# On the Number of Moths (Lepidoptera) that Occur in Trinidad and Tobago

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## ABSTRACT

The number of species of moths known from Trinidad has increased from 242 in 1901 to 1,016 in 1927, 1,195 in 1950, and is presently around 2,275. Attempts to estimate the total number of species that occur on the island suggest a fauna of around 3,500 species. The moths of Tobago have been less well collected than those of Trinidad and currently only 259 species are known. This represents just 11% of the currently known Trinidad list, but in the best-documented moth family from Tobago (Pyralidae) this increases to 18%. If this ratio is applied to the projected Trinidad total, this would give an estimate of 640 moth species for Tobago, but even this is likely to be an underestimate.

## INTRODUCTION

The insect order Lepidoptera comprises about 26 superfamilies (Heppner 1984). Two of these, Papilionoidea and Hesperioidea, are the butterflies, while the remainder are moths. Butterflies normally fly by day, and are often brightly coloured, often on both the upper surface and the under surface of the wings, whereas moths mostly fly by night, and their wing markings are largely restricted to the wing upper surface. Many Lepidoptera are effective fliers, in common with dragonflies and some groups of flies, wasps and bees, but unlike most groups of insects, which are weak fliers or flightless. Thus insect powers of dispersal vary, and the ability of Lepidoptera and other effective insect fliers to colonise new habitats or islands is likely to be qualitatively greater than for other insect groups.

While the butterflies of Trinidad are relatively well known (Barcant 1970) and have been intensively collected (Tikasingh 2003), the moths have been collected by only a handful of naturalists, and are poorly documented by comparison. However, moths are one of the richest groups of insects in Trinidad and Tobago, including many large and colourful species - and many more small and predominantly brown species (see Plates 1 and 2). They include more than 50 pest species that feed on, and can seriously damage, agricultural and forestry plants (CABI 2001), and many more that attack ornamental plants. Sphingidae, or hawk moths, include some of the largest Trinidad moths, with wing-spans of 5-18 cm. The caterpillars are correspondingly large, and always have a more or less well developed tail at the rear end of their bodies – hence their common name, hornworms. Many members of the public will have seen hornworms feeding on allamanda, cassava, frangipani, papaya, rubber, tobacco, tomato or sweet potato.

Most moths are attracted to lights at night. Light sources with a strong ultra violet component, such as those based on a mercury vapour discharge tube are especially effective. This makes moths straightforward subjects for some types of ecological research and quantitative studies. For example, Stradling, Legg and Bennett (1983) analyse light trap records of Sphingidae from more than 8 years of collecting at light traps which D.J. Stradling and F.D. Bennett ran in their St. Augustine gardens. They were able to examine relative abundance, long-term sampling trends, phenological patterns (in response to the pattern of rainfall and the lunar cycle).

William James Kaye (1875-1967) studied the butterflies and moths of Trinidad in the first half of the twentieth century, and published two lists of the moths known from Trinidad. In 1901, he published a preliminary catalogue comprising 242 species (Kaye 1901) based mostly upon his collecting and that of his brother, S. Kaye. Subsequently Sir Norman Lamont collected moths from around 1913, until his death in 1949, and was responsible for collecting many new records from the island, so that in 1927, when Kaye and he published the last catalogue of Trinidad moths, they recorded 1,016 species (Kaye and Lamont 1927). More than 40 years later, William Beebe published a list of 179 further records of moths, based on a list of 150 new records which Lamont prepared in 1941, but did not publish before his death, and records compiled by E. Mc C. Callan (Lamont and Callan 1950). The only other substantial work recording the moths of Trinidad since then has been on Ctenuchinae (Arctiidae) and Sphingidae. The Ctenuchinae are a group of small (mostly <2.5 cm wing-span) brightly coloured moths, often with transparent patches in their wings, many of which fly by day, or by both day and night. Flemming (1957, 1959) revised the Trinidad Ctenuchinae based mainly on the collecting of William Beebe and Jocelyn Crane of the New York Zoological Society at Simla. Stradling, Legg and Bennett (1983) include a full list of hawk moth species known at that time.

During my stay in Trinidad, 1978-1982, I made a collection of Lepidoptera. This was supplemented to a limited extent during nine return trips between 1988 and 1999, of which three involved significant moth collecting. Since I left Trinidad, I have worked intermittently on identifying my moth material and compiling an updated list of the Trinidad species (Annex 1). This work is far from complete, and there are many questions still to answer, but it has reached the stage where I can now start to provide realistic estimates on the numbers of species collected, even if I cannot name them all as yet. From this it is possible to make some informed extrapolations as to the total number of species which may be found to occur in the future.

Butterflies, because they are conspicuous, beautiful and fly by day have been intensively collected in Trinidad by local collectors and visitors. Hence, Barcant (1973) was able to give a comprehensive account of the superfamily Papilionoidea (all butterflies except skippers). There has been a slow but steady trickle of new species records since then, but the total probably hasn't increased by more than 10%. By comparison, the superfamily Hesperioidea (skippers) contains a large proportion of small brown species, making them less attractive to collectors, especially local

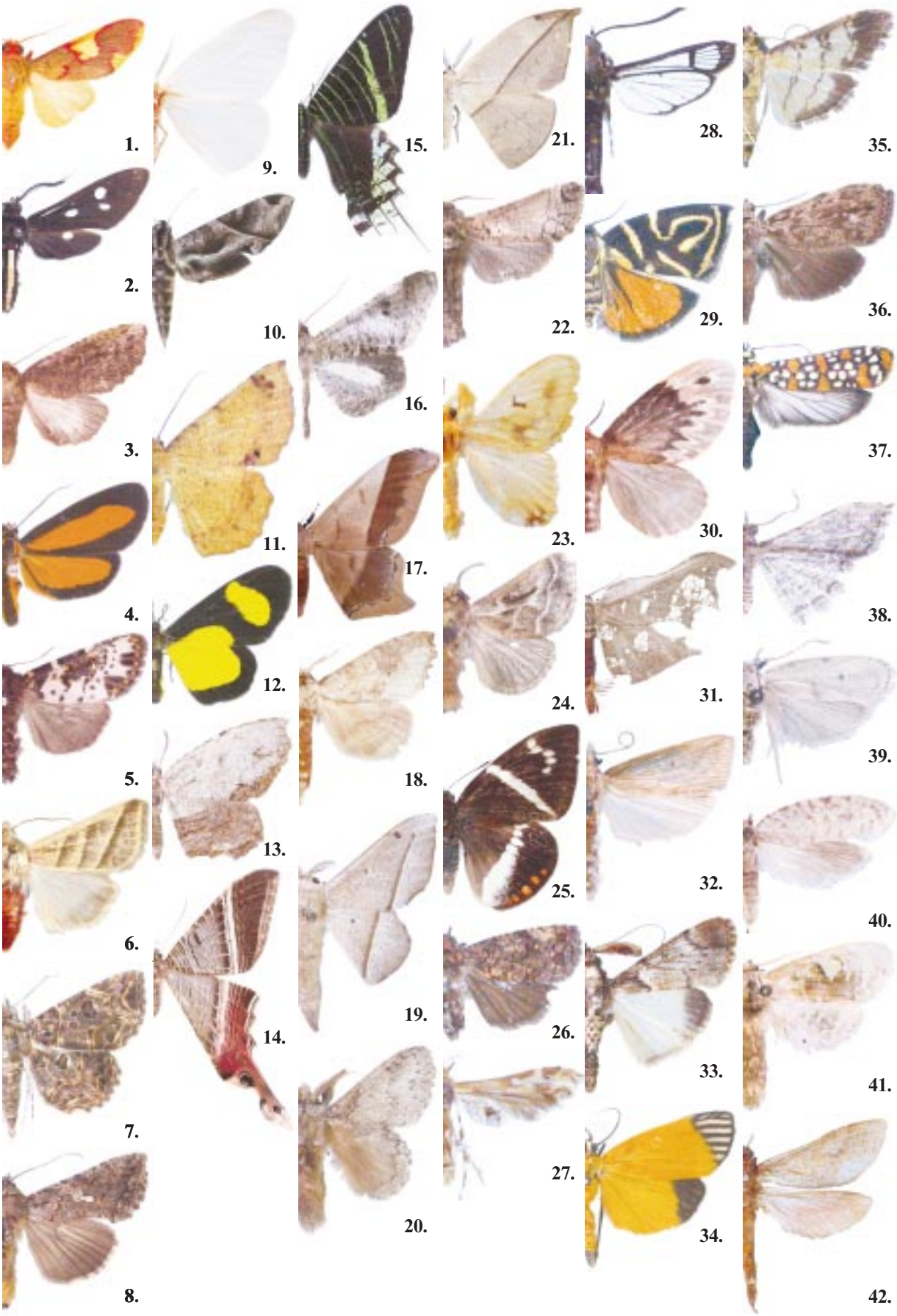

*(Cont'd on P. 54)*

**LEGENDS TO PLATE 1**

Representative moths of Trinidad. All specimens collected by M.J.W. Cock, except as stated. F refers to the forewing length measured from the base of the wing.

**1.** Male *Paranerita gaudialis trinitatis* Rothschild (Arctiidae, Arctiinae), Valencia Forest, MVL, 5.viii.1981; F 15 mm.
**2.** Male *Calonotos craneae* Flemming (Arctiidae, Ctenuchinae), Above St. Benedict's, MVL, 26.v.1981; F 20 mm.
**3.** Female *Dicentria nondescripta* Kaye (Notodontidae), Curepe, at light: 5.i.1980; F 23 mm.
**4.** Male *Josia oribia* Druce (Notodontidae, Dioptinae), Parrylands, at *Eupatorium* flowers, 7.xi.1980; F 14 mm.
**5.** Male *Xanthopastis timais* Cramer (Noctuidae, Hadeninae), Curepe, MVL, 26-31.xii.1980; F 20 mm.
**6.** Male *Heliothis subflexa* Guenée (Noctuidae, Heliothinae), Curepe, MVL, 8.xi.1978; F 14 mm.
**7.** Male *Antiblemma caparata* Kaye (Noctuidae, Ophiderinae), Hollis Reservoir, at light, 5.ix.1978; F 10 mm.
**8.** Male *Trichoplusia ni* Hübner (Noctuidae, Plusiinae), Aranguez Gardens, larva on cabbage, x.1980; F 15 mm.
**9.** Female *Eloria subapicalis subapicalis* Walker (Lymantriidae), Cumaca Road, 0.5 miles, MVL, 27.x.1980; F 25 mm.
**10.** Male *Eumorpha triangulum* Rothschild & Jordan (Sphingidae), Brigand Hill, lighthouse, MVL, 25.iii.2003 ; F 67 mm.
**11.** Female *Erastria decrepitaria decrepitaria* Hübner (Geometridae: Ennominae) Hollis Reservoir, at light, 2.xi.1978; F 20 mm.
**12.** Female *Cyllopoda jatropharia* Linnaeus (Geometridae, Sterrhinae) Maracas Valley, Ortinola Estate, 5.xii.1978; F 22 mm.
**13.** Male *Schidax squammaria* Hübner (Epiplemidae) Parrylands, 10.iii.1980 14 mm.
**14.** Female *Sematura lunus* Linnaeus (Sematuridae) Curepe, MVL, 5.x.1979; F 50 mm.
**15.** Female *Urania leilus* Linnaeus (Uraniidae) Maracas Valley, Ortinola Estate, 10.iii.1982; F 49 mm.
**16.** Male *Macrosoma conifera* Warren (Hedylidae) Morne Bleu, Textel Installation, at light, 30.i.1981; F 22 mm.
**17.** Male *Arsenura beebei* Flemming (Saturniidae, Arsenurinae), Arima Blanchisseuse Road, milestone 9.75, MVL, 9.xi.1978; F 70 mm.
**18.** Male *Ephoria marginalis* Walker (Apatelodidae), Cumaca Road, 4.6 miles, MVL, 21.x.1982; F 29 mm.
**19.** Male *Druentica scissa* Herrich-Schäffer (Mimallonidae), Hollis Reservoir, at light, 2.xi.1978 16 mm.
**20.** Male *Euglyphis olivetta* Schaus (Lasiocampidae), Hollis Reservoir, at light, 2.xi.1978; F 20 mm.
**21.** Male *Homoeopteryx malecena prona* Jordan (Oxytenidae), St. Benedict's, at light, 5.x.1994; F 34 mm.
**22.** Male *Inguromorpha polybia* Schaus (Cossidae), Brigand Hill, lighthouse, MVL, 28.iii.2003; F 12 mm.
**23.** Male *Acraga angulifera* Schaus (Dalceridae), Morne Bleu, Textel Installation, at light, 9.xi.1978; F 12 mm.
**24.** Male *Perola bistrigata* Hampson (Limacodidae), Tobago, Crown Point, at light, 15-17.v.1981; F 8 mm.
**25.** Female *Leucocastnia licus insularis* Houlbert (Castniidae) Lalaja South Road, milestone 1, 8.xi.1978; F 50 mm.
**26.** Female *Ecdytolopha aurantianum* Lima (Tortricidae) Curepe, ex cocoa pod, v.1981; F 8 mm.
**27.** Male *Sphenarches anisodactyla* Walker (Pterophoridae), St. Augustine, Texaco Farm, ex pupa on pigeon pea pod i.1979; F 7 mm.
**28.** Male *Synanthedon santanna* Kaye (Sesiidae), Arena Forest Reserve, 2.x.1982; F 7 mm.
**29.** *Hemerophila albertiana* Cramer (Choreutidae), Moruga East Oilfield, nr. Moruga Bouffe, 24.iii.2003 ; F 8 mm.
**30.** Female *Podalia farmbri* Kaye (Megalopygidae), Nariva Swamp, Manzanilla-Mayaro Road, milestone 46.5, MVL, 19.i.1988; F 22 mm.
**31.** Female *Draconia rusina* Druce (Thyrididae) St. Augustine, 2.ii.1982 (M. Alkins); F 26 mm.
**32.** Male *Diatraea saccharalis* Fabricius (Pyralidae, Crambinae) laboratory stock, ix.1981; F 12 mm.
**33.** Male *Macalla thyrsisalis* Walker (Pyralidae, Epipaschniinae) Arima Valley, Simla, MVL, 18.x.1982; F 14 mm.
**34.** Male *Mapeta xanthomelas* Walker (Pyralidae, Pyralinae) Mt. Tamana, summit ridge path, 14.x.1995; F 16 mm.
**35.** Female *Ategumia matutinalis* Guenée (Pyralidae, Pyraustinae) Blanchisseuse - Paria Bay Track, larva on *Clidemia hirta* 20.i.1980; F 10 mm.
**36.** Female *Imma cancanopis* Meyrick (Immidae) Curepe, xi.1980; F 10 mm.
**37.** Female *Atteva punctella* Cramer (Yponomeutidae), Morne Bleu, Textel Installation, at light, 29.iii.1979; F 10 mm.
**38.** Female *Alucita eudactyla* R. Felder & Rogenhofer (Alucitidae) Curepe, MVL, 7-13.xi.1980; F 8 mm.
**39.** Female *Cerconota anonella* Sepp (Oecophoridae, Stenomatinae) Curepe, MVL, 2.ii.1979; F 10 mm.
**40.** Female *Tiquadra aeneonivella* Walker (Tineidae, Tineinae) Arima Valley, Simla, MVL, 12.ii.1982; F 13 mm.
**41.** Male *Arrhenophanes perspicilla* Stoll (Arrhenophanidae) Curepe, Black Light Trap, 11-20.ii.1982 (F.D. Bennett); F 13 mm.
**42.** Male *Aepytus terea* Schaus (Hepialidae) Inniss Field, MVL, 17.v.1999 24 mm.

# PLATE 1



# PLATE 2

**LEGENDS TO PLATE 2**

Photographs of living larvae and adults of Trinidadian moths. Photographs by M.J.W. Cock where not indicated otherwise.

**1.** Male *Ceroctena amynta* Cramer, Maracas Valley (J.S. Kenny); F 19 mm. A distinctive member of the subfamily Ophiderinae (Noctuidae); green markings are unusual in this family.

**2.** Male *Dinia eagrus* Cramer, Rio Claro - Guayaguayare Road, 11.x.1993; F 16 mm. This ctenuchine (Arctiidae) flies by day, when it comes to flowers and *Heliotropium* bait, and by night, when it comes to light. It can be recognised by the red margins to the abdomen.

**3.** *Pseudsphex kenedyae* Flemming (Arctiidae, Ctenuchinae) at *Heliotropium* bait, Lalaja Ridge, 6.v.1995; F 11 mm. This species was described from Simla, Arima Valley, and named after Ms. Rosemary Kennedy, who was a Research Assistant at Simla. It is one of three ctenuchines that are consummate mimics of *Polistes* wasps in Trinidad.

**4.** The distinctive and unusual larva of *Phobetron hipparchia hipparchia* Cramer (Limacodidae) (K.G. Preston-Mafham/ Premaphotos); c. 15 mm. Larvae of this species feed on various plants including cocoa and citrus.

**5.** The striking larvae of *Crinodes striolata* Schaus f. *insularis* Rothschild (Notodontidae), Maracas Valley, 25.vi.1978, on an unidentified vine; c. 70 mm..

**6.** Adult male *Crinodes striolata* f. *insularis* reared from the larva illustrated; F 37 mm. These moths are occasionally common at light in the forests of the Northern Range.

**7.** Full grown larva of *Pseudosphinx tetrio* Linnaeus; c. 120 mm. Larvae feed on frangipani and sometimes allamanda.

**8.** Female of *Pseudosphinx tetrio*, attracted to light at St. Benedicts, 12.x.1993; F 70 mm.

**9.** Adult *Trygodes musivaria* Herrich-Schäffer (Geometridae, Sterrhinae) (K.G. Preston-Mafham/Premaphotos); F 17 mm.

**10.** Male *Apicia cayennaria* Guenée (Geometridae, Ennominae) (K.G. Preston-Mafham/Premaphotos); F 14 mm. This species is sexually dimorphic, and both sexes were described as new species; hence this species appears in Kaye & Lamont (1927) under two names (*A. alteraria* Guenée and *A. distycharia* Guenée, both synonyms of A. cayennaria).

**11.** Adult *Paloda acutangulata* Herrich-Schäffer (Epiplemidae) (K.G. Preston-Mafham/Premaphotos); F 14 mm. Like several other members of this family, this moth holds its wings in a very distinctive way.

**12.** Unidentified larva of an *Automeris* sp. (Saturniidae) on a species of Convolvulaceae, Morne Bleu, 16.i.1985, c. 60 mm.

**13.** Newly emerged E *Cerodirphia speciosa* Cramer (Saturniidae) uncharacteristically at rest on a tree trunk (K.G. Preston-Mafham/Premaphotos); F 44 mm.

**14.** Male *Phiditia cuprea* Kaye (Apatelodidae) (K.G. Preston-Mafham/Premaphotos); F 22 mm. This species was described from Trinidad; note the characteristically bent abdomen at rest.

collectors, and Barcant (1973) provides only a list based on earlier publications (Cock 1982). Since 1973, my studies (Cock 2003 and earlier papers) have added more than 10% to the known number of species. As I complete my review of the Trinidad Hesperiidae, the number of new species recorded is likely to slow, and we can be fairly sure by then that the total number of butterfly species known will be close to the true total. In contrast, moths in Trinidad and both butterflies and moths in Tobago have not been as comprehensively collected, and so it is necessary to estimate the number of species involved from available information. Extrapolation from the best-collected groups to the less well-collected groups is the first approach used here.

The theory of island biogeography (McArthur and Wilson 1967) predicts that the number of species on an island will increase with the size of the island (less frequent local extinction, more niches), and decrease with the distance from a rich source of colonising species (fewer colonisation events). On both counts, Tobago can be expected to have an impoverished fauna compared to Trinidad. With the exception of social wasps, most groups that have been well-collected on both islands have between twice and five times as many species in Trinidad as in Tobago (C.K. Starr, unpublished) – or conversely, the number of Tobago species in a group represents between 20% and 50% of the number of Trinidad species. The number of species of moths estimated for Tobago is interpreted in light of C.K. Starr's finding.

## MATERIALS AND METHODS

In Table 1, the numbers of species of moths are presented by families, based on the published lists (Kaye 1901, Kaye and Lamont 1927) and my unpublished lists for Trinidad and Tobago (Annex 1). The classification used here is that of Heppner (1984, 1995, 1996). I am aware that this classification appears to need modification (see e.g. Epstein 1996), but for the purposes of this analysis, this is not critical.

I have interpreted the lists of Kaye (1901) and Kaye and Lamont (1927) in light of the classification used here, so that in the presentation of numbers by families, there are small differences between Kaye's allocations and mine, but the totals are correct. My own studies have shown that several times Kaye referred to one species by two or more different names in his lists, and equally,

**Table 1.** Historical overview by families of the known species of Trinidad and Tobago moths.

| Superfamily | Family | Kaye (1901) | Kaye and Lamont (1927) | Cock Trinidad unpublished (2003) | Cock Tobago unpublished (2003) |
|---|---|---|---|---|---|
| Noctuoidea | Arctiidae | 43 | 137 | 244 | 18 |
| | Notodontidae[1] | 8 | 69 | 149 | 7 |
| | Noctuidae | 71 | 364 | 745 | 81 |
| | Lymantriidae | | 2 | 3 | 1 |
| Sphingoidea | Sphingidae | 15 | 54 | 91 | 12 |
| Geometroidea | Geometridae | 35 | 135 | 286 | 31 |
| | Epiplemidae | 2 | 7 | 16 | |
| | Sematuridae | 2 | 2 | 2 | |
| | Uraniidae | | 1 | 1 | 1 |
| | Hedyliidae | 1 | 1 | 2 | |
| Bombycoidea | Saturniidae | 13 | 23 | 44 | 1 |
| | Apatelodidae | 2 | 4 | 9 | |
| | Mimallonidae | 1 | 2 | 11 | 1 |
| | Lasiocampidae | | 6 | 18 | 1 |
| | Oxytenidae | | 2 | 3 | |
| Cossoidea | Cossidae | | 3 | 12 | 1 |
| | Dalceridae | | 2 | 5 | |
| | Limacodidae | | 14 | 36 | 3 |
| Castnioidea | Castniidae | 1 | 6 | 9 | 1 |
| Tortricoidea | Tortricidae | | 1 | 15 | 1 |
| Pterophoroidea | Pterophoridae | | | 1 | |
| Sesioidea | Sesiidae | 1 | 3 | 9 | |
| | Choreutidae | | 1 | 6 | |
| Zygaenoidea | Zygaenidae | | 1 | 1 | |
| | Megalopygidae | 1 | 8 | 22 | 4 |
| Pyraloidea | Thyrididae | | 2 | 8 | |
| | Pyralidae | 46 | 151 | 443 | 80 |
| Immoidea | Immidae | | 1 | 4 | |
| Yponomeutoidea | Plutellidae | | | 1 | 1 |
| | Yponomeutidae | | 2 | 1 | 1 |
| | Heliodinidae | | | 3 | |
| Copromorphoidea | Alucitidae | | | 1 | |
| | Carposinidae | | | 1 | 1 |
| Gelechioidea | Oecophoridae | | 7 | 43 | 5 |
| | Momphidae | | | 1 | 1 |
| | Gelechiidae | | 1 | 6 | 1 |
| Tineoidea | Tineidae | | 4 | 13 | 2 |
| | Psychidae | | | 6 | 1 |
| | Arrhenophanidae | | | 1 | |
| | Lyonetiidae | | | 1 | 1 |
| | Gracillariidae | | | 5 | |
| Hepialoidea | Hepialidae | | | 2 | 1 |
| Total | | 242 | 1016 | 2275 | 259 |

[1] Including Dioptinae, i.e. Dioptidae of Kaye & Lamont (1927)

sometimes what he referred to as one species represents two or more species. I have ignored this in my analysis, on the basis that the number of species involved is not large and these factors at least partially cancel each other out.

In Table 2, I show how the number of species known from Trinidad has increased since 1927, by calculating the percentage increase in numbers for each of the larger groups compared to Kaye and Lamont's (1927) list. I also calculate the Tobago representation as a percentage of the Trinidad 2003 list. Because many of the families known from Trinidad are represented by small numbers of species, I have selectively pooled these to present a clearer picture of the patterns. Partly, I have used the traditional (but taxonomically invalid) groupings Macrolepidoptera (or larger moths, including Zygaenoidea, Cossoidea, Castnioidea, Uranioidea, Geometroidea, Bombycoidea, Sphingoidea, and Noctuoidea) and Microlepidoptera (all other superfamilies). The rationale for this is that the Macrolepidoptera are relatively well collected in Trinidad, whereas the Microlepidoptera have been more or less ignored (apart from the Pyraloidea) because of their small size, and difficulty to prepare and identify.

**Table 2.** Increases in the number of known Trinidad moths, by family groups, 1927 to 2003, and the currently known Tobago moth fauna as a proportion of the known Trinidad fauna.

| Family Group | Kaye & Lamont (1927) | Cock Trinidad unpublished 2003 | % increase from 1927 to 2003 | Cock Tobago unpublished 2003 | Tobago / Trinidad (%) |
|---|---|---|---|---|---|
| Arctiidae | 137 | 244 | 78 | 18 | 7 |
| Notodontidae | 69 | 149 | 116 | 7 | 5 |
| Noctuidae | 364 | 745 | 105 | 81 | 11 |
| Sphingidae | 54 | 91 | 69 | 12 | 13 |
| Geometridae | 135 | 286 | 112 | 31 | 11 |
| Saturniidae | 23 | 44 | 91 | 1 | 2 |
| Pyralidae | 151 | 443 | 193 | 80 | 18 |
| Limacodidae | 14 | 36 | 157 | 3 | 8 |
| Other Macrolepidoptera | 49 | 122 | 149 | 10 | 8 |
| Microlepidoptera | 20 | 120 | 500 | 16 | 13 |
| Total / average | 1016 | 2275 | 124 | 259 | 11 |

In Table 3, I show two attempts to estimate the total number of species of moths that occur in Trinidad, one partially objective, the other largely subjective. The former approach is based on the fact that numbers are available for the known neotropical fauna for all Lepidoptera families. If one assumes that the Trinidad fauna for each family comprises a fairly constant proportion of the total neotropical fauna, then one can calculate this proportion for the well known families and use it to predict the Trinidad fauna for the less well known families as the same proportion of the neotropical fauna.

The numbers of species in the neotropical fauna by families were abstracted from the neotropical checklist (Heppner 1984, 1995, 1996) – those for Uranioidea, Geometroidea and Noctuioidea being estimates in Heppner (1984), the others based on the actual checklist numbers.

The second approach is subjective, and basically represents my best guess. This is loosely based on (1) I have seen but ignored many, diverse, very small moths that came to light when I collected, (2) the rate at which I continue to find new island records when collecting at any but the most well collected sites, and (3) surveys of plants in Trinidad for potential biological control agents turn up species of Microlepidoptera not present in general collections, and often impossible to identify because they have not yet been described.

**Table 3.** The known total neotropical fauna for the moth families, compared to the known Trinidad totals, and extrapolations as to the possible total number of moths for Trinidad.

| Superfamily or Family | Known neotropical Fauna | Trinidad fauna (Cock, unpublished 2003) | Trinidadian fauna as %age of neotropical fauna | Trinidad fauna: Estimate (1) | Trinidad fauna: Estimate (2) |
|---|---|---|---|---|---|
| Micropterigoidea | 2 | 0 | | 0 | 0 |
| Heterobathmoidea | 2 | 0 | | 0 | 0 |
| Neopseustoidea | 4 | 0 | | 0 | 0 |
| Hepialoidea | 133 | 2 | 1.5 | 9 | 4 |
| Neptiuloidea | 29 | 0 | | 2 | 0 |
| Tischeroidea | 8 | 0 | | 1 | 0 |
| Palaephatoidea | 28 | 0 | | 2 | 0 |
| Incurvarioidea | 46 | 0 | | 3 | 0 |
| Tineoidea | 691 | 26 | 3.8 | 44 | 250 |
| Gelechioidea | | | | | |
| Oecophoridae | 1733 | 43 | 2.5 | 111 | 100 |
| Other Gelechioidea | 1187 | 7 | 0.6 | 76 | 150 |
| Copromorphoidea | 46 | 2 | 4.3 | 3 | 10 |
| Yponomeutoidea | 208 | 5 | 2.4 | 13 | 30 |
| Immoidea | 36 | 4 | 11.1 | 4 | 8 |
| Pyraloidea | | | | | |
| Other Pyraloidea[a] | 190 | 8 | 4.2 | 8 | 15 |
| Pyralidae[a] | 4562 | 443 | 9.7 | 443 | 600 |
| Pterophoroidea | 208 | 1 | 0.5 | 13 | 10 |
| Sesioidea | 433 | 15 | 3.5 | 28 | 50 |
| Zygaenoidea[a] | 411 | 23 | 5.6 | 23 | 30 |
| Cossoidea[a] | 671 | 53 | 7.9 | 53 | 70 |
| Castnioidea[a] | 134 | 9 | 6.7 | 15 | 10 |
| Tortricoidea | 1454 | 15 | 1.0 | 93 | 200 |
| Uranioidea[a] | 271 | 19 | 7.0 | 19 | 25 |
| Geometroidea | 7804 | 288 | 3.7 | 288 | 350 |
| Bombycoidea | | | | | |
| Other Bombycoidea | 1147 | 41 | 3.6 | 41 | 60 |
| Saturniidae[a] | 926 | 44 | 4.8 | 44 | 55 |
| Sphingoidea[a] | 406 | 91 | 22.4 | 91 | 100 |
| Noctuoidea[a] | | | | | |
| Other Noctuoidea[a] | 180 | 5 | 2.8 | 5 | 10 |
| Notodontidae[a] | 2150 | 147 | 6.8 | 147 | 200 |
| Arctiidae[a] | 6300 | 244 | 3.2 | 244 | 300 |
| Noctuidae[a] | 8516 | 745 | 8.7 | 745 | 900 |
| Total / average | 39916 | 2280 | 5.7 | 2562 | 3537 |

[a] – these families are relatively well-collected in Trinidad, and for estimate (1) were used to predict the numbers in other families less well-collected (i.e. the sum of the totals for each well-known Trinidad family divided by the sum of the totals for the same neotropical families, i.e. 6.4%, was multiplied by the current neotropical total for each less well-known family).

**RESULTS AND DISCUSSION**

Table 1 shows how our knowledge of the moths of Trinidad has increased substantially over the last century. The number of species of moths known has increased from 242 in 1901 to 2,275. The five largest families account for nearly 90% of this total.

Table 2 shows the relative increase in our knowledge from 1927 until now. Overall, the 1927 total has been increased by 124%. Within individual families, the increase is variable, with Sphingidae (69%), Arctiidae (78%) and Saturniidae (91%) showing the smallest increases. This is most probably explained by the relative efforts of the early collectors who would have concentrated on these families with large and colourful species first. These are also the species noted by naturalists and the public and brought to collectors' notice. Although comprising smaller species, Arctiidae are often brightly coloured, and include the Pericopinae which are mainly day-flying and hence more frequently caught by butterfly collectors, Arctiinae which includes many colourful species, and Ctenuchinae, which, as noted above, includes many colourful and distinctive species, including a proportion of day-flying species, and furthermore was a particular interest of W.J. Kaye.

Conversely, Table 2 shows that the largest increases are in the Microlepidoptera (500%) and Pyralidae (193%). The Microlepidoptera, except for a few larger species, were mostly ignored by early collectors. Apart from the Oecophoridae, I too have largely neglected these small moths, and many of the new records represent economic records (pests or herbivores found during surveys for weed biological control agents). So, although there has been a large proportional increase in the number of species, the current total surely represents only a small proportion of those that may be found in the future.

The two attempts to estimate the number of Trinidad moths (Table 3) produce figures of 2,562 extrapolating from the known neotropical fauna and 3,537 based on the author's informed guesses. The obvious flaws with the first approach are (1) it would be naïve to think that even the best known families are comprehensively known in Trinidad, and (2) the less well-known families in Trinidad are probably equally poorly known in the rest of the neotropical region. The second explanation would lead to a predicted fauna not so different to that currently known – as is the case here. I attempt to take these flaws into consideration in my subjective estimate (Table 3). As the study of Trinidad moths continues, and particularly if attention is paid to the Microlepidoptera, I believe the likely total would be of the order of 3,500.

It is also worth noting from Table 3, that Trinidad records of the well-collected family Sphingidae (hawk moths) represent 22.4% of the total known for the neotropical region, whereas the next best represented families are only around 10% of the neotropical fauna. While, without doubt the efforts of F.D. Bennett and D.J. Stradling (Stradling, Bennett and Legg 1983) mean that this family has been far more comprehensively sampled than any other in Trinidad, this high percentage may be a reflection of the known dispersive powers and vagile habits of these large powerful fliers. Comparing the Tobago numbers with the Trinidad numbers (Table 1) shows some interesting differences. Most strikingly, the number of Pyralidae at 80 is relatively high, and only just less than the number of Noctuidae. This reflects the results of the collecting in Tobago by D. Hardy and W. Rowe. Their material is in the USNM, and has been curated for Pyralidae but not for the other common families of moths, such as Noctuidae.

On average, the Tobago fauna is equivalent to 11% of the Trinidad fauna (Table 2), but Saturniidae at 2% and Pyralidae at 18% represent the extremes. Only one saturniid is recorded from Tobago, compared to 44 from Trinidad. I cannot explain this, but one contributing factor may be the lack of collecting in forested parts of Tobago, since I have noted that there is a greater diversity of Saturniidae in forested areas of Trinidad.

Given that Pyralidae is the best documented family for Tobago, one might take 18% as the most realistic estimate of the percentage that the Tobago fauna comprises of the Trinidad fauna. Extrapolating from the subjective Trinidad total suggested above (3,537 species), the Tobago fauna might be expected to be of the order of 640 species. The known Tobago butterflies comprise 20 – 21% of the known Trinidad butterfly fauna (M.J.W. Cock, unpublished), but as noted above the Tobago butterflies are far less well collected than those of Trinidad. Extrapolating 21% of the Trinidad estimated moth fauna gives a prediction of 742 moths for Tobago. However, taking into consideration C.K. Starr's unpublished observation that this proportion is between 20% and 50% for other groups of animals and plants, even 21% is likely to be on the low side. Thus, the true total for Tobago is likely to be higher than 742, although I think it is unlikely to be as high as 50% of the Trinidad fauna.

Seventy-five years ago, Kaye and Lamont (1927) commented on the likely number of species of moths to be found in Trinidad. "It is impossible to forecast what the fauna will be when fully explored, but it can be safely assumed that we do not know half the smaller species of the Pyralidae, Geometridae or Noctuidae. In the Sphingidae the total of 54 species is already large and additions are not likely to be numerous, …. The Castniidae with 6 species, the Syntomidae [Ctenuchinae] with 83 species, … are … very well represented, and … are not likely to give many more." It is still very difficult to hazard a justifiable guess of the total, but not only has the total number of species been more than doubled, but even the numbers for the well-known groups highlighted by Kaye and Lamont have increased by more than 50%: to 91, 9 and 133 respectively. It would be rash to suggest that further additions will not be made in these or other groups, but for Sphingidae and Castniidae at least, I think there will be rather few additions now (Table 3).

In 1941, Sir Norman Lamont wrote in the introduction of his list of additions published posthumously as Lamont and Callan (1950): "The combined total of 1166 species can, however, bear little relation to the total number inhabiting Trinidad. …. Several of the more interesting captures now recorded came from the Arima Valley and I think that there is little doubt that, if lights were systematically worked in the valleys of the northern range, an immense number of interesting captures would be made, of insects new to this imperfect list …". Many of the new records in my list were obtained by doing exactly what Lamont suggested. The Arima Valley at least is now relatively well collected – for the future I suggest the lowland forest areas of southern Trinidad, the drier North-West peninsula and other habitats such as savannahs and swamps will yield many more new records. However, as indicated above, the greatest increases are likely to be made amongst the Microlepidoptera, perhaps best collected by rearing from leaf mines, stems, buds, inflorescence, fruits and seeds etc. of known host plants. For now, I hope my predecessors would be satisfied

with the progress made.

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# Annex 1.

## The basis of my unpublished lists of moths of Trinidad and Tobago

My list of Trinidad moths (referred to here as Cock Trinidad unpublished 2003) is based largely upon my own collecting. This material is currently divided between my personal collection, the collection of CABI Bioscience in Curepe, and the Natural History Museum, London. The great majority of my collection was made by collecting at light, particularly mercury vapour light. Day-flying moths were collected using a net. Many Ctenuchinae, some Pericopinae and some Arctiinae were collected using dried *Heliotropium* (Boraginaeae) as an attractant (Beebe 1955), mainly by day, but also by night. The following were the principal venues for collecting by light:

1. Curepe. I ran a mercury vapour light trap in my garden more or less continuously when I was present between 1978 and 1982. F.D. Bennett also ran a light trap at his house on Santa Margarita Road, and provided many specimens.
2. Morne Bleu. More than 20 visits were made to collect at the lights of the Textel Morne Bleu Installation, mostly 1978-1979.
3. Simla, Arima Valley. Thanks to the hospitality of Jack Price, a mercury vapour light trap was run overnight on more than 20 occasions during 1981-1982.
4. Collections at mercury vapour light during the early night using a portable generator at Arima-Blanchisseuse Road, milestone 10.5 (6.ix.1982), and milestone 9.75 (21.ix.1982), Caura Valley (24.ix.1978), bottom of Cumaca Road (27.x.1980), Cumaca Road Quarry (18.vii.1981, 21.x.1982), Inniss Field (17.v.1999), Lalaja Ridge (3.ix.1982), Nariva Swamp (19.i.1988), North Coast Road, Carisal Trace (5.iv.1979), Rio Claro – Guayaguayare Road (30.ix.1978), Parrylands Oilfield (13.xi.1980, 25.vii.1981), Point Gourde (16.v.1999), Sangre Grande (6.viii.1982), St. Benedicts (26.v.1981), and Valencia Forest (iv.1980, 31.vii.1980, 5.viii.1981).

I have reviewed much of the taxonomic and economic entomology literature, and although this process is not yet complete, the number of new records found in this way is small, and mostly relate to species of the so-called Microlepidoptera. More importantly, I have reviewed the main collections containing Trinidad moths, and extracted data, as follows:

1. The collection of the Natural History Museum, London, which contains historical material collected by J.H. Hart, H. Caracciolo, Dr. Rendall, and S. Kaye in the 19th century and extensive material collected by W.J. Kaye, W.E. Broadway, F. Birch, S.M. Klages, F.W. Jackson, F.W. Urich, Sir N. Lamont, C.L. Withycombe, F.D. Bennett, R.E. Cruttwell, myself and others in the 20th Century;
2. Sir Norman Lamont's collection divided between the National Museums of Scotland and the University of the West Indies (St. Augustine);
3. The collection of the Oxford University Museum, containing material collected by F.W. Jackson, R.M. Farmborough, A. Lickfold, Mrs. H. Turner and others;
4. The CABI Bioscience collection in Curepe containing material collected by F.J. Simmonds, F.D. Bennett, M. Yaseen, R.E. Cruttwell, myself and others;
5. The collection of the United States National Museum (Smithsonian Institution) which contains limited Trinidad material collected by A. Busck, F.W. Urich, etc. and a collection of Pyralidae and Oecophoridae made by D. and S. Duckworth at Simla in 1966.
6. The collection of the University of the West Indies (St Augustine), incorporating the collection of the Imperial College of Tropical Agriculture and part of Sir Norman Lamont's collection (referred to above); and
7. The Allyn Museum of Entomology, Sarasota, Florida which contains W.J. Kaye's collection of Ctenuchinae.

*There is relatively little information available on the moths of Tobago. This is based on much more limited collecting than is the case for Trinidad, and nothing has as yet been published on the moths of Tobago. Nevertheless, I have been able to compile a list*

*of Tobago Lepidoptera including moths (referred to here as Cock Tobago unpublished 2003). This includes my own collecting, mainly around Crown Point (at house lights), Scarborough (one light trap night in January 1982 at Marden House with a UWI field course) and Speyside (four light trap nights, May 1982). I have also incorporated a list of Sphingidae caught by light trap one night at Arnos Vale by D.J. Stradling (pers. comm.), and collections made at house lights in Charlotteville by R.A. Hammond and P. Meynell in June 1998 and by R.A. Hammond in June 1999. I have also searched for Tobago specimens in museum collections while reviewing the Trinidad fauna. There is quite extensive material in the USNM collected at light by D. Hardy and W. Lowe at several localities in March 1966, 1979 and 1999 (only Pyralidae and Oecophoridae are incorporated into the collection – possibly other families are awaiting curation). Otherwise, I have found only a handful of specimens in other museum collections, e.g. a small collection made in 1914 by W.E. Broadway now in the NHM. There is still much work to be done on the Tobago moth fauna.*

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# NATURE NOTE

## The Moruga Silk Cotton Tree: Grandest of them All

*Ceiba pentandra* (silk cotton or kapok, family Bombacaceae), reaches a height of 60 m and is the tallest tree in Trinidad and Tobago (Quesnel and Farrell 2000). It is the tallest tree in the Amazon rain forest (www.tropilab.com) and tropical Africa (Watson and Dallwitz 1992). The silk cotton with its massive, wide spreading, plank-like buttresses inspires awe in some and fear in others. Legends abound about this tree which is reputed in local folklore to be a haven for jumbies and frequented by practitioners of spiritism. The ancient Mayas considered the tree to be sacred and today the Maroons and Amerindians share that tradition (www.tropilab.com). *Ceiba pentandra,* though scattered throughout the forests of Trinidad and Tobago, does not occur in pure stands (Beard 1946). In 1983, during a field trip of the Trinidad and Tobago Field Naturalists' Club to Moruga Bouffe, David Rooks, an ornithologist and a past president of the Club, mentioned that the largest tree he had seen was a silk cotton in a section of the nearby mora (*Mora excelsa*) forest. They did not see the tree at that time.

Glenn Wilkes, returned on 22 January, 1984, and made an attempt, using triangulation, to estimate the height of the Moruga silk cotton. He failed because he could not see the topmost branch.

A second attempt was made on 14 May 1984, when Glenn Wilkes returned on foot with Victor Quesnel and Frankie Farrell in a helicopter above. A rope was lowered from the hovering helicopter, and when it touched the ground, the rope was cut at the level of the top of the tree. This gave a height of 56 m. Mora trees attain a height of of 45 m and it was assumed that this mora canopy was 45 m. Therefore, the silk cotton was 11 m above the canopy.

On 21 July, 2002, the authors set off to measure the girth of the Moruga silk cotton. The tree has nine massive buttresses to support its giant trunk. The tallest one is 13 m high. The plan was to cut two long poles, secure a tape measure firmly to one pole and loosely to the other, which would then be carried around the tree. This took three hours as the tree is closely surrounded by thick forest and it was necessary to prevent the tape from getting entangled among hanging lianas, epiphytes and the branches of under-storey trees. The circumference measured 10.3 m just above the buttresses. We also measured a hexagonal perimeter at 1.7 m above the ground on the six most prominent buttresses. This perimeter was 27.2 m.

This silk cotton thrives in a well-watered area with a thick mat of decaying vegetation. It appears to be in excellent shape, with no healed over scars and no indications that it has started rotting from within (21 July, 2002). The tree is probably no more than 200 years old.

We hope this report will encourage others to record the girth and height of giant silk cottons and any uncommonly large trees.

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