

***Troides andromache* Staudinger 1892:
The Natural History and Conservation of the Kinabalu
or Borneo Birdwing Butterfly**

STEPHEN SUTTON^{1*}; CORNÉ F. H. van der LINDEN²,
TOM M. FAYLE³, KALSUM M. YUSAH⁴, ALIM BIUN⁵, ARTHUR CHUNG⁶,
PAUL FORONDA⁷, SAIHENG TARADAS⁸ and BART P. J. BURGER²

Abstract : We review the distribution and life history of this rare and elusive birdwing, endemic to Borneo, known only from ten isolated localities and one major cluster of sites – Mt Kinabalu. We judge ‘Vulnerable’ as a fair recent assessment for this species in the Red Data List of IUCN (Böhm, 2018). We review what is known of the evolutionary relationships of *Troides* species and outline the work underway to place *andromache* in this context through work at Wageningen University in the Netherlands, partly by profiling 100-year-old DNA from museum specimens. We discuss the risk factors of forest clearance, increasing forest patchiness, drying out and regional temperature rise due to global warming on the future of this species. We describe our nascent methodology for breeding free-flying birdwings which will stay close to village homestays because of the provision of abundant food sources for larvae and adults. The aim is to create a new income stream for the homestay owners through ecotourism. We discuss the promotional and fund-raising strategies we are employing to aid the conservation of this noble butterfly, and the promise of raising conservation awareness generally, through art.

Keywords: *Troides andromache*; Kinabalu or Borneo Birdwing, conservation, life history; *Aristolochia foveolata*; breeding; endangered status; montane forest clearance; climate change; nature tourism

INTRODUCTION

Birdwings, genera *Ornithoptera*, *Troides* and *Trogonoptera*, are large swallow-tail butterflies (family Papilionidae) that evolved in the area between the Philippines and New Guinea, which is still the centre of their distribution (Condamine *et al.*, 2015). The genus *Troides* is found from India to Australia, with many species and subspecies.

¹Institut Biologi Tropika dan Pemulihan, Universiti Malaysia Sabah

²Biosystematics Group, Wageningen University & Research, Droevendaalsesteeg 1, 6708 PB Wageningen, The Netherlands

³Biology Centre of the Czech Academy of Sciences, Institute of Entomology, Ceske Budejovice 370 05, Czech Republic

⁴Institut Biologi Tropika dan Pemuliharaan, Universiti Malaysia Sabah

⁵formerly of Sabah Parks

⁶Forest Research Centre, Forestry Department Sabah

⁷Rotary Club of Kota Kinabalu, Sabah

⁸Guas Nabal Homestay, Kg. Kiau, Sabah

*Stephen Sutton, PO Box 13908, 88845, Kota Kinabalu, Sabah, Malaysia (tel +6016 828 248)

In 1892, Johannes (John) Waterstradt visited the Pinosuk Plateau on the SE slope of Mt Kinabalu (Barlow, 1969). An adventurer and prospector for minerals, he also made collections for insect dealers and museums in Britain and Europe. A customer was Otto Staudinger, who was part museum curator, part learned professor and part successful insect dealer. From a batch of six specimens, Staudinger in 1892 described a new species of birdwing butterfly, *Troides andromache*⁹.

'*Troides andromache* Staudinger 1892', is therefore this birdwing's official name but, informally, it is known in Sabah as the Kinabalu Birdwing because Mt Kinabalu is far and away its stronghold. Abroad it is known as the Borneo Birdwing. Within the genus *Troides*, *T. andromache* is part of the *amphrysus* clade, and is most closely related to *Troides cuneifera*, a species which is absent from Borneo but, like *T. andromache*, is a montane forest birdwing occurring between 1000 and 1500 m, in the Malay Peninsula, Java and Sumatra. These two species are regarded as 'sister' species. In Borneo *Troides amphrysus* and *Troides miranda* are lowland sister species (Braby et al., 2005; Condamine et al., 2015).

After discovery, specimens of *T. andromache* were obtained by overseas expeditions to North Borneo from time to time for museums and private collections. Birdwings occupy a special place in the passions of butterfly collectors. Many came to Borneo to collect it, but nearly all returned without it, because of its rarity of encounter and the difficulty of taking specimens.

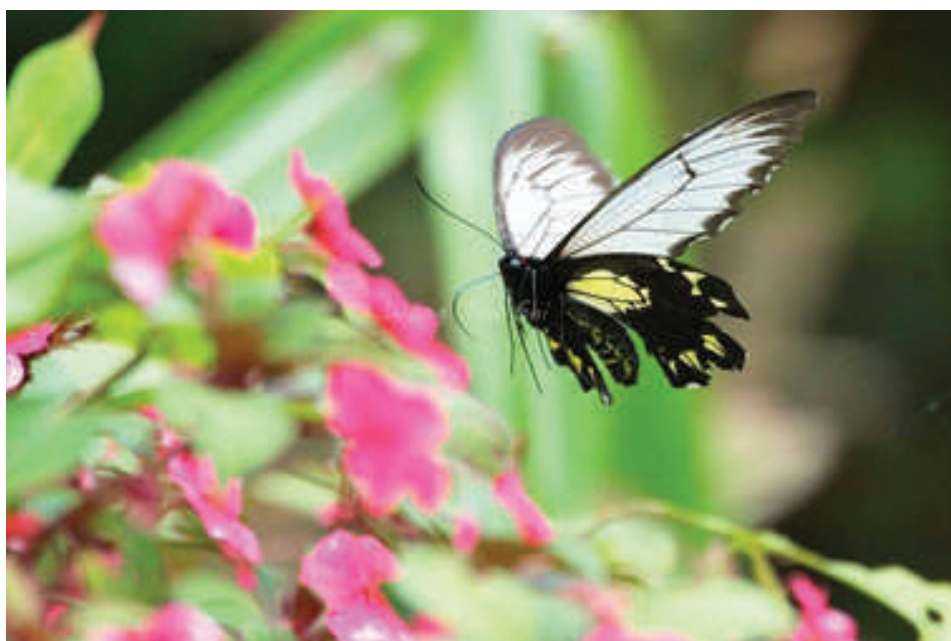


Fig. 1: *Troides andromache* approaching nectar source with proboscis extended. Mt Kinabalu.

Photo credit: Wong Tsu Shi

⁹When naming a new species one looks for a character which will distinguish it from near relatives. *T. andromache* females have white forewings with black veins with a dusting of brown, and narrow dark wing borders. This colour scheme is diagnostic amongst birdwing butterflies *Andromache*, in the Greek fable, was a Princess of Troy. Her husband Prince Hector was killed by Achilles in the sack of Troy, and their nine-year-old son was thrown from the city walls for good measure, to terminate the royal line. In an act of deep cruelty and calculated humiliation, *andromache* was then assigned to Achilles' son as slave and concubine. Classical scholars thereafter took the Princess as the epitome of tragic widowhood. White was the colour of mourning amongst the people of the city of Troy. In his original description of the species Staudinger (1892), Staudinger did not mention why he chose the name, but it is hard to resist the conclusion that, a classical scholar that he certainly was, he had in mind the tragic widow of Troy and her mourning clothes of white.

There was no focus on the scientific study of its life history or abundance and we have been unable to find any published details of these except for Matsuka (2001), published in Japanese. Even records of definite sightings are hard to come by.

In 2017 we were commissioned by then newly formed Swallowtail & Birdwing Butterfly Trust (www.sbbt.org.uk) to report (1) on the conservation status of *T. andromache*, (2) to study methods to build up the population to compensate for centuries of loss of native forest habitat. We added a third aim, to encourage retention of the pristine montane forest of Borneo as a resource for the birdwing, and for a sustainable tourism income stream based on providing opportunities to photograph this rarely encountered and elusive species, which (we think) should rightly become an icon of Sabah's rich natural heritage. These tasks are continuing. For this special issue of MNJ, we offer a provisional account of the present situation'.



Fig 2. Mating pair of *Troides andromache*. The male is much smaller. Kinabalu National Park.
Photo credit: Ooi Chin Hock

Historical Distribution records (pre-1970s')

Past records are nearly all in the zone of mists typified by tree ferns (Cyatheales). World-wide this zone tends to be known as the 'cloud forest'. Only a small minority of records were from the lowlands (below 750 m). Cloud forest is confined to northern and central Borneo on a NE to SW axis, generally occurring (where forest has not been cleared) from 750 m up to 2000 m altitude. The principal range of the nominate race of *Troides andromache andromache* extended in this cloud forest (or lower montane forest zone) along the mountain range from Mt Kinabalu and Trus Madi, SW along the Crocker Range spine to a well-known site on Mt Merapok, just over the border in Sarawak, type locality of a subspecies *T. andromache merapokensis* Fruhstorfer 1899, typified by a heavier brown dusting on the female forewings.

No other sites were recorded in Sarawak but, in 1992, the species was found some 640 km further SW in a remote hilly area of West Kalimantan, on Mt Saran (1758 m), south of the Kapuas River, at the headwaters of its tributary the Sepauk. This population has heavy brown dusting to the female which led to its recognition as a third subspecies, *T. andromache nishikawai* Kobayashi 1992.

Mazidi (unpubl. MSc thesis. University Malaysia Sabah & York University, UK) compiled a 'Borneo Butterfly Distribution Database' based on a thorough literature search and visits to museums. He listed 66 individual records of *andromache* for Sabah from 1899 - 2005, mostly from museum labels. Most were from upland sites. There were multiple records ('a major cluster') of records from the Mt Kinabalu region and minor clusters from several sites, e.g above Keningau, and Mt Alab along the Crocker Range spine. There were ten lowland records scattered across the east of Sabah from the Gomantong cave area and along the Kinabatangan River. The locations of the specimens supporting these records are not now available but Mazidi (pers. com) has said most of them are museum records, not sight records. Sight records are often misidentifications, partly because *andromache* is so rarely seen except in a handful of favoured spots that it is difficult to become familiar with it. Because female *Troides amphrysus flavicollis* (and particularly the *f.* "*olympia*" form) are easily mistaken on the wing as *andromache*, we do not accept sight records unless supported by still or video images.

The records from Gomantong and the Kinabatangan seem to represent isolated relict populations which are no longer present. It seems unlikely that they were strays from hilly areas, which are far away.

Although we are tentative with such a statement, due to the largely under sampled rough terrain in these mountain ranges which may provide a sampling bias, from these records it seems that *T. andromache* was always rare and elusive except for in a handful of hotspots.

Present Distribution (post-1970s')

In Borneo as a whole, *T. andromache*'s present range differs little from the past; but more hotspots have been located within it. Nearly all verified records since 1970 are from Sabah, from the montane cloud forest, apart from one female from Lungmanis Forest Reserve in the Forest Research Centre Collection in Sepilok. Hauser *et al.* (1997) confirmed *andromache*'s presence at 3 localities around Mt Kinabalu. It is still present in these places, along with another seven or so localities within the broader Crocker Range. In fact, a collecting effort by Sabah Parks staff and our own observational surveys show that it is fairly often seen right around the top of the Kadamaian Valley on the SW slope of Mt Kinabalu, from the Kiau Gap (the Bundu Tuhan junction with the Ranau Road) to Kg Kiau Nuluh, with several clearings where it is regularly seen when the sun is out. Two of these clearings are adjacent to a mature foodplant (*Aristolochia foveolata* - a liana) reaching to canopy level. Such mature *A. foveolata* lianas are often surrounded by a cluster of younger individuals.

Just SE of Mt Kinabalu there are reports of a sizeable population on Mt Trus Madi. However due to the difficulties with accessing this site we have been unable to confirm this population.

In Sarawak *T. andromache* is now known to occur beyond Mt Merapok, in the Mt Murud upland region (Morita, 2000). Access to most of this high ground is difficult, so there are almost certainly undetected sites. Such an elusive species is easily missed, but there are many places which have been surveyed by experienced lepidopterists, without it being found. It is a canopy species, but it regularly comes down to ground level to look for nectar flowers in clearings.

Over the border in Kalimantan (Indonesia) Mt Saran remains the only confirmed location. There are 65 specimens in the Himeji Science Museum. Whether these indicate that the butterfly is widespread in the scattered hills south of the Kapuas River is unknown, as all seem to have been collected from a single locality. The area is remote and may be unexplored entomologically, but language barriers prohibit our access to the Japanese literature to find out. Just over the border from SW Sabah, in northern Kalimantan, there is

a record on a map in Matzuka (2001) at Lumbis. This is not far from Long Pasia in Sabah, which is a known site. South of Lumbis there is a very large area of lower montane forest, patchily cleared for hill farming, which is virtually unexplored by entomologists as the logistics of reaching there are too challenging.

Conservation Status

T. andromache was listed as ‘Near Threatened’ by IUCN in 1985, because of large-scale forest clearance of the Pinosuk (now Mesilau) Plateau of Mt Kinabalu following de-gazettement of that area of the Kinabalu National Park. A further encroachment was made with the clearing of the Mamut Copper Mine site. Since then, the boundaries of the Park have been rationalized but without significant loss of protected area.

Böhm (2018) updated IUCN’s status to ‘Vulnerable’ and judged that there might be only 10 localities for *T. andromache* in the whole of Borneo. IUCN noted that there was a large area of potentially suitable forest, if the foodplant was present. Recent surveys of National Parks in Sarawak and Kalimantan have failed to record it (Chung *et al.*, 2016).

Our own estimate would be around 20 breeding sites. We support the designation ‘Vulnerable’ by IUCN as fairly judging the present situation. We are mindful however this species could be at risk of extinction if there was major instability in the montane forest biome.

Illegal commercial collection does take place but does not seem to have a serious impact. Collectors still pay high prices for birdwings, but *T. andromache* is less spectacular than the big New Guinea birdwings, and therefore not so intensely pursued.

In both countries in Borneo in which its presence is confirmed (Malaysia – Sabah and Sarawak, and Indonesia -Kalimantan) *T. andromache* is now protected by law from being collected. It is retained under Appendix II, Annex B of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). This listing implies that commercial trade is allowed providing a permit from the country of export is obtained, (which would only be granted if, in the future, farming of the species became successful). Because it is so difficult to find and catch in the wild, this birdwing is a very limited commercial prospect unless it can be farmed. It can be found on online trade outlets (i.e., www.ebay.com) but only in small numbers. This could indicate that there is ‘leakage’ due to unlicensed collecting, but some of the items for sale have been specimens from old private collections.

Citizen science is increasingly providing a welcome development in unravelling the largely unknown life history of *T. andromache*. Entomotourism in Sabah, particularly evident from the increasing number of visiting macro-photographers focusing on insects, with butterflies a favourite target. Amateur naturalists, both local and from overseas record valuable information on new sites and life history information. An example of this is the first image of *T. andromache* ovipositing that we know of, which also provided the initial record showing that the lowland *Aristolochia acuminata* (formerly *tagala*) is acceptable for oviposition (although we do not know if the larva grew successfully) (SK Khew Singapore Butterfly Circle online). We have several other photographic records of *T. andromache* from the Mt Kinabalu/Crocker Range, but the localities we have been given are approximate to avoid illegal collecting for the trade. We have yet to make a thorough search of social media and citizen science data repositories (e.g. iNaturalist.org) to find more photos and videos.

In this Special Conservation Issue, it is relevant to consider the risks that face the butterflies of the montane forest in the future. Looking back to the 1961 Special Conservation Issue of the Malayan Nature Journal, the words of A. B. Russell, still apply,

a propos of butterfly conservation:

"The risk of extermination of a rare local species, however, remains. If this country were to become highly developed and, in other words, deforested to a large extent, many species would undoubtedly disappear..... jungle is the natural home of nine-tenths of our butterflies"

Risks for future distribution of *T. andromache*: Forest Clearance as a Factor

The Kinabalu Birdwing is at risk from ongoing forest clearance for agriculture and tourism development, notably in the remaining forests outside the Kinabalu National Park. These forests are either privately or community owned. Slash and burn clearings (kebun) for growing hill rice, vegetables and fruits for home consumption are now being enlarged to grow pineapples and arabica coffee as cash crops. The rate of forest clearance continues to increase, albeit at a slow rate.

Additionally, small plots (5 hectares or so) in the closed canopy forest above the kebun clearance line are being bought by investors from the cities for development as lodges for wildlife-minded vacationers. AirBnB is beginning to be a driver of this demand. The steepness of much of the terrain and the resulting high cost of infrastructure are deterrents but even on these steep areas there is demand from investors. They then find they have to clear some of their new-bought land to create resort conditions (access to the sun and the view across the mountains). The result is an emerging mosaic of small clearings in a matrix of pristine forest. This is happening in the upper valleys close to the border of the National Park but so far on a small scale. The Park itself is well-patrolled and the forest within is in good condition. There appear to be few effective regulatory restrictions on development outside the Park.

This ongoing creation of a mosaic of small clearings in the forest, outside the National Park, does not necessarily negatively impact *T. andromache*, as the host plant vines (*Aristolochia* spp.) are light-loving and readily become established on the forest edges. Later these young vines will grow into the forest canopy if they are lucky enough to scramble sufficiently to make contact with a tall tree – not easy if you are on the forest edge. The specific impact of these land use changes on the population development and habitat suitability for *T. andromache* are still relatively unknown.

Typically, when a small resort is built, the clearing occupies about 20% of a 5ha plot and is planted with flowers to create pleasant surroundings for guests. If these flowers are nectar producing then *T. andromache* benefits, because in nectar-feeding Lepidoptera there is known to be a positive correlation between nectar consumed and eggs laid (Romanowski, 1991) Long term observations indicate that if the resort (or *kebun*) owners plant the correct nectar flowers and plenty of the host plant, they can provide all the requirements for the birdwing. But close proximity to a tract of intact lower montane forest is probably still necessary to avoid local extinction.

There is, however, a threat from overseas investors who have plans to clear fell whole plots if they see a market from mainland China seeking cool, pure mountain air. They omit to consider that the mist comes down around 11am and the rain follows shortly after, and the climate goes from cool and sunny to cold and downright miserable - for the rest of the day.

Climate Change as a Factor

Climate change has been a feature of planet Earth's dynamics since the beginning of time. Over the ages, in mountainous areas on land, this has forced plants and animals to move up and down in altitude tracking these climate changes. In particular, changes in temperature. These changes have mostly been gradual, over hundreds of thousands of years.

Currently there is a new challenge. It is now generally accepted that climate is changing in the time frame of tens, rather than thousands of years. Probably never before in human history, even in the most turbulent of the Ice Ages, has climate changed as rapidly as it is now doing. It is a crisis which will not pass unless humanity takes drastic action to mitigate it.

One aspect of this crisis is the threat to biodiversity. The island of Borneo is widely recognised as one of the richest places for biodiversity on Earth. One of the most diverse habitats on this large island is the lower montane forest. With a cool, cloudy climate and a day/night temperature range of 22 down to 15deg C., it has a very specialised fauna and flora with many endemic species. If the ambient temperature increases, this domain needs to track the change by moving up in altitude to survive. However, a striking (and little realised) feature of the Borneo mountain mass is that only a tiny proportion of it exceeds 2000 m elevation (Fig 3, main map). There is a limit on upward movement, because there is simply nowhere to go. In the worst case, if ambient conditions in the zone 750-2000 m were no longer tolerable for elements of cloud forest fauna and flora, they would become extinct. There would only be fragments of montane forest on Mt Kinabalu and a handful of other peaks in the whole of the island of Borneo where cloud forest species could survive. Fig 3 (inset) shows the area between 750-2000 m that would be lost to this fauna and flora.

In other mountainous areas, high elevation taxa have been found to be particularly under threat from climate change, even under conservative estimates (Dirnböck *et al.* 2011; Soh *et al.*, 2021).

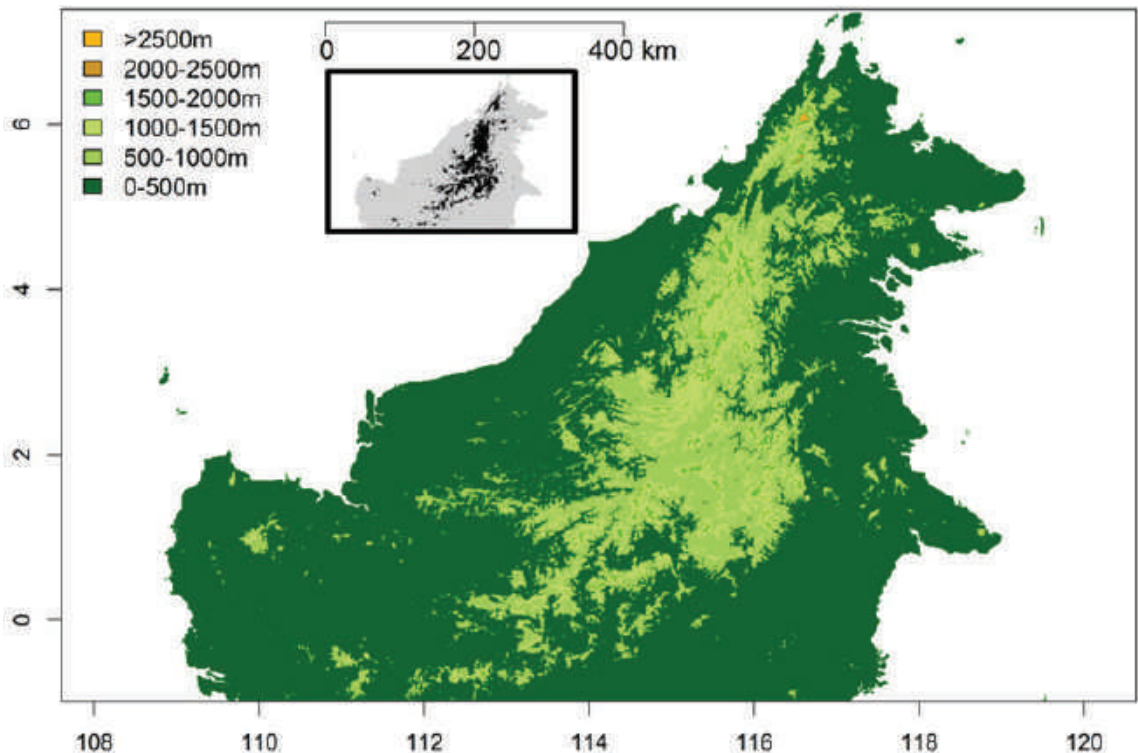


Figure 3: Main map: Elevation map of Borneo, created using global elevation dataset GMTED2010 (Danielson and Gesch 2011). Mean elevation is depicted for each grid cell per kilometre square. Inset map: Montane zone between 750-2000 m above sea level (the “cloud forest” zone and elevational niche of *Troides andromache*). The majority of mountainous terrain lies below the 2000m elevation mark, with only small areas exceeding this altitudinal limit around Mount Kinabalu, Mt Trus Madi and Mt Murud and the summits of small number of other peaks.

That the Lepidoptera fauna on Mt Kinabalu is beginning to move upwards has been demonstrated by a meticulous comparative study on Geometridae moths over four decades. In 1965, Henry Barlow¹⁰ organised an expedition from Cambridge University to Mt Kinabalu, which collected a wide spectrum of moths and butterflies. A fully quantified re-sampling of the Geometridae in 2007 by Chen *et al.* (2009) showed that 102 species in this moth family increased in upward elevation by a mean of 67m over the 42-year period. With current increases in temperature world-wide, there is every sign that the ambient temperature in Borneo, will also continue to rise. Over several hundred years the present altitude zone of 750-2000 m may become untenable, and with few options for moving above 2000 m (see above). If the elevational shift in geometrid ranges recovered by Chen *et al.* (2009) were to continue, the elevation niche of these species would shrink dramatically (see Fig 3).

Examples of such elevational range shifts have been found and predicted in mountainous areas in both the tropics and temperate regions (Lenoir *et al.*, 2008; La Sorte and Jetz, 2010) for a wide selection of taxa including butterflies (Papilionoidea), angiosperm plants and bumblebees (*Bombus* spp.) (Lenoir *et al.*, 2008; Marshall *et al.*, 2020). Rates of upward shift are also occurring faster than previously thought (Chen *et al.*, 2011). Such distributional restraints may lead to serious declines or even species extinctions. Similar patterns and consequences are likely for other elevational specialists, across all taxa. However, the complete effects of climate change on a certain species are the result of a complex set of factors and future changes at the species level therefore remain uncertain.

Evolutionary studies and determination of subspecies status

The presence of *T. andromache* and *T. cuneifera* in the cloudy, wet montane rainforest niche raises questions. When and why did the genus *Troides* colonise the cloud forest? Were they driven from the sunnier lowlands by competition with *T. amphrysus*, *T. helena* and *T. miranda*? And how has speciation led to two montane *Troides* species with a disjunct distribution? These questions are currently being addressed by C. van der Linden as part of this project. He is also carrying out DNA profiling to assess the taxonomic status of the two recognised subspecies of *T. andromache*, namely *andromache* Staudinger, *marapokensis* Fruhstorfer. These two subspecies vary in colouration and follow a distinct gradient, occurring, in their respective order, the montane forest spine from Mt Kinabalu to Mt Saran. Their subspecies status has been debated, especially that of subsp. *marapokensis* which is not recognised by Collins and Morris (1985) or Ohya (2001). The subspecies complex is currently awaiting detailed systematic treatment in the form of phylogenomic research (Van der Linden, 2020 *pers. comm.*). Morita (2000) recorded *T. andromache* from Mt Borak & Garam in the Central Highlands of Sarawak, and named specimens as a new subspecies. It seems unlikely that this designation will be supported by the DNA profiling exercise.

The expected outcomes of this research are the presentation of a distribution map of *T. andromache*, and the identification of uniquely evolving subspecies and populations of the species. These may or may not be congruent with the currently described subspecies. The relationships of *T. andromache* subspecies with those of *T. cuneifera* will also be examined in this research and may allow for further insights into the evolution of the species.

Life History Stages of *Troides andromache*

The only published account of the life history of *Troides andromache* is by Matsuka (2001), written in Japanese and summarised in a series of tables and images of many birdwing species. The book is not in general circulation. Fig 4 shows the egg, larva, pre-pupal larva, pupa and adult, from several sources. A specimen has been bred through from a young larva by a homestay operator in Kg Kiau Nuluh, Mt Kinabalu, but we only have printable quality of images of this individual for the pupae and the adult (a male).

¹⁰ Dato' Henry Sackville Barlow OBE is an Honorary Member of the Malaysian Nature Society

Life stages of *Troides andromache*



Fig 4. Life stages of *Troides andromache*. The pupa and adult images are of a specimen recently bred through from a small larva in Kg. Kiau, Mt Kinabalu. The host plant was *Aristolochia foveolata*.
Photo credit: Ovum: Matsuka (2001); Larva: Chien C. Lee; Pupa: Saiheng Taradas; Adult: Saiheng Taradas.



Fig. 5 Images of *T. andromache* and *T. helena* larvae ready to pupate are shown above
 (Note: young *Troides helena* and *Trogonoptera brookiana* larvae have been frequently observed by our homestay co-operators in Kg Kiau Nuluh, but the very distinctive orange larva of andromache is rare)
Left: *T. andromache* Photo credit: Chien C. Lee;
Right: Pre-pupal larva of *T. helena* Photo credit: Stephen Sutton

Aristolochia foveolata* – host plant of *Troides andromache

There is strong evidence that *Aristolochia foveolata* is the host plant of *Troides andromache*, particularly in the vicinity of Kinabalu National Park, where most of our fieldwork has taken place. This plant occurs in and around Kinabalu National Park at 1600 m. In fact, there may be more than one species in the “*foveolata* group” in the Upper Kadamaian Valley above Kg Kiau, as two entirely different shapes of seed capsule have been collected. The sole record of ovipositing behaviour on another host plant species (*A. acuminata*- formerly *tagala*) was made at a low-elevation site, Mahua Falls, in Crocker Range National Park (S.K. Khew, Singapore Butterfly Circle, see above) This is a low-elevation (<1000m) *Aristolochia* species, and a known host plant of many other closely related *Troides* species. This valuable record highlights the importance of citizen science in recording and sharing life history observations.

Scarcity of the host plant may be a natural limiting factor of *T. andromache* abundance. We have only discovered five mature lianas in 2 years of opportunistic survey efforts. Mature *Aristolochia foveolata* lianas often reach to the top of the lower montane forest canopy, which decreases the chances of detection by surveyors at ground level. But *T. andromache* has been observed to oviposit at ground level, and young *A. foveolata* plants are quite frequent in the montane forest, mainly where there has been disturbance i.e. forest gaps.

Nectar plants and notes on adult lifespan

Both sexes appear to be long lived, but this has not been confirmed by tracking individuals over their lifetime. As an indication, another birdwing species, *Ornithoptera alexandrae* completes its development in around 5 months and adults then live for up to three months (males) and six months (females) (Mitchell *et al.*, 2016). Both sexes of *T. andromache* feed on nectar, attracted to tubular flowers, but females spend much more time nectaring in clearings than males, which do visit the clearings but seem more confined to the canopy. This may be a result of a differential energy requirement between the sexes, with females requiring more nectar-derived resources for egg production – as reported in other Papilionoidea (Cahenzli & Erhardt, 2012). In the canopy both sexes feed on flowers of the woody climbers *Bauhinia* spp. (Fabaceae) and *Mussaenda* spp. (Rubiaceae). At ground level they have been noted on a number of introduced species which out-compete native flora in clearings made for cultivation or lodges. A favourite nectar plant for *T. andromache* around the periphery of Kinabalu National Park is an introduced ‘Poinsettia’ (*Eurphorbia* sp., Euphorbiaceae), a fast-growing small tree. Orange balsams (*Impatiens walleriana*, Balsaminaceae) growing in masses in cleared areas are also highly attractive. Yellow day-lilies (*Hemerocallis* spp., Liliaceae), *Lantana* spp. (Verbenaceae) and *Hibiscus rosa-sinensis* (Malvaceae) seem to be nectar flowers of choice in gardens or other disturbed habitats. Although such introduced plant species do not form part of the native flora, they can still provide valuable nectar resources, particularly in habitats where the native flora has vanished. In the light of our *T. andromache* conservation project, homestay operators are being encouraged to plant these flowers as a nectar resource. Because, under World Heritage rules, introduced plants must be removed in National Parks, the banks of yellow lilies and balsams, once a feature of Kinabalu Park HQ, have gone. *T. andromache* is rarely seen now within the Park at ground level but is still visible in the canopy or crossing clearings high up, at speed.

Abundance & Activity

Like other birdwings, this is a very ‘low density’ species even at sites where it is regularly observed (3 or 4 sightings per day on average). Alim Biun (*pers. comm.*) from thirty years of observations while on the staff of Sabah Parks studying butterflies and birds, has found that *T. andromache* can be seen almost daily in good weather in all seasons from vantage points over the canopy around Kinabalu Park, but is much more common when canopy-reaching lianas are in flower. Furthermore, it is only active in sunshine or very light rain. In the heavy mist which usually begins around between 11am and noon time in this cloud forest belt, it does not fly, or at least, does not visibly visit flowers at ground level. Daily flight activity is limited, mostly between 9 – 11am (see Fig 6), but if the sun comes out it may reappear, even in late afternoon.

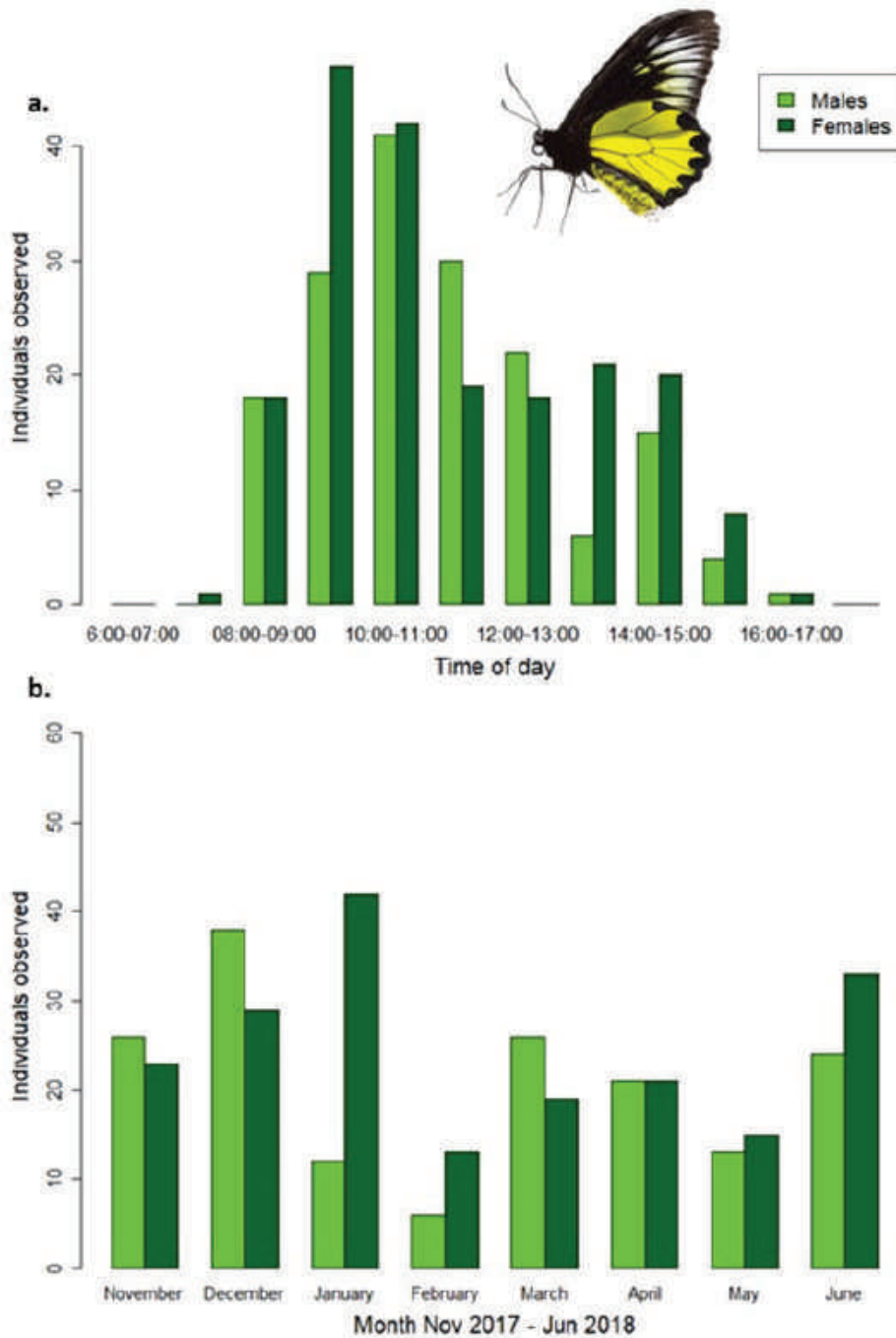


Fig. 6 a & b. Caption: Activity noted from the verandah at Kinabalu Mountain Lodge at 1558 m, 22 November 2017 to 23 June 2018. Total number was 402 (212 males and 190 females).

Max no. in 1 day = 25. Blank days were frequent. This was a good example of citizen science by members of the Kg Kiau community. Photograph is of a male *T. andromache*.

Photo credit: Corné van der Linden

Conservation effort: rearing of larvae

Since the SBBT commission, we have been training village homestay operators to breed the birdwings to increase the population, and have linked this to more general nature tourism training in the field (i.e., bird guide training courses). The Rotary Club of Kota Kinabalu has raised funds for this training and supervised its planning.

Large scale propagation of the host plant has been started by the homestay owners from seed and cuttings of local provenance. The aim is significant population growth of the butterfly to compensate for losses due to past forest clearance, as it can be done on a very large scale whereas sleeving or larval pens can only be small scale. A reality check over the last two years is that the *Aristolochia* sp. takes a long time to propagate and establish, and needs to be produced in large quantities to feed the larvae, which are enormous when full grown, and voracious. *Aristolochia foveolata* can be cultivated in the higher, cooler kebun, growing up old rubber trees, while *acuminata* can be cultivated lower down and in more open areas. Our target of increasing the host plant population by 300 young plants, mainly around Kg. Kiau, is expected to boost *T. andromache* numbers in this area and further facilitate life history studies by making it easier to locate eggs and developing larvae.

In the higher levels of the Kadamaian Valley, a community commercial birdwing farm may well be successful but would need a great deal of planning and training. The easier income stream would be to develop the current scheme for paying guests in homestays, surrounded by flowers with foodplant vines growing up old rubber and fruit trees and *T. andromache* flying freely, providing ready opportunities for photographers.

In order to enhance nectar supply and bring the butterflies close to waiting photographers, we plan a training programme for the homestays on how to exploit the behaviour of birdwings to attract them down from the canopy. The old timers collecting birdwings in New Guinea used scarlet cloths spread on the ground. Brightly coloured nectar flowers are preferable. We plan to experiment with artificial nectar ‘super-flowers’ and decorated feeders modelled on hummingbird feeders as used in the Americas, to bring the butterflies to the homestay verandas. Advances in 3D printing are making it possible to design such feeders cheaply to suit the preferences of the butterflies, once these particulars have been established.

Promotion and Awareness - Butterflies in the imagination.

Probably for millenia, and certainly for hundreds of years, butterflies have been symbols of beauty, youth, adventure, carefree existence and romance. They are also symbols of elusiveness and, for some, lack of commitment. Whatever the sentiment, butterflies are popular. Evidence for how deeply butterflies are engrained in the human psyche is widespread in literature and in images on clothing and as logos of commercial brands. It should be possible to play on this interest to make Sabahans more aware of icon of their natural heritage. At the moment the *rakyat* (people) are hardly aware of it. The Kinabalu Birdwing is large (females can be small dinner-plate size - 18.5cm wingspan), elusive and still largely unknown. It is endemic to Borneo and its stronghold is Mt Kinabalu. It is well qualified to be a ‘mystery’ icon for Sabah and/or Sabah’s State butterfly. At present there is almost no awareness among the general public in the State that they possess such a natural asset. We have made a start over the last 3 years on promotion of awareness with:

2018 and 2019. ‘Kids Bird and Butterfly Festivals’ for local school children (including the homestay operators’ own children) to promote awareness of the need to build up the birdwing population. Further funding has come from the Sabah State Ministry of Tourism, Culture and Environment, to breed the butterfly and to promote awareness of its natural heritage significance: [Mysterious Birdwing sheds new light on Mt Kinabalu](#)

2019. The Kg. Kiau childrens' traditional dance group choreographed and performed a 'Kinabalu Birdwing Courtship' in butterfly costume complete with large wings, to considerable acclaim in the kampong. [Trailer & Kinabalu Birdwing Butterfly Courtship Dance.](#)

This prompted a second full page special feature in the Daily Express Sabah:
[https://www.dailyexpress.com.my/read/4237/how-society-romanticises-butterflies/.](https://www.dailyexpress.com.my/read/4237/how-society-romanticises-butterflies/)
There is a strong case to be made for promoting *conservation through art.*

ACKNOWLEDGEMENTS

Grateful thanks for support and information from:

Rotary Club of Kota Kinabalu. President: P.M. Koshy. Past District Governor: Datuk Hj. Zainie Abdul Aucasa. Past Presidents: Jack Ong, Dr Ravi Mandalam, Jeyan Marimuttu, Philip Koh, Prof. Datuk Seri Panglima Dr Kamaruzaman Haji Ampon,

and Members Swallowtail & Birdwing Butterfly Trust, UK. Dato' Henry Sackville Barlow OBE, Dr Dick Vane-Wright, Dr Mark Collins (Chair), Martin Partridge, Clive Huggins

Asian Lepidoptera Conservation Symposium Convener: Dr Terry Whitaker

University Malaysia Sabah:

- Institute of Terrestrial Biology and Conservation: Dr Monica Sulaiman
- Department of Sustainable Agriculture, Sandakan: Dr Suzan Benedick, Mazidi Abdul Ghani
University of York, UK: Prof Jane Hill, Dr Sarah Scriven

Sabah Ministry of Tourism, Culture and Environment: Mary Malangking
Sabah Forestry Department, Forest Research Centre: Dr Arthur Chung's staff Razy Japir
Sabah State Museum, Natural History Division: Anati Sawang and staff
Sabah Biodiversity Centre of Sabah Biodiversity Council
Sabah Parks: Fred Tuh Yit Yu (Zoology) and staff Justinah Parentis, Jusimin Duaneh

Guas Nabalu Homestays. Coordinator: Hunter Ginsos. Members: Sugarah Duaneh; Lily Banati; Saiheng Taradas; Kinahim Sampang; Florence Duaneh; Jimmy Ginsos; Jeffry Downy; Suning Taragas; Ginik Lunsin, Rainie Halang

Kg Kiau Bird Watching Team: Sapinus Tuboh, Alexzander Bulangei, Bingker Sapinggi, Lerry Dominic, Jobiay Limundok, Brendon Kimpong, Edwin Mogurin, Bonifatreno Jurunin, James Yasin, Ehing Sakumbang
Sometime Trainer to both teams: Denis Degulacion

Kg Kiau Cultural Dance Troupe

Publicity & Information.

Daily Express, Sabah: James Sarda, Chief Editor. Journalists: Sherell Jeffrey, Lorena Binisol, Leonard Alaza

Blue Sky (documentary and feature article productions, KK): William Chiang
Teaching aids & publishing graphic design: Suzanne Goh, Victor Wah
Satellite mapping advisor: Jetse Stoorvogel (Netherlands)
Fund raising advisor: Amanda Allus

Kinabalu Mountain Lodge (formerly); Nittie Sapinggi; Linda Eting; BJ Lim
Kiau Sanctuary: Eugenie Cham, Mathew Kong Yin
Kokol Haven Resort, Kota Kinabalu: Datin Rubina Majin, Datuk Vincent Pung
Jorica Nature Lodge, Kiau: Michael Chong
Pristine Highlands Sdn Bhd: Vector Tsen

Grateful thanks to Sabah Ministry of Tourism, Culture & Environment, Swallowtail and Birdwing Butterfly Trust, UK and Hyatt Regency Hotel, Kota Kinabalu for funding this project.

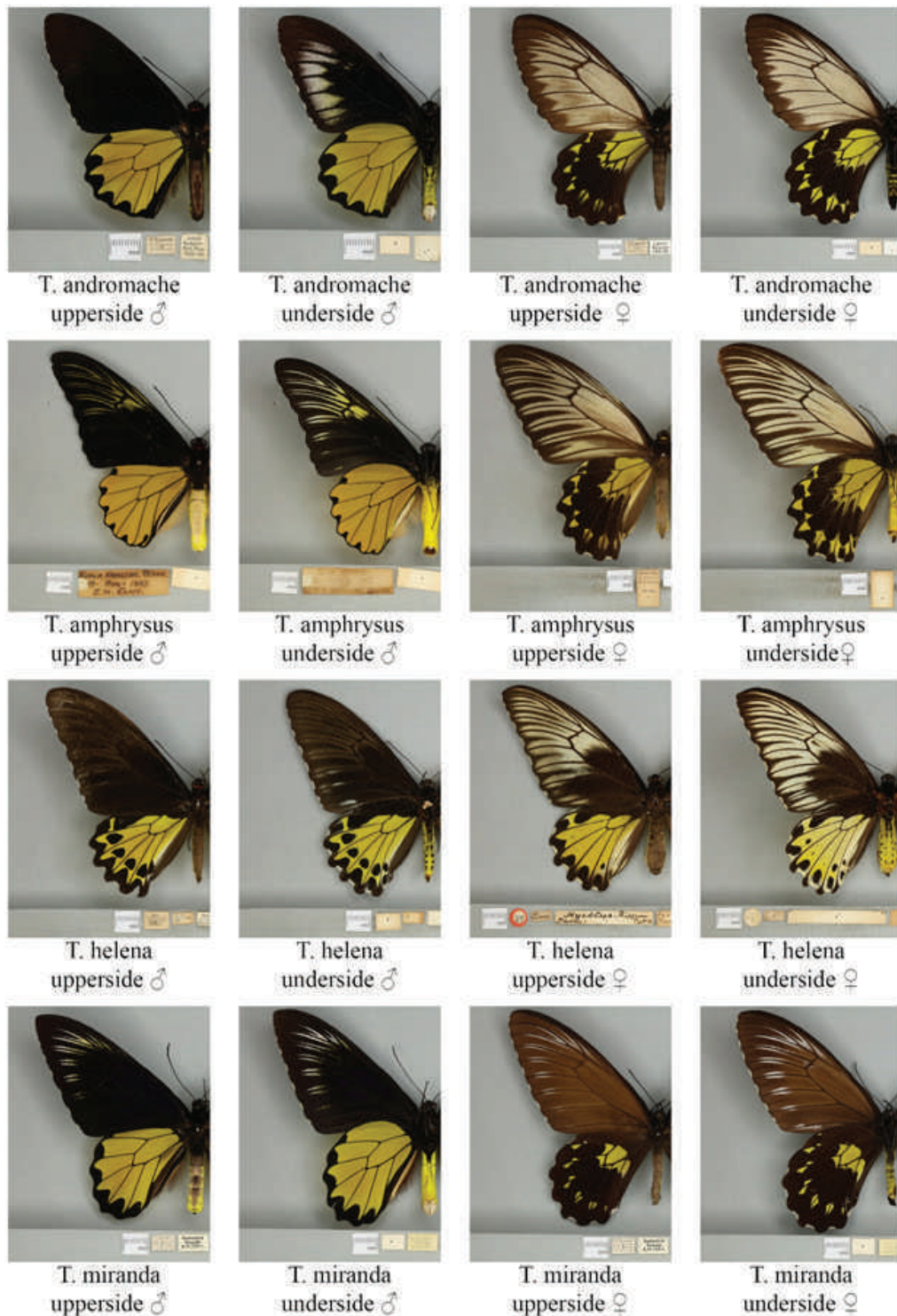
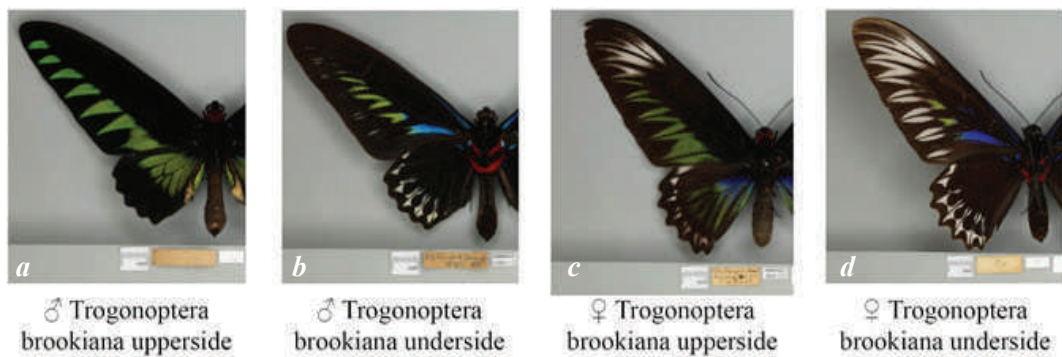


Fig. 7 Identification of adult birdwings of the Genus *Troides* recorded in Sabah. Van der Poorten, G. M. & N.E. (2020) in *The Butterflies of the Malay Peninsula*, have a detailed taxonomic key for separating *andromache* from other *Troides* species found in Malaysia (page 55).
Photo credit: Peter Wing; E. Louise Allan; James Ayre; Charlotte Barclay *et al.* (2019).
Dataset: Birdwing Butterfly Collection. Natural History Museum Data Portal (data.nhm.ac.uk).
<https://doi.org/10.5519/0014723>



Papilio memnon



Troides amphrysus



Troides andromache



Troides miranda



Trogonoptera brookiana



Troides helena

Fig 8 a, b, c & d: Identification of adult *Trogonoptera brookiana*.

Photo credit: Peter Wing; E. Louise Allan; James Ayre; Charlotte Barclay *et al.* (2019).

Dataset: Birdwing Butterfly Collection. Natural History Museum Data Portal (data.nhm.ac.uk).

<https://doi.org/10.5519/0014723>.

Fig. 8 e: Pale morph *agenor* of *Papilio memnon* for comparison with female *Troides andromache*.

Photo credit: Suzanne Goh

Fig 8 f, g, h, i & j: Well grown larvae of *Troides* and *Trogonoptera brookiana* as named.

Photo credit: Matsuka 2001

REFERENCES

- Barlow, H. S. 1969. John Waterstradt 1869—1944. *Journal of the Malaysian Branch of the Royal Asiatic Society* 42:115-129.
- Böhm, M. 2018. *Troides andromache*. In IUCN Red List of Threatened Species 2018: e.T22301A87310563 IUCN, <https://dx.doi.org/10.2305/IUCN.UK.2018-1.RLTS.T22301A87310563.en>.
- Braby, M. F., Trueman, J. W. H., and Eastwood, R.. 2005. When and where did troidine butterflies (Lepidoptera: Papilionidae) evolve? Phylogenetic and biogeographic evidence suggests an origin in remnant Gondwana in the Late Cretaceous. *Invertebrate Systematics* 19:113-143.
- Cahenzli, F. and Erhardt, A. 2012. "Enhancing offspring quality or quantity? Different ways for using nectar amino acids in female butterflies." *Oecologia* 169 (4): 1005-1014.
- Chen, I. C., Shiu, H.-J., Benedick, S., Holloway, J. D., Chey, V. K., Barlow, H. S., Hill, J. K. and Thomas, C. D. 2009. Elevation increases in moth assemblages over 42 years on a tropical mountain. *Proceedings of the National Academy of Sciences* 106:1479.
- Chen, I. C., Hill, J. K., Ohlemüller, R., Roy, D. B. and Thomas, C. D.. 2011. Rapid Range Shifts of Species Associated with High Levels of Climate Warming. *Science* 333:1024.
- Chung, A. Y., S. Bosuang, R. Majapun, and R. Nilus. 2016. Diversity and Geographical ranges of Insects in Crocker range forest reserve, Sabah, Malaysia. *Journal of Tropical Biology & Conservation*. 13:135-155
- Collins, N. M. and Morris M. G.. 1985. Threatened swallowtail butterflies of the world. *The IUCN Red Data Book*. IUCN, Gland and Cambridge
- Condamine, F. L., Toussaint, E. F., Clamens, A.-L., Genson, G., Sperling, F. A. and Kergoat, G. J.. 2015. Deciphering the evolution of birdwing butterflies 150 years after Alfred Russel Wallace. *Scientific Reports* 5:11860.
- Danielson, J. J. and Gesch, D. B.. 2011. *Global multi-resolution terrain elevation data 2010* (GMTED2010). Pp. 26. US Department of the Interior, US Geological Survey.
- Dirnböck, T., Essl, F., and Rabitsch, W. 2011. Disproportional risk for habitat loss of high-altitude endemic species under climate change. *Global Change Biology* 17:990-996.
- Hauser, C., Schulze, C., and Fiedler, K.. 1997. The butterfly species (Insecta: Lepidoptera: Rhopalocera) of Kinabalu Park, Sabah. *Raffles Bulletin of Zoology* 45:281-304.
- La Sorte, F. A. and Jetz, W. 2010. Projected range contractions of montane biodiversity under global warming. *Proceedings of the Royal Society B: Biological Sciences* 277:3401-3410.
- Lenoir, J., Gégout, J. C., Marquet, P. A., de Ruffray, P., and Brisse, H. 2008. A Significant Upward Shift in Plant Species Optimum Elevation During the 20th Century. *Science* 320:1768.
- Marshall, L., Perdijk, F., Dendoncker, N., Kunin, W., Roberts, S., and Biesmeijer, J. C. 2020. Bumblebees moving up: shifts in elevation ranges in the Pyrenees over 115 years. *Proceedings of the Royal Society B: Biological Sciences* 287:20202201.
- Matsuka, H. 2001. トリバネチョウ生態図鑑: [Natural history of birdwing butterflies]. 松香出版.
- Mitchell D. K., Dewhurst, C. F., Tennent, W. J., and Page, W. W. 2016. *Queen Alexandra's Birdwing Butterfly Ornithoptera alexandrae* (Rothschild, 1902): *a review and conservation proposals*. Pp. 88 Southdene Sdn Bhd
- Morita, S. 2000. A new subspecies of *Troides andromache* (Staudinger, 1892) from Mt. Goram and Mt. Batak, central Sarawak, Malaysia (Lepidoptera: Papilionidae). *Futao* 35:4-7.
- Ohya, T. 2001. Checklist of Birdwing Butterfly. Pp. 346-348 in H. Matsuka, Ed. *Natural History of Birdwing Butterflies*. Matsuka Shuppan, Tokyo, Japan.
- Romanowski H 1991 Population ecology of *Pleuroptya ruralis* (Scopoli) (Pyrallidae: Pyraustinae). Pp. 60-71 PhD thesis, University of Leeds, UK.
- Russell, A B 1961 *Malayan Nature Journal 21st Anniversary Special Issue*
- Soh, Malcolm M.C.K., Ng, Carilynne Puan, C.L., and Peh, K S-H. 2021. Implications of climate change for Malaysian tropical montane bird communities discernible over a 14-years interval. *Malaysian Nature Journal 81st Anniversary Special Issue*
- van der Poorten, Michael G & Nancy E. 2020. *The Butterflies of the Malay Peninsula (Corbet & Pendlebury, 5th edition)*; pp.49, Plates 142. Text ©Malaysian Nature Society. Published by Southdene Sdn Bhd.