Butterflies of Semuliki National Park, Uganda

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The Afrotropical region and equatorial belt geography

Semuliki National Park, a lowland rainforest in western Uganda, will become the focus of my attention for the next four years of doctorate study on its butterfly composition and conservation. It is a little-known and isolated pocket of protected tropical rainforest within Uganda's National Park network managed by the Uganda Wildlife Authority (UWA). Considerably more famous for its birdlife, with over 400 species (Chege et al., 2002), than its insect fauna, I realised on a trip there in 2011 that here was the perfect location to undertake Afrotropical butterfly research. It is located within the biogeographic Afrotropical region (Crosskey and White, 1977), a region defined to include Africa south of the Sahara, including Madagascar and Southern Arabia. This region has approximately 4,000 butterfly species; roughly 20% of the world's total, and is second only in species number to the Neotropical region, which has approximately 8,000 species. The butterflies of this biome show remarkable regional species-level endemism with around 98% of Afrotropical species and approximately 76% of the genera not occurring outside the region (Carcasson, 1964).

The park is also confined within the narrow African equatorial belt which extends from the Atlantic at Basse Casamance in Senegal to western Tanzania and western Kenya. This belt of forest is only interrupted by the Dahomey Gap, a broad band of Guinean forest-savannah mosaic that extends to the coasts of Togo, Benin and Ghana. All the lowland rainforests of Africa are restricted within this narrow equatorial belt. These lowland forests are richer in biomass and plant species than any other vegetation type in Africa and subsequently provide one of the richest habitats for butterflies. They contain the greatest diversity of butterfly species, though not necessarily abundance. This diversity gradually reduces with altitude.

Salient characteristics of Semuliki National Park

Semuliki National Park has an area of 219 km^2 and is part of the Central African Congo Basin forest system of the Democratic Republic of Congo (DRC), being separated from the Ituri forest of the DRC only by the Semliki River. It is separated from the rest of East Africa by the Rwenzori Mountain range and with it being located within the Albertine Rift (Fig. 1), the western arm of the Great Rift Valley, it is included within the Eastern Afromontane biodiversity hotspot (Myers et al., 2000).

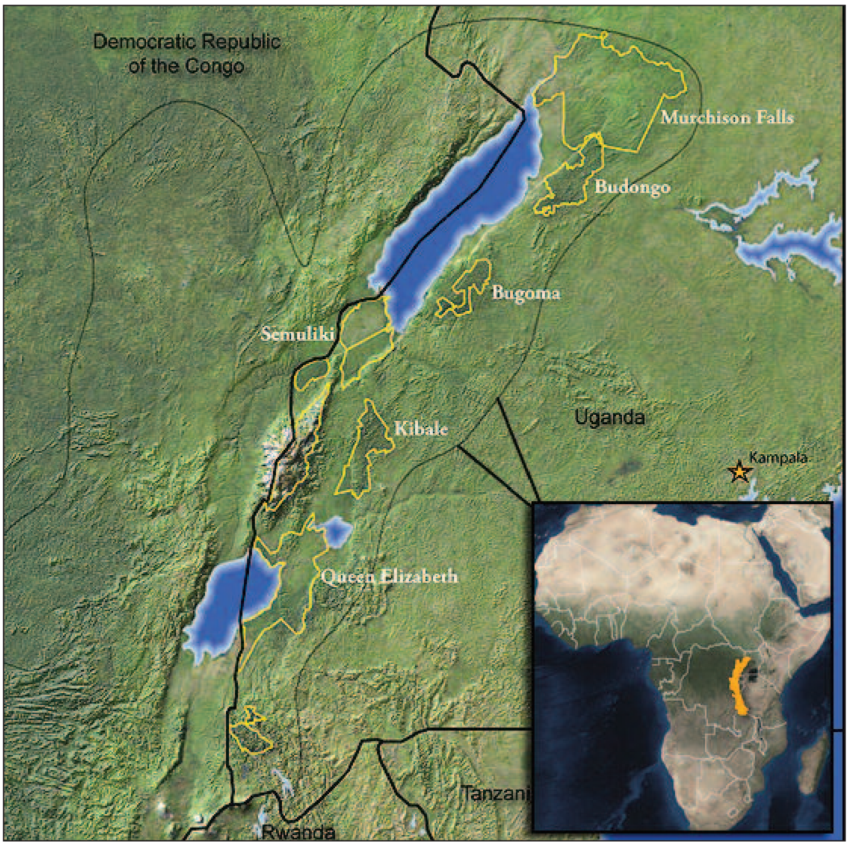


Figure 1. Albertine Rift Valley.
Map courtesy of the PAWAR project / Woods Hole Research Center.

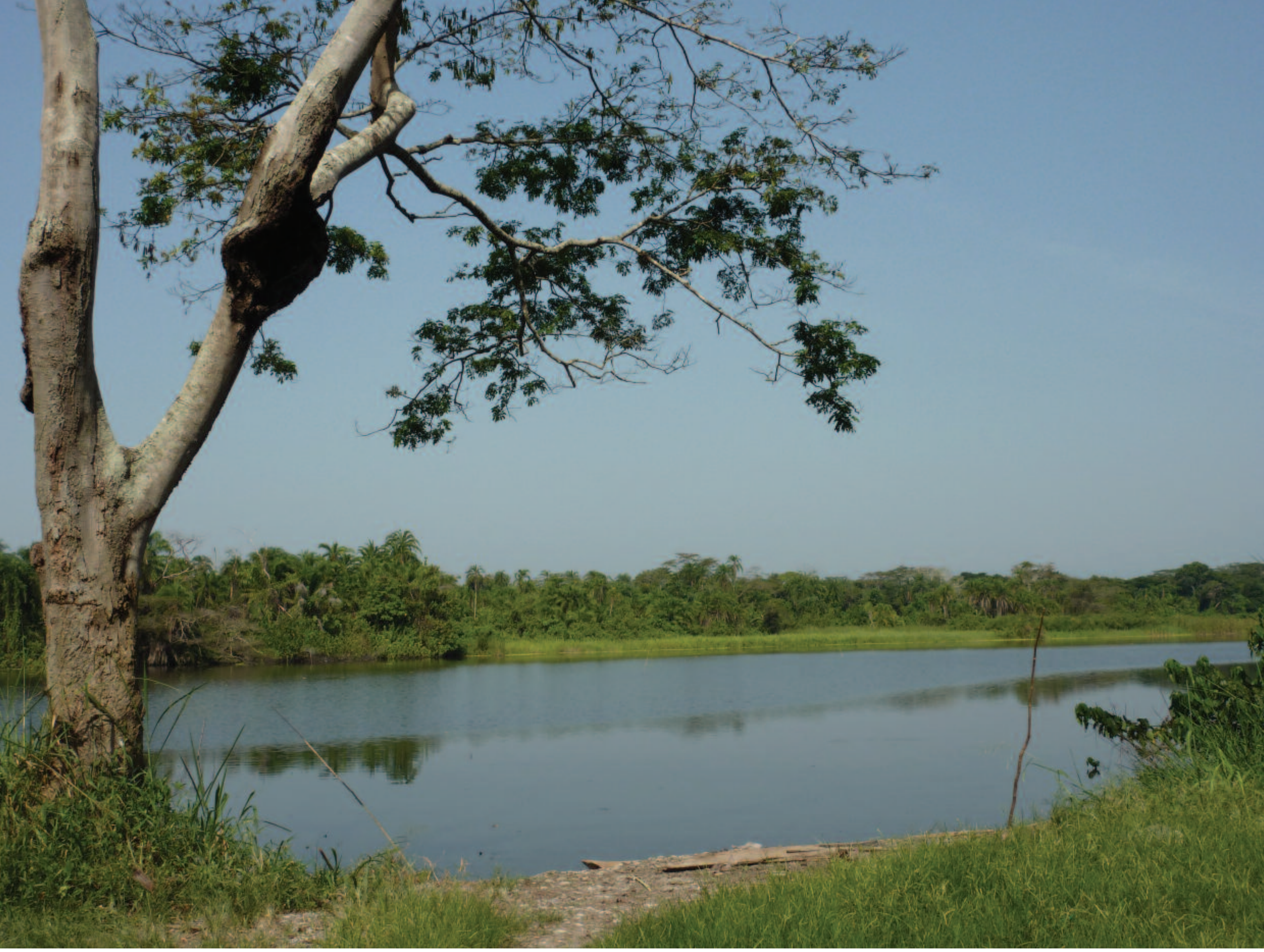


Figure 2. Semliki River.

Semuliki National Park is a closed canopy, moist semi-deciduous forest, with an altitude ranging from 670 m to 760 m and is the only lowland forest in Uganda. There has been no accurate historical meteorological data taken for the Park, but average temperature is around 30^0 C and average rainfall around 1,500 mm/year. With a Central African influence on its fauna and flora the park is comprised predominantly of Uganda ironwood, *Cynometra alexandrii*, with other common trees including the Wild Oil Palm, *Elaeis guineensis*, and a number of different fig tree species, including *Ficus vogeliana*, which provide an excellent food resource for my targeted butterfly communities. There are small areas of bamboo swamp near the Semliki River dominated by *Mitragyna stipulosa* and a small area of grassland covering approximately 75 ha enclosed within the forest. Areas of the park have poor drainage and in the rainy seasons, between March-May and Sept.-Dec., these can experience extensive flooding.

The park is bordered to the south by the main Fort Portal to Bundibugyo road and to the north by the Semliki River (Fig. 2), which runs north for approximately 140 km from the northern end of Lake Edward in the DRC, eventually draining into Lake Albert in Uganda. The river also effectively divides Semuliki National Park from the Ituri forest in the DRC. Long ago an inquisitive colonial administrator was making his way through the forest and came across an as yet unnamed river. An old lady from the local Bakonzo tribe happened to be passing with a wicker basket half full of fish strapped around her head, so he stopped her and asked her in Swahili what the river was called. The old lady, not understanding Swahili, assumed that this was yet another plundering adversary who was actually wanting to know what was in her basket, and not wanting to tell him that she had fish replied in her Lukonzo language 'semuliki, semuliki' translating as 'nothing, nothing'. So the ignominious name was duly noted and wrongly transcribed by the administrator as 'Semliki' and has been retained. This word in both guises is also used for The Semliki Wildlife Reserve which borders Lake Albert and also for the Semuliki National Park (the correct spelling).

Afrotropical research and historical studies on Lepidoptera at Semuliki

Research on African Lepidoptera and their conservation is urgently needed with the present pressures for multiple land use on protected land and the possible effects of climate change. Although it is situated within one of the most biodiversity rich regions of Africa in The Albertine Rift, this region also has a very high human population density. Logistically, working with Lepidoptera in Africa also produces its own personal challenges. The scarcity of resources for field-based research, a small local research community, together with climate difficulties makes any research proposition a stimulating challenge.

Research in Semuliki has been restricted in the last few decades due to instability within the region, a lack of general security and an incredibly bad access road from the nearest town, Fort Portal, 60 km away. The last large scale biological survey was a Uganda Forest Department, now National Forest Authority, census of its fauna and flora in 1996 (Howard and Davenport, 1996). Since 1996 small scale research had amounted to a trickle of studies, mostly by ornithologists. An excellent new road, recently built by the Chinese, now allows access to the Park Headquarters from Fort Portal in less than 45 minutes, with the road continuing on to the border of the DRC.

Unlike other East African countries, such as Kenya (Larsen, 1991) or Tanzania (Kielland, 1990), there is no country guide to Uganda's butterflies. As Semuliki has its faunistic influence from Central Africa the excellent but now rare 'Papillons du Zaire' by Lucien Berger has proved my most useful aid for field identification and is still also a highly accurate source of information. The story behind this publication, commissioned by the then President of Zaire, Mobutu Sese Seko, is a fascinating historical anecdote. Apparently, the majority of the copies of this book that were published ended up being stored at the Mobutu palace deep in the jungle at Gbadolite as gifts for visiting dignitaries. A few copies were distributed to Mr Berger for his personal use and to provide for friends. On Mobutu being expelled from the country in 1997 his palatial residence was ransacked and the remaining books that he had stored were destroyed. Only a few copies remain and the price of a copy reflects the scarcity and quality of the book.

The Lepidoptera data from the 1996 census showed Semuliki to be the most butterfly rich park in Uganda, containing 309 species from a country with a total of approximately 1,300 species (Davenport, 2001). My first period of research was primarily interested in any changes in the butterfly biodiversity of the park since 1996 and the patterns of community biology making up that biodiversity. I focused on the frugivorous species of the family Nymphalidae (the brushfoots), primarily because they are easily caught in traps which have been baited with fermented banana. This allowed quantification of species richness and evenness and over the longer term would allow monitoring of trends in species diversity and community structure with a focus on understanding resource availability and seasonality. Subsequently, the introduction of a long-term collaborative monitoring programme with UWA, investigating the spatial and temporal variation of communities, would allow a greater understanding of the park's ecosystem and therefore enable an influence on future management actions, especially with respect to the butterfly communities present in Semuliki.

Semuliki habitat

There are no roads into the park and so the entrances to the Park's trails have to be accessed by foot. There are two main trails in the park (Red Monkey trail, named after one of the common primates found in the park, and the Kirumya trail named after a nearby river). About 10 km apart, both trails eventually lead to the Semliki River around 14 km west of the park boundary road. There is a marked difference in the forest structure around these trails with Red Monkey containing classic dense closed canopy ironwood forest with an open understorey. The forest around the Kirumya trail has quite extensive sections that had been allocated to the surrounding local communities for cultivation during Idi Amin's era. With further encroachment of the Park continuing during Amin's period and beyond, all settlers were evicted from the Park in the early 1990's before it was granted National Park status in 1993. In this section of the park you can find abandoned fruit orchards and coffee or cocoa plantations and the secondary forest understorey can be fairly impenetrable, except with the use of a machete. Community resource use of the park is now allocated to a period of one day per week, when the women of the surrounding communities can enter the forest for the collection of deadwood. The Batwa, the original inhabitants of the forest, are allowed unrestricted access to the forest, although they are not allowed to live there. Fishermen are allocated permits to catch fish in the Semliki River.

The two accessible trails are ideal transects, allowing for sample replication in the park but at different locations, thus taking into account the park's spatial habitat heterogeneity. I have employed the traditional method of trap type used in the tropics, this being the hanging of cylindrical van Someren fruit-baited traps (Fig. 3) at various height elevations (forest floor to canopy), using fermented bananas as bait. These traps attracted the frugivorous butterflies from the family Nymphalidae, especially the large Afrotropical genera *Bebearia*, *Euphaedra* and *Bicyclus*. There were also rarer catches of *Cymothoe*, *Charaxes* and *Euriphene* species.

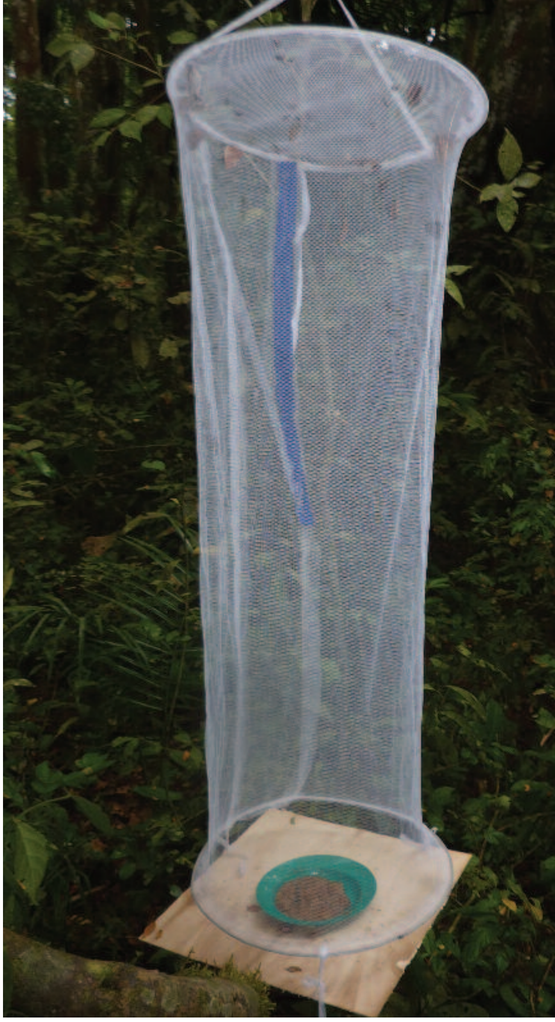


Figure 3. van Someren Trap example.

Capturing, photographing and identifying specimens

The canopy traps were positioned with the assistance of one of the Batwa from the local communities. I hired the local Batwa King, named Joffra (Fig. 4), whose climbing skills were impressive. He climbed seven trees in one day positioning the canopy traps at a distance of between 20-25m above the ground. The heights of the canopy traps were accurately measured using a rangefinder. In the forest I am also assisted by two armed rangers from UWA who accompany me at all times, providing welcome security in the unlikely event of buffalo or elephant meetings. These are not unusual, and during the initial phase of my first period of research I was charged by a buffalo in a small grassland area. Elephant tracks are regularly seen on the trails while chimpanzees are regularly heard.

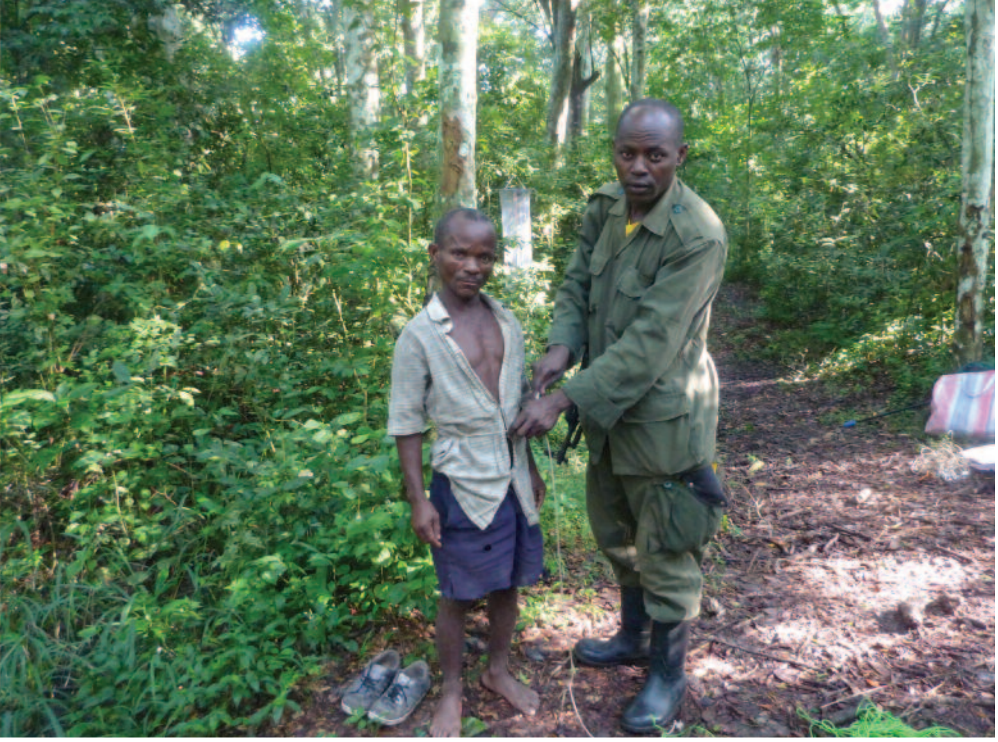


Figure 4. Joffra, Batwa King with Justice.

Figure 5. Handling *Charaxes fulvescens.*

Figure 6. *Charaxes pollux* feeding after handling

Figure 7. *Bicyclus* feeding on banana bait after handling

It is not uncommon during the early dry season period when species abundance is greatest to have over 100 butterflies caught in the traps at one time. All butterflies in the traps which are not readily identified in the field are photographed. For photographing, the butterfly is held gently by the thorax (Fig. 5) which immobilises it and allows time to take the necessary images of both its dorsal and ventral surface. All the Nymphalidae caught in the traps are robust enough to tolerate this handling and appear unaffected by the experience. After handling and photographing a *Charaxes* for example (Fig. 6), I can place it on my arm or hand and it will immediately start probing its proboscis for my perspiration. The smaller *Bicyclus* specimens on release onto banana bait will begin feeding immediately once placed on the bait (Fig. 7). This system cannot be used for the butterflies from the family Pieridae or Lycaenidae found at Semuliki as I have found even the lightest of handling can cause distress. The scales can be easily damaged while handling and so any species from these families caught in a hand net are placed in a small pot and photographed. Pierids and Lycaenids, although found in the forest, are rarely caught in traps. Pierids are, however, commonly seen at mud puddles on forest tracks.

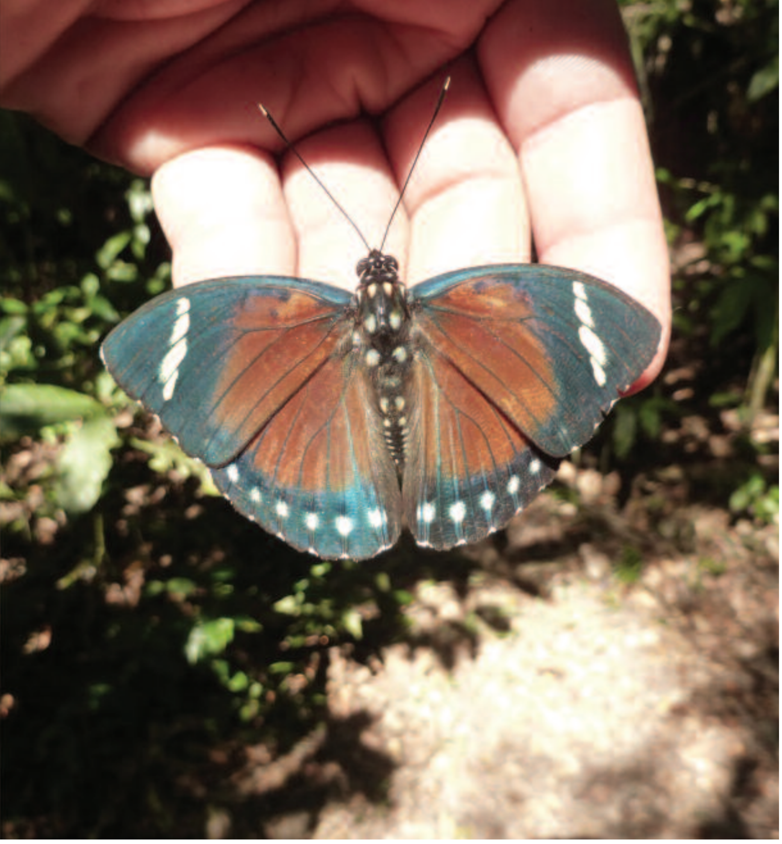
Initial data analysis suggests that there is a peaking of abundance and diversity at the end of the wet season and beginning of the dry season. At the end of the dry season there is a large decrease in both species diversity and abundance with some very common species found at the beginning of the dry season, for example *Bebearia laetitiodes*, disappearing almost completely. This change in temporal abundance and diversity in African equatorial tropical forests is common and can also be found in the Atlantic Forests of Brazil (J. Carreira, pers comm). Trapping data has yielded an estimated 344 species which is close to the original 1996 census of 309 species. However, the more varied sampling methods and extended period of trapping used during my research have identified more than 80 new species records additional to the 1996 census.

Some of the more commonly trapped species

The majority of trap captures are from the Nymphalidae subfamilies, Limenitidinae and Satyrinae. Nymphalidae butterflies are identified as having only four functional legs instead of the usual six, with a reduced pair of forelegs. The higher systematics of the Nymphalidae family is still a matter of some conjecture between various authors, and the subfamily Limenitidinae has been described as an 'unnatural assemblage' by Harvey (1991). A more recent attempt to reclassify the Nymphalidae family by Freitas (1999) has considered six distinct groups based on characteristics of both adult and larval morphology. However, this is again being superseded by ongoing molecular work on the Nymphalidae family by Wahlberg (2003). Details of current work and information can be found on the website of his 'Nymphalidae Systematics Group'.

The colourful African genus *Euphaedra* Hubner 1819 is the second most species-rich in Africa after the genus *Acraea*, currently with more than 200 recognised species and numerous subspecies (Hecq, 1999). It is the largest entirely endemic genus found in Africa although interestingly the larval food plants, *Sapindaceae* and *Anacardiaceae*, are not exclusively Afrotropical (Ackery, 1988). *Euphaedra*, along with the genus *Bebearia*, are characteristically common on forest floors of good condition.

The genus is characterised by a forewing dorsal subapical band and a characteristic ventral basal wing pattern shape and colour (Figs. 8 and 9), with the majority of species having a white, cream or orange subapical band and a diffuse basal pattern of various shades and colours. The dorsal pattern is tremendously variable, but the ventral



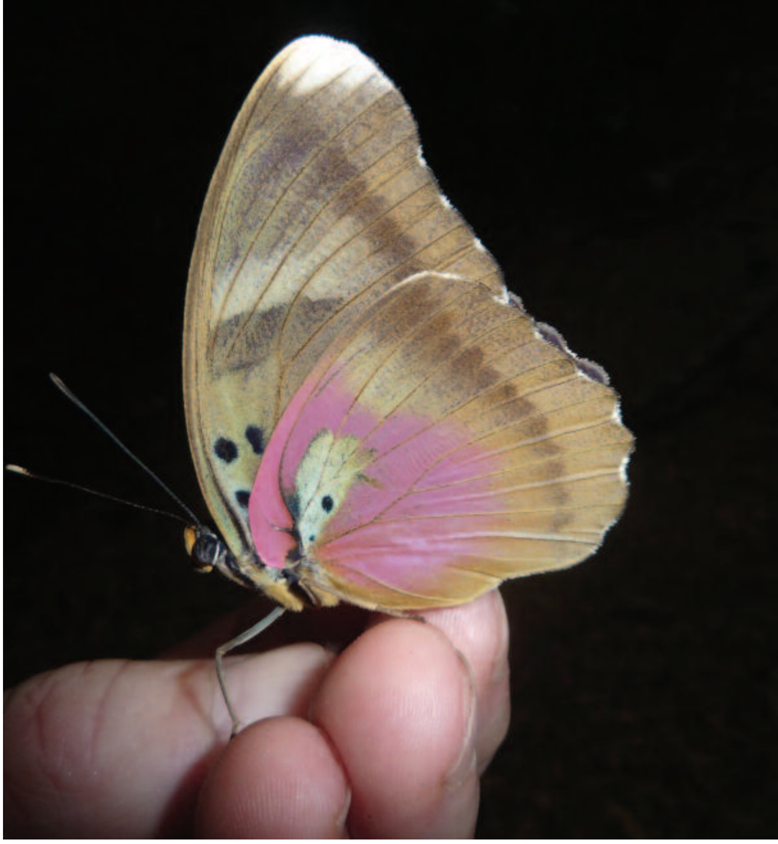


Figure 8 (left). *Euphaedra alacris*; Figure 9 (right). *Euphaedra hollandi*.

Figure 10. *Aletis helcita*.

Figure 11 (left). *Bebearia barce*; Figure 12 (right). *Catuna crithea*.

pattern of the hind wing is generally species specific, with the common features being a selection of differing black spots and stripes, sometimes with a splash of pink.

The genus was revised by Hecq (1976) and divided into eight well-defined sub-genera based on morphological and anatomical characteristics. Hecq considers that there are no intermediate species. They are exclusively frugivorous, being particularly attracted to rotting forest floor fruits (in Semuliki this is provided by the numerous figs that drop to the forest floor) and are therefore easily drawn to the forest traps. There can be particular difficulty in distinguishing between species of the red *eleus* group which all mimic the unpalatable day flying moth *Aletis helcita* (Fig. 10). Hecq (1997) considers that there are 12 species in the *eleus* group which are distinguished by very slight differences in the white subapical band on the forewing. There are possibly three species of the red *eleus* group present in Semuliki; *Euphaedra eleus, Euphaedra alacris* and *Euphaedra rattrayi*. Compared to the 1996 data my current research has added eight or possibly nine new recorded species to this location, with a new total of 14 species of *Euphaedra*.

Another common genus found in the traps from the subfamily Limenitidinae is *Bebearia* Hemming (1960), an Afrotropical genus which comprises 95 species. Again the taxonomy of this group is complex and was last updated and summarised by Hecq (2000). This genus is taxonomically close to the genera *Euphaedra* and *Euriphene* and the traditional method of separating *Euphaedra* and *Bebearia* is by the colour of the labial palps; grey in *Bebearia* and orange in *Euphaedra*. Other major defining characteristics separating the two genera are that *Bebearia* show strong sexual dimorphism and the subapical forewing band shape is generally thinner (Fig. 11). While in *Euphaedra*, sexual dimorphism is not as marked and is only evident through secondary charactersitics such as wing margins.

One of the commoner species of *Bebearia* found in the traps, together with *Bebearia laetitiodes* and *Bebearia brunhilda*, is *Bebearia cocalia*. It has been described as part of a complex – the *mardania* complex which comprises five species (Holmes, 2006), with each species being separable on one aspect of the angle of the apical band on the forewing, wing venation or female genitalia. Females of many *Bebearia* and *Euriphene* species mimic *Catuna crithea* (Fig. 12), also a species from the Nymphalidae subfamily Limenitidinae. *Catuna crithea* does not actually appear to be distasteful to predators, but the mottled brown and white wing pattern may provide the advantage of camouflage in the shadowy mottled light of closed canopy forest floors (Larsen, 2005). Four further *Bebearia* species have been recorded since the 1996 census.

Another genus that contributes greatly to the trapping figures is *Bicyclus* Kirby (1871), the bush browns, a large endemic African genus, from the subfamily Satyrinae (Fig.13). This genus, which is again currently under revision, was monographed 40 years ago by Condamin (1973). Unfortunately all the images in the book are in black and white, but the distribution of each species is described and it is currently the only detailed resource of its kind. There are 21 species that have been described from Semuliki, however the taxonomy for this genus is still far from complete and one species found in Semuliki, *Bicyclus mesogena*, is two or possibly even three species (O. Brattstrom, pers comm). Females of certain species of *Bicyclus* can be impossible to distinguish and are really only roughly identified by their size and the presence of males in the same vicinity. Some *Bicyclus* species, however, can be identified by their modified wing scales, called hair pencils, or androconial spots which excrete pheromones to attract females or repel other males. This genus is characterised by undergoing marked seasonal polyphenism of the size of the eyespot markings on the wings. The dorsal wing eyespots appear to be involved in mate signalling, while the ventral characters may play a role in predator avoidance (Oliver, 2009). One species, *Bicyclus anyana* (not found at Semuliki), is extensively studied as a model for the study of wing pattern development and genetics (Beldade and Brakefield, 2002).

The Afrotropical genus *Cymothoe* Hubner (1819), the gliders, from the subfamily Limenitidinae also contributes a number of different species, but with very low numbers. Usually *Cymothoe* species are caught in traps as singles and very rarely will there be more than one individual for each *Cymothoe* species in a trap. We have image data for 12 species so far, either through trapping or through

Figure 13. *Bicyclus alboplagus.*

Figure 14 (left). *Cymothoe cyclades* female and Figure 15 (right) *Cymothoe cyclades* male.

conventional collecting with a net. This genera exhibits strong sexual dimorphism (Figs. 14 and 15) and all *Cymothoe*, with the exception of *Cymothoe caenis*, are restricted to primary forests. The females of *Cymothoe caenis* which are found at Semuliki are infraspecifically variable and up to 20 forms have been described (Ackery and Vane-Wright, 1995; Berger, 1981). West of the Niger Delta in Nigeria, *Cymothoe caenis* females are monomorphic and this has led to the proposal of a recent change in its taxonomy by Van Velzen et al. (2009) to describe this species of *Cymothoe caenis* as being a distinct species, *Cymothoe druryi*.

Finally, the Nymphalidae subfamily *Charaxinae* is predominantly represented by the genus *Charaxes* Ochsenheimer (1816), which comprises over 183 species in Africa and approximately 250 subspecies (Henning, 1989). These are well represented in the traps, but usually as single specimens. *Charaxes fulvescens* is the most common species trapped. Few *Charaxes* species are found in open or savannah country, with the majority of species being found in or near large tracts of forest. This preference for unbroken strands of evergreen forest allows some species to be considered as excellent bioindicators of forest health. Adult *Charaxes* feed on decomposing animal or plant matter and also animal scats. They are extremely robust butterflies and very fast flyers. They are frequently caught in both understorey and canopy traps. The census of 1996 listed 27 species and the current research has added a further five species to this number: *catachrous*, *viola*, *hadrianus*, *epijasius* and *anticlea*. Semuliki National Park can therefore claim to contain over 15% of all *Charaxes* species found in Africa.

The future

The lowland forests of Africa have suffered considerably through habitat destruction, degradation and human land use pressures. This will undoubtedly have an effect on butterfly species diversity found within these forests. Semuliki National Park is effectively managed and management is proactive in terms of conservation measures. The future for this relatively small tract of forest appears to be positive.

Further research will consider vertical stratification and effect on composition within the park, with trapping also occurring deeper into the forest away from the trail network. A long-term monitoring programme investigating seasonal trends in spatial and temporal abundance and diversity is a collaborative project that is continuing with the UWA. Another collaborative effort with Makerere University in Kampala is permitting the digitisation of the 20,000-30,000 butterfly specimens presently being housed in the University's museum. Specimens will be photographed and their data collated and uploaded for dissemination onto the internet. My own research work in Semuliki is also aiming to encourage local Ugandan undergraduate students to participate in small scale entomological research projects, by providing field equipment, appropriate field literature and technical expertise.

Acknowledgements

I would like to express considerable thanks to the Uganda Wildlife Authority for their backing and ongoing logistical support while I am based at Semuliki. I would also like to recognize the invaluable assistance of my two field assistants Justice Olibokiriho and Martha Ndyabahika.

Semuliki Team: L to R. Joffra, Justice, Martha and Scott Forbes

Together with Joffra, aka 'The King', their commitment and work ethic in the project are exemplary, even under the testing conditions in which we work.

Extreme thanks are also due to Dr Oskar Brattstrom from the University of Cambridge for his invaluable assistance in opening up the intricacies and delights which is *Bicyclus* identification.

Also, thanks are due to colleagues at the National Scottish Museum of Edinburgh entomology collections department, Dr Keith Bland and Mr Richard Lyszkowski for our too infrequent conversations around the coffee table. I am also indebted to my supervisor, Dr Mike Gillman at The Open University, for his invaluable insight and advice in tropical Lepidoptera research.

I am grateful for the opportunity to have visited Mr Steve Collins at the African Butterfly Research Institute in Nairobi, whose advice and access to his specimens provided some clarity for the more difficult to identify *Bebearia* and *Euphaedra* species. Thanks are also due to Jean-Pierre Lequeux in Kampala for assistance in any *Charaxes* or *Papilio* identification queries. I am also indebted to Mr Robert Ducarme, from Beni in the DRC, who provided me data on butterflies of the Ituri Forest.

I would also like to extend my sincere appreciation to the Ruffords Small Grant Foundation and the Royal Entomological Society for providing the financial assistance that is opening up the entomological secrets at Semuliki. Their funding is also contributing to the digitisation work at Makerere University.

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