis, from the base of which fine, branched rhizoids arise. These anchor the thallus in the substratum.

The main axis is differentiated into nodes and internodes. (Fig. 2). The nodes consist of a pair of central cells, surrounded by a ring of 6-20 peripheral cells, from which four types of structures arise: **branches of limited growth –** these are produced in whorls of 6 -20 and are themselves differentiated into nodes and internodes; they are called branches of first order, primary laterals or leaves.; **branches of unlimited growth -** these arise from the axils of the branches of limited growth hence they are called auxiliary branches or long laterals. These may produce branches of limited growth; **stipulodes** – these are short, oval, pointed, single-celled structures (akin to leaves) produced from the basal node of the branches of limited growth, and **cortex-** defined later**.**

The internode consists of a single, much-elongated cell. In some species this cell may be surrounded by a layer of cells called the cortex; such species are corticate species. The cortex consists of vertically elongated, narrow cells. The upper half of each internodal cell is covered by corticating filaments known as descending filaments, developed from the peripheral cells of the upper node. The lower half is covered by filaments developed from the lower peripheral cells of the node; these are known as ascending filaments. The two meet at the middle of internode (Fig. 3).

Reproduction

Both asexual (without nuclear fusion) and sexual (with fusion of nuclei) reproduction are recognised in species of the genus.

Asexual reproduction is purely vegetative. Two forms are recognised: (a) the production of oval, tube-like structures, known as bulbils, on the rhizoids and lower nodes of the main axis, which on detachment, germinate to produce new thalli; and (b) in some species the production of multicellular, star-shaped aggregates of cells filled with starch grains, known as amylum stars, on the lower nodes of the main axis. When they become detached, they develop into new thalli.

Sexual reproduction is recognised in all species of the genus. Two kinds of gametangia are produced, an oogonium (female) – referred to as the nucule and an antheridium (male) referred to as the globule. Both nucule (Fig. 4 left) and globule (Fig. 4 right) are highly differentiated structures.

The globule is the earlier of the two to develop. It is initiated by an adaxial (near to the main axis) peripheral cell of the basal node of a primary branch and is surrounded by a few stipulodes. It is positioned opposite to the descending tube cells of the lower internode. A sterile jacket of cells referred to as the shield is the outermost layer of the organ, and surrounds the numerous sperm cells or male gametes. A sterile jacket around the sex organs is not seen in other algae but is a typical feature of land plants for protection of the gametes against desiccation. The nucule is similarly produced from an adaxial peripheral cell on the basal node of a branch and is opposite to the ascending tube cells of the upper internode. In essence it consists of a central, large ovum (egg), surrounded by long, tubular, sterile cells known as tube cells, which are spirally coiled around the ovum, to form the protective jacket. The terminal portions of the tube cells are cut off by a cell wall; these tips form a crown at the top of the nucule, known as the corona.

When the calcium carbonate encrustation is removed with dilute hydrochloric acid and the chlorophyll bleached, the structure of the sex organs is seen more clearly (Fig. 5).

At maturity of the nucule, the spiral tube cells separate from each other, making a space for entry of the sperm, one of which enters the ovum and effects fertilisation (Kumar and Singh 1979).

In some species, both sex organs are produced on the same plant, these are said to be monoecious; in other species, plants of different sexes are produced. These are said to be dioecious.

Two species of the genus appear to grow in the ponds at Mayo. This observation is based on the facts that: (a) in one, the branching is more profuse than in the other and the internodes are shorter, making it more bushy that the other (Fig. 6); (b) there is a difference between the two in the shape of the units of the corona – in one they are acutely triangular, in the other the upper portions of the sides are concave; and the angle of the coils of tube cells is different in the two (Figs. 7); and (c) one species is monoecious (Fig. 8 left), the other is dioecious (Fig. 8 right).

Fig. 4. Nucule on upper side of node (left) and Globule, on lower side of node (right)

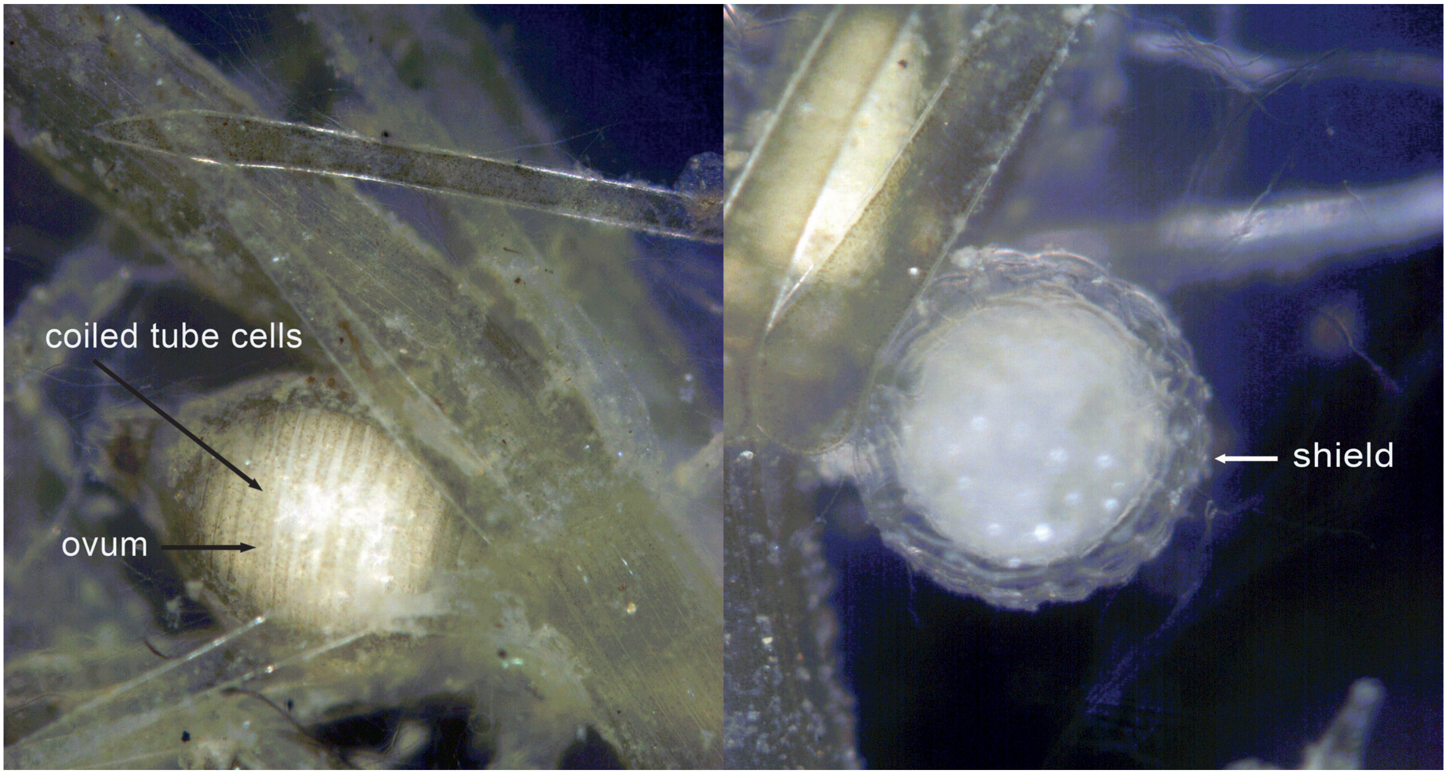

Fig. 5. *Chara* sp sex organs; female nucule (left), and male globule (right), cleared of calcium carbonate encrustation and chlorophyll to show sex organs in greater detail.

Fig. 6. Sparsely branched (left); richly branched (bushy) right

Interesting facts about the genus

Lucus (1982) demonstrated that exogenous bicarbonate HCO_3- dissolved in the water entered the internodal cells of *C. corallina* Klein ex C. L. Willdenow across the plasmalemma. In the cell carbon dioxide is acquired from the bicarbonate for photosynthesis and hydroxyl (OH−) ions are released into the water which increases the water pH and results in the remaining bicarbonates (HCO3−) combining with dissolved calcium ions (Ca2+), forming calcite crystals (Pelechaty *et al.* 2013). The thallus of *Chara* is often encrusted with calcium carbonate as a result of these deposits (Fig. 8b.) Those with a single internodal cell (which can be up to 2cm in length) may show discrete 2-3mm acid and

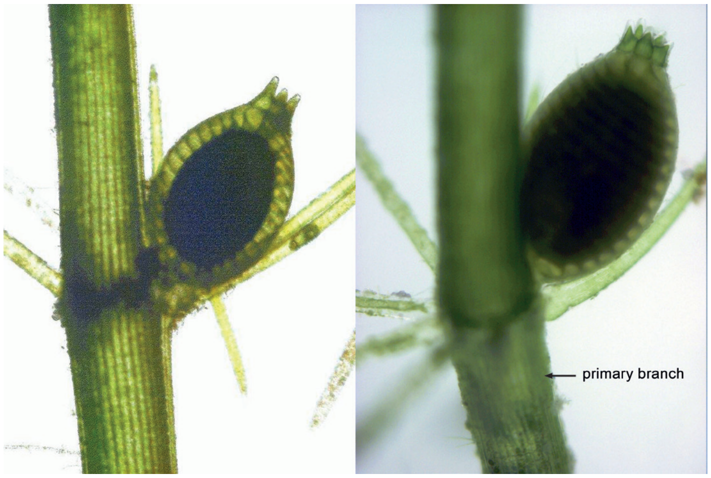

Fig. 7. Corona with cone-shaped units (left); corona with pen nib shaped units (right)

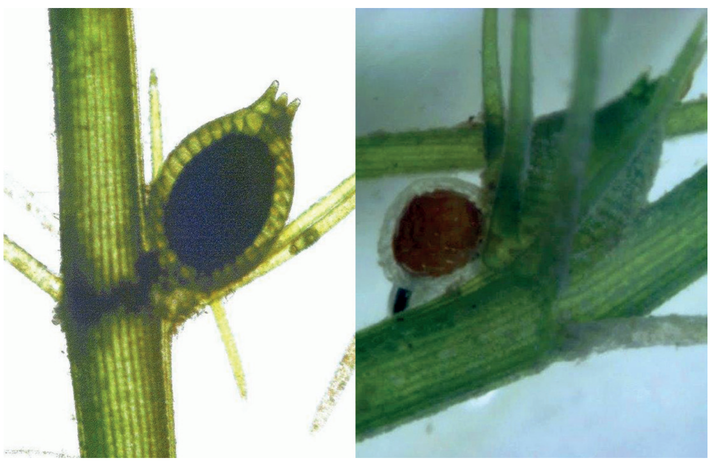

Fig. 8. monoecious species (left), dioecious species (right)

alkaline bands, Such "giant algal cells" were also used in pioneering studies on plant ionic balance across cell membranes providing fundamental insights into cellular electrical and ionic interactions which may have applicability to land plant cells.

The phenomenon of allelopathy is also observed in *Chara* spp. with several reports reviewed by (Wium-Andersen *et al.*1982) indicating the absence of phytoplankton epiphytes on stands of *Chara* spp. growing in both freshwater lakes and in brackish waters. Wium-Anderson *et al.* 1982 credits this observation to the adverse effect of sulphur compounds produced by *Chara vulgaris* L. on photosynthesis in epiphytes and suggests a use for these extracts in reducing growth of phytoplankton.

Matheson and Hinman (1928) made mention of an observation of Caballero's on the larvicidal properties of *Chara* spp. He pointed out that in a spring-fed pond in New York in which *Chara globularis* Thuiller (synonym *Chara fragilis* Desvaux) grew densely, no mosquito larvae were present.

In an experiment in which large, water-filled wooden buckets were placed in the ground, it was found that the mosquito *Culex territans* WIk bred in large numbers, but in similar buckets in which *C. vulgaris* was grown, few eggs were laid and the resulting larvae all died (Matheson and Hinman 1928). Jacobsen and Pedersen (1983) found in an extract from *C. globularis* Thuiller, a fraction with insecticidal properties similar to those of the structurally related nereistoxin.

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Glossary

Allelopathy - the adverse effect of one organism on another expedited through chemical agents.

Asexual reproduction - the formation of new individuals from the cell(s) of a single parent and does not involve nuclear fusion

Axil – in an alga or plant, the angle between the main axis and any lateral structure, such as branch or leaf.

Circadian rhythm – a physical, mental or physiological change that follows a roughly 24-hour cycle, responding primarily to light and darkness

Dioecious - having the male and female organs on separate and distinct individuals.

Eukaryotic - any organism having as its fundamental structural unit, a cell that contains specialised organelles in the cytoplasm, such as a nucleus and mitochondria

Gamete - a cell that fuses with another cell during fertilisation in organisms that reproduce sexually.

Monoecious - having both male and female organs in the same individual.

Oligotrophic – characterised by a low accumulation of dissolved nutrient salts, supporting but a sparse growth of algae and other organisms, especially in the case of lakes

Osmoregulation - maintenance by an organism of an internal balance between water and dissolved materials

Polyphyletic - developed from more than one ancestral type, as a group of animals or plants

Rhizoid - protuberances that extend from the lower epidermal cells of bryophytes and algae. They are similar in function and in some respects structure to roots.

Sexual reproduction- the formation of a new individual following the union of two gametes.

Stonewort - a plant-like group of green algae constituting the class Charophyceae, having a jointed body frequently encrusted with calcium carbonate

Thallus (pl. **thalli**) - the body of a plant that does not have leaves, stems and roots.

Tropism - a growth movement the direction of which is determined by the direction from which the stimulus strikes the plant.

Whorl - an arrangement of sepals, petals, leaves, stipules or branches that radiate from a single position around the stem.

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Six New Records of Butterflies (Lepidoptera, Papilionoidea) from Trinidad, West Indies

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ABSTRACT
Details of six new butterfly records from Trinidad are presented: *Phoebis agarithe* (Boisduval) (Pieridae), *Macrosoma ustrinaria* (Herrich-Schäffer) (Hedylidae), *Udranomia kikkawai* (A.G. Weeks), *Telemiades squanda* Evans (Hesperiidae, Eudaminae), *Morvina morvus para* Evans (Hesperiidae, Pyrginae) and *Thoon modius* (Mabille) (Hesperiidae, Hesperiinae). Notes on the biology of *U. kikkawai*, reared on *Ouratea guildingii* (Ochnaceae) are presented. The total number of butterfly species known from Trinidad is now 781.

Key words: Pieridae, Hesperiidae, Hedylidae, Ochnaceae

INTRODUCTION

Following the recent publication of three checklists for the larger butterflies Pieridae, Papilionidae and Nymphalidae (Cock 2014a), Hedylidae and Hesperiidae (Cock 2014b), and Lycaenidae (Cock and Robbins 2016), it is no great surprise that new records and adjustments come to light. Morrall (2015) records the capture of *Megeuptychia antonoe* (Cramer) in southern Trinidad, a new satyrine (Nymphalidae) for the island. Cock (2016) reports that what he listed as *Staphylus* sp. (Hesperiidae) (Cock 2014b) is actually *S. kayei* Cock, which is more variable than previously thought. In this paper we publish and illustrate new island records for one Pieridae (previously overlooked), one hedylid (newly observed) and four hesperiids (three previously unidentified and one newly found).

We refer to material examined in the following collections:
MJWC Matthew J.W. Cock, private collection
SAS Scott Alston-Smith, private collection
ABCT Angostura-Barcant Collection, Laventille, Trinidad
NHMUK The Natural History Museum, London, UK

Phoebis agarithe (Boisduval, 1829) (Pieridae)

This species was not considered or included in Cock (2014a). However, in preparing an updated list of the butterflies of Tobago (Cock 2017) it became apparent that this species is not rare in Tobago, based on Sheldon (1936) and several recent records. Accordingly, collections of Trinidad butterflies were examined, and *P. agarithe* was found to be mixed with *P. argante* (Fabricius) in ABCT. There are two males in the collection, both displayed as the underside only; one labelled Cruse, 4 October 1966, and the other unlabelled. The fact that Barcant displayed the diagnostic undersides of two different males side by side (Fig. 1) suggests he had noticed this difference, but had not appreciated its significance. There is a further specimen, in the collection of John Morrall, from Point Gourde, 11 Jun 2013. *Phoebis agarithe* is most easily distinguished from the two species under the name *P. argante* in Trinidad (Cock 2014a and below) by the forewing underside submarginal line which is continuous and straight in *P. agarithe* and stepped at vein 4 (M3) mid wing in the *P. argante* complex (Fig. 1). We conclude that *P. agarithe* is a resident species in Trinidad, easily overlooked as *P. argante* complex.

Janzen *et al.* (2009) reported that *P. argante*, as then understood, comprises two similar species, with distinct markings, genitalia and barcodes, but did not resolve the nomenclature, referring to them as *P. argante* DHJ01 and *P. argante* DHJ02. Cock (2014a) recognised the same two species from Trinidad. Janzen *et al.* (2009) suggest that it seems likely that *P. argante* DHJ01 represents the true *P. argante*, while *P. argante* DHJ02 will prove to be *P. hersilia* (Cramer). The names suggested by Janzen *et*

Fig. 1. Underside of male *P. argante* (left) and male *P. agarithe* (right), Trinidad, no data labels, M. Barcant (ABCT). Scale bar = 1cm. (Photo M.G. Rutherford).

al. are coming into use (e.g. Janzen and Hallwachs 2015), although there has as yet been no formal taxonomic treatment. However, *Papilio hersilia* Cramer, 1777 is an unavailable homonym of *P. hersilia* Fabricius, 1776 (Lamas 2004), and the oldest available name for this species is probably *Phoebis larra* (Fabricius) (Lamas 2004), which is why Cock (2014a) referred to *P. argante* DHJ02 as likely to be *P. larra*. For the moment, it is probably better to continue to refer to them as *P. argante* DHJ01 and *P. argante* DHJ02 until the group is revised.Because of their similarity to *P. agarithe* here recorded as new to the island, we illustrate the two species confused under *P. argante*, to facilitate the separation of all three species. *Phoebis argante* DHJ01 has dark spots at the outer margin of the upper side forewing (Fig. 2), whereas *P. argante* DHJ02 has a continuous narrow, dark, marginal line (Fig. 3). Barcant (1970, plate 11.3) illustrates a male of *P. argante* DHJ02 as *P. argante*, and his collection contains five male and two female *P. argante* DHJ01, six male and six female *P. argante* DHJ02 and two male *P. agarithe* all treated as *P. argante*. It would appear that *P. argante* DHJ01 and *P. argante* DHJ02 are both relatively common in Trinidad, while *P. agarithe* is relatively uncommon.

***Macrosoma ustrinaria* (Herrich-Schäffer, [1854]) (Hedylidae)**

Cock (2014b) listed just two species of Hedylidae from Trinidad. A third species is now known. Steve Nanz (2016) photographed an adult *M. ustrinaria* at the Asa Wright Nature Centre, 23 March 2015 (Fig. 4). It was identified by comparison with the illustration in Herrich-Schäffer (1850–1858) and from Scoble (1990). This species is found from Panama, south to Peru and east to French Guiana (Scoble 1990), so its presence in Trinidad is not surprising.

***Udranomia kikkawai* (A.G. Weeks, 1906) (Hesperiidae, Eudaminae)**

This species was described from Venezuela and is reported from Mexico to the Guianas to Brazil (Evans 1952), so its presence in Trinidad is not unexpected. However, *U. kikkawai* is now known to be a complex of at least three species in Costa Rica, almost identical in appearance, male genitalia, early stages and food plants but occupying different habitats and with different barcodes (Janzen *et al.* 2011). Bächtold *et al.* (2017) report that the species they studied in southeast Brazil is the true

Fig. 2. *Phoebis argante* DHJ01; male (left) Rio Claro, July 1954, M. Barcant; female (right) West Trinity, 2 July 1967, M. Barcant (ABCT) (photos M.G. Rutherford). Scale bar = 1cm.

Fig. 3. *Phoebis argante* DHJ02; male (left) Ariapita Estate, 3 September 1966, M. Barcant; female (right) Rio Claro, 20 September 1954, M. Barcant (ABCT) (photos M.G. Rutherford). Scale bar = 1cm.

Fig. 4. Adult *Macrosoma ustrinaria* (probably male) Asa Wright Nature Centre, 23 March 2015 (Photo: S. Nanz).

U. kikkawai, based on a barcode obtained from the type. It is not known whether the other species found in Costa Rica also occur in South America.

We initially identified this species from Evans (1952) and Warren *et al.* (2016); the three Trinidad specimens lack the white cell spot UNH which Evans (1952) considered diagnostic for *U. kikkawai*, but so do several specimens illustrated by Warren *et al.* (2016). We were able to obtain a barcode of one Trinidad specimen (Fig. 5, DNA ref. MJWC-2016-012) which was an exact match to *Udranomia kikkawai* DHJ02 in BOLD (2016), and which Bächtold *et al.* (2017) state matches the barcode obtained from the type specimen of *U. kikkawai*. We are therefore confident of the identification of the species in Trinidad.

Cock and Alston-Smith (2013) gave an account of the two known *Udranomia* spp. of Trinidad: *U. orcinus* (C. Felder and R. Felder) and *U. eurus* (Mabille & Boullet). Neither Cock and Alston-Smith (2013), nor Cock (2014b) mention *U. kikkawai*, which SAS discovered in Trinidad in 2015 (Fig. 5). *Udranomia kikkawai* is similar in appearance to the other two *Udranomia* spp. found in Trinidad. It is significantly larger than *U. orcinus*, and differs in details of the markings, and in particular it does not have the white veins UNH and UNF found in *U. orcinus* (Cock and Alston-Smith 2013, Fig. 1). Although comparable in size to *U. eurus*, the ground colour is more uniformly dark brown in that species, making the white spots more contrasting (cf. Cock and Alston-Smith 2013, Fig. 5).

SAS found mature caterpillars on *Ouratea guildingii*

(Ochnaceae), growing in the savannah land about 400m short of the Toco lighthouse, March 2015 (male), August 2015 (female) and January 2016 (female). The caterpillar heads were light brown, with red-brown eye spots; body pale green, with a thin yellow line across each of T1–T3. The pupa was similar to that of *U. orcinus* (Cock and Alston-Smith 2013, Fig. 3), but slightly larger. The caterpillar is not an exact match to those shown by Janzen and Hallwachs (2016) from Costa Rica which have the head reddish brown, the eye spots hardly or not differentiated, and in some cases a dark bar across the face, tapering laterally. Similarly, it is not an exact match to the caterpillars shown by Bächtold *et al.* (2017) from south-east Brazil, which have a 'dark brown head and diffusely black spots extended laterally in the adfrontal area'.

Janzen and Hallwachs (2016) reared this species many times from *Ouratea lucens* and *Cespedesia spathulata* (Ochnaceae) in Costa Rica, and Bächtold *et al.* (2017) reared it from *O. hexasperma* and *O. spectablis* in south-east Brazil. In Trinidad, the family Ochnaceae comprises two species of *Ouratea*, and two species of *Sauvagesia*, which are low herbs (Williams 1929). *Ouratea guildingii* grows to be a tree, but these collections were made on young or regrowth plants. *Ouratea purdieana* has already been reported as the food plant of *U. orcinus* in Trinidad (Cock and Alston-Smith 2013), but SAS also found and reared it on *O. guildingii* at Toco, which is a new food plant record.

Fig. 5. Adult male *Udranomia kikkawai* collected March 2015 as caterpillar on *Ouratea guildingii*, Toco, S. Alston-Smith (SAS). Scale bar = 1cm

***Telemiades squanda* Evans, 1953 (Hesperiidae, Eudaminae)**

Cock (2014b) noted SAS' view that two species are mixed as *T. epicalus* Hübner in Trinidad usage. We have now investigated this and find that the name *T. epicalus*

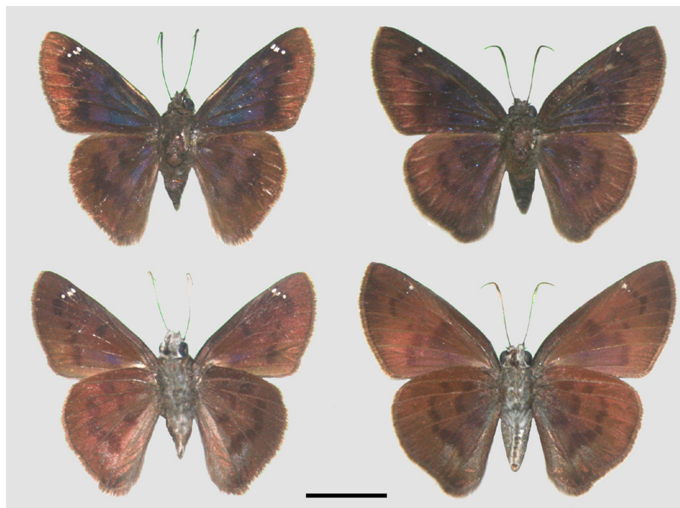

Fig. 6. Adult male (left) and female (right) *Telemiades squanda*. Male, Los Bajos, November 1994, S. Alston-Smith (SAS); female, Quinam, August 1992, S. Alston-Smith (SAS). Scale bar = 1cm.

Fig. 7. Adult male (left) and female (right) *Telemiades epicalus*. Male, Guanapo Valley, December 2000, S. Alston-Smith (SAS); female, West Moreau, 31 December 1979, M.J.W. Cock (MJWC). Scale bar = 1cm.

was correctly applied, but SAS had a second large species of *Telemiades* in his collection. MJWC dissected a male of the second species and was readily able to identify it as *T. squanda* from Steinhauser (1989). The two species are shown for comparison (Figs. 6 and 7). *Telemiades squanda* was described from near Rio de Janeiro and is recorded from Bolivia to Guyana (British Guiana) from a handful of specimens (Evans 1953).

SAS has collected two males: Rio Claro – Guayaguayare Road, September 1993 (dissected) and Los Bajos, November 1994, and two females: Fondes Amandes, March 1983, and Quinam, Aug 1992. Adults of this species were observed to sunbathe, often returning to more or less the same perch, and were also seen at flowers. The life history of *T. squanda* does not seem to have been recorded, but *Telemiades* spp. are known to feed on Fabaceae such as *Inga* spp., *Lonchocarpus* spp. and *Machaerium* spp. (Janzen and Hallwachs 2016).

Morvina morvus (Plötz, 1884) *para* Evans, 1953 (Hesperiidae, Pyrginae, Erinnini)

Judging by the collection of the NHMUK (Evans 1953), this species is rare throughout its range. Three subspecies are recognised: the nominate ssp. *morvus* from southern Brazil, ssp. *para* from Belem (Pará) and Santarém, and ssp. *cyclopa* Evans, which was described from Bolivia, but has a disjunct distribution, as it is also known from Guyana (Evans 1953). SAS has collected one male (Inniss Field, January 2007) and two females (Brigand Hill, January 1980 and August 1980) of this new skipper for Trinidad (Fig. 8). Our identification is from Warren *et al.* (2016) and Evans (1953).

The congeneric *M. fissimacula pelarge* (Godman & Salvin) feeds on Rutaceae, primarily *Toxosiphon lindenii* and to a lesser extent on *Galipea dasysperma* (Janzen and Hallwachs 2016). Neither genus occurs in Trinidad (Williams 1929), so the food plant of *M. morvus* may be some other indigenous Rutaceae.

This skipper is superficially similar to *Mimia phydile* (Godman & Salvin), which Kaye (1940) recorded from Trinidad, based on a specimen taken by F.W. Jackson at Tabaquite, 3 April 1922. Having located no such specimen, Cock (2014b) suggested this record was an error, however, it may well be that what Jackson caught was *Morvina morvus*.

Thoon modius (Mabille, 1889) (Hesperiidae, Hesperiinae, Moncini)

This species is found from Guatemala to Bolivia and East to the Upper Amazon, so this record from Trinidad is a considerable extension of its range. It was identified from Evans (1955) and Warren *et al.* (2016) and confirmed

Fig. 8. Adult male *Morvina morvus para* Evans, collected Innis Field, January 2007, S. Alston-Smith (SAS). Scale bar = 1cm.

by dissecting the male genitalia and comparing them with the figure in Godman & Salvin (1893–1901, plate 97, fig. 38). Fig. 9 is a good match to the type.

S. Alston-Smith has captured a male at roadside eupatorium flowers, Balata East, January 2015 (Fig. 9), and a female, also at roadside flowers, Inniss Field, May 2003 (Fig. 10). The adults fly very rapidly and quickly change their positions on flowers.

This species can be distinguished from the other spotted brown Moncini known from Trinidad (Cock 2012) by the presence and alignment of the UPH yellow spots in spaces 2, 3 and 4-5, combined with the cell spot UNH, the spot in space 1B UPF and the spots in spaces 2 and 3 UPF which just overlap at the adjacent corners.

DISCUSSION

The new record of *Phoebis agarithe* is based on the historical collection made by Malcolm Barcant, and

Fig. 9. Adult male *Thoon modius*, collected at roadside eupatorium flowers, Balata East, January 2015, S. Alston-Smith (SAS). Scale bar = 1cm.

Fig. 10. Adult female *Thoon modius*, collected at roadside yellow Asteraceae flowers, Inniss Field, May 2003, S. Alston-Smith (SAS). Scale bar = 1cm.

preserved in Trinidad by Angostura Ltd. (ABCT). Because Barcant's collection contained 22 specimens, all of which he thought were *P. argante*, it was possible to not only recognise the three different species amongst them, but also suggest that *P. agarithe* is relatively rare in Trinidad. This demonstrates the importance of keeping a reference collection of this standard in Trinidad, and making it available to researchers.

Cock (2014a) suggested that about 765 butterfly species are now known from Trinidad. The total is now 781, comprising Papilionidae 15, Pieridae 30, Nymphalidae 162, Lycaenidae 131, Riodinidae 123, Hedylidae 3, and Hesperiidae 317 (Cock 2014a, 2014b, Cock and Robbins 2016, Cock and Hall in prep., this work).

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Occurrence of Fibropapilloma Tumours on Green Sea Turtles, *Chelonia mydas* in Trinidad, West Indies

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ABSTRACT

Fibropapillomatosis, a debilitating disease of marine turtles associated with a herpesvirus, is commonly seen in green sea turtles, *Chelonia mydas* (Chelonia: Cheloniidae) throughout the tropics. It is characterised by the development of external and visceral tumours, which though benign, often obstruct organs or hinder bodily functions that are critical to survival in the wild and can therefore lead to death of the affected animal. Deleterious environmental factors are also thought to contribute significantly to the development of the disease in susceptible animals. A recent upsurge in the incidence of the disease globally has elevated the disease to panzootic status. Several anecdotal reports have suggested that this disease may be present in green turtles that inhabit the coastal waters of Trinidad and Tobago. Herein we document lesions consistent with fibropapillomatosis found in green turtles that stranded across Trinidad between 2010 and 2016, and discuss the implications.

Key words marine turtles, fibropapilloma, tumours, herpesvirus, *Chelonia mydas*, Caribbean

INTRODUCTION

Green turtles *Chelonia mydas* (Chelonia: Cheloniidae) are distributed throughout the coastal waters of the tropics, and to a lesser extent, the subtropics (Seminoff 2004). They are currently listed as Endangered by the IUCN (Seminoff 2004), and have been designated as an Environmentally Sensitive Species in Trinidad and Tobago. They are considered important indicators of the health of the marine environment, especially since juveniles spend many years resident in nearshore feeding habitats (Aguirre and Lutz 2004). The distribution of green turtles has not been studied in Trinidad, but juveniles have been reported from Saut D'eau, Matelot, Grande Riviere, Toco, Matura, Mayaro, Soldado Rock and Chacachacare (Forestry Division *et al.* 2010), and they have been harvested in nearshore fisheries throughout Trinidad including multiple fishing depots on north, south and east coasts in addition to Carenage in the Gulf of Paria (Fisheries Division data and Chu Cheong 1995). Based on their herbivorous diet and preference for *Thalassia testudinum* in the Caribbean (Bjorndal 1980, Bjorndal 1985), their distribution around Trinidad has generally been assumed to be coincident with seagrass beds (Forestry Division *et al.* 2010), however some green turtles in the Atlantic also feed on algae and sometimes sponges (Mortimer 1981, Sazima and Sazima 1983, Makowski, Seminoff, and Salmon 2006, Nakashima 2008), therefore they may also inhabit coral reef and hard-bottom habitats, as has been found in Tobago (Cazabon-Mannette 2016), and they may be widely distributed around Trinidad.

Fibropapillomatosis (FP) is a disease of marine turtles, most commonly seen in green turtles (*Chelonia mydas*), though it has been reported in low frequencies in all hard-shell turtle species (George 1997, Guillen and Villalobos 1999, D'Amato and Moraes-Neto 2000) and at least once on a leatherback (Huerta *et al.* 2000). First documented by Smith and Coates (1938) in a green turtle in Florida, outbreaks have been increasingly recorded around the world since the 1980s, including the Caribbean (Williams *et al.* 1994) and most prominently in the Hawaiian Islands and Florida (Jacobson *et al.* 1989, Balazs and Pooley 1991, Balazs, Aguirre, and Murakawa 1997, Murakawa *et al.* 1999, Work *et al.* 2004, Foley *et al.* 2005). FP now has a circumtropical distribution and has been observed in all major oceans (George 1997, Aguirre 1998). In Hawaii, FP prevalence increased rapidly since an outbreak in the late 1980s, peaked during the mid-1990s, and has been in decline since the late 1990s (Chaloupka *et al.* 2009).

FP is characterised by external benign tumours of the skin, flippers, periocular tissues, carapace, and plastron (Aguirre and Lutz 2004), which can grow to more than 30 cm in diameter (George 1997, Aguirre 1998). Fibropapilloma tumours are most common on the axillary region of the flippers, and on the eyes, neck, and tail (Balazs, Aguirre, and Murakawa 1997). Depending on the location, larger tumours can impair vision, locomotion, breathing and the ability to locate, capture, and swallow food, and avoid predators (Herbst and Klein 1995, Balazs, Aguirre, and Murakawa 1997, Aguirre and Lutz 2004), and may ultimately prove fatal (George 1997). Internal tumours may be found in the oral cavity (Balazs, Aguirre and Murakawa 1997), kidneys (Norton, Jacobson and Sundberg 1990), lungs, heart, liver, spleen, gastrointestinal tract and gonads (Campbell 1996, cited by Aguirre and Lutz 2004), and are present in 39% of stranded turtles with external tumours in Hawaii (Work *et al.* 2004). Such internal or visceral tumours can disrupt organ function and lead to death (Herbst and Klein 1995). Concomitant infections with vascular spirorchid trematodes have also been recorded among some fibropapilloma turtles (Aguirre *et* *al.* 1998). The most severely affected turtles often exhibit physiological stress characterised by immunosuppression, with serum biochemical abnormalities which may include, anaemia, leukopaenia, heterophilia, uraemia, hypoproteinaemia, hypoalbuminaemia, electrolyte imbalance, lowered levels of cholesterol and triglycerides and wound infection which may progress to bacteraemia (Norton, Jacobson, and Sundberg 1990, Work and Balazs 1999, Aguirre and Balazs 2000, Work *et al.* 2003, Work *et al.* 2004).

An alphaherpesvirus, referred to as chelonid fibropapilloma-associated herpesvirus (CFPHV) or chelonid herpesvirus-5 (ChHV5) has been consistently detected in tumour tissue and is recognised as the most likely aetiological agent responsible for fibropapillomatosis (Quackenbush *et al.* 1998, Lackovich et *al.* 1999). Phylogenetic analyses have detected multiple separate lineages of CFPHVs with a shared mutation responsible for FP acquired prior to the emergence of the current panzootic, suggesting environmental or host factors underlie the recent disease expression, rather than recent virulence mutations (Herbst *et al.* 2004, Greenblatt *et al.* 2005, Patrício *et al.* 2012). This genetic evidence is consistent with field observations that a high prevalence of FP is associated with anthropogenically altered environments such as heavily polluted coastal areas (Aguirre and Lutz 2004, Van Houtan, Hargrove, and Balazs 2010, Santos *et al.* 2010). Furthermore, there is molecular evidence that FP is acquired after the recruitment of juveniles into coastal areas (Ene *et al.* 2005), consistent with field observations which find that fibropapilloma tumours are most common in juveniles of intermediate size (Borrowman 2000, Work *et al.* 2004, Foley *et al.* 2005, Tagliolatto *et al.* 2016).

As far as could be ascertained, the earliest published report of fibropapillomatosis in Trinidad is by Jacobson (1991); though no details were provided. The Sea Turtle Recovery Action Plan for Trinidad and Tobago (Forestry Division *et al.* 2010) cites a number of unconfirmed reports of green turtles with fibropapillomas in Chaguaramas, Paria Bay, Matelot and nesting at Grande Riviere, with the earliest report from 1983 in Chaguaramas. Cooper and Seebaransingh (2008) described a case of fibropapillomatosis (confirmed by cytological and histopathological techniques) in a green turtle (*Chelonia mydas*) found in the sea at Chaguaramas, in February 2008 and transported by the Trinidad Wildlife Section to the University of the West Indies School of Veterinary Medicine (UWI-SVM) for post-mortem examination. During a survey of fisherfolk in Tobago, fishers were shown images of turtles with fibropapilloma tumours and 13 of 215 fishers indicated they had encountered turtles with similar growths (Cazabon-Mannette, unpublished data), however there are, to date, no confirmed reports of this disease in Tobago (personal communication, Giancarlo Lalsingh, Programme Manager, SOS Tobago).

CASE SUMMARIES

The UWI-SVM has been a repository for reports of fibropapilloma cases around Trinidad since 2008. Following the 2008 case report by Cooper and Seebaransingh, four green turtle cases have since been submitted to the Aquatic Animal Health (AAH) Unit of the UWI-SVM for evaluation. Two specimens bore no lesions consistent with fibropapillomatosis; one was a live juvenile found in a tidal pool in North Manzanilla in 2015, and the other was an adult measuring ~110cm carapace length that died after being struck by a boat in the offshore Soldado Fields, in 2016. The two other specimens, however, bore lesions consistent with fibropapillomatosis. Below we present a summary of the findings from these two cases, as well as the findings on one additional specimen that was found dead on a beach in southern Trinidad. Figure 1 shows a map of Trinidad with the location of each case.

Case 1- 3 May, 2011

A live, emaciated, poorly responsive juvenile green turtle (37.5cm straight carapace length) was found in Chaguaramas (coordinates not reported) and was submitted to the AAH Unit at the UWI-SVM. Two fibropapillomas, each measuring approximately 1cm × 0.75cm, were present on the lateral canthus of the left eye with corneal attachments. A multilobulated fibropapilloma (1.8cm × 1.9cm) was present on the right eye. Numerous larger fibropapillomas covered the dorsal and lateral aspects of the neck, the left and right pectoral and hind flippers, the tail base and plastron. The animal had minimal body fat,

Fig. 1. Location of documented strandings of green sea turtles with fibropapilloma tumours at Chaguaramas (Case 1), Matura (Case 2) and Moruga (Case 3).

poor muscling, diffuse softening of the plastron, mild separation of abdominal scute sutures with leakage of haemorrhagic coelomic fluid. Preliminary radiographs showed no evidence of internal masses. Oesophageal tube feeding, additional nutritional supplementation and medical management were initiated to improve the animal's body condition prior to scheduling endoscopic evaluation and surgical excision of external masses. However, the animal did poorly and died on 14 May, 2011. Necropsy findings revealed cachexia, indicating that the animal was debilitated and unable to feed for a considerable period resulting in severe wasting. Histological analysis of the masses revealed characteristic stromal and epidermal hyperplasia, with fibroblast proliferation and zones of cytoplasmic vacuolation of epithelial cells (Fig. 2), consistent with other reports (Herbst 1994, Matushima *et al.* 2001). Samples were collected for confirmatory immunohistochemical and polymerase chain reaction (PCR) analysis. Investigations are ongoing and will be presented in a subsequent report.

Case 2- 28 February, 2016

A live, emaciated, weakly responsive juvenile green turtle (38.0cm straight carapace length) was found on Matura beach, Trinidad (coordinates not reported) and was examined at the AAH Unit of the UWI-SVM. The animal was in very poor body condition, with numerous eroded and ulcerated fibropapillomas around the neck and shoulders. There was also evidence of human interaction prior to the animal's rescue, where several other masses were crudely excised, leaving broad-based open wounds that had become infected. The animal was tube fed and antimicrobial therapy initiated, but the animal succumbed to its injuries on March 4th, 2016. Necropsy findings also revealed severe inanition and cachexia. Histopathological findings were similar to those presented in figure 2.

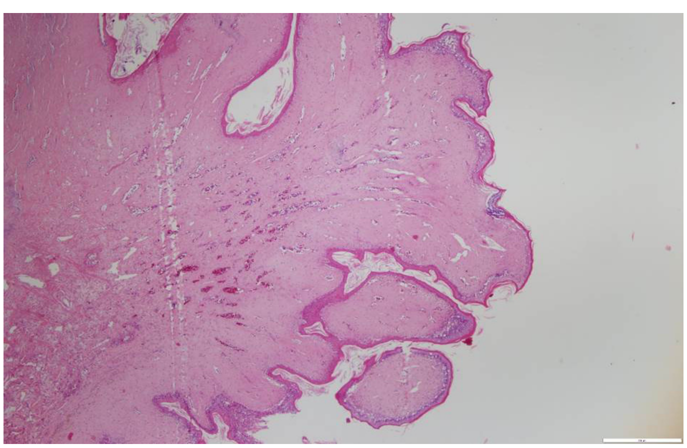

Fig. 2. External papilloma from a green sea turtle (*Chelonia mydas*) that stranded in Chaguaramas (Case 1). Characteristic stromal and epidermal hyperplasia, with fibroblast proliferation and zones of cytoplasmic vacuolation of epithelial cells are evident. Hematoxylin and Eosin x4.

Case 3- 3 December, 2016

A dead juvenile green turtle (approximately 35cm carapace length), was discovered stranded on shore at L'Anse Mitan, Moruga, between the Moriquite and Moruga Rivers (1115397 N, 0689324 W). The turtle was covered in a heavy burden of external tumours consistent with fibropapillomas (Fig. 3), located on its neck, the axillary and inguinal regions bilaterally, the eyes and the plastron. The largest tumour was approximately 15cm in length and located in the gular region. This is the first record of fibropapilloma for south east Trinidad. A fisherman from the area indicated that they often encounter live turtles with similar tumours within the bay.

DISCUSSION

Fibropapillomatosis is a severely disfiguring and debilitating disease of sea turtles. A common finding among the cases reported to the AAH Unit of the UWI-SVM was that of severe wasting (cachexia). If animals were found or were admitted for treatment earlier, the prognoses may have improved. Early treatment allows these animals to be rehabilitated and returned to a state of health that would allow for successful surgical excision of the tumours, thus significantly improving the overall survival rate of affected green turtles. Timely detection and intervention is therefore key for cases presenting with external lesions only. If visceral fibropapillomas are detected, however, the prognosis is considered grave.

Green turtles are a species of global and local conservation concern, which are also postulated to play important roles in seagrass and coral reef health through their highly specific diets (Thayer, Engel, and Bjorndal 1982, Thayer *et al.* 1984, Wabnitz *et al.* 2010, Goatley, Hoey, and Bellwood 2012). Therefore threats to individuals' health and more importantly population viability are of immediate conservation concern. The geographic spread of the documented cases around the coast of Trinidad certainly is concerning, however the presence of FP within a green turtle population does not necessarily imply a threat to population viability. While continued passive documentation of FP among turtles encountered by members of the public gives valuable insight into the local distribution of FP, further applied research through in-water studies is also necessary, to allow for a meaningful estimate of FP prevalence and the survivorship of turtles, and to therefore determine the impact of FP on local population viability (Rees *et al.* 2016).

The precise role of environmental factors in the development of FP is not well understood, but FP has generally been observed to be associated with heavily polluted coastal areas (Aguirre and Lutz 2004, Foley *et al.* 2005, Van Houtan, Hargrove, and Balazs 2010). Environmental

Fig. 3. (a) (i) and **(ii)** Juvenile green sea turtle (*Chelonia mydas*) that stranded in Chaguaramas (Case 1). **(b)** Juvenile green sea turtle (*Chelonia mydas*) that stranded at Moruga (Case 3), **(i)** dorsal view with GPS unit for scale **(ii)** view of ventral surface **(iii)** dorsal view of head, neck and fore flippers.

factors that have been associated with high prevalence of FP include heavy metals in Brazil (da Silva *et al.* 2016), land-based nutrients in Hawaii (Van Houtan, Hargrove, and Balazs 2010), and biotoxins (Landsberg *et al.* 1999, Arthur *et al.* 2008). Therefore the presence of FP in Trinidad may reflect poor water quality due to some form of anthropogenic pollution, and may be a symptom of a larger environmental issue that deserves attention.

Since 2008, we have documented three cases of green turtles stranding with lesions consistent with FP around the coast of Trinidad. This is a relatively small number of cases, and suggests that the disease may be relatively rare locally (at least as a cause of stranding). However, the wide geographic distribution of the cases around Trinidad is cause for concern and it is possible that the disease is more prevalent than these documented strandings indicate, since many cases may go unreported. Members of the public, naturalists, fisherman, yachtsmen and others are urged to report to the SVM if they observe any turtle, alive or dead that may have this disease. It may be helpful to have a national awareness campaign to encourage persons to make such reports. The AAH Unit of the UWI-SVM will continue to conduct systematic necropsies, with histological analysis and confirmatory immunohistochemical and PCR analysis on any stranded turtles with suspected FP.

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Moths (Lepidoptera) from the Five Islands, Trinidad and Tobago, Including New Country Records

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ABSTRACT

The Five Islands are a group of very small, uninhabited low islands lying about 2km south of Trinidad's north-west peninsula, of which Nelson Island and Caledonia Island are the largest. A 125W mercury vapour light trap was run for two nights on each island in January 1981 and a total of 50 species of moths identified. Sixteen of these are here also recorded from Trinidad for the first time. Comparisons are made with the known fauna of other islands off the north-west peninsula of Trinidad, Trinidad itself and Tobago.

Key words: Pyraloidea, Geometroidea, Bombycoidea, Noctuoidea, Nelson Island, Caledonia Island

INTRODUCTION

The Five Islands are a group of very small, uninhabited, low islands lying close together about 2km south of Trinidad's north-west peninsula (Fig. 1). The two largest are Caledonia (c. 250m at longest) and Nelson (c. 200m at longest).

Nothing has been recorded regarding the Lepidoptera of the Five Islands, but in view of recent interest in the Lepidoptera of Trinidad's offshore islands, I am placing these observations from 1981 on record. At that time, the vegetation of Nelson was very disturbed, consisting of mixed trees towards the east end, but mostly tall grasses around the buildings with a variety of weeds including *Lantana camara* and *Chromolaena odorata*, while that of Caledonia was wooded and presumably approached the natural vegetation. Images from 2008 examined on the internet suggest little change or increased tree cover (Fig. 1).

In association with a University of the West Indies field course, a standard Robinson 125W mercury vapour light trap was run off a portable generator for four nights

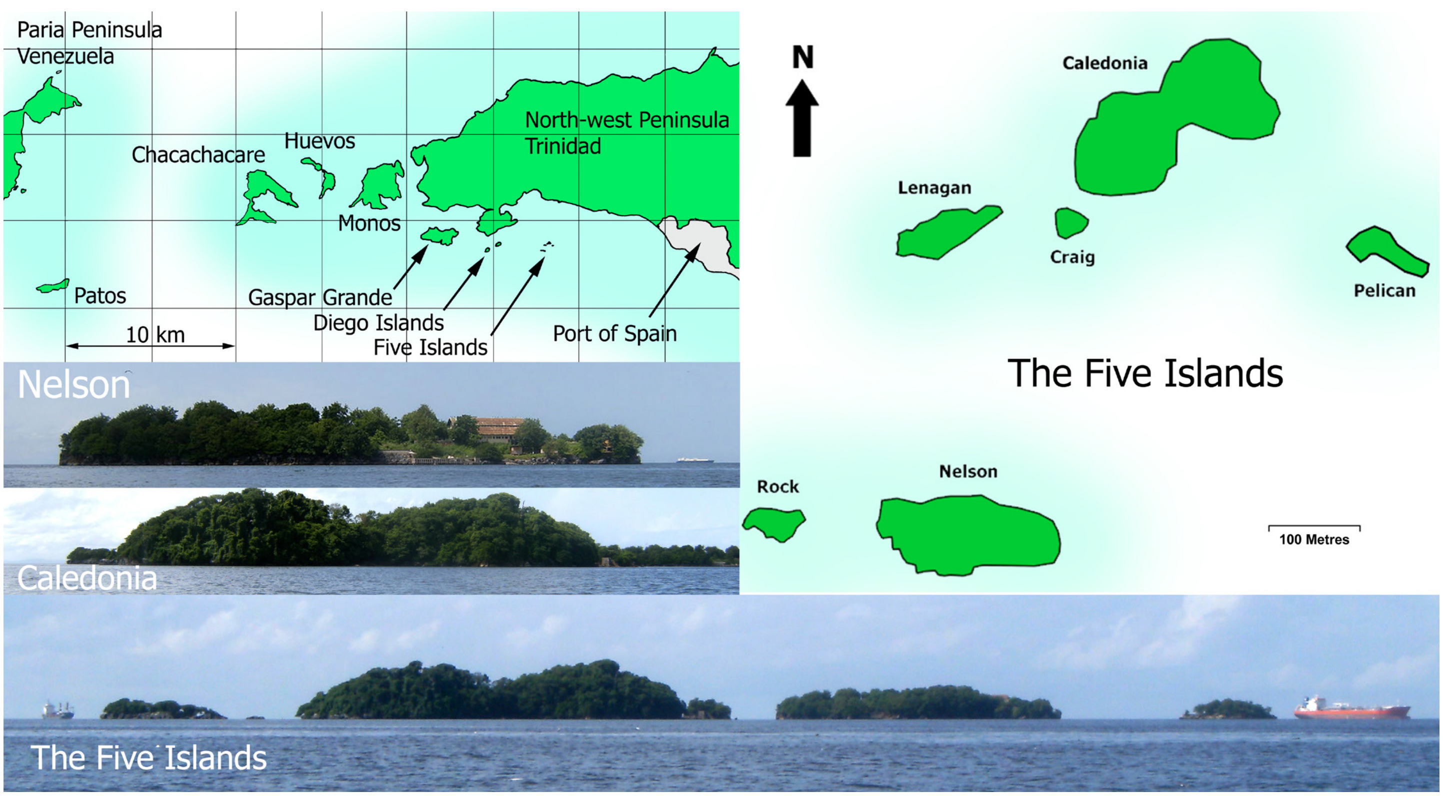

Fig. 1. The Five Islands, Trinidad and Tobago. Images are edited from the 2008 work of R45 on Wikipedia under a CC 3.0 license, apart from the first, which is redrawn from MOD (1970).

during the dry season as follows:

4-5	January 1981	Nelson Island, north of main building
5-6	January 1981	Caledonia Island
6-7	January 1981	Nelson Island, towards east end, where less disturbed
8-9	January 1981	Caledonia Island, near the sea overlooking Craig Island

The trap was set up late afternoon each day and left to run until the fuel in the generator ran out, and the contents were examined in the morning. It is not certain how long the trap operated each night, but as the generator had an eight hour capacity, it can be assumed that it went off well before dawn each night. One further species, *Pseudopyrausta santatalis* (Barnes & McDonnough) (Crambidae) was reared from a caterpillar collected on *L. camara* on Nelson.

A total of 54 species of eight families was recorded (Table 1) – see comments in Cock (2017) about the identification of Trinidad and Tobago moths. One species, *Condica* sp. nr. *concisalis* (Walker) (Noctuidae) was only partially identified, so is shown here to facilitate future recognition (Fig. 2). Members of the so-called Micro-Lepidoptera were not included in the enumeration, apart from the Pyralidae and Crambidae. The relative strengths of the families found are about typical for Trinidad and Tobago apart from the very low number of Noctuidae recorded from Caledonia. The numbers of species and individuals caught each night are not dissimilar to those obtained in a Trinidad suburban situation, but considerably less than those found in a Trinidad forested situation.

Comparing the two islands, 39 species were collected on Nelson and 21 on Caledonia, but only six species were common to both. Four species were not identified at the time, and I cannot now associate them with reference material. Of the remaining 50 species, all bar one (*P. santatalis*) are known from Trinidad (Kaye and Lamont 1927, Lamont and Callan 1950, author's unpublished records – see Cock 2003), and 24 are known from Tobago (Cock 2017). It seems likely that the Lepidoptera fauna of the Five Islands will have many species in common with the other offshore islands of north-west Trinidad, including the Bocas Islands – lying between the north-west peninsula of Trinidad and the Paria Peninsula of Venezuela, of which Monos, Huevos and Chacachacare are the largest (Fig. 1). However, there is very little information reported regarding the moths of any these islands as yet, and only very provisional lists are available for Huevos (Sookdeo and Cock 2017) and Chacachacare (K. Sookdeo pers. comm.). Of the 50 species here recorded from the Five Islands, five (10%) are in common with Huevos and four (8%) in common with Chacachacare based on these provisional lists.

Fig. 2. *Condica* sp. nr. *concisalis* (Walker), dorsal view above, ventral view below. Left, male, Curepe, black light trap, 21-28 February 1982, F.D. Bennett [MJWC]. Right, female, St. Benedict's, at light, 10-16 July 1996 (M.J.W. Cock) [MJWC].

It is not clear what the balance of species is in terms of long-term breeding residents, short-term breeding residents and casual visitors. Undoubtedly there must be some turnover of species as some are lost and others are gained, but we don't know enough about the biology of Trinidad moths to assess whether a breeding population is likely to be maintained. However, some species can be associated with their food observed on the islands, e.g. *Pareuchaetes pseudoinsulata* Rego Barros feeds on *Chromolaena odorata*, *Diastema tigris* Guenée, *Pseudopyrausta santatalis* and *Salbia haemorrhoidalis* (Guenée) feed on *Lantana camara*, *Spodoptera frugiperda* (J.E. Smith) and *Herpetogramma phaeopteralis* (Guenée) feed on grasses, etc.

The moths of Trinidad were catalogued by Kaye and Lamont (1927) and Lamont and Callan (1950). The author has been studying the moths of Trinidad for many years and is aware of many more species not recorded by the earlier workers (Cock 2003), and of the species listed here, 16 from the Five Islands also occur on Trinidad but have not hitherto been recorded to do so (Table 1).

ACKNOWLEDGEMENTS

I thank colleagues of the UWI Department of Zoology who invited me to visit the field course based on Nelson Island and operated the trap on my behalf. My thanks also to Dr J.D. Holloway and Dr J.D. Bradley, the Commonwealth Institute of Entomology (CABI) and Mr M. Shaffer of the Natural History Museum, UK, who made initial identifications of this material or duplicates that I sent to them. I have subsequently checked and refined these identifications, so that any errors are now my responsibility.

Table 1. Tabulated results of light trap catches for each night on the Five Islands, January 1981.

	Nelson Island		Caledonia Island		Vouchers[1]	National distribution[2]				Comments
Date (January 1981):	4-5	6-7	5-6	8-9		Chacachacare	Huevos	Trinidad	Tobago	
PYRALIDAE										
Piesmopoda xanthomera Dyar			1♂		MJWC			X[3]		Records from Arima Valley (Simla), Curepe, Point Gourde
Unidentified Pyralidae species				1						No voucher material located
Xantippe olivalis Dyar			1				X	X[3]		Records from Arima Valley (Simla), Curepe
CRAMBIDAE										
Helvibotys helvialis (Walker)			1					X	X	
Herpetogramma phaeopteralis (Guenée)	1+	3	2	1+				X		
Lamprosema canacealis (Walker)		1						X[3]		Records from Curepe, Palmiste
Lygropia cernalis (Guenée)	1♂			1	MJWC			X[3]		Records from Curepe, Parrylands
Microthyris anormalis (Guenée)	1							X	X	
Omiodes indicata (Fabricius)	1	1						X		
Polygrammodes elevata (Fabricius)			1					X	X	
Polygrammodes lichyi Munroe			1♀		MJWC			X[3]		Records from Arima Valley (AWNC), Curepe
Pseudopyrausta santatalis (Barnes & McDonnough)		1♂			MJWC					New national record
Salbia haemorrhoidalis (Guenée)			1					X		
Synclera jarbusalis (Walker)	1							X	X	
Unidentified Crambidae species		2								No voucher material located
GEOMETRIDAE										
Unidentified ?*Scopula* sp.		1								No voucher material located
Erastria decrepitaria decrepitaria (Hübner)		1	1		NHMUK			X		
Eusarca crameraria (Guenée)	1				MJWC			X		
Idaea rufarenaria (Warren)	1	9	4		MJWC	X	X	X[3]	X	Records from Arima Valley (Simla), Curepe, Point Gourde, St. Benedict's
Leptostales desmogramma (Dyar)			1					X	X	
Prochoerodes onustraria (Hübner) Probably		1						X		
Sphacelodes vulneraria (Hübner)	1	2				X		X	X	
Synchlora gerularia (Hübner)	1							X		
SATURNIDAE										
Automeris zurobara zurobara Druce			1♂					X[3]	X	Widespread in Trinidad
SPHINGIDAE										
Erinnyis ello (Linnaeus)		1♂						X	X	
NOTODONTIDAE										
Nycterotis lucia (Schaus)		1♂	3♂	5♂	MJWC, UWIZM		X	X[3]		Records from Curepe, Palmiste
Porionella fragilis (Schaus)		1♂			MJWC			X[3]		Records from Arima Valley (Simla)

Table 1. Continued. Tabulated results of light trap catches for each night on the Five Islands, January 1981.

	Nelson Island		Caledonia Island		Vouchers[1]	National distribution[2]				Comments
Date (January 1981):	4-5	6-7	5-6	8-9		Chacachacare	Huevos	Trinidad	Tobago	
EREBIDAE										
Azeta versicolor (Fabricius)		2						X	X	
Baniana ypita Schaus		1						X[3]		Records from Arima-Blanchisseuse Road (milestone 9.75), Brigand Hill, Morne Bleu Textel, Parrylands, St. Benedict's
Bleptina caradrinalis Guenée				1			X	X	X	
Cosmosoma remota (Walker)		1						X	X	
Episcepsis lenaeus (Cramer)			1♂					X		
Eublemma recta (Guenée)	1♂				MJWC			X		
Gabara bisinuata (Hampson)			1♂		MJWC			X[3]	X	Records from Curepe, St Benedict's
Gabara insuetalis (Kaye)		1						X		
Glympis arenalis (Walker)		1♂			MJWC			X[3]		Records from Curepe
Heterogramma circumflexalis Guenée	2		1					X	X	
Lesmone formularis (Geyer)		1♀						X	X	
Melipotis famelica (Guenée)		1♂			MJWC			X[3]	X	Records from Sangre Grande, St. Benedict's
Melipotis fasciolaris (Hübner)		2						X	X	
Melipotis januaris (Guenée)	1	1						X		
Pareuchaetes pseudoinsulata Rego Barros	1♀							X	X	
Ptichodis immunis (Guenée)	1				NHMUK			X	X	
Renia clavalis Guenée		1					X	X	X	
Unidentified Erebidae species			1							No voucher material located
NOCTUIDAE										
Anicla infecta (Ochsenheimer)	1	1						X	X	
Condica sp. ?nr *concisa* Walker[4]		1♂			MJWC			X		Records from Curepe, Morne Bleu, St. Benedict's
Condica sutor (Guenée)	1							X	X	
Diastema tigris Guenée	1					X		X	X	
Dyops chlorargyra Hampson		1						X[3]		Records from Arima Valley (Simla), Curepe, Morne Bleu Textel
Leucania polystrota (Hampson)		2						X		
Pararcte schneideriana (Stoll)	1							X		
Speocropia placida (Stoll)	1♂				MJWC			X[3]		Records from Curepe, Morne Bleu Textel. Palmiste
Spodoptera frugiperda (J.E. Smith)	1							X	X	

[1]Specimens from this study may be found in the author's collection (MJWC), The University of the West Indies Zoology Museum (UWIZM) and The Natural History Museum, UK (NHMUK).

[2]Distribution based on Kaye and Lamont (1927), Lamont & Callan (1950) and the author's unpublished observations for Trinidad, Cock (2017) for Tobago, Sookdeo & Cock (2017) for Huevos, and K. Sookdeo (pers. comm.) and the author's unpublished observations for Chacachacare.

[3]These species have not previously been recorded from Trinidad in the literature, but the author is aware of unpublished records as listed under Comments.

[4]This species also occurs in Trinidad (Fig. 2). I have been unable to match it in NHMUK, although there are similar specimens un-named in the United States National Museum from Venezuela, Ecuador and Guatemala.

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Citizen-based Observations on Shark and Mobulid Species in Tobago,West Indies

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ABSTRACT
Recreational dive operators in Tobago have indicated that shark and mobulid species sightings have become increasingly rare. However, in the absence of documentation these trends are difficult to verify. We engaged nine dive operators and collated the sightings of sharks and mobulid rays for the period November 2015 to January 2017 in Tobago. From the data, we conclude that nurse sharks,*Ginglymostoma cirratum* are the most commonly sighted and widely distributed shark species both spatially and temporally. Overall, eight shark species and two mobulid species were recorded. This report highlights the importance of citizen-based science in identifying key areas for future research into Tobago's shark and mobulid populations.

Key words: *Ginglymostoma*, *Sphyrna*, *Carcharhinus*, *Mobula*, *Squalus*, *Negaprion*, Tobago dive site, citizen science

INTRODUCTION

Historical accounts of recreational diving in Tobago describe flourishing coral reefs with diverse and plentiful fish assemblages, fields of gorgonians and widespread hard coral cover. Sightings of hammerhead sharks (*Sphyrna* spp.), reef sharks (*Carcharhinus* spp.) and manta rays (*Mobula* spp.) were common throughout the year (A. Wothke, pers. obs.). In recent years the chances of observing sharks and mantas during recreational dives have consistently diminished to the point where nurse sharks (*Ginglymostoma cirratum*) are the most commonly encountered, albeit in small numbers (Authors and dive tour operators, pers. obs.).

There is growing global concern regarding shark and manta declines, and the future ramifications of their removal and consequential trophic cascades (Heithaus *et al.*, 2008). Furthermore, ethical considerations associated with shark finning have been highlighted in the media. Economically speaking, studies of the global socio-economic benefits of manta ray dive and snorkel tours estimate a direct revenue of US$73 million annually, in contrast to the value of the international manta ray gill plate trade of US$5 million annually (O'Malley, Lee-Brooks and Medd 2013). Shark-based tourism in Palau generates US$18 million in business and tax revenue per year, (Vianna *et al.* 2012). Similarly, Anderson and Ahmed (1993) determined that grey reef sharks (*Carcharhinus amblyrhynchos*) are a magnitude of 100 times more valuable alive than dead in the Maldives. There has been research on the willingness to pay for turtle sightings by recreational divers, which indicated a significant non-use value of these species (see Cazabon-Mannette *et al.* 2017), but as yet there are are no similar studies estimating the value of sharks and mantas to tourism in Tobago.

Sharks rank fourth in Trinidad and Tobago's artisanal fisheries estimated landings, primarily as bycatch from gill-nets, and hook and line fisheries (Shing 2006). International long liners use Trinidad and Tobago's ports as transhipment points, resulting in the country being listed among the top 15 suppliers of dried and frozen fins, according to the Hong Kong 2011 Census Trade Statistic (Pew Environment Group 2012; Solomon 2017). Data indicating the quantity of sharks caught in Trinidad and Tobago's waters are limited.

Mobulid rays (*Mobula* spp.) and sharks such as hammerhead (*Sphyrna* spp.) and silky sharks (*Carcharhinus falciformis*) have been documented in Tobago's waters (FAO 2002), and are listed under CITES Appendix II (CITES 2017). These inclusions and the development of International and National Plans of Action (Shing 2006) towards regulating shark fisheries, are intended to improve and develop shark and manta conservation, and sustainable resource use.

A growing number of studies have focused on the ecological role of sharks as meso- and apex predators, both in oceanic and coral reef ecosystems, and the potential ecological and economic consequences of their decline due to direct and indirect fishing pressure (Heithaus *et al.* 2008). Studies on the roles of mobulid rays have lagged behind somewhat, although recent isotopic analyses and electronic tag studies suggest that *Mobula birostris* may be a primarily mesopelagic forager, contradicting historic reports of a predominantly surface zooplankton diet (Burgess *et al.* 2016). Continued research is needed to further understand the ecological role of mobulid rays in marine ecosystems (Sobral 2013).

While fisheries data are important for establishing trends in elasmobranch populations, the use of citizen-based observations plays an increasingly valuable role in elucidating distribution patterns of sharks and mobulid rays (Ward-Paige *et al.* 2010a; Ward-Paige and Lotze

2011). Citizen observers increase the number of observations by visiting a greater number of sites at a higher frequency than would be possible for scientific divers (Ward-Paige *et al.* 2010b).

For this study, the Environmental Research Institute Charlotteville (ERIC) collaborated with Tobago's dive operators to determine spatial and temporal trends for species of shark and mobulid rays using observations made during their recreational dive activities.

METHODOLOGY

On a weekly basis, nine dive operators submitted data for all shark and manta sightings from their recreational dives. The submitted data included date, location, species, estimated total length (TL) of sharks (from snout to tip of caudal fin), and estimated wingspan of mobulid rays (width across body from tips of pectoral fins). The data collection covered a 14-month period from November 2015 to January 2017.

Hammerhead sharks were classified as *Sphryna* sp. since identification to species level was not possible from all diver operators. Manta rays were historically classified as *Manta* spp., however recent phylogenetic research determined significant morphological and genetic similarities between *Manta* spp. and mobula rays *Mobula* spp. (White *et al.* 2017). As a result, a single genus, *Mobula* spp. is now recognised (White *et al.* 2017). Since mantas and other mobula rays (also known as devil rays) were reported as separate species by dive operators, due to their distinct diagnostic features they are treated separately and are referred to by their common names. The description "mobulid ray" refer to both species collectively. This study does not include rays outside of the family Mobulidae.

RESULTS

Dive operator sightings

Eight species of sharks from four families (Carcharhinidae, Ginglymostomatidae, Sphrynidae and Squalidae) and at least two species of mobulid rays (*Mobula* spp.) were identified. Nurse (*G. cirratum),* blacktip (*Carcharhinus limbatus*) and Caribbean reef sharks (*Carcharhinus perezi*) were the most frequently reported among the shark species while manta rays were most often sighted among the mobulid species (Table 1).

The highest number of recreational dive events with affirmative shark and mobulid ray sightings occurred in November 2015 (40) and 2016 (27). Consequently, these two months also represented the highest number of reported sharks and mobulid rays with 85 and 74 individuals respectively.

Overall, 352 individual sightings of *G. cirratum* were recorded, with numbers peaking in November 2015 (72) and 2016 (69) in contrast to other months (Table 1). *C. limbatus* was the second most reported shark species with

Table 1. Total number of sightings of each species per month from November 2015 to January 2017

Month	Number of dives	Species										Total number of sightings
		Carcharhinus falciformis	*Carcharhinus leucas*	*Carcharhinus limbatus*	*Carcharhinus perezi*	*Ginglymostoma cirratum*	*Mobula* sp. (Manta)	*Mobula* sp. (Devil ray)	*Negaprion brevirostris*	*Sphyrna* spp.	*Squalus cubensis*	
Nov-15	40	0	0	5	0	72	6	1	1	0	0	85
Dec-15	22	0	0	2	4	27	1	0	0	1	0	35
Jan-16	11	0	0	1	0	10	2	0	0	0	0	13
Feb-16	12	0	0	1	0	17	3	0	0	0	0	21
Mar-16	15	0	0	0	5	20	4	0	0	0	0	29
Apr-16	12	1	0	1	1	10	2	0	0	0	0	15
May-16	10	0	0	0	0	11	0	0	0	0	0	11
Jun-16	10	0	0	2	0	14	1	0	0	0	0	17
Jul-16	23	0	0	0	0	19	7	3	0	2	0	31
Aug-16	13	0	0	1	0	14	4	0	0	0	0	19
Sep-16	8	0	1	0	1	6	4	0	0	0	0	12
Oct-16	8	0	0	0	0	29	0	0	0	0	0	29
Nov-16	27	0	0	0	1	69	4	0	0	0	0	74
Dec-16	8	0	0	15	0	13	0	0	0	0	0	28
Jan-17	12	0	1	0	4	21	0	0	0	0	1	27
Total	231	1	2	28	16	352	38	4	1	3	1	446

28 sightings during the study period. An unusual spike in sightings of this species in December 2016 was observed (Table 1). Manta sightings were consistent throughout the study period with 38 individuals reported over 14 months, and no record of their presence for four months (Table 1). The remaining five species, bull shark (*Carcharhinus leucas*), Cuban dogfish (*Squalus cubensis*), hammerhead shark (*Sphyrna* spp.), lemon shark (*Negaprion brevirostris*) and silky shark (*Carcharhinus falciformis)* made very rare appearances (Table 1).

Length estimates of *G. cirratum*

G. cirratum were reported ranging from estimates of 0.6m total length (TL) to 3.0m TL (Fig. 1). Eighty percent of all individuals were between 1.1m TL and 2.5m TL wherein 131 individuals were estimated between 1.1m TL and 1.5m TL. 10% of individuals were small, ranging between 0.6m TL and 1.0m TL whereas only 21 were greater than 2.5m TL (Fig. 1). The estimated total lengths of 11 *G. cirratum* were unrecorded.

Shark and mobulid ray distribution

Dive sites with reported sharks and mobulid rays were combined into five geographical regions around Tobago (Fig. 2). The fifth region, approximately 46km south of Scarborough and 33km east of Toco, Trinidad, is not shown on the map.

Dive operators reported shark and mobulid ray sightings at 28 recreational dive sites in Region 3, in the northern Atlantic. This region also showed the greatest diversity with five species of shark including, *N. brevirostris* and *C. falciformis*, and two species of mobulid rays (Table 2).

There were three species each in Regions 1 and 2 in the south and north Caribbean respectively (Fig. 2) and these were the only areas with sightings of *Sphyrna* spp. (Table 2). *G. cirratum* was present in the four regions surrounding Tobago. No sightings of *G. cirratum* were made in Region 5, however this represents the lone site at which *S. cubensis* was reported (Table 2). *C. leucas* sightings were confined to south Tobago in Regions 4 and 5 (Table 2).

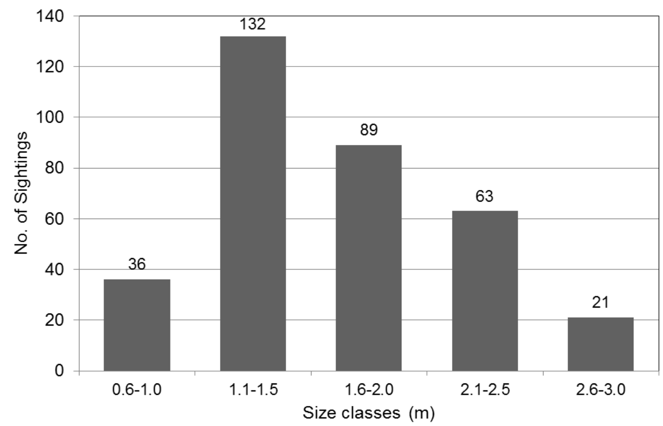

Fig. 1 Estimated total lengths (TL) of *G. cirratum* recorded from November 2015 to January 2017.

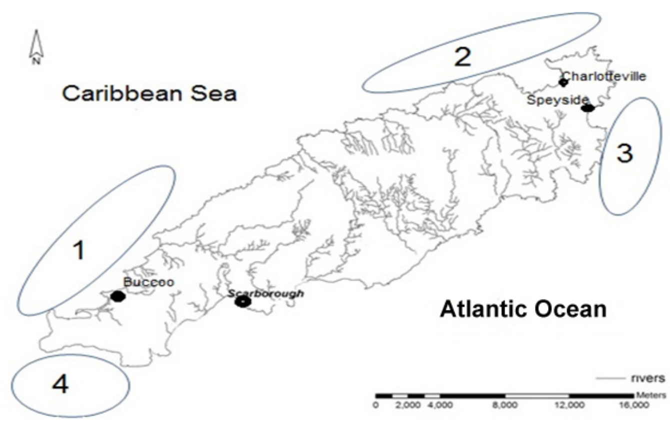

Fig. 2. Location of four of the five dive regions. The fifth region is located 46km south of Scarborough and is not shown on this map.

Table 2. Number of encounters of each species at the five dive regions in Tobago (Number of reported dive sites per region in parentheses)

Species	Region 1 (13 sites)	Region 2 (6 sites)	Region 3 (28 sites)	Region 4 (14 sites)	Region 5 (1 site)
Carcharhinus falciformis	0	0	1	0	0
Carcharhinus leucas	0	0	0	1	1
Carcharhinus limbatus	0	0	23	5	0
Carcharhinus perezi	0	4	3	4	5
Ginglymostoma cirratum	15	8	61	267	0
Mobula sp. (Manta)	13	0	19	7	0
Mobula sp. (Devil ray)	0	0	3	0	0
Negaprion brevirostris	0	0	1	0	0
Sphyrna spp.	2	1	0	0	0
Squalus cubensis	0	0	0	0	1
Total number of species seen	3	3	7	5	3

DISCUSSION

The information provided in this report relies on diver reports of sightings of sharks and mobulid rays. It does not take into account the effort required at each site for successful sightings, specifically the number of visits per site, as these data were unavailable. However, we do know that Regions 1, 3 and 4 are generally areas frequented by more tourists and as such they support more dive operators. The effort of data collection was dependent on operation of dive shops and influenced by client availability, diver experience, site preference and conditions and is therefore highly variable.

Shark and manta identifications rely on the dive operators' cumulative decades of experience, however there are shark species with very subtle diagnostic traits that are easily missed. Species identification can be improved by providing dive tour operators with photographs highlighting these features. Marine turtle monitoring using recreational divers by Williams *et al.* (2015), demonstrated the validity of incorporating both photographic and non-photographic data recording, further emphasising the usefulness of citizen science.

Several other species of sharks and mobulid rays, not recorded in this report, are known from Tobago waters (FAO Keys 2002). However, these may not have been present at these specific dive sites since these sites are selected based on criteria of dive operators and not to cover a representative coverage of Tobago's marine habitats.

Anecdotal evidence from diver operators suggests that the chance of encountering large sharks during recreational dives around Tobago has decreased over time, perhaps with the exception of nurse sharks (*G. cirratum*). Unlike more mobile shark and manta species, *G. cirratum* has been documented as having strong site fidelity, often resting during the day and within possible aggregations (Rosa *et al.* 2006), arguably increasing the probability of diver encounter over a period of time. We suggest that spikes in *G. cirratum* sightings in November 2015 and 2016 (Table 1) may be due to larger aggregations at dive sites, more frequent dive activities, or repeated visits to sites with aggregations. Region 4 (Fig. 2), had the highest number of *G. cirratum* sightings.

No trends were observed with respect to aggregations among other species, with the exception of *C. limbatus* in December 2016, where a school of 15 individuals were present at a single dive site (Table 1). Mantas were recorded only in Regions 1, 3 and 4 (Table 2) perhaps due to lower dive frequency and frequently visited dive sites in Region 2, reducing the probability of encountering individuals. Contrary to anecdotal evidence that March and April were the ideal months for manta sightings, dive operator reports showed that individuals were present throughout the year. The four months with no sightings were scattered and since no pattern is apparent, it is likely that this species is present year-round.

Anecdotal evidence (dive tour operators) also describes aggregations of hammerhead sharks (*Sphyrna* spp.) migrating from the Gulf of Paria in Trinidad to the Caribbean coastline of Tobago, particularly from January to March. However, there were only three sightings in December 2015 and July 2016 (Table 1). Their location in Regions 1 and 2 (Table 2) supports previous reporting of their presence along the Caribbean coast.

There has been similar anecdotal evidence of bull shark (*C. leucas*) encounters along the eastern coast of Trinidad. Their presence in only Regions 4 and 5 (Table 2), located in the southern Atlantic end of Tobago (Fig. 2) and to the east of Trinidad reflects this. To prevent possible exploitation of the information by thrill-seekers and fishers, specific dive sites are not identified in this article.

Investigations in Florida indicated that male and females *G. cirratum* attain sexual maturity greater than 2.1m and 2.2m TL respectively, and juveniles at birth are between 28 to 30cm (Castro 2000). Based on the provided total length estimates of *G. cirratum*, 73% of individuals in our study were estimated under 2.1m. It seems likely that only a small percentage of those individuals sighted, and by projection the local population, are reproductively capable. A Belize survey (Pikitch *et al.*, 2005) indicated the reported TL range was 1.85m to 2.0m. However, in Brazil, Santander-Neto *et al.* (2011) noted a wider range of 0.73 to 2.74m TL, which closely matches the range found in our study (0.6 - 3m TL).

There is a lack of local data on elasmobranch diversity, abundance, distribution, biology and ecology. This study is a first step towards rectifying this situation. By gathering data using citizen-based observations, we capitalised on a cost-effective means of collecting preliminary baseline data that would not otherwise be economically or logistically feasible. Resources can now be deployed focusing on specific regions for further work, such as deployment of baited remote underwater video (BRUV) for data collection. Additionally, an assessment of the economic value of elasmobranchs to Trinidad and Tobago both as a consumptive and non-consumptive resource is necessary to formulate adequate shark fisheries management, including regulations and conservation measures such as the establishment of marine protected areas or shark sanctuaries.

Our study confirmed the presence and distribution of ten species of elasmobranchs and also highlights the importance of citizen-based science in identifying key areas for future surveys. These subsequent surveys should involve rigorous scientific techniques such as BRUV deployment, and underwater visual census specific to all elasmobranchs to fill the much-needed information gaps.

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Aquatic Fauna of Three Rivers in Northeast Tobago, West Indies: Updated Species Assemblages and Distributions

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ABSTRACT

To fill gaps in our knowledge of the fish and macroinvertebrate fauna of streams in northeast (hereafter NE) Tobago, we surveyed the upper reaches, middle reaches and river mouths of three NE Tobago rivers; Hermitage, Doctors (Speyside) and Delaford Rivers. We employed multiple sampling techniques at these nine sites to survey ichthyofauna, decapod crustaceans and molluscs. We recorded 11 freshwater and four brackish water fish species, 10 decapod species, and four gastropod mollusc species. The molluscs included two invasive snails (*Tarebia granifera* and *Melanoides tuberculata*) and their expanded distributions in NE Tobago. We also noted a new aquatic gastropod species for the island, *Neritina punctularia,* and a new site locality for the catadromous fish, *Anguilla rostrata,* within the Delaford River. Lastly we have re-documented the presence of the freshwater shrimp *Macrobrachium acanthurus,* which was not detected in the most recent report on macroinvertebrates for the island.

Key words: *Tarebia, Melanoides, Neritina, Anguilla, Macrobrachium,* alien invasive species, macroinvertebrates, ichthyofauna, aquatic diversity

INTRODUCTION

The aquatic fauna of a river reflects the overall condition of the system (Heatherly *et al.* 2007; , Karr 1991; Wallace and Webster 1996). Baseline data on aquatic assemblages are therefore needed for assessing future environmental impacts and forming management plans. For example, they allow the documentation of rare or threatened species in need of protection, such as *Anguilla rostrata* (Benchetrit and McCleave 2016). Equally, such data enable the tracking of invasive species, such as the gastropod molluscs *Tarebia granifera* and *Melanoides tuberculata* which have already been documented in the region (Mohammed 2014).

The freshwater fish of Tobago have recently been reviewed (Mohammed *et al.* 2015), however this review did not include estuarine species, which form an important element of the fish fauna in the lower reaches of Trinidad and Tobago's rivers (Phillip *et al.* 2013). Notable surveys of Tobago's aquatic invertebrates include those conducted by Bass (2003) and Rostant (2005). Bass sampled 17 sites, three of which fell within NE Tobago (two in Doctors River, Speyside, and one in the Delaford River), while Rostant (2005) surveyed eight sites for freshwater decapods, two of which were in NE Tobago (Doctors River).

This report is intended to add to the body of knowledge on the aquatic faunal assemblages of NE Tobago focusing on the ichthyofauna (fish), decapod crustaceans and gastropod molluscs within the Hermitage, Doctors and Delaford rivers.

A key strength of this study is the sampling of upper, middle and lower river reaches, so that trends along this gradient can be detected. The study also benefits from a broader-than-usual scope, due to the inclusion of both vertebrates (fish) and invertebrates (decapods and molluscs).

METHODOLOGY

Sites

Three rivers were surveyed: Hermitage River, flowing northerly towards the Caribbean Sea into Man O' War Bay; Doctors River (also known as the Speyside River), flowing south-easterly towards the Atlantic Ocean; and the Delaford River flowing southerly towards the Atlantic Ocean into King's Bay (Fig. 1). These are the three major rivers in NE Tobago. On each river, three 50m stretches were identified as our sampling sites; one in the upper reach, one in the middle reach and one in the lower reach (at the river mouth). The exact location of each site was determined by its accessibility, and whether it included a deep enough section of river for seining (>0.3m). All survey sites comprised clear water sites with a relatively small catchment area and short water course less than 2 km (Fig. 1). Appendix 1 elaborates on the geographic locations as well as the site descriptions. Other small tributaries, drainages and rivers in NE Tobago were also sampled in an ad hoc manner and observations were noted.

Sampling

Sampling took place in June 2016, during the meteorological rainy season. Herein, each site was selected as being a 50m portion of river. The sites were selected via stratified convenient sampling. This meant that for

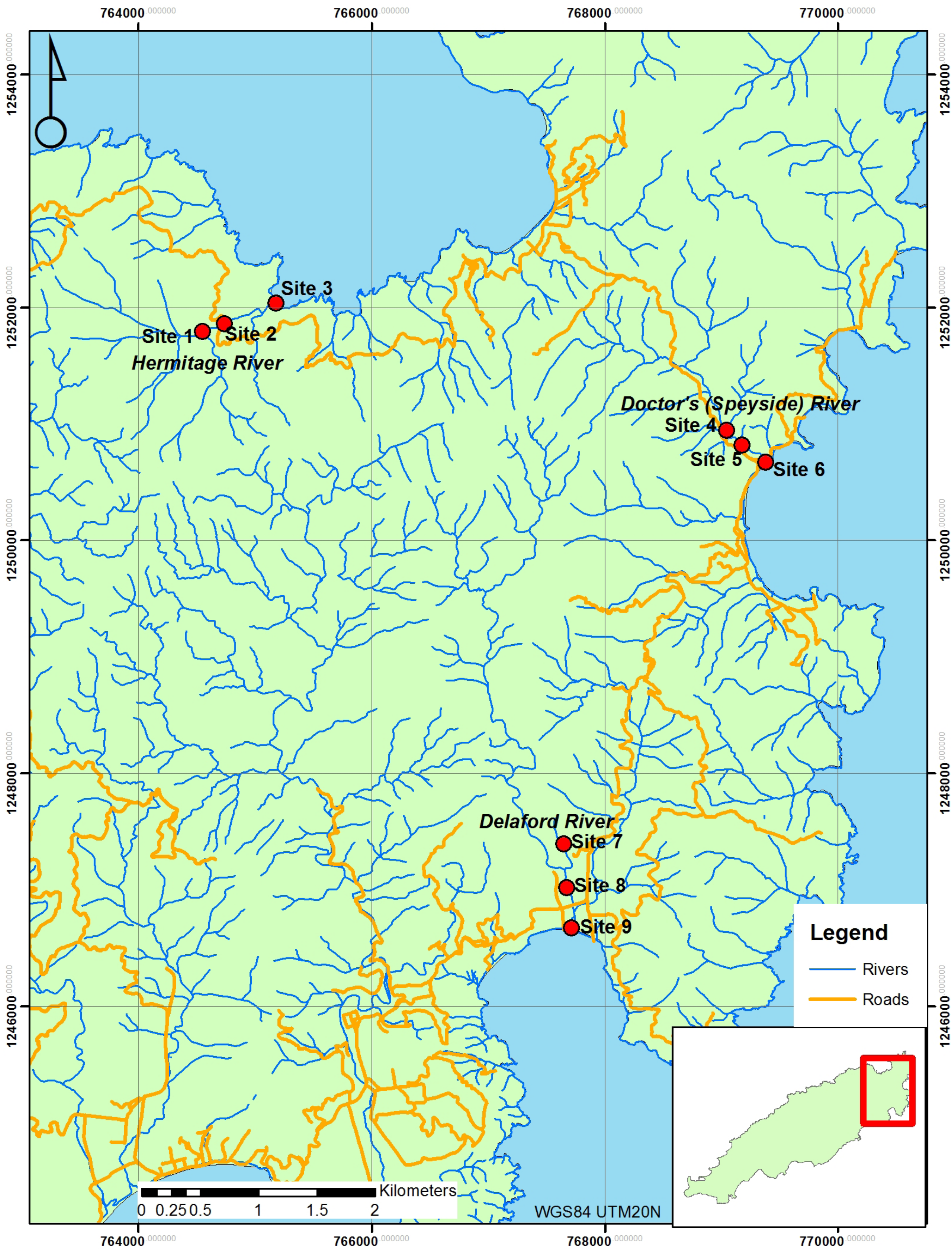

Fig. 1: Sample locations in northeast Tobago.

each site, a general area was chosen based on relative ease of access. Once this area was identified, the criteria of depth and shape were used to select the specific start point. Sampling of each river took place on a single day. At each site, three deployments of a 5m long seine with 0.5cm mesh (aimed at both fish and decapods) were conducted. The seine was dragged along the river bed, moving towards shallower regions. This allowed for cordoning off and capture of the more mobile fish species. Cavities were probed and any individuals that emerged were captured with landing nets. This activity was done in tandem with the use of the seine and was conducted wherever viable cavities were noted.

At each of the nine sites, three 0.25m^2 quadrats were randomly laid on the river bed and the identities (to species level) and abundances of all molluscs and crustaceans within each quadrat were recorded.

Lastly, at the middle reach and river mouth sites, a fish trap (30cm × 30cm × 60cm, 0.5cm mesh, single funnel entrance) was deployed. These sites were chosen because the fish traps required a minimum depth of 50cm for effective deployment. Upper sites were not sampled using the fish traps as these sites did not meet the minimum depth requirement. The fish traps (baited with scraps of fish and bread) were left for a total of 48hrs and checked at 12hr intervals.

Identification and Analysis

Specimens were identified using available taxonomic keys (Phillip *et al.* 2013; Rostant 2005; Carpenter 2002). All data were tabulated using Microsoft Excel 2007, and species richness calculated per site. Maps were constructed using ArcMap 10.5 (ESRI 2016) and QGis (Quantum GIS Development Team 2012).

The mollusc density data were grouped into four categories: very high (>100m^{-2}), high (30-99m^{-2}) medium (10 to 29m^{-2}) and low (1-9m^{-2}).

RESULTS

In total 15 fish species, 10 decapod crustacean species, and four species of mollusc were detected during sampling (Table 2).

Of the fish species, seven are typically freshwater, two are freshwater river species tolerant of brackish water (*Eleotris pisonis* and *Micropoecilia picta*) and four are marine estuarine species known to venture into river mouths (*Lutjanus griseus*, *L. jocu, Mugil hospes* and *Trinectes paulistanus*). One catadromous species, *Anguilla rostrata*, was noted. Most species occurred at multiple sites, while three species were detected at only one (Table 2).

It should be noted that *L. griseus* and *L. jocu* were additionally observed at the Bloody Bay and Parlatuvier River mouths during the period of this survey, although these rivers were not sampled systematically and so are not included in the present analyses.

Of the decapods, three were crabs, *Armases roberti, Callinectes sapidus* and *Rodriguezus garmani* (formerly *Eudaniela garmani*). All others were freshwater shrimp. The freshwater shrimp *Xiphocaris elongata* was found at all nine sites, and was noted as the most abundant overall. *Macrobrachium crenulatum* was found at eight sites but was typically less abundant than *X. elongata.* The freshwater shrimp *Jonga serrei* was only found at two sites, both being in the upper reaches. Similarly, two crab species (*Armases roberti* and *Callinectes sapidus*) were found only at two sites (both of them river mouths). Additionally, *C. sapidus* observed at the Bloody Bay and Parlatuvier River mouths.

Neritina punctulata was found at only two sites on the Hermitage River, and at low densities (1-9 m^{-2}), while *Neritina virginea* had medium densities (10 to 29 individuals m^{-2}) at the five sites where it was present. *Tarebia granifera* was found in high abundance at all nine sites; with its density being highest at the Speyside River mouth. *Melanoides tuberculata* was present at six sites at consistently moderate densities (Table 2).

All four species were also noted at the Parlatuvier and Bloody Bay Rivers, with *T. granifera* having the highest densities and *N. punctularia* having the lowest. Both *M. tuberculata* and *T. granifera* were also noted in the small drainages within Charlotteville and Pirate's Bay.

River mouth sites tended to have fewer decapod species than middle and upper sites. Conversely, fish species richness was consistently lowest at the upper sites, and was similar between middle and lower sections for each river. Freshwater gastropods had low species richness at all sites (Table 1).

DISCUSSION

A previous survey by Mohammed *et al.* (2015) included 81 sites across the rivers of Tobago, taking a broad-scale approach and focusing on the freshwater fish alone. In contrast, our present study concentrates on just three rivers, while widening its scope in terms of taxa (freshwater fish, estuarine fish, crustaceans and molluscs). We also achieved a finer spatial resolution of the communities by sampling upper, middle and lower reaches on each river. It should be noted that the lack of detection of a taxon during one survey does not imply absence. The current survey rather serves to provide additional information regarding fish, crustacean and mollusc assemblages at three rivers in NE Tobago.

Of the 12 freshwater fish species Mohammed *et al.*

Table 1. Species list, distribution and richness per site.

TAXA	SPECIES	SITE NUMBER 1 U	2 M	3 L	4 U	5 M	6 L	7 U	8 M	9 L	Number of sites species observed
FISH	*Agonostomus monticola*	X	X	X		X	X	X			6
	Anablepsoides hartii				X	X					2
	Anguilla rostrata $^{\Phi}$		X	X		X		X			4
	Awaous banana	X	X			X	X		X	X	6
	Ctenogobius boleosoma		X		X	X			X		4
	Eleotris pisonis			X			X		X	X	4
	Gobiomorus dormitor		X	X		X	X		X	X	6
	Lutjanus griseus ç			X			X		X	X	4
	Lutjanus jocu ç			X		X	X			X	4
	Poecilia picta					X	X				2
	Mugil hospes ç						X			X	2
	Poecilia reticulata				X						1
	Sicydium punctatum	X	X			X	X	X	X		6
	Synbranchus marmoratus					X					1
	Trinectes paulistanus ç									X	1
	Fish Species Richness	**3**	**6**	**6**	**3**	**10**	**9**	**3**	**6**	**6**	
DECAPODS	*Armases roberti*						X			X	2
	Atya scabra	X	X		X	X			X		5
	Callinectes sapidus						X			X	2
	Eudaniela garmani	X	X		X	X		X	X		6
	Jonga serrei	X			X						2
	Macrobrachium acanthurus						X	X	X	X	4
	Macrobrachium carcinus	X	X		X	X		X			5
	Macrobrachium crenulatum	X	X	X	X	X	X	X	X		8
	Potimirim glabra	X	X		X			X	X		5
	Xiphocaris elongata	X	X	X	X	X	X	X	X	X	9
	Decapod Species Richness	**7**	**6**	**2**	**7**	**5**	**5**	**6**	**6**	**4**	
MOLLUSCS	*Neritina punctulata***	X	X								2
	Neritina virginea	X	X			X		X	X		5
	*Melanoides tuberculata**		X		X	X	X		X	X	6
	*Tarebia granifera**	X	X	X	X	X	X	X	X	X	9
	Mollusc Species Richness	**3**	**4**	**1**	**2**	**3**	**2**	**2**	**3**	**2**	

U-upper M-middle L-lower (river mouth)
*Invasive species **New species documented for Tobago Φ Catadromous species ç Marine estuarine species

Table 2. Gastropod density (m^{-2}) at nine river sites in NE Tobago

SITE	*Neritina punctulata*	*Neritina virginea*	*Melanoides tuberculata*	*Tarebia granifera*
1 (U)	1-9	10 to 29	0	30 to 99
2 (M)	1-9	10 to 29	10 to 29	30 to 99
3 (L)	0	0	0	30 to 99
4 (U)	0	0	10 to 29	30 to 99
5 (M)	0	10 to 29	10 to 29	30 to 99
6 (L)	0	0	10 to 29	>100
7 (U)	0	0	0	30 to 99
8 (U)	0	10 to 29	10 to 29	30 to 99
9 (L)	0	10 to 29	10 to 29	30 to 99

(2015) documented for NE Tobago, 11 were detected in this present study, with only *Gobiesox nudus* absent. Phillip (1998) noted *G. nudus* at Site 5 (Doctors River) but this species was not detected in the 2015 survey, and has still not been detected elsewhere in NE Tobago, perhaps indicating its rarity. *Synbranchus marmoratus* was previously noted at Site 5 (Mohammed *et al.* 2015) and was again found in this survey. *Anguilla rostrata* was noted by Phillip (1998) at Site 5, Doctors River and noted by Mohammed *et al.* (2015) at the Hermitage River (Sites 2 and 3). This species was again confirmed at all three of these sites in the present study, and was additionally noted at the Delaford River (Site 7) at the base of a waterfall.

Of the 63 estuarine fish species Phillip (2013) noted for both Trinidad and Tobago, four were recorded in our survey. It is likely that additional estuarine species venture into the lower portions of these three river systems, as the composition is temporally dynamic and our survey represents only a snapshot in time. Furthermore, at the time of sampling all three rivers had physical barriers near their mouths, limiting the movement of fish between the sea and the river. During the survey period, only the Delaford River showed evidence of flow at high tide, which likely explains why this river had the greatest number of brackish water fish species detected.

In addition to Rostant (2005), four other surveys have examined decapod distributions in rivers of Tobago. These include Chace (1972), who sampled the middle Hermitage River (Site 2); Hart (1980), who surveyed Doctors River in detail, as well as the mouths of the Delaford, Bloody Bay and mid Roxborough Rivers; and Ramnarine *et al.* (1994) who surveyed 22 sites across the island, including detailed surveys of Doctors River and its tributaries, as well as the mouth of the Delaford River (Site 9). Lastly, Bass (2003) surveyed the entire island for macroinvertebrates in 1996. All species previously documented by these authors were noted again by Rostant (2005), with the exception of *Macrobrachium acanthurus.* In our current survey we note for the first time since 2003 the presence of *M. acanthurus* at the Delaford River (all sites) and Doctors River mouth. Four species (*Atya innocuous, Macrobrachium faustinum, Macrobrachium heterochirus* and *Micratya poeyi*) were not detected during our survey. All four were previously observed at Site 4, upper Speyside River (Bass 2003; Hart 1980; Ramnarine *et al.* 1994; Rostant 2005). Further sampling with additional gear such as electrofishing should be conducted to confirm whether their absence is an artefact of under sampling (Deacon *et al.* 2017).

Of the ten gastropod species listed by Bass (2003), only two species (*Melanoides tuberculata* and *Neritina virginea*) from his NE Tobago sites were detected in our survey. Our surveys only shared two sites in common; Sites 7 and 8 at the upper and middle Delaford River. Like Bass, we found three species at these sites, however they are not the same three. Missing from our survey is *Pyrgophorus parvulus*, while we add *T. granifera* to the species assemblage for the site. At Site 9 on the same river, only the invasive freshwater gastropods were observed. Van Oosterhout *et al.* (2013) noted *T. granifera* for the first time on the island in 2012, and demonstrated that it had some tolerance to sea water. Based on their distribution map (which included similar sites to Bass (2003)) and our current survey, there is an indication that this species may be spreading in the rivers of NE Tobago, an issue which deserves further attention. Both *M. tuberculata* and *T. granifera* are alien invasive species and it has been suggested that the more recent arrival, *T. granifera,* may be outcompeting *M. tuberculata* (Van Oosterhout *et al.* 2013; Snider 2007).

In Bass' 1996 list (Bass 2003), *Neritina punctularia* is absent (either through misidentification or genuine absence), making this the first report of this species for the island. Given that we know so little about the status and distribution of *N. punctularia*, and that it appears to be fairly rare, potential effects of competition from *T. granifera* and *M. tuberculata* should be monitored in future surveys as it is already present at the same locations. Bivalves were not noted for any sites in NE Tobago but have been noted previously by Bass (2003) in southern rivers on the Caribbean coast.

In conclusion, our study adds to our knowledge of the fish, crustacean and mollusc assemblages of three rivers in NE Tobago. We have noted the expanded distributions of two alien invasive gastropods, listed a new gastropod species for Tobago and new distribution records for crustaceans and fish. These findings justify the approach of sampling smaller regions in greater detail using multiple types of sampling gear and techniques to provide higher resolution of species composition within a river. With this in mind, further detailed surveys should be conducted on selected rivers and catchments with repeated sampling events and longer sampling periods, which can be used to inform the future management of riverine and estuarine ecosystems by providing a baseline of species distributions and abundances.

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Colours and Spots: Do they Tell the Story of an Ocelot's Origin?

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ABSTRACT

Morphological differences in ocelots were suspected to occur between Trinidadian and South American populations. Data for 49 individuals inclusive of camera trap photographs and captive ocelots in private and zoo collections was collected. Observations of spot size and colour, spot outline thickness, dorsal stripe and nose colour were noted. These were then compared to the origins of the respective specimens. Lastly, camera trap photographs of wild ocelots in Trinidad and live specimens were compared to test the hypothesis. Of these parameters, only spot outline thickness and nose colour were significantly different with specimens from Venezuela having mostly pink noses and Trinidadian ocelots having mostly black noses. To a lesser extent, there were no Trinidadian ocelots with thick spot outlines.

Key words: *Leopardus pardalis*, Trinidad, Venezuela, South American, dorsal stripe, pelage colour

INTRODUCTION

The ocelot is a small to medium sized spotted cat and is the largest of the small cats in Latin America (Murray and Gardner 1997). The Aztecs and other Native Americans respected the ocelot (*Leopardus pardalis*) for its overwhelming beauty and hunting skills. The word 'ocelot' comes from the Mexican Aztec Nahuatl word "*thalocelot"* with various meanings, including tiger of the field and jaguar (Murray and Gardner 1997). Due to increasing demands for pelts and furs, the ocelot is one of many felids that had long been hunted for their coat patterns (Khan, 2008).

Ocelots historically ranged from Southern United States throughout Central and South America to Northern Argentina, including the islands of Margarita (Venezuela) and Trinidad (Nowell and Jackson 1996, González *et al.* 2003). In Trinidad the ocelot is classified as an 'Environmentally Sensitive Species' (Environmental Management Act, 2013). It is considered endangered in the US where currently the remaining populations reside within forested portions of Texas, however it is rated on the International Union for the Conservation of Nature (IUCN) Red list as 'least concern'(Paviolo *et al.* 2016).

The patterns found on the flank, shoulder, forehead, and across the body of ocelots vary among individuals. The pelage colour of ocelots varies as well, sometimes even within populations (Kitchener *et al.* 2006; Murray and Gardner 1997). It was noted by Murray and Gardener (1997) that ocelots north of the Rio Grande, are more greyish than those to the south, with black markings being reduced to the width of the space between them. The ground or base colours are also variable from greyish to buff, with colouration from head to shoulders being a deeper tone than the lower half of the dorsal area, and the sides also being paler than the back. The most distinguishing marks would be expected along the flanks of the felids (Kitchener *et al.* 2006) Underparts are generally white and spotted with black (Murray and Gardner 1997).

Many studies examining the adaptive functions of felid coat patterns indicate that the main purpose is for camouflage (Eizirik *et al.* 2010; Ortolani 1999). Since felids stalk their prey, they benefit considerably from being camouflaged for as long as possible before capturing prey (Allen *et al.* 2011; Godfrey *et al.* 1987; Ortolani 1996). Additionally, small cats such as ocelots tend to utilise camouflage from prey as well as potential predators (Allen *et al.* 2011; Ortolani and Caro 1996). In Costa Rica, studies have shown that during the rainy season ocelots have been included in the diet of the jaguar (*Panthera onca*), which is the top felid predator in that region (Gonzalez-Maya *et al.* 2010). In Trinidad, the ocelot, is the only native feline predator (Reid 2012).

In a study by Ortolani and Caro (1996), spots on felids were found to be significantly associated with forested habitats; additionally, they found that dark spots on carnivores are associated with closed habitats and arboreal locomotion. In general, it was found that felid flank patterns evolved to match the visual appearance of the background, a finding further supported by Allen *et al.* (2011). They concluded that particular patterns evolved to resemble the various shapes and sizes of the natural patterns that exist in their habitat background. In addition, felids that reside within closed arboreal environments would tend towards more complex camouflage patterns on their coats with especially irregular patterns, such as on the ocelot (Allen *et al.* 2011).

Allen *et al.* (2011) also found that felid patterning and camouflage adapts to ecology over relatively short time scales. Since the ocelot is the top predator in Trinidad, camouflage type would be definitive of both the landscape ecology, as well as potential prey type. However, it is theoretically possible that a recent habitat shift, which might result from Trinidad separating from the mainland, would produce outliers and camouflage changes.

Numerous zoological researchers have employed the use of various natural markings on organisms as a means of identification of individuals (Eizirik *et al.* 2010, Ortolani 1999, Godfrey *et al.* 1987). Animals such as gorillas (*Gorilla gorilla beringei*), chimpanzees (*Pan troglodytes*), orangutans (*Pongo pygmaeus*), deer (*Cervus elaphus*), rhinoceroses (*Diceros bicornis*), elephants (*Loxodonta africana*), zebras (*Equus burchelli*), tigers (*Panthera tigris*), lions (*Panthera leo*), giraffes (*Giraffa camelopardalis*), servals (*Felis serval*) and even swans (*Cyguns bewickii*) could be individually identified through the natural markings on each organism (Miththapala *et al.* 1989).

In studies done on another felid species, the clouded leopard (*Neofelis nebulosa)*, morphometric analyses of the pelage of these cats showed that there were two distinct morphological groups, each of which showed differences in size and colour of the cloud markings on their coats. The clouded leopards with large clouds tended to have fewer markings than others with smaller cloud markings. The former were often lighter in colour and were tawny coloured, whereas the clouded leopards with small clouds tended towards having many distinct spots, greyer in colour. It was demonstrated that two clusters of clouded leopards could be differentiated based on their pelage characteristics (Kitchener 2006). These morphological variations were later on verified through genetic analyses showing that these were two distinct species with one in mainland Asia, and the other in the Sunda or Indo-Malay Archipelago (Kitchener 2006; Wilting *et al.* 2007).

Currently, little is known about the natural breeding populations of ocelots in Trinidad. Previous studies done by Nelson (2004) and Khan and Mohammed (2015), have not addressed the population ecology or distributions of ocelots throughout Trinidad's landscapes, although the first major research project on ocelot ecology is currently underway in at least three or four study sites (pers. comm. A.J. Giordano). No studies however have been conducted on ocelot morphological patterns and variations. Here we hypothesised there are variations in coat and facial patterns of ocelots originating from Venezuela and Trinidad.

METHODOLOGY

To investigate our hypothesis of morphological variations between Trinidadian and Venezuelan ocelots, we examined 49 ocelots visually through camera-trap photographs of wild specimen, as well as live captive specimens. Pictures were taken of the flanks, dorsal regions, and face of live ocelots. Firstly, nine ocelots housed at the Emperor Valley Zoo (EVZ) were examined without our prior knowledge of the origins of the cats. Once data was collected we tested whether we were able to successfully match the origin of the specimens based on morphological data. The actual origins were verified after data collection. These verifications were done by reviewing the records as well as communications with zookeepers and the curator of the zoo. Secondly, four ocelots housed at Serpentarium (Aranguez, Trinidad), three from El Socorro Centre for Wildlife Conservation, and three from a private permitted owner, were examined and the geographical source of the animals were recorded. All captive animals were confiscated by the Forestry Division, Wildlife Section, Trinidad and Tobago or were born in captivity.

Observations were made on variations in coat and facial patterns and these were scored ordinally. We recorded spot size [small (1), medium (2), large (3)], spot shape [circular (1), elongated (2), chainlike (3)], dorsal stripe [present (1), absent (2)], spot outline thickness [thin (1), intermediate (2), thick (3)], nose colour [pink (1), pink and black (2), black (3) and lastly specimen origin [Trinidadian (1), Venezuelan (2). Pearson's Chi square analyses were done using SPSS version 22.0 to evaluate the likelihood of any observed differences between independent variables (origin) and these dependent morphological variables.

Once the data was obtained, the hypothesis was then tested by examining and comparing with camera trap photographs (source UWI, K.S, M.R) of wild ocelots from the Northern Range and southern parts of Trinidad. Mostly black and white (infrared) photographs of ocelots were obtained from camera traps in Trinidad, which limited the analysis of coat and spot colour. Nonetheless, we were still able to estimate spot size, thickness of spot outline and nose colour from these images. Based on the camera trap photographs, individual ocelots were differentiated and analysed based on location, date of image, interval time between shots and patterns on individual ocelots (looking at the same side of the flank) to ensure there was no pseudo-replication of individuals.

Finally, we ensured that no animals were harmed during the examining and photographing of the specimens, and all captive specimens were housed using permits provided by the Wildlife Section of Trinidad & Tobago's Forestry Division.

RESULTS

In total 49 ocelots were observed which included 30 wild specimens from camera trap photographs and 19 individuals housed in captivity. We determined 12 individuals (24.5%) were of Venezuelan origin and 37 (75.5%) were Trinidadian.

Our analysis of several morphological features on ocelots yielded varied results. Parameters such as spot size, spot shape and dorsal stripe did not indicate significant differences between individuals of Trinidadian and Venezuelan origins. However, spot outline thickness were significantly greater for Venezuelan ocelots (Pearson's Chi-square test: χ^2=12.22; d.f. =2, p=0.002) (Fig 1a). Trinidadian ocelots did not have relatively thick spot outlines. There was also a significant difference in nose colour (either pink or black) between both populations (Fig 2A-C) (Pearson's Chi-square test: χ^2=23.77; d.f. =2, p < 0.001) (Fig 1b), with Trinidadian ocelots having mostly black noses, and Venezuelan specimens having mostly pink noses.

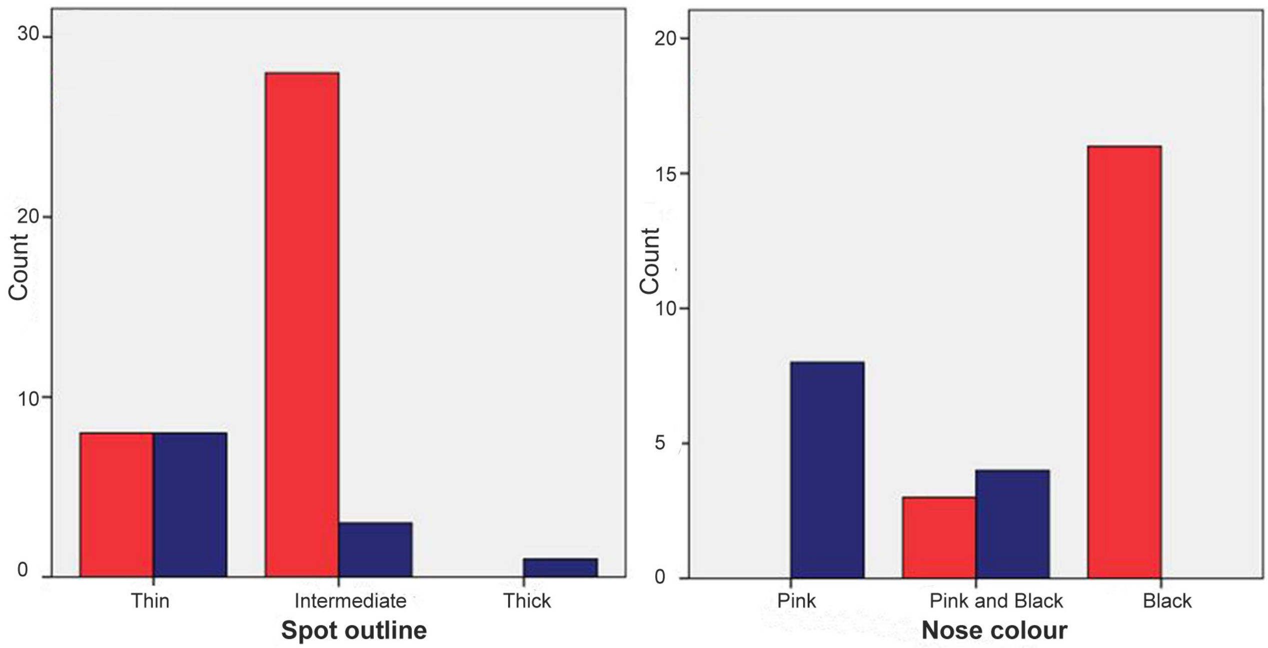

Fig.1. (left) Local ocelots had thin and intermediate spot outlines only, whereas Venezuelan ocelots varied among thin, intermediate and thick spots. (right) Black noses were indicative of individuals from Trinidad (51.6%), and pink noses were typical of Venezuelan ocelots (25.8%). Specimens with mixed coloured noses were rarer (22.6%), and were from either Venezuela or Trinidad.
Key: Red- Trinidad Blue-Venezuela

Fig. 2. A. Venezuelan ocelot with pink nose housed at Serpentarium. B. Venezuelan ocelot with mixed nose colour housed at Serpentarium. C. Trinidadian ocelot with black nose housed at EVZ.

DISCUSSION

Our observations of photographs led to some distinguishing characteristics between the Venezuelan and Trinidadian ocelots. We found that Trinidadian and Venezuelan specimens varied in nose colouration and spot size and shape. Trinidadian ocelots tended towards completely black or to a lesser extent black and pink noses, whereas Venezuelan individuals tended towards completely pink noses. Additionally, the thickness of spot outlines was also interesting, as we found no Trinidadian ocelots with thick outlines.

It is well known that ocelots and any captive organism tends to vary in colouration and size in captivity due to diet, habitat enrichment, age and disease, among other factors (Cubas 1996). However, in discussions with zookeepers and private owners, it was noted that the Venezuelan ocelots seemed to be larger than the Trinidadian ocelots, with colour tending towards yellow and grey and Trinidadian specimens tending towards brown and orange (Pers. comm. S. Moonilal and W. Bonyun). However this was not a trait that was evaluated since it is difficult to gauge size and age from camera trap photographs.

Given that Trinidad is such a small landmass compared to the mainland of Central and South America it is possible that there would be a loss of genetic diversity within Trinidadian populations compared to mainland populations which can eventually lead to inbreeding depressions and other genetic disorders. Studies done by Janecka *et al.* (2014) showed that small fragmented populations in Texas had major issues of inbreeding depressions. However this can only be verified through genetic testing. Isolated genetic dynamics could be one factor that possibly leads to Trinidadian ocelot populations becoming genetically different from those of the mainland which could be expressed phenotypically. This might explain the subtle differences between Trinidadian and Venezuelan individuals.

There were various limitations to this study. We were very sceptical about using colour as a major distinguishing factor since visual perception of colour can be subjective. Nonetheless colour variations are possible in felids between populations (Murray and Gardner 1997; Kitchener *et al.* 2006). Therefore all authors independently determined colours and compared afterwards. Additionally, the photographs from most of the camera traps were not of high resolution, and were black and white (infrared). Access to captive ocelots was limited, and thus we could complete only short periods of visual observations, as animals were highly agitated upon the presence of strangers. To reduce the stress on the animals, we kept encounters brief (under 10 minutes). Additionally, there was a relatively small Venezuelan sample size to examine. However, to support our findings, observations were made of two specimens in French Guiana housed at Zoo de Guyane and it was noted that both specimens had completely pink noses. One specimen was observed in Guyana at Guyana Zoological Park (Georgetown) and it also had a pink nose. We also have anecdotal evidence from an observer (M. Rutherford) of another ocelot at Summit Municipal Park, Panama which also had a pink nose. Even closer to Trinidad, the La Guaricha Zoo and Chorros de Milla Zoo in Venezuela both house ocelots with pink noses. This supports our hypothesis that the completely pink nose is mostly a mainland trait.

It is increasingly clear through discussions with several private permitted owners, handlers and wildlife rehabilitation facilities that the illegal wildlife trade of both foreign and local animals is a concern and is increasing. More striking is the number of imported ocelots as well as other wildlife into Trinidad that have been reported to have escaped (pers. comm. Rehabilitation Facilities).

Whilst we can conclude the difference in nose colour and to a lesser degree thickness of spot outline are the distinctive features between Trinidad and Venezuelan ocelots, we are also mindful that scaring on the noses of captive ocelots do not cause the presence of a pink nose. Based on this study, we conclude that ocelots with thin and intermediate spot outlines and black noses are more likely to have originated from Trinidad. However, to increase confidence, further comparisons of the coat colour and pattern variations are required. Comparisons should include more individuals and with images of higher resolution. Ultimately, genetic testing and development of a database would give the greatest resolution regarding the source region for a specimen. With this in mind, we suggest the next step should be genetic testing and comparing morphological features. We also hope this new information can be used to advise regulating authorities on the origins of captive or confiscated specimens.

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Notes on the Lepidoptera of Huevos, Trinidad and Tobago

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ABSTRACT

Lepidoptera of Huevos were surveyed during two-day visits in the dry season of 2014 and the wet season of 2015. Butterflies were surveyed by searching during the day and a light trap was operated at night to sample moths. Thirteen species of butterfly and 35 species of moth were recorded. The moths are all documented with images of living individuals from Huevos. Fourteen of the moth species have not been recorded previously from Trinidad, although we here record that they are also found there. We document and illustrate several moth species which have not previously been found in Trinidad or Tobago, but cannot be identified satisfactorily at this time.

Key words: butterflies, moths

INTRODUCTION

The Lepidoptera of the islands offshore northwestern Trinidad are poorly known, particularly Huevos where nothing has bene recorded on the Lepidoptera due to its rugged terrain and carefully controlled access. Accordingly, when the TTFNC overnighted on the island on 22 February 2014 and 4 October 2015, attempts were made to record the species encountered.

METHODS

Butterflies were recorded by visual identification during a walk to the highest ridge of the island and on shorter trips closer to the house. To record moths, a light trap was operated in the dry gulley that runs northward from the house in an area of dry forest. On both occasions, this trap was operated from approximately 1900 h that evening to 0230 h the following morning, with photographs taken of all the species that were attracted to the trap.

As is typical for the region, there was no rain for the entire duration of both trips. It was hot and dry during the day. At night, a light warm wind blew in from the sea and up the gully nearly throughout the entire trapping period, and negatively affected trap performance.

Moths were identified by MJWC by comparing KS's photographs with pinned specimens from Trinidad in his collection and photographs of specimens in the museums named below. MJWC's Trinidad material was mostly identified by comparison with named material and often type material in the Natural History Museum, London (NHMUK) and the United States National Museum (USNM). Additional material was examined in the Oxford University Natural History Museum (OUNHM). National Museums of Scotland, Edinburgh (NMSE) and the University of the West Indies Zoological Museum, St. Augustine (UWI).

RESULTS

Lepidoptera numbers were generally low, both at night and at day. An annotated list of the moths observed is presented overleaf and illustrated in plates 1 and 2. The most commonly observed butterfly on both visits was *Morpho helenor* (Cramer) as one or two were almost always in sight in the gully during the day. During the first trip, on the ridgeline, Lycaenidae were easily disturbed from the dry scrub, but these could not be captured or photographed. All appeared similar in form to *Calycopis origo* (Godman & Salvin) but the exact identity remains uncertain. Also observed on the ridgeline during the first trip was *Anteros carausius.* This species appears to be restricted to dry forests on Trinidad, having only been recorded from nearby Chachachacare, Gaspar Grande (Cock 1981) and Point Gourde (Cock 2004), so that its presence on Huevos is not surprising.

<u>List of butterflies observed on Huevos, 22/23 February 2014 and 4/5 October 2015</u>

Nymphalidae, Nymphalinae
Historis odius dious Lamas. Oct. 2015.

Nymphalidae, Biblidinae
Biblis hyperia hyperia (Cramer). Feb. 2014.
Mestra hersilia hersilia (Fabricius). Feb. 2014.
Pyrrhogyra neaerea (Linnaeus). Feb. 2014.

Nymphalidae, Satyrinae
Morpho helenor insularis (Fruhstorfer). Feb. 2014.

Lycaenidae, Theclinae
Strymon albata (Felder & Felder). Feb. 2014.
Calycopis ?origo (Godman & Salvin).Feb. 2014.
***Cyanophrys* sp.** Oct. 2015.

Riodinidae, Riodininae
Anteros carausius Westwood. Feb. 2014.
Melanis electron electron (Fabricius). Feb. 2014.
Juditha molpe (Hübner). Feb. 2014.

Hesperiidae, Eudaminae:
Chioides catillus catillus (Cramer). Feb. 2014.
***Epargyreus* sp.**, prob. *E. socus chota* Evans. Oct. 2015.

During the night of the first trip, the most common moth was *Nycterotis lucia* (Schaus), of which three individuals were attracted to the light. Of the other moths, there was never more than one of the same species on the sheet at the same time.

The combination of a dry environment and its distance from mainland Trinidad does not favour a wide range of Lepidoptera on Huevos. A high percentage of dry forest specialists is to be expected and indeed, the moth diversity observed on these trips was similar to collections made by MJWC on the Five Islands (Cock 2017a) and around Crown Point, Tobago (Cock 2017b). The near continuous winds negatively affected both moth trapping efforts as moths were having difficulty alighting on the sheet.

Future collection efforts on Huevos should focus on the area north of the main ridge towards Balata Bay and amongst the open patches of low scrub along the ridge line where butterflies appeared to be more numerous than on the forested southern slope.

Annotated list of moths observed at light on Huevos, 22/23 February 2014 and 4/5 October 2015

Cossidae, Hypoptinae

***Gaviria* sp. unknown #1**. Feb. 2014. Plate 1, No. 1 The generic placement is tentative based only on external similarities. MJWC has not been able to identify this species, of which he has three specimens from Trinidad (Curepe). Matching material was not found in NHMUK or USNM.

Crambidae, ?Crambinae

Unidentified Crambidae genus and sp. #1. Oct. 2015. Plate 1, No. 2. This species does not match any recorded from Trinidad.

Crambidae, Glaphyrinae

***Aureopteryx argentistriata* (Hampson).** Feb. 2014 and Oct. 2015. Plate 1, No. 3. Identified by comparison with the USNM series, but the type has not been examined. Although this species has not previously been recorded from Trinidad, there is a ♀ in USNM from Mt. St. Benedicts (M. St. B., 1923, collected by Bro. Maur[ice]) and MJWC has specimens from Curepe, Point Gourde and Simla.

***Schacontia nyx* Goldstein & Solis**. Feb. 2014. Plate 1, No. 4. One specimen of this recently described species was provisionally identified from Goldstein *et al.* (2013). It has not previously been recorded from Trinidad, but MJWC has a ♀ from Point Gourde that also appears to be this species.

Unidentified Glaphyriinae genus and sp. #1. Feb. 2014. Plate 1, No. 5. This species could not be matched in NHMUK.

Crambidae, Nymphulinae

***Petrophila* unidentified sp. #1**. Oct. 2015. Plate 1, No. 6. This species could not be matched in NHMUK. At least four *Petrophila* spp. are known from Trinidad (MJWC unpublished). This species also occurs on Chacachacare Island (K. Sookdeo photo, 24.i.2015), but is not known from Trinidad (MJWC unpublished).

Erebidae, Eulepidotinae

***Ephyrodes cacata* Guenée.** Oct. 2015. Plate 1, No. 7. Identified by comparison with the NHMUK series. This species is known from Trinidad (Kaye & Lamont 1927), but not from Tobago (Cock 2017b).

Erebidae, Herminiinae

***Bleptina caradrinalis* Guenée.** Feb. 2014. Plate 1, No. 8. Identified by comparison with the NHMUK series. Recorded from Trinidad (Kaye & Lamont 1927) and Tobago (Cock 2017b), this species is common and widespread on both islands.

***Renia clavalis* Guenée**. Feb. 2014 and Oct. 2015. Plate 1, No. 9. Identified by comparison with the NHMUK series. Recorded from Trinidad (Kaye & Lamont 1927) and Tobago (Cock 2017b), this species is also common and widespread on both islands.

Erebidae, Hypocalinae

***Gabara bisinuata* (Hampson).** Oct. 2015. Plate 1, No. 10. Identified by comparison with the type (NHMUK). Recorded from Trinidad (Kaye & Lamont 1927) and Tobago (Cock 2017b), this species is common and widespread on both islands.

Erebidae, Scolecocampinae

***Pharga pholausalis* (Walker).** Oct. 2015. Plate 1, No. 11. Identified by comparison with the NHMUK series. Recorded from Trinidad (Kaye & Lamont 1927) and Tobago (Cock 2017b), this species is moderately common and widespread on both islands.

Erebidae, Arctiinae

Unidentified Lithosiini. Feb. 2014. Plate 1, No. 12. A plain white 'footman' probably representing a *Euthyone* sp. but could not be identified with confidence. There are three *Euthyone* spp. known from Trinidad (MJWC unpublished), but none from Tobago (Cock 2017b).

Erebidae, incertae sedis

***Orsa deleta* Hampson.** Feb. 2014. Plate 1, No. 13 This species was identified by comparison with the type, which is a male from Trinidad in the NHMUK. It is uncommon in Trinidad, with records from Curepe and Port of Spain (MJWC unpublished).

Gelechiidae, Dichromeridinae
***Trichotaphe* sp.** Feb. 2014. Plate 1, No. 14. This is not the same as the common *T. nessica* (Walsingham), which MJWC (unpublished) has recorded from both Trinidad (Brigand Hill, Curepe, St Benedicts, Simla) and Tobago (Cock 2017b).

Geometridae, Geometrinae
***Oospila confundaria* (Möschler)**. Oct. 2015. Plate 1, No. 15. Identified by comparison with the NHMUK series. Not previously recorded from Trinidad, although MJWC (unpublished) has records from Cumaca Road (0.5 milestone), Curepe and Point Gourde. Not recorded from Tobago (Cock 2017b).

Geometridae, Sterrhinae
***Idaea cellifimbria* (Prout).** Feb. 2014. Plate 1, No. 16. Cock (2017b) discusses the use of this name. It is a common and widespread species in Trinidad (MJWC unpublished) with records from Brigand Hill, Caparo, Curepe, Inniss Field, Parrylands, Point Gourde, St Benedict's. It is also known from Chacachacare Island (K. Sookdeo photos, 3♀ at light 24 Jan 2015) and Tobago (Cock 2017b).
***Idaea incanata* (Schaus).** Feb. 2014 and Oct. 2015. Plate 1, No. 17. Identified by comparison with the type from Peru in the USNM and the NHMUK series; the type is more heavily and clearly marked than Trinidad material. Although it has not previously been recorded from Trinidad, there are specimens from Caparo and Curepe (MJWC unpublished) and it is recorded from Tobago (Cock 2017b).
***Idaea rufarenaria* (Warren)**. Feb. 2014. Plate 1, No. 18. Identified by comparison with the ♂ type from French Guiana in USNM. It is quite common on Trinidad (MJWC unpublished) with records from Arima Valley, Curepe, Point Gourde, St. Benedicts. It is also found on Chacachacare Island (K. Sookdeo photos, at light, 24 Jan 2015), Caledonia, Five Islands (Cock 2017a) and Tobago (Cock 2017b).
***Idaea triangulata* (Warren)**. Oct. 2015. Plate 2, No. 19. Identified by comparison with the male and female types (USNM, French Guiana) and USNM series. It is widespread in Trinidad (MJWC unpublished) with records from Brigand Hill, Bush Bush, Manzanilla-Mayaro Road (milestone 46.5), and Parrylands, and also known from Tobago (Cock 2017b)
***Leptostales subrubella* (Warren)**. Feb. 2014. Plate 2, No. 20. Identified by comparison with the male type from French Guiana in the USNM. Although not previously recorded from Trinidad, MJWC has a specimen from Curepe and KS has photographed it at Penal.
***Scopula apparitaria* (Walker).** Feb. 2014. Plate 2, No. 21. Identified by comparison with the type from Honduras and NHMUK series. Although not previously recorded from Trinidad, there is material in the NHMUK from Ariapite [*sic*] Valley, Caparo and Tabaquite, in OUNHM from Caigual, MJWC has specimens from Curepe, and KS has photographed this species at Penal.
***Scopula* sp**. Feb. 2014. Plate 2, No. 22. Two specimens appear to represent a species similar to *S. apparitia* that is also found on Tobago (Cock 2017b). No matching material has been located in NHMUK or USNM.
Unidentified ?Sterrhinae sp. Feb. 2014. Plate 2, No. 23. A worn, obscurely marked dull green species could not be identified. It is not the superficially similar *Dithecodes deaurata* (Warren) which is known from Trinidad (Kaye & Lamont 1927).

Geometridae, Ennominae
***Psamatodes abydata* Guenée**. Feb. 2014. Plate 2, No. 24. Identified by comparison with the NHMUK series. This species was recorded from Trinidad by Kaye & Lamont (1927) misidentified as *Semiothisa confusaria* Walker. It is common in Trinidad and also recorded from Tobago (Cock 2017b).

Geometridae, Laurentiinae
***Dislisioprocta stellata* (Guenée)**. Feb. 2014. Plate 2, No. 25. Identified by comparison with the type and NHMUK series. Kaye and Lamont (1927) recorded this species from Trinidad (as *Camptogramma stellata*) and Cock (2017b) recorded it from Tobago.

Limacodidae
***Euprosterna elaea* (Druce)**. Oct. 2015. Plate 2, No. 26. Identified by comparison with the NHMUK series. Kaye and Lamont (1927) recorded this species from Trinidad and Cock (2017b) recorded it from Tobago.

Noctuidae, Acontiinae
***Chalenata mesonephele* Hampson**. Oct. 2015. Plate 2, No.27. Identified by comparison with type (NHMUK, Argentina) and NHMUK series. This species is also common in Trinidad (MJWC unpublished) with records from Curepe, Palmiste, and Valencia Forest, but not known from Tobago (Cock 2017b).

Noctuidae, Eustrotiinae
***Marimatha botyoides* (Guenée)**. Oct. 2015. Plate 2, No. 28. Identified by comparison with NHMUK series. This species is common and widespread in Trinidad (Kaye & Lamont 1927), but not known from Tobago (Cock 2017b).
Noctuidae, *incertae sedis*
***Melagramma* sp. ?nov. nr. *expetita* Walker**. Oct. 2015. Plate 2, No. 29. *Melagramma expetita* is the only described species of the genus. Trinidad specimens

represent a similar species, segregated as an un-named species in NHMUK and USNM. It is recorded from Trinidad as *M. expetita* (Kaye & Lamont 1927), also occurs on Chacachacare Island (K. Sookdeo photo, 2 Jan 2015), but has not been recorded from Tobago (Cock 2017b).

Notodontidae, Nystaleinae

***Nycterotis lucia* (Schaus).** Feb. 2014. Plate 2, No. 30. The commonest species. Identified by comparison with the male type from St Lucia in the USNM. This species has not previously been recorded from Trinidad, but there is a ♂ from Palmiste in UWIZM (29 Sep 1946), and MJWC has a male from Curepe (Apr 1982). In 1981 it was the commonest species found in the Five Islands (Cock 2017a). It has not been recorded from Tobago (Cock 2017b), but might well occur there.

Pyralidae, Chrysauginae

***Parachma* sp(p).** Feb. 2014. Plate 2, No. 31. One (or perhaps two) unidentified species could not be matched in NHMUK. This species also occurs on Chachacare Island (K. Sookdeo photo, 24 Jan 2015), but not on Trinidad, although two other species of *Parachma* do occur (MJWC unpublished).

***Xantippe olivalis* Dyar.** Feb. 2014. Plate 2, No. 32. Identified by comparison with the NHMUK series, but the type has not been examined, so this identification needs confirmation. Although it has not previously been recorded from Trinidad, there is a long series from the Arima Valley in the USNM (Feb. 1966, S.S. & W.D. Duckworth, as *Xantippe* sp.) and MJWC has specimens from Curepe and Simla.

Chrysauginae unidentified genus and sp. #1. Feb. 2014. Plate 2, No. 33. This species could not be matched in NHMUK. It has also been found at Brigand Hill, Trinidad (MJWC unpublished).

#Chrysauginae unidentified genus and sp. #5. Oct. 2015. Plate 2, No. 34. Another species that could not be matched in NHMUK.

***Galasa* sp.** or near. Feb. 2014 and Oct. 2015. Plate 2, No. 35.

Tineidae, Acrolophinae

***Acrolophus tretus* Kaye**. Feb. 2014. Plate 2, No. 36. This species was described from Trinidad (Kaye 1925). MJWC identified Trinidad material from the type illustrated in Kaye (1925).

Tortricidae, Tortricinae

***Platynota* sp**. Feb. 2014. Plate 2 No. 37. This species has not been found elsewhere in Trinidad and Tobago. MJWC's provisional allocation to this genus was confirmed by J.W. Brown (pers. comm.). It is not the common *P. rostrana* (Walker) which is widespread in Trinidad (MJWC unpublished).

The following species mentioned in the annotated list have not previously been reported from Trinidad:
Cossidae: *Gaviria* sp. unknown #1
Crambidae: *Aureopteryx argentistriata* (Hampson), *Schacontia nyx* Goldstein & Solis
Gelechiidae: *Trichotaphe nessica* (Walsingham)
Geometridae: *Oospila confundaria* (Möschler), *Idaea incanata* (Schaus), *Idaea rufarenaria* (Warren), *Idaea triangulata* (Warren), *Leptostales subrubella* (Warren), *Scopula apparitaria* (Walker)
Noctuidae: *Chalenata mesonephele* Hampson
Notodontidae: *Dasylophia lucia* Schaus
Pyralidae: *Xantippe olivalis* Dyar
Tortricidae: *Platynota rostrana* (Walker)

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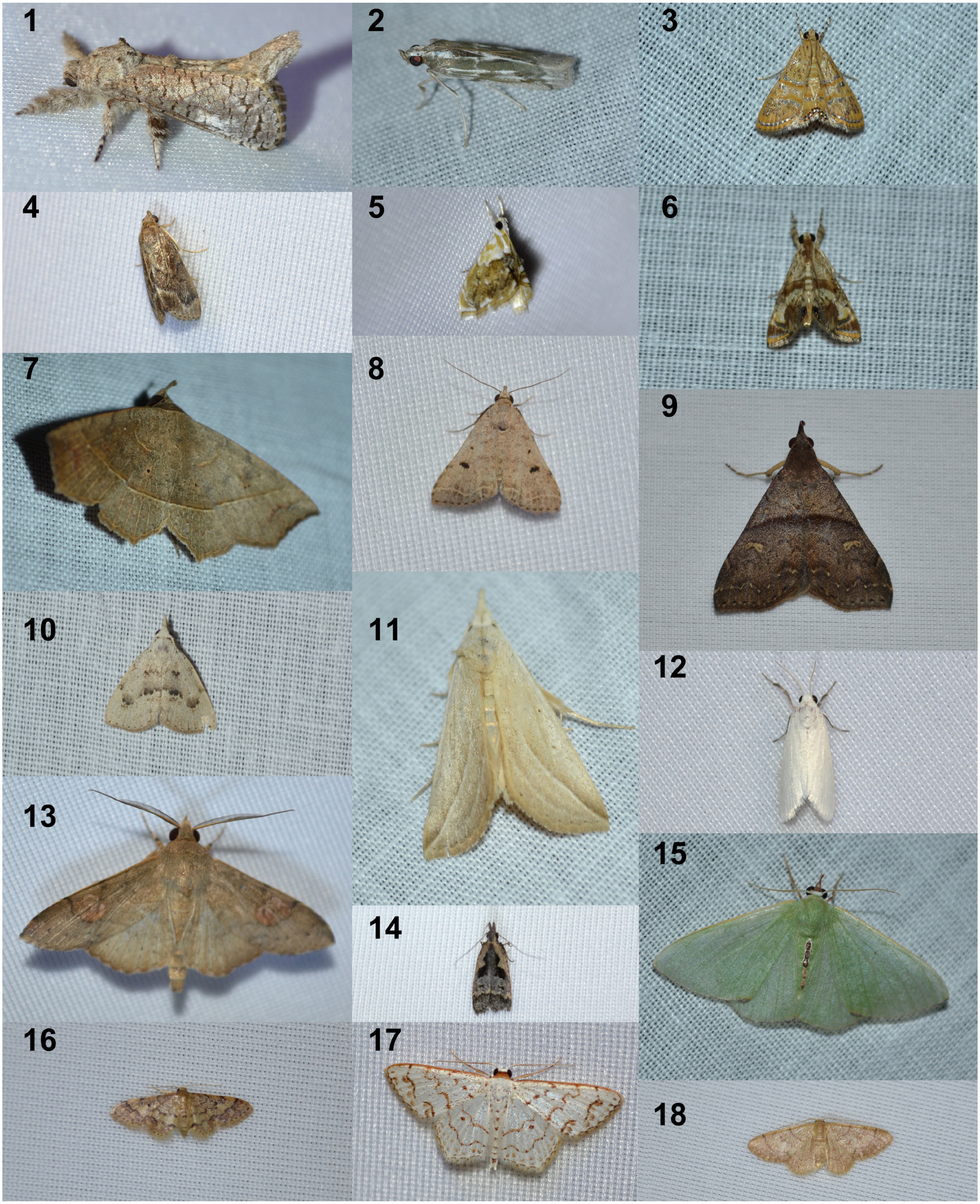

Plate 1 Moths of Huevos Part 1. See text for species names.

Plate 2 Moths of Huevos Part 2. See text for species names.

Urban Ant Fauna of Port of Spain, Trinidad, West Indies

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ABSTRACT

A one-day survey of ants in the city of Port of Spain yielded 154 samples representing 23 species. The greater part of these were found in two relatively well-vegetated areas. The pattern of samples gives a diversity index of H' = 2.39 and an estimate of the number of species present but not collected of f_0 = 5.3. The overall faunal composition was largely as expected, with no notable distinction between daytime and nighttime sampling except for the strictly nocturnal presence of *Camponotus atriceps.*

Key words: neotropical, diversity

INTRODUCTION

Habitat disturbance is well known to diminish species diversity, and urbanisation is the most severe of all very widespread forms of terrestrial disturbance. Ants (Hymenoptera: Formicidae) are a prominent feature in virtually all terrestrial habitats. With about 16,000 known species (Bolton *et al.* 2007) and an enormous density of individuals, they are a key ecological force (Hölldobler and Wilson 1990). 209 species are recorded from Trinidad, West Indies (Starr and Hook 2003), although the true total is certainly substantially higher. Although urban environments are certainly relatively poor in species of ants, no unitary trend has yet appeared in this trend (Philpott *et al.* 2010). Our purpose here is to report a preliminary survey of ants in a tropical city, with comments on the findings.

MATERIALS AND METHODS

All collecting was on 5 November 2016 in the city of Port of Spain, Trinidad & Tobago. Our focus was entirely urban and external, extending from the north end of the Queen's Park Savanna to the area in and around the Lapeyrouse Cemetery (10°40'N 61°31'W), disregarding the nearby Royal Botanic Garden and other garden-like localities. We collected about two-thirds of our samples in the morning between 08:00-12:00h, the rest in the early night between 18:30-20:00h.

Ants, like other social insects, occur in more or less discrete groups (colonies). Accordingly, our sampling and analysis were based on colonies, rather than individual organisms. We walked slowly while scanning the ground and tree trunks. On encountering ants, we collected one or a few apparent nestmates, after which we walked an estimated five meters further before resuming the search. This five-meter interval was to minimize the likelihood of taking to samples from a single colony.

We later sorted all samples into morphospecies, which we identified to genus and in a few cases to species by reference to Hölldobler and Wilson (1990) and other identification materials. Specimens are deposited in the University of the West Indies Zoology Museum Land Arthropod Collection (UWIZM).

RESULTS AND DISCUSSION

Our 154 samples represent 23 morphospecies (Table 1). The faunal composition contained no surprises, except perhaps for the paucity of *Pheidole*. Our comparison between the day and night fauna was far from rigorous. Nonetheless, it allows the rough generalisation that these are much the same except for the nocturnal habit of *Camponotus atriceps*.

Although there is no known way to predict the ant fauna of a disturbed habitat, the species richness in our samples was greater than expected. The Shannon diversity index (Magurran 2004) yields a moderately high figure of H' = 2.39. Eight of our morphospecies were represented by a single sample (singletons) and another six by two samples (doubletons). Applying the Chao1 method (Gotelli and Colwell 2011) estimates the number of undiscovered species at f_0 = 5.3. That is, it is estimated that by continuing our search method in the study area we would eventually reach a total of 28 or 29 morphospecies, about 13% of those known from the island.

It is plain that the two well-vegetated parts of our study area -the savannah and cemetery- contributed disproportionately to this diversity. The rest of the area was a wasteland with respect to ants, with a few samples of *Paratrechina* sp. A and almost nothing else. This is in line with the commonsense expectation that parks and similar features furnish the

Table 1. Samples of ants collected during a single day in Port of Spain, Trinidad. Each sample of one or more workers was collected at least five meters from any other. Further explanation in text.
+ = 1-4 samples during the period.
++ = 5 or more samples during the period.

	No. of samples	Day	Night
Dolichoderinae			
Azteca sp. A	5	++	
Azteca sp. B	2	+	
Azteca sp. C	4		+
Dolichoderus sp.	2	+	
Tapinoma sp. A	9	++	+
Tapinoma sp. B	2	+	
Ectatomminae			
Ectatomma ruidum	1	+	
Formicinae			
Camponotus atriceps	28		++
Paratrechina sp. A	37	++	++
Paratrechina sp. B	1		+
Myrmicinae			
Acromyrmex sp.	2	+	
Atta cephalotes	1	+	
Cephalotes atratus	17	++	+
Cephalotes sp. A	2	+	
Cephalotes sp. B	1		+
Pheidole sp.	1		+
Solenopsis sp. A	3	+	
Solenopsis sp. B	21	++	+
Solenopsis sp. C	2	+	
Tetramorium sp.	1	+	
Pseudomyrmecinae			
Pseudomrymex sp. A	10	++	+
Pseudomrymex sp. B	1	+	
Pseudomrymex sp. C	1	+	
Total	**154**		

greater part of the biodiversity of any city. Gardens (which we did not include) are presumably even more diverse on account of the intentional variety of plants.

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Nature Notes

New Localities for the Introduced *Anolis wattsi* (Squamata: Dactyloidae) on Trinidad, West Indies

The island of Trinidad in the Caribbean currently has one native Anolis lizard: *Anolis planiceps* Troschel 1848, a second suspected native species: *Anolis tigrinus* Peters 1863, and has had at least five introduced ones: *Anolis aeneus*, *Anolis extremus*, *Anolis sagrei*, *Anolis trinitatis* and *Anolis wattsi* (Murphy *et al.* 2017). The latter, *Anolis wattsi* (Boulenger 1894, Watt's Anole) (Fig. 1) is native to Antigua and is also distributed across Anguilla, St. Eustatius, St. Lucia, St. Martin, and Trinidad (Schwartz and Henderson 1991; White and Hailey 2006). Watt's Anoles spend much of their time on the ground and on the lower end of trees, and are typically active in the early morning when the temperature is cooler. They grow to about 58 mm snout to vent length. On Trinidad, individuals were first discovered in 1992 by G. White at the Caroni Research Station at Waterloo (Boos 1996). Field surveys conducted in 2000 and 2004 (White and Hailey 2006) showed the species to be spreading over an area of about 75 square km in west-central Trinidad. This report documents new localities for *A. wattsi* in southwest, northwest, and north-central Trinidad subsequent to the 2000 and 2004 surveys.

Watt's Anoles were observed at Reform Village, roughly 5 km east of San Fernando in 2009 (A. Hailey, personal communication). In 2014, A. Fifi observed a male and female individual near the University of Trinidad and Tobago building in Chaguaramas, and in 2015, individuals were observed at the seaward side of West Shore Hospital and the southern side of Wrightson Road at the junction of French Street and Wrightson Road, Port of Spain (H. Boos, personal communication). Also, in 2015, AF saw two adult pairs at the O'Meara Industrial Estate, in Arima. An adult was collected and catalogued at the University of the West Indies Zoology Museum St. Augustine Campus, Trinidad and Tobago (UWIZM.2016.4). Finally in 2017, R.J. Auguste saw a single individual at the University of the West Indies St. Augustine campus near cocoa trees in the leaf litter.

The new localities for *A. wattsi* are within urban developed areas, as previously documented by White and Hailey (2006). It is likely that the movement of these lizards is facilitated by human transportation. Competition with the native species (*A. planiceps*) is currently unlikely, as that species is restricted to forested areas in Trinidad (Murphy 1997; Murphy *et al.* 2017). However, it will be important to keep track of the distribution of *A. wattsi* in Trinidad, as White and Hailey (2006) suggested that it would be interesting to track the outward spread from its first known established location on the island.

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Fig. 1. Adult Male *Anolis wattsi.* Photo by A. Fifi.

First Record of the Dragonfly *Erythemis attala* (Selys in Sagra, 1857) (Odonata: Libellulida) for Trinidad, West Indies

Dragonflies are an ancient group of predatory arthropods belonging to the order Odonata, infraorder Anisoptera. They are almost exclusively carnivorous and can be observed in the field eating a wide variety of insects ranging from mosquitoes to butterflies, moths, damselflies and even smaller conspecifics. Adults are characterised by large multifaceted eyes, two pairs of strong transparent wings that are held horizontally both in flight and at rest, sometimes with coloured patches and an elongated body. About 3000 extant species are known (Zang 2011), with most found in tropical regions (Powell 1999). They can also be found at varying elevations ranging from sea level up to the mountains, however, there is a subsequent decrease in species diversity with altitude (Carchini *et al.* 2005). Dragonflies also inhabit every type of aquatic habitat, from the most pristine streams to swamps and even roadside ditches. Their sensitivity to habitat qualities such as water chemistry and their amphibious life cycle together with their relative ease of identification make dragonflies well suited for evaluating environmental changes (Kalkman *et. al.* 2010), and this together with other key features and attributes nominates them as excellent candidates to serve as biological indicators for the monitoring of ecosystem health and integrity.

On 20 August 2016 I was conducting a field survey of dragonflies in the Nariva Swamp as part of the FAO-GEF funded project *"Improving Forest and Protected Area Management in Trinidad and Tobago"*. As part of the project, baseline surveys are being conducted to identify and assess indicator species for future and ongoing monitoring in each of six proposed protected areas across Trinidad and Tobago. During a survey at the western edge of Nariva Swamp (10°27'34.7"N, 61°04'27.8"W), I photographed a female *Erythemis attala* (Selys in Sagra, 1857), darting back and forth over the edge of a stagnant body of water. At first glance it appeared to be *Erythemis plebeja* also known as the Pin-tailed Pondhawk, the closest resembling species in the genus. However, upon closer examination of the photograph this proved to not be the case as it had two distinctive white spots on the abdomen. Positive identification was subsequently sought by one of the world's pre-eminent odonatologists, Nick Donnelly, who confirmed the species. *E. attala,* also referred to as the Black Pondhawk, is an agile blackish species, with large blackish spots on base of hind wing and a body length of 42-44mm Needham *et al.* 1975. Their incessantly active species makes them difficult to collect. Its previously known range includes the West Indies as well as countries from Texas south to Argentina (Paulson 2012). In the West Indies these include countries primarily in the Greater Antilles: Cuba, Haiti, Jamaica, Martinique (Needham *et al.* 1975) as well the Dominican Republic. Its presence here in Trinidad therefore suggests that this species is dispersing and expanding its range within the West Indies. However, because it is also distributed throughout the South American continent, most notably Venezuela, whose fauna we share many similarities with, it might just be a case where this species always existed and went undiscovered due to the limited field work conducted on dragonflies as a whole, or when encountered in the field, mistaken for its relative, *E. plebeja.*

On a global basis, members of the genus *Erythemis* Hagen, 1861, are commonly known as Pondhawks and comprises ten species distributed in the Neotropical and Nearctic regions, which are found from sea level to 2300 meters above sea level. These medium- to large-sized skimmers are voracious predators of other insects up to their own size, including other dragonflies (Paulson 2009). Six species of this genus were previously recorded from Trinidad and Tobago as listed in the monograph, "The Dragonflies & Damselflies of Trinidad and Tobago" by John Michalski (2015) (See book review on page 71 of this issue). This new species record therefore brings the number of *Erythemis* species inhabiting the islands to seven, and drives up the total number of Odonata that inhabit the islands to 122.

It would be worthwhile to make a return trip to this location to conduct further surveys and get an estimate of population size and distribution within this Protected Area.

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Fig 1. Adult female *Erythemis attala* (Selys in Sagra, 1857) hovering over waterbody. (Tip of head to tip of abdomen approx. 72 mm in length).

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The Solitary Wasp *Trypoxylon albitarse* (Hymenoptera, Sphecidae) is Now in Tobago, West Indies

Three solitary wasp species are conspicuous in Trinidad on account of their free-standing mud nests, usually on buildings or other human-made structures. *Zeta argillaceum* (Olivier) (Vespidae), *Sceliphron fistularium* (Dahlbom) (Sphecidae) and *Trypoxylon albitarse* Fabr. (Crabronidae) are slim wasps of similar size (body length 17-24 mm). The first provisions its nests with caterpillars, while the others provision with spiders. Their nests can persist for years when under shelter and are all so distinctive that they can usually be recognised at a glance (Fig. 1).

In contrast to their abundance in Trinidad, none of the three species is recorded from nearby Tobago (Starr and Hook 2003, Hook and Starr 2006), despite focused search for the nests in suitable sites (Starr *et al.* 2015).

In September 2016 one of us (CKS) found several old nests and one active nest of *T. albitarse* in a roadside shed about two kilometers north of Roxborough, Tobago. A follow-up survey by RB in February 2017 revealed nests in the same locality and five others. Four of these latter were in the same general vicinity as the first, up to about two kilometers north of it. The last was about five kilometers yet further north, within about a kilometer of the island's north coast. Two of the sites were under concrete bridges, the other four on buildings. Present indications, then, are that Tobago is now home to at least one diffuse population of *T. albitarse*. As evidenced by the many emergence holes of adult offspring (Fig. 2), the population appears to be flourishing.

These nests are in rather puzzling sites. If the population was founded by a mated female flown or blown over from Trinidad, it would be expected toward the southwest end of the island or in the windward coastal zone, yet all localities are about 30 km from the nearest point to Trinidad and at least two km from the windward coast. No locality is in a place that seems likely to receive immigrants flying off of ships from Trinidad or elsewhere.

If *T. albitarse* continues to do well, we can expect it to disperse very gradually to other parts of Tobago, followed by rapid spread when it is established in an area with many human-made structures.

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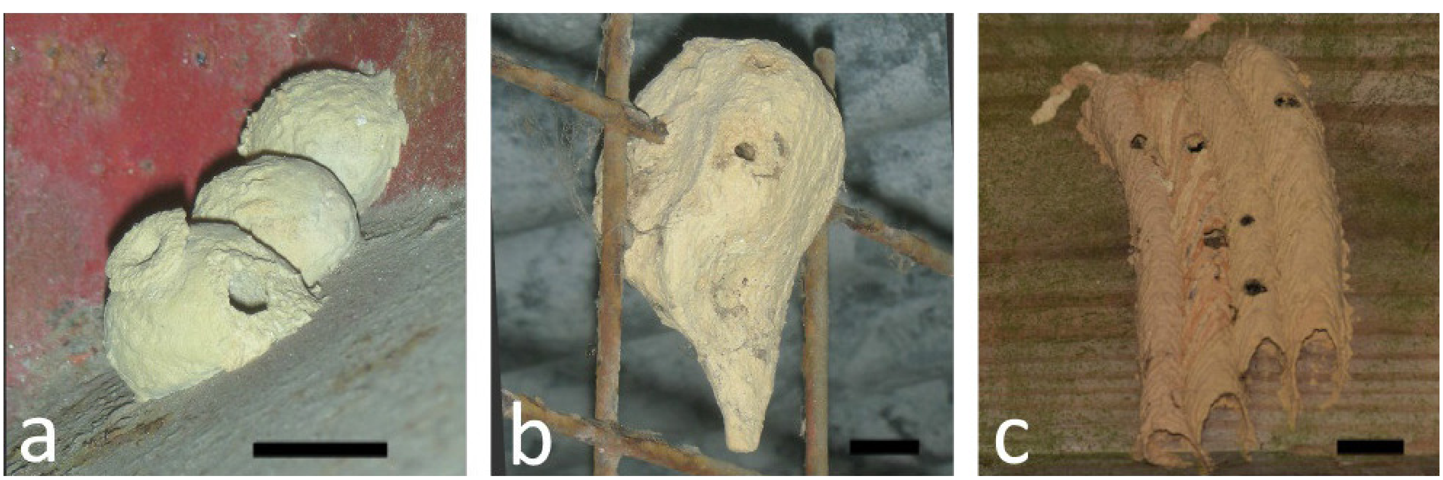

Fig. 1. Nests of three mud-nesting solitary wasps. a. *Zeta argillaceum*, Trinidad. Note emergence hole made by adult offspring in the side of the lower cell. b. *Sceliphron fistularium*, Trinidad. Note drip tip at the bottom, which presumably functions to drain rain water from the nest surface. c. *Trypoxylon albitarse*, Tobago. Scale bars = 1 cm.

Fig.2. A cluster of *T. albitarse* nests under a concrete bridge, showing abundant reproductive success. Each of the larger emergence holes (1) was made by an adult offspring of this species, while each of the smaller holes (2) indicates emergence of another wasp (*T. nitidum* F. Smith), which has reutilised a successful *T. albitarse* cell. In addition, some cells (3) show evidence of successful *T. albitarse* emergence followed by *T. nitidum* reutilisation that has not (yet) produced offspring. In all, 83 *T. albitarse* emergences are evident in this photo.

Sightings of *Trachemys scripta elegans* (Reptilia: Emydidae), a New Potential Aquatic Alien Invasive Species in Trinidad, West Indies

The first sightings of the Red eared pond slider *Trachemys scripta elegans* in Trinidad were documented by Mohammed *et al.* (2010). That data included sightings from 2000 to 2010, and anecdotal records from F. Lucas dating back to the late 1980's (Mohammed *et al.* 2010). Records from various independent baseline surveys by R.S. Mohammed and S.H.. Ali spanning 2005 to 2016 have now been collated to provide an updated account of the distribution. This species is aggressive, and competes both for food and basking resources with our native wild freshwater turtles (Cadi and Joly 2003) making this a potential aquatic alien invasive species. An Invasive Alien Species refers to a species or subspecies or lower taxon, introduced outside its natural past or present distribution; includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce; whose introduction and/or spread threatens ecosystems, habitat or species (UNEP, GEF, CABI, 2011).

The natural distribution of *T. scripta elegans* occurs within the Mississippi Valley, from northern Illinois to south of the Gulf of Mexico (Lever 2003) but this has now expanded to several temperate and tropical regions placing this species in the list of the world's 100 most invasive species published by the IUCN (Lowe *et al.* 2000).

Site records of *Trachemys scripta elegans* between January 2005 and January 2017 are presented in Table 1 and Figure 1.

A large majority of these individuals would have made their way to the wild either by escaping from their enclosures or by pet owners' intentional releasing of animals that they could no longer care for. It is clear the distributions of sightings are very similar to major residential areas which support the suspicion these populations originated from individuals that were released or accidental escapees. Whilst most of the sightings have been of less than ten adults (per occurrence) we assume there are breeding populations as a wide range of sizes are observed but not measured.

We also suspect the population range might be expanding, however this might be the early phases of the invasion as egg clutches have not been detected. This suspicion is solely on the increased numbers being found at some sites, whereas in the 2010 report (Mohammed *et al.*) only lone individuals were found. We also suggest there is need to keep an account of the sightings as well as evidence of nesting (eg.egg shells) or juveniles where the density seems high currently. They seem to be ubiquitous as we have noted them in earthen and concrete ponds and rivers with a wide range of riparian and aquatic vegetation types. We have not observed this species being preyed upon by

Table 1. Notes on escapees and site descriptions where specimens have been caught or observed.

Date	General location	Site #	Grid Reference	Site descriptions	Number of individuals	Maturity and sex	Occurrence
1-Jan-05	Moruga, pipe line	1	684206E, 1123943N.	Earthen pond	2	Adult	Sighting
1-Jan-05	La Fortune, Moruga	2	689514E, 1118477N.	Earthen pond	2	Adult	Sighting
1-Mar-05	Cacandee River	3	670952E, 1167455N.	River	1	Adult male	Caught
1-Jan-09	Salazar Road	4	648979E, 1121605N.	River	1	Adult	Sighting
1-Jan-09	Forest Reserve	5	651592E, 1118406N.	Earthen pond	2	Adults	Sighting
1-Apr-10	St. Augustine	6	675047E, 1176519N.	Concrete drainage pond	2	Adults	Sighting
1-May-10	Churchill Roosevelt Highway	7	668505E, 1176191N.	Alongside highway near swamp	1	Adult male	Caught
1-May-10	Bamboo grove	8	672394E, 1175759N.	Aquaculture pond	2	Adult male and female	Caught
1-Jun-11	Point a Pierre	9	671335E, 1141520N.	Earthen pond	<1	Adults	Sighting
13-Jan-17	Tunapuna	10	677720E, 1177651N.	Yard	1	Adult	Escapee
1-Apr-14	Aranguez	11	670445E, 1174834N.	Aranguez south road	2	Adults	Sighting
1-Jul-14	Point a Pierre	12	669604E, 1142268N.	Earthen ponds (Dam #3)	< 10	Adults	Sighting
7-Jul-05	Diego Martin	13	657021E, 1184921N.	Yard	1	Juvenile	Escapee
1-Apr-15	Princes Town	14	676360E, 1137302N.	Along dirt road, former cane field	1	Juvenile	Caught
1-Oct-15	Aranguez	15	670156E, 1177029N.	Aranguez River	1	Adult	Sighting
1-Apr-16	Point a Pierre	16	670125E, 1141969N.	Earthen pond	11	Adults	Sighting
1-Dec-16	Orange grove	17	677633E, 1175624N.	Irrigation agriculture ponds	< 10	Adults	Sighting
1-Jan-17	Trincity	18	680308E, 1175059N.	Drainage pond near mall	3	Adults	Sightings
1-Jan-17	Point a Pierre	12	669604E, 1142268N.	Earthen ponds (Dam #5)	5	Adults	Sightings

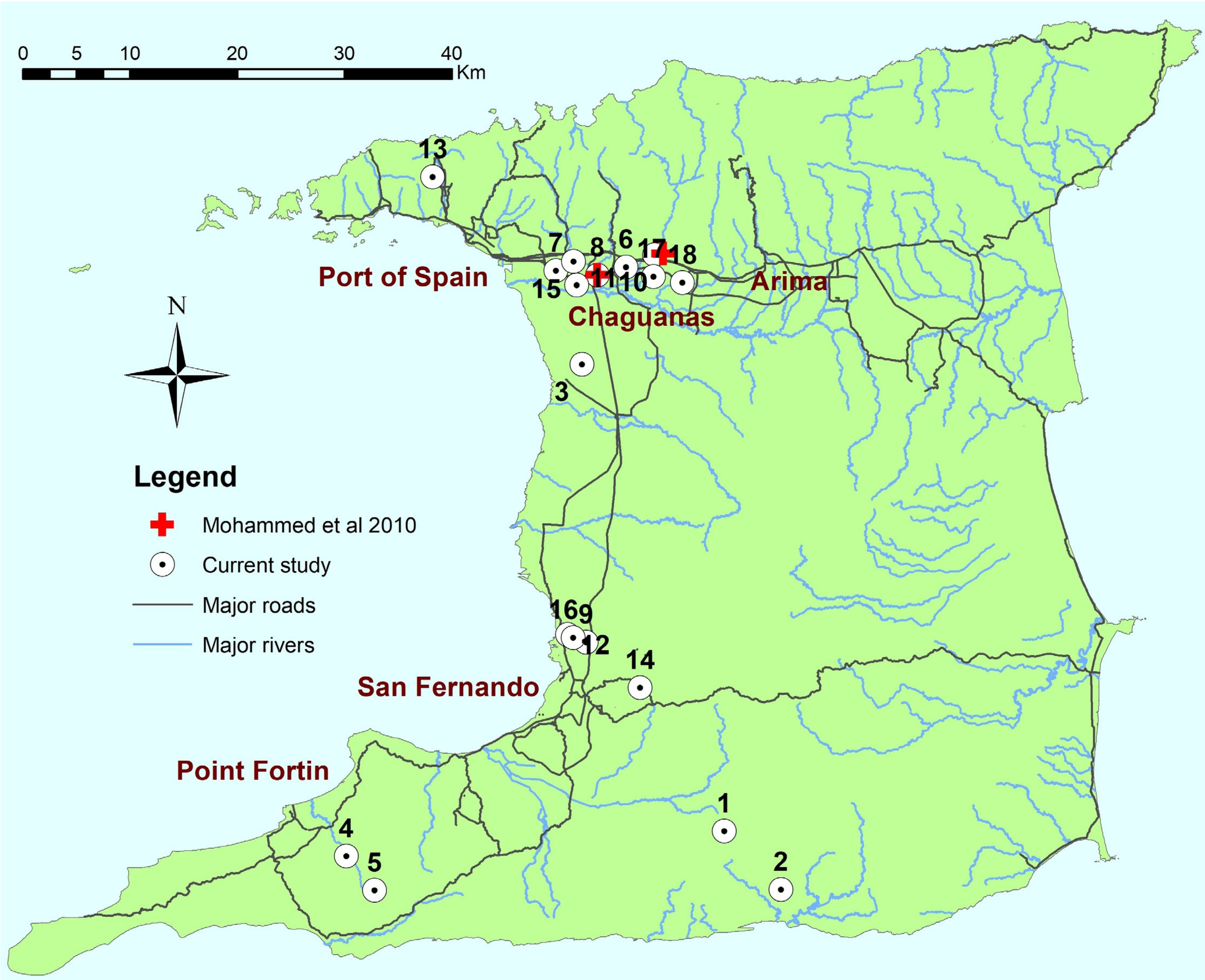

Fig.1. Occurrences of *Trachemys scripta elegans* between 2005 to 2017.

any other animals. They typically live approximately 30 to 40 years in nature (Cleiton and Giuliano-Caetano, 2008).

The authors would like to offer their assistance to owners who feel the need to dispose of their unwanted pets. However it is strongly advised that before pet owners decide to acquire any animal, that they consider the biological and ecological needs of that animal. This would include its dietary requirements, lifespan, territory ranges of the animal and suitable housing as these would reduce the incidences of both escapees as well as intentional releases. The carapace of *T. scripta elegans* can reach more than 40cm in length, but the average length ranges from 15 to 20 cm (Close and Seigel, 1997) and this should be considered as these are currently sold as juveniles (carapace length <4cm) without any regulation in Trinidad and Tobago.

Lastly, we would like to acknowledge Mr Graham White and Mr Renoir Auguste for informing us of sites where the species were likely to inhabit.

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Further Expansion of the Range of the Frog *Eleutherodactylus johnstonei* (Anura: Eleutherodactylidae) in Trinidad and Tobago, with a Note on Reproduction

The Lesser Antillean whistling frog *Eleutherodactylus johnstonei* (Fig. 1.) may have originated on Saint Lucia or one of the other Antillean islands (Hedges *et al*. 2010). It has expanded well beyond its original range, probably aided by human agency, to occupy most Caribbean islands, Bermuda and some of Central and South America. It is considered that the species' reproductive mode and habitat needs have helped its expansion. It is a direct developer, requiring no standing water, with eggs deposited in damp soil; females can produce clutches of up to 30 eggs as often as four times a year; the frogs are small (males up to 25mm long, females 35mm) and cryptically coloured (Bourne 1997); they thrive in human-disturbed habitats such as gardens and waste ground. All these factors would aid dispersal through trade in plants and plant produce.

Kenny (1979) was first to report *E. johnstonei* (as *E. martinicensis*) from Trinidad, around the docks of Port of Spain, the species not having been found for his 1969 account of Trinidad's amphibians (NB this report is mis-cited as Kenny 1980 in Kaiser 1997). Kaiser (1997) and Murphy (1997) both report *E. johnstonei* , still apparently restricted to the dockland area of Port of Spain (Kaiser's personal observations were made in 1992). However, one of us (JRD, previously unpublished field notes) noted the presence of many *E. johnstonei* calling from a wasteland site close to the junction of the Priority Bus Route and the Lady Young Road on the outskirts of eastern Port of Spain in July 1996; this population was noted again in 1998 and 2000, and a further population recorded from gardens in Diego Martin in 1998. Since Kaiser does not state how extensively he searched for *E. johnstonei* around Port of Spain in 1992, we cannot determine how soon these frogs dispersed from the dockland area, but they had clearly expanded beyond it by 1996.

In 2011, Manickchan *et al.,* based on fieldwork from 2000 until 2002, and then October 2009 to February 2011, reported a considerable expansion of *E. johnstonei*: the frog could now be found along Trinidad's northern east-west corridor from Chaguaramas to La Horquetta. Manickchan *et al.* surveyed very extensively along Trinidad's roads at night, listening for *E. johnstonei*'s distinctive call, so we can be reasonably sure that their work defined the frog's dispersal up to 2011. In addition, White (2013) reported the occurrence of a small number of *E. johnstonei* from the grounds of the Magdalena Hotel in southern Tobago in November 2012.

Fig 1. *Eleutherodactylus johnstonei* photographed at Surrey Village, Lopinot Rd. February 2013.

While carrying out night-time audio monitoring in 2013-16 along the Trinidad road network for the Trinidad and Tobago endemic frog *Pristimantis urichi*, two of us (JRD, MSG) were able to listen out for *E. johnstonei.* We never found these two species in the same locations. *P. urichi* was restricted to relatively undisturbed forest areas (work in progress), while *E. johnstonei* occurred only in gardens and other disturbed areas in towns and villages. We found *E. johnstonei* well beyond the localities reported by Manickchan *et al*.(2011); see Table 1. *E. johnstonei* occurred east to Sangre Grande and south beyond the Mount Harris forest to Cushe; in central Trinidad, we heard the frog at Piarco Airport and south of Piarco at Carapo; in west Trinidad, along the Southern Main Road, there are extensive populations from Chaguanas south to California. In addition, White (pers.comm.) reported to us a 2013 record from Surrey Village. In Tobago, one of us (RJA) heard *E. johnstonei* near Parlatuvier in June 2016 and at Speyside in August 2016 (Table 1).

We cannot tell when these new localities were reached by *E. johnstonei* , nor how well established and numerous these populations are, though at some locations in Trinidad, we heard the frogs in more than one year. We also do not know how these frogs disperse. As small frogs, with preference for a particular and discontinuous habitat, their ability to disperse on their own may be limited. However, both Kenny (1979) and White (2013) suggest that dispersal may occur via the transportation of plants. This certainly appears the most likely explanation for *E. johnstonei* reaching Cushe, which is separated by an extensive forest from the next nearest population at Sangre Grande, and what appears to be a rapid expansion in Tobago.

Table 1 New *Eleutherodactylus johnstonei* sites in Trinidad and Tobago

Location	GPS recording	Date[1]
Trinidad		
Cushe	10.384700, 61.178033	June 2016
California/Couva	10.419850, 61.471000	July 2013, 2016
Piarco carpark	10.602230, 61.337767	July 2013-16
UWI grounds	10.644295, 61.400205	July 2013-16
Sellier Street, St Augustine	10.649542, 61.407203	July 2014-16
Lady Young Road/ EMR	10.648037, 61.469762	June-August 1996-2000
Carapo	10.589800, 61.322767	July 2016
Arouca (EMR east of Lopinot Rd.)	not recorded	June 2016
Surrey Village (Lopinot Rd.)	10.65657, 61.32881	February 2013
Sangre Grande bus station	10.585980, 61.131255	July 2014-16
Sangre Grande, Fishing Pond Rd.	10.584012, 61.123483	July 2016
St. Ann's valley	not recorded	July 2013
Tobago		
Speyside	11.297640, 60.649670	August 2016
Parlatuvier	11.302866, 60.533145	June 2016

[1] The dates given are when we heard calling; since we did not search systematically at all sites each year, we cannot tell when *E. johnstonei* first arrived at these sites.

Our observations show that *E. johnstonei* is continuing its colonization of Trinidad and Tobago, and accord with Manickchan and others' conclusion that, although this frog is an invasive species, it is unlikely to pose a threat to Trinidad's other amphibians. Although some of the native species, such as *Rhinella marina,* occur in the disturbed habitats preferred by *E. johnstonei*, their main distribution tends to be in the less disturbed habitats. One caveat is that alien species can sometimes adapt in unexpected ways to their new surroundings and then begin to threaten native species, a key amphibian example being the cane toad in Australia (Kosmala *et al*. 2017).

Bourne (1997, 1998) reported on reproduction of *E. johnstonei* in Guyana. He found that each male sired 3.3 +/-1.2 clutches and each female laid 4.3+/-2.1 clutches per annum; clutches contained 14.6 +/-6 eggs and hatched directly into froglets after 13.2 +/-2.1 days. Bourne also found that either the male or the female provided parental care, but not both, and that care, which persisted several days beyond hatching, significantly reduced mortality of eggs and embryos.

Fig. 2 Photo of clutch/parents (Photo by P.A. Geerah)

Reproduction of *E. johnstonei* in Trinidad and Tobago has not previously been reported. On 2 March 2014, still during the dry season, a clutch of 15 eggs with two adults in attendance, presumably just laid, was discovered on the surface of damp soil under a flower pot in a garden in Diego Martin, Trinidad (Fig.2.). Two of us (RJA,PAG) followed the development of the clutch and the behaviour of the frogs. No adults were seen on 4, 6, 9 and 11 March; over this period, two eggs were lost to ants. On 13 March, one adult was seen attending the remaining 13 eggs. No adults were seen on 14 and 16 March and three more eggs were lost to ants. On 19 March, the remaining eggs were found to have hatched, with seven froglets visible, five remaining by the empty eggs capsules and two others at a short distance away; no adult was present. On 21 March, three froglets remained at the nest site, but they were gone by 23 March. Our patchy observations of parental attendance may have been caused by disturbance. In general, our observations accord with those of Bourne (1997, 1998) but with a slightly longer incubation time of 17 days.

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An Updated Distribution of the Frog *Adenomera* cf *hylaedactla* (Anura: Leptodactylidae) on Trinidad, West Indies

Murphy and Downie (2012) noted that there is a growing list of cryptic species being discovered in Trinidad and Tobago. The genus *Adenomera* consists of dull-coloured, small-sized frogs that typically display characteristics of a group rich in cryptic species (Angulo *et al*. 2003). Indeed, the systematics of frogs of the genus *Adenomera* have puzzled amphibian systematists for decades (Heyer 1973; Duellman 2005). New *Adenomera* species have recently been described (Carvalho and Giaretta 2013), and there are a number of other species awaiting formal description across South America (Foquet *et al*. 2014).

In Trinidad, *Adenomera hylaedactyla* was previously only known from the southwestern peninsular (Murphy. 1997), and a thriving population was observed during a recent trip in 2017 by the author. However, during the period of 2014 to 2017, the author and others (J. Murphy, R. Downie and R. Deo) have observed *Adenomera* cf *hylaedactyla* to be far more widespread. Records span from Port of Spain in the north-west, Aripo Savannas (Auguste *et al.* 2015) and Arena Forest in north-central Trinidad, Matura in the north-east, Nariva Swamp and near Trinity Hills in the south-east; and at Freeport, west central Trinidad. It is not known whether populations are well established at each of these localities as only single individuals were visually observed. However, there is no reason to doubt that the species has become established. Given the new found locally widespread distribution in Trinidad and the current taxonomic uncertainty of the genus as a whole, it is worth future investigation of the various populations in Trinidad to determine precisely which and how many species are present.

Adenomera hylaedactyla (= *Leptodactylus hylaedactylus*) was described by Cope (1868) "from the Napo or Upper Maranon". AmphibiaWeb (2017) gives the following general description of its morphology: Males are 22-24 mm, and females are 26-27 mm, snout to vent length (SVL). The dorsum consists of scattered dark markings on a brown background. There are two distinct glandular dorsolateral folds on either side of the body. The distance between each eye to the snout is about one and a half times the diameter of the eye. The ventral surface, including the belly and throat are white. The iris is bronze.

Adenomera cf *hylaedactyla* occurs throughout South America, including Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Paraguay, Peru, Suriname, Venezuela (AmphibiaWeb 2017), and also on Trinidad (Murphy 1997). *Adenomera* cf *hylaedactyla* from Trinidad is illustrated in Figure. 1.

In Trinidad, *Adenomera* cf *hylaedactyla* can be distinguished from the similar *Leptodactylus* species by size, the relative lengths of the first and second finger and by the shape of the dorsal markings. *Leptodactylus validus* males are 42 mm and females 50 mm SVL and *L. fuscus* males are 42 mm and females 50 mm SVL. The first finger of *Adenomera hylaedactlyla* is shorter than the second finger, while for all *Leptodactylus* spp. recorded in Trinidad, the first finger is longer than the second (Murphy 1997). The dorsal markings of *A.* cf *hylaedactyla* include two dark triangles along the vertebral line; one on the head, the base of which connects the two orbital sockets and the apex of which points posteriorly, and a second with an anterior pointing apex in loose contact with the first. In contrast, any dorsal markings on the two mentioned *Leptodactylus* spp. are irregular (with *L. validus* only occasionally having indistinct irregular dorsal markings, and more often not having much in the way of distinct dorsal markings).

Little is known about the natural history of *Adenomera* cf *hylaedactyla* in Trinidad but the natural history of *Adenomera* species have been well documented in South America (Almeida and Angulo 2006) and it is likely that the species in Trinidad may exhibit similar attributes to that described for the genus in Venezuela. Leaf litter has been reported as the most common microhabitat for *Adenomera* species (Borges-Leite *et al*. 2015), but Heyer (1977), referring specifically to *A. hylaedactyla* suggested that they inhabit open grassy areas. The individuals observed at Matura, Aripo Savannas, Arena Forest, Freeport and Nariva Swamp were found in a leaf-litter microhabitat, and the individuals the author saw at Port-of-Spain and near Trinity Hills were in a grassy habitat. All of the individuals observed by the author and others in Trinidad have been during the wet season (June to December).

Given the current lack of natural history data for this species on Trinidad, including recordings of its call, the author encourages additional surveys and ecological observations, in conjunction with DNA tests to further clarify the taxonomic uncertainty.

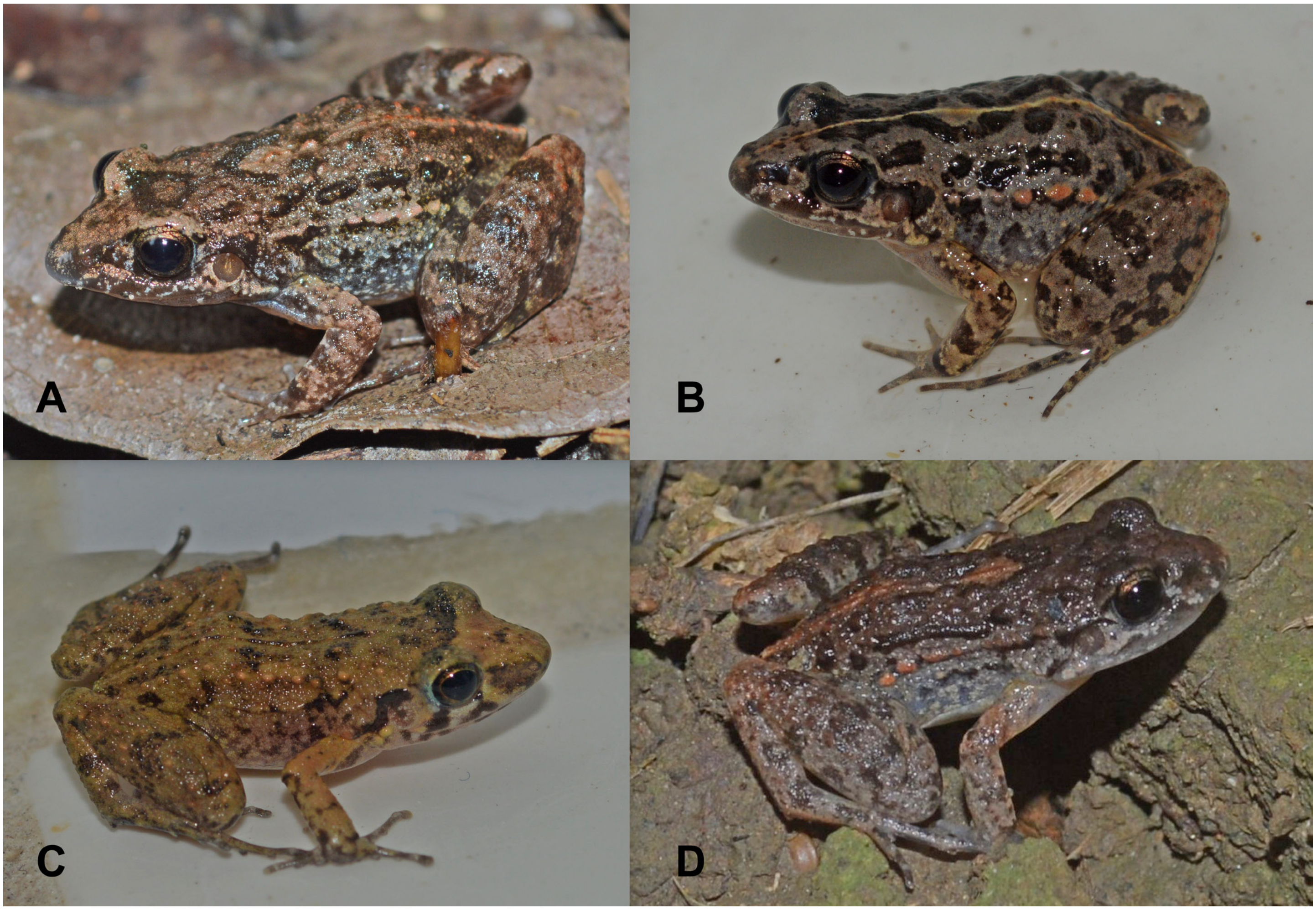

Fig. 1. *Adenomera* cf *hylaedactyla* from Trinidad. A and B- Nariva Swamp, C- Port-of-Spain, D- Trinity Hills. Individuals were identified by the author based on visual observations of their morphology as noted in Murphy *et al*. (2017).

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Fourteenth Report of the Trinidad and Tobago Birds Status and Distribution Committee Records Submitted during 2016

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INTRODUCTION

The abundance and status of most of our bird species, especially the common ones, are well known and described in the available guides (ffrench, 2012; Kenefick *et al.* 2012). Our knowledge of the rarer species is less complete. Rare species comprise 45% of our bird species richness, and since they are rare, years of accumulated records are needed to assess status or changes in abundance. Without formal review and archiving, records would be haphazard and confidence low, making trends difficult to detect or interpret. The Trinidad and Tobago Rare Birds Committee 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. Now re-named the Birds Status and Distribution Committee, we have assessed all records submitted during 2016. In all 129 records were adjudged, representing 67 different species. This is the highest total of sightings submitted since the formation of the Committee and illustrates the growth and popularity of birdwatching nationally. Of the submissions assessed, in only four cases did the Committee deem the identification inconclusive. A major review of the systematic order of species was undertaken during 2016 by the South American Classification Committee and the records presented below follow the revised nomenclature and taxonomic order as at November 2016.

The Committee comprises the following members: Martyn Kenefick (Secretary), Geoffrey Gomes, Floyd Hayes, Nigel Lallsingh, Bill Murphy, Kris Sookdeo and Graham White. Floyd tended his resignation from the Committee during the year, having been a founder member. We wish to acknowledge both his contribution and expertise and thank him for his sterling work over the last 21 years. There are instances where we need supporting international expert knowledge to assist us with identification. We wish to acknowledge the valuable assistance provided by James Smith (USA), David Cooper, Richard Fairbank and Robin Restall (UK) during 2016.

Archived records including photographic submissions number 1,346 at the end of 2016. . Previous reports of this committee were prepared by Hayes and White, (2000); White and Hayes (2002) and Kenefick (2005, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016).

The Official List of the Birds of Trinidad and Tobago, the list of species considered by the TTBSDC (TTRBC) and details of all records accepted by the Committee can be accessed, from our website at http://rbc.ttfnc.org. We urge finders to document and report their sightings to us.

During 2016, Eurasian Wigeon, Slender-billed Kite and Audouin's Gull were accepted as new species for the country. However following an in-depth review, the South American Classification Committee has re-assessed Caribbean Coot, *F. caribea* as being conspecific with American Coot, *F. americana.* As a consequence the Official List total now stands at 482.

RECORDS ACCEPTED

A flock of nine **White-faced Whistling-Duck, *Dendrocygna viduata*** were photographed in Caroni Rice Project on 30 May 2016 (CC). Several remained throughout the summer months with two still present until 2 October. These wanderers from mainland South America occur in Trinidad almost annually between mid May – mid October.

Two **American Wigeon, *Anas americana*,** which were first found on 27 November 2015 (see Kenefick 2016) were still present at Bon Accord sewage ponds, Tobago until at least 16 January 2016 (many observers).

An immature/female plumaged **Northern Shoveler, *Anas clypeata*** was photographed amongst a feeding group of Blue-winged Teal at Icacos on 24 October 2015 (DH). This is the second documented sighting of this winter visitor from continental North America in the last 22 years.

A sub-adult male **Eurasian Wigeon, *Anas penelope*** was found at Bon Accord sewage ponds, Tobago on 2 January 2016 in the company of both American Wigeon mentioned above (see plate). It remained until 16 January at least (TJ *et al.*).This constitutes the first record for Trinidad and Tobago of this predominantly old world duck. However in recent years, it has become much more regularly found along the north-west coast of continental North America.

A female, or immature, plumaged **Green-winged Teal, *Anas crecca*** was photographed at Bon Accord sewage ponds, Tobago on 2 January 2016 (TJ *et al.*). There have now been six documented sightings of this species in the last 22 years. Its similarity in this plumage from the more common migrant Blue-winged Teal may have masked its true abundance.

A pair of **Ring-necked Duck, *Aythya collaris*** were found on Canaan sewage ponds, Tobago on 30 November 2016 (MKe). Whilst still a rare winter visitor from continental North America, this species has now been found in ten of the last 22 years, all sightings from south-west Tobago.

A drake **Lesser Scaup; *Aythya affinis*** was found on 23 December 2016 at Bon Accord sewage ponds, Tobago and remained until the year end. (MKe, JR, SPo). In the last 22 years, 20 of these migrant ducks have been found between November-February and all but two from Tobago

Three adult **American Flamingo, *Phoenicopterus ruber*** were photographed on the tidal mudflats at Orange Valley on 29 March 2016. One was seen intermittently until 8 August at least (JF,NL). This species is hard to overlook and this is the first documented sighting in the last three years.

Blue Ground Dove, *Claravis pretiosa* is one of our rarest resident species. Three or four males were seen and heard calling in the Granville area on 17 February 2016 (SP). Elsewhere, a male was found along Caltoo trace, Plum Mitan on 17 July (LJ,KM) and seen by many observers. It is a testament to their shy and elusive behaviour that these are the first documented sightings for five years and only the sixth in the last 22 years.

A moulting male **Amethyst Woodstar, *Calliphlox amethystine*** was photographed at Yerette, Maracas St Joseph on 26 July 2016, and present briefly the following morning (TF). A species first recorded in Trinidad and Tobago in 2015, we have now documented four birds all during the period late May – late July.

The fresh corpse of a **Paint-billed Crake, *Mustelirallus erythrops*** was found at Palmiste on 30 June 2016 (JW). This species remains an extremely rare wanderer from mainland South America and this occurrence is the first for six years. Almost all records are from late June – mid September.

The two **American Coot, *Fulica americana,*** which were first found at Bon Accord sewage ponds, Tobago in November 2015 (see Kenefick 2016) remained in the area until at least 15 March 2016 (many observers).

Two **Double-striped Thick-Knee, *Burhinus bistriatus*** were found just before sunrise at Caroni Rice Project on 7 July 2016 (NL). Of the 13 birds documented in the last 22 years, of this crepuscular species, all but two have occurred between 7 July – 2 September.

A **Marbled Godwit, *Limosa fedoa*** was photographed on the tidal mudflats at Brickfield on 25 March 2016 and was seen for a further four days at least (NL). Sightings of this migrant shorebird have become increasingly scarce. Indeed this was the first documented record for eight years.

An immature male **Ruff, *Calidris pugnax*** was found on the Trincity river on 21 November 2016 (MK) and remained until 28 November at least (see plate). This remains an extremely rare wanderer to Trinidad and Tobago from Eurasia and is only the second documented sighting in the last 10 years.

An immature **Curlew Sandpiper, *Calidris ferruginea*** was photographed on the tidal mudflats at Brickfield on 18 September 2016, and remained present until 21 September at least (JF,NL) (see plate). This is just the second documented sighting of this migrant Eurasian shorebird, the previous being an adult found in May 2002.

A juvenile **Pomarine Jaegar, *Stercorarius pomarinus*** was carefully studied flying close to the coast of south-west Tobago on 27 December 2015. The waters between St Lucia and St Vincent are a common wintering ground for this species, yet there have been just seven documented sightings in the last 22 years, most during January to March.

Two winter-plumaged **Black-headed Gulls, *Chroicocephalus ridibundus*** were found in Tobago on 16 February 2016. One at Milford Bay (MKe) and one further north at Castara (GW). This species is a rare winter migrant from the north with 16 documented sightings in the last 16 years.

Once considered a major rarity, we now understand **Franklin's Gull, *Leucophaeus pipixcan*** to be a scarce but regular winter visitor to the west coast of Trinidad. However it's close resemblance to the ever present Laughing Gulls continue to mask their true abundance. Up to six birds, an adult and five in first-winter plumage were present at the beginning of the year commuting between Brickfield and Orange Valley (NL *et al.*) with. at least one remaining until 23 April. During the second winter period, at Brickfields, an adult was found on 27 November (NL) and a first-winter plumaged bird on 4 December (MK). Both birds remained until the year end.

An immature **Audouin's Gull, *Ichthyaetus audouini*** moulting from first-winter to first-summer plumage was well documented and photographed on 10 December 2016 amongst the Laughing Gulls at the high tide roost at Brickfield (NL) (see plate). This is not only the first documented record for Trinidad and Tobago, it is also the first ever sighting for "the Americas". Its breeding range is restricted to the Mediterranean basin and winters along coastal north-west and west Africa

A first-winter plumaged **Ring-billed Gull, *Larus delawarensis*** was found at the Brickfield high tide roost on 25 November 2016 (NL). Over the course of the next two weeks, two more were seen, an adult and a first-summer plumaged bird (MK, GW). Once almost annual, these are the first documented records for five years.

A first-winter plumaged **Lesser Black-backed Gull, *Larus fuscus*** was photographed amongst the fishing boats moored beside Milford Bay, Tobago on 30 November 2016 (MKe). Single birds have been found in three of the last four years at this site. Interestingly, all were in first-winter plumage.

An immature **Wood Stork, *Mycteria americana*** was found feeding in a shallow lagoon at Fullerton on 17 April 2016 (FO *et al*.). It remained in the area until 19 April at least. Despite five birds being documented in 2015 (see Kenefick 2016) this is still a rare wanderer from mainland South America with only two other sightings in the last 22 years.

Gray Heron, ***Ardea cinerea*,** was once considered an extreme rarity in Trinidad and Tobago. However in recent years, documented records of this species have become much more frequent with eight sightings in the last five years. During 2016, an adult was found at Bon Accord sewage ponds, Tobago on 27 January (BM *et al*.); and immatures were photographed at Brickfield on 18 December (NL) and again at Bon Accord on 28 December (MKe). Both of these latter birds remained until the years end at least. Whilst adult *ardea* herons are straightforward to identify, immature birds can be frustratingly similar. The situation is further compounded as Trinidad and Tobago is probably the only country in the world where all three "gray *ardea* herons" can realistically be found.

The dark morph **Western Reef-Heron; *Egretta gularis*** first found at Bon Accord, Tobago in December 2014 and seen intermittently throughout 2015 (see Kenefick 2016) was last reported from Lowlands, Tobago on 17 February 2016 (GW).

The **Little Egret, *Egretta garzetta*** first found on 9 December 2015 at Bon Accord (see Kenefick 2016) remained until 21 April 2016 at least. Another remained loyal to a stretch of the Trincity river on 19 September 2016 (MK et al). It was joined by a second bird on 12 December with both remaining until the years end. Back in Tobago, another bird was photographed at Lowlands on 30 November (MKe), before moving to Canaan sewage lagoons on 28 December. The status of this species in Trinidad and Tobago fluctuates dramatically. Several birds were almost ever present between 1995-2001. There followed an absence for 11 years. However there have now been nine documented sightings in the last four years

The two **Glossy Ibis, *Plegadis falcinellus*** seen at Bon Accord, Tobago on 27 November 2015 (see Kenefick 2016) remained in the area throughout the year. Additionally an adult was photographed at Lowlands, Tobago on 15 March 2016 (MKe). On Trinidad, a flock of 18 birds were seen flying over Rahamut Trace, South Oropouche on 9 January 2016 (KA,WR). This is the largest group documented for the islands. Finally on 2 July 2016, three birds were photographed at Caroni Rice Project (LJ).

Despite its abundance in Trinidad, **Black Vulture, *Coragyps atratus*** is an extremely rare sight in Tobago. One seen soaring over St Giles rocks on 5 December 2014 (KP) is just the third documented sighting in the last 22 years.

A **White-tailed Kite, *Elanus leucurus*** was seen and heard flying over the mangrove at Carli Bay on 10 November 2016 (NL). Whilst this species is widespread in Venezuela, this is the first documented record for at least 25 years.

An adult **Black-collared Hawk, *Busarellus nigricollis*** was photographed perched beside Cocos Bay Road, adjacent to Nariva Swamp on 31 December 2015 (AB, MR). This species is not uncommon in similar habitat along the coasts of mainland South America adjacent to Trinidad, but this is the first documented sighting from Nariva Swamp since 1998.

A male **Snail Kite, *Rostrhamus sociabilis*** was first observed just east of Southern Main Road, Caroni on 24 March 2016 (GW) (see plate). Subsequent visits to the area yielded a second male and a female which were regularly seen until the end of April. One male then moved to Caroni Rice Project where it was intermittently seen by many observers until at least 11 August 2016.

An adult **Slender-billed Kite, *Helicolestes hamatus*** was photographed soaring over Los Blanquizales swamp on 5 March 2016 (RG) (see plate). This constitutes the first documented record in Trinidad and Tobago of this wanderer from mainland South America.

An adult **White-tailed Hawk, *Geranoaetus albicaudatus*** was photographed close to Kernaham settlement on 1 October 2016 (KM). This is the fourth documented sighting of this species in the last eight years and all from the same general area. It is conceivable that the same individual is involved, hunting over this vast area of marshland

Aplomado Falcon, *Falco femoralis* is no longer the rarity it once was. There has, in recent years, been a change in their status and distribution in Trinidad. A total of eight birds were photographed and reported during 2016 as follows :- an adult at Aripo Livestock Station 31 December 2015 (TJ,EH); an adult at Caltoo trace 6 February 2016 (KM); an adult flying over Rochard Rd, Penal on 4 April 2016 (NH); three immatures together at Cedros on 20 August 2016 (JF); an adult at Sudama Steps on 27 August 2016 (SB) and an immature over Orange Grove on 17 November 2016 (SB). Historically these falcons arrived in Trinidad to prey upon the shorebird passage during July-October, indeed some 55% of all records still support this trend. However the species has now been documented in every month of the year except May.

For the third year running, a pair of **Brown-throated Parakeet, *Eupsittula pertinax*** have been seen entering and exiting a hole in a termite nest close to the Aripo savannah (see Kenefick 2015,2016) (many observers). The small population residing near Princes Town (see Kenefick 2016) increased to at least 17 birds on 6 August 2016 (RG). Successful breeding is yet to be proven.

Further sightings of **White-eyed Parakeet, *Psittacara leucophthalmus*** comtinued through Trinidad during 2016. A feeding group of five were found in Arouca on 31 January (BM) and a single bird was photographed at la Brea on 17 December (RG). The feral flock in St Anns, POS was regularly reported throughout the year (many observers).

Despite being an abundant Trinidad resident, the occurrence of **Great Kiskadee; *Pitangus sulphuratus*** in Tobago is exceptional. One found on the outskirts of Scarborough on 15 March 2016 (MKe) may have journeyed by ferry.

Three **Caribbean Martins, *Progne dominicensis*** were photographed soaring over El Tucuche on 21 February 2016 (FO) and a single male at L'Anse Noir on 6 March 2016 (GW). Whilst an abundant breeding visitor to Tobago, this remains a rare passage migrant through Trinidad with just five documented sightings in the last 21 years. The whereabouts of their wintering grounds remains largely unknown. Almost all have left Tobago and islands to the north in their thousands by the end of October, returning early February. However there are very few sightings in Venezuela, Guyana and Brazil.

A **Bank Swallow; *Riparia riparia*** was seen feeding at the Bon Accord sewage ponds, Tobago on 2 January 2016 (TJ *et al.*), and continued to be seen until 4 January at least. Whilst a regularly seen migrant over Trinidad wetlands, this is just the third documented sighting for Tobago in the last 22 years.

An unseasonal **Cliff Swallow; *Petrochelidon pyrrhonota*** was found at Bon Accord sewage ponds on 2 January 2016 (TJ *et al.*). Of the 18 documented sightings in the last 22 years, only four have occurred away from the traditional migration months of March to April and September to October.

A juvenile **Yellow-bellied Seedeater, *Sporophila nigricollis*** was photographed on Chacachacare on 25 August 2016 (KM). Seedeaters are nomadic and eruptive in nature. After bumper years in 2011 and 2012 where multiple birds were found on the Bocas Islands and the dry southern slopes of the Northern Range, this is the first documented record for four years.

An adult male **Summer Tanager, *Piranga rubra*** was photographed at Carli Bay on 13 February 2016 (NL,RJ). This is a rare but regular winter visitor with 12 documented sightings in the last five years.

A non-breeding plumaged male **Scarlet Tanager, *Piranga olivacea*** was photographed at Cuffie River, Tobago on 13 November 2004 (MG). There have only ever been three documented, south-bound migrant sightings in Trinidad and Tobago, two of which were from Tobago, and both were in November 2004.

An adult male **Rose-breasted Grosbeak, *Pheucticus ludovicianus*** was photographed at Asa Wright Nature Centre on 14 April 2016 (JP) and an immature male at Carli Bay on 11 November 2016 (NL). There have now been 15 documented sightings in the last 22 years, with all but one during the period November – April.

A **Black and White Warbler; *Mniotilta varia*** was recorded in the mangrove close to Carli Bay on 7 November 2016 (NL). It is presumably the same individual that overwintered in the same stand of trees during the winters of 2014 and 2015 (see Kenefick 2015, 2016). This is a rare species, with only ten other individuals recorded in the past 22 years, all form the Northern Range.

An adult **Tennessee Warbler, *Leiothlypis peregrina*** was photographed at Gran Couva on 5 March 2016 (NL) and another at Brickfield on 3 December 2016 (NL). This species was first recorded in 2014 and already six individuals have been documented. This may represent a change in their known migration route.

The increase in sightings of **Bay-breasted Warbler; *Setophaga castanea*** continued throughout the Review Year with basic plumaged birds being found as follows :- 28 December 2015 at Gran Couva remaining until 5 March 2016 at least (NL); Millennium Lakes, Trincity on 12 December 2016 (MK, NL) and Carli Bay on 18 December 2016 (NL). Whilst it is still possible that the recent upsurge in sightings represents a subtle change in migration route for this species, it is known that the presence of their preferred food source in their breeding grounds, Spruce Budworm, *Choritoneura sp*), has increased dramatically in recent years.

An adult female **Blackburnian Warbler, *Setophaga fusca*** was photographed at Gran Couva on 6 March 2016 (NL,MK) and a basic plumaged male at Bon Accord, Tobago on 15 December 2016 (TM). Whilst this species is still considered to be a rare migrant through Trinidad and Tobago, there have now been three documented sightings in the last three years. They are closely related to Bay-breasted Warbler, *S castanea* and are likely also benefiting from the dramatic population increase in Spruce Budworm

An immature **Chestnut-sided Warbler, *Setophaga pensylvanica*** was seen briefly at Asa Wright Nature Centre on 29 December 2015 (TJ). Additionally, an adult in alternate plumage was photographed at Grande Riviere on 6 April 2015 (BAh). There have now been eight documented sightings of this migrant warbler in the last 22 years; all during the period mid-December to early April.

An adult male **Black-throated Blue Warbler, *Setophaga caerulescens*** was found feeding beside the Guacharo trail at Asa Wright Nature Centre on 15 October 2016 (RD). This is the third documented record for Trinidad and Tobago and the first since 1992.

An immature female **Baltimore Oriole, *Icterus galbula*** was photographed at Asa Wright Nature Centre on 13 May 2016 (CW). This is the first documented record for 11 years.

A loose flock of at least ten **Bobolink; *Dolichonyx oryzivorus*** was photographed feeding on tall dry grass seeds on 1 October 2016 at Caroni Rice Project (LJ). This species should be considered a passage migrant as three-quarters of sightings have been in October.

We received an old report of a pair of **Red-breasted Meadowlark, *Sturnella militaris*** from Crown Point Airport, Tobago on 6 December 2007 (TMu). Historically, this species appeared occasionally in Tobago during the latter part of the 20th century, but reports thereafter are extremely rare.

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 these birds.

Elsewhere, exotic parrot species continue to be reported. **Painted Parakeet***, Pyrrhura picta* has been photographed in both Princes Town and Port of Spain and **Red and Green Macaws,** *Ara chloropterus* from La Brea, Palo Seco, Santa Flora, Cumuto and Moka.

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 based on identification alone. A **Chestnut-bellied Seed-Finch**, *Oryzoborus angolensis* was reported from South Oropouche and Carli Bay and an adult male **Lesson's Seedfinch**, *Sporophila bouvronides* from Nariva.

A Chestnut Munia, *Lonchura atricapilla* was photographed at Caroni Rice Project and a Venezuelan **Troupial,** *Icterus icterus* in Carlsen Fields.

ADDITIONAL RECORDS

Acceptable records were also received for a further 55 sightings of the following species whose status has been established but who's distribution continues to be monitored by the Committee. **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;* **Crested Caracara,** *Caracara cheriway;* **Scaled Dove***, Columbina squammata;* **Striped Owl,** *Asio clamator;,* **Variegated Flycatcher**, *Empidonomus varius* and **Black-whiskered Vireo**; *Vireo altiloquus*.

INCONCLUSIVE RECORDS

Submissions of the following species were deemed inconclusive :- Great Black Hawk *Buteogallus urubitinga,* Blue-chinned Sapphire *Chlorestes notata,* Gray Heron *Ardea cinerea* and Hook-billed Kite *Chondrohierax uncinatus*.

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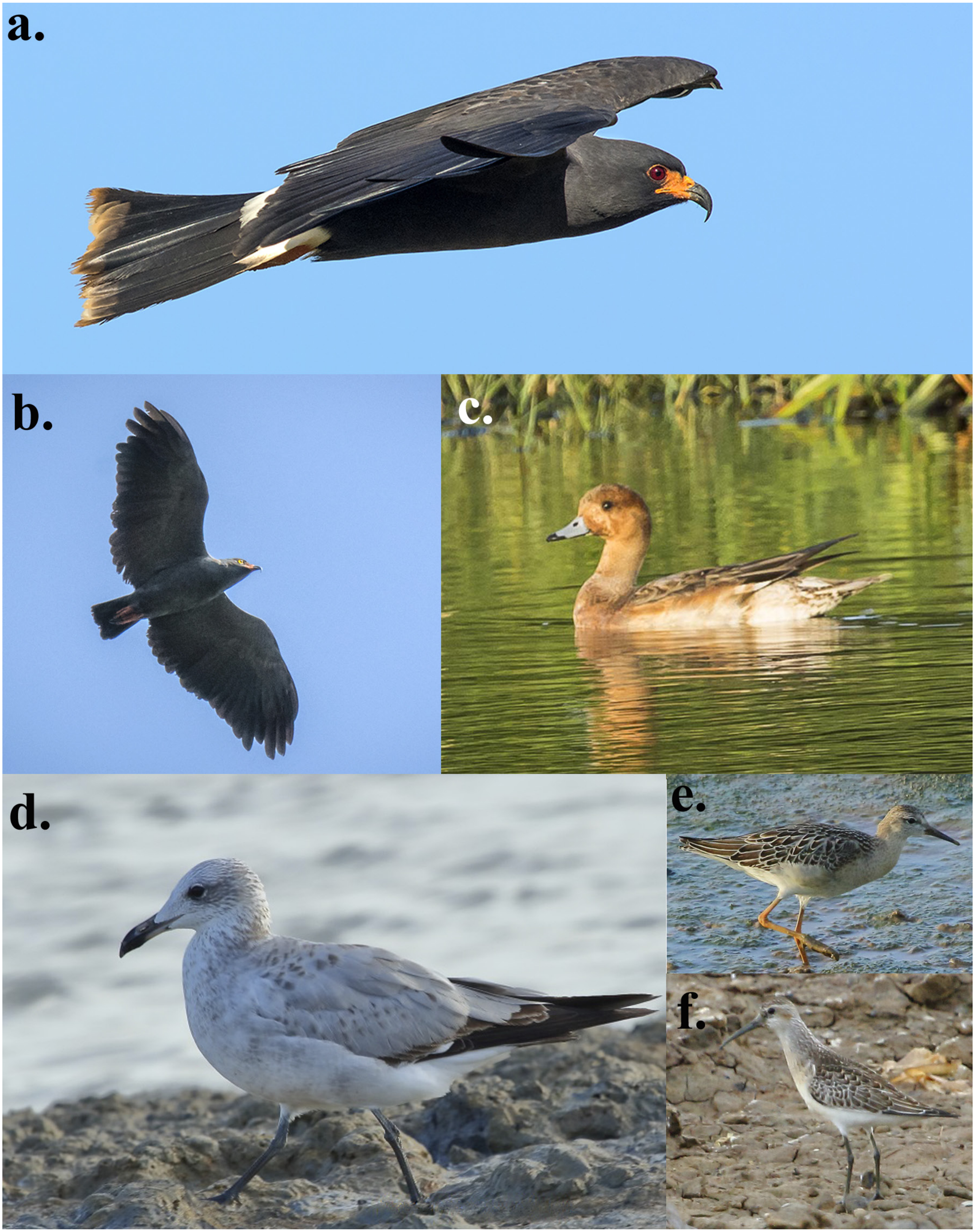
LEGEND TO PLATE

a. Snail Kite, Caroni Rice Project, March 2016, photographed by Wendell Reyes.
b. Slender-billed Kite, Slender-billed Kite, Los Blanquizales Swamp, 5 March 2016, Photographed by Rishi Goordial.
c. Eurasian Wigeon, Bon Accord sewage ponds, Tobago, 2 January 2016, photographed by Sataish Rampersad
d. Audouin's Gull, Brickfield Mudflats, 10 December 2016, Photographed by Nigel Lallsingh
e. Ruff, Trincity River, 21 November 2016, photographed by Nigel Lallsingh
f. Curlew Sandpiper, Brickfield Mudflats, 18 September 2016, Photographed by Nigel Lallsing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Book Review

The Dragonflies & Damselflies of Trinidad & Tobago
by John Michalski

The Dragonflies & Damselflies of Trinidad & Tobago is a comprehensive and relatively easy to use guide dedicated to the Odonatan fauna of Trinidad & Tobago. It is the product of several years of hard work and dedication to the study of the fauna of these islands by John Michalski and contains enough information to allow for identification to the species level. Accounts of all 121 species of Odonata that inhabit the islands are given, along with brief defining characteristics. From personal experience it has proven to be an invaluable resource in the identification of dragonflies and damselflies of these islands, both in and out of the field.

This book is suited for use by both the casual naturalist and professional entomologist alike, containing a rigorous level of scientific and technical detail that is presented in a clear and concise manner. Additionally, the inclusion of both common and scientific names in the text will make it significantly easier for readers to achieve a degree of familiarity with this group of insects. Each species entry is supplemented by colour photographs as well as detailed keys to aid in their identification. Photographic comparisons along with excellent hints for distinguishing similar species aid in the identification of very similar looking species, a feature most welcome by anyone studying or working with Neotropical Odonata fauna.

The descriptions, and other parts of the species accounts are well written, very helpful and interesting. The introductory sections on morphology, general biology and history of Odonatology in Trinidad and Tobago is very concise and engaging. Particular focus was paid to key Odonate habitats in Trinidad and Tobago, a section that I particularly favoured as one can know what groups to potentially expect when visiting various habitat types throughout Trinidad and Tobago. There is also a section highlighting suggested areas for future study..

This book follows in the legacy of his earlier work, a catalogue titled: A Catalogue and Guide to the Dragonflies of Trinidad (Order Odonata), published by the Zoology Department of the University of the West Indies, St. Augustine Campus (Occasional Papers No. 6, 1988). That catalogue was the last comprehensive work done on this subject since that of D. C Geijskes in 1932, it however lacked many of the key features of his current manual such as colour photographs, common names, and the general user friendliness that this current book provides and was probably best suited for a scientific audience. In the context of specimen identification and faunistics, this current book is undoubtedly the most significant contribution in almost three decades and it is recommended to anyone wanting to know more about the dragonfly and damselfly fauna of Trinidad and Tobago.

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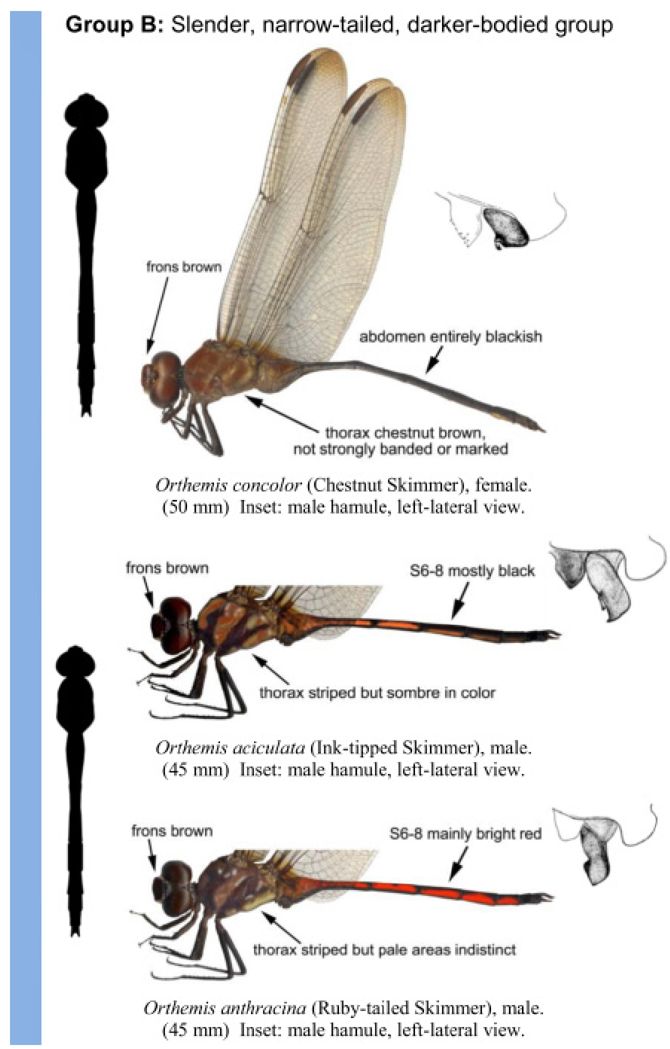

Sample plate

Notes to Contributors

Living World, the journal of The Trinidad and Tobago Field Naturalists' Club, publishes articles on studies and observations of natural history carried out in Trinidad and Tobago, and in the Caribbean Basin. Contributors to *Living World* are not limited to members of the Club.

Articles submitted for publication are sent to two referees for review.

Articles are accepted on the condition that they are submitted only to *Living World*. Regarding a co-authored article, the senior author must affirm that all authors have been offered an opportunity to peruse the submitted version and have approved of its publication.

Articles may be emailed to: **g.whitett@gmail.com** or **ysbaksh.comeau@gmail.com**

In general, we follow the Council of Science Editors Style Manual (https://writing.wisc.edu/Handbook/DocCSE.html). All articles, except for Nature Notes, should be accompanied by an abstract and a list of key words.

Nature Notes is a section allowing contributors to describe unusual observations on our flora and fauna. The title of each Nature Note should include key words and the note should not exceed three journal pages in length, including tables and photographs. Only a few key references should be included.

References should follow the Name and Year system. Some examples:

1. **Journals:**
   The full title of a journal should be given.
   Larsen, N.J. and **Levesque, A.** 2008. Range expansion of White-winged Dove (*Zenaida asiatica*) in the Lesser Antilles. *Journal of Caribbean Ornithology*, 21: 61-65.
   Quesnel, V., Farrel, T. F., Hilton, A., Hilton, J. and **Zuniaga, L.** 1996. The revegetation of the McClean Monument. *Living World, Journal of The Trinidad and Tobago Field Naturalists' Club,* 1995-1996: 9-12.

2. **Books and Monographs:**
   Kenny, J. 2008. The Biological Diversity of Trinidad and Tobago. Maraval, Trinidad and Tobago: Prospect Press. 265 p.

3. **Citation from Books and Monographs with Editors:**
   Collins, C.T. 2002. Notes on the biology of the Band-rumped Swift in Trinidad. p. 138-143. *In* **F.E. Hayes** and **S.A. Temple,** eds. Studies in Trinidad and Tobago's Ornithology Honouring Richard ffrench. St. Augustine, Trinidad and Tobago: Department of Life sciences, University of the West Indies, Occasional Paper No. 11.

4. **Online References:**
   Rutherford, M.G. 2012. Tucker Valley BioBlitz 2012 Summary. *Field Naturalist* 2012(4), p. 6-17 [Online]. Available at http://ttfnc.org/photojournals/2012-4.pdf (Accessed 02 February 2013)

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