

Fieldguide Masoala Moths

Complementing the book "Magic Eyes of Masoala", published by Benteli, this PDF enables the quick identification of 400 Lepidoptera species in the field.

The unique diversity especially of the moths of Masoala's rainforests is presented systematically and in great detail. Using a light trap, author Armin Dett captured and photographed the fascinating creatures alive and then released them.

In cooperation with leading scientists and specialists the specimens were precisely identified and assigned into their families. The photos and additional texts not only inspire wonder at what nature is capable of creating, but they also serve as a valuable research tool and a source of interesting stories about Madagascar's moths.

Many thanks go to the following authors who make their expert knowledge of Lepidoptera and their experience in research available to the general public free of charge: Dr. Martin Bauert, Dr. David Lees, Dr. Marcin Wiorek, Dr. Axel Hausmann, Dr. Rodolphe Rougerie, Dr. Alexander Schintlmeister, Dr. Roland Hilgartner, Dr. Aristide Andrianarimisa, and Lovy Rasolofomanana.

Armin Dett

Hello Moth!
Who are you?

WCS

zooh! ZÜRICH

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Book “Magic Eyes of Masoala“

Hello Moth! Who are you?

This illustrated fieldguide to Lepidoptera from the Masoala Peninsula is a digital edition that has been expertly tailored for devices, showcasing the remarkable work "Magic Eyes of Masoala" by Armin Dett. The comprehensive volume documents over 400 species of Lepidoptera, especially moths, across 416 pages and weighs almost three kilograms.

The exquisite detail captured in the masterful photographs is even more pronounced in the digital format, allowing users to zoom in and observe individual scales, antennae, and other intricate structures in stunning clarity.

One of the key advantages of this digital edition is that it allows you to carry several hundred images on a smart device without any added weight. This facilitates an immersive exploration of the rich diversity and extraordinary beauty of Lepidoptera found in the rainforests of the Masoala region.

The Masoala Rainforest at Zoo Zurich, a remarkable replica of Masoala National Park housed in a vast greenhouse, has served as a powerful ambassador for rainforest beauty and conservation for over two decades. For more than 20 years, Zoo Zurich has contributed a quarter of the annual operating costs of Masoala National Park while also supporting numerous projects in the surrounding area. These initiatives include promoting sustainable agricultural practices, enhancing healthcare and educational resources, reforesting with endemic tree species, and encouraging biodiversity research in one of the planet's most species-rich forests.

Armin Dett's publications on the Lepidoptera of the Masoala region represent an extraordinary blend of design and scientific value. Over the course of 61 nights spent in the rainforest, he meticulously documented several thousand observations of moths and butterflies with his camera before releasing the individuals back alive into their habitat. Among these are at least 30 species that have yet to be scientifically described. Through months of diligent effort and collaboration with leading experts, he has analyzed his images, accurately identified the species, and compiled them into an exceptional body of work.

We are proud to have been able to provide significant support to Armin Dett during his research stays and in the publication of his outstanding works, thanks in part to the support of generous donors.

His contributions also serve as a vital historical record, methodically capturing the diversity of Lepidoptera. May Armin's passion for moths inspire countless nature enthusiasts to observe and document these fascinating creatures. There is still so much to uncover! So, don't hesitate to share your copy of the fieldguide with your friends and say "Hello!" to the Madagascan moths.

Dr. Martin R. Bauert
Head of Conservation, Zoo Zurich



Hello to the beauty of moths!

Insects – such small creatures and yet they represent the most diverse group of living organisms. There are so many of them and they are found everywhere, and in all types of habitats. They are little known to us, and in a place like Madagascar it is highly likely that many of these animals will disappear before we even learn that they exist. Together, butterflies and moths form the insect order Lepidoptera. Both are equally amazing, not only because of their various shapes, sizes, and patterns but also because of their colorful appearance at the different stages of their life cycle: caterpillars, pupae, and adults. However, while almost everybody finds butterflies interesting, very few of us pay any attention to moths.

People enjoy seeing butterflies but tend to overlook moths. In Madagascar, while everybody is aware of their existence, very few pay attention to these insects even though they are so numerous and exist everywhere: in the forest, on farmland, and even in towns. Many people are actually afraid of certain species of moth, believing that they foretell misfortune. Some species – mainly of saturniid moths – are called in the Malagasy language « lolom-paty », which literally means butterfly of death, and people believe that they are messengers between life and death, incarnating certain deceased relatives. It is believed that these moths do not just appear by chance but are a harbinger of impending events. When these creatures cross our path, it is a warning of grave moments that may soon come, whether the loss of a loved one or the echo of the spirits of the departed.

Adult moths and their caterpillars are an important element of the food chain as prey for a wide variety of other animals such as birds, amphibians, small mammals, bats, and other insectivorous animals. If Lepidoptera disappear, the ecosystem equilibrium would be greatly affected.. They are also important pollinators, thus helping in seed production. Since they are so widespread, found in so many different habitats, and so sensitive to changes, moths are particularly useful as indicator species. But apart from these ecosystem values, moths also exhibit several others. Not only are they of aesthetic, educational and scientific importance, they are of economic value also. In the MaMaBay area, for example, there is a program that assists local farmers in the production of artisanal silk from endemic moths helping to create more economically stable communities.

For all these reasons, moths are just as valuable as any other animals and deserve much greater attention. The myriad species of moths described in this digital medium reveal and reflect the biodiversity richness of Masoala's rainforests. To ensure better conservation of these creatures, the first step would be to become aware of their existence and to identify them! This PDF showcases numerous moth species displayed in beautiful photos in full color. Images taken from different angles are accompanied by short descriptions of their behavior.

As an amateur entomologist, I am fascinated by this PDF. Not only does it enrich my knowledge of these creatures, which play a key role in the life of forests while for the most part they remain hidden from sight and act chiefly at night. But at the same time I find the numerous beautifully colorful photographs are truly a delight. This electronic version is much better with its high-resolution photos of the moths that can be enlarged to appreciate the tiny details that escape the naked eye.

But this portable PDF version of the book is not just for entomologists. It is also for schoolchildren and students, to contribute to their education; for researchers, to satisfy their curiosity; for nature lovers, to discover the beauty of the forest that might otherwise escape even watchful eyes. It is for all community members to encourage appreciation for insects and foster support for programs to preserve biodiversity and the environment. Readily available, this portable guide is a handy reference that all nature lovers should have on their mobile phone, tablet or computer. Let's keep it close to hand at all times.

Lantoniaina Andriamampianina
Director Terrestrial Conservation,
Wildlife Conservation Society Madagascar



Tutorial for this PDF - Skill comes with practice

And this is how you can identify around 400 species of Lepidoptera visually using this PDF. Look closely at the appearance:

How are the antennae designed?

How are the wings held at rest?

On the central overview page 14 you will find a quickfinder for 10 superfamilies. Representative and frequently observed members of butterfly families are shown there. Look closely for similarities to the observed species that you want to identify:

What are the body proportions?

How big is the butterfly?

How are the wings shaped?

Head shape, eyes, palps and proboscis?

What markings do you recognize?

For each superfamily in question there are page references to the illustrated species gallery. Switch to the relevant pages and see if you can find the species you observed.

The family chapters contain introductory texts and stories about selected family representatives. Together with around 70 short texts, they provide interesting information about the biology of butterflies. In this way, you will gradually become a butterfly expert with in-depth knowledge. In doing so, you will realize how amazing butterflies are and what adaptations and abilities make them an important group of animals.

If the species you want to identify is not in the picture gallery, this is another reason to report and share your observation. In this way, you will gradually contribute to the knowledge about the butterflies of the Masoala region. Share your findings in working groups, in school projects, with laypeople and experts, with friends or online! If possible, include a photo and precise information about the location and date of discovery.



Agathia malgassa Herbulot, 1978

Explanation of abbrevations used in this PDF:
cf. = confer
sp. = species

- **Kingdom** Animalia (animals)
  - **Eumetazoa** (metazoans)
    - **Bilateria** (bilaterally symmetrical animals)
      - **Protostomia** (protostomes)
        - **Ecdysozoa**
          - **Arthropoda** (arthropods)
            - **Hexapoda**
              - **Class** Insecta (insects)
                - **Order** Lepidoptera (butterflies and moths)
                  - **Ditrysia**
                    - **Apotrysia**
                      - **Obtectomera**

The French lepidopterist Claude Herbulot (*19.02.1908–† 19.01.2006) was the first person who described this species in 1978 and gave it the scientific name.
All other names given later are synonyms. He is mentioned in the complete name of the moth.

                        - **Superfamily** Geometroidea
                          - **Family** Geometridae
                            - **Subfamily** Geometrinae
                              - **Genus** *Agathia*
                                - **Species** *Agathia malgassa* Herbulot, 1978

Species, Stories and Family Portraits



Antherina suraka
(Boisduval, 1833)

Still alive!
This individual presumably survived a predator attack from a bat or bird directed at the eye on the hindwing.

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Microheterocera and Macroheterocera

Text by David Lees

In Madagascar, at the most recent count in 2021, there were 1,418 genera and 5,016 species of Lepidoptera. Of these, 681 genera and 2,989 species are classified as Macroheterocera, (which are a natural group, loosely known sometimes as Macrolepidoptera, although those may include some micromoths like cossids too). The remaining 744 genera and 2,051 species are a really heterogeneous group that comprises both micromoths and butterflies.

Micromoths comprise 23 heterogeneous superfamilies, butterflies (Papillionoidea) are added.

Macroheterocera are divided into just five superfamilies, whereas the others, most of which are micromoths, comprise approximately 23 superfamilies and 70 families, only one superfamily of which (Papilionoidea) represents butterflies, of which there are six families in the fauna. So micromoths are very much more diverse, and include undoubtedly also the highest percentage of undescribed species. There are no good characters to separate macromoths from the other Lepidoptera. However, in the DNA barcode of Macroheterocera, the 177th complete codon is almost invariably Phenylalanine (F) rather than another amino acid state (typically Leucine; L).



Stathmopoda cf. *vadoniella* Viette, 1954

This PDF concerns itself principally with the macromoths of the Madagascan rainforest. On the left is a micromoth, a Stathmopodidae *(Stathmopoda* cf. *vadoniella)* species in its typical defensive posture, with one of the hindlegs sticking up like the warning sign of a stinging insect. On the right is a typical macromoth, an Erebidae in the subfamily Arctiinae, *Madagascarctia madagascariensis* (Butler, 1882). Sometimes such tiger moths pretend to play dead, on their back.

The Macroheterocera are divided into five superfamilies:

– Drepanoidea (drepanids)
– Noctuoidea (owlet moths)
– Geometroidea (inchworms)
– Lasiocampoidea (lappet moths)
– Bombycoidea (bombycoid moths)



Madagascarctia madagascariensis (Butler, 1882)

What is the difference between a butterfly and a moth?

Text by David Lees and Armin Dett

While there are around 18,500 species of butterflies worldwide, there are around 155,000 described species of moths. Thus around 11.5% of all Lepidoptera worldwide are butterflies, although this is an upper estimate as more moths must be undescribed. Butterflies are underrepresented in Madagascar: only about 6.5% of all Lepidoptera in Madagascar are butterflies. But how can butterflies be distinguished from moths? The following typical butterfly characteristics, which can also be observed in nature with the naked eye, serve to simplify allocation in the field.

Sensory apparatus

Butterflies have antennae that are knob-like or at least slightly thickened at the end. Indeed the Latin term Rhopalocera means club horns. In Madagascar, the antennae of moths do not exhibit such thickening, except in rare cases. The most spectacular exception is the male of *Pemphigostola synemonistis* Strand, 1909 (Noctuidae, Agaristinae), narrowly endemic to south-western Madagascar.

Wing coupling

The forewing of butterflies overlaps with an expanded 'humeral' area at the base of the hindwing but they are not physically coupled to each other. This allows butterflies to fly more erratically and to be highly manoeuvrable against pursuit by predators. By contrast, in the majority of moths (but not some primitive ones, outside the main grouping called Ditrysia) the forewings and hindwings of a single wing pair in moths are coupled to form a functional unit. A strong bristle (frenulum) on the upper edge of the hindwing engages with a hook-like, curved band below the upper edge of the front wing (retinaculum). This flexible coupling is formed differently in males and females of most moth families. The wings can quite easily be unlinked, but can be reconnected.



Junonia oenone epiclelia (Boisduval, 1833)

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Maassenia heydeni (Saalmüller, 1884)

Antennae – cleaning important sense organs

The antennae of moths are important sensory organs and are covered in tiny sensillae and minute pores used to detect chemicals such as trace quantities of female pheromones in the air. To keep them in top condition many species use a cleaning hook and brush (the epiphysis) on the foreleg tibia, which is the perfect shape for the antenna to slip through.

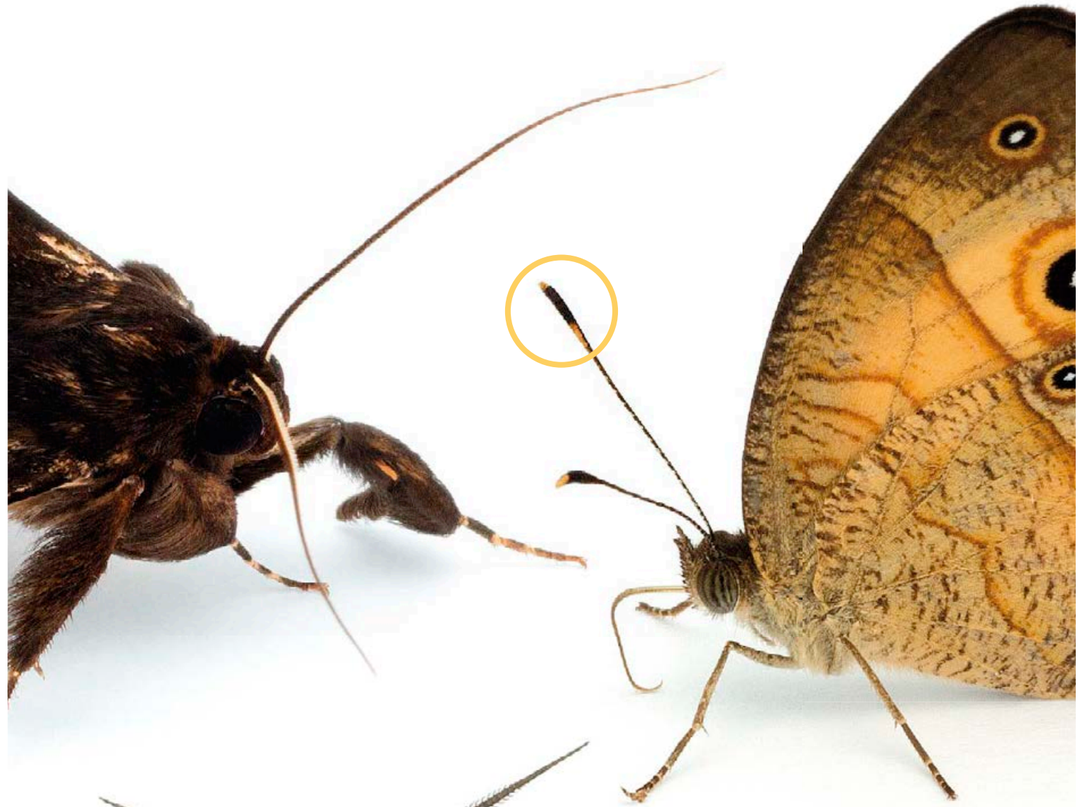


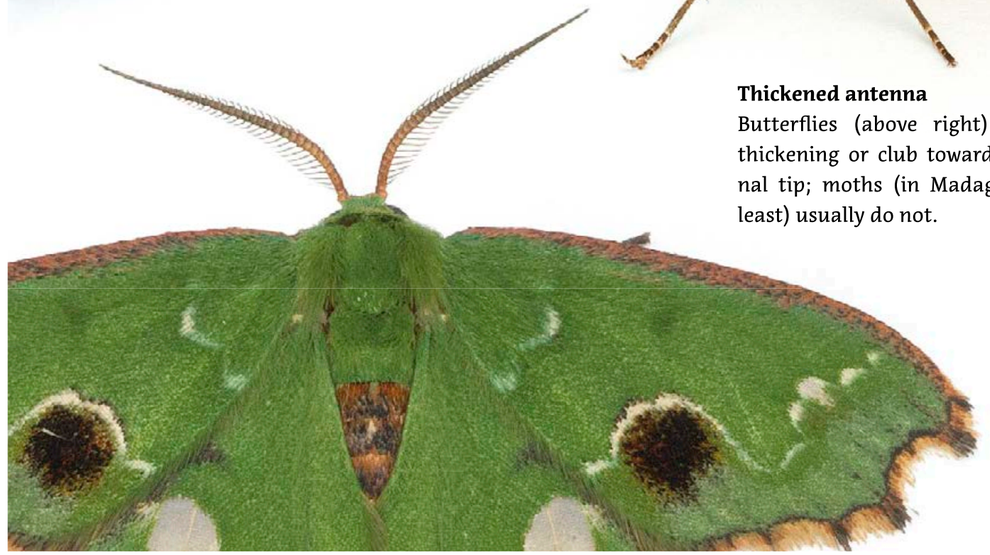
Hypolimnas misippus (Linnaeus, 1764)
female

Cleaning the antennae

This mimic butterfly is using her right midleg to clean the antenna. As with other nymphalids, the foreleg is reduced. Some nymphalids can also clean the compound eyes using a sideways movement of the labial palps.







Thickened antenna
Butterflies (above right) have a thickening or club towards antennal tip; moths (in Madagascar at least) usually do not.





Eudasychira ampliata (Butler, 1878)
Lymantriinae





Acroctena pallida (Butler, 1882)
Notodontidae



Acherontia atropos (Linnaeus, 1758)
Sphingidae



Wing coupling between forewing and hindwing
Examples of paired wings are shown from different Lepidoptera families. Unlike in butterflies, which have no such linking system, the strong, curved and pointed bristle or frenulum at the base of the leading edge of the hindwing upperside of a vast variety of moths is hooked into a flexible band or retinaculum on the forewing underside, which can be clearly seen in these moth examples from Sphingidae, Erebidae: Lymantriinae and Notodontidae. This purely mechanical connection can come loose and even be rethreaded by the moth. In many cases the number of bristles can be greater in females.





Heteropsis fraterna
(Butler, 1878)

Activity

Butterflies are for the vast majority only active during the day – while there are also species of moths in several families that are active during the day. Butterflies are not usually attracted to artificial light, which is due to the way their eyes are adapted. Butterfly eyes generally consist of many individual lenses (ommatidia), which together form a compound eye. In butterflies, the individual eyes are completely surrounded by pigment cells (the apposition eye type). Light only reaches the light entering through the lens, while the surrounding pigment cells absorb a large proportion of the light. In moths, the pigment cells around the individual eyes can be reduced (superposition eye). Incident light then also hits the neighboring individual lenses or ommatidia – the moth can then see less clearly, but perceive more light.

Proboscis

Butterflies always have a functional proboscis and use it to suck up liquids as food. Among the moths, however, there are families (see e.g. Bombycoidea) that do not feed as adults and have proboscis reduced or absent.

Resting posture

Butterflies typically hold their wings upright and closed over the body when at repose or sleeping. Moths usually rest with their wings folded over the body like a tent, but some, like many geometrids, rest with the wings very flat to the surface.

Auditory organs

Butterflies lack typical tympanic structures, or ears. However, they are very sensitive to vibrations and also some, like Satyrinae, have balloon-like veins at the forewing base that may allow them to enhance sounds. Some moths have hearing organs, particularly

among the Pyraloidea and the Macroheterocera, which are developed differently depending on the family and are located on different parts of the body (in Uraniidae on different abdominal segments!). This allows, for example, bird beak clicks or the sonar of nocturnal bats to be perceived. However, this is already a specialization that arose more than once against predators, because research has shown that moths were able to hear around 30 million years before the first bats appeared. Some moths also produce sounds, but clicking is unusual in butterflies.

Developmental stages

All Lepidoptera are holometabolous, that is to say, they have four developmental stages, eggs, larvae (usually with five growth stages or instars, sometimes more), pupae and adults. The early stages of Malagasy Lepidoptera are only known for a small proportion of species. Eggs and caterpillars are very varied in morphology, and without a guide rearing is usually necessary to identify them (some butterfly families though can be readily identified by particular structures, such as a pungent organ called an osmeterium extruded on disturbance and unique in swallowtail butterflies). Butterfly pupae are most often free, but Papilionidae and Pieridae have a silken girdle like a few Geometridae (Sterrhinae), and in Madagascar they are always without a cocoon and never under a silken web. Moth pupae are often hidden in cocoons, silked together in leaves or buried naked in the ground.

It should be noted that all Lepidoptera that are not butterflies are called moths. Only butterflies, in an evolutionary sense, are a natural group. In view of the huge diversity of species among the Lepidoptera, however, there are almost always exceptions and specializations and so not all characteristics can be truly diagnostic. Diurnal activity and coloring of the moths are not suitable as systematic distinguishing features, for example. Butterflies are often considered more “colorful” than “moths”: but this is mainly due to the cryptic, hidden way of life of moths. This PDF sheds light on the secret life and comportment of adult moths, in particular.





Resting posture
Butterflies usually hold their wings closed over their back when at rest (moths rarely do; an exception is *Chrysiridia* at night as well as a few geometrids). When feeding, some skipper butterflies hold their wings flat.



Papilionoidea 15–22



Cossoidea 23/24



Zygaenoidea 25–30



Bombycoidea 47–80



Lasiocampoidea 81–87









Geometroidea 88–108

Quickfinder Lepidoptera superfamilies



Gelechioidea 31–33



Thyridoidea 34–36



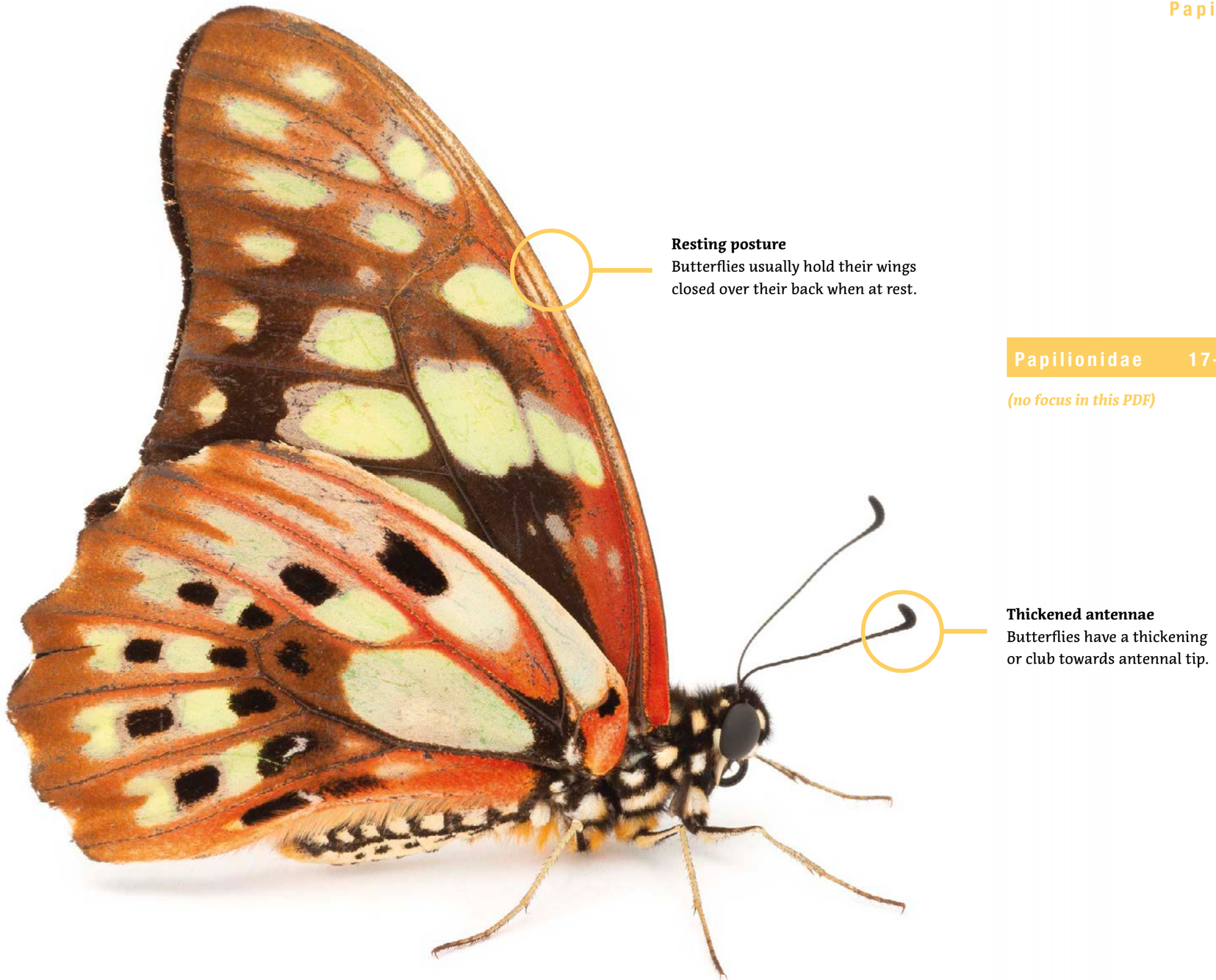
Pyraloidea 37–46



Noctuoidea 109–159

14

Papilionoidea



Resting posture
Butterflies usually hold their wings closed over their back when at rest.

Thickened antennae
Butterflies have a thickening or club towards antennal tip.

Papilionidae 17–22

(no focus in this PDF)

15

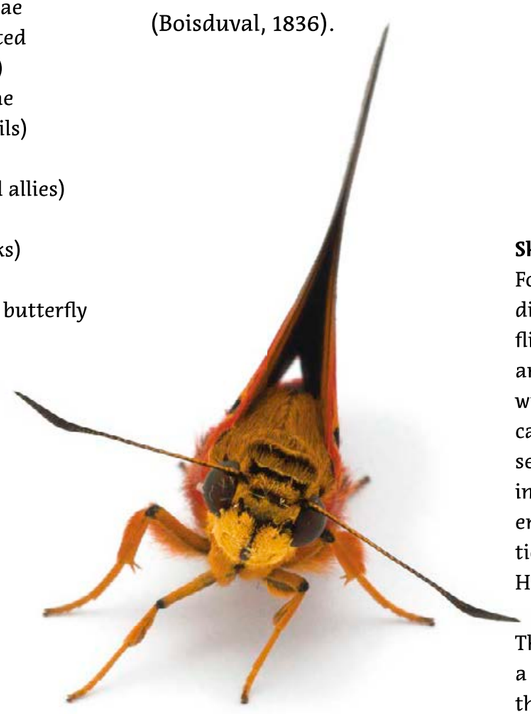
Papilionoidea (Butterflies)

Text by David Lees

The superfamily Papilionoidea includes seven families within the Lepidoptera, six of which occur in Madagascar (Hedylidae is absent). The shape, formation and position of certain hard parts (sclerites) of the chitinous exoskeleton of the moth butterflies and the branching of their wing veins are anatomical features that serve, among other things, for taxonomic family classification.

Papilionoidea include seven families:
– Hesperiidae (skippers)
– Lycaenidae (Blues, coppers, hairstreaks)
– Nymphalidae (brush-footed butterflies)
– Papilionidae (swallowtails)
– Pieridae (whites and allies)
– Riodinidae (metalmarks)
– Hedylidae (New world butterfly moths)

In Masoala and Makira well over 150 butterfly species are known. They vary from the rather small blue butterfy *Cacyreus darius* (Mabille, 1877) and the skipper *Galerga (Fulda) rhadama* (Boisduval, 1833) to quite large and strikingly colorful species such as the papilionid *Graphium cyrnus* (Boisduval, 1836).



Malaza fastuosus (Mabille, 1884)

Skippers

For a long time Hesperiidae or Skippers were distinguished from so-called 'true butterflies'. In fact, Hesperiidae are an important and integral family of butterflies worldwide, with over 4,100 species, and in Madagascar, where about 57 species are known, some seven of the nineteen genera are endemic, including the genus *Malaza* (Malazinae, also endemic). There are also endemic radiations of forest skippers in the subfamilies Hesperiinae and Heteropterinae *(Hovala)*.

The antennae of skippers frequently feature a crochet after the club. Adults rest with the wings over the back or sometimes hold them flat when nectaring. The larvae of most species feed on grasses / bamboos.



Graphium cyrnus (Bosiduval, 1836)

Papilionidae



Graphium cyrnus (Boisduval, 1836)

Hesperiidae



Galerga (Fulda) rhadama (Boisduval, 1833)



Malaza fastuosus (Mabille, 1884)

Hedylidae
(Neotropical family, missing in Madagascar)



Macrosoma hyacinthina (Warren, 1905)

Pieridae



Leptosia sylvicola (Boisduval, 1833)



Eurema pulchella (Boisduval, 1833)

Nymphalidae







Hypolimnas misippus (Linnaeus, 1764)
female

Protogoniomorpha duprei (Vinson, 1863)

Lycaenidae



Chilades pandava (Horsfield, [1829])

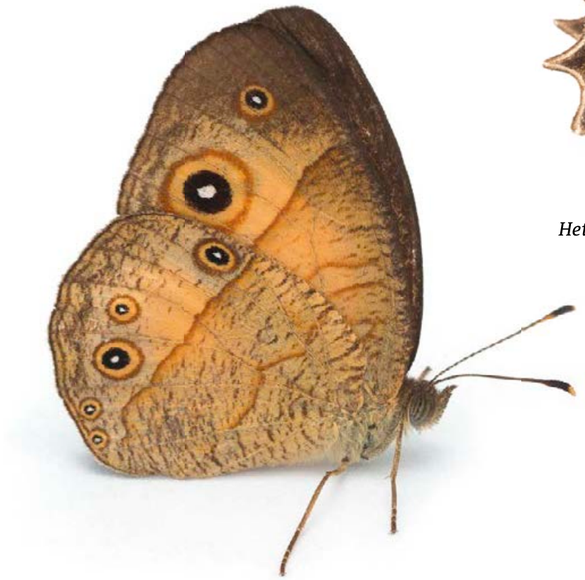


Cacyreus darius (Mabille, 1877)

Riodinidae

Saribia perroti Riley, 1932
Photo: David Lees





Heteropsis fraterna (Butler, 1878)



Heteropsis uniformis (Oberthür, 1916)



Heteropsis pauper (Oberthür, 1916)

Camouflage colors
Butterflies are usually more colorful than most moths, as they fly by day, but the brown butterflies (Satyrinae) represent about a third of the butterfly fauna and like some skippers (Hesperiidae) tend to be drab in color with cryptic undersurfaces. The genus *Heteropsis* boasts over 60 species alone.



Junonia oenone (Boisduval, 1833)



Phalanta aethiopica Rothschild & Jordan, 1903

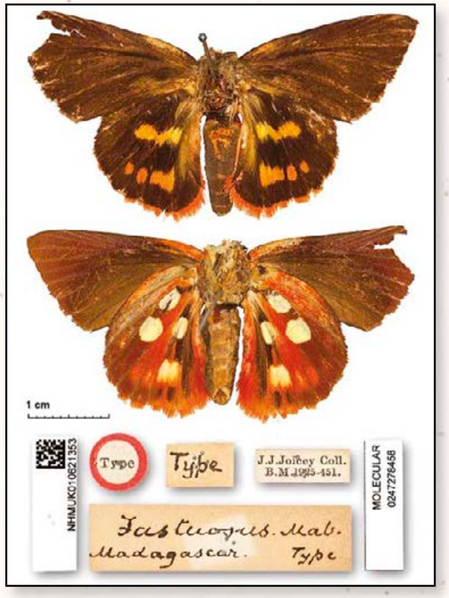


Junonia goudotii (Boisduval, 1833)

Missing for five Decades - rediscovered in 2019 *(Malaza fastuosus)*

Text by David Lees

One of the most exquisite and yet seldom seen skippers (Hesperiidae) in Madagascar is the so-called Lavish Malaza, *Malaza fastuosus*. Apparently the last known specimen was collected in 1971 in Ankarafantsika National Park. To find the pupa and then to observe an adult emerging of this species in Masoala, after a half century without observations, is perhaps the breathtaking experience for a butterfly photographer. What is more, the butterfly belongs to a subfamily that was only recently recognized as novel for the World, and also endemic to Madagascar. Few Malagasy Lepidoptera families or subfamilies have this special honor, two others being Whalleyanidae and Griveaudiinae.



Picture: Courtesy Trustees of the Natural History Museum, London
Photo: Nick Grishin

A team led by Jian Zhang and Nick Grishin at the University of Texas Southwestern Medical Center and David Lees at the Natural History Museum in London published a study in Genome in 2020 where they were successful in sequencing the mitochondrial genome of the holotype specimen of this species from a single foreleg. Because the holotype is the specimen on which its nomenclature is based, it is very precious (even though this specimen lacked a head!), so the partially digested leg was returned to the specimen after minute quantities of the DNA were extracted. This type specimen, although its exact collection details were not recorded on its label, was collected well before 1884 when it was described by Paul Mabille, in fact before 1878 when it had been thought to be the female of a smaller species, *Malaza empyreus*. The DNA of this specimen was therefore very degraded, present in only tiny pieces, and so the fragments were stitched together into a complete mitochondrial genome of 15,579 nucleotides using the power of modern technology (Next Generation Sequencing). Their analysis showed that the genus *Malaza*, which contains two other described species, does not belong to any known Hesperiidae subfamily. It appeared closest to Heteropterinae and the Australia subfamily Trapezetinae. Like some other Malagasy skippers, the species was originally described in the genus *Trapezites*. Its compound eyes exhibit a very fine layer of setae or hairs. Hairy compound eyes are rare in skippers, but known from a couple of other genera. Zhang et al. (2020) provide many more details.



Malaza fastuosus (Mabille, 1884),
hatched on 14.03.2019, Masoala Forest Lodge.



Unusual pupa

The pupa was found on a leaf of *Toddalia* sp. (Rutaceae), but it seems questionable that this was the larval foodplant. It is unusual among skipper butterflies in that the front of the pupa has three horns, two of them lateral. Before emergence, yellow bands from the abdomen show through strongly. It is not known if *Malaza* might contain toxins against predators, but this is often the case for brightly colored butterflies. The resting posture of the genus is unknown, but they fly by day and take nectar from flowers.

The hostplants of Malazinae have never been reported, but are thought to be monocotyledons, because of the phylogenetic position of the subfamily which in the study of Zhang et al. was close to the grass-feeding Heteropterinae (the genus *Hovala* occurs in and is endemic to Madagascar). Probably then Malazinae are an ancient lineage of skipper butterflies.



Malaza fastuosus (Mabille, 1884)

Story
Hesperiidae

Malazinae



Malaza fastuosus (Mabille, 1884),
hatched on 14.03.2019, Masoala Forest Lodge



Malaza fastuosus (Mabille, 1884),
hatched on 14.03.2019, Masoala Forest Lodge

Story
Hesperiidae

Malazinae



Malaza fastuosus (Mabille, 1884),
hatched on 14.03.2019, Masoala Forest Lodge

Dangerous Neozoa to endemic Cycads

Text by David Lees

The arrival of the Cycad Blue *Chilades pandava* in the Masoala peninsula not only adds a new lycaenid butterfly species to the fauna, which was previously documented to have 135 butterfly species by Claire Kremen and colleagues in 2001, but it also adds a potential threat.



Feeding pattern and caterpillars of *Chilades pandava* on the foliage of *Cycas thouarsii*
Photo: Martin Bauert, Masoala, Tampolo, 2019

That is because not only does the butterfly larva feed on the young fronds of the introduced Sago Palm (actually a cycad!), *Cycas revoluta*, popular for planting in hotel gardens, but it is also known, according to observations by Steve Collins, to feed on the Madagascar Cycad *Cycas thouarsii*. A population of this rather rare plant occurs on the western side of the Masoala Peninsula, and in 2001 D. Lees examined these plants and found no herbivores on them. However, the plant also is found in the Comoros, Seychelles and Eastern Africa.

Chilades pandava was first observed in Madagascar on Île Sainte-Marie in 2006 and has since been observed in several places along the eastern coast, where it can severely defoliate the young leaves of cycads. It has not, however, colonised the uplands. The study by Li-Wei Wu and his coauthors in 2010 showed that the Malagasy population probably originated in Southeast Asia, occurring to its mitochondrial haplotype. It is likely to have arrived via the ornamental plant trade, rather than of its own accord.



Chilades pandava (Horsfield, [1829]),
photo taken on 28.02.2019, Masoala Forest Lodge

Cossoidea

Cossidae 23–24



23



Zeuzeropecten occultoides (Kenrick, 1914)



Cossidae sp. Leach, 1815

Pseudocossus sp. Kenrick, 1914





Limacodidae 26–30

Zygaenoidea

Text by Marcin Wiorek

The superfamily Zygaenoidea with its around 3,300 species is a rather small group of moths, occurring worldwide, but mostly in the tropics. From Madagascar some 85 species are known. An interesting feature of this superfamily is that it comprises around 12 families, but most of them comprise only a couple to a few dozen species. Their representation in Madagascar also looks interesting. Only three species of Epipyropidae, nine Lacturidae, one Somabrachyidae, and five Zygaenidae have been described – the latter actually represented only by the subfamily Procridinae. The most species-rich family in Madagascar, as also worldwide, is Limacodidae with around 65 species, and some of them are displayed in this chapter.

An interesting thing about Zygaenoidea is that some species, like *Pseudolatoia oculata*, *Ximacodes pyrosoma* or *Parasa reginula*, are somewhat aposematically colored (even more so the strangely, shaped caterpillars, in the case of Limacodidae, here, giving the popular name of Slug Moths), which means that they may contain toxic substances, as you can learn elsewhere in this app. And indeed, some Zygaenoidea are known to contain in their bodies cyanogenic glycosides, which are extremely poisonous as they transform into hydrogen cyanide in the predator's organism. However, the moths themselves have special enzymes that protect them from self-poisoning. The low numbers of Zygaenoidea species recorded from Madagascar do not necessarily derive solely from the evolutionary history of that group – for example the subfamily Zygaeninae has passed Madagascar by. Some of them, like procrinines, for which there are five known species, are elusive forest moths, so more species remain to be discovered.

An unrecognized feature of Madagascan Procridinae is that they include presumed mimics of other insects. Some of them resemble Lycidae beetles, known also as net-winged beetles, and the others perhaps imitate tiger moths from the tribe *Syntomini*, mentioned later. Actually, mutual similarities between certain Zygaenoidea and Arctiinae species are observed worldwide, but this phenomenon is still not fully studied.



Parasa valida Butler, 1879



Latoia vadoni Viette, 1980



Latoia catalai Viette, 1980

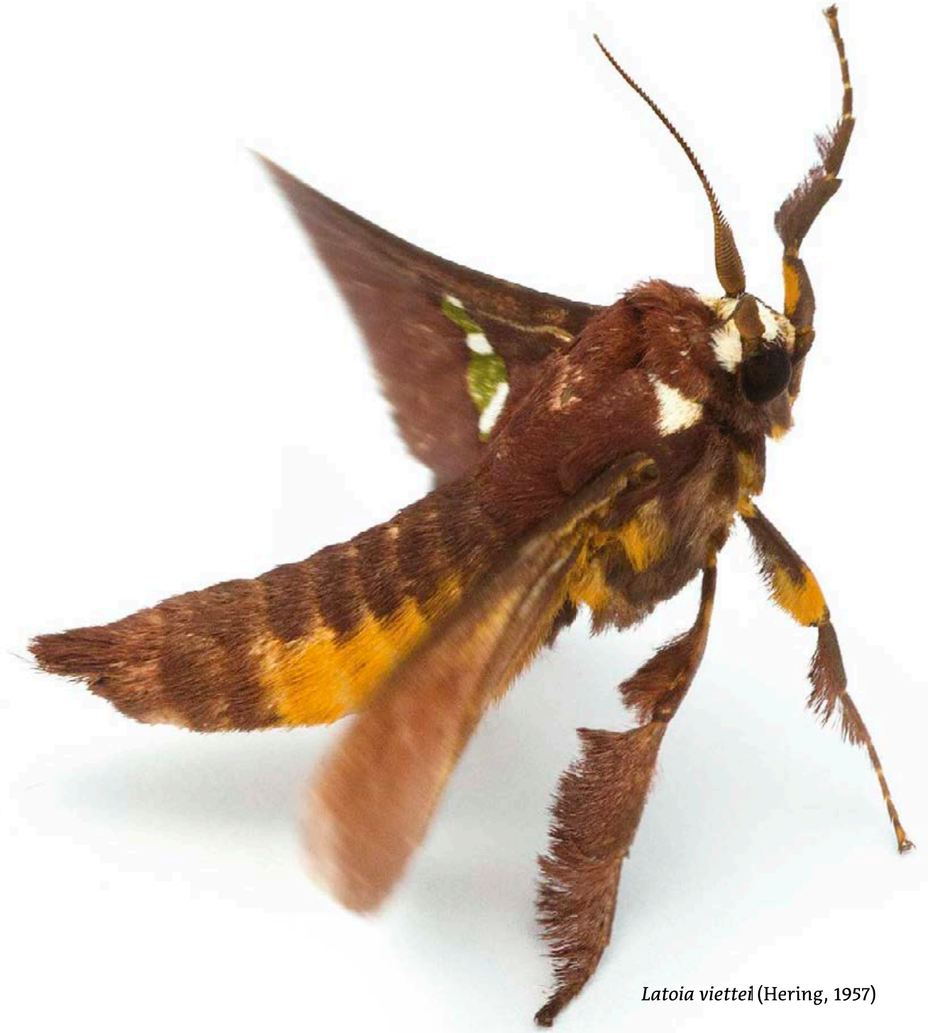


Pseudolatoia sp. Hering, 1954



Latoia viettei (Hering, 1957)





Latoia viettei (Hering, 1957)



Parasa ankalirano Viette, 1980



Parasa valida Butler, 1879



Parasa reginula Saalmüller, 1884



Ximacodes sp. Viette, 1980



Thliptocnemis barbipes Mabille, 1900



Thliptocnemis pinguis (Saalmüller, 1880)



Pseudolatoia oculata Hering, 1957



Ximacodes pyrosoma (Butler, 1882)



Ximacodes sp. Viette, 1980



Ximacodes pyrosoma (Butler, 1882)

Scaly legs

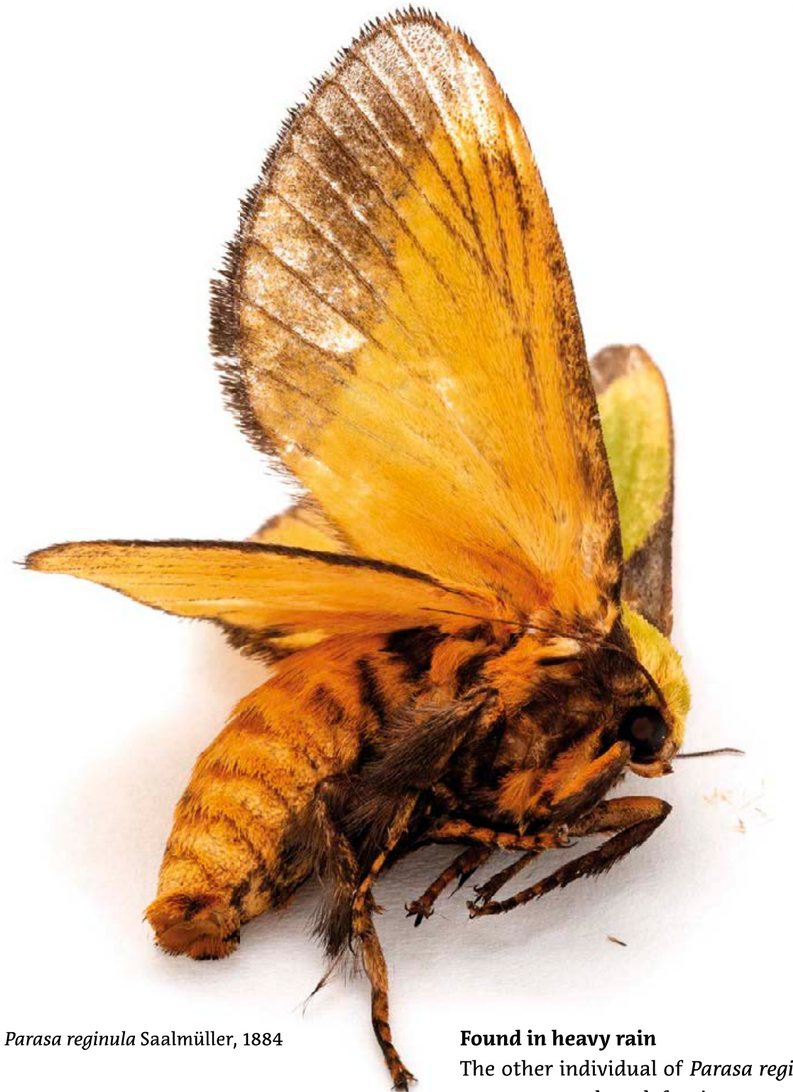
The moths of species *Ximacodes pyrosoma* here, similarly as with those of *Parasa reginula* mentioned previously, are shown in their defensive poses. First, they spread wide their legs, densely covered with hairy scales, which make them resemble a spider. Additionally, they expose their vividly colored back. Perhaps this combination of this unusual shape and aposematic coloration is meant to discourage the potential predators.





Parasa reginula Saalmüller, 1884

Spider or moth?
Parasa reginula shows its defensive poses: it has spread wide its legs, densely covered with hairy scales making it resemble a spider.



Parasa reginula Saalmüller, 1884

Found in heavy rain
The other individual of *Parasa reginula* displayed here presents another defensive strategy – thanatosis or playing possum, described in detail on the example of a lymantriinae moth later in the PDF. This moth here also is apparently playing a dead individual, with wings and legs laid out. Note that it is completely soaked, because it was collected in heavy rain; this does not stop the flight activity in many moths.

Gelechioidea



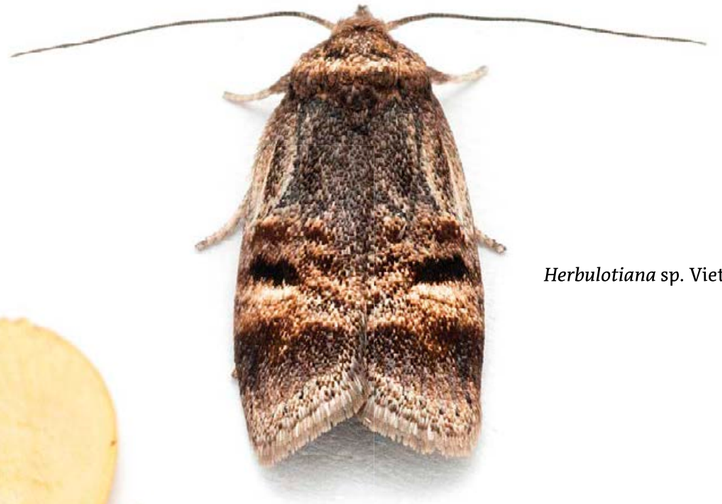
31

Stenomatidae and Peleopodidae (curved-horn moths)

Text by David Lees

Sometimes classified as a subfamily of Depressariidae and sometimes as a distinct family, Stenomatidae, the genus *Herbulotiana* is considered to be the only Malagasy representative of a largely Neotropical group.

Mnarolitia is a member of Peleopodidae, subfamily Oditinae. These belong to the superfamily Gelechioidea, as can be seen by the strongly recurved palps, but the body is more robust in shape than in the vast majority of micromoths. Unfortunately nothing is known of their biology.



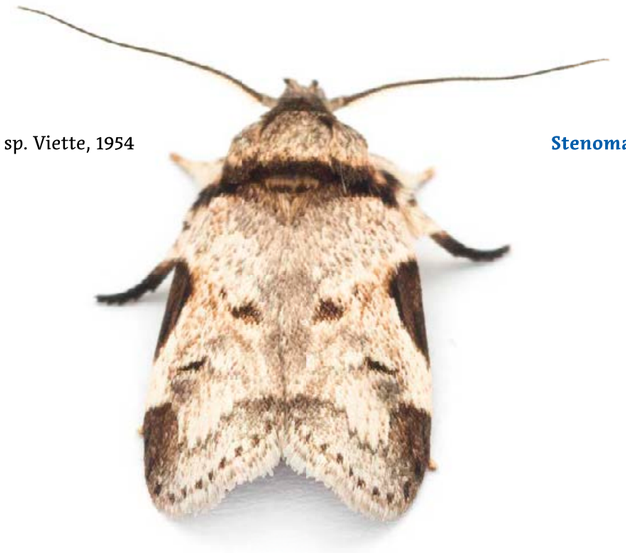
Herbulotiana sp. Viette, 1954



Mnarolitia sp. Viette, 1954

Small, quick and agile

These small moths are agile and swift fliers. They manage to reach almost every blossom in the rainforest, no matter whether flowering in the dense foliage of the treetops or on the trunks of trees. They are found regularly at the light trap in Masoala and Makira but they are agile, always in motion, and difficult to photograph. Little is known of their biology and the numbers of species. *Herbulotiana* has a short proboscis.



Herbulotiana sp. Viette, 1954

Stenomatidae



Odites sp. Viette, 1954

Peleopodidae



Mnarolitia sp. Viette, 1954

Oditinae



Herbulotiana sp. Viette, 1954



Herbulotiana sp. Viette, 1954



Herbulotiana cf. *bicolorata* Viette, 1954



Herbulotiana sp. Viette, 1954



Herbulotiana sp. Viette, 1954



Herbulotiana sp. Viette, 1954



Herbulotiana sp. Viette, 1954



Herbulotiana sp. Viette, 1954



Herbulotiana sp. Viette, 1954



Herbulotiana sp. Viette, 1954



Herbulotiana longifascia Viette, 1954

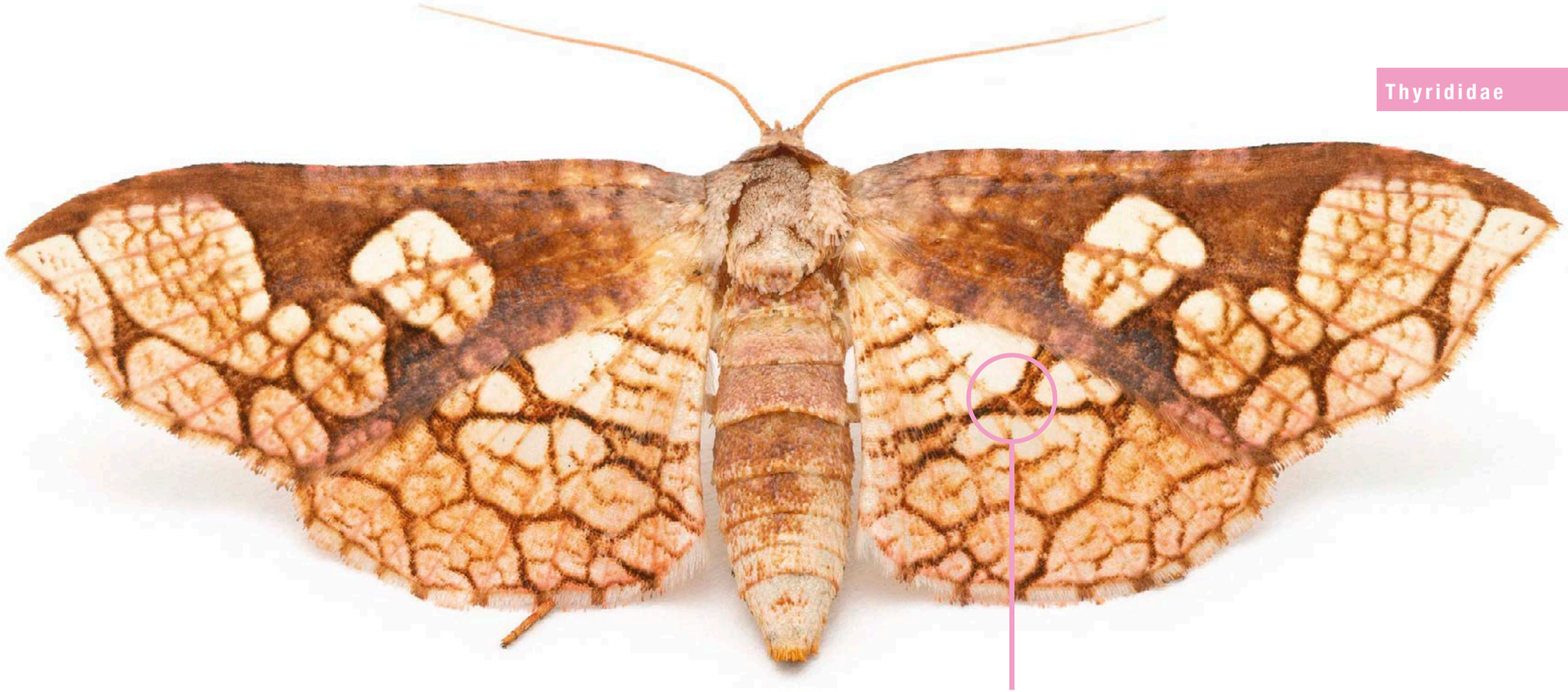
Radiative adaptation

Herbulotiana is a nice example of an evolutionary species radiation. The genus is unique to Madagascar and the only Afrotropical representative of the giant, mainly Neotropical, moth family Stenomatidae. It has radiated into numerous different color variations on the same basic body structure. Many species must be undescribed.

Gelechioidea
Stenomatidae

Thyridoidea

Thyrididae 35–36



often net-like semi-transparent wing pattern

34



Chrysotypus cupreus Kenrick, 1914



Rhodoneura opalinula (Mabille, 1880)



Rhodoneura sp. Guenée, 1858



Rhodoneura zophocrana Viette, 1957



Rhodoneura cf. *werneburgalis* (Keferstein, 1870)



Banisia myrsusalis (Walker, 1859)



Striglina cf. *minutula* (Saalmüller, 1880)

Tropical leaf moths

Tropical leaf moths of the family Thyrididae are so called because of their predominance in tropical forests and the resemblance of some to dead leaves or leaf skeletons. At the light trap they are delicate and rather inconspicuous guests that settle down quickly and stay motionless. Parts of their wings are often scaleless and translucent, which helps in the imitation of decaying leaves. In Madagascar there are 32 known species in the subfamily Siculodinae, compared to at least 940 species worldwide.



Rhodoneura cf. *werneburgalis* (Keferstein, 1870)



Thyridoidea
Thyrididae

Siculodinae







36

Pyraloidea

Resting position
slightly angled,
antennae placed back



Crambidae 38–45

37

Pyraloidea (Snout moths)

Text by Marcin Wiorek & David Lees

The family Pyraloidea, comprising around 16,000 known species, is one of the most diverse groups of Lepidoptera. Currently it comprises two main families: Pyralidae and Crambidae, with around 6,000 and 10,000 species respectively. In Madagascar, there are around 370 known species of pyralids and 350 crambids.

In moths generally, assignation of a species to family or even superfamily based solely on superficial characters, like body shape and coloration, can be quite tricky and very often misleading. However, the members of Pyraloidea are usually relatively easy to distinguish. These moths most often have elongate, subtriangular body shape in resting position, with very long and thread-like antennae oriented backwards (e.g. *Megatarsodes baltealis*), and sometimes with elongate labial palpi on their heads. Some species, especially in Spilomelinae, have striking, pearly and glittering wings that can either be almost unicolorous (e.g. *Palpita jacobsalis*, *Stemorrhages uniformis*) or covered with a pattern of subrounded or subtriangular blotches. Within this superfamily has evolved also a huge diversity of different life strategies. The larvae of Pyraloidea feed not only on leaves, but also e.g. inside plant stems. Moreover, some of them develop under water on aquatic plants (e.g. probably Acentropinae spp., and *Eoophyla* sp.), or even scavenge in ant nests. *Acracona pratti* has been recorded in Madagascar to live in the large carton nests of *Crematogaster* sp., Formicidae!

A number of species within this subfamily are considered serious pests on crops (e.g. *Spoladea recurvalis* and *Maruca vitrata*) and stored products.



Megatarsodes baltealis (Mabille, 1881)

38

Musotiminae



Ambia sp. Walker, 1859

Spilomelinae



Glyphodes sp. Guenée, 1854

Odontiinae



Viettessa bethalis (Viette, 1958)

Subfamilies covered in this app

The subfamilies of Crambidae covered in this app include: Acentropinae (these are the ones living in aquatic habitats), Musotiminae (these are fern feeders), Galleriinae (caterpillars of some species are known as waxmoths), Odontiinae and Spilomelinae. Regarding Pyralidae, depicted here are some members of Pyralinae.

Pyralinae



Zitha sp. Walker, 1866

Galeriinae



Yxygodes vieualis (Viette, 1960)

Musotiminae



Ambia sp. Walker, 1859

Acentropinae



Acentropinae sp. Stephens, 1836



Acentropinae sp. Stephens, 1836



Cataclysta sp. Hübner, 1825



Orphnophanes ankarampotsyalis Marion & Viette, 1956



Orphnophanes ankarampotsyalis Marion & Viette, 1956

False eyes on the hindwings

As you can learn reading other chapters of this app, many moths have developed special patterns on their wings, protecting them from predators by resembling the body parts of other animals – such as, apparently, lemur eyes in Saturniidae. Perhaps the most amazing example of such strategy in micromoths is the mimicking of jumping spiders (family Salticidae). This strategy has been brought almost to perfection by the metalmark moths (family Choreutidae, not covered in this app), but has appeared independently in the crambid subfamily Acentropinae. Perhaps it is not so obvious when looking at a spread specimen in a collection, but living moths display their multiple eyespots clearly, as here in *Eoophyla* species.

Folded wings seen from the right angle look like a salticid spider: the dark dots on the hindwing margin are the spider's eyes, and the zig-zag pattern of the forewing – its legs. The reason for such protection is apparently protection from being eaten by salticids. These spiders are territorial and usually back away when encountering another spider. But considering the relatively small size of many jumping spiders, another hypothesis has been proposed: mimicking such fast and jerky spiders may make them look like unprofitable prey.



Yxygodes vieualis (Viette, 1960)



Acracona pratti (Kenrick, 1917)



Yxygodes insignis (Mabille, 1900)



Yxygodes insignis (Mabille, 1900)



Yxygodes zonalis (Mabille, 1900)



Yxygodes zonalis (Mabille, 1900)



Clupeosoma sp. near *orientalalis* (Viette, 1954)



Viettessa bethalis (Viette, 1958)

Ant as a stowaway

As already mentioned, in Pyraloidea have evolved some of the most amazing life strategies in all Lepidoptera. Why should it not include interactions with other insects? In a few different species ants have been observed hanging around a moth, behaving a bit as if they were stowaways. It might be some completely unknown interaction, but perhaps the explanation is simpler and more brutal – ants may prey on weakened, dying moths. But nevertheless, in Pyraloidea there are other known kinds of interactions with ants. For instance, larvae of *Acracona pratti*, an adult of which is displayed on the previous page, develop inside the nests of *Crematogaster* ants and have apparently found a way to trick their hosts into leaving them alone.



Glyphodes boseae (Saalmüller, 1880)



Agrioglypta toulgoetalis (Marion, 1954)



Bocchoris inspersalis (Zeller, 1852)



Botyodes andrinalis Viette, 1958



Cirrhochrista cygnalis Pagenstecher, 1907



Botyodes asialis Guenée, 1854



Coptobasoides pauliani (Marion, 1955)



Diaphania indica (Saunders, 1851)



Euphyciodes albotessulalis (Mabille, 1900)



Ghesquierellana hirtusalis (Walker, 1859)



Ghesquierellana hirtusalis (Walker, 1859)



Ghesquierellana sp. Berger, 1955



Glyphodes paramicalis Kenrick, 1917



Glyphodes shafferorum Viette, 1987



Glyphodes shafferorum Viette, 1987



Sinomphisa jeannelalis (Marion & Viette, 1956)



Hymenia perpsectalis (Hübner, 1796)



Maruca vitrata (Fabricius, 1787)



Megatarsodes baltealis (Mabille, 1881)



Obtusipalpis rubricostalis Marion, 1954



Palpita jacobsalis (Marion & Viette, 1956)



Parotis sp. Hübner, 1831



Omphisa sp. Moore, 1886



Pramadea ovialis (Walker, 1859)



Pycnarmon sp. Lederer, 1863



Syllepte lanatalis Viette, 1960



Pramadea ovialis (Walker, 1859)



Syllepte lanatalis Viette, 1960



Sinomphisa jeannelalis (Marion & Viette, 1956)



Synclera traducalis (Zeller, 1852)



Ulopeza crocifrontalis Mabille, 1900
male



Ulopeza crocifrontalis Mabille, 1900
female

Sexual dimorphism – males and females are colored differently

Polymorphism, i.e., occurrence of different forms (so called morphs), is quite common in Lepidoptera. There are many different types of this phenomenon, and one of them is sexual dimorphism, meaning that the male and the female of a species look different. Usually these differences are subtle, as for example shape of the antennae, but sometimes very distinct, as in *Ulopeza crocifrontalis* displayed here: The male has subtriangular blotches on the forewings, whilst in the female they are almost entirely orange.







Stemorrhages uniformis (Maes, 2023)







Pyraloidea
Crambidae

Spilomelinae

Pheromone scales at the end of the abdomen

How a male and female of a moth species are able to locate each other within a vast area is a wondrous thing. In fact, Lepidoptera leave almost everything to the sense of smell. Individuals of one sex emit special chemical substances, so-called pheromones, that diffuse in the air and transmit the signal of their presence to the individuals of the opposite sex (or even competitors of the same sex!), that detect it with their antennae. If these are males that emit pheromones, then they usually have on their bodies some special structures made up of scales, sometimes in the form of a brush or tuft. In the case of males of *Stemorrhages uniformis*, shown here (but also *Diaphania indica* on page 42), it is a special tuft of pheromone scales at the end of the abdomen, which is normally folded, and unfolded when needed. The scent release might help the females to judge between rival males in the close stages of courtship.



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Galleriinae



Lamoria clathrella (Ragonot, 1888)

Pyralinae



Lophocera vadonalis Marion & Viette, 1956



Lophocera flavipuncta Kenrick, 1917



Sacada cf. *madegassalis* Viette, 1960



Zitha sp. near *sanguinalis* (Marion, 1954)

Pyralinae



Sindris sganzini Boisduval, 1833



Sindris leucomelas Kenrick, 1917



Sindris sganzini Boisduval, 1833





Bombycoidea (Silkworm moths)

Text by David Lees

The superfamily Bombycoidea includes some of the largest and most spectacular as well as most popular moths. There are over 6,000 species worldwide and at least 92 in Madagascar. There are four families recognized for the fauna out of 10 worldwide. The Bombycidae have one native species in western Madagascar, *Ocinara malagasy*. The Eupterotidae have one unique species, which is known from Antongil Bay forests, *Malagasanja palliatella* (Viette, 1954). In Madagascar the Saturniidae have 26 species, 22 of which are in the genus *Maltagorea* while 64 are Sphingidae species.

Many bombycoids have short lifespans as adult moths of about a week or less, since they have atrophied proboscises and all feeding occurs in the larval stage. The adults live just for dispersal and reproduction, their males usually sporting highly pectinate antennae to detect the female pheromones from afar; the fat females mate rapidly and race in their short lives to lay all their eggs, sometimes in batches. Many Sphingidae (hawkmoths), however, are important pollinators of flowers, often with significantly long tongues to probe elongated nectar tubes. Female hawkmoths are generally more selective in finding the right plant on which to oviposit, which they usually do singly.

Some bombycoid moths are culturally important in Madagascar. The introduced Silkworm *Bombyx mori* supplements some lasiocampid moths for the purpose of weaving silk to produce lambas (shrouds), particularly on the high plateaux. Pupae of some saturniid moths such as those of *Antherina suraka* are also sought after by Malagasy people for food, while cocoons of other species like *Bunaea aslauga* and *Ceranchia apollona* are stitched together to make beautiful artisan products in a highly successful cooperative SEPALI formed of local farmers in Makira, who rear these silkmoths sustainably for much needed income on the international market. In Masoala, the adult of *Argema mittrei* has significance in village culture and beliefs; it is said that if one is found dead it can be placed on the end of a hoe, which presumably is a good sign for work on the ricefields!



Malagasanja palliatella (Viette, 1954)

47

Eupterotidae 49–51

Sphingidae 65–80

antennae
pointed at the end

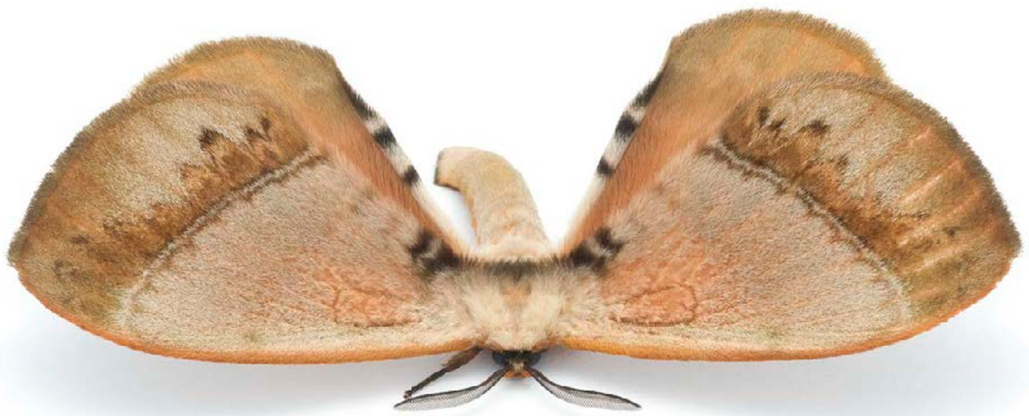
eye marks

antennae
large, feathered

Saturniidae 52–64

Families of the superfamily Bombycoidea dealt with in this guide
Worldwide there are around 3,350 known species of Bombycoidea. Most of the adult moths are powerfully built and have heavily scaled, often broad wings. Except for sphinx moths, they have feathered antennae which in the case of the males have strikingly long rami that look like a comb.





Malagasanja palliatella (Viette, 1954)

Bombycoidea
Eupterotidae

Janinae





Malagasanja palliatella (Viette, 1954)



Malagasanja palliatella (Viette, 1954)

Bombycoidea
Eupterotidae

Janinae



Malagasanja palliatella (Viette, 1954)



Response to disturbance

Malagasanja palliatella is the only known representative of the family 'Monkey moth' Eupterotidae in Madagascar, better known in Africa and Australia. Individuals perform a broad range of behaviors in response to disturbance. The moths hold the wings together and play dead, but in doing so the legs are drawn up and the abdomen curved in a false stinging action. Occasionally an additional foul-smelling waste liquid (meconium) is excreted that in air dries quickly and turns dark brown. If the disturbance persists, the moth holds the wings like an umbrella over its thorax with head held up. Thus it resembles large dry leaves. Once the disturbance goes away, the wings are slowly folded back and the moth runs away unharmed. The life history is not reported.



Malagasanja palliatella (Viette, 1954)

Bombycoidea
Eupterotidae

Janinae



Malagasanja palliatella (Viette, 1954)

Saturniidae (Wild Silkmoths)

Text by Dr. Rodolphe Rougerie

More than 3.500 species worldwide, in Madagascar five genera with a total of 26 species, all are endemic.

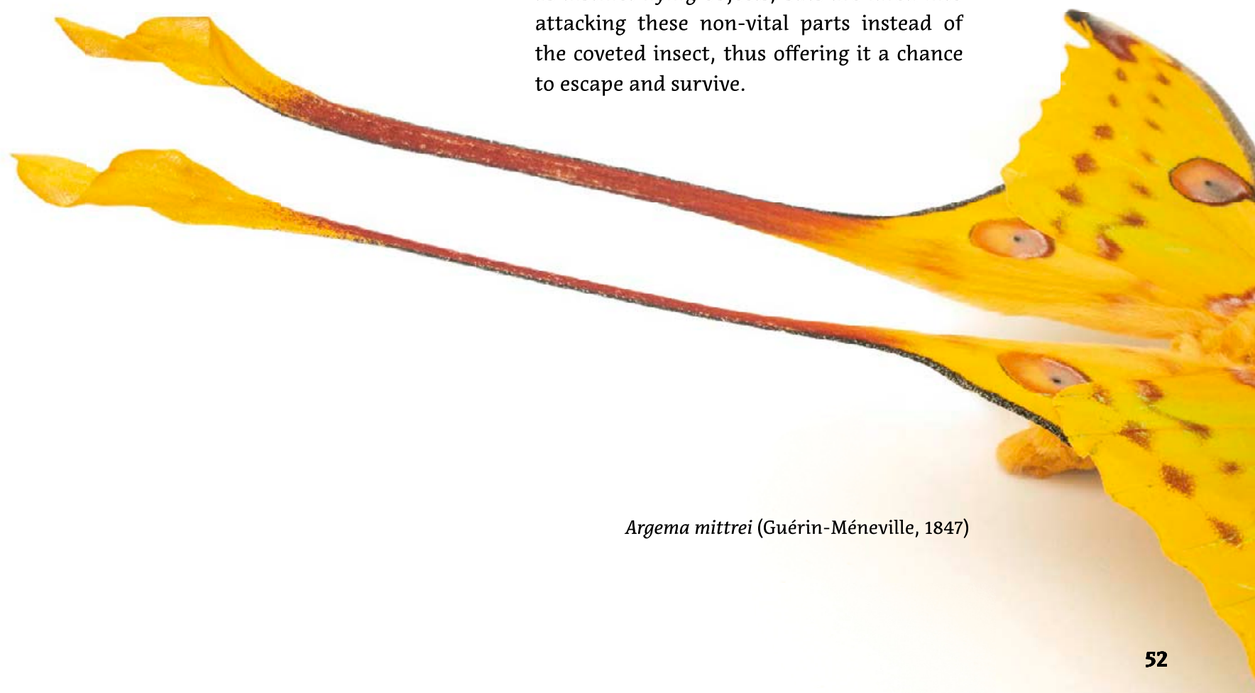
The fascinating diversity of Madagascan moths is rather discrete and largely unsuspected, but there are giants among them that do not go unnoticed. The Wild Silkmoths are massive insects that can exceed 30cm in wingspan and have fascinated generations of naturalists with their spectacular size and the diversity of their forms and patterns. They are distributed worldwide, with their diversity peaking in tropical regions of the globe, and their popularity made them one of the most studied and best-known groups of insects. Giant Atlas-, Hercules-, Emperor-, Moon- or Comet-moths are some of many popular names given worldwide to saturniid moths in relation to their shapes and patterns, but it is probably for the ability of their caterpillars to spin large and qualitative silk cocoons that they first bore importance to humans, with evidence of the use of their silk in Antiquity.

The large caterpillars of Wild Silkmoths are no less spectacular and diverse than the adults, and they are also consumed – sometimes even much prized – as food on several continents, especially in Africa where they represent a major source of proteins for the local populations of some regions. Besides their large size, saturniid moths often have patterns imitating eyespots on their hindwings; these, made of multiple concentric rings reminding us of those of the planet Saturn, are at the origin of the name taxonomists gave to the family. Hidden at rest and brusquely displayed when the moth is attacked, the eyespots offer protection to the moth against birds or lizards by suddenly surprising them. Big insects like saturniids are a feast for their predators; natural selection, during the course of their evolution, has been at the origin of a diversity of adaptive innovations, from moths with frenzied flight behavior, long-tailed hindwings or abdominal urticating scales, to caterpillars bearing

A tale of long tails

Of all moths in the world, the Madagascan Comet-moth is one of the most striking and has become a popular emblematic insect for the island. Males are only active at night, seeking females using their large feathery antennae as a chemical radar. In forested areas of eastern Madagascar, it is not rare to observe this extraordinary moth near the public light of a village, fortuitously distracted from its path.

The absence of its fascinating long tails may disappoint the lucky observer, but it actually tells a fortunate tale of this moth escaping the deadly teeth of an insectivorous bat. Evolution, through millions of years of natural selection, has shaped these wings into the most elegant and smartest decoy against the sophisticated echolocation scanner of bats. Perceiving the twisted tips of the tails as distinct flying objects, bats are lured into attacking these non-vital parts instead of the coveted insect, thus offering it a chance to escape and survive.



Argema mittrei (Guérin-Méneville, 1847)

poisonous spines, exhibiting camouflage patterns or being venomous and aposematic (warning) in color. After metamorphosis and emergence from their pupa or cocoon, the adult saturniid moths only live for a few days, maybe a week, and their life is entirely devoted to reproduction. In fact, they do not even feed and their mouthparts are reduced, non-functional. In effect, for such large prey, this singular trait reduces the time of exposure to predation by their main natural enemies at night: bats. Once emerged, the female individuals remain motionless, emitting pheromones that are chemical clues traveling at random, carried in the air. At night, male saturniids become active for a very short period of time only, probably a couple of hours at most, using their characteristic large and feathery antennae to detect infinitesimal amounts of the female pheromones. Following that faint scent, they fly their way back to the source, where the molecules are more concentrated and where the female awaits patiently.

Research on the evolution of saturniid moths has revealed that the family likely diverged from its common ancestor with hawkmoths (family Sphingidae) about 50–60 million years ago, during the early Tertiary. The family is represented on all continents and comprises more than 3,500 species worldwide, most of which occupy the Neotropical region. Remarkably, more than a third of these species were described by taxonomists within the past two decades, as the result of the combination of traditional morphological comparisons with molecular approaches using a small fragment of DNA, called "DNA barcode". As one of the best-documented groups of arthropods, saturniids represent unique insect models and are central to research programs investigating the spatial and temporal dynamics of their diversification, and the determinism of their responses to environmental changes.

In Madagascar, Wild Silkmoths are represented by five lineages, formally recognized as distinct genera in the Linnean classification of the family. Four of them (*Argema, Antherina, Bunaea* and *Ceranchia*) are represented by a single and unique species, whereas the fifth lineage, namely genus *Maltagorea*, is the only one that diversified significantly on the island, with 22 species known so far. All 26 Madagascan species of saturniids are endemic to the island, with their ranges only extending to Comoros in two of them, but none reaching the Mascarene Islands.



Bunaea aslauga Kirby, 1877

Bombycoidea
Saturniidae



Argema mittrei (Guérin-Méneville, 1847)
male



Argema mittrei (Guérin-Méneville, 1847)
female



Bunaea aslauga Kirby, 1877
male

As large as a school ruler

Bunaea aslauga is a very impressive moth. With an almost 30 cm wingspan and a labored, flapping flight, it comes in to land at the light. At first one thinks of a bird or large bat. Pretty soon the moths settle in the surrounding vegetation and can be found, having evaded predators, in the morning. *Bunaea* features a scaleless transparent window in each wing, whose function is not quite clear but may resemble a hole eaten in a dead leaf.



Antherina suraka (Boisduval, 1833)





Antherina suraka (Boisduval, 1833)



Maltagorea auricolor (Mabille, 1879)
female



Maltagorea auricolor (Mabille, 1879)
female



Maltagorea auricolor (Mabille, 1879)
female



Maltagorea auricolor (Mabille, 1879)
female

Hide and play dead ...
Large moths like saturniids are particularly vulnerable to predators when they are active during the night, but also during the day when they rest motionless in the vegetation.
For species in the genus *Maltagorea*, it's all about not being seen and their wing patterns and colors make their detection by predators difficult among dead leaves. When discovered, individuals of *Maltagorea auricolor* have a very specific behavior: after releasing the support they were resting upon, they quickly curl their abdomen and tighten their legs against their body, effectively playing dead and using their wings to protect all the vital parts of their body.



Maltagorea auricolor (Mabille, 1879)
male





Maltogorea rostaingi (Griveaud, 1962)
female



Maltogorea rostaingi (Griveaud, 1962)
male



Maltagorea dura (Keferstein, 1870)
male



Maltagorea dura (Keferstein, 1870)
female



Maltagorea dura (Keferstein, 1870)
male



Maltagorea dura (Keferstein, 1870)
female



Maltagorea sp. Bouyer, 1993



Maltagorea sp. Bouyer, 1993



Maltogorea vulpina (Butler, 1882)

More species remain to be discovered

The genus *Maltagorea* is the only lineage of saturniid moths whose diversity exploded in Madagascar, with 22 distinct species recognized today. Of these, nine were discovered and described after the beginning of the 21st century, and it is expected that a few more species, from remote areas of Madagascar, remain to be unveiled and described as new for science by taxonomists. Standard methods now use a combination of morphological comparisons, with specimens in existing collections, and molecular analyses that build on the publicly available DNA sequences for these moths.



Maltogorea rostaingi (Griveaud, 1962)
female





Antherina suraka (Boisduval, 1833)

Bombycoidea
Saturniidae





Antherina suraka (Boisduval, 1833)



Antherina suraka (Boisduval, 1833)



Bombycoidea
Saturniidae



Antherina suraka (Boisduval, 1833)



Rest position – defense
In rest position *Antherina* conceals the eyespots on the hindwings. After being disturbed all wings are raised slightly and spread so that the eyespots are visible. The displaying of these "false eyes" is intensified by a rhythmic sideways movement of the hindwings against each other inward toward the body.



Bunaea aslauga Kirby, 1877

Life's (too) short

While the early stages of their development can span over several months, the life of adult saturniid moths is very short, rarely exceeding a week in nature. These large insects do not feed as adults and simply live upon the reserve accumulated during the larval stages. When flying erratically at night to find the chemical clues that will lead them to a female, the male saturniids often suffer severe damage to their wings, either from the vegetation they fly through, or from the teeth of their nocturnal predators such as bats ... Their chances of surviving the quest for a partner are thin.



Antherina suraka (Boisduval, 1833)



Antherina suraka (Boisduval, 1833)









Don't bite off more than you can chew
Eyespots are a very common feature found on the hindwings of saturniid moths worldwide. In the Madagascan species *Antherina suraka*, these motifs are very realistic and mirror in both size and aspect the eyes of much larger animals such as lemurs. When attacked, by brusquely displaying their previously hidden hindwings the moth surprises its predator with the unexpected stare of a much bigger, threatening animal, and thus triggers abortion of the attempt.











Lemur Photos: Zoonar GmbH, Hamburg

Sphingidae (hawkmoths)

Text by David Lees

The hawkmoths are among the most charismatic of all moths. Their name derives from a supposed Sphinx-like resting posture of some larvae. They boast at least 1,443 species worldwide. In Madagascar, there are at least 64 species, of which some half are endemic. The hawkmoths are large and robust moths, many with sleek, arched forewings with pointed apices, ideally for fast flight, and so some, like *Acherontia atropos*, are powerful migrants.

The subfamily Smerinthinae (e. g. *Gynoeryx meander* (Boisduval, 1875) do not feed as adults and have reduced proboscises, whereas those of the subfamily Macroglossinae often have quite long tongues, ideal for pollination of flowers with long nectar tubes, such as those of the coffee family Rubiaceae, or even orchids. The moth, indeed the insect, with the longest reported insect tongue is Wallace's Sphinx *Xanthopan praedicta*. Recently raised to species level, this is an iconic species of hawkmoth that was imagined by Darwin and Wallace to exist in Madagascar as the specialist pollinator of an endemic orchid with an approximately 30 cm long corolla, *Angraecium sesquipedale*, also known as Darwin's Star Orchid. Record holders of this moth have only recently been found in Madagascar possessing (in the male) a 28–28.5 cm long proboscis. This is exactly within the range (10–11 inches) imagined by Darwin in 1862. The moth was, however, only described in 1903 by Lord Walter Rothschild and Karl Jordan, although *Xanthopan morganii* (which has on average a shorter proboscis) was known to exist in Africa, and indeed Alfred Russel Wallace in 1877 included a figure of just such a moth flying to this plant in the Madagascar rainforest. Yet there was no actual observation of such a visit to *A. sesquipedale* until 2004.

Another moth with a long proboscis, which is also a member of the subfamily Sphinginae, is *Coelonia insularis* Basquin, 2021, only recently realized to be endemic to the island. A relative, *C. solani,* has a really long proboscis sometimes over 20 cm rivaling that of *Xanthopan praedicta* and it even pollinates a different star orchid *Angraecum sororium*, among other flowers it visits. However, these orchids may be helplessly dependent on these species of moths for transfer of their pollen far and wide.



Endemic to Madagascar
Daphnis kitchingi was recently split from the more famous Oleander Hawkmoth *Daphnis nerii* (also in Madagascar).

Daphnis kitchingi Haxaire & Melichar, 2011

Wallace's Sphinx

Text by David Lees

Xanthopan praedicta, recently raised to species level, is an iconic species of sphingid moth that was imagined by Darwin and Wallace to exist in Madagascar as the specialist pollinator of an orchid with an approximately 30 cm long corolla, _Angraecium sesquipedale_ Thouars, 1822.

Specimens of this moth have only recently been found in Madagascar possessing a very long proboscis. Darwin predicted that this moth should have a 10–11 inches long proboscis so that it can use the nectar tube of *Angraecium* and pollinate this orchid. The moth was only described in 1903 by Rothschild and Jordan, although *Xanthopan morganii* (which has on average a shorter proboscis) was known to exist in Africa, as it was described (as a species of *Macrosila*) by Francis Walker in 1856.



Artist: Thomas W. Wood

Alfred Russel Wallace whose name was adopted for the moth's common name, went as far as to say in 1867: *"That such a moth exists in Madagascar may be safely predicted, and naturalists who visit that island should search for it with as much confidence as astronomers searched for the planet Neptune, and they will be equally successful."*

Glowing tapetum
When moths are found at night, the tapetum often glows red. This effect vanishes during daylight. Photo: David Lees





Xanthopan praedicta
Rothschild & Jordan, 1903
Photo: Marie Evans picture library



Angraecium sesquipedale Thouars, 1822

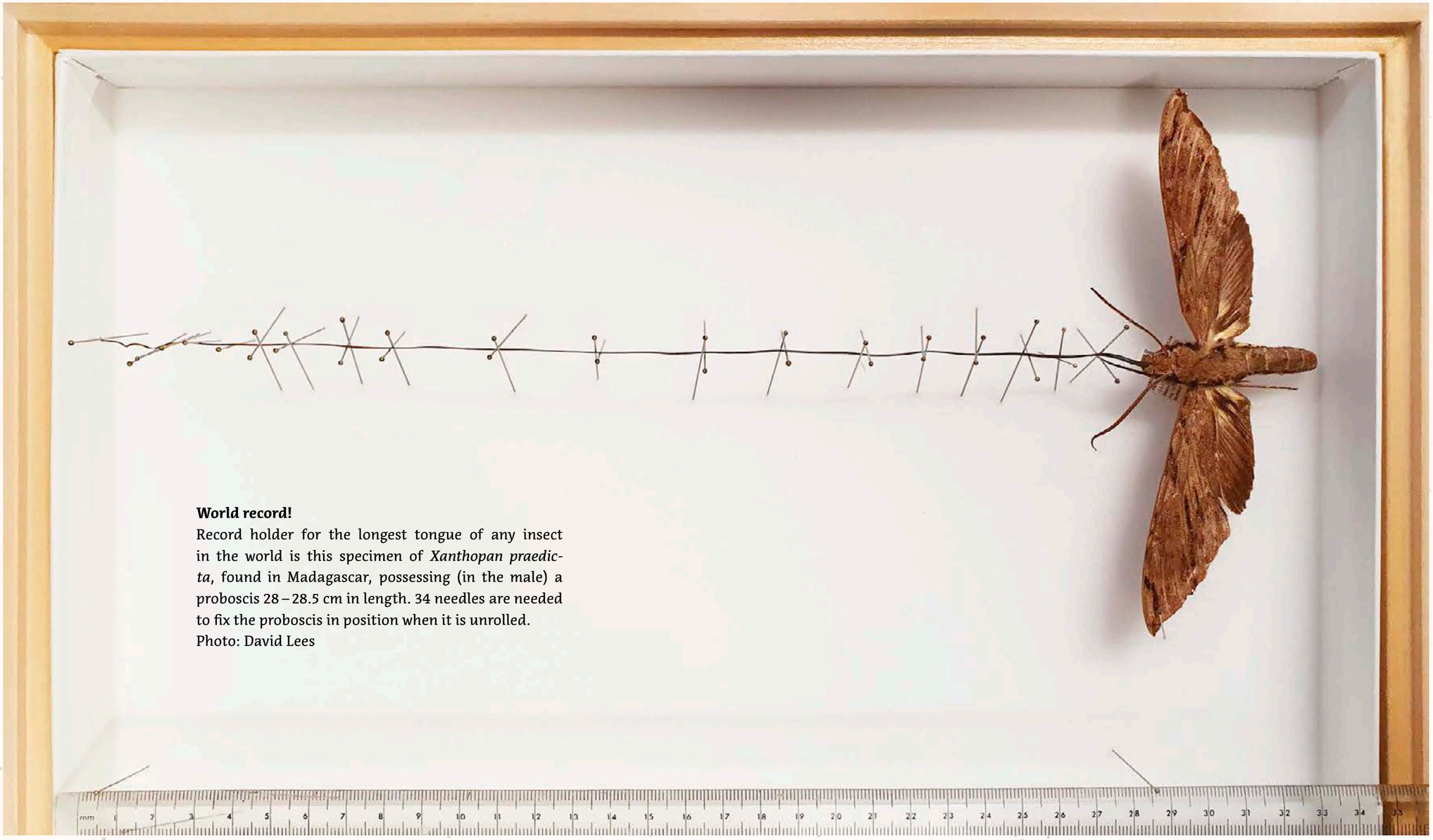
Camounflage
The upperside of the wings is gray with black streaks camouflaging the moth on tree trunks, while the underside is pinkish.



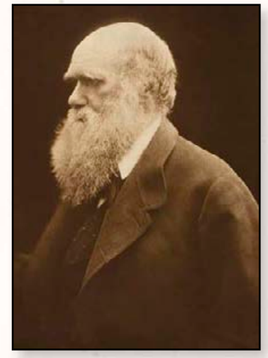
X. praedicta
With rolled-up proboscis ready to fly away. Note the pinkish coloration. Photo: Marcin Wiorek

Wallace's Sphinx

Text by David Lees

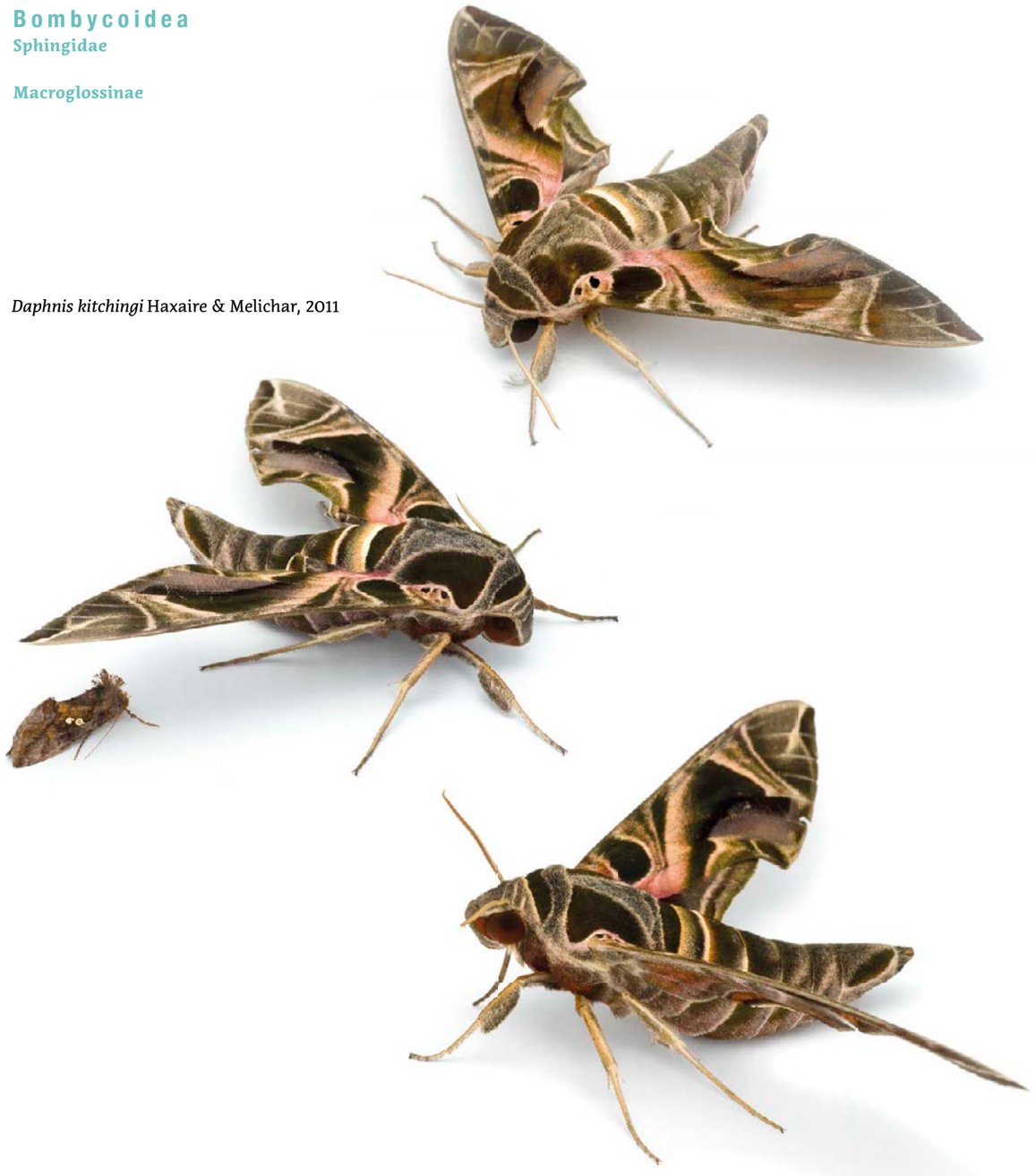


World record!
Record holder for the longest tongue of any insect in the world is this specimen of *Xanthopan praedicta*, found in Madagascar, possessing (in the male) a proboscis 28 – 28.5 cm in length. 34 needles are needed to fix the proboscis in position when it is unrolled.
Photo: David Lees



Charles Darwin
Worse luck! Darwin never saw this moth, he died 21 years before its description, not realizing that 19th century specimens had already existed from Madagascar.

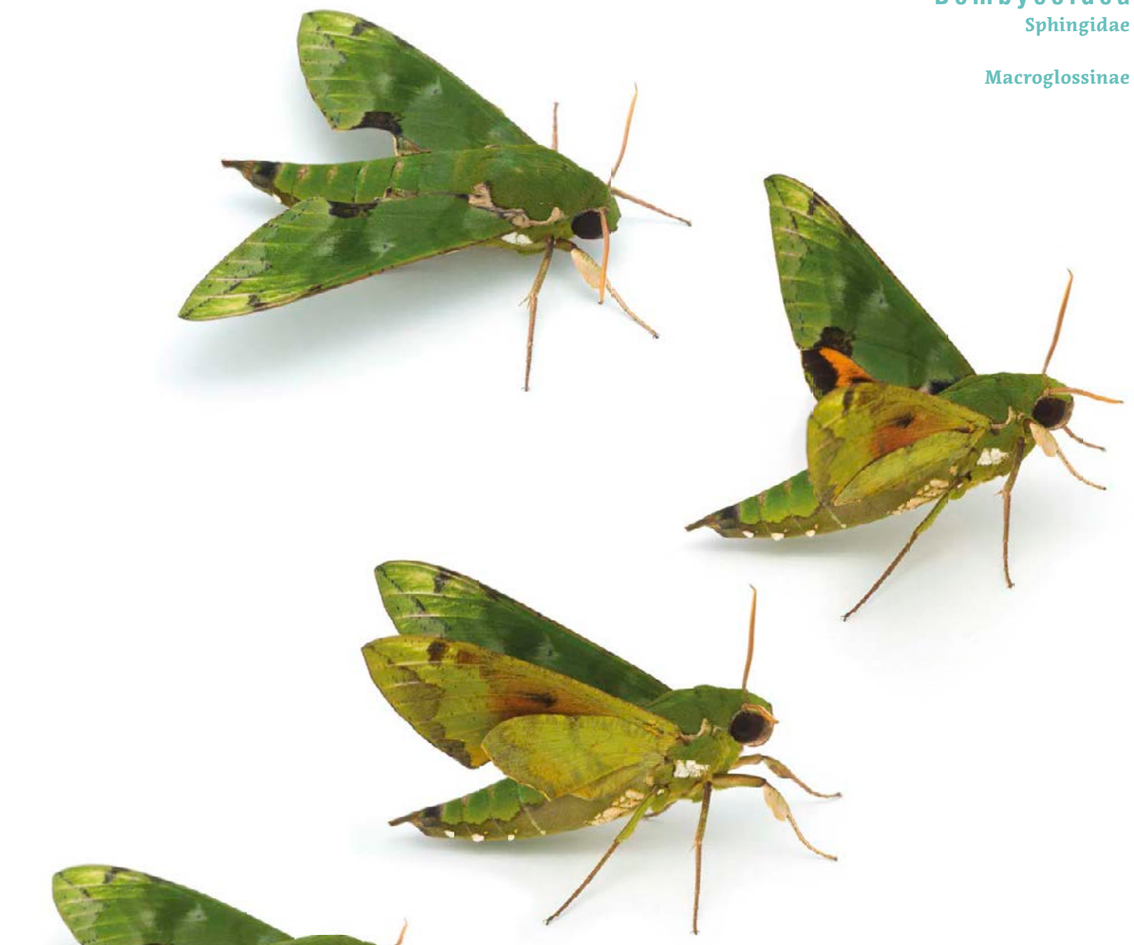
67



Daphnis kitchingi Haxaire & Melichar, 2011

Bombycoidea
Sphingidae

Macroglossinae



Euchloron megaera lacordairei (Boisduval, 1833)

Colorful green hawkmoths
Among the most exquisite hawkmoths of Madagascar, colored in varying shades of green, are *Daphnis kitchingi* and *Euchloron megaera*. The white flecks on the underside of thorax and abdomen of *E. megaera* help camouflage it when at rest among vegetation to resemble skeletonized parts of leaves.

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Nephele charoba Kirby 1877



Nephele charoba Kirby 1877



Nephele oenopion (Hübner, 1824)



Nephele densoi (Keferstein, 1870)



Hippotion aurora (Rothschild & Jordan, 1903)



Bombycoidea
Sphingidae

Macroglossinae









Hippotion butleri (Saalmüller, 1884)







Hippotion celerio (Linnaeus, 1758)



Hippotion geryon (Boisduval, 1875)







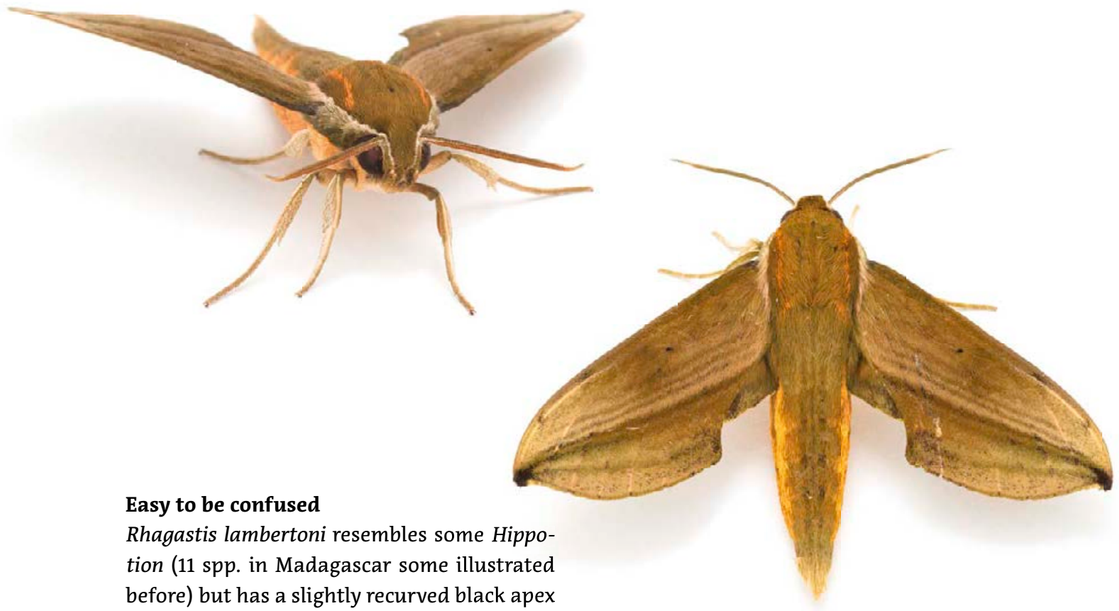


Bombycoidea
Sphingidae

Macroglossinae



Rhagastis lambertoni (Clark, 1923)



Easy to be confused
Rhagastis lambertoni resembles some *Hippotion* (11 spp. in Madagascar some illustrated before) but has a slightly recurved black apex at the wingtip and is endemic to Madagascar. Its green caterpillar has a bizarre projection from the anterior eyespot that looks like a yellow tentacle.



Temnora grandidieri (Butler, 1879)

Temnora argyropeza (Mabille, 1879)



Nocturnal and diurnal species
A genus with nine species of only medium size in Madagascar is *Temnora* (the commonest is *Temnora grandidieri* (Butler, 1879)). The species of the genera *Cephenodes* (great mimics of bees) and *Macroglossum* (closely resembling hummingbirds) visit flowers by day, taking off at considerable speed.



Acherontia atropos (Linnaeus, 1758)



Bombycoidea
Sphingidae

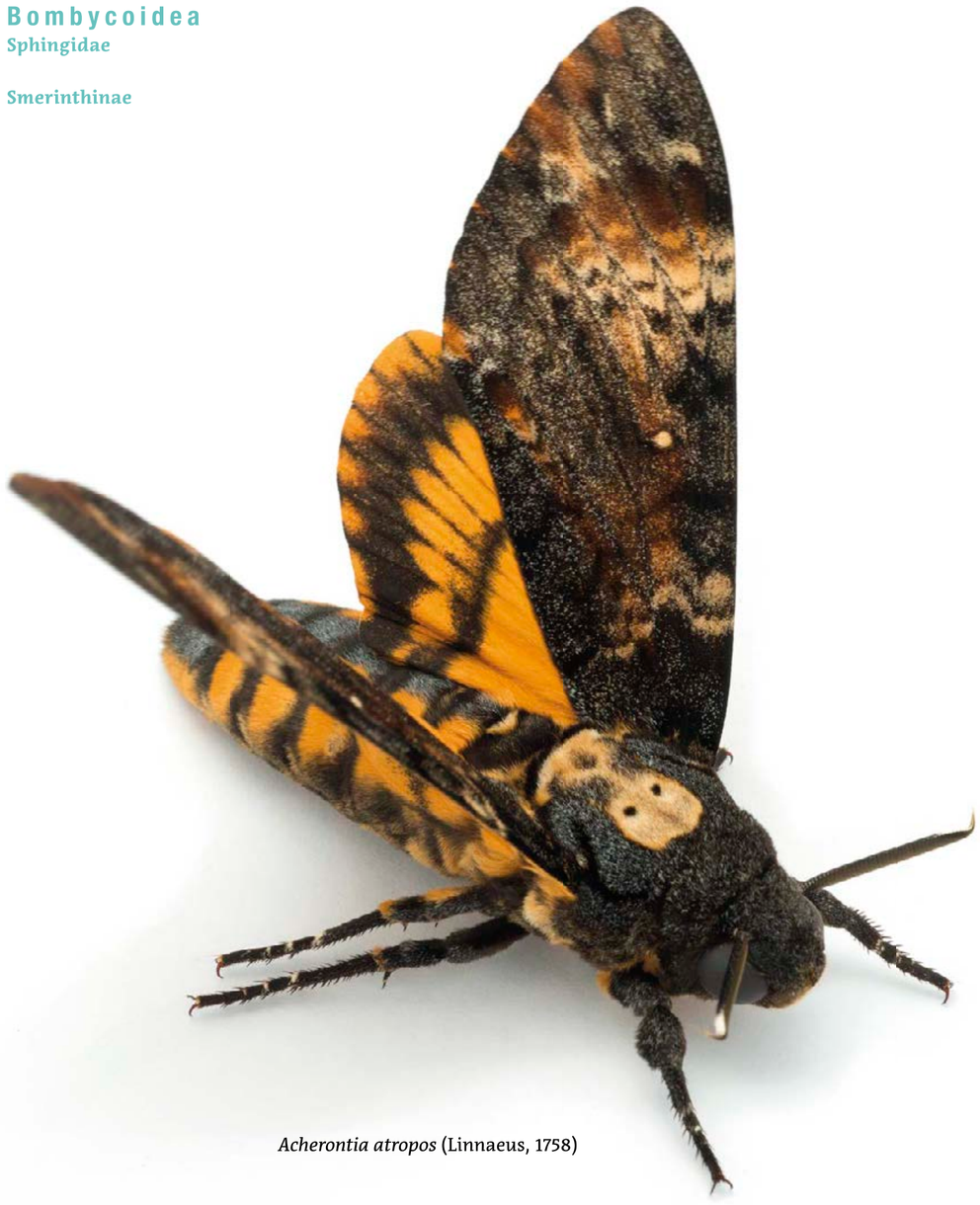
Smerinthinae







73



Acherontia atropos (Linnaeus, 1758)

Huge range – same looks

The genus *Acherontia* comprises three species (*A. lachesis*, *A. styx* and *A. atropos*). The distribution range of *A. atropos*, a species which migrates over long distances, is enormous and extends from the Afrotropic, including Madagascar, through Türkiye as far as northern Europe.



Madagascar, Makira, 21.03.2022, at 23:22

Germany, Markelfingen, 24.09.2020, at 22:23

Mimic of a queen bee

One of the more famous hawkmoths in the world is the Death's Head Hawkmoth *Acherontia atropos* (Linnaeus, 1758). It squeaks when disturbed and even sometimes in flight, and for food it plunders bee-hives at night, its short sharp tongue being especially adapted for piercing honeycombs. This moth usually has a sinister reputation because of the skull-like markings on the thorax and strange behavior. They mimic attributes of queen bees such as the banded patterns of the body, the squeaking, and the use of pheromones to avoid being stung to death.









Batocnema coquerelii (Boisduval, [1875])







Green turns to yellow
Batocnema coquerelii is beautifully airbrushed with pink. Their green pigments fade to yellow over time. The two subspecies in Madagascar have an identical DNA barcode so the status of the western subspecies is questionable.









Gynoeryx meander (Boisduval, 1875)





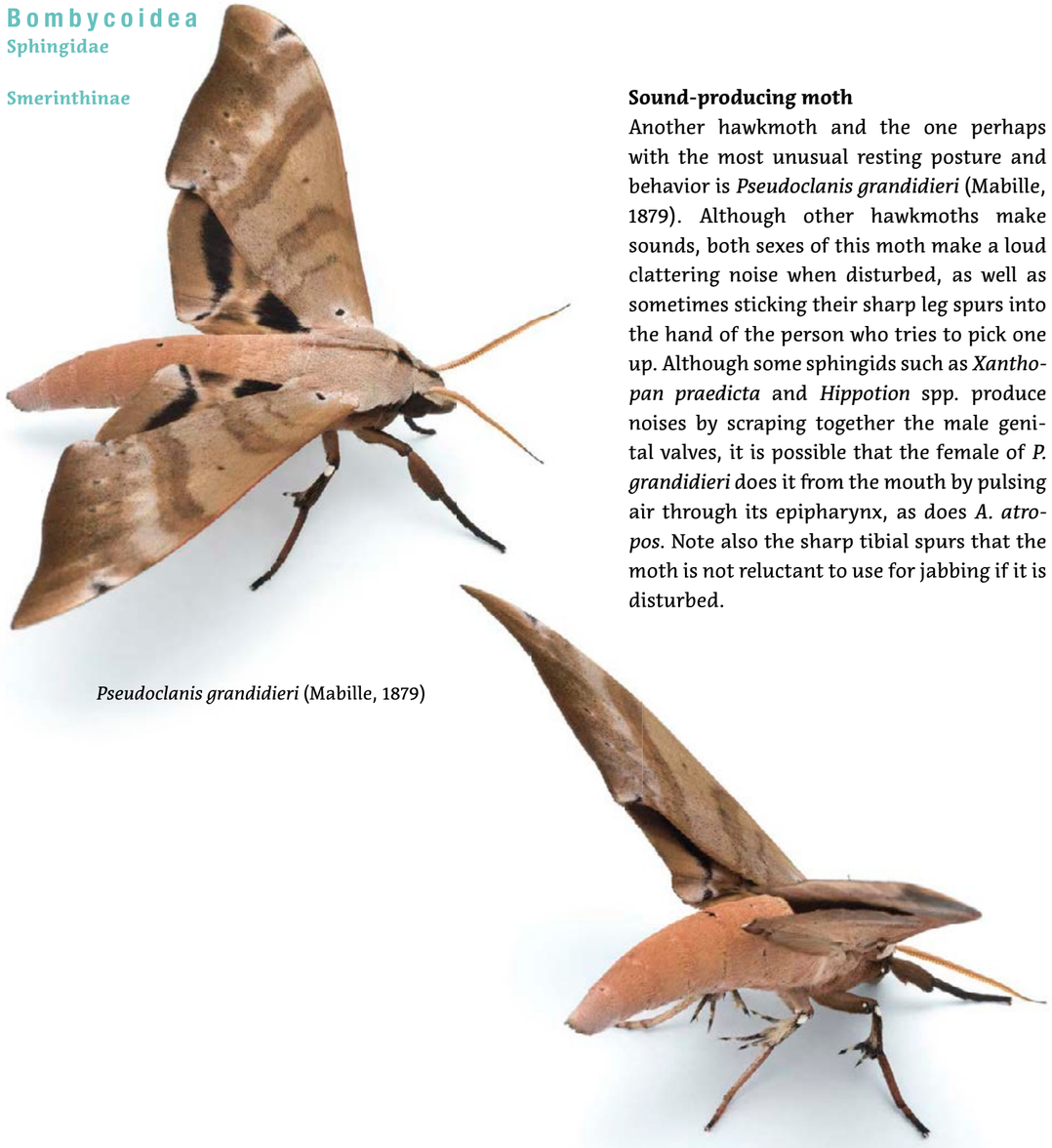
Maassenia heydeni (Saalmüller, 1884)











Pseudoclanis grandidieri (Mabille, 1879)

Sound-producing moth

Another hawkmoth and the one perhaps with the most unusual resting posture and behavior is *Pseudoclanis grandidieri* (Mabille, 1879). Although other hawkmoths make sounds, both sexes of this moth make a loud clattering noise when disturbed, as well as sometimes sticking their sharp leg spurs into the hand of the person who tries to pick one up. Although some sphingids such as *Xanthopan praedicta* and *Hippotion* spp. produce noises by scraping together the male genital valves, it is possible that the female of *P. grandidieri* does it from the mouth by pulsing air through its epipharynx, as does *A. atropos*. Note also the sharp tibial spurs that the moth is not reluctant to use for jabbing if it is disturbed.

Bombycoidea
Sphingidae

Smerinthinae





Coelonia insularis Basquin, 2021



Coelonia solani (Boisduval, 1833)





Bombycoidea
Sphingidae

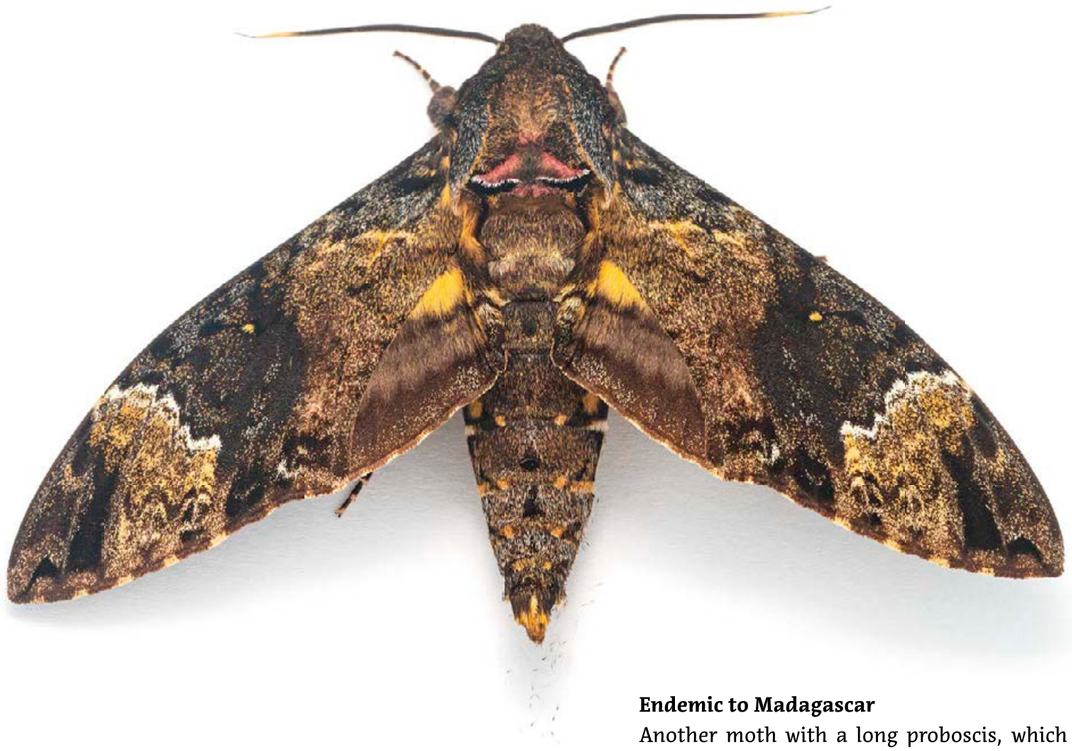
Sphinginae

Symbiotic relationship with an orchid

Coelonia solani possesses a very long proboscis and pollinates the long-spurred orchid *Angraecum sororium*. Such a close evolutionary relationship can become a one-way journey without a happy end. Another member of the genus, *Angraecum longicalcar*, has a spur on average much longer than the proboscis of any known Madagascan moth species. This orchid is currently known only from a single, endangered population and, despite many efforts, scientists still have not detected any potential pollinator of this plant. Thus, hypothetically there could have been another species of long-proboscis hawkmoth that is now extinct …



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Endemic to Madagascar
Another moth with a long proboscis, which is also a member of the subfamily Sphinginae, is *Coelonia insularis* Basquin, 2021, only recently determined to be endemic to the island. On the left, a color variation found in Makira, to the right, the same species found in Masoala.

Bombycoidea
Sphingidae

Coelonia insularis Basquin, 2021

Sphinginae





Lomocyma oegrapha (Mabille, 1884)

Endemic to Madagascar
In this case not only the species but the genus is endemic to Madagascar and the Comoro Islands. Little seems to be known about its biology.



Bombycoidea
Sphingidae

Sphinginae



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Lasiocampoidea

Antennae
kinked to about half length



Resting position
hindwings overlap forewings

Lasiocampidae 81–87

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Lasiocampiodea (Lappet moths)

Text by Marcin Wiorek



The family Lasiocampidae, the only member of the superfamily Lasiocampoidea, is a relatively small group of around 1,950 species distributed worldwide. From Madagascar some 100 species have been recorded. To this family belong some quite big moths, and as you can see in the photos displayed in this chapter, they are very often colored uniformly, in brown or ochraceous, with only a poorly marked wing pattern. A specific character of these moths is the manner of folding their wings in the resting position. The forewings are oriented downwards, resembling somehow a roof over the abdomen, while the margins of the hindwings generally protrude horizontally from underneath, which serves to break up their outline.

The cocoons spun around themselves by the caterpillars of *Borocera* species before pupation are used in Madagascar to produce silk – as for those of some Saturniidae species. The silk created from *Borocera* is in Malagasy called landibe. This material is not as fine, smooth and shiny as the most commonly known silk made of the yarn of the mulberry-fed Silkworm *Bombyx mori* (in Malagasy: landikely). However, this fabric has a very important role in the traditional and still practiced beliefs of the Malagasy people. As already mentioned in the chapter about Erebidae, ancestor worship is the central part of their spirituality, and therefore funerals are very important celebrations. Landibe is used to produce traditional burial shrouds – burial in a shroud dyed red is a sign of the greatest respect. What is interesting is that the relatives open the tomb every few years, change the shroud for a new one, and dance with the cadaver. This celebration is very joyful and involves the entire community. However, the tradition of landibe manufacturing is slowly disappearing as it is more difficult than obtaining silk from the mulberry silkworm. Also, because *Borocera* moths are connected with the tapia tree, *Uapaca bojeri*, which forms sparse woodlands on the Central Plateau of Madagascar, the cocoons are wild collected. Additionally, as also for *B. mori*, the pupae are a very important by-product, as they are traditionally eaten and served fried with rice and chicken. They are considered a true delicacy, an important contrast with Africa, where silk moth caterpillars are preferred over pupae.



Callopizoma malgassica (Kenrick, 1914)

Lappet moth with eyespots
C. malgassica, with its conspicuous colors, is an endemic – it is found nowhere in the world but in Madagascar. Eyespots are rather unusual with Lasiocampidae.



Lamprantaugia tamatavae (Guenée, 1865)

Living with serious injuries

This male *Lamprantaugia* has a serious injury on its abdomen which has healed at least enough for it to still be able to fly and reach the light trap in Makira. The cause of the injury is a matter for speculation: Perhaps it was an accident incurred on the not yet hardened chitinous outer shell when it was emerging from the pupa and cocoon. Or is it a wound from a bite? Birds, reptiles, bats, spiders, and praying mantises are some of the myriad moth predators.



Borocera cajani Vinson, 1863

Food delicacy and silk production

Borocera (Lasiocampidae) caterpillars spin cocoons in which they pupate. In Madagascar the rare high-quality landibe silk is spun from the *Borocera* cocoons. In the highlands *B. cajani* has been used for centuries for this purpose, and on the coast, similarly, *B. madagascariensis*. The caterpillars feed on tapia trees *(Uapaca bojeri)*.

The deceased are wrapped in cloths that are woven from landibe silk and buried. Every 5–10 years they are then shrouded in new cloths – having been exhumed for this purpose – and subsequently interred with great ceremony. *B. cajani* is now endangered because of slash-and-burn practices in the *tapia* forests, among other circumstances. The *B. cajani* pupae are also considered a food delicacy; they are fried and eaten with chicken and rice.



Borocera cajani Vinson, 1863
male



Acosmetoptera sp. de Lajonquière, 1972





Closterothrix near *leonina* (Butler, 1882)



Apatelopteryx deceptrix (Kenrick, 1914)



Lasiocampoidea



Borocera cajani Vinson, 1863
female



Phoenicladocera xanthogramma de Lajonquière, 1972
female



Borocera cajani Vinson, 1863
male



Phoenicladocera xanthogramma de Lajonquière, 1972
male



Callopizoma malgassica (Kenrick, 1914)



Lamprantaugia tamatavae (Guenée, 1865)



Acosmetoptera sp. de Lajonquière, 1972



Apatelopteryx deceptrix (Kenrick, 1914)



Eupagopteryx affinis (Aurivillius, 1909)



Europtera punctillata (Saalmüller, 1884)



Acosmetoptera sogai (de Lajonquière, 1970)







Callopizoma malgassica (Kenrick, 1914)



Rare visitor to the light trap
This Lappet moth with its beautiful markings appeared at the light trap in Masoala only once. The scaling is flawless – presumably this is a freshly hatched individual, which was flying very actively on this hot night. I found it at the house of Maria and Pierre at the Masoala Forest Lodge.



Borocera cajani Vinson, 1863
eggs and female



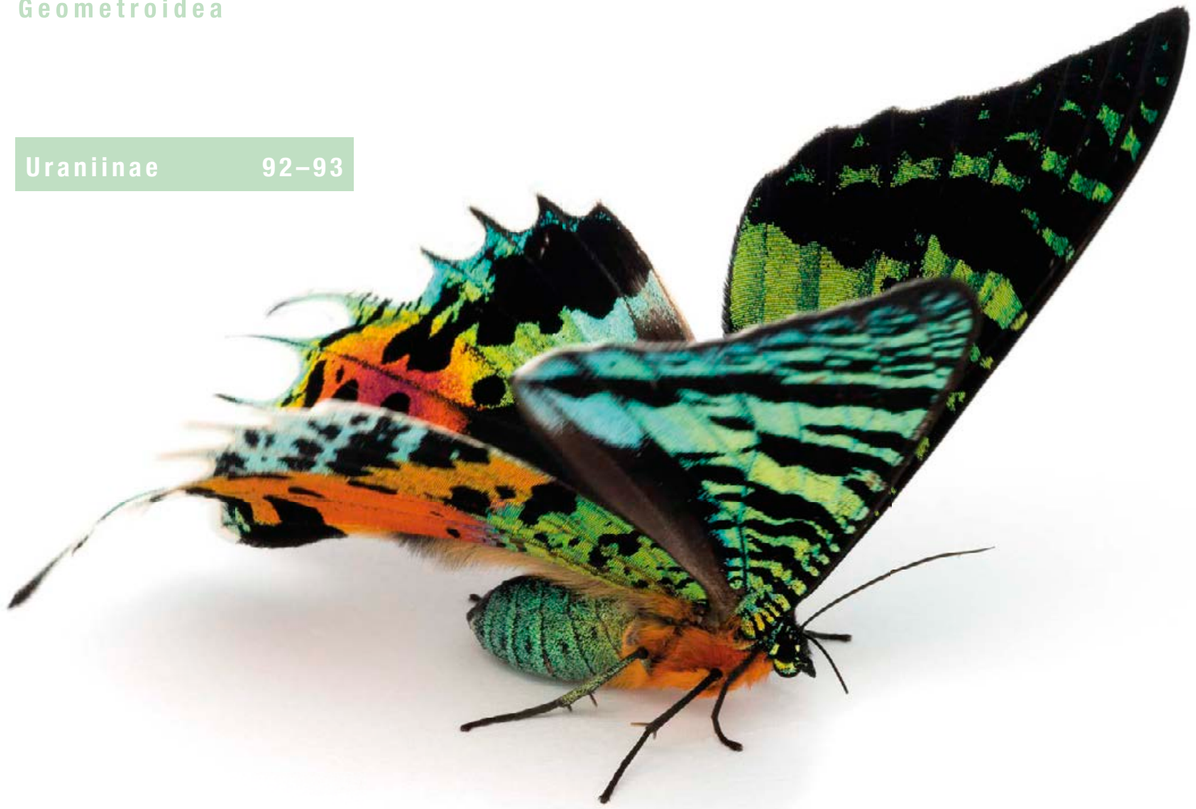


Apatelopteryx deceptrix (Kenrick, 1914)

Eye wipes

As you can see in the photo of *Apatelopteryx deceptrix* displayed here, moths also need to wipe clean their sensitive compound eyes. The forelegs of this moth seem to be perfectly designed for the purpose, with long, hair-like scales, wiping the eye like a fine brush. Interestingly enough, many moths also have on the forelegs another special device for cleaning the antennae. It is called the epiphysis and is located on the ventral side of the tibia in the form of a protrusion oriented in such a way that the antenna is cleaned when it is dragged through the gap between the surfaces of the epiphysis and leg.

Uraniinae 92–93





Uraniidae: Epipleminae 91

Epipleminae 91

Resting position
forewings folded lengthwise





Resting position
all wings held outspread, level

Geometridae: Ennominae, Geometrinae, Larentiinae, Sterrhinae 94–108

Subfamilies of the superfamily Geometrioidea dealt with in this guide.

Geometrid moths in Madagascar

Text by Dr. Axel Hausmann

History

The exploration of Madagascan geometrids started with the description of three species by Boisduval in 1833 *(Scopula minorata, Venusia distrigaria, Erastria madecassaria)*. Only 67 species were described from Madagascar before 1900. The first remarkable advance in the taxonomic research on the geometrids of Madagascar was made by Louis B. Prout (1864–1943), of the Natural History Museum in London who contributed the description of 130 valid species. However, next came the very important expeditions of French entomologists in the second half of the 20th century, especially those leading to the descriptions by Claude Herbulot (1908– 2006; 253 valid species and subspecies!) and Pierre Viette (1921–2011; 171 species and subspecies).

Today the main source for studying the geometrid fauna are the original descriptions (most of them in smaller articles spread over many different journals) and the collections where the type specimens are deposited (NHMUK, London; MNHN, Paris; SNSB-ZSM-collection Herbulot, Munich).

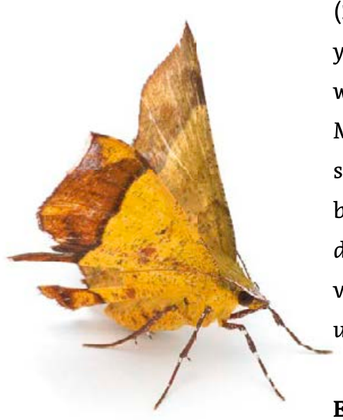
Diversity

So far, 638 valid geometrid species are described from Madagascar, with an additional 21 subspecies of a nominotypical mainland species and with a few additional species which were described from mainland Africa but occur in the nominotypical subspecies also on Madagascar *(e.g. Thalassodes quadraria, Chiasmia normata, Zamarada calypso)*. When counting also the 17 additional subspecies described from Madagascar (several species split up into different subspecies in different regions of Madagascar), the number of valid taxa described from Madagascar is raised to 676 species and subspecies.



Archichlora trygodes Prout, 1922





Erastria madecassaria (Boisduval, 1833)

Knowledge gaps

So far, the global DNA barcoding initiative (iBOL) has provided DNA barcodes for 1,203 geometrid specimens from Madagascar, clustering to 413 BINs (barcode index numbers) which can be regarded as a proxy for species numbers. Only a few of these clusters are currently reliably identified to exact Linnean species names (260 names = 63 %). Surely some of the remaining 153 clusters will yet be able to be attributed to described species after accurate study, which highlights the urgent need to study the geometrid fauna of Madagascar more in depth by assembling information on the type specimens. However, this pattern also seems to point to a remarkable potential of hidden and cryptic diversity. The amplitude of undescribed geometrid species in Madagascar can be estimated only very roughly and is suggested here to range from a minimum of 100 up to several hundreds.

Evolution

Several geometrid genera are particularly species-rich in Madagascar suggesting recent radiations after colonization of one or just a few species from mainland Africa, e. g., in the genera *Archichlora* (32 species), *Chrysocraspeda* (54 species), *Drepanogynis* (35 species), *Epigelasma* (23 species), *Hylemera* (41 species), and *Psilocerea* (30 species). The genus *Idiodes* shows an interesting zoogeographical disjunction: 11 species are present in Madagascar, only three are known from continental Africa, and 14 are described from Australia and Pacific islands, while the genus is completely unknown from continental Asia. The genus *Blechroneromia* (15 species) is exclusively known from Madagascar and may either have evolved on Madagascar from another genus or represent the product of a radiation from a continental ancestor which has become extinct. The genus *Hypocoela* has 17 species in Madagascar and only four in continental Africa.

It will be highly interesting to reconstruct the evolutionary history of the related speciation scenarios. To achieve this, sound investigation of their phylogeny is necessary, involving integrated analysis (morphology, molecular data including nuclear genes and genomes, and host plants as well, if possible) and their potentially closest relatives on the African mainland.

Emblematic species

Most geometrid species in Madagascar show a camouflaged wing pattern and brown, ochreous, or greenish coloration, but a few are characterized by spectacular colors and wing patterns, e. g. *Rhodophthitus formosus* or *Hylemera euphrantica*.

Importance for humans

Three geometrid moths from Madagascar have been reported as regular or occasional pests, i. e., *Scopula minorata* (polyphagous on field crops, tobacco etc.), *Phaiogramma stipolepida* (on cotton) and *Thalassodes quadraria* (polyphagous on coffee, maize, mango, pepper, etc.).

All geometrid species play an important role in the balance of the ecosystems, as pollinators (also of crops, fruits and ornamental plants), in the food chain (e. g. as important prey for birds, bats etc.), and as decomposers and detritivores, e. g., in the case of the species of the genus *Idaea* with caterpillars regularly feeding on withering or dead leaves.



Archichlora catalai Herbulot, 1954

Ennominae



Zamarada oxybeles Fletcher, 1974

Geometrinae



Archichlora cf. *engenes* Prout, 1922

Larentiinae



Eois cf. *grataria* (Walker, 1861)
[ab. mediofusca Prout]

Sterrhinae



Problepsis meroearia Saalmüller, 1884

Uraniinae



Chrysiridia rhipheus (Drury, 1773)

Epipleminae



Phazaca cf. *theclata* (Guenée,1858)



Phazaca cf. *theclata* (Guenée,1858)



Epiplema malagasy Boudinot, 1982

Subfamilies of the superfamily Geometroidea dealt with in this guide.

“Lolonandriana“

Text by David Lees & Armin Dett

A mistake 250 years ago

The British butterfly expert and goldsmith Dru Drury, well-known at the time for his passion for collecting and enthusiasm for butterflies and his outstanding books on exotic butterflies, received a particularly beautiful Lepidoptera from the ship captain William May of Hammersmith, who had perhaps just returned home from China. The beauty of the moth could even then not be surpassed and, according to the state of knowledge at the time, was new to science.

Despite the complete lack of tails on the specimen he had English illustrator Moses Harris paint, Drury was convinced that it must be a particularly beautiful and new species of swallowtail butterfly and named it *Papilio rhipheus* in 1773.

What Drury missed was that in order for the butterfly to look perfect as a collector's item – and perhaps make it more valuable – the head had been replaced with one from a true butterfly! Drury described it as bearing bulbous antennae, a key distinguishing feature from most moths.

It was not until 1816 that the German entomologist Jacob Hübner recognized Drury's error, i.e. that this represented a moth in the familuy Uraniidae, although he renamed it as *Chrysiridia rhiphearia*. But Drury's species name still stands today (as *Chrysiridia ripheus* (Drury, 1773)). Even though Drury's actual type specimen appears to be missing, Harris' painting of the underside is at least an excellent match for an already famous uraniid moth from Madagascar and does not match *C. croesus* (Gerstaecker, 1871) from Tanzania, despite the missing tails and symmetrically painted pattern. Hübner's generic name *Chrysiridia* borrows from Greek and refers to the golden colors and rainbow-like spectrum of scales. Ripheus (which Drury spelled with an 'h') was a Trojan war hero who was killed fighting the Greeks.

In Malagasy, the butterfly is one of the few with a widespread vernacular name, known as “lolonandriana“ and means the king of spirits (or butterflies). Translated, “lolo” also means the soul of a deceased person who is resurrected.



Chrysiridia ripheus (Drury, 1773)

Icon among Lepidoptera

Chrysiridia ripheus is a species endemic to Madagascar and the icon par excellence among Lepidoptera. The species is one of the most sought-after Lepidoptera in the world and is in almost every collection. Their iridescent colors are based on a scale ultrastructure. Laminae within the ribbon-like scales interfere with incident light and reflect the entire light spectrum in rainbow-like colors varying with the adjacent scales. The black parts of the wings are due to scales with embedded melanin, which absorb light and only partially reflect it.

Biology

Chrysiridia rhipheus has a fascinating developmental biology (Lees, D.C. and Smith, N.G.). As for three other genera of Uraniinae, the caterpillars feed exclusively on *Omphalea* trees, which belong to the Euphorbiaceae (spurge family). Leaves, blossoms and fruits of the tree are eaten. When feeding, the caterpillars ingest sugar-mimicking alkaloids, but they avoid the latex by cutting the veins before feeding. These toxins are passed on to the adult moth. The fact that the moths are poisonous is shown by their striking warning coloring (aposematism) and daytime activity. All of the species of *Omphalea* in Madagascar are eaten, even deciduous species in the West. This property can temporarily lead to the dwindling food sources of the caterpillars and, as a result, to strong population fluctuations of the moths. The caterpillars live on the host trees unmolested by ants, which actually protect and defend the plant from being eaten. The *Chrysiridia* caterpillar hangs off on threads at the risk of hymenopteran attacks. The shrubs themselves respond to herbiviory by producing even more toxins and becoming increasingly inedible.

The moths respond by migrating to regions where other *Omphalea* species grow. This means that although the moth ranges over most of the island except the south the localized occurrences of the hostplants ultimately control the reproduction of the moths. *Chrysiridia rhipheus* is diurnal except occasionally coming to lights during migration. By day it sits upside down on plants but at night the wings are held over the body – a curiosity among moths which is sometimes found in some Geometridae, but a much more typical feature of butterflies.

The eggs are laid singly or in clutches on the underside of the *Omphalea* leaves, or quite often off the hostplant completely (to escape parasitism). The eggs are yellowish and ribbed. After the larvae hatch, they disperse. Pupation occurs in a web on the ground. The flight activity during the day changes. When the sun is shining, the moths can be observed in large numbers visiting flowers. Suddenly, however, they seem to have disappeared from the face of the earth – only to fly again just as suddenly. The females like to oviposit during the afternoon and often in thundery weather.



Oviposition
Chrysiridia rhipheus female oviposits on *Omphalea oppositifolia* (photo: Edi Day).
Below: A cluster of eggs and newly hatched first instar larvae.



Chrysiridia rhipheus (Drury, 1773)



Chiasmia crassilembaria (Mabille, 1880)



Chiasmia simplicilinea (Warren, 1905)



Hypomecis idiochroa (Prout L. B., 1925)



Hypomecis idiochroa (Prout L. B., 1925)



Hypomecis idiochroa (Prout L. B., 1925)



Cleora legrasi (Herbulot, 1955)



Cleora legrasi (Herbulot, 1955)



Cleora legrasi (Herbulot, 1955)



Cleora legrasi (Herbulot, 1955)



Cleora cf. *macracantha* (Herbulot, 1955)



Cabera cf. *cadoreli* Herbulot, 2001



Drepanogynis alina Viette, 1980



Drepanogynis alternans Herbulot, 1960



Drepanogynis near *hiaraka* (Viette, 1968)



Drepanogynis purpurescens Herbulot, 1954



Drepanogynis near *hiaraka* (Viette, 1968)



Drepanogynis sp. Guenée, [1858]

Geometroidea
Geometridae

Ennominae



Drepanogynis sp. Guenée, [1858]



Drepanogynis sp. Guenée, [1858]



Drepanogynis sp. Guenée, [1858]



Drepanogynis sp. Guenée, [1858]



Drepanogynis sp. Guenée, [1858]



Epigynopteryx colligata (Saalmüller, 1891)

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Ectropis sp. [‘perineti Herbulot‘]



Ectropis sublutea (Butler, 1880)



Ectropis basalis Herbulot, 1981



Ectropis sublutea (Butler, 1880)



Epigynopteryx glycera Prout L. B., 1934



Luxiaria pratti Prout L. B., 1925



Erastria madecassaria (Boisduval, 1833)



Erastria madecassaria (Boisduval, 1833)



Erastria madecassaria (Boisduval, 1833)



Erastria madecassaria (Boisduval, 1833)



Erastria madecassaria (Boisduval, 1833)



Erastria madecassaria (Boisduval, 1833)



Melinoessa catenata (Saalmüller, 1891)



Ochroplutodes hova Herbulot, 1954



Racotis sp. Moore, 1887



Racotis sp. Moore, 1887



Racotis cf. *squalida* (Butler, 1878)



Racotis madagascariensis Chainey & Karisch, 2017



Xenimpia fletcheri (Herbulot, 1954)



Xenimpia fletcheri (Herbulot, 1954)



Xenimpia fletcheri (Herbulot, 1954)



Xenimpia fletcheri (Herbulot, 1954)



Xenimpia fletcheri (Herbulot, 1954)



Psilocerea barychorda Prout L. B., 1932



Psilocerea barychorda Prout L. B., 1932



Psilocerea barychorda Prout L. B., 1932



Psilocerea swinhoe Herbulot, 1859



Psilocerea tigrinata Saalmüller, 1880



Psilocerea tigrinata Saalmüller, 1880



Psilocerea viettei Herbulot, 1954



Psilocerea ferruginaria pallidizona Herbulot, 1959



Psilocerea swinhoe Herbulot, 1859



Psilocerea monochroma Herbulot, 1959



Psilocerea tigrinata Saalmüller, 1880



Psilocerea sp. *S*aalmüller, 1880



Psilocerea sp. Saalmüller, 1880



Psilocerea toulgoeti Herbulot, 1859



Psilocerea jacobi Prout, 1932



Psilocerea vestitaria Swinhoe, 1904



Xenostega ochracea (Butler, 1879)



Xenostega ochracea (Butler, 1879)



Zamarada oxybeles Fletcher, 1974



Zamarada oxybeles Fletcher, 1974



Zamarada sp. Moore, 1887



Zamarada sp. Moore, 1887



Xenostega sp. Warren, 1899



Zamarada sp. Moore, 1887



Antitrygodes dentilinea Warren, 1897



Antitrygodes dentilinea Warren, 1897



Chrysocraspeda cf. *erythraria* (Mabille, 1893)



Chrysocraspeda tantale (Viette, 1970)



Cyclophora metamorpha (Prout, 1925)



Chrysocraspeda sp. Swinhoe, 1893



Traminda obversata atroviridata (Saalmüller, 1880)



Chrysocraspeda cosymbia (Viette, 1984)



Traminda obversata atroviridata (Saalmüller, 1880)



Chrysocraspeda cosymbia (Viette, 1984)



Traminda obversata atroviridata (Saalmüller, 1880)



Metallaxis sp. Prout 1932



Metallaxis teledapa Prout, 1932



Problepsis meroearia Saalmüller, 1884



Problepsis meroearia Saalmüller, 1884



Scopula gibbivalvata Herbulot, 1972



Scopula internataria (Walker, 1861)



Scopula minuta (Warren, 1900)



Scopula rubrosignaria rubrosignaria (Mabille, 1900)



Scopula cf. *sparsipunctata* (Mabille, 1900)



Scopula sp. Schrank, 1802



Agathia malgassa Herbulot, 1978



Agathia malgassa Herbulot, 1978



Archichlora catalai Herbulot, 1954



Archichlora catalai Herbulot, 1954



Archichlora Warren, 1898



Archichlora cf. *malgassa*



Archichlora cf. *engenes* Prout, 1922



Archichlora cf. *engenes* Prout, 1922



Archichlora cf. *engenes* Prout, 1922



Archichlora cf. *chariessa* Prout, 1925



Archichlora cf. *nigricosta* Herbulot, 1960



Archichlora cf. *nigricosta* Herbulot, 1960



Archichlora hemistrigata (Mabille, 1900)



Archichlora hemistrigata (Mabille, 1900)



Archichlora hemistrigata (Mabille, 1900)



Archichlora hemistrigata (Mabille, 1900)



Archichlora hemistrigata (Mabille, 1900)



Archichlora hemistrigata (Mabille, 1900)



Archichlora trygodes Prout, 1922



Archichlora trygodes Prout, 1922



Archichlora trygodes Prout, 1922



Archichlora trygodes Prout, 1922



Archichlora trygodes Prout, 1922



Archichlora trygodes Prout, 1922



Archichlora cf. *stellicincta* (Herbulot, 1972)



Archichlora cf. *stellicincta* (Herbulot, 1972)



Comibaena punctaria (Swinhoe, 1904)



Comibaena punctaria (Swinhoe, 1904)



Comibaena punctaria (Swinhoe, 1904)



Comibaena leucochloraria (Mabille, 1880)



Comostolopsis rufocellata (Mabille, 1900)



Comostolopsis rufocellata (Mabille, 1900)



Comostolopsis stillata (Felder & Rogenhoffer, 1875)



Heterorachis sp. Warren, 1898



Comibaena leucochloraria (Mabille, 1880)



Dryochlora cinctuta (Saalmüller, 1891)



Dryochlora cinctuta (Saalmüller, 1891)



Heterorachis insueta Prout, 1922



Heterorachis insueta Prout, 1922



Blechroneromia herbuloti Viette, 1976



Epigelasma cf. *disjuncta* Herbulot, 1972



Phaiogramma stibolepida (Butler, 1879)



Epigelasma olsoufieffi Herbulot, 1972



Rhodesia alboviridata (Saalmüller, 1880)



Blechroneromia malagasy Viette, 1976



Hypocoela abstrusa Herbulot, 1956



Hypocoela fasciata Herbulot, 1956



Hypocoela abstrusa Herbulot, 1956



Hypocoela fasciata Herbulot, 1956



Hypocoela abstrusa Herbulot, 1956



Hypocoela fasciata Herbulot, 1956



Hypocoela humidaria (Swinhoe, 1904)



Hypocoela spodozona Prout L. B., 1925



Hypocoela spodozona Prout L. B., 1925



Hypocoela spodozona Prout L. B., 1925



Hypocoela spodozona Prout L. B., 1925



Hypocoela spodozona Prout L. B., 1925



Leptocolpia superba Herbulot, 1965



Leptocolpia superba Herbulot, 1965



Leptocolpia superba Herbulot, 1965



Leptocolpia superba Herbulot, 1965



Leptocolpia superba Herbulot, 1965



Lophostola cf. *cara cumatilis* Prout L. B., 1922



Lophorrhachia rubricorpus (Warren, 1898)



Maxates cowani (Butler, 1880)



Lophorrhachia rubricorpus (Warren, 1898)

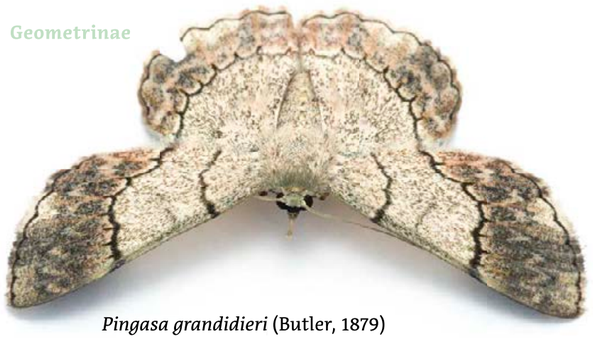


Metallochlora glacialis (Butler, 1880)



Phaiogramma stibolepida (Butler, 1879)

Geometrinae



Pingasa grandidieri (Butler, 1879)



Pingasa grandidieri (Butler, 1879)



Pingasa herbuloti (Viette, 1971)

Larentiinae



Eois cf. *grataria* (Walker, 1861)
[ab. mediofusca Prout]

Geometrinae



Thalassodes cf. *progressa* Prout, 1926



Thalassodes cf. *progressa* Prout, 1926



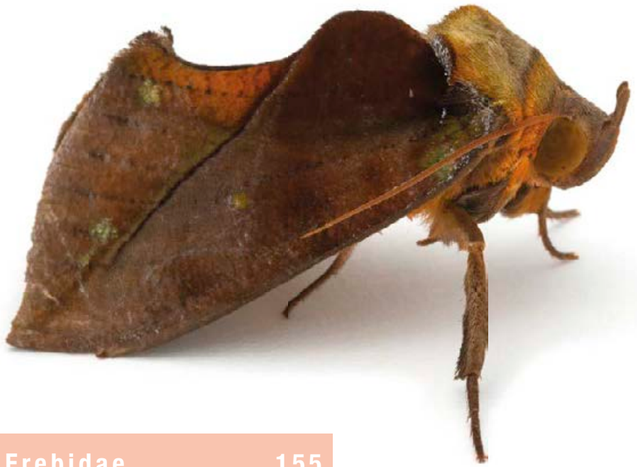
Thalassodes cf. *progressa* Prout, 1926



Thalassodes cf. *progressa* Prout, 1926



Victoria sp. Warren, 1897



Erebidae 155



Euteliidae 155



Nolidae 156



Noctuidae 113–123



Notodontidae 113–123



Scranciidae 159

Families of the superfamily Noctuioidea dealt with in this PDF.

Noctuoidea

Text by Marcin Wiorek

Noctuoidea is the most diverse and the largest superfamily within all Lepidoptera, comprising around 48,000 species, of which more than 2,000 have been reported from Madagascar. This group has definitely achieved evolutionary success, since despite its huge number of species it is also one of the youngest.

Among the families belonging to Noctuoidea, are Erebidae, Euteliidae, Nolidae, Notodontidae, Scranciidae, and – obviously – Noctuidae, the family that gives the name to the entire superfamily. Representatives of each of these families are depicted below, giving a glimpse of the overwhelming diversity of Noctuoidea.



Eudocima boseae (Saalmüller, 1880)



Caligatus splendidissima (Viette, 1958)



Chrysodeixis chalcites (Esper, 1798)



Blenina near *hyblaeoides* Kenrick, 1917



Vietteella madagascariensis (Draeseke, 1937)



Malgadonta idioptila (Bethune-Baker, 1916)

Madagascar's Tear Drinker

Text by Dr. Roland Hilgartner

The amazing and unique nature of Madagascar has long attracted the focus of researchers. Madagascar's long isolation from the African mainland has resulted in the evolution of a breathtaking array of flora and fauna. The vast majority of Madagascar's animal and plant species is endemic and can be found nowhere else in the world. The same is true for several unique biotic interactions that can be only observed on the island of Madagascar but not on the African mainland or elsewhere. In 2004 I was lucky to add one more peculiarity to Madagascar's bizarre parade of exceptional behaviors.



Madame Berthe's Mouse lemur
Roland Hilgartner did research on the smallest known species of lemur, Madame Berthe's Mouse lemur *(Microcebus berthae)*, our smallest relative. It lives in the Kirindy Forest where at night it catches moths that visit baobab flowers to feed on nectar.
Photo: R. Hilgartner

During my nightly observations in the Kirindy Forest in western Madagascar I located a single Common Newtonia bird. The bird was sleeping on a branch in a bush at low height. On its neck sat the calpine moth *Hemiceratoides hieroglyphica*. A closer inspection revealed that the moth had its proboscis inserted beneath the lid of the closed eye of the bird. At this point it became clear to me that this was something very special never observed or documented before. While photographing this bizarre interaction the flash of my camera briefly disturbed the Common Newtonia. The bird moved its head and the proboscis of the moth lost contact with the bird's eye. However, the moth stayed on the bird's neck and after a few seconds searched actively with its proboscis, inserting it beneath the lid of the closed eye. The moth stayed in this position for 35 minutes apparently drinking tears from the bird. During two years of research in Kirindy forest I observed this behavior only two more times. In one case the moth fed on tears of another bird species (Madagascar magpie-robin). The third observation was again with Common Newtonia as host species. These three observations were the world's first and only known observations of moths feeding on the tears of birds in Madagascar.





Hemiceratoides hierogyphica (Saalmüller, 1891)
Photo: Dr. R. Rougerie
Specimen of the Collection MNHN, Paris

Calpinae

Harpoon Moth
Hemiceratoides hieroglyphica sitting on the neck of a Common Newtonia *(Newtonia brunneicauda)*. The moth specializes in drinking the tears of sleeping birds. This remarkable behavior was discovered by Roland Hilgartner in the dry deciduous forest of western Madagascar in 2004.
Photo: Roland Hilgartner

Madagascar's Tear Drinker

Text by Dr. Roland Hilgartner



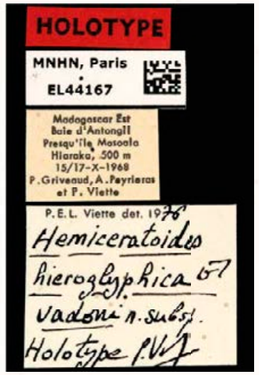
A lot of research questions about the tear-drinking behavior of *H. hieroglyphica* still remain unresolved. While the bird's eye was closed and the moth continued feeding, the host birds never showed signs of being disturbed. It would therefore be interesting to know whether the moths are able to introduce compounds such as antihistamines or narcotics to reduce irritation while the moth is feeding or to keep the bird asleep over such a long period of time. Another important question is the possible transmission of avian eye diseases. More observations are also needed to determine if the eastern rainforest species of the genus *Hemiceraroides* also exhibit tear-drinking behavior. To conclude: Madagascar remains a hotspot for naturalists to make new discoveries!

Harpoon-like proboscis
The harpoon-like proboscis is characteristic for *Hemiceratoides hieroglyphica*. To drink tears from sleeping birds it uses its specialized proboscis which it introduces underneath the bird's eyelid.
Photo: Harald W. Krenn
Coloration: Mamisolo R. Hilgartner

Tear-drinking moth
The overwhelming diversity of Noctuoidea - with over 2,000 species in Madagascar - also includes a huge diversity of life strategies. One of the most unusual has evolved in the Harpoon moth, *Hemiceratoides hieroglyphica*. All living organisms need micro- and macro-elements, and Lepidoptera are no exception. You may have observed butterflies and moths imbibing from mud puddles, or even from animal cadavers or feces – these are just some of the sources of these crucial elements. *Hemiceratoides hieroglyphica* is one of several species that have found a very interesting solution for this need – namely, drinking the salty tears of sleeping, completely unaware birds. This could well be an adaptation to the fact that many frogs and reptiles are predators while at the same time there are few large mammals to leave feces.



Hemiceratoides vadoni (Viette, 1976)
Photo: www.gbif.org
Specimen of the Collection MNHN, Paris



Genus *Hemiceratoides*
The genus *Hemiceratoides* comprises five species, and of these *H. hieroglyphica* has been substantiated in western Madagascar (Kirindy) and *H. vadoni* in the eastern part of the country (Masoala). *H. sittaca* and two more species are found in Africa.

Notodontidae (Prominent moths)

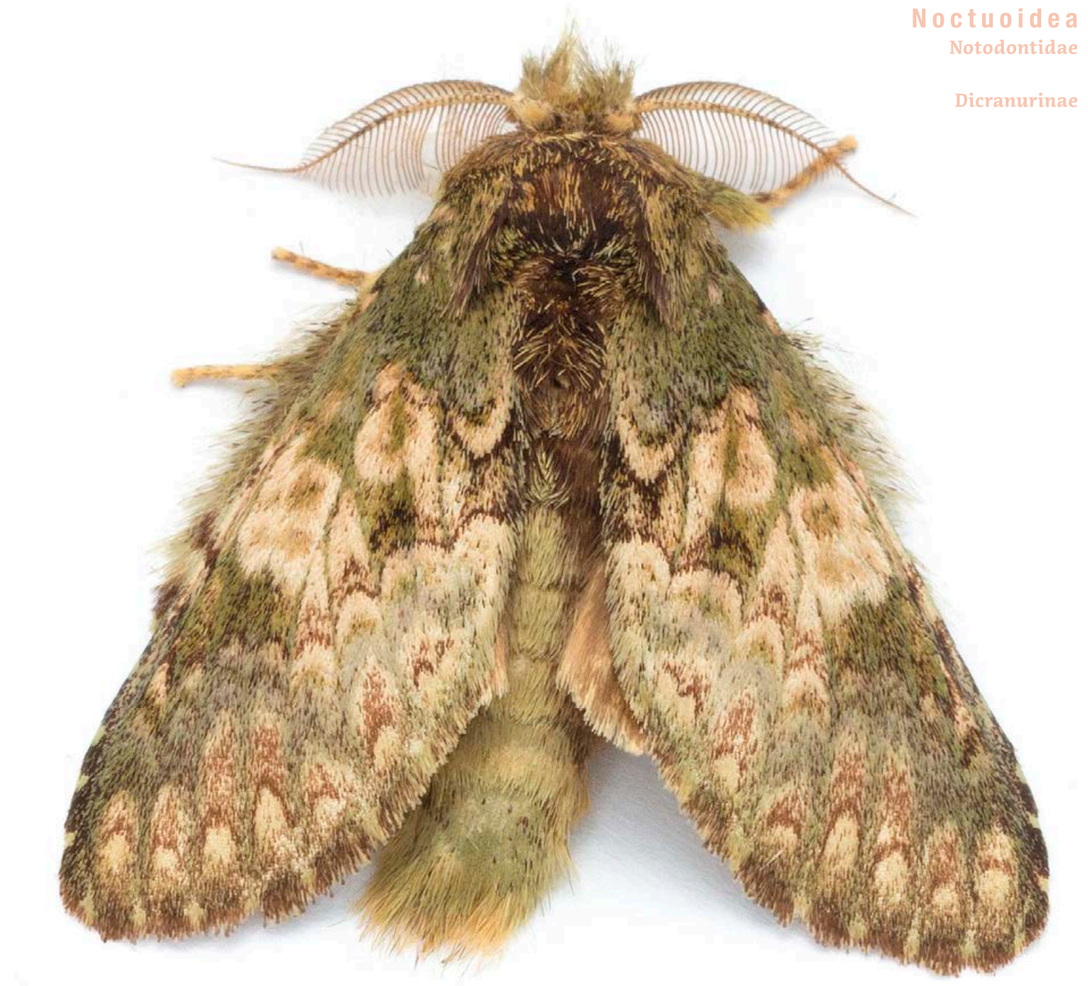
Text by Dr. Alexander Schintlmeister

The Notodontidae or Prominent moths are one of the families in the Noctuoidea, the most species-rich super family of Lepidoptera (butterflies and moths) with about 60,000 currently recognized species. Nearly 5,000 of these belong to the Prominent moths and are found on every continent except Antarctica.

However, the actual number in Notodontidae is likely to be over 10,000 species because many of them await their discovery and description. Notodontid caterpillars eat a wide range of woody and herbaceous plants, and grasses (Poaceae) (Schintlmeister, 2008, Kroon, 1999). Caterpillars of some species are regarded as human food sources (Mabossy-Mobouna et al. 2022).

Family characteristics of Notodontidae are to be found specifically in the abdominal tympanal organ (an auditory structure), wing venation, male genitalia (well-developed socii), and larval morphology. Molecular phylogenetic research on Notodontidae began only recently. Initial results established Scranciidae, which formerly had been recognized as a subfamily within Notodontidae (Schintlmeister, 2008), as a distinct family (St. Laurent et al. 2023). Scranciidae are represented in Madagascar by three species but have not yet been found in Masoala.

In most cases the various subfamilies of Notodontidae are represented by only one species in Madagascar. But Thaumetopoeinae, Pygaerinae and Dicranurinae are rich in species in Madagascar. From the subfamily Thaumetopeinae alone, 34 species have been described from Madagascar, with other Notodontidae in Madagascar currently numbering 73 species.



Desmeocraera robustior Kiriakoff, 1960

Color palette green
The antennae of male Dicranurinae are often bushy with naked tips. Many species appear green and are highly specialized ecologically. *Desmeocraera* is one of the largest genera among African Notodontidae with about 100 known species. But the author already is familiar with a further 47 new species that await description. Most *Desmeocraera* display green forewings. In Madagascar only three *Desmeocraera* occur: *robustior* (Kiriakoff, 1960), and two further similar species.



Vietteella madagascariensis (Draeseke, 1937)

Noctuoidea
Notodontidae

Dicranurinae



Lost male
This species is less well known. The lucky photographer was able to find the first male *Chlorocalliope dubiefae* (Viette, 1978) – the species was described from a female, which to date is the only known specimen in collections.

Chlorocalliope dubiefae (Viette, 1978)
February 23, 2019

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Vietteella madagascariensis (Draeseke, 1937)

Noctuoidea
Notodontidae

Dicranurinae



Stowaways
A glance at the underside of this moth reveals signs of life. On this male *Chlorocalliope dubiefae* two mites can be seen, in the area of the left antenna and on the abdomen. They are living on the moth. The leg scaling is in very large part missing and it can be surmised that the creature is already a few days old.

Chlorocalliope dubiefae (Viette, 1978)
February 23, 2019

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Vietteella madagascariensis (Draeseke, 1937)





Multivariate coloration
Vietteella madagascariensis is the largest Dicranurinae in Madagascar and from the wingspan readily recognizable, although the range of individual variability of the fore-wing pattern is wide. Sometimes almost all green fields are replaced by brown.

Noctuoidea
Notodontidae

Dicranurinae



Vietteella madagascariensis (Draeseke, 1937)







Vietteella madagascariensis (Draeseke, 1937)



Pycnographa viridissima (Kiriakoff, 1958)

Elongated abdomen
This elegant species is unmistakable because of the intense dark-green forewings. The cryptic patterns hide the moth perfectly in the dense green rainforest. The bushy front legs are stretched forward when at rest, as in many Notodontidae. The abdomen is also longer than the folded forewings and only the protruding end is colored green like the forewings.



Chlorocalliope antongilensis (Viette, 1955)



Chlorocalliope grandidieranum (Viette, 1954)



Chlorocalliope dubiefae (Viette, 1978)



Vietteella madagascariensis (Draeseke, 1937)



Pycnographa viridissima (Kiriakoff, 1958)



Chlorocalliope antongilensis (Viette, 1955)



Chlorocalliope grandidieranum (Viette, 1954)

Fringed look
The fringes of the hindwings project beyond the forewings and permit moths sitting in rest position to merge into the background.





Vietteella madagascariensis (Draeseke, 1937)



Pycnographa viridissima (Kiriakoff, 1958)



Chlorocalliope antongilensis (Viette, 1955)



Chlorocalliope grandidieranum (Viette, 1954)

Perfect camouflage in resting position
When at rest, *Chlorocaliope* and *Pycnographa* press themselves down against the background. Moving from side to side, the abdomen positions itself centrally under the closed wings, with antennae and legs bent inwards and concealed under wings and body. Long scales on the upper thorax near the base of the antennae are folded forward and protect the eyes.



Chlorocalliope dubiefae (Viette, 1978)





Acroctena fissura Saalmüller, 1884

Acroctena pallida (Butler, 1882)





Taxonomically difficult
Four or five species are in the genus *Acroctena* Saalmüller, 1884, of which the pallida group is taxonomically difficult.







Wide range of variability
Ambina adults display a remarkably wide range of individual variability in forewing pattern. There are individuals with almost uniformly pale orange-brown forewings; other specimens display a blackish pattern, such as lines, spots, and three circles with a blackish border with various modifications. This led to the description of five more species between 1960 and 1969. But they belong, in fact, to one species and the different names are merely junior synonyms.







Ambina spissicornis (Mabille, 1899)























Variability in *Ambina ochreopicta*

This species is also very variable in forewing pattern, as the illustrations demonstrate. Of the 5 *Ambina* occurring in Madagascar it is by far the most common. In longer series all transitional forms are seen, and this is probably the reason why it was described only once.

Pygaerinae have a rather slender body; the thorax bears a dorsal tuft and in males the anal tuft of the abdomen is prominent – and bifid. In mainland Africa, the caterpillars are associated with willows and poplars (Salicaceae); caterpillars of Madagascan species and their host plants are hitherto unknown.

Noctuoidea
Notodontidae

Pygaerinae

Dicranurinae



Brachychira cf. *destituta* Kiriakoff, 1966
(identity and genus unknown,
probably a new species)





Clostera albidilinea (Gaede, 1928)
Eutronotus albidilinea



Clostera pratti (Kenrick, 1917)

Worldwide range
Clostera is distributed worldwide in many, mostly smaller, species and Madagascar hosts no fewer than 16 species, 2 of which are illustrated here.

Not assigned
The contrasting white discal streak on the forewings make this small species unmistakable. Its assignment to a subfamily, however, remains uncertain.



Romaleostaura insularis Kiriakoff 1960





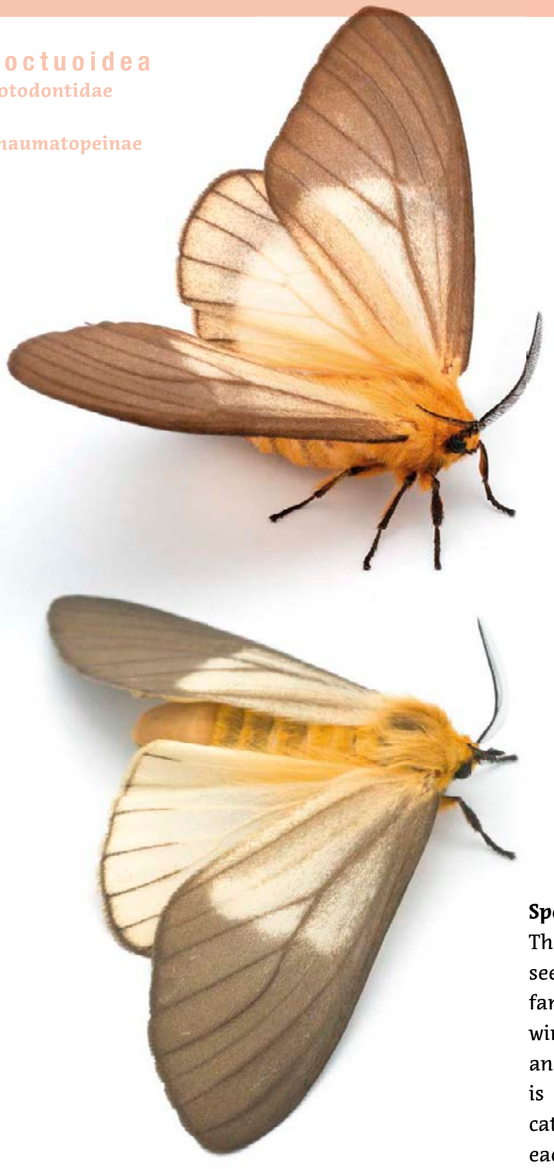
Spataliinae

Elaphrodes simplex (Viette, 1955)



Dicranurinae

Omocerina cf. Kiriakoff, 1970



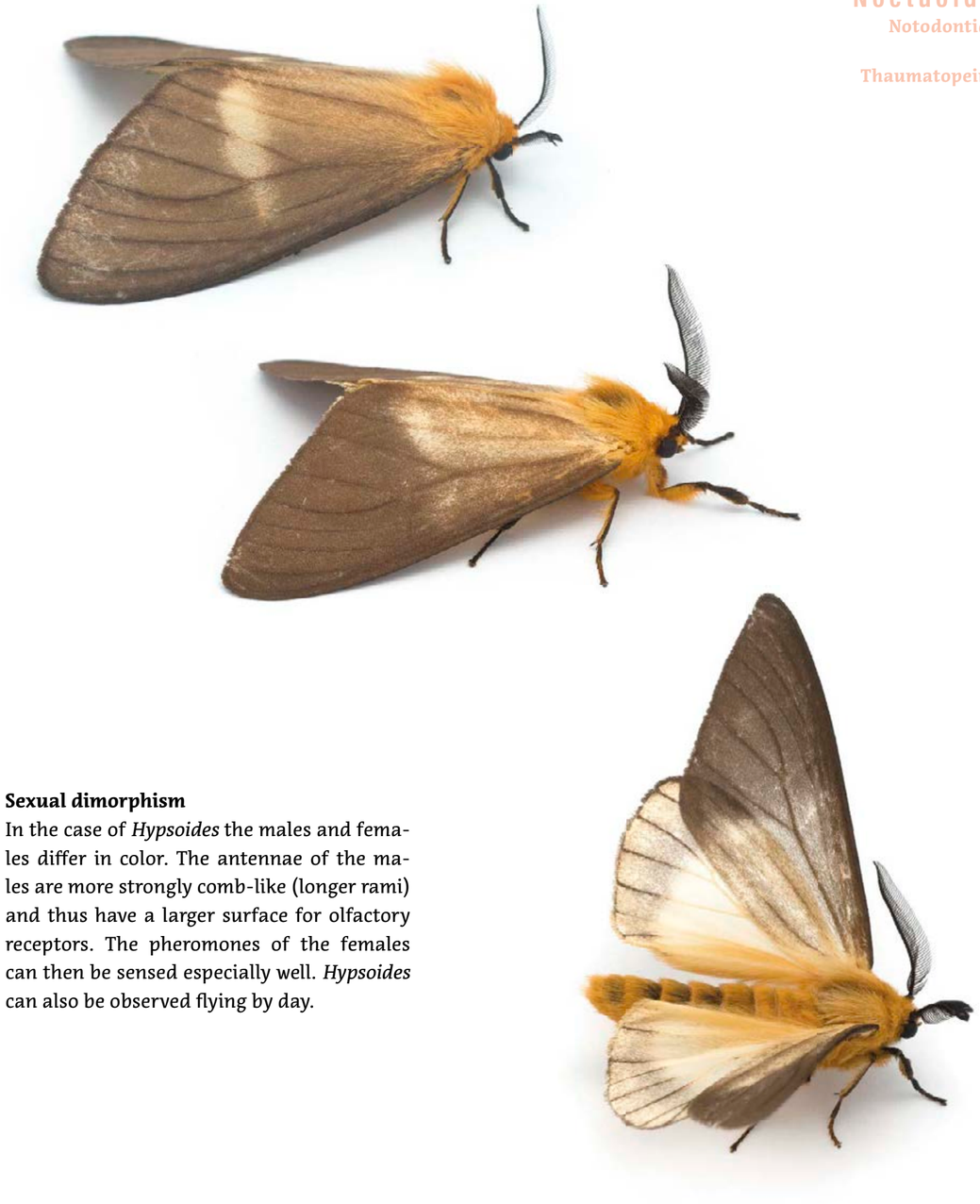
Hypsoides radama (Coquerel, 1855)

Species-rich genera
Thaumetopoeinae or Processionary moths – seen by some authors as their own distinct family – are, in Madagascar, moths with large wing areas and wings that are often whitish and blackish. The name Processionary moths is derived from the habit of the gregarious caterpillars of walking in "processions", i.e., each caterpillar's head touches the hindquarters of the preceding one. From Madagascar, 34 species in 3 genera have been described and all of them are endemic.

Sexual dimorphism
In the case of *Hypsoides* the males and females differ in color. The antennae of the males are more strongly comb-like (longer rami) and thus have a larger surface for olfactory receptors. The pheromones of the females can then be sensed especially well. *Hypsoides* can also be observed flying by day.

Noctuoidea
Notodontidae

Thaumatopeinae



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Erebidae

Text by Marcin Wiorek

The family Erebidae is evolutionarily a very young yet highly diverse group and its classification is still quite a riddle for scientists. Right now, to this family are assigned around 25,000 species distributed worldwide, and it includes some of the moths with both the largest and the smallest wingspans on earth.

In Madagascar there are around 1,250 known species of erebids. Among the numerous subfamilies belonging to Erebidae, there are for example tiger moths (subfamily Arctiinae), piercing moths (subfamily Calpinae), underwings (subfamily Erebinae) and tussock moths (subfamily Lymantriinae).

An interesting detail is that the entire family Erebidae derives its name from the genus *Erebus* – such a genus in systematics is called the typical genus, being the "namebearer" of the entire group. The only species of this genus occurring in Madagascar is *Erebus walkeri*.

Subfamilies of Erebidae:
- Aganainae
- Anobinae
- Arctiinae
- Boletobiinae
- Calpinae
- Erebinae
- Eulepidotinae
- Herminiinae
- Hypeninae
- Hypenodinae
- Hypocalinae
- Lymantriinae
- Pangraptinae
- Rivulinae
- Scolecocampinae
- Scoliopteryginae
- Tinoliinae
- Toxocampinae



Erebus walkeri (Butler, 1875)

Erebinae



Eudocima boseae (Saalmüller, 1880)



Asota borbonica (Boisduval, 1833)
female



Mecodinops anceps (Mabille, 1879)

Noctuoidea
Erebidae

Aganainae

Asota borbonica (Boisduval, 1833)
male



Flexible proboscis with a brush-like tip
Butterflies and moths ingest liquid food – whether this be nectar from flowers or sap from trees. Any other sources of liquids are used, including also dung, sugary or salty juices from fruits, sweat, or many other kinds, even the tears of birds. In order to do this, they sop up the liquids with the tip of their flexible proboscis. The proboscis itself is a supple, maneuvrable double tube whose tip is shaped like an artist's paintbrush – thus the large surface area of the proboscis tip produces a capillary effect that enables the nutrient solution to be sucked up. Here, *Asota borbonica* is ingesting a sugar solution. By moving the head and the proboscis the solution is soaked up. At the same time, the antennae are repeatedly raised or extended forward, while keeping the same posture. After taking the food the proboscis is rolled up and placed between the palpi in rest position.



Asota borbonica (Boisduval, 1833)
male

Noctuoidea
Erebidae

Aganainae

New family status in 2024
A small, notodontid-like family that only gained its own family status in 2024. According to the Global Lepidoptera Index, 124 species in 22 genera have been described. Previously, they belonged to the family Notodontidae. Adults exhibit elongated body features in all areas: long antennae, long legs, and long forewings.



Malgadonta idioptila (Bethune-Baker, 1916)



Mafana lajonquierei Viette, 1979



Mafana lemairei Viette, 1979



Anoba malagasy Viette, 1970



Plecoptera lacinia (Saalmüller, 1880)



Mafana lajonquierei Viette, 1979



Mafana lemairei Viette, 1979



Anoba malagasy Viette, 1970



Acripia megalesia Viette, 1965



Marcipa noel Viette, 1966



Marcipa callaxantha (Kenrick, 1917)

Anobinae



Acripia megalesia Viette, 1965

Erebinae



Audea agrotidea (Mabille, 1880)

Pangraptinae



Episparis vitrea (Saalmüller, 1891)

Scaly legs

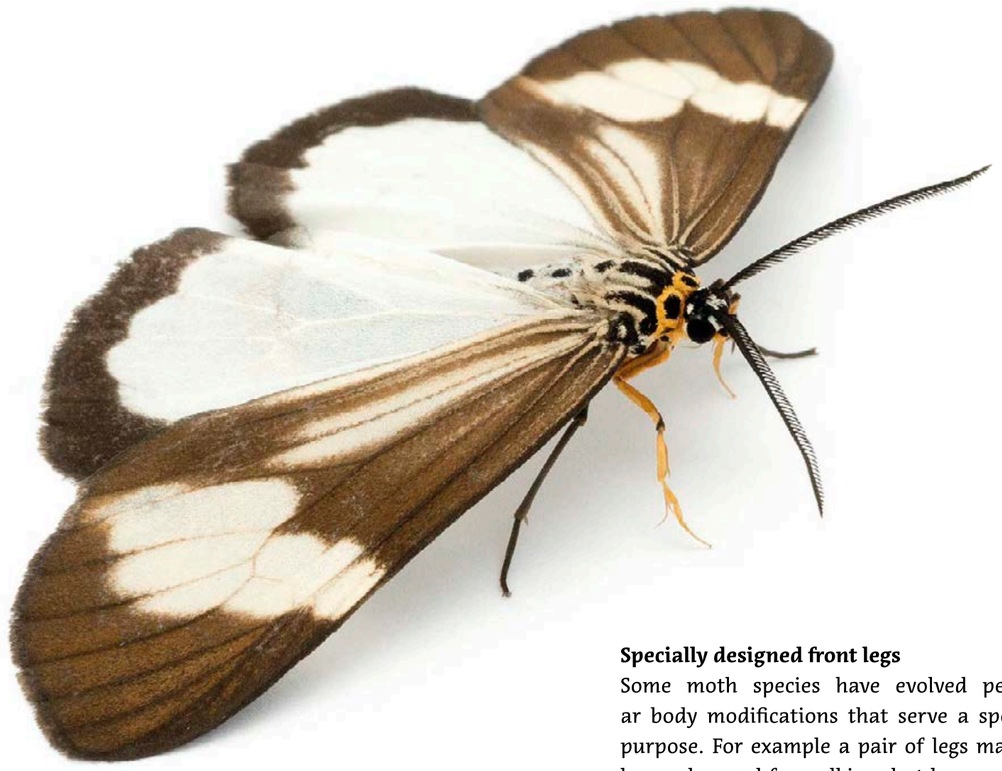
Legs, as for the entire moth body, are covered with scales. In some erebids this vestiture is very varied, forming different kinds of tufts or brushes, as in *Acripia megalesia* and *Audea agrotidea* shown here. The exact functions of these scales is unknown, but considering the cryptic coloration of these moths, it may simply help them to blend more efficiently into the background in the resting position. Additionally, the beak-like tuft on the thorax of *A. megalesia* is perhaps part of such camouflage making the moth look like a piece of broken twig. In the similar way, projecting front legs of *Episparis vitrea* displayed here fit well with the general appearance of this moth, resembling a withered and already perforated leaf.

Arctiinae (Tiger moths)

Text Marcin Wiorek

Arctiinae is a large subfamily of Erebidae moths, comprising some 11,000 species inhabiting mostly the tropics. Their scientific name derives from the Greek word arktos meaning "bear", which refers to the caterpillars of these moths, which are often densely hairy and called woolly bears. Adult arctiines, due to their very characteristic appearance, are commonly named tiger moths, wasp moths, lichen moths, footmen and polka-dot moths.

In Madagascar there are only about 370 known arctiine species, but that number comprises some of the most interesting groups of moths endemic to the island. A treasure trove of the Madagascan arctiines is the group of around 100 species of polka-dot moths of the tribe Syntomini – one of them, representing the genus *Tenuinaclia*, can be seen at the bottom of page 136. The unique thing about these moths is that all of them derive from a single ancestor, and in a relatively short time (in the evolutionary timescale) diversified into a hundred species.



Chiromachla insulare (Boisduval, 1833)

Specially designed front legs

Some moth species have evolved peculiar body modifications that serve a specific purpose. For example a pair of legs may no longer be used for walking, but have a completely new function. In the case of genus *Chiromachla* the male forelegs are reduced and have a modified shape, different in each species of the genus! In *Chiromachla insulare* displayed here, the front legs are orange, have a club-like contraction and are provided with a row of very long, hair-like setae. It is believed that these structures have a sexual function, but their exact role still remains unknown.

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Chiromachla insulare (Boisduval, 1833)



Parachelonia cf. *simulans* (Toulgoët, 1971)



Utetheisa elata (Fabricius, 1798)



Fodinoidea rectifascia Collenette, 1930





Madagascarctia cellularis (Toulgoët, 1954)



Detoulgoetia virginalis (Butler, 1878)



Madagascarctia madagascariensis (Butler, 1882)



Madagascarctia madagascariensis (Butler, 1882)







Detoulgoetia virginalis (Butler, 1878)









Aposematism – warning coloration on abdomen

Tiger moths owe their name to the bright and vivid coloration, which often does indeed include tiger-orange, as in *Detoulgoetia virginalis* shown here. Such patterns and colors in nature are a universal sign that their owner is dangerous, unpalatable or even poisonous. In the case of arctiines it is actually a true warning as bodies of many species contain secondary compounds obtained from plants. These substances are completely harmless to the moths, but unpalatable or toxic to a potential predator. Thus, if any predator were to ignore the visual signals, it is then immediately taught through the sense of taste to avoid this kind of prey.



Chiromachla insulare (Boisduval, 1833)











Noctuoidea
Erebidae

Arctiini

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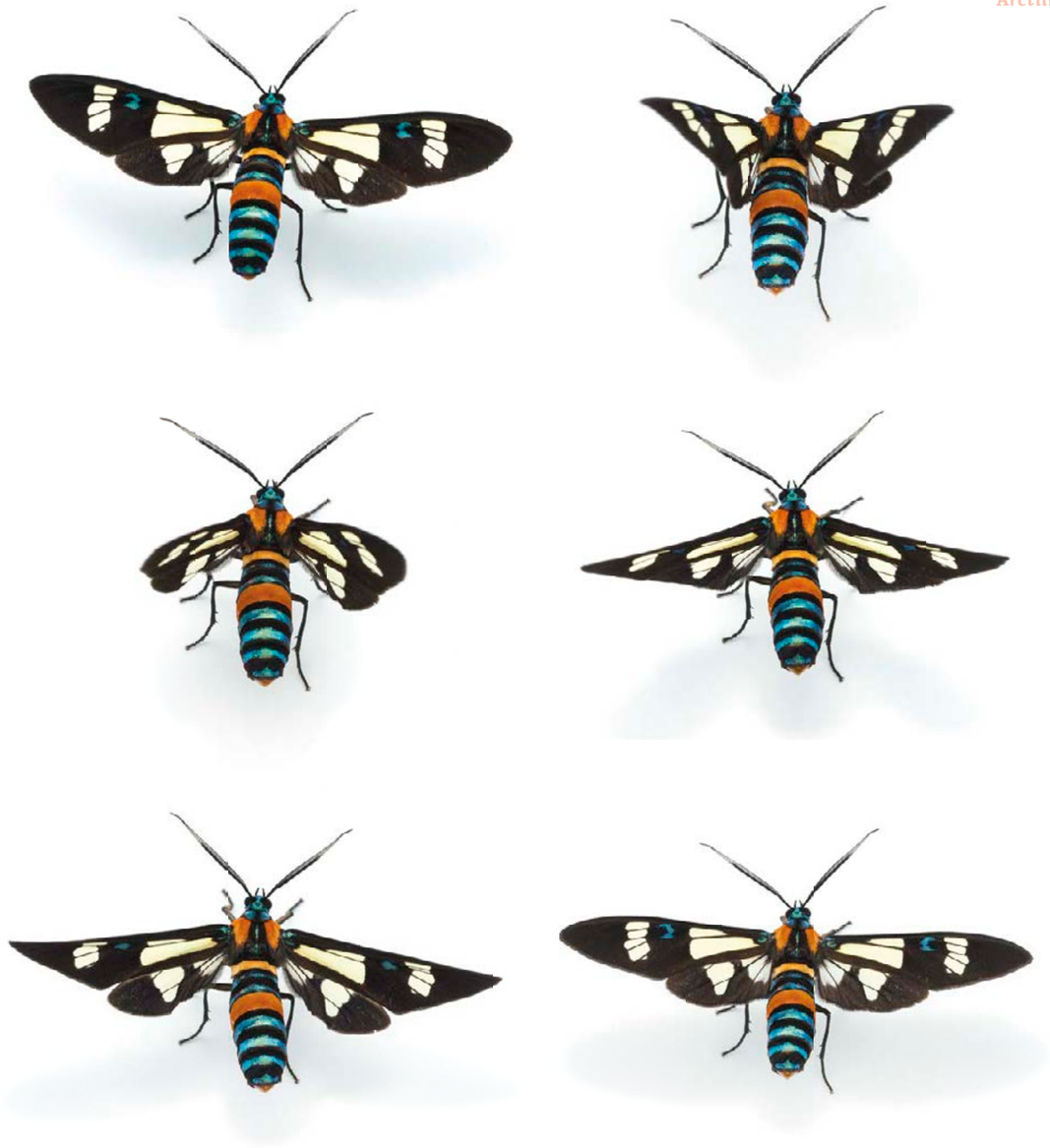
Euchromia folletii (Guérin-Méneville, 1832)

Mimicry – wasp or moth?

There are around 50 species of *Euchromia* wasp moths, inhabiting the tropics of the Old World. *Euchromia folletii* shown here is one of the two species occurring in Madagascar. The common character of all moths from this genus is their wasp-like appearance. With their striped abdomens and large blotches on elongate and narrowed wings, they more resemble big hornets than moths. An interesting thing is the metallic-blue gloss of their body, being the effect of structural coloration. It means that this color is not the result of pigmentation of scales, but their nanostructure. Thus, this phenomenon in *Euchromia* follows the same principles as in the widely known neotropical butterflies of the genus *Morpho* – the scales themselves are brownish but their surface refracts light in such a way that only the blue part of the spectrum is reflected.

Noctuoidea
Erebidae

Arctiini





Euchromia folletii (Guérin-Méneville, 1832)





Busy behavior – show that you might be armed and dangerous

But it is not only the body shape and coloration that produce the wasp-like effect. *Euchromia* moths also behave like wasps, folding their wings in a specific, sharply angled position and being active by day, flying slowly and ponderously in the sunlight. Moreover, the appearance is not the only weapon they possess. As already mentioned, some arctiines accumulate unpalatable or toxic substances in their bodies. This phenomenon is called pharmacophagy, which means taking substances that are not nutrients. *Euchromia* moths do it as adults, imbibing exudation or nectar of some plants containing so-called pyrrolizidine alkaloids. The purpose of this behavior seems to be simply enhancement of the aposematic signals. If any predator, not discouraged by the moth's appearance, dares to try to eat it, it then detects an unpleasant taste. It has already been proven experimentally that animals that encountered these moths for the first time avoided eating them after only a few attempts.











Cyana amatura (Walker, 1863)



Phryganopteryx triangularis Toulgoët, 1958



Phryganopteryx convergens Toulgoët, 1958

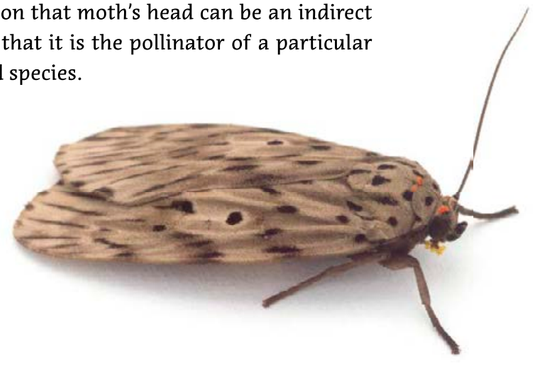


Phryganopteryx convergens Toulgoët, 1958



Pollinators

You may have seen busy bees, bumblebees and butterflies bustling around flowers, collecting nectar and pollen. It is no exaggeration to state that this activity keeps our planet – and us – alive, since the majority of fruits and vegetables we eat are pollinated by insects. But this is not only a diurnal service – there is also a night shift, as many moths are very efficient pollinators. In the picture displayed above of *Phryganopteryx triangularis*, a tiger moth species occurring only in Madagascar, you can see some yellow, egg-like granules on its labial palps. These are so-called pollinaria of some orchid species. Orchids have a very peculiar trait of distributing "packed" pollen, whereby the pollinators collect entire pollinaria – not just separate pollen grains, as in the case of other flowering plants – and move them to the stigma of another plant. Thus, the presence of pollinaria on that moth's head can be an indirect proof that it is the pollinator of a particular orchid species.





Eilema argentea (Butler, 1878)



Eilema hybrida Toulgoët, 1957



Eilema kingdoni (Butler, 1877)



Eilema sp. near *laurenconi* Toulgoët, 1976



Eilema pallidicosta (Mabille, 1900)



Eilema recticosta Toulgoët, 1956



Siccia nigropunctana (Saalmüller, 1880)



Isorropus tricolor Butler, 1880
female



Isorropus tricolor Butler, 1880
male

Tenuinaclia andapa Griveaud, 1964





Eilema marginata (Guérin-Méneville, 1844)



Eilema marginata Guérin-Méneville, 1844

Tenuinaclia andapa Griveaud, 1964



Adaptive radiation in polka-dot moths
The Malagasy polka-dot moths are an example of adaptive radiation in Lepidoptera. All of their nearly 100 valid described species derived from a single ancestor in a relatively short evolutionary timescale.



Acremma axerina (Viette, 1988)



Acremma thyridoides (Kenrick, 1917)



Acremma sp. near *thyridoides* (Kenrick, 1917)



Acremma sp. Berio, 1959



Acremma neona (Viette, 1962)



Acremma cf. *thyridoides* (Kenrick, 1917)



Acremma thyridoides (Kenrick, 1917)



Acremma sp. Berio, 1959



Acremma sp. near *ingens* (Viette, 1968)



Acremma sp. Berio, 1959



Acremma sp. Berio, 1959



Acremma sp. Berio, 1959

Noctuoidea
Erebidae

Boletobiinae



Andrianam poinimerina Viette, 1954



Bertula sandrangato (Viette, 1962)



Cautatha cf. *coenogramma* (Mabille, 1900)



Argyrolopha trisignata (Mabille, 1900)



Corgatha zotica (Viette, 1956)



Corgatha falcigera (Berio, 1959)



Macella euritiusalis (Walker, 1859)



Corgatha fissilinea (Hampson, 1910)



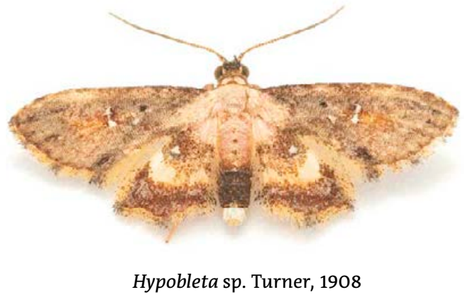
Corgatha sp. Walker, 1859
(Acremma sp. near *funebris* (Viette, 1962))



not assigned



Corgatha latifera (Walker, 1869)



Hypobleta sp. Turner, 1908



Boletobiinae sp. Guenée, [1858]



Aburina dufayi Viette, 1979



Claterna sp. near *berioi* Viette, 1954



Claterna ochreoplaga Viette, 1966



Claterna sparsipuncta Viette, 1966



Claterna sp. Walker, 1858



Eudocima boseae (Saalmüller, 1880)



Avitta cf. *lineosa* (Saalmüller, 1891)



Eudocima phalonia (Linnaeus, 1763)



Eudocima imperator (Guérin-Méneville, 1832)







Eudocima boseae (Saalmüller, 1880)





Eudocima imperator (Guérin-Méneville, 1832)

Noctuoidea
Erebidae

Calpinae



Eudocima boseae (Saalmüller, 1880)



Eudocima phalonia (Linnaeus, 1763)



Eudocima imperator (Guérin-Méneville, 1832)

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Fodina decussis (Saalmüller, 1891)



Fodina hayesi Viette, 1981



Fodina insignis (Butler, 1880)



Fodina laurentensis Viette, 1966



Fodina madagascariensis Viette, 1966



Fodina vieui Viette, 1966



Hondryches incertana (Viette, 1958)



Hondryches sp. Nye, 1975



Fodina insignis (Butler, 1880)



Marcipopsis Berio, 1966



Eublarginea argentifera Berio, 1966

Boletobiinae



Maxera nova Viette, 1956



Maxera nova Viette, 1956

Hypeninae



Hypena simplicalis Zeller, 1852



Zekelita sp. Walker, 1863

Scoliopteriginae



Argyphia arcifera (Mabille, 1881)



Mepantadrea reuteri (Saalmüller, 1881)
unplaced



Maronis rivosa Saalmüller, 1891
unplaced



Prominea porrecta (Saalmüller, 1880)
unplaced



Thausgea cf. *lolo* Viette, 1966
unplaced



Paralephana angulata (Viette, 1966)
unplaced



Miniophyllodes aurora Joannis, 1912



Miniophyllodes aurora Joannis, 1912



Miniophyllodes sikorai Viette, 1974



Miniophyllodes aurora Joannis, 1912



Miniophyllodes aurora Joannis, 1912



Miniophyllodes sikorai Viette, 1974



Hydrillodes cf. *uliginosalis* Guenée, 1854



Heteromala rougeoti Viette, 1979



Singara sp. Walker, 1865



Coelophoris sogai Viette, 1965



Polypogon (Nyctennomos) descarpentriesi (Viette, 1954)



Polypogon (Nyctennomos) descarpentriesi (Viette, 1954)



Episparis malagasy Viette, 1966



Episparis vitrea (Saalmüller, 1891)



Pangrapta fauvealis Viette, 1965



Episparis vitrea (Saalmüller, 1891)



Zethes near *humilis* Mabille, 1899



Episparis vitrea (Saalmüller, 1891)

Noctuoidea

Erebidae

Erebinae



Achaea catella Guenée, 1852



Achaea cf. *faber* Holland, 1894



Achaea dejeanii (Boisduval, 1833)



Achaea euryplaga (Hampson, 1913)



Achaea cuprizonea (Hampson, 1913)



Achaea oedipodina Mabille, 1879



Lophotavia near *globulipes* (Walker, 1865)



Calligraphidia tessellata (Kenrick, 1917)

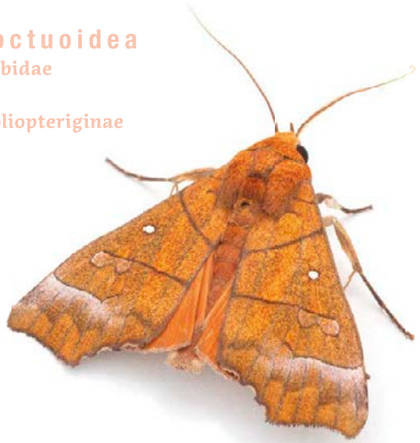
Hypopyrini



Hypopyra cf. *capensis* Herrich-Schäffer, 1854



Hypopyra cf. *capensis* Herrich-Schäffer, 1854



Anomis alluaudi Viette, 1965



Anomis simulatrix (Walker, 1865)



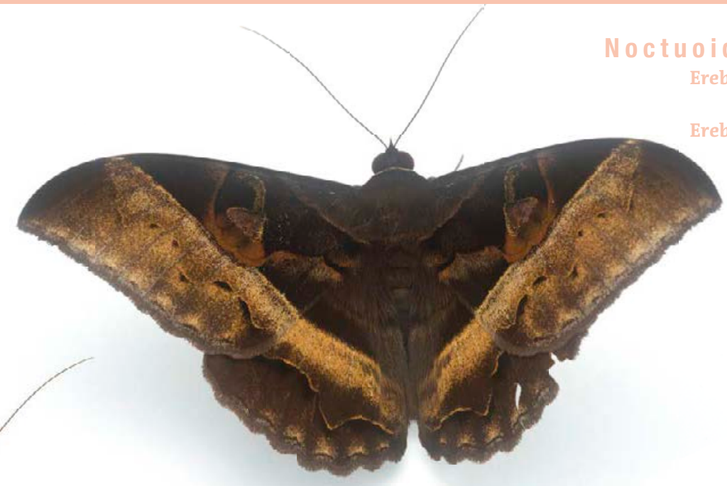
Audea agrotidea (Mabille, 1880)



Audea agrotidea (Mabille, 1880)

Spirits of the ancestors

It is culturally important that the Malagasy word for moth or butterfly, "lolo" also means "ghost" or "soul". Actually, there must be something universal in that association of the human soul with an ephemeral lepidopteran, as it is known in the European culture too – the Greek word "psyche" also means both "soul" and "butterfly". The Malagasy people call some large and dark-colored erebid moths, especially *Erebus walkeri* and *Cyligramma* species displayed here,"lolo- paty", which can be translated as "spirit of the dead". It corresponds with the ancestor worship that occupies the central place in the traditional spirituality of the Malagasy people. They believe that their beloved ones who have passed away return to this world as large moths like *Cyligramma disturbans*, shimmering in the darkness with the wing pattern filigreed with gold. It probably comes from the behavior of these moths, quite often flying into houses lured by light. Additionally, by day they hide in shadowy places, e. g. among the stones used for the tombs, and thus can be observed flying out of the grave.



Cyligramma disturbans (Walker, 1858)



Cyligramma joa Boisduval, 1833



Ericeia inangulata (Guenée, 1852)



Erebus walkeri (Butler, 1875)

Erebinae



Hypopyra guttata Wallengren, 1856



Ophiusa pelor (Mabille, 1881)



Hypopyra leucochiton (Mabille, 1884)



Mocis proverai Zilli, 2000



Mocis mayeri (Boisduval, 1833)

Hypocalinae



Hyperlopha rectefasciata (Kenrick, 1917)



Hypocala sp. Guenée, 1852



Hypocala sp. Guenée, 1852



Pericyma Herrich-Schäffer, 1851



Pericyma near *viettei* (Berio, 1955)



Serrodes trispila (Mabille, 1890)



Stenopis mabillei Viette, 1974



Thyas minians (Mabille, 1884)



Tolna complicata (Butler, 1880)



Ugia radama Viette, 1966



Stenopis cf. *reducta* Mabille, 1880



Stenopis cf. *reducta* Mabille, 1880



Stenopis mabillei Viette, 1974



Grammodes bifasciata (Petagna, 1787)

Mocis proverai Zilli, 2000



Noctuoidea
Erebidae

Erebinae

Stenopis mabillei Viette, 1974



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Abakabaka phasiana (Butler, 1882)



Rahona cf. *albilunula* (Collenette, 1936)



Jabaina ithystropha (Collenette, 1939)



Jabaina sp. Griveaud, 1976



Eudasychira ampliata (Butler, 1878)



Eudasychira diaereta (Collenette, 1959)



Labordea cf. *hedilacea* (Collenette, 1936)



Labordea marmori (Mabille, 1880)



Euproctis ochrea (Butler, 1878)



Mpanjaka pyrsonota (Collenette, 1939)



Collenettema sp. Griveaud, 1977



Collenettema sp. Griveaud, 1977



Eudasychira ampliata (Butler, 1878)

Noctuoidea
Erebidae

Lymantriinae



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*Lymantria barica (*Mabille, 1879), male



*Lymantria barica (*Mabille, 1879), female



Lymantria joannisi (Le Cerf, 1921)



Lymantria malgassica (Kenrick, 1914)



Lymantria rosea Butler, 1879



Marblepsis flabellaria (Fabricius, 1787)



Mpanjaka junctifascia (Collenette, 1936)



Eudasychira aurantiaca (Kenrick, 1914)



Lymantria polycyma Collenette, 1936



Noliproctis sp. Hering, 1926



Zavana cf. *acroleuca* (Hering, 1926)



Stenaroa miniata (Kenrick, 1914)



Lymantria barica (Mabille, 1879)

Catalog of protective behaviors: delay, distract, flee, play dead, defend

Moths have evolved a stunning diversity of defense strategies against predators. One of them is cryptic coloration, displayed by many species of Lymantriinae which resemble just a piece of bark covered with moss and lichen, as for example *Abakabaka phasiana*, *Jabaina ithystropha* or *Mpanjaka* species.

Just look at the individual of *Lymantria fuliginea* shown here. When sitting in its resting position, it has cryptic, dark-brown coloration and can remain undetected, e. g. on a tree trunk. However, once noticed and disturbed, it can unfold the wings displaying the vivid red, aposematically colored abdomen, curled, moreover, in a pseudostinging display. Any potential predator most probably will be startled by this surprise long enough to give the moth time to escape or be avoided completely. Lymantriinae also have a noise-producing organ, called the Goodger organ, which protects against bats when flying at night by advertising their likely unpalatability.















Remote sensing

The displayed male of *Lymantria barica*, as with males of many lymantriines, shows remarkable antennae. Their many feathered branches provide a maximal array for detection of just a few molecules of a distant female's calling pheromone; the female (left) by contrast has antennae with much less prominent side branches.



Noctuoidea
Erebidae

Lymantriinae

*Lymantria barica (*Mabille, 1879)



After a rainstorm

The scales covering the wings of Lepidoptera are hydrophobic, which means water resistant. Thus, interestingly enough and maybe a bit counter-intuitively, many moths fly in the rain not caring about the circumstances at all. Moreover, in tropics, including Madagascar, the method of collecting moths by attracting them to light is very often the most successful in rainy weather. Moths fly most intensely in a downpour, when bats' sonar is less efficient as it bounces off raindrops. However, being completely soaked in heavy rain can wash the scales away, as in the case displayed here. Now we can see the venation, the "scaffolding" of the wing. An interesting detail is that many groups of insects, including moths, have their own, characteristic branching scheme of the veins, which when classified can be used to distinguish them from other families.

Lymantria barica (Mabille, 1879)



Playing dead

Another possible strategy to discourage predators is thanatosis, known also as apparent death, or "playing possum". This phenomenon is quite widespread among animals, and means quite simply posing as a dead individual. In the case of a moth it means folding the wings upwards over the abdomen and folding the legs inwards. This strategy is based on the fact that those predators which are not scavengers generally avoid potential prey that are already dead, that may no longer be juicy or may contain toxic microorganisms.



Stictoptera cf. *semipartita* Saalmüller, 1880



Stictoptera cf. *semipartita* Saalmüller, 1880



Stictoptera antemarginata Saalmüller, 1880



Stictoptera sp. Guenée, 1852





Caligatus splendidissima (Viette, 1958)

Rare guest at the light

The specific epithet of the scientific name of the species of *Caligatus* displayed here, *splendidissima*, (Euteliidae), literally means "the most splendid" – and indeed, the colorful pattern of its wings is magnificent. This moth is, however, a very rare guest at the light, and this brings up the question of why moths are attracted to light. The phenomenon of moths being lured to "the flame" has been observed even long before the invention of artificial light sources. Such potentially suicidal behavior has baffled humans since antiquity, yet this seemingly basic phenomenon is still not fully understood. One of the earliest hypotheses, reformulated recently, is that moths navigate by positioning their body at a right angle to the light source. This works perfectly well with remote light sources like the Moon but fails with lightbulbs, which are too close. A moth trying to keep the position relative to the light beams needs to turn all the time, and the effect is that it starts to fly in spiral as it approaches the light source. There are several other leading theories, including that moths get disoriented by interpreting the light as the sky, to which they would normally keep their bodies back-upwards in flight. The matter is not fully resolved.









Blenina near *hyblaeoides* Kenrick, 1917





Sex-specific frenulum

Many groups of insects provided with two pairs of wings have different mechanisms to join them into one functional flying surface. In the majority of moths such as Noctuoidea the linking mechanism is made up of a thread-like protrusion of the hindwing, called a frenulum, that interlocks with a hook-like structure of the fore-wing, called a retinaculum. In males, the retinaculum takes the form of an actual cuticular hook, whilst in females this structure missing and its place taken by a tuft of special scales. Also, the frenulum is a sex-specific character, in males consisting of single, thick filament, whilst in females there are a few thinner ones. Thus, now you can easily tell that the individual of *Blenina* species (Nolidae) shown in the photo is a female, as it has a dichotomous frenulum, interlocked with a tuft of scales directed upwards. In a male the retinaculum would be located a bit closer to the wing margin, and directed downwards.







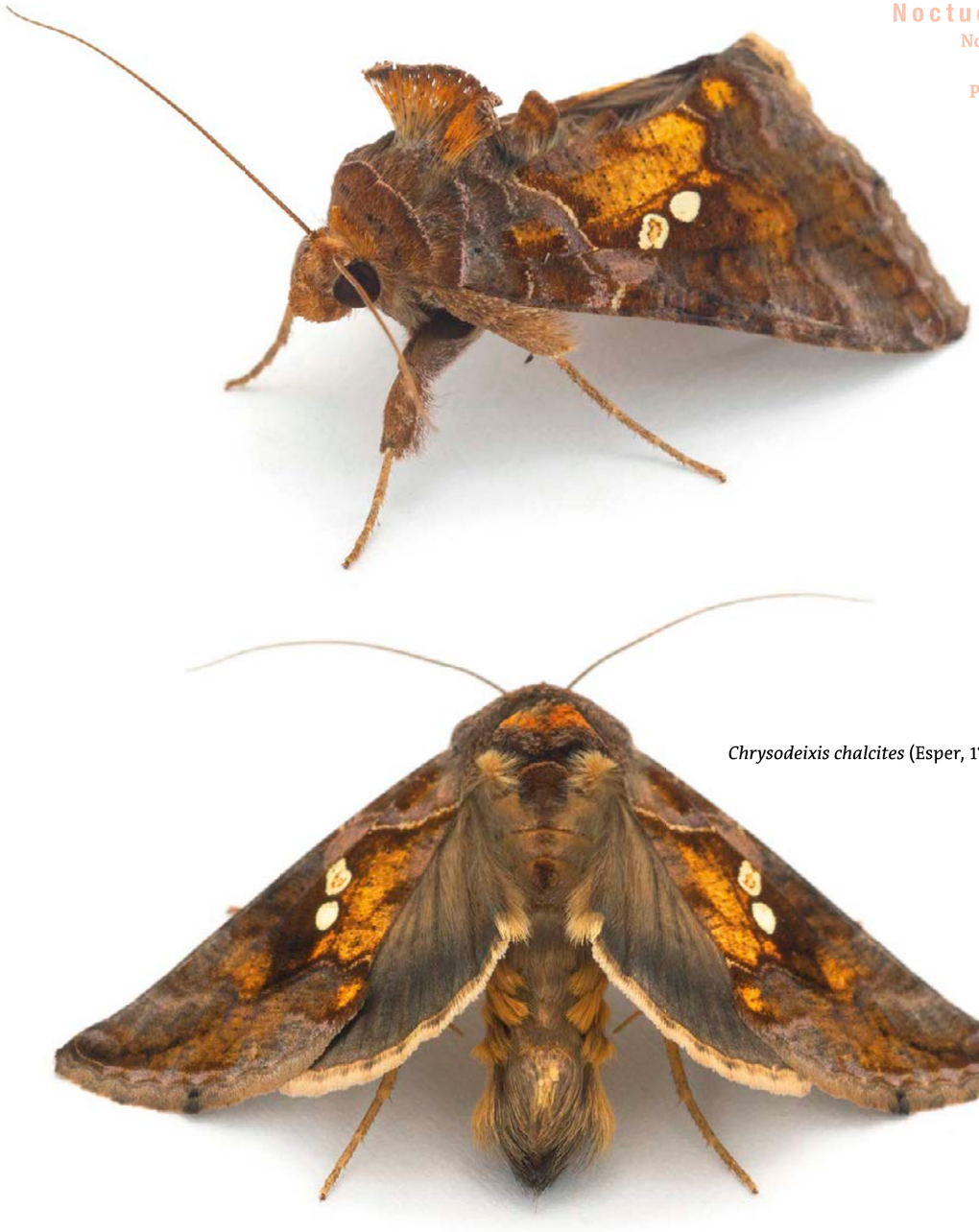
Noctuidae (Owlet moths)

Text by Marcin Wiorek

Noctuids, known also as owlets, are usually cryptically colored, with grays and browns dominant. The characteristic feature of this group with 11,750 species worldwide is the forewing pattern that includes two spots, which have different forms but are obscure in some species: the round, basal one, called the orbicular stigma, and the other one, kidney-shaped, called the reniform stigma. Additionally, some noctuoids have elongate scales on the thorax and head directed downwards, so that in effect they resemble sticks or dead wood, as with the *Stictopera* species (Euteliidae) or the noctuids *Lyncestis* species or *Campydelta stolifera*.

However, some noctuids can be quite vividly colored, like the pinkish *Acontia viettei*. This species is named in honor of the late Pierre Viette, a renowned French lepidopterist, who throughout his entire life made great contributions to the knowledge of the moths of Madagascar, not just to Noctuidae; in all he contributed almost 1,200 currently recognized species and subspecies, or just less than a quarter of the known fauna!

Some noctuids, which can also be found in the rainforest, are serious agricultural pests, as for example the nearly-cosmopolitan genus *Spodoptera*. One of its members, *Spodoptera mauritia*, is shown on the following pages. However, its specific epithet refers to Mauritius, a small island located almost 1,000 km east from Madagascar, from which it was originally described, but the species has a very wide range extending from Africa to Hawaii. Larvae of this moth feed on many plants, including rice, *Oryza sativa*, which is the staple diet of the Malagasy. Thus, its outbreaks in rice paddies can cause serious damage, exacerbating the already difficult food situation on the island.



Chrysodeixis chalcites (Esper, 1798)

Noctuoidea

Nolidae

Nolinae



Meganola sp. Dyar, 1898

Chloephorinae



Earias biplaga Walker, 1866



Microzada sp. Hampson, 1912

Westermanniinae



Plusiocalpe micans (Saalmüller, 1891)

Noctuoidea

Erebidae

Acontiinae



Acontia gloriosa (Kenrick, 1917)



Acontia viettei Hacker, 2010



Acontia viettei Hacker, 2010

Aediinae



Melanephia vola Viette, 1971

Amphipyrinae



Lyncestis grandidieri Viette, 1968



Lyncestis grandidieri Viette, 1968

Bagisarinae



Androlymnia malgassica Viette, 1965



Androlymnia malgassica Viette, 1965

Plusiinae



Chrysodeixis chalcites (Esper, 1798)

Noctuinae



Spodoptera mauritia (Boisduval, 1833)



Brithys crini (Fabricius, 1775)

Eriopinae



Campydelta stolifera (Saalmüller, 1891)



Callopistria cf. *miranda* (Saalmüller, 1880)

Condicinae



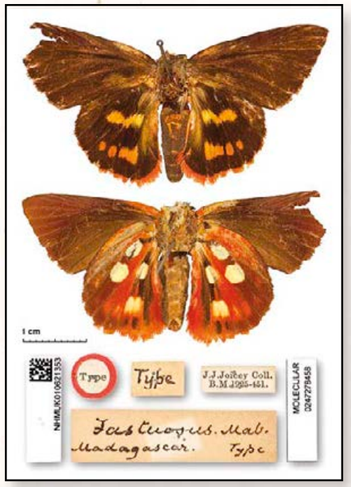
Kenrickodes rubidata (Kenrick, 1917)

How taxonomists identify species

Text by David Lees

The general reader may be curious how some of the specimens in the guide can be confidently identified as the given scientific names. It is then necessary to explain a bit about museum collections, and the type specimens of each species.

Natural History Museums have differently colored labels on certain specimens that are the accepted reference basis of scientific names, ever since Linnaeus in 1758 called them types. Such specimens are therefore called 'types'. When a species is described, the name either is based on a single specimen, or a series of specimens. The case of a single type specimen is the simplest case mentioned here. Usually, such specimens sport a red label on the top of the pin which clearly references the specimen in question as the 'holotype', or the primary type, i.e., the material point of reference for the original scientific name. When though the original author did not single out a particular specimen as the primary type, and when, as often is the case, the type labels are of different colors (or there may not yet even be such a label placed on the pin of a suspected type), the taxonomist's work becomes more complicated.



Holotype of *C. fastuosus*
Picture: Courtesy Trustees of the Natural History Museum, London
Photo: N. Grishin

In the case of *Malaza fastuosus*, the holotype specimen indeed bears such a red label, and there is only one such specimen: it is unique. But it has an interesting history. The specimen was first described by Paul Mabille in 1878 as the female of another species, *Malaza empyreus* (at the time, he put in a different genus, Cyclopides). That means the described female also belongs to this name, and so to clarify the species concept, another kind of primary type, a 'lectotype', eventually needs to be designated. This is especially useful in such a case where more than one species might be involved (indeed, *Malaza* currently has three known species, two of them with crimson-red hindwings!). That would fix the meaning of *'empyreus'* to just the (smaller) male specimen that Mabille had described in 1878, and thus avoid any future confusion. Later, in 1884, Mabille realized his mistake and named the larger, albeit incomplete specimen (it was lacking a head, and an abdomen may have been added later) as a distinct genus and species, *Trapezites fastuosus*. This means that the holotype of the later species represents the correct and currently accepted name for the species, even though it was described twice. There are enough details such as crude wingspan dimensions in the original descriptions and from specimens that Mabille subsequently had painted for *Grandidier's Histoire physique, naturelle, et politique de Madagascar* (volume 19, available online in the Biodiversity Heritage Library – and in the accompanying text volume 18 –) to be sure that the broken specimen that is illustrated here (and that eventually had its fragmentary DNA sequenced and assembled into a whole mitochondrial genome), is indeed the holotype specimen of Mabille's *Trapezites fastuosus*. This underscores the importance for taxonomists to check the original description in verifying types, many of which are readily available to check online.

The taxonomists who helped identify the species in this PDF had only high-resolution pictures of live individuals to go on, since no specimens were collected. In many cases, moth specimens may rest in a very different way from how specimens of them are neatly spread out when conserved in museums, and thus overall shape is not the only clue. A good example of such unusual resting postures and the peculiar wing foldings (like those in Epipleminae) that was challenging for initial identification is the genus *Acremma*. But access to extensive museum collections of Madagascan Lepidoptera such as are held in London, Paris and Munich, or to digital images of the type specimens that are often available today on their data portals, has really helped make identifications in the PDF more accurate by facilitating the comparison of wing scale patterns. Along with primary works such as the extensive *Faune de Madagascar* series, more modern books with color plates, such as the Moths of Africa series, have proved particularly helpful in narrowing down the identifications to a family and then to a particular species, even if there was not time to double-check images of type specimens or original descriptions.



Species of *Acremma* in cryptic resting postures.







Excitingly, it is likely that some of the specimens illustrated represent species previously unknown to science (the term 'cf.' stands for the Latin 'confer' or 'compare against'). Such species will have to be searched for again in the field or in unsorted collections before they can finally be described. The above points really emphasize the synergistic scientific value of continuing natural history collections and of identifying photos of live specimens such as are available today e.g., on the iNaturalist platform.













High-resolution pictures enable species identification in the wild

Each species in this app was photographed in a strict photo concept in the form of high-resolution photos from different angles and with its typical behavior in the wild. These views were sent to taxonomists to correct after the author's provisional identifications from AfroMoths, GBIF, iNaturalist and other online platforms showing live insects. The resolution of the images is high enough that they could be printed out in large format and used in a traveling exhibition or other media that help finance the expensive moth project.



Drepanogynis sp. Guenée, [1858]



Additional Contents



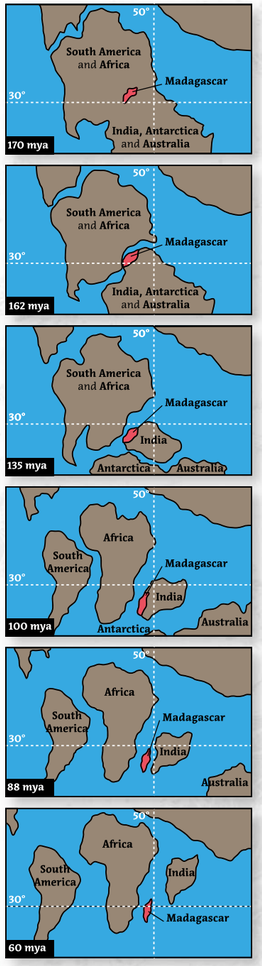
Brookesia vadoni Brygoo & Domergue, 1968

Eudocima sp. Billberg, 1820

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The Eighth Continent - Eyes of Masoala

Text by Dr. Martin Bauert



Many biologists refer to Madagascar as the eighth continent because this island harbors an incredibly unique flora and fauna that is outstanding and quite different from the biodiversity on the seven recognized continents. Madagascar's species richness surpasses that of entire continents in various respects: despite being fifty times larger, Africa has only about 70 palm species compared to the more than 170 palm species that are known to exist in Madagascar. A similar case is the distribution of the legendary Baobab trees: Only one species is found growing on the continents of Africa and Australia, but Madagascar features six endemic Baobab species.

Madagascar: Isolated in the Indian Ocean eons ago

The outstanding diversity of plants and animals in Madagascar is the result of its isolation for eons as an island off the coast of Africa. Roughly 220–150 million years ago, the Mozambique Channel was formed and eventually separated Madagascar from the African mainland. Madagascar remained connected to the landmass that now forms the Indian subcontinent for another 60 million years. Around 90 million years ago, the Indian continental plate began moving north, separating from Madagascar, and eventually colliding with the Eurasian plate, creating the tallest mountain range on our planet – the Himalayas.

Evolution in relative isolation

For almost 90 million years – a duration that is hardly comprehensible on a human timescale – the plants and animals in Madagascar outlasted and evolved in relative isolation from the evolution that burst into flame on the continents after the extinction of the dinosaurs. Dinosaurs disappeared only relatively recently in geological timescales – the impact of an asteroid 66 million years ago put an end to their dominance. Madagascar's position near the equator remained stable over this vast time span, resulting in relative climatic stability throughout the geological turnovers.

Occasional immigration of species

Despite being situated 420 km off the coast of Africa, Madagascar was still accessible to species adapted for long-distance migration. Madagascar shares with Africa and the entire Indo-Pacific region many species of migratory birds and coastal plants that have seeds adapted to water dispersal. However, some plants and animals that are not adapted to water dispersal or long-distance migration must have colonized Madagascar occasionally.

Lemurs, for instance, which evolved in Africa after the accidental extinction of the dinosaurs, are thought to have been dispersed to Madagascar on plant rafts that were washed from rivers into the Mozambique Channel. Lemurs represent the most basal group of primates and today are known on the African continent only from fossils. However, on Madagascar, they thrived until the arrival of humans.

Center of Gondwana
The landmass that forms Madagascar originally lay in the center of the ancient continent Gondwana. This also explains why some groups of organisms have their closest relatives in South America, while others have them in Asia or Australasia.



Amazing adaptive radiation

The ancestors of today's lemurs underwent astonishing development upon their arrival in Madagascar. In the absence of the many other competing mammal species found in Africa, they developed amazing adaptations to their new habitat. More than 100 distinct lemur species evolved and adapted to extremely specialized niches.

Bamboo lemurs feed exclusively on bamboo, which is toxic to most species due to its cyanide content. Indris have adapted to eating the leaves of *Uapaca* tree species, which belong to the notoriously poisonous *Euphorbia* family.

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The Aye-aye is one of the most unique species of animals in Madagascar and is also one of the most unusual primates globally. With a weight of approximately 2.5 kg, it is a medium-sized lemur species that has adapted to very specific food niches that are used by woodpeckers in other parts of the world. The Aye-aye, which is nocturnal, is characterized by bony, elongated fingers (excluding the thumb) that bear claw-like nails. The middle finger, in particular, is thin and skeletal. The incisors are rodent-like and continue to grow throughout their entire life, which is unique among primates. The Aye-aye uses its strong, sharp incisors to feed on very hard seeds and also to track down beetles and larvae in wood. Like a woodpecker with a strong beak and long tongue, the Aye-aye probes for beetles and larvae in gnawed burrows using its thin middle finger. Adaptive radiation into unoccupied niches is typical of isolated habitats and was most prominently first described for finches on the Galapagos Islands by Darwin. The relative isolation of Madagascar also enabled many ancient plant and animal groups to survive until the present day.

Aye-aye *(Daubentonia madagascariensis)*
The Aye-aye is a unique and fascinating species of lemur. It is known for its distinctive appearance with large, round eyes and long, bony fingers. Photo: © Joel Sartore / Photo Ark

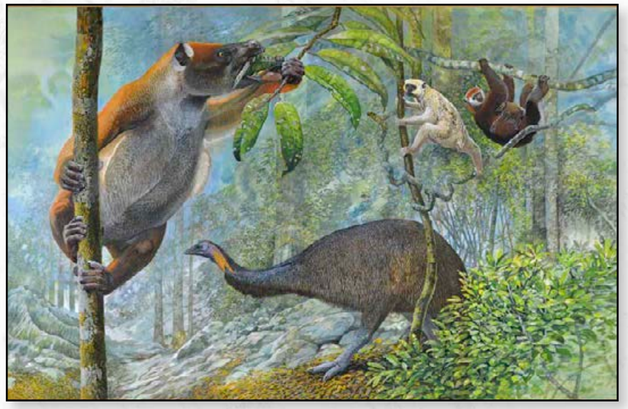


"A World Like Our Own"

Alison Jolly, a primatologist known for her studies of lemur biology, depicts Madagascar in her book "A World Like Our Own" as a sort of parallel reality in which the same biological rules apply, but the outcome is as different as if it were another world. The fauna that exists in Madagascar today is remarkable, but it was even more so a mere instant in geological time ago when the first people arrived. Herds of small hippopotamuses and groups of giant tortoises grazed on short grass patches within forests and bushland. In the tall grass and brushy areas, huge elephant birds *(Aepyornis)* scratched and pecked for food. *Megaladapsis* lemurs – similar to giant koalas the size of female gorillas – slowly and carefully climbed up trees. Deeper in the forest, chimp-sized *Palaeopropithecus* moved along the branches like sloths. These herbivores kept parts of the land neatly trimmed, just like in an African game park today. However, typical African herbivores such as antelopes and elephants never arrived in Madagascar.

Madagascar's megafauna
After the arrival of humans, the fauna in Madagascar changed very quickly: large animals were hunted, and landscapes were altered by agricultural activities. This led to the extinction of the entire megafauna in a relatively short period of time. Artworks: Peter Schouten





Climate and geography shape the vegetation cover

Madagascar extends over 1,600 km from 12°S to 25°S. An old granitic mountain range runs north to south throughout the length of the island with peaks exceeding 2,600 m. The terrain and the primarily westerly winds are the primary drivers of its climate. Madagascar experiences dry trade-wind conditions in winter (May – September) and monsoon-driven tropical storms in summer (December – March). The uplift of the westerly monsoon winds along the mountain ranges results in regular and heavy rainfall, leading to a dense covering of tropical rainforest on the east coast. The western regions, which are leeward, have lower rainfall and drier vegetation formations, with subarid conditions even occurring at the southwestern end of the island.



Madagascar
A mountain range stretches along the east coast from north to south. The east coast drops steeply into the sea, unlike the west coast, which slopes gently.

Tropical cyclones frequently occur between mid-January and mid-March. Many of them make landfall on the northeast coast of Madagascar. Unfortunately, an unprecedented accumulation of cyclones has been hitting the Masoala region since 2000, with the region being hammered by extraordinary storms almost every second to third year. The average annual rainfall for rainforest stations on the east coast is around 3,500 mm. However, this is exceeded by 6,000 mm measured at Andranobe on the Masoala Peninsula.

The Masoala and Makira region: one of the world's hottest biodiversity hotspots

Biodiversity hotspots are defined as areas with exceptional species richness and concentrations of endemic species. Madagascar holds roughly 5 % of the world's biodiversity, despite covering only 0.4 % of the Earth's land mass. Biodiversity culminates in the forests of the Masoala and Makira regions, where more than 50 % of all plant

Organism group	Approximate number of known species	Percentage endemic
Lemurs	103	100
Carnivores	8	100
Rodents	24	100
Tenrecs	28	100
Bats & Fruitbats	36	66
Birds	310	35
Reptiles (non-marine)	363	92
Frogs	238 *	99
Terrestrial Snails	651	100
Scorpions	40	100
Spiders	459	85
Dragonflies & Damselflies	200	93
Lacewings	163	75
Tiger beetles	233	99
Scarab beetles	148	100
Freshwater Crayfish & freshwater Shrimp	32	100
Flowering Plants	12,000	85
Trees & large shrubs	4,500	95
Lepidoptera	5,024	80–90
Butterflies	325 **	72–74
Moths	4,699	

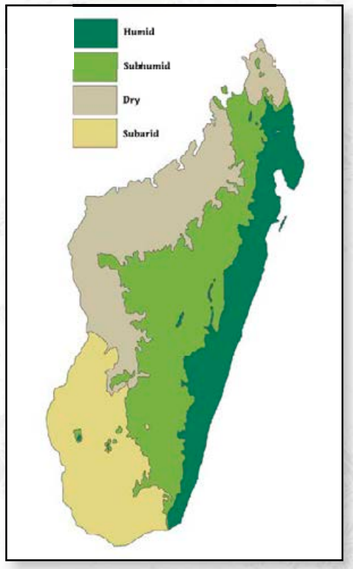
*) + 150 in progress being described
**) since Balletto et al. (2026)

New species are constantly being described in Madagascar and their distribution areas are being better investigated. The percentage of endemism varies between publications and the detailed delineation of the organism groups.





species in Madagascar can be found. The forests of the Masoala and Makira region (MaMaBay) represent the last vast tropical forest blocks that were able to be preserved, with still many scientifically undiscovered and undescribed species. Almost every year, new species of amphibians, reptiles, plants, and even lemurs are discovered and published in scientific literature.



The bioclimatic regions of Madagascar
Simplified representation of the four major bioclimates. From west to east, the climate becomes wetter. However, from north to south, it becomes drier. Derived after Comet, 1974

The Rainforests of the Masoala region

The most beautiful and least disturbed lowland forests in Madagascar are found today around Antongil Bay. In a few places forest still can be found from sea level on the coast up to the summits of the mountain ranges from 400 to 1,200 m above sea level.

The lowland rainforests occur from sea level up to about 800 m elevation. Around this rather arbitrary altitude an almost imperceptible transition from lowland forest to submontane forest occurs. The rainforests of Madagascar are still today a wonderland of tall canopy trees, dripping and densely covered with epiphytic ferns, mosses, and orchids. The tree flora consists of about 4,500 species, of which 95 % are endemic. Some families are of Gondwanaland origin, reflecting the ancient connection with South America, Africa, and Australia. The botanical richness of Madagascar's rainforest surpasses that of most sites in Africa.

The lowland rainforest is 25 to 35 meters high, relatively dense and compact compared to the rainforests on the African continent or in South America. The height of the tree canopy gradually decreases with increasing altitude. Above about 800 meters, the trees become gnarled and are even more densely covered with mosses and lichens and grow just a few meters high.

The extraordinary diversity of species in the Madagascan rainforests is not immediately noticeable. Many trees and shrubs have similarly shaped leaves and the differences in bark between the various species can only be discerned by the eye of a trained specialist. There is a particularly great abundance of screw palms (*Pandanus* sp.), which present an unusual sight with their differently formed stilt roots depending on the species. The sheer quantity of epiphytic ferns (nest ferns, *Asplenium* sp.), mosses and orchids, as well as tree ferns (*Cyathea* sp.) – contemporaries of the dinosaurs – creates a unique ambiance. As the rootable soil layer is very thin, a dense layer of roots covers the thin layer of topsoil, loosely covered by a surprisingly thin layer of litter consisting of dead leaves and branches.





The high density of young trees is also striking, often with stems no thicker than a thumb, waiting in the shade of the large trees for a gap in the canopy to open so that they can have a chance to emerge. Many tree species develop buttress roots and stilt roots to provide the necessary stability to withstand the strong winds of cyclones.

In contrast to the rainforests of South America or Asia, Madagascar does not have any reptiles or amphibians that are fatally poisonous to humans or particularly dangerous insects and ants. This allows one to explore the forests, which are filled with the sounds of various voices especially during the rainy season, bare-

Race to full sunlight
Nest ferns, which usually grow epiphytically, occasionally thrive on the forest floor (above).
There is no seed bank in the soil of the rainforests. The seeds germinate immediately and try to grow upwards as quickly as possible as soon as a giant tree falls and the canopy opens.

Lowland Streaked Tenrec
There are more than 30 species of this endemic mammal family in Madagascar. They are an example of adaptive radiation: all species are believed to have originated from a common African ancestor and have separated into different species in a relatively short period of geological time, specializing in the use of different niches.



Elephant bird *(Aepyornis maximus)*
With a height of three meters and a weight of half a ton, it is the largest bird of all time. DNA studies have shown that *Aepyornis* is more closely related to the flightless birds of Australia and New Zealand than to the ostriches of Africa.
Artwork: Peter Schouten

foot like the local residents or perhaps better in sandals. Cicadas, frogs, birds, and lemurs create a unique and partly astonishingly loud background sound, which changes constantly throughout the day. The forest often becomes quieter around noon and then picks up again for a "Furioso" during dusk.

Small terrestrial leeches are also part of the Madagascan rainforests and are an excellent indicator of undisturbed forests: the more leeches, the more pristine the forest. Thankfully, they do not transmit any diseases but are rather annoying and particularly active above an altitude of around 50 meters above sea level and on rainy days. Among the local population, who generally know the behavior and occurrence of any animal and plant species very well, there is much disagreement about what the leeches feed on when no humans are roaming the forest. Some believe that leeches only seek out animals without fur for their blood meal, while others firmly believe that even lemurs and birds are part of the leeches' prey. The terrestrial leeches of Madagascar still represent an understudied group, despite every researcher of Malagasy rainforests inevitably sacrificing at least a few drops of their blood. Four species of leeches are known to exist, but there is morphological and genetic evidence that more species exist. While generally thought to be mammalophilic, recent DNA studies have revealed that leeches feed on mammals, birds, reptiles, and amphibians.

The loss of Madagascar's megafauna due to human settlement

The first human settlers of Austronesian origin arrived in Madagascar about 1,300 years ago. Following the Indonesian settlers, Muslim traders were likely to have been regular visitors by the 13th century. These first settlers encountered one of the most unusual fauna on earth. Although our knowledge of the fossil and subfossil records of Madagascar's terrestrial life forms is still very incomplete, we must conclude from traces on excavated bones and analysis of archaeological sites that Madagascar's outstanding megafauna was over-hunted and consumed by human settlers.

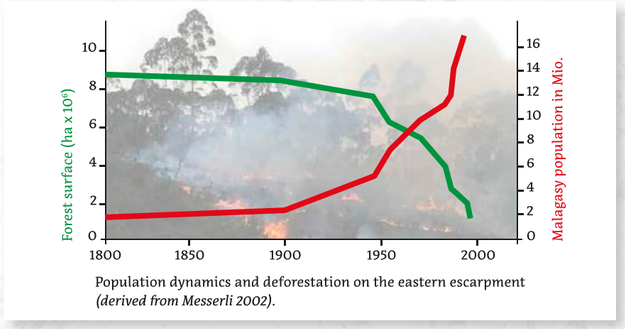
Archeological records show that human activities varied temporally and regionally, and that impacts on endemic fauna were far greater after the arrival of farming and pastoralism around 1,000 years ago. As Marco Polo traveled back through the Persian Gulf from his famous journey to the Far East in the early 1290s, he heard accounts of a huge island named Madagascar. The legend of the bird 'roc' in the story collection "One Thousand and One Nights" is almost certainly referring to the flightless Elephant bird *Aepyornis*, which was driven to extinction after the arrival of humans in Madagascar. Despite losing its most spectacular megafauna relatively recently, Madagascar's richness in lemurs, tenrecs, and taxonomically isolated plant species remains outstanding even today.



High rates of deforestations and degradation of natural resources

Unfortunately, the human inhabitants of Madagascar have devastated their land through shifting agriculture and the use of fire. Deforestation rates

have been increasing since the 1920s. The practice of slash-and-burn agriculture, known as tavy, has been accelerated by the exponential increase of the human population over the last century. As a result, up to 95 % of Madagascar's forested areas have been cleared or drastically altered, leading to a significant impact on biodiversity.



Population dynamics and deforestation on the eastern escarpment *(derived from Messerli 2002).*



Tavy: Slash-and-burn agriculture
Clearing steep slopes makes the soil vulnerable to erosion, which in turn leads to a rapid depletion of the soil. This causes floods, rice fields in the valley bottoms become silted, drinking water sources dry up, and even coral reefs in the nearby sea are damaged by the sediments washed away.
Photo: Martin Bauert

Repetitive use of fire to clear by tavy results in vast, unproductive grasslands that are particularly susceptible to erosion during heavy rainfall. Despite numerous efforts supported by international organizations to prevent the loss of forests and mitigate tavy, the increasing human population that is dependent on subsistence farming has prevented the forest loss from being halted throughout Madagascar.

After the forest has been cleared secondary scrub (savoka) develops, often dominated by the traveller's palm, *Ravenala madagascariensis* and invasive weeds, which hinder reforestation.

History of the Masoala region

There are several explanations for the origin of the name Masoala: often, the creation of the term is thought to be derived from the Malagasy words **maso** (eye) and **ala** (forest) meaning "Eye of the Forest". Another interpretation derives the name from the terms **masina** (sacred) and **oala** (lagoon). Even today, the lagoon in front of Cap Masoala is considered sacred by the locals, and many taboos regulate access and usage.



Some of the earliest traces of humans found in Madagascar have been discovered on Nosy Mangabe, an island at the base of the Antongil Bay. Accumulations of soil eroded from hill slopes, attested in archaeological soundings, suggest a fairly dense human occupation of the region until some time after the arrival of Europeans in the early 16th century. Historical accounts of European visits to Antongil Bay are documented from 1595 onwards. Engraved messages from Dutch sailors can still be found today on granite rocks at the "Dutchmen's Beach" on Nosy Mangabe.

In the absence of spices, gold or abundant supplies of food, it turned out that the most sought-after commodity was its human population, which became the focus of an active slave trade that linked Antongil Bay to Dutch colonies in Mauritius, South Africa and southeast Asia.



Short messages
The messages left by the Dutch sailors for each other 400 years ago can still be read today, as they are engraved on rock boulders at „Dutchmen's beach" on the island of Nosy Mangabe.
Photo: Martin Bauert

The economic potential of the forests of the Masoala region began to be realized during the 19th century. The French seized power in 1896 and commercial logging was first set up in the Cap Est region while the Masoala penisula also swiftly became renowned as a source of latex for rubber production. Commercial logging continued under the French administration and was extended in particular on the flat coastal plain south of Cap Tampolo on the east coast of the peninsula, which appers to have been largely clear-cut in the 1930s.

Creation of the Masoala National Park

By the mid 1920s scientists who were part of the French colonial administration started to understand the unique wealth and value of Madagascar's flora and fauna and of the Masoala penin-

sula in particular. In 1927 Madagascar's first nature reserves were established, including the Réserve Naturelle Intégrale de Masoala comprising 27,682 hectares of lowland tropical forest in the north-eastern part of the Masoala Peninsula inland from Cap Est.

After the independence of Madagascar from the French colonial power in 1960, the Réserve Naturelle Intégrale de Masoala was declassified in 1964 and granted in 1967 as a logging concession to the company Grands Moulins de Dakar. When Grands Moulins left in the 1970s, the lowland forests of the region had been further destroyed.



Silky Sifaka
The ICUN lists the Silky Sifaka as critically endangered. There are only about 250 adult individuals left of this splendid lemur with white and silky fur. Photo: Martin Bauert

The first attempt to address broad natural resource management issues was initiated by the Missouri Botanical Garden in partnership with the Ministry for Water and Forests. The Masoala Project with funding from the United States Agency for International Development USAID, initiated a series of botanical surveys on the peninsula. First attempts were made to combine rural development in local communities on the peninsula with a package of conservation measures, whose goal was to create a national park.

In 1992, a group consisting of CARE International, the Wildlife Conservation Society (WCS), the Peregrine Fund, the newly established national parks service, Association Nationale pour la Gestion des Aires Protégées (ANGAP, today branded as Madagascar National Park; MNP), and the Ministry of Water and Forest (MEF) joined together to submit a proposal to USAID for an ambitious Integrated Conservation and Development Project (ICDP) at Masoala. CARE tackled the development needs of the people, while WCS and the Perigrine Fund worked in close partnership with ANGAP and MEF to create and design a new national park.



After a long process of public consultation the final park delimitation proposal represented a compromise between what would have been ideal boundaries from the ecological point of view and what was possible given the reality on the ground and the needs of the villages around the proposed park. Preparations were made to inaugurate the new national park on June 5th, 1996, as part of Madagascar's celebration of World Environment Day. However, on June 2nd the creation of the park was suspended by the government with the bland explanation that the creation of a national park at Masoala was no longer in the national interest. A few weeks later, after a change in the central government, the real reason for the cancelled inauguration was rumored to be that negotiations of the former government had been under way to issue big logging concessions at Masoala as part of a contract with a Malaysian company to build roads in the capital.

The inauguration of the Masoala National Park finally went ahead in September 1997 with the approval of local residents by a national decree. The consideration of local needs and the national economy was a key element in gaining approval for the Masoala National Park which encompasses 2,100 square kilometers of rainforest and three satellite marine reserves with a surrounding multiple-use zone of approximately 1,000 square kilometers.

Today the Masoala National Park is co-operated by Madagascar National Parks (MNP, formerly ANGAP) and WCS. Zoo Zurich has been supporting the establishment and the functioning of the Masoala NP since 1997, when the first MoU with the Ministry of Water and Forest (MEF) was signed.





Establishment of Makira Nature Park

In 2001 the Ministry of Environment and Forests, in collaboration with the Wildlife Conservation Society, launched a program to protect the dwindling forests north-west of the Masoala National Park. In 2012 the Makira Natural Park was established encompassing 3,720 square kilometers of strictly protected forest buffered by more than 3,500 square kilometers of community-managed forests. The Makira Nature Park is today managed by WCS on behalf of the government of Madagascar in collaboration with 75 community associations. Makira Nature Park provides natural resources and ecological services to the surrounding populations of around 90,000 people, including land for agriculture, timber, bushmeat, non-timber forest products and water supply. Makira is a functioning REDD+ project that sells emission reduction credits on the voluntary markets with revenues from sales used to finance Park management and community development activities around the Park.

Zoo Zurich's engagement for Masoala: Vision and mission

The Masoala Rainforest, located at Zoo Zurich, is a greenhouse measuring 1,100 square meters and standing more than 30 meters tall. It serves as an exceptional animal enclosure, allowing the public to experience the world of rainforest animals and plants outside of their typical context. The Masoala Rainforest is designed to replicate the natural habitat of a Malagasy rainforest as faithfully as possible, providing a unique opportunity for visitors to witness the interplay between animals (from insects to mammals) and plants in their native environment. Through this experience, visitors can learn to value rainforests and engage in their protection.

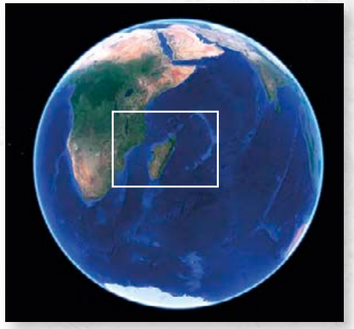


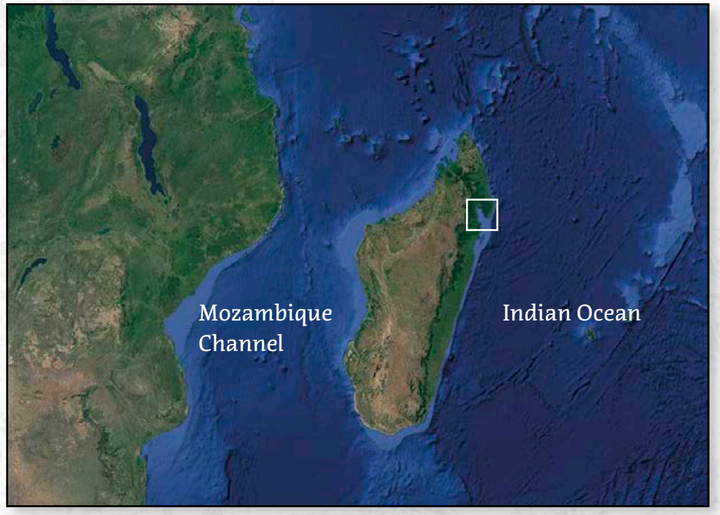
The Masoala Rainforest project at Zoo Zurich is built on two foundational pillars. The first is the construction of the Masoala Rainforest in Zurich, which acts as an ambassador for the beauty and uniqueness of this region. The second pillar is the support given to partners in Madagascar for the long-term conservation of rainforests that are in peril. The main aim of Zoo Zurich's agreements with the Wildlife Conservation Society and the Ministry of Water and Forests is to contribute to biodiversity conservation in the Masoala region, as well as ensure the sustainable use of natural resources in the area around the national parks.



Since 2003, Zoo Zurich has been contributing 25 % of the annual operating costs of the Masoala National Park and investing in an endowment fund that will ensure financial support for the park indefinitely through the financial returns it generates. In addition to supporting the management of the Masoala National Park, Zoo Zurich also finances projects such as the Open Classroom in Maroantsetra, supports public schools around the Masoala National Park, and invests in sustainable agriculture techniques, agroforestry, and the reforestation of critical corridors for wildlife.

Furthermore, Zoo Zurich supports humanitarian projects including providing access to clean drinking water and healthcare services as well as family planning. To date, over 43,000 people in the Masoala and Makira regions have directly benefited from these initiatives. Zoo Zurich has invested $7.5 million in its community-centered conservation approaches in the MaMaBay region. This sum is composed of revenue from the zoo gastronomy, donations by zoo visitors, and contributions from foundations. The projects and initiatives are implemented by the Wildlife Conservation Society and by the team of the Masoala National Park, which acts as the local partner and representative of Zoo Zurich in Madagascar.



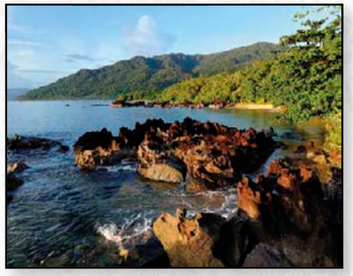


Isolated in the Indian Ocean
The Mozambique Channel, which is 420 to 1,200 km wide and 1,500 km long, separates Madagascar from the African continent. For about 200 million years, Madagascar has been isolated from other land masses in the Indian Ocean and is exposed to the region's monsoon and trade winds.

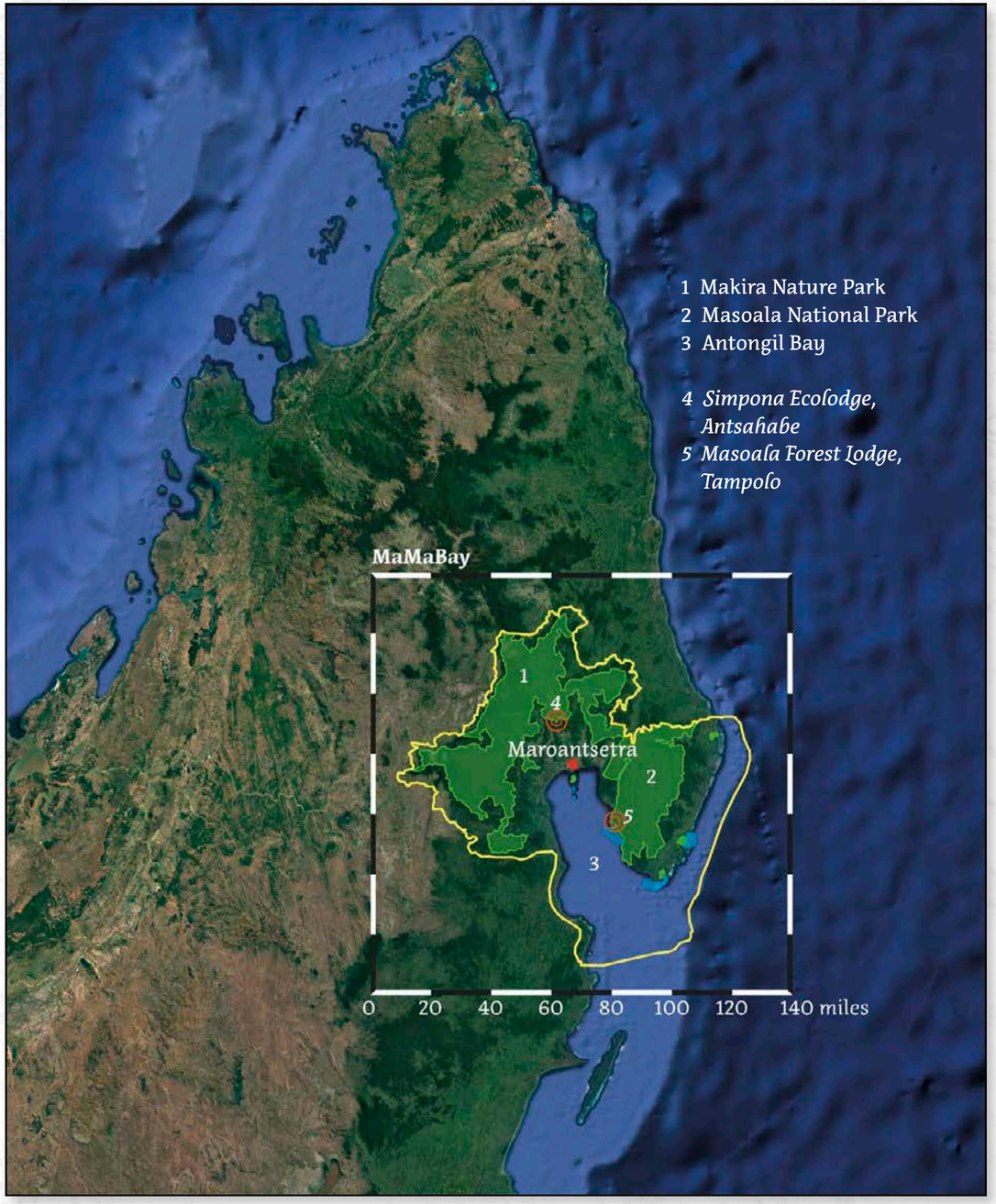




Zenithal Rains
Almost daily, thunderstorms occur in the afternoons over the rainforests of the Masoala and Makira regions. Zentihal rains are typical of tropical regions. The water that has evaporated from the dense rainforest vegetation as a reaction to sunshine rises in the atmosphere throughout the day and condenses. A significant portion of the tropical rainfall comes from this cycle.



Primary investigation area
A narrow coastal strip characterized by sandy beaches interspersed with sharp-edged granite blocks, as well as river mouths and mangroves, forms the contact zone between the sea and the steep rainforests of Masoala National Park. Here, idyllically situated, is the Masoala Forest Lodge, which served as the main base for this moth study.



MaMaBay Landscape

Text by Lovy Rasolofomanana



Comprising Makira Nature Park, Masoala National Park, Nosy Mangabe National Park and Antongil Bay, the MaMaBay Landscape is located in the northeast of Madagascar and constitutes the country's last great expanse of nature and the epicenter of its unique biodiversity. Covering more than 1.8 million hectares, the region contains the largest intact blocks of mid-level to lowland rainforest, including a broad band of dense rainforest stretching from the coast at sea level to more than 1,200 m above sea level. It is home to the highest diversity of lemurs in the country, and exceptional floristic diversity. It also contains coral reefs, mangroves, wetlands, and dry thorn forests in places. Its remarkable diversity of intact ecosystems sustains habitats teeming with wildlife and provides essential ecological services for humans, plants and animals in the region.

Since 1993, within MaMaBay, the Wildlife Conservation Society (WCS) and its partners have had an ambitious vision for the conservation of Madagascar's last great natural expanse, with its abundant and diverse flora and fauna protected and linked by community areas for sustainable forestry, agriculture, and fisheries.

Makira Nature Park

The Makira Nature Park, an IUCN category II site, is the largest terrestrial protected area in the country, covering 372,000 hectares. Its lush, low- and mid-altitude forests contribute to high rainfall and support a watershed covering a vast area of 2.5 million hectares. The park is home to more than 60 species of mammals, including 17 species of lemurs, more than 120 species of birds, at least 200 species of reptiles and amphibians, and 450+ species of plants.

Rainforests

The water flow of the creeks and streams in the Makira and Masoala regions fluctuates extensively. For the station Andranobe on the west coast of the Masoala Peninsula, precipitation amounts of more than six meters per year have been measured. Places where streams might still be easily crossed when the sun is shining can quickly become an obstacle during heavy rain. These two screw pines (*Pandanus* cf. *macrophyllus* Martelli, and *Pandanus* cf. *guillaumetii* B.C. Stone, to the right, behind) are growing on a small sandbank. During heavy rain they suddenly find themselves in the middle of a raging stream.





Threats mainly include deforestation due to slash-and-burn agriculture, cutting of hardwood trees and expansion of agricultural land as the population gradually increases and people move into the park in search of land and resources.

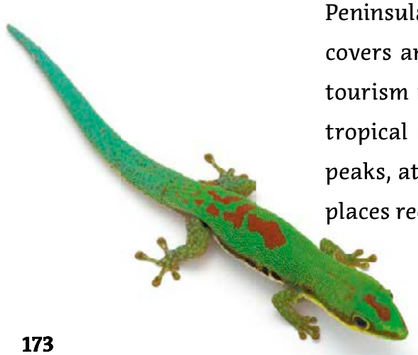
Since its inception WCS has continued to manage Makira Nature Park on behalf of the Malagasy government and, as part of this process, it has implemented the REDD+ pilot project to develop a sustainable financing mechanism for supporting conservation and development. The project has established 80 community-managed forests around the park and continues to provide technical and financial support to improve resource management. In addition to protecting the park and supporting good community forest governance, WCS has a range of other community-based projects, including sustainable agriculture (agroforestry, cash crops, livestock), health and education, and reforestation to reduce pressure on the forests.

Lowland rainforest in Masoala

The lowland rainforest, which reaches a height of 25–30 meters, consists of multiple strata and has a dispersed understory. These forests are abundant in species. Screw palms, such as this small group of *Pandanus* cf. *oligocephalus* Baker, are a characteristic element which is often found in the middle stratum.

Masoala National Park and Nosy Mangabe National Park

Masoala National Park is one of the jewels in Madagascar's crown and represents one of the most biologically diverse protected areas in the world. The 230,000-hectare park was created in 1997 and consists of distinct units, including three marine parcels, three detached parcels, and most of the tropical forest of the Masoala Peninsula. As for Nosy Mangabe National Park, created in 2016 it covers an area of 697 ha and is an important focal point for ecotourism in Antongil Bay. The natural habitat of the region is the tropical rainforest, which is found from sea level to the highest peaks, at 1,300 m. It is the wettest region of Madagascar, with some places receiving 7,000 mm of rain per year.





Introduction and setup

Text by Armin Dett

I can still remember very precisely when I was first seized with a bout of 'Tropic Fever'. I remain under its spell to this very day. It is contagious, as you will see from this PDF. Here's a simplified reconstruction of events ...



Light trap setup consisting of UV lamp and mosquito net
This mobile, self-made construction has proven its worth in the dense rainforest of Masoala. Placed about 50 cm above the ground, it afforded the moths a big surface area on which to land while at the same time giving them plenty of opportunities to fly in and settle. The canopy also offered me protection against stinging pests.

Tarzan and wild animals

My Tropic Fever began in earliest childhood and was black and white. Tarzan was on tv in the evening and I sat there on the sofa, spellbound – fascinated by fighting gorillas, tigers, giant snakes, lions, and elephants interspersed with zebras and hippos, on whose backs Johnny Weissmuller leapt across rivers. Even back then I had a vague idea that the mix of species wasn't quite right. Nonetheless, and despite the goose bumps, the childhood fantasy was born of someday being "Tarzan in the jungle" – because of the wild animals, although Jane did look seductively beautiful. Over the years, naturalist stars on tv kept my Tropic Fever near boiling point: people like Eugen Schumacher, Malcolm Douglas and Austin Stevens who made wildlife films in the vast expanses of Asia and Australia; Heinz Sielmann and, of course, the Grzimek family, whose wildlife films we experienced as family events that took up the whole evening. And I soaked up like a sponge every piece of reading matter that had to do with the rainforest of course ... yet just as thrilling for me were the animated images and the actual making of each film.

Sunset moths

At some time or another in the early 80s my father bought a tropical butterfly collection and my Tropic Fever peaked for a good while. I studied each of the 40 boxes whenever I could – and whenever I was allowed. Because my father treated the collection as if it were classified material! I suppose that's where I got my ability to distinguish so many colors, forms and patterns and commit them to memory. Among the boxes of butterflies there were two that



Giant buttress tree
Canarium sp., known locally as "ramy," can be easily recognized by its prominent buttress roots and can grow up to 40 meters in height. These trees play an important role in the composition of lowland humid forests. The wood is utilized for various purposes, such as constructing pirogues (dugout canoes). The edible fruit pulp and seeds are often sought after by children and various lemur species. The aromatic resin is vaporized during ceremonies and partly used as glue to trap birds. The resin is also utilized for sealing pirogues and boats and is nowadays cooked with used motor oil to delay biodegradation.

stirred in me deep yearnings. One sheltered a pair of *Argema mittrei* with cocoon, while the other was home to three *Chrysiridia ripheus*. I still had no idea that one day – actually in the the night – I would be roaming through the rainforests of Madagascar in search of them.

Design vs. biology

My enthusiasm for colors, forms, and patterns evolved into a durable artistic talent which led to my studying graphic design at university. The application portfolio and entrance exam posed no great problem – all I had to do to make beautiful designs was rekindle in my mind those butterfly boxes. I wanted to study tropical ecology but my high-school final exam grade did not immediately suffice, and so I concentrated on the talent I had and became a designer. A new world opened up to me, one that overlaps with biology and evolution at a surprising number of points. Then came the career stages typical of someone now 57 years of age: graduate degree, a self-employed career start-up, marriage, starting a family, house construction – but the Tropic Fever still smoldered inside. It fired me up for my first backpacking trips into the tropics, with sketchbook, binoculars, camera, and bad gear: these led me, traveling on my own, through Costa Rica, Venezuela, Bolivia, and Brazil. These were the way stations for my Tropic Fever.



Moths – meaningful sleepless nights

Meanwhile, the career stages underwent some positive – and some not so positive – developments. I taught graphic design for 18 years, the two daughters grew up into adulthood – but the marriage failed spectacularly. My Tropic Fever evolved into moth fever and shook me out of my misery. I began to fill sleepless nights with light-trapping and wrote my first moth book with observations made in my own garden. It received an internationally highly prestigious design award. This book was pretty much the test run for my childhood dream: aged 50 I finally wanted to become a rainforest researcher and surrender myself utterly and completely to my Tropic Fever. I conceived the idea of writing a moth book for Costa Rica! A different continent, a different language and an unknown world of plants and animals – this brought huge challenges, not to mention how to finance this undertaking myself. All that was familiar to me were just a few neotropical moths and butterflies from the tropical collection. Several research trips to Costa Rica ensued, and a project was born



that was to take the best part of five years, working independently and managing in the end to finance the book myself by creating and then renting out a traveling exhibition. It also led to my close friendship with Paul.

First contact with „Masoala“

“For every animal you discover you‘ll get a scoop of ice cream“. With this wholehearted statement I persuaded my family one day to take a trip to the Masoala Rainforest House at the Zoo Zurich. It ended up being 13 scoops per child – and today I still owe my daughters a few scoops … Well, the trip to the Masaola House gave me another intense bout of Tropic Fever, and so in 2018 I plucked up the courage to introduce myself in person at the Zoo. I took with me in my hand luggage my two specially designed moth books. There, luckily, I bumped into Martin Bauert – with whom my idea for a ‘Masoala moth book‘ fell like a seed on particularly fruitful soil, easily able to germinate.

Eyes of the forest

Eventful years followed. Both my parents died and I inherited the tropical butterfly collection. My marriage ended in divorce, and after I spent eight years as a single father my daughters moved out. I ended my teaching post, paid off my house, and gathered my strength and money for the first research trip to Masoala. My Tropic Fever now hit top temperature: Despite previous

Secondary lowland rainforest at Masoala

Almost all flat, coastal lowland rainforests in the Masoala region were selectively logged until the mid-20th century through hard manual labor. Especially the large, old hardwood trees were targeted at that time. On the east coast of the Masoala Peninsula even a small hand-operated railway was installed between Antalaviana and Tampolo to facilitate the transport of the logs. Even today, occasionally one can find logs left behind from that time with their core wood still largely intact, despite lying in the soaking rainforest for almost 100 years. Despite beeing stripped of the large, emergent trees, these forests have hardly lost any of their original biodiversity. Remarkably, there is a very high density of young trees striving towards the sunlight to overshadow their competitors. In the lower and middle layers of these highly diverse secondary forests, palms and „screw palms“ (*Pandanus sp.*) are particularly abundant with numerous species.

experience in the tropics, my impression was that of landing on another planet. Intense weeks at Pierre and Marie's Masoala Forest Lodge came next – intense both in substance and emotionally. I had enough hours of solitude in which to work through my anguish and work on a concept for this book as well. Because for Masoala I didn't want to do just a standard moth book. I meant it to be artistic, encompassing all issues so that it would be a total experience for its readers. I wanted it to infect people with Tropic Fever!



Lighttrap in Makira
Paths in the Makira Rainforest are narrow and slippery and often they fall away steeply into gorges. At night in the rain and afflicted by moth fever caution is advised!

Authors and mentors

Once back from Masoala (2019), evaluation commenced of the moths I had photographed and the result was my first digital species collection. Martin Bauert was with me as a mentor constantly, and for the first time I was able to come into contact with scientists who were doing research on Madagascar butterflies and moths in famous museums in London, Paris and Munich. Once again, I was unbelievably lucky because David Lees, Axel Hausmann, Rodolphe Rougerie, Alexander Schintlmeister and others were open to questions and enormously helpful. David Lees especially was surprised at the wealth of species and the quality of the images. Because the biggest sensation was that I had in fact documented *Malaza fastuosus*, which had supposedly been extinct for about 50 years. I would not have begrudged David this rediscovery – for he would have deserved it. It became clear to me that I had to share the book and its contents with experts, and I wished to do so as well. Accordingly, I designed a draft for the subject areas and sent invitations for authors to write pieces. How helpful for the book's enrichment and for its technical quality that all the specialist authors agreed to do so and wrote contributions – without charging any professional fees! My great thanks go to them. Thanks also go to the young researcher Marcin Wiorek from Cracow who assisted me greatly. He will certainly go on to make and describe many more discoveries. Neither would I have been able to complete the book without my friend Paul. I knew that I could rely on his talent for languages and on his commitment. His support was greatly encouraging and motivating. Thank you Paul.

On the second research trip I was able to develop the concept for the book further and at the same time investigate Makira, another rainforest adjacent to Masoala, for butterflies and moths. After an almost two-year break caused by the Corona pandemic, I was able to travel to Madagascar again for a few weeks together with Zoo Zurich and Frank Glaw. Not even the constant downpours, which persisted for four weeks and were caused by the cyclone "Batsirai", could quell my tropical fever. Meanwhile, I was in contractual negotiations with Benteli Publishers and was again financially supported by Martin Bauert and Zoo Zurich. The concretization phase of "Eyes of Masoala" came next.

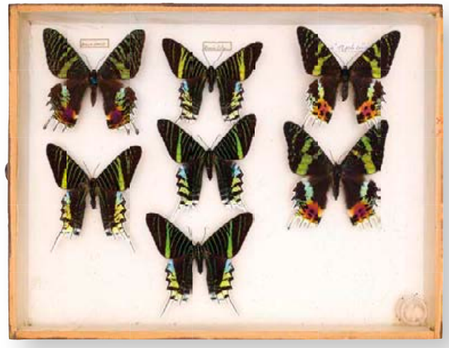




Study area in Makira
Apart from the flat coastal plains, the topography of the Masoala and Makria regions is very rugged. The valleys and gorges are steep and deep, making access difficult and arduous. At first glance, the living conditions in a tropical rainforest may seem fairly uniform: hardly a day goes by without sunshine followed by rain. However, the microclimate in the different layers of the forest can be vastly different for the organisms that are adapted to different strata.

The epiphytes in the canopy layer, for example, must protect themselves against the relentlessly burning, almost vertically standing sun in order to survive periods of low relative humidity and high temperatures. Trees and vines in the canopy layer must absorb enough water from the shallow soil with their root systems to replace the water lost through leaf transpiration.

Only a small fraction of the blazing tropical sunlight reaches the understory and ground vegetation. These plants must rely on this scant solar radiation to produce their photosynthetic products. Herbacous plants growing in the shaded understory often have red or purple leaf undersides that allow them to absorb reflected light, or light with longer wavelengths, and leaf forms that align and maximise exposure to light at different times of day.



The path described here leading to this book is of course compressed and ignores many sideshows and their actors. But it shows what happens in fractions of seconds, emotionally and mentally inside me, at the sight of an 80-year-old butterfly showcase with giant butterflies. Then I feel like the little boy running after a swallowtail butterfly in the high grass of a flowering meadow on a hot summer's day – alive, bold and inquisitive. Present in the here and now. All worldly cares become as light as a butterfly's wingbeat. Wolfgang Roell understands this internal transformation and strength and gave this book his generous support.

Book concept – Opportunities and goals

The three big main chapters describe, you might say, the structure of my Citizen Science Project. The chapter 'Tropic Fever' is about my motives and goals and the forests in which the field research took place – almost a brief 'The Making of'. 'The Eighth Continent' gives an insight into the natural history of Madagascar, and in the longest chapter, 'Encounters', the research results are shown in the form of images of direct confrontations or incidents with species. It also serves as a identification tool for 400 moth species.

The more intensively and meticulously I worked on the book concept, the more I realized that this book brings me not only great opportunities but also great responsibility. Outstanding specialist authors took joint responsibility and helped me to prepare texts that are just as multifaceted and interesting as the plant and animal world of the island of Madagascar itself. Martin Bauert first introduces Madagascar's natural history and how the species diversity came about and how to protect it. David Lees and Marcin Wiorek start by presenting readers with the moth superfamilies dealt with in the identification section, while Alexander Schintlmeister, Axel Hausmann and Rodolphe Rougerie give insights into the specific moth families and research areas in which they specialize. In his article, Aristide Andrianarimisa persuades readers – and hopefully also many decision-makers in the future – how important it is to collect plants and animals if we are to understand and protect nature. Lovy Rasolofomanana paints brief portraits of Masoala and Makira, the two big rainforest areas in which the moths were surveyed. Thomas Bucheli humorously describes the local weather conditions, and Moritz Grubenmann comments on seldom-observed praying mantises that turned up at the light traps, while reptile researcher Frank Glaw introduces a variety



Study area in Makira

of amphibians and reptiles that I encountered while light-trapping at night. I was permitted to share my hut in Makira with him and his frogs until deep in the night and to learn a great deal about about these amphibians. Interspersed in the technical moth section of the book are curious stories that serve to introduce a few superfamilies. Take for instance Roland Hilgartner's sensational account of the discovery of the tear-drinking moths. Also introduced is the Wildlife Conservation Society (WCS), which sets itself the ambitious goal of protecting the biodiversity of our planet. I thank these authors most wholeheartedly.

This is how this possibly unique book was created, making it at the same time my personal plea for the moths of Madagascar. There are double pages that look like collection showcases displaying a wealth of species and a rich variety of variants. But there are also some that portray moths as personalities and invite a study of their beauty and anatomy. On each double page the moths are illustrated proportionate to each other in size. I am quite sure that because of its design and the prepared list of species it constitutes a thus far unique, visual historical document. But what will the species list look like in five, ten or 20 years? What will be the effects of climate change and population growth?

The book is a living, visual report on intensive weeks of natural field research. It documents and visualizes which moth species were found alive in the research periods in 2019 and 2022 in the two rainforests, Masoala and Makira. The book will also be able to contribute in future to sight identification of 400 Madagascan moth species and will update the previous species lists for the two regions. Perhaps the book will also serve as an initial impulse and basis for further research into the moths of Madagascar. The following objectives, at a minimum, are intended: To bring joy, to cause astonishment at nature and its biodiversity, and to make each of us aware of our own responsibility.











Rainforests: the Battle for Sunlight
Every plant needs light to grow, bloom, and bear fruit. The competition for light is the dominant issue for all plants in the rainforest that cannot directly unfold their leaves in the canopy layer, such as emergent trees, lianas, or epiphytes. Many palms (*Dypsis* sp.), dragon trees (*Dracaena* sp.), and screw pines (*Pandanus* sp.) grow like an umbrella as an adaptation to the scarce light conditions in the understory.

Palms in the lowland rainforest at Masoala in the study area
Madagascar, and in particular the Masoala Peninsula, is a significant center of global palm diversity: over 170 species of palms are known, with all but 5 species being endemic. Over 100 palm species occur on the Masoala Peninsula. This is a strong contrast to the approximately 70 species documented across the entire African continent.

Lowland rainforest at Masoala in the study area
Uapaca sp. trees can be identified by their well-developed and prominent stilt roots. The genus is found in Madagascar in humid evergreen forests ranging from sea level to over 2,000 meters in elevation, as well as in semi-deciduous forests in the central highlands. *Uapaca* is an African-Malagasy genus with roughly 12 endemic species in Madagascar. Previously classified in the Euphorbiaceae family, *Uapaca* is now grouped with the Phyllanthaceae. *Uapaca* bears fleshy fruits that are heavily consumed by various lemur and bird species. Several species, such as *Tapia (U. bojeri)*, the host of the Malagasy silk moth, have edible fruits.

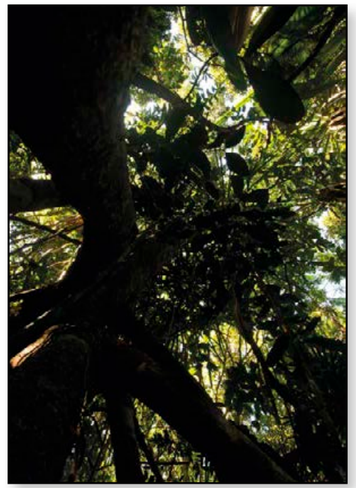


Trymalitis scalifera Meyrick, 1912 (Tortricidae)

















Polypogon (Nyctennomos) peratosema (Hampson, 1926)

Lowland rainforest at Masoala in the study area
The lowland rainforests have different strata and there is strong competition for light. The canopy of the forests is dense; only a relatively small amount of sunlight reaches the undergrowth on the ground. Epiphytic nest ferns growing on the trunks are very typical for the Malagasy rainforests. Vines wind from the ground up to the canopy layer to unfold their leaves and flowers in full sunlight. Vines are one of the least explored plant groups in the rainforest, as they pose major difficulties for botanists. On the ground only roots and the winding wooden stems can be studied, because the leaves, flowers, and fruits that are essential for scientific research are often out of reach for scientific analysis.

Habitats for various frogs
Small streams are a unique habitat in rainforests, particularly used by various frog species. On the moss-covered rocks, *begonias* are often found, which can thrive with limited access to light. But even nest ferns (*Asplenium* sp.), which usually grow epiphytically, and screw palms (*Pandanus* sp.) find suitable conditions here.

Rainforests: the Battle for Sunlight
Young trees invest as little as possible of their scarce photosynthesis products in their trunks, as wood is not productive. Instead, they try to align their leaves optimally and grow towards the light as quickly as possible. In the German language, the term "Schopfbaum" (tufted tree) was coined for this growth form: Small trees with thin trunks extend a whorl of leaves as high as possible towards the sun. *Oncostemom* sp. with its large, dark-green leaves that hardly shade each other is a typical example.

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Setting up in the twilight
Above can be seen the light traps employed: A bed sheet with sown-on tabs, a mosquito net converted into a canopy and a professional light tower made of gauze fabric are what I used. In this way a suitable mobile construction could be used for any site. Below, my research hut in Masaola – my heaven on earth. It offered me everything I needed: a dry roof over my head, cool during the day and secure at night.





Bites, scratches and fever
The long weeks of light-trapping and nightly excursions left their mark. The strenuous day-night rhythm with little sleep, biting pests at the light trap, leeches and plants armed with thorns and stinging hairs brought mental and physical stress. All that could help to keep me going was rest and to concentrate on the next night's light-trapping. Also a few SMS messages from my partner Sigrid, from my sister Manuela or from my daughters Amelie and Helena proverbially healed my wounds.

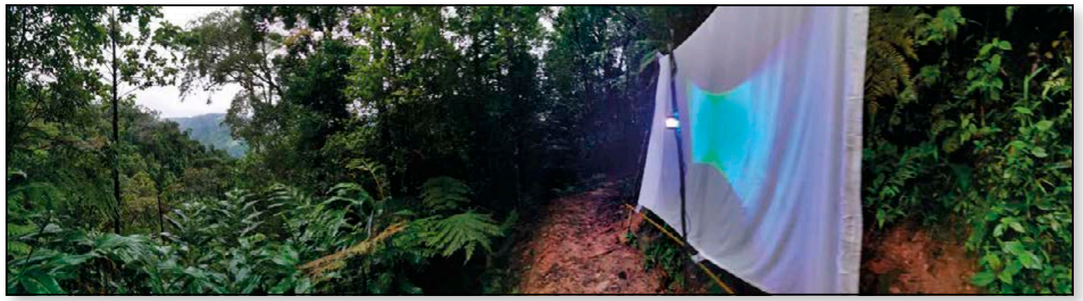














Sunshine at last – washday in Makira
Whenever heavy rain wasn't pounding deafeningly on the corrugated roofs, the time could be used to wash clothes, clean equipment, and, especially, to charge batteries for camera and UV lamp. After just a few days of rain shoes were covered with an overlay of mold and the equipment was damp and musty. Half-charged batteries increasingly shortened the fluorescent time of the UV lamp and the light strength of the flash. Each photo had to be carefully considered.

Flight activity during cyclone rains
Animals and plants are adapted to this wet and hot climate and so flight activity is good despite heavy rain. But evaluating the captures at the light trap became more difficult with each passing day and my own strength began to wane.

Time and commitment
The isolation of my two „research stations" gave me intensive periods of time in which to concentrate fully on the moths. This resulted in a picture archive of more than 400 species and 10,000 photos.





Acontia viettei Hacker, 2010



Save 50 % of the world's biodiversity

Text by Dr. Martin Bauert

About the Wildlife Conservation Society (WCS)

Founded in 1895 as the New York Zoological Society, the Wildlife Conservation Society (WCS) was one of the first conservation organizations. The Society began with a clear mandate: Advance wildlife conservation, promote the study of zoology, and create first-class zoos to inspire visitors about the beauty of wildlife. In fact, WCS today still runs five living institutions in New York: the Bronx Zoo, Central Park Zoo, Queens Zoo, Prospect Park Zoo, and the New York Aquarium.



Global priority regions to save the world's biodiversity.

WCS is committed to conserving 50% of the world's biodiversity

WCS's goal is to conserve the world's largest wild places in 14 priority regions, home to more than 50% of the world's biodiversity. The challenges are greater than ever, but with the focus, dedication, and passion of more than 4,000 committed staff – combined with a unique mixture of field, zoo, and aquarium expertise – WCS will continue to set the bar for science, conservation action, and education in protecting wildlife and wild places in more than 50 countries across the world.

There is no other organization in the world with a greater track record of results in conservation science, policy, and on-the-ground field work – or with a more talented, diverse team of people getting the hard work done every day, hand in hand with Indigenous Peoples, local communities, and governments. This makes WCS uniquely positioned to take on the biodiversity, climate, and zoonotic pandemic crises in this decisive decade for the planet.



WCS Madagascar Program in Partnership with Zoo Zurich and the Malagasy Government

The WCS Madagascar Program works throughout Madagascar to ensure the long-term conservation of the country's unique biological diversity with a focus on activities in the Masoala, Makira and the Antongil Bay landscape and seascapes.

Zoo Zurich and WCS have signed a long-term partnership to foster the protection and management of the Masoala National Park in close collaboration with Madagascar National Parks (MNP) and the Ministry of Environment and Sustainable Development of the Republic of Madagascar.

WCS's interventions are focused in the MaMaBay Landscape/Seascape – where WCS is the delegated manager of the Makira Park and the co-manager of the Masoala National Park. But WCS also works in the southwest and northwest of the country to support the management of a network of locally managed marine areas, environmental education, and community engagement, as well as research and conservation of marine mammals.

WCS achieves its outstanding conservation impact through terrestrial and marine protected area management, engagement with local communities to support them to become effective stewards of natural resources, environmental education, and a program of applied conservation science.

Sustainable wildlife management by integrated conservation

All rural families living in and around the Masoala National Park and the Makira Natural Park depend heavily on natural resources for their wellbeing. Though wild animals are seldom eaten they provide a very important source of micro-nutrients, particularly for growing children. Unfortunately, even when each hunter only takes a few wild animals each year, the very large number of people who live in the area means that hunting of most species is unsustainable. Lemurs are most at risk. These primates, which are only found in Madagascar, breed very slowly, and hunting is driving them to extinction.

To meet this challenge, the Sustainable Wildlife Management Program coordinated by WCS aims to improve the management of hunting and fishing by rural communities, and encourage the production and consumption of poultry and farmed fish. By doing so WCS ensures the sustainability of natural resource use, helps protect Madagascar's unique and irreplaceable wildlife heritage, and improves the food and income security of rural families.



The herpetologist Frank Glaw shows eggs of a chameleon to the team, Makira, 2022.
Photo: M. Bauert

Environmental Education and Community Health

WCS Madagascar has an integrated health and conservation education program that aims to empower local populations to build awareness, knowledge, and skills to sustain a healthy environment and assure human wellbeing. Through an innovative approach the program supports environmental education with schools through environmental activities that focus on the use of internet technology. WCS also help youth conservation clubs to address environmental issues through advocacy, practical environmental actions, and youth radio broadcasting, and supports media outreach through weekly radio-programming, magazine production, and yearly cultural and environmental festivals.

WCS's integrated health and nutrition program includes activities on youth reproductive health, healthy nutrition and linkages with landscape/seascape conservation. The Living Environmental Campus in Maroantsetra serves as a unique resource for WCS's education program and provides visitors – including communities, students, teachers, and government officers – with a central location for learning and decision-making.

Science-based conservation approach

WCS is committed to science-based conservation and research activities that focus on the presence of and threats to the emblematic Silky Sifaka, Red Ruffed lemurs and Indri lemurs, the drivers of bushmeat hunting by local communities in Makira Natural Park and Masoala National Park, the status of endemic carnivore species, optimization of connectivity between marine protected areas, and threats and conservation strategies for sharks, rays, and dugongs.



A curious Silky Sifaka observes the team, Simpona Lodge, Antsahabe, Makira, 2019.
Photo: M. Bauert

Online Biodiversity Database: REBIOMA

Rebioma (http://www.rebioma.net) – Madagascar Biodiversity Network – is a web-based tool developed by WCS that aims to promote the use of biodiversity data in conservation and spatial planning, including in climate change analyses. The Rebioma project was established in 2000 and it places a strong emphasis on science-based conservation action and on training Malagasy conservation biologists and professionals. It is an initiative that centralizes biodiversity data in Madagascar and allows a wide range of users to freely access and analyze that data to inform conservation decision-making and spatial planning. Prior to the creation of Rebioma, no common biodiversity database existed in Madagascar despite the exceptional and unique biodiversity that is found in the country.

Rebioma was set up in order to provide open access to trusted and reliable data. Working with the specially created Taxonomy Review Board (TRB), which reviews every database record, Rebioma has assembled marine and

terrestrial taxonomic lists and built the online infrastructure needed to discover, use, and publish high-quality biodiversity data.

Over the last ten years, Rebioma has gained recognition as a leader in major national and regional biodiversity planning and conservation projects. Its major technical achievements include its support in the identification of more than 4 million hectares of terrestrial protected areas in Madagascar through science-based analyses to contribute to the fulfillment of Madagascar's 2003 "Durban Vision".

SMART (Spatial Monitoring and Reporting Tool)

In 2013 WCS initiated training on the use of the Spatial Monitoring And Reporting Tool (SMART) throughout Madagascar, with a focus on nine high-risk terrestrial-protected areas: Makira and Andasibe Mantadia parks, the Tsaratanana Reserve, and the six parks that comprise the Rainforests of the Atsinanana World Heritage Site, namely Masoala, Marojejy-Anjanaharibe Sud, Zahamena, Ranomafana, Andringitra, and Andohahela National Parks. Following this successful piloting of SMART, it has been adopted by Madagascar National Parks and the Ministry of Environment, Ecology and Forests as the national Law Enforcement Monitoring (LEM) tool for Madagascar.

SMART is a key part of the successful law enforcement and threats monitoring (LEM) system. It has the ability to improve the effectiveness of wildlife law enforcement patrols and site-based conservation activities.







Dr. Frank Glaw in class with two students. Photos: Edi Day





Discussion of the situation in camp after evening meal, between Antonio (WCS Regional Director), Martin (Zoo Zurich) and biologist and tree-climber Hasina.



Lots of action and good planning: out on expedition with the WCS
In 2022 the editor had the good fortune to be able to join an exploratory expedition led by the herpetologist Dr. Frank Glaw to the Simpona Lodge in Makira. The light trapping in Makira added substantially to the list of Lepidoptera species observed in Masoala. During the expedition the organizational skills of the WCS were demonstrated – this is a group that is very familiar with the localities and fosters good relationships with the people of the region. They in turn participate by assisting either as porters, cooks, guides, or future scientists. And they at the same time become familiar with their own natural world in an especially intensive way. Reinforced by the great interest shown by the researchers, they understand and cherish the value of keeping intact their own forest environment.



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Happy Guides - successful field researcher

As beautiful and intensive an experience as it certainly was to have abandoned myself, alone, to the rainforest and its breathtaking diversity, my fieldwork was still further enriched through contact with the local guides. This brought me great joy and some wonderful experiences. At all times I had the feeling that I was under their escort, being providentially watched over by them – but at the same time being given enough space, support, and freedom to do my work at the light traps each night. Eric was also always there to reassure me when I was having a bad time of it because of health issues – a high fever that lasted for days on end, hundreds of insect bites, and abrasions caused by rocks and thorny plants all sapped much of my energy. To strengthen me Eric brought avocados of various different colors to my hut with precise instructions as to when each one would ripen and had to be eaten. Even during my bouts of fever, I could tell that he came by regularly to check up on me. But I couldn‘t speak to him to thank him for it. He had my back – I was not alone. With Ursula I shared the good fortune of capturing a comet moth in Makira, and each afternoon for 2–3 hours I walked with Eric slowly and in perfect silence through the Masoala Rainforest looking for animals of all kinds. Without actually speaking we communicated a lot to each other and had a good understanding. One unforgettable moment was when I had to swear an oath of disclosure on the beach at sunset. When I first arrived at the Masoala Station, I presented to everybody there my idea of attracting moths at night and photographing them. In my clumsy French I described myself as an “artiste“. The following evening the whole staff gathered on the beach at sunset and I was invited to come. Someone fished out a guitar and handed it to me with the expectation that, since I was an “artiste“, I would be able to give them a sample demonstration of who I was. But the thing is, I can‘t even read a single note of music! This was then followed by loud laughter as well as with even more beads of sweat on my brow on what was already a very clammy evening.



My guides Ursula and Eric
After just a few attendances at the light trap in Makira, Ursula could already identify many moths and assign them to their respective families. Eric was my ‘good genie‘ during my stays in Masoala. My every wish was his command. With his machete he would build a stable framework for my light trap set-up in a matter of minutes, no matter where or when. It was amazing to see how he went about doing this, staying spotlessly clean, with not a drop of sweat to be seen, and moving light as a feather, barefoot, without getting stung or injuring himself.



Mentors and authors





Dr. Martin Bauert

Martin Bauert, 58, grew up in Zurich and earned his doctorate from the University of Zurich with a research project on the genetic diversity and reproductive strategy of arctic-alpine plants. In 2002 he joined the Zoo Zurich with the task of setting up the operating of the Masoala Rainforest, a greenhouse spanning over one hectare and over 30 meters high, inaugurated in 2003 for the public. The integration of diverse animal species into the still young forest and the biological control of insects were the first major challenges. Since then, the Masoala Rainforest has become an authentic ambassador for the then unknown Masoala National Park in Madagascar. Dr. Bauert is also responsible for the partnership that the Zoo Zurich has established with the Masoala National Park and the Malagasy Government. Today, he serves as the Head of Conservation overseeing all eight major nature conservation partnerships of the Zoo Zurich, located on all continents.





Dr. David Lees

David Lees is a Senior Curator at the Natural History Museum London (NHMUK) responsible for the Microlepidoptera collections. He has visited Madagascar around 20 times and is a specialist on the butterfly and moth fauna. He has a particular interest in Lepidoptera systematics, biogeography and evolution as well as conservation. He has published over 150 scientific papers with high scientific and popular impact. These include studies on such iconic moths as *Xanthopan praedicta* and *Hemiceratoides hieroglyphica* and he recently coauthored a popular book on moths worldwide and a comprehensive book on Madagascan butterflies.

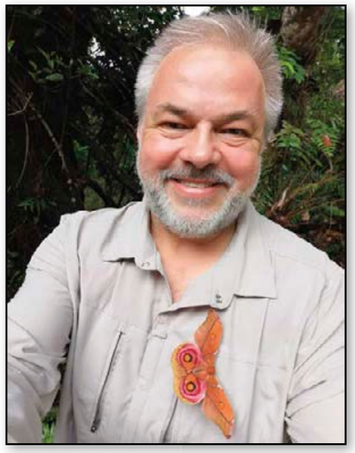
Consultant and editor





Dr. Marcin Wiorek

Marcin Wiorek is a researcher at the Institute of Systematics and Evolution of Animals at the Polish Academy of Sciences in Cracow, Poland. He started his adventure with insects by studying weevils as a biology student at the Jagiellonian University in Cracow, graduating in 2019. Currently he is interested in the taxonomy, phylogeny, biogeography and ecology of tropical tiger moths. His adventure with Madagascar moths began in 2020 with a research expedition with Dr. Łukasz Przybyłowicz and Dr. David Lees. In colllaboration with them he is realizing a project on the phylogeny and biogeography of a unique and amazing group of Madagascan moths, namely around 100 endemic species of polka-dot moths (Syntomini). They have already published a couple of papers on these moths.



Editor



Armin Dett

Armin Dett, year 1966, is a designer who for the past 34 years has been self-employed, with a design studio in the city of Konstanz on Lake Constance, southern Germany. His work focuses mainly on exhibition design for museums (scenography), illustration, and educational nature-trail design. He has won several international design awards and spent 18 years teaching graphic design as a lecturer. "Eyes of Masoala" is his third self-commissioned book on moths. He collected the respective data in the field and designed both concept and book in the spirit of a private citizen science project. The work on this book took roughly five years to complete.

Authors





Dr. Axel Hausmann

Axel Hausmann is curator at the Bavarian State Collection of Munich (SNSB–ZSM) with research focus on the systematics of Geometridae and on DNA barcoding. He published several hundreds of scientific papers, in the last 20 years more and more focused on the fauna of the Afrotropical region. As a curator he is responsible for the famous collection of Claude Herbulot (1908–2006) which is one of the collections worldwide with the best coverage of Geometridae from Madagascar.

To access Alex Hausmann's publications see: https://zsm.snsb.de/sektion-mitarbeiter/dr-axel-hausmann/publikationen/?lang=en





Dr. Roland Hilgartner

Roland Hilgartner is primatologist, author and professional photographer. He is director at Affenberg Salem, Germany's largest monkey enclosure. His passion for tropical forests has led him to all significant tropical rainforests of the world (Amazon, Congo, Madagascar, South-East Asia and Papua). Taking all his field stays in Madagascar into account, Hilgartner has spent nearly three years in Madagascar's forests. He has done extensive research on lemurs and described three new lemur species in cooperation with an international research team. However, his most spectacular discovery was with moths. In Madagascar he observed and photographed for the first time a tear-drinking moth that specializes in drinking the tears of birds. His discoveries and spectacular photos can be also admired in his most recent book published in National Geographic Germany "Das Geheimnis der Tränentrinker".
For more info: instagram: roland_hilgartner, www.rolandhilgartner.com

Authors



Dr. Rodolphe Rougerie

Rodolphe Rougerie is a researcher and curator for Lepidoptera at the Muséum national d'Histoire Naturelle (MNHN) in Paris, an institution hosting one of the largest collections of Malagasy moths. His research focuses on the evolutionary dynamics and macroecological patterns of species diversity in wild silkmoths (Saturniidae) and hawkmoths (Sphingidae), building on the use of phylogenomics and large-scale databases of species diversity, distribution and traits. He is also involved in the development of DNA-based species identification (DNA barcoding) and its applications (e.g., metabarcoding for biosurveillance) in Lepidoptera and other organisms.





Dr. Alexander Schintlmeister

Alexander Schintlmeister earned his doctorate in 1987 from the Humboldt-University, Berlin, on the biogeography and evolution of Notodontidae. He is the author of 14 books and more than 100 scientific papers dealing with Notodontidae worldwide. Numerous expeditions have taken Schintlmeister to almost every country in Asia, to Brazil, and to many African countries. In this way he has built one of the largest collections of Prominent moths.



My special thanks also go to Joël Minet, who provided advice behind the scenes for several identifications.

Authors



Dr. Aristide Andrianarimisa

Malagasy researcher involved in landscape ecology, conservation technology, ornithology, and zoology. I have worked to improve protected areas and conservation practices in developing countries hotspots like Madagascar by implementing technology-based conservation tools for evidence-based conservation practices in order to improve the decision-making efficiency of managers of protected areas. As University Professor, I have been involved in various subjects related to conservation biology, climate change, functional ecology, ecological modeling, marine science, etc. I have enjoyed an accomplished and rich professional life with more than 20 years of hands-on experience in conservation science with international NGOs as a senior staff member.





Lovy Rasolofomanana

I am an economist by training but have worked mainly for social development in Mali and Madagascar for the last 30 years. I have been involved in a wide range of activities including education, health, microcredit, employment training, habitat, infrastructures, land tenure and conservation.



I have been the Country Director for the Wildlife Conservation Society in Madagascar for the last four years. My work is focused on saving wildlife and wild places worldwide and particularly those in Madagascar. I am contributing towards reducing the threats to biodiversity and ensuring that populations of key species (threatened and locally endemic species, as well other conservation targets) remain stable or increase in protected areas managed by the Wildlife Conservation Society, and that the status of important habitats stabilizes or improves.

Cordial thanks!



Maria and Pierre Bester

Masoala Forest Lodge is a seven-bungalow ecolodge in Masoala, Madagascar, one of the remotest and most preserved places in the world, a hotspot of biodiversity, and home to many endemic species that are under threat. The vision of the lodge is to conserve the forest and animals and support the local communities. With over 50 staff employed from the surrounding villages, Masoala Forest Lodge is the biggest employer on the Masoala peninsula. They have a reforestation project and support and encourage projects and research on their premises that follow conservational interests.

Maria and Pierre, founders of Masoala Forest Lodge (in white shirts), promoted this book project.



Photo: Edi Day

Simpona Ecolodge, Antsahabe and the village of Andaparaty

Despite weeks of heavy rainfall, good meals were cooked for me and I was well provisioned by the hard-working women of the adjacent village of Andaparaty. What for me were difficult adverse conditions, i.e., heavy backpack, slippery paths, perpetually damp laundry, shoes covered with mold, downpours of unrelenting rain, sudden hot spells, insect bites, etc. – were for them normal daily life, which they handled with ease and grace.

It was a very special experience to discuss the daily and nightly discoveries with my traveling companions Edi Day, Moritz Grubenmann and Frank Glaw, as well as to learn from them about photography and the rainforest. I would love to return one day to Simpona and do further research on Lepidoptera. Hopefully with the same team!

Species list Masoala [2019]*, Makira [2022]**, Masoala+Makira [2022]***, Masoala [2022]****



Abakabaka phasiana (Butler, 1882) ***150*** **
Aburina dufayi Viette, 1979 ***127*** **
Achaea catella Guenée, 1852 ***145*** **
Achaea cf. ***faber*** Holland, 1894 ***145*** *
Achaea cuprizonea (Hampson, 1913) ***145*** **
Achaea dejeanii (Boisduval, 1833) ***145*** *
Achaea euryplaga (Hampson, 1913) ***145*** **
Achaea oedipodina Mabille, 1879 ***145*** *
Acherontia atropos (Linnaeus, 1758) ***11, 73, 74*** ***
Acontia gloriosa (Kenrick, 1917) ***158*** ***
Acontia viettei Hacker, 2010 ***157, 158, 180*** **
Acosmetoptera sogai (De Lajonquière, 1970) ***85*** **
Acosmetoptera sp. de Lajonquière, 1972 ***81,84, 85*** *
Acracona pratti (Kenrick, 1917) ***38,41*** **
Acremma axerina (Viette, 1988) ***137*** *
Acremma neona (Viette, 1962) ***137*** *
Acremma sp. Berio, 1959 ***137*** ***
Acremma sp. near ***ingens*** (Viette, 1968) ***137*** ***
Acremma sp. near ***thyridoides*** (Kenrick, 1917) ***137*** *
Acremma thyridoides (Kenrick, 1917) ***137*** *
Acripia megalesia Viette, 1965 ***127, 128*** **
Acroctena fissura Saalmüller, 1884 ***120*** **
Acroctena pallida (Butler, 1882) ***11, 120*** **
Agathia malgassa Herbulot, 1978 ***102*** *
Agrioglypta toulgoetalis (Marion, 1954) ***42*** **
Ambia sp. Walker, 1859 ***39*** ****
Ambina ochreopicta (Kenrick, 1917) ***121*** *
Ambina spissicornis (Mabille, 1899) ***120*** *
Andrianam poinimerina Viette, 1954 ***138*** **
Androlymnia malgassica Viette, 1965 ***159*** ***
Anoba malagasy Viette, 1970 ***127*** ***
Anomis alluaudi Viette, 1965 ***146*** **
Anomis simulatrix (Walker, 1865) ***146*** *
Antherina suraka (Boisduval, 1833) ***48, 55, 56, 61–63*** ***
Antitrygodes dentilinea Warren, 1897 ***100*** **
Apatelopteryx deceptrix (Kenrick, 1914) ***84, 85, 87, 191*** *
Archichlora catalai Herbulot, 1954 ***90, 102*** ***
Archichlora cf. ***chariessa*** Prout, 1925 ***102*** **
Archichlora cf. ***engenes*** Prout, 1922 ***91, 102*** ***
Archichlora cf. ***malgassa*** Herbulot, 1978 ***102*** *
Archichlora cf. ***nigricosta*** (Herbulot, 1960) ***102*** *
Archichlora cf. ***stellicincta*** (Herbulot, 1972) ***104*** *
Archichlora hemistrigata (Mabille, 1900) ***103*** ***
Archichlora trygodes Prout, 1922 ***89, 103*** ***
Archichlora Warren, 1898 ***90*** *
Argema mittrei (Guérin-Méneville, 1847) ***47, 52, 54, 175*** **
Argyphia arcifera (Mabille, 1881) ***142*** **
Argyrolopha trisignata (Mabille, 1900) ***138*** *
Asota borbonica (Boisduval, 1833) ***125, 126*** ***
Athetis sp. Hübner, 1821 ***159*** **
Audea agrotidea (Mabille, 1880) ***128, 146*** ***
Avitta cf. ***lineosa*** (Saalmüller, 1891) ***139*** *
Banisia myrsusalis (Walker, 1859) ***35*** **
Batocnema coquerelii (Boisduval, [1875]) ***75*** *
Bertula sandrangato Viette, 1961 ***138*** *
Blechroneromia herbuloti Viette, 1976 ***105*** *
Blechroneromia malagasy Viette, 1976 ***105*** **
Blenina near hyblaeoides Kenrick, 1917 ***110, 156*** *
Bocchoris inspersalis (Zeller, 1852) ***42*** *
Borocera cajani Vinson, 1863 ***83–85, 87*** *
Botyodes andrinalis Viette, 1958 ***42*** **
Botyodes asialis Guenée, 1854 ***42*** **
Brachychira cf. ***destituta*** Kiriakoff, 1966 ***122*** **
Brithys crini (Fabricius, 1775) ***159*** *
Bunaea aslauga Kirby, 1877 ***47, 53, 55, 63*** ***
Cabera cf. ***cadoreli*** Herbulot, 2001 ***94*** **
Cacyreus darius (Mabille, 1877) ***16,17*** ***
Caligatus splendidissima (Viette, 1958) ***110, 155*** *
Calligraphidia tessellata (Kenrick, 1917) ***145*** *
Callopistria cf. ***miranda*** (Saalmüller, 1880) ***159*** *
Callopizoma malgassica (Kenrick, 1914) ***82, 85, 86*** *
Campydelta stolifera (Saalmüller, 1891) ***159*** ***
Cataclysta sp. Hübner, 1825 ***40*** ****
Cautatha cf. ***coenogramma*** (Mabille, 1900) ***138*** *
Chiasmia crassilembaria (Mabille, 1880) ***94*** *
Chiasmia simplicilinea (Warren, 1905) ***94*** ***
Chiasmia sp. Hübner, 1823 ***94*** *
Chilades pandava (Horsfield, [1829]) ***17, 22*** *
Chiromachla insulare (Boisduval, 1833) ***129, 132*** ***
Chlorocalliope antongilensis (Viette, 1955) ***117–119*** *
Chlorocalliope dubiefae (Viette, 1978) ***114–115, 117, 119*** *
Chlorocalliope grandidieranum (Viette, 1954) ***259, 261, 263*** *
Chrysiridia ripheus (Drury, 1773) ***91–93*** ***
Chrysocraspeda cf. ***erythraria*** (Mabille, 1893) ***100*** **
Chrysocraspeda tantale (Viette, 1970) ***100*** **
Chrysodeixis chalcites (Esper, 1798) ***110, 157, 159*** ***
Chrysotypus cupreus Kenrick, 1914 ***35*** **
Cirrhochrista cygnalis Pagenstecher, 1907 ***42*** ***
Claterna ochreoplaga Viette, 1966 ***139*** *
Claterna sp. near ***berioi*** Viette, 1954 ***139*** **
Claterna sp. Walker, 1858 ***139*** **
Claterna sparsipuncta Viette, 1966 ***139*** **
Cleora cf. ***macracantha*** (Herbulot, 1955) ***94*** *
Cleora legrasi (Herbulot, 1955) ***94*** ***
Clostera albidilinea (Gaede, 1928) ***122*** *
Clostera pratti (Kenrick, 1917) ***122*** *
Closterothrix near ***leonina*** (Butler, 1882) ***84*** *
Clupeosoma sp. nea***r orientalalis*** (Viette, 1954) ***41*** **
Coelonia insularis Basquin, 2021 ***78,79*** **
Coelonia solani (Boisduval, 1833) ***79*** ****
Coelophoris sogai Viette, 1965 ***144*** **
Collenettema sp. Griveaud, 1977 ***150*** *
Comibaena leucochloraria (Mabille, 1880) ***104*** ***
Comibaena punctaria (Swinhoe, 1904) ***104*** ***
Comostolopsis rufocellata (Mabille, 1900) ***104*** ***
Comostolopsis stillata (Felder & Rogenhoffer, 1875) ***104*** **
Coptobasoides pauliani (Marion, 1955) ***42*** *
Corgatha falcigera (Berio, 1959) ***138*** *
Corgatha fissilinea (Hampson, 1910) ***138*** **
Corgatha latifera (Walker, 1869) ***138*** **
Corgatha zotica (Viette, 1956) ***138*** **
Cossidae sp. Leach, 1815 ***23,24*** **
Cyana amatura (Walker, 1863) ***135*** *
Cyclophora metamorpha (Prout, 1925) ***100*** *
Cyligramma disturbans (Walker, 1858) ***146*** ***
Cyligramma joa Boisduval, 1833 ***146*** *
Daphnis kitchingi Haxaire & Melichar, 2011 ***48, 65, 68*** *
Desmeocraera robustior Kiriakoff, 1960 ***113*** *
Detoulgoetia virginalis (Butler, 1878) ***130,131*** *
Diaphania indica (Saunders, 1851) ***42, 45*** **
Drepanogynis alina Viette, 1980 ***95*** **
Drepanogynis alternans Herbulot, 1960 ***95*** **
Drepanogynis near ***hiaraka*** (Viette, 1968) ***95*** ***
Drepanogynis purpurescens Herbulot, 1954 ***95*** *
Drepanogynis sp. Guenée, [1858] ***95, 161*** *
Dryochlora cinctuta (Saalmüller, 1891) ***105*** *
Earias biplaga Walker, 1866 ***158*** *
Ectropis basalis Herbulot, 1981 ***96*** ***
Ectropis sp. [‘perineti Herbulot’] ***96*** *
Ectropis sublutea (Butler, 1880) ***96*** ***
Eilema argentea (Butler, 1878) ***135*** **
Eilema hybrida Toulgoët, 1957 ***135*** **
Eilema kingdoni (Butler, 1877) ***135*** ***
Eilema marginata (Guérin-Méneville, 1844) ***136*** *
Eilema recticosta Toulgoët, 1956 ***135*** **
Eilema sp. near ***laurenconi*** Toulgoët, 1976 ***135*** **
Elaphrodes simplex (Viette, 1955) ***122*** **
Eois cf. ***grataria*** (Walker, 1861) ***91, 108*** *
Eoophyla sp. C. Swinhoe, 1900 ***38, 40*** **
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Field research dates:

Masoala 2019: 34 Light trap nights beginning 12.02.
Masoala 2022: 12 Light trap nights beginning 02.04.
Makira 2022: 15 Light trap nights beginning 17.03.

As if taken straight from real life

All butterflies and moths in the book and its digital version were photographed alive where the author found them and then released unharmed back into the forest. These are wild creatures that were under the respectful care of the author for only a fleeting moment. The moths display their natural movements, rest postures, defensive and mitigation strategies, as well as evidence of their daily fight for survival in the Malagasy rainforests of Masoala and Makira. The moths were not anesthetized for the photo sessions. The images were created in RAW format and were processed by the author for printing. Dirt spots, stains, and scales left on the white paper background have been retouched. All shadows were caused by the photoflash inside the white, homemade 'softbox'. The strict photographic concept – with no other compositional influences that affect the image elements – leaves the Lepidoptera in their natural state as pristine works of art. The images should be something both to admire and to study, but at the same time they constitute a unique 'moth collection' – without any creature having been killed in exchange.

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Hypopyra guttata Wallengren, 1856

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Apatelopteryx deceptrix (Kenrick, 1914)

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