UNIVERSITÀ DEGLI STUDI DEL MOLISE

Department of Agricultural, Environmental and Food Sciences

PhD Course in:

AGRICULTURE TECHNOLOGY AND BIOTECHNOLOGY

(Curriculum: Sustainable Plant Production and Protection)

(Cycle XXXII)

Related disciplinary scientific sector: AGR/11 (Entomologia generale e applicate)

PhD Thesis

Ecological and taxonomic studies on Lepidoptera from Ethiopia: Assessing Lepidopteran biodiversity among various land use types in Choke Mountain, Ethiopia. Revision of the genus *Orbamia* (family Geometridae) in Africa

Coordinator of the PhD Course: Prof. Giuseppe Maiorano

Supervisor: Prof. Andrea Sciarretta

Doctoral Student: Tesfu Fekensa Tujuba
158067

Academic Year 2018/2019

TABLE OF CONTENTS

List of Acronyms

BOLD	THE BARCODE OF LIFE DATA SYSTEM
BIN	BARCODE INDEX NUMBER
CBD	CONVENTION ON BIOLOGICAL DIVERSITY
CCDB	CANADIAN CENTRE FOR DNA BARCODING
COI	CYTOCHROME OXYDASE SUBUNIT I
DNA	DEOXYRIBONUCLEIC ACID
DMU	DEBRE MARKOS UNIVERSITY
DS	DATASET
EBI	ETHIOPIAN BIODIVERSITY INSTITUTE
MA	MILLENNIUM ECOSYSTEM ASSESSMENT
NHMUK	NATURAL HISTORY MUSEUM, LONDON, UK
NN	NEAREST NEIGHBOUR
SP. N	SPECIES NEW
UNIMOL	UNIVERSITY OF MOLISE, CAMPOBASSO ITALY
ZSM	ZOOLOGISCHE STAATSSAMMLUNG MÜNCHEN

ABSTRACT

Lepidoptera, which represent among most species-rich taxa, are extremely important ecosystem components. Their taxonomic and ecological studies however, are still limited in Afrotropics, and in Ethiopia in particular. Moreover, most recent studies have indicated that frequent anthropogenic disturbances in tropical countries are primary drivers of reduction in community diversity and local extinction of many insect groups, including Lepidoptera.

The aim of my thesis was to investigate the diversity of Ethiopian Lepidoptera from different points of view, going from a more general revision of the current knowledge of Lepidoptera order in the country to a detailed taxonomic study of a single genus at the continental level. Thus, after a general introduction (Chapter 1), the dissertation has been divided into three sections:

In the first part (Chapter 2), I presented an updated comprehensive overview of Lepidoptera record in Ethiopia, composed of 2,438 taxa in 48 families, of which 662 are endemic. Records were compiled from various literature sources and website databases. Though still being far from completeness, this review provides important baseline data for understanding zoogeographic patterns and thus for undertaking effective conservation action.

In the second part (Chapter 3), I assessed the impact of anthropogenic disturbances on lepidopteran assemblages across five different land use types, in Choke Mountain, Ethiopia. Four light traps were used to survey Lepidoptera species for 12 months in forest fragments, crop fields, bush land, mosaic environment and undisturbed natural forest. Fourteen families were considered in the analysis and specimens identified at species level. Overall, 4,461 moth individuals belonging to 344 species were sampled. The highest species diversity was captured from the natural forest, followed by forest fragment, bush land, crop fields and mosaic environment. The monthly trend of biodiversity indices showed strong variations among the various land categories during the year. Floristic and faunistic abundance were clearly related, both considering the observed and estimated Lepidoptera species richness. Results in Choke Mountains showed that a significant proportion of Lepidoptera diversity is hosted also in habitat where human modifications are more relevant, pointing out the importance of forest fragments, but also more degraded habitats, as suitable refugee for many species.

In the third part (Chapter 4), a taxomonic study of the genus *Orbamia* Herbulot, 1966 (family Geometridae) was carried out, examining the material collected in the last hundred years from all over Africa, stored at the Bavarian State Collection of Zoology (Munich, Germany). The integrative taxonomical analysis was based on both morphological and genetic COI data. A model of accelerated taxonomy was applied, where genetic data, images and metadata are directly stored into the Barcode of Life Data (BOLD) Systems. As a result of the revision, two new genera were described: *Rabomia* Hausmann & Tujuba (type species: *Ectropis? subaurata* (Warren, 1899), comb. n.) and *Morabia* Hausmann & Tujuba (type species: *Morabia politzari* Hausmann & Tujuba, sp. n.). Ten new species and two new subspecies were also described.

RIASSUNTO

I Lepidotteri, tra i gruppi animali più ricchi di specie, sono componenti molto importanti dell'ecosistema. Nelle regioni Afrotropicali, tra cui l'Etiopia, il loro studio tassonomico ed ecologico risulta carente. Studi recenti hanno indicato che il forte impatto antropico che si sta verificando nei paesi tropicali è il principale responsabile della riduzione della diversità e dell'estinzione locale di molte specie di insetti, inclusi i Lepidotteri.

Scopo della mia tesi è stato quello di indagare la diversità dei Lepidotteri in Etiopia sotto diversi punti di vista, passando da una revisione generale delle attuali conoscenze nel paese africano, ad uno studio tassonomico dettagliato di un singolo genere a livello continentale. Dopo un'introduzione generale (Capitolo 1), la tesi è stata divisa in tre sezioni:

Nella prima parte (Capitolo 2) ho presentato una revisione aggiornata dei Lepidotteri noti per l'Etiopia, la cui fauna risulta al momento composta da 2.438 taxa (a livello di specie o sottospecie), di cui 662 endemici, appartenenti a 48 famiglie. La lista è stata ottenuta a partire da varie fonti bibliografiche, oltre che da database specialistici disponibili online. Pur essendo ancora incompleta, questa rassegna fornisce importanti dati di base per la comprensione dei modelli zoogeografici necessari per intraprendere un'efficace azione di conservazione.

Nella seconda parte (Capitolo 3) ho valutato l'impatto delle azioni antropiche sulle comunità di Lepidotteri, utilizzando nel corso di 12 mesi quattro trappole luminose in cinque ambienti con diversi tipi di utilizzo del suolo, nelle Choke Mountains (Etiopia): frammenti di foresta, terreni coltivati, cespuglieto, ambiente a mosaico e foresta naturale. Quattordici famiglie sono state prese in considerazione per l'analisi della biodiversità e i relativi esemplari identificati a livello di specie. In totale sono stati campionati 4.461 individui appartenenti a 344 specie. La maggiore diversità è stata osservata nella foresta naturale, seguita da frammenti di foresta e quindi dalle altre tipologie. L'andamento mensile degli indici di biodiversità ha mostrato forti variazioni tra le varie tipologie di ambienti nel corso dell'anno. La ricchezza di specie floristica e faunistica sono risultate fortemente correlate, sia quella osservata che quella stimata delle specie di Lepidotteri. I risultati nelle Choke Mountains hanno mostrato che una parte significativa della biodiversità dei Lepidotteri è ospitata in habitat dove l'impatto antropico è più rilevante, sottolineando l'importanza rivestita da tutti gli habitat indagati, e in particolare dai frammenti di foresta, come rifugio per molte specie.

Nella terza parte (Capitolo 4) è stato effettuato uno studio tassonomico del genere *Orbamia* Herbulot, 1966 (famiglia Geometridae), in cui si è esaminato il materiale raccolto in tutta l'Africa, conservato presso la Bavarian State Collection of Zoology (Monaco di Baviera, Germania). L'analisi tassonomica si è basata sull'analisi morfologica e del gene mitocondriale COI. È stato inoltre applicato un modello di tassonomia accelerata, in cui i dati genetici, le immagini e i metadati sono stati memorizzati nei sistemi di codici a barre del sistema BOLD. Come risultato della revisione, sono stati descritti due nuovi generi: *Rabomia* (specie tipo: *Ectropis? subaurata* (Warren, 1899) comb. n.) e *Morabia* (specie tipo: *Morabia politzari* Hausmann & Tujuba, sp. n.), oltre a dieci nuove specie e due nuove sottospecie.

1. GENERAL INTRODUCTION

1.1. BIODIVERSITY

Biodiversity is the variety and variability among living organisms at all levels of biological organization and the ecological complexes in which they occur (Dirzo and Raven 2003). The ecological complexes are the intricate and interdependent relationships that often occur among coexisting organisms, including the ecosystem processes that are more than just the collection of its parts. Correspondingly, the Convention on Biological Diversity (CBD) also defined it as ‘‘the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems (UNEP 1992). Biodiversity may be considered at three different levels of biological organisation: genetic diversity, species diversity and ecosystem diversity (Hooper et al. 2005). A holistic evaluation of this biodiversity over a landscape or region would ideally focus on all of these levels, but because of resource constraints and on the other hand increased scientific interest in recent decades (Kremen 2005; Zavaleta et al. 2010), biodiversity assessments often focus on species diversity. Likewise, in this thesis, we also rely on Lepidoptera diversity at the species level.

The complexity of biological diversity is one of the most remarkable features of biota, estimated to range five to fifteen million different species (Dirzo and Raven 2003) based on different estimation methods (Stein et al. 2008; May 2010). This range of estimates itself indicates the lack of knowledge of biodiversity. Most recent study (Mora et al. 2011) suggested 8.7 (±1.3 SE) million seems a reasonable estimate for multi-cellular organisms, from which merely 1.75 million living species are taxonomically described (Scheffers et al. 2012).

In combination with physical and chemical processes, biodiversity largely influences the conditions on Earth including ecosystem processes that provide many services to humanity, including production of food and fibre, purification of water and air, formation of soil, and carbon sequestration. Human beings strongly depend on biodiversity and the well functioning of ecosystems for their existence (Stein et al. 2008). As a result, studies on both the biotic and the abiotic components of ecosystems are required to investigate the existing condition of a given ecosystem. Most importantly, quantitative measures of species and individual abundance provide standardized comparative values for evaluation of various habitats, communities, and ecosystem.

1.1.1 INSECT DIVERSITY

Insects comprise the lion's share of the known global biodiversity (more than 58%), with more than one million described species and millions more either awaiting description or simply undiscovered (Scheffers et al. 2012; Foottit and Adler 2017). Likewise, Hebert et al. (2004) stated that only about 10% of all insects have scientific names, with many taxonomic revisions still required, and many species, even common ones, with the determination of their DNA, revealed as multispecies' complexes.

On the contrary, large number of insect species, including those not known to science, continue to become extinct or extirpated from local habitats worldwide (Smith et al. 1993). About 83% of the Earth's land surface has been influenced by human beings (Sanderson et al. 2002), including the conversion from natural habitats into agricultural land and urban systems, the destruction and fragmentation of habitats, environmental pollution and global warming. The most dramatic and irreversible human impact is the extinction of species (Chapin 2003; Dirzo and Raven 2003). Describing all unknown species before they become extinct is the taxonomic challenge. Still, there are likely to be many extinctions, even of species that have never and will never be described (Hebert et al. 2004).

Interestingly, the decline in insect populations cannot be generalized, as it is not observed in all orders and species of insects. The adaptability to habitat partitioning and global warming along with resistance to foreign invasion varies across a broad spectrum. It is important to understand that some insect species adapt easily to rapid changes in the environmental conditions, while others struggle to survive (Reckhaus 2017).

Overall, insects are enormously successful organisms, both in terms of numbers of species and abundance. They inhabit all habitat types and play major roles in the function and stability of terrestrial and aquatic ecosystems. Moreover, they are closely associated with our lives and affect the welfare of humanity in diverse ways. For instance, ecologically, they create the biological foundation for all terrestrial ecosystems, cycle nutrients, pollinate plants, disperse seeds, maintain soil structure and fertility, control populations of other organisms, and provide a major food source for other animals and plants (Sánchez-Bayo and Wyckhuys 2019). In the same manner, Reckhaus (2017) stated that insects maintain the balance in the cycle of feeding, digestion, and decay. They decompose substances that are harmful to other organisms and they force the flora and fauna to respond to the complex behaviour of insects with increasingly better co-evolutionary strategies that play a key element in biodiversity.

Insects are important elements of the food chains, or rather of food webs, since the trophic relationships between the organisms are not linear; insects have a significant influence on the abundance and species diversity of other organisms. They are the main source of food for many animal species and at the same time, predators of other insects and microorganisms from lower trophic levels (Golubkina et al. 2014).

Arthropods are of special concern because they not only represent a large proportion of species diversity (Duelli and Obrist 2003) but also provide valuable ecosystem services, such as pollination and biological pest control, bio-degraders in the form of dung beetles, termites, and flies (Power, 2010). Additionally, they are essential food sources for species at higher trophic levels, such as birds (Wilson et al. 1999) and bats (Wickramasinghe et al. 2004). In contrast, very few insects have negative effects as vectors of disease agents and as agricultural pests.

At the meantime, flower pollination is an essential aspect of reproduction for a number of plant species, and it often relies on animal pollinators (Potts et al. 2010). Frequently, there is a mutualistic relationship between a plant and its pollinators, with plants providing pollinators with resources, such as food in the form of nectar and/or pollen, and pollinators transporting pollen grains from stamens to stigmas (Pettersson 1991). Approximately 87% of the angiosperm plant species (Ollerton et al. 2011) are dependent on animal pollination, with insects providing a major part of this service (Kearns et al. 1998). Lepidoptera are among the valuable pollinators in ecosystems because they show diurnal, crepuscular, and nocturnal habits, and a number of species visit flowers throughout an entire day; they also transport pollen across a range of distances from short to long; and they are a species-rich group of potential pollinators (Travers et al. 2011).

Moreover, because of their diversity, their significant ecological role, and influence on agriculture, human health and natural resources, they are viewed as good indicators of ecosystem biodiversity and health (Samways 2007).

Because of all the above-mentioned paramount ecological and economic roles, insects are familiar to the general public, even though, their conservation is challenging. Thus, we urgently need to explore and describe insect diversity and to better understand the biology and ecology of insects if ecosystems are to be managed sustainably and if the effect of global environment change is to be mitigated.

1.1.2 CURRENT STATUS AND TRENDS OF BIODIVERSITY

During the last centuries and more dramatically in the last four decades, natural habitats were destroyed at rates much higher than ever observed in human history (Pellens and Grandcolas 2016). The United Nations Environment Programme report also indicated that the planet's biodiversity has declined, and population sizes and ranges of the majority of species across many taxonomic groups are currently declining (UNEP 2006). The report has highlighted the alarming decline of biodiversity on earth. Firstly, the total biodiversity on the planet is declining due to increased extinction rates. Secondly, across a range of taxonomic groups, the population sizes, densities or distribution areas of the majority of species are declining and within species, the genetic diversity has declined. Thirdly, the distribution of species on earth is becoming more homogeneous. The millennium ecosystem assessment (MA), as the main cause, mentioned a dramatic growth in the human demand for food, water, timber, fiber and fuel. This is expressed in, among others, agricultural intensification, increased deforestation and increased use of fossil energy sources, leading to habitat fragmentation and destruction, pollution, dehydration, extremely high levels of nitrogen inputs and climate change (UNEP 2006).

Human-driven land-use changes increasingly threaten biodiversity, particularly in tropical forests where both species diversity and human pressures on natural environments are high (Dirzo and Raven 2003; Sánchez-Bayo and Wyckhuys 2019). The rapid conversion of tropical forests for agriculture, timber production and other uses has generated vast, human-dominated landscapes with potentially dire consequences for tropical biodiversity (Sala 2000; Dirzo and Raven 2003). In general, ecosystems that were established over the course of centuries are being modified or even destroyed by human use, with the result that the species inhabiting there survive with reduced populations or die out completely (Chapin 2003; Samways 2007; Sánchez-Bayo and Wyckhuys 2019).

According to Wheeler and Miller (2017), at the current rate of extinction, an estimated 70% or more species will be lost within 300 years. Similarly, Pimm et al. (2006) estimated that from the 16th century until the end of 20th century, the mean annual species extinction rate was about 26 per million, while this number is estimated to reach 1000 per million in the 21st century, and if current forest loss rates continue, it could even reach 1500 per million by the end of the 21st century.

Convention on biological diversity (CBD 2011) also reported that in recent decades, biological diversity has decreased significantly. Several thousand animals and plant species disappear every year. From 1970 to 2006, the overall vertebrate population dropped by one-third, from 1980 until today, bird populations decreased by 50%, more than 40% of all birds and all amphibians are endangered, one quarter of all plants are threatened with extinction and worldwide, almost one-third of the species recorded by the international Union for Conservation of Nature are endangered today (Reckhaus 2017). Furthermore, the same author indicated that the population of arthropods and invertebrates has declined by 45% in the last 35 years.

Therefore, recent scenarios integrating main extinction drivers suggest that rates of extinction are likely to rise by at least a further order of magnitude over the next few centuries (Ceballos et al. 2005; Barnosky et al. 2012). Thus, this critical situation is now recognized as the "sixth mass extinction", i.e. the sixth period in the history of life in which more than three-quarters of the living species is lost in a short geological interval (Barnosky et al. 2011). Compared to the first "big five", this extinction period has the peculiarity of being caused mainly by the way of living of one single species: man. Counteracting this trend is perhaps the biggest ethic, political and scientific challenge of our time. As the time for action is short, funds for biodiversity conservation are far from below the real needs (McCarthy et al. 2012), uncertainties are enormous (Forest et al. 2015), and the solution of conflicts with main-trend ways of living and main patterns of distribution and consumption (Lenzen et al. 2012) often takes much longer than habitat destruction.

1.1.3 BIODIVERSITY OF ETHIOPIA

Ethiopia, one of the top twenty mega diverse country in the world (EBI 2014; Tesfu et al. 2018), has a diverse topography that ranges from 126 m below sea level at Danakil Depression to 4620 m above sea level at Ras Dashen (Tesfu et al. 2018) and is also notable for containing 50% of the Afrotropical region's land above 2000 m asl than any other country in Africa (Yalden 1983). It is the largest landlocked and the second populous country in the continent with a total area of 1.12 million km^2 and 112.9 Million population (Jacobs and Schloeder 2001; http://worldpopulationreview.com/countries/ethiopia-population/), situated in the Horn of Africa, neighbouring with (the approximate length of the shared borders indicated in brackets): Eritrea (910 km), Djibouti (342 km), Somalia(1640 km), Kenya (867 km), Sudan (744 km) and South Sudan (1,299 km) (Friis et al., 2010 ; CIA World Fact book, 2019) (**Fig. 1**)

Figure 1. Physical map of Ethiopia (Source: https://en.wikipedia.org/wiki/Geography_of_Ethiopia).

The geographical location, diverse ecosystems and various climatic conditions have resulted in the diversification of its flora and fauna (Yalden 1983). Moreover, the country is one of the top 25 endemic rich countries of the world (Groombridge 1992). It hosts two of the biodiversity hotspots of the world, namely: the Eastern Afromontane and the Horn of Africa hotspots. It comprises highland massifs surrounded by arid lowlands, which contain various wildlife taxa and habitats ranging from alpine moorlands to lowland savannas and arid lands, and extensive wetlands (Yalden 1983). The two largest and highest massifs in the Ethiopia highlands are the Semien Mountains in the north and the Bale mountains in the southeast. The rainfall patterns of the country are generally described as unimodal, bimodal or scanty and erratic. The western and southwestern part of the country gets the highest annual rainfall (unimodal); whereas the northeastern, eastern and southeastern part gets low and erratic rainfall (bimodal or erratic and scanty) (Friis et al. 2010).

The described number of species of Ethiopian vertebrate diversity and the endemics (numbers in bracket) are: mammals 320 (36); birds 926 (24); reptiles 201 (16); amphibians 73 (30); fishes 200 (40) (EBI 2015). The country possesses an estimated number of 6000 species of higher plants, out of which about 10% are endemic to the country (EBI 2014). There is a huge knowledge gap on other components of the fauna owing to the absence of systematic surveys, especially for the insects where high diversity and endemism are expected from the array of diverse ecosystems in the country (IBC 2009). There have been expeditions to the country, especially during the first half of the twentieth century, but there are very few published and accessible literatures related to arthropods. Information on the insect fauna of Ethiopia has never reviewed, i.e. no checklist for the insects of Ethiopia is available except for order Odonata (Dijkstra and Viola 2013) and Lepidoptera (see Chapter 2).

Based on vegetation types as the main distinguishing factor, there are 12 major ecosystem categories represented in Ethiopia (**Fig. 2**). These ecosystems are geographically located in different altitudes, and harbour unique and diverse biological resources, which include Afro-alpine and sub afro-alpine ecosystems (3200 – 4620 m asl), Montane grassland ecosystems (1500 – 3200 m asl), Dry evergreen montane forest and Evergreen scrub ecosystems (1500 – 3200 m asl), Moist montane forest ecosystems (800 – 2500 m asl), *Acacia* - *Commiphora* woodland ecosystem (900 – 1900 m asl), *Combretum* - *Terminalia* woodland ecosystem (500 – 1900 m asl), Lowland tropical forest ecosystem (450 – 800 m asl), Desert and semi-desert scrubland ecosystems (>500 m asl), Wetland ecosystems and Aquatic ecosystems (EBI 2015; Friis et al. 2011).

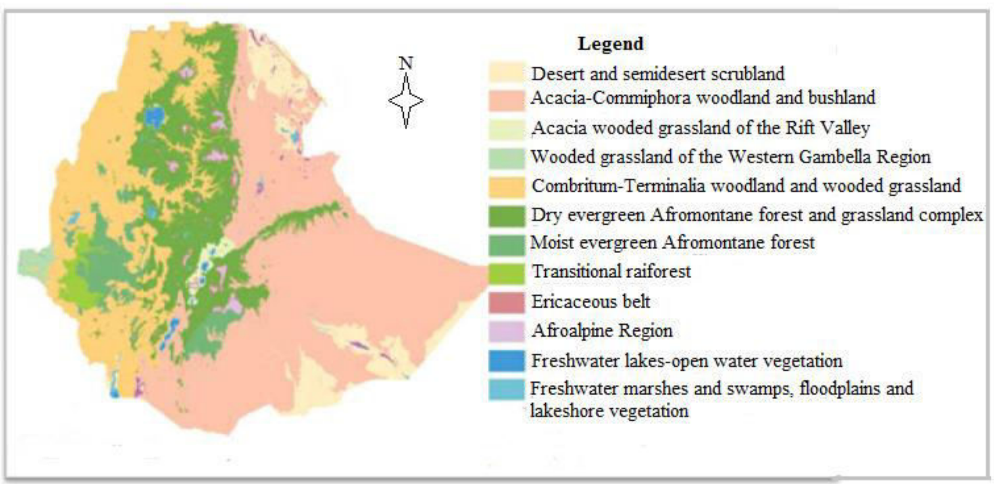

Figure 2. Vegetation types of Ethiopia (from Friis et al. 2011).

In Ethiopia, there are 15 National Parks, 3 Sanctuaries, 8 Wildlife Reserves, 24 Controlled Hunting Areas, 58 Forest Priority Areas and seven World Heritage Convention Sites (IBC 2007).

The trend in the conservation status of Ethiopia's biodiversity is not an exception from the current global biodiversity trend, thus is in decline as a result of a number of factors. In the country, agriculture is the dominant economic sector providing employment for about 83% of the population that contributes 90% to the country's export value and 45% to the GDP (EBI 2014). Thus, the major threats to the biodiversity of the country are unsustainable utilization of natural resources (over-exploitation), deforestation, conversion of natural vegetation to farmland, land degradation, habitat loss and fragmentation, extensive replacement of farmer's/local varieties/breeds by improved ones, invasive species, illegal trafficking of domestic and wild animals, poaching, wetland destruction, climate change and human - wildlife conflict. Some studies showed that most of the vegetation cover of the country is degraded and few remnant high forests are found in southwestern and western parts as patches in conservation sites, churches and sacred areas (Sebsebe Demissew and Friis 2009; Friis et al. 2010). Especially, in the last two decades, large-scale agricultural investments, construction of mega projects, resettlements and expansion of cities are severely damaging the remaining forest patches in northwestern, western and southwestern Ethiopia (Amogne 2014).

1.2 LEPIDOPTERA

Lepidoptera – moths and butterflies – represent one of the largest, diverse, widespread, and widely recognized insect order in the class Insecta of phylum Arthropoda and are the largest evolutionary radiation of herbivorous animals (Goldstein 2017; Wahlberg et al. 2013). Currently, the order Lepidoptera, consists of about 160,000 species in approximately 16,000 genera, 140 families and 48 super families worldwide (Kristensen et al. 2007; Nieukerken et al. 2011) and they account for approximately 10% of all known insect species (Willmer 2011). Although a large portion of research on Lepidoptera has focused on butterflies (New 2004), though, the majority of Lepidoptera (approximately 90%) are classified as moths (Shields 1989).

Early taxonomic studies of Lepidoptera relied on morphological characters that were easy to observe: details of wing venation, wing pattern, shape of palps and antennae, and to some extent structures in the early stages. Many of the characters previously used for classification are today recognized to have some limits for classification, as they have evolved several times independently within the order. The plumous shape of the antenna in many moths, for example, has evolved from filiform antennae several times independently in different groups (Aarvik et al. 2017). During the last century, dissection of the male and female genitalia became common practice; an array of new morphological characters became available. Characters of the genitalia are particularly useful for resolving and diagnosing the lower systematic categories, species and genera. Thus, it is now standard procedure to figure the genitalia in taxonomic works on Lepidoptera. Of course, at higher taxonomic levels, the genitalia provide less systematic information as they evolve quickly and are difficult to homologize over more distantly related groups (Aarvik et al. 2017). Molecular data are now being used to explore phylogenetic relationships at all taxonomic levels within the order. At the species level, comparative morphological methods and COI mitochondrial DNA sequence divergences are used to delimit the taxa, estimate their taxonomic status and for revealing cryptic species (Hebert et al. 2004).

Modern lepidopteran phylogenetic research began in the 1970s and 1980s with detailed studies of anatomy coupled with early application of Hennigian phylogenetics (Mitter et al. 2017). The most securely established large subgroup of Lepidoptera is the clade Ditrysia, which contains 98% of lepidopteran species, having two distinct sexual openings: one for mating, and the other for laying eggs, like Hepialoidea. It is believed that Lepidoptera underwent a burst of rapid radiation during the Cretaceous, together with the rise of the flowering plants, and that many of the Ditrysian superfamilies came into existence during a relatively short time span (Grimaldi and Engel 2005; Cummings et al. 2017). Currently, three nested major sub-divisions in Ditrysia are recognized: Apodytrisia, to which belongs all ditrysian apart Tineoidea, Yponomeutoidea, Gracillarioidea, characterized by an apomorphic sternum II structure. Within Apoditrysia, the group Obtectomera, defined initially by a pupa with fused abdominal segments. Within Obtectomera, Macroheterocera group includes macromoth taxa such as Geometroidea, Noctuoidea, and Bombycoidea, forming, with Pyraloidea, the so-called eared moths.

As a summary, a more comprehensive phylogeny of Lepidoptera isillustrated in **Fig. 3** (Regier et al. 2013; Aarvik et al. 2017).

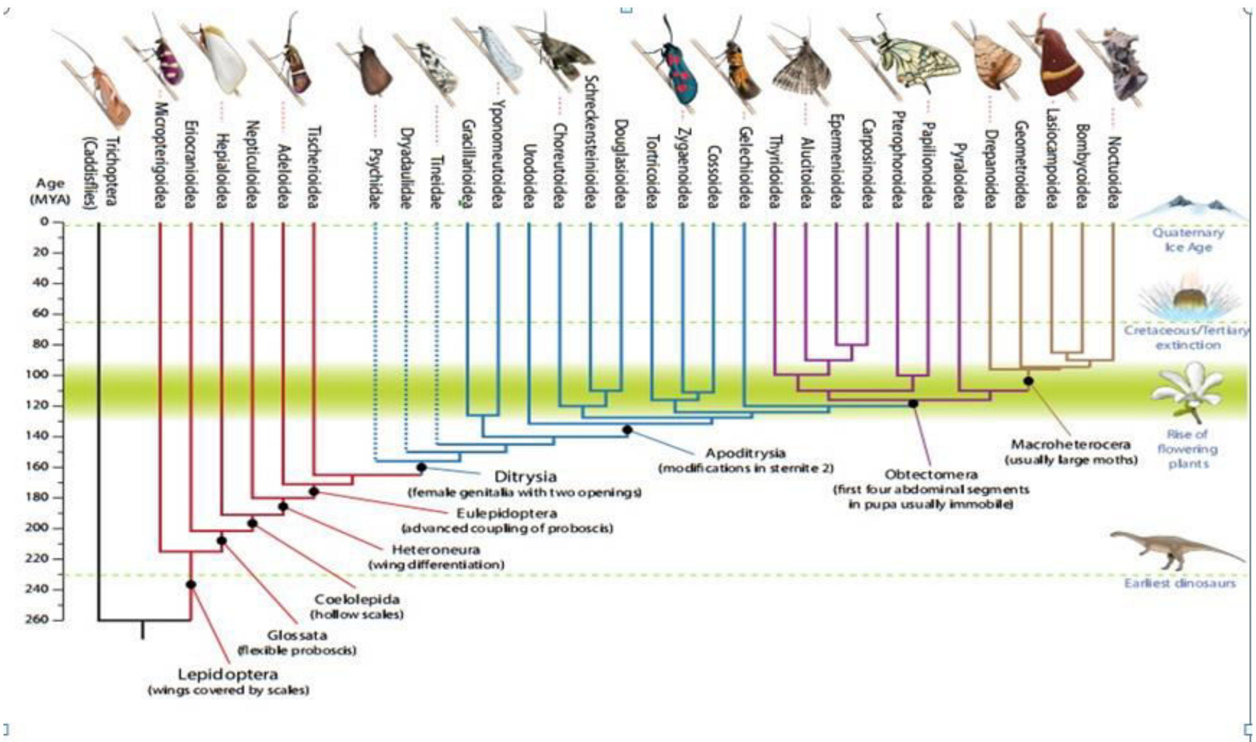

Fig. 3 Summary of phylogenetic analyses of Lepidoptera (Modified from Aarvik et al. 2017).

Among the 48 Lepidoptera superfamilies, those included in Chapter 3 of the thesis are briefly dealt with below:

- Yponomeutoidea: a heterogeneous assemblage of relatively primitive micro-moths which include approximately 1,800 species, belonging to the lower Ditrysia, characterized mainly by the presence, in males, of VIII pleural lobes enclosing the genital apparatus (Dugdale et al. 1999). The family classification is still unclear and varies considerably between authors. Among main families are Yponomeutidae and Plutellidae.
- Zygaenoidea: good autapomorphies and molecular analysis support the superfamily monophyly, with two groups: limacodid and zygaenid moths (Vegliante and Zilli 2004; Mitter et al. 2017). Adults small to medium size, with coloration from cryptic to aposematic or metallic in species with diurnal habits. Larvae usually external feeders, also in two families parasites of other insects. Here contains 12 families, including Zygaenidae and Limacodidae, with 3,300 known species (van Nieukerken et al. 2011).
- Cossoidea: considered as among the earliest branches within Apoditrysia, they share with Sesioidea common apomorphies in larval ground plan (Edwards et al. 1999). Adults are

small to very large, usually robust, and larvae are generally stem borers. Cossidae is the largest family with 970 species described (van Nieukerken et al. 2011).

- Tortricoidea: is a monophyletic and relatively homogeneous group with only the family Tortricidae, with more than 10,000 species (van Nieukerken et al. 2011). Moths are small to medium size and easily recognizable by various morphological characteristics; the common recognized autapomorphy is the large flat ovipositor in females. Larvae can be either internal or external feeders and many species are economically important crop pests (van der Geest and Evenhuis 1991).
- Pyraloidea: one of the larger group of Lepidoptera, with over 16,000 species, characterized by a pair of unique ventral tympanal organs on the second abdominal segment. At present, it includes two families, Pyralidae and Crambidae, based on differences on the tympanal organs, also supported by molecular evidences. Moths are typically small- to medium size. Most feed as larvae on living plants, both external folivores or stem borers, with many diverse ecological adaptations (Mitter et al. 2017).
- Geometroidea: large group of medium to large-sized moths with larvae external leaf feeders, typically on woody plants. Morphological and molecular diagnostics bears to different family assemblages, from 3 to 5, based on the distribution of paired tympanic organs (Mitter et al. 2017). Geometridae are the largest family, with 23,000 described species (van Nieukerken et al. 2011), worldwide distributed, with typical larvae bearing prolegs only on A6 and A10 abdominal segments.
- Lasiocampoidea: this group, classically based on morphological autapomorphies (larvae never possess furecoxae and base of M2 vein; in adult forewings closer to M3 than M1), according to molecular data could be included in Bombicoidea (Lemaire and Minet 1999; Mitter et al. 2017). Moths of the family Lasiocampidae are large, with broad wings, stout body and antennae bipectinate that possesses 1950 species (van Nieukerken et al. 2011).
- Bombicoidea: a monophyletic group of nine families based on several larval and adult automorphies, well supported also by molecular data (Mitter et al. 2017). Moths are usually large to very large in size. The two largest families are Saturniidae (2350 species) and Sphingidae (2200 species) (van Nieukerken et al. 2011).
- Noctuoidea: moths belonging to this group form the most abundant and cosmopolitan lineage of Lepidoptera, with huge diversity in sizes, shapes, colors and ecological habits (Kitching and Rawlins 1999). Monophyly of the Noctuidae is based on the presence of

metathoracic tympanals organs. In recent years, the delimitation of families and subfamilies underwent to extensive revisions. At present, six families with approx. 70,000 described species are recognized. Most abundant are Erebidae (24,600 species) and Noctuidae (11,800 species) (van Nieukerken et al. 2011). Many species are economically important crop pests, especially of herbaceous crops.

As Lepidoptera, especially butterflies are among the most well known insects, they have become flagship organisms for the decision of invertebrate conservation plans. Their ecological significance is massive, not only because of the greatest percentage of species and biomass they account for in ecosystems, but also acting as herbivores, pollinators, and food for insectivores. On the other hand, given their presence in a broad range of habitats, their loss may directly affect the delivery of key ecosystem services such as pollination and natural pest control (Fox 2013). For researchers, scientists, and students, they serve as a model taxon to study researches related to biodiversity, conservation, environmental impact estimates, monitoring of animal populations, ecology, ethnology, evolution, genetics, systematic, and many other ecological and genetic studies. They open doors to the establishment of chemical ecology as a scientific discipline for study and applied research.

1.2.1 LEPIDOPTERA DIVERSITY IN AFROTROPICAL REGION

The Afrotropical region (or Ethiopian region as defined by Wallace in 1876) is part of the Paleotropical realm (with the Oriental region) and comprises continental Africa south of the Sahara, the southern Arabian Peninsula, and the offshore islands, including Madagascar (Crosskey and White 1977). Although the North Africa and the Sahara are usually considered Palaearctic rather than Afrotropical, there are Authors who place the boundary along the northern Sahara or the Mediterranean coast (Cox 2001; Kreft and Jetz 2010). Madagascar fauna is so peculiar that some zoologists consider it as a separate biogeographic region (Krijanovskiy 2002). Southern Iran and extreme southwestern Pakistan are sometimes also included (Wikipedia 2019).

The African continent has an average high altitude, with a widespread of plateaus (averaging over 1000 m) that extend continuously from the Red Sea to South Africa. There are no extended mountain ranges and the massifs present, located mainly along the Rift Valley, even at a considerable altitude, are usually extinct volcanoes rather isolated from each other. Along the equator, the rainfall gradient has the highest in the west and the lowest in the east. In most areas, the rainfall has a markedly seasonal character, with the alternation of wet and dry seasons. Moving away from the equator, we change from a humid to a dry tropical climate. The rainforest extends from the Congo River Basin westwards, as it becomes more and more punctiform and localized towards the east. The tropical forest goes from Sierra Leone to the Rift Valley, surrounded by a strip of humid savannah, in turn surrounded by dry steppe-like savannahs. Southern Africa has a peculiar vegetation composed of Mediterranean scrub, karroo and bushveld. The mountain ranges of the Rift Valley and the Ethiopian and Cameroonian highlands have a characteristic vertical zoning of the vegetation, which, starting at the base with the savannah continues with the juniper and *Podocarpus* mountain forest, the bamboo forest, the *Erica* bushes and, at the highest altitude, the Afro-Alpine area, with giant *Lobelia* and *Senecio*. In Madacascar, the rainfall increases from west to east, resulting in three longitudinal bands of xerophilous vegetation, wet savannah and rainforest (Sbordoni and Forestiero 1998).

Major events of the geological history and movement of continents influenced the affinities of the faunas with the other zoogeographical regions. Due to the recent radiation, if compared with other holometabolous orders, largely during the Cretaceous and Early Tertiary, Mesozoic geological events such as the breakup of Gondwana are considered to have had more limited influence in shaping biogeographical patterns. After the breakup, Africa underwent a prolonged period of geographical isolation before repeatedly being connected to Eurasia during the Tertiary (Krüger 2008). The afrotropical Lepidoptera fauna accordingly consists mainly ofautochthonous elements resulting from endogenous post-Gondwanan speciation, with Gondwanan relicts being much less numerous, i.e., the non-dytrisian family Cecidosidae with a geographic distribution (South Africa, South America, New Zealand) that suggest an origin before the fragmentation of the Gondwana (80 million years ago) (Holloway and Nielsen 1999).

The African continent, as well as other tropical areas, has been affected by the effects of Pleistocene glaciations, which have caused the alternation of rainy and inter pluvial periods, with strong pulsations in the extension of forests at low altitudes (Hamilton 1976). In more recent times, between 10,000 and 7,000 years ago, the climate was warmer and wetter and the forests much more extensive than they are today. Climatic variations caused significant adaptation of vegetation biomes, causing the low-altitude tropical forests to expand and contract correspondingly. The fragmentation of rain forests, home of the richest communities of species, combined with the presence of a huge desertic barrier at the North, caused alterations of ranges and lowered the species richness observed, when compared to rain forests in other tropical regions (Sbordoni and Forestiero1998).

Existing biogeographical classifications are based mainly on vascular plants or one or more vertebrate groups, with the underlying assumption that such partial analyses can be extended to all other groups (Linder et al. 2012).

However, due to its geological history and climatic configurations, Afrotropical region shows huge variability in patterns of distribution of the flora, fauna, biomes, or combinations of these. The African savanna biome, which comprises about half of the continent's surface area, carries Earth's greatest diversity of ungulates, more than in any other biome or continent (Scholtz and Mansell 2019). The mediterranean scrub of the southern most part of Africa has one of the richest endemic floras of the world (Linder 2003). On the other side, the equatorial rain forests are anomalously species-poor in global terms (Richards 1973; Beentje et al. 1994), but Afromontane forests across the tropical belt are remarkably species-rich (Burgess et al. 2007). The glaciated mountains close to the equator (Rwenzori, Mount Kenya and Mount Kilimanjaro) and the extensive Ethiopian alpine plateau harbour a very distinct biota, with high levels of endemism (Friis et al. 2010).

A better understanding of the entomofauna of this zoogeographic region presents enormous challenges to scientists because of the profusion of insect taxa that have evolved in the multitude of ecological systems of the region and because of historical and socio-political issues that afflict the continent. Miller and Rogo (2001) pointed out that in the continent:

- species numbers are vast, but dramatically unknown. For example, Hacker (2019) recently stated that there has never been a systematic survey of the Lepidoptera of the African continent. Even the existing local surveys that provide useful information published are either out dated or are restricted to smaller geographical areas or to particular taxonomic units.
- insect habitats are fast declining: FAO (2005) report estimated that worldwide six million hectares of primary forest are lost or modified each year and the severity is specifically high in afrotropical region, the annual rate of loss has been around 4 million hectares or 0.62 % of the continent's forest resources.
- few African countries house insect collections or employ taxonomists. Despite the insect richness and possession of all insect orders in this continent, few taxa have been collected extensively and even fewer have been studied comprehensively; moreover, taxa that have been studied have mostly determined outside Africa. Therefore, most Afrotropical countries (with execption of South Africa) do not have reasonable collections and a history of taxonomic research. At the same time, there are not many experts on Afrotropical

Lepidoptera and within this group only a few specialists work on the nocturnal groups (Thomas Baron et al. 2014; Scholtz and Mansell 2019).

Due to the above-mentioned reasons, it is difficult to provide an acceptable picture of the Lepidoptera biogeographical features of this biogeographical region.

At the high taxonomic level, Lepidoptera endemic for this region are family Prototheoridae; subfamilies Chrysopolominae (Limacodidae), Hibrildinae (Eupterotidae), Apoprogoninae (Sematuridae), Charideinae (Thyrididae), Ludiinae (Saturniidae), Lipteninae (Lycaenidae), tribe Thyretini (Erebidae). Well-represented taxa areEriocottidae, Metarbelidae, Lemoniidae (shared with Palaearctic region), Eupterotidae, Lasiocampinae (Lasiocampidae), Aganainae (Erebidae), Acraeini (Nymphalidae).

Most affinities of Afrotropical region are shared with the Oriental Region, at level of families (i.e., Himantopteridae and Hyblaeidae) and genera. Fewer taxa are shared with the Australian Region (i.e., Xyloryctidae and Hyblaeidae families) and the Neotropical Region (i.e., Thyridinae; Nacophorini among Geometridae). The affinities with the Palearctic Region concern mainly temperate species extending to tropics (*Pieris*, *Pontia*, *Colias*, *Euchloe*, *Pararge*, *Issoria*, *Melithea*), less the opposite (*Charaxes jasius*) (Sbordoni and Forestiero 1998).

More in-depth studies have concerned butterflies. The Afrotropical region boasts over 4,000 described species of butterfly and skipper, about one fifth of the world total (Larsen 2011; Williams 2018), although among tropical regions is the least species-rich. Four center of butterfly species richness are recognized: African sylvan (Congo Basin and coast of Gulf of Guinea), African savannah (Eastern Africa from equator southwards), Cape (South Africa), Madagascar (Holloway and Nielsen 1999). The richest geographical areas are from Cameroon, Zaire, Ivory Coast and Ghana. The eastern Africa hosts a minor number of species but higher level of endemicity, with some typically forest genera poorly represented (*Najas*, *Cymothoe*, *Bebearia*, *Bematistes*) or missing (*Kallima*, *Ariadne*). Madagascar and South Africa are relatively poor of species. Madagascar has the highest rate of endemic species (about 70%), with two genera absent from African continent (*Euploea* and *Atrophaneura*) and many vicarious species/subspecies of those living on the continent, most of clear African derivation (Sbordoni and Forestiero 1998).

1.3 AIMS OF THE RESEARCH

In the present thesis, Lepidoptera has been selected as model group, focusing, especially, on the fauna of Ethiopia, country located in the horn of Africa.

According to Scoble (1992), Lepidoptera fulfil the criteria that make them to be appropriate as an indicator. First, the group in question should be, as far as possible, widely distributed; second, it should be sensitive to environmental change at the level of species; third, it should be capable of easy sampling in the field and identification in the laboratory; and fourth, confidence in the results from a particular group of organisms will be increased if the group is diverse. Potentially, Lepidoptera meets most of these requirements; thus, they are an interesting model group. They are very rich in species, their larvae are herbivorous and adults are accessible to standardized sampling and they contain species as readily identifiable (Scoble 1992). As herbivorous insects, they are expected to respond sensitively to habitat modification, and have a close functional relationship with the vegetation they live in.

The aim of this thesis is to investigate the diversity of Ethiopian Lepidoptera from different points of view, going from a more general revision of the current knowledge of Lepidoptera order in the country to a detailed taxonomic study of a single genus at the continental level. Thus, after a general introduction (Chapter 1), the dissertation has been divided into three sections:

- The first section (Chapter 2) elaborates an updated and comprehensive review of the actual knowledge of Lepidoptera in Ethiopia, including a complete checklist of species so far described from the country and providing some estimates for the expected biodiversity of this major insect order in the country. The paper has been published in Zookeys;
- The second part (Chapter 3) reported an assessment of the Lepidopteran diversity among various land-use types in Mounts Choke, Ethiopia, in order to evaluate the potential impacts of human activities on habitats. For the actualisation of these outputs, the research has involved extensive field and laboratory works including collecting, preparing and identifying thousands of moth’s specimens from different sites, characterized by various land use types.
- The last section (Chapter 4) presents a taxonomic revision of the genus *Orbamia* in the family Geometridae, with the description of new genera and species by using the modern comparative systematic methodologies and standards, which integrates morphological and molecular taxonomic techniques.

1.4 REFERENCES

Aarvik L., Bengtsson B.A., Elven H., Ivinskis P., Jurivete U., Karsholt O., Mutanen M., SavenkovN. (2017). Nordic-Baltic Checklist of Lepidoptera. Norwegian Journal of Entomology. Supplement 3: 1-236.

Amogne Asfaw (2014). Forest resource management systems in Ethiopia: historical perspective.International Journal of Biodiversity and Conservation, 6(2): 121-131.

An S., Choi W. (2013). Forest moth assemblages as indicators of biodiversity and environmental quality in a temperate deciduous forest. European Journal of Entomology, 110 (3): 509–517.

Baron T., Akite P., Barnett M., Collins S.C., Dobson J, Fric Z.F.,Henning G., Kühne L., Mey W., Michael Ochse, Łukasz Przybyłowicz, Szabolcs Sáfián,Schutte R., Selb H., Ward P. (2017). The second Afrotropical Lepidoptera Workshop in Uganda –A contribution to the Lepidoptera fauna of Kibale National Parkand the Mpanga Forest Reserve. Entomologische Zeitschrift, 127(2): 77-105.

Barnosky A.D., Matzke N., Tomiya S., Wogan G.O, Swartz B., Quental T.B., Marshall C., McGuire J.L., Lindsey E.L.,Maguire K.C., Mersey B., Ferrer E.A. (2011). Has the Earth's sixth mass extinction alreadyarrived? Nature, 471(7336):51–57.

Barnosky A.D., Hadly E.A., Bascompte J.,Berlow E.L., Brown J.H., Fortelius M., Getz W.M., Harte J., Hastings A., Marquet P.A., Martinez N.D., Mooers A., Roopnarine P., Vermeij G., Williams J.W, Gillespie R., Kitzes J., Marshall C., Matzke N., Mindell D.P., Revilla E., Smith A.B. (2012). Approaching a state shift in Earth's biosphere.Nature, 486(7401):52–58.

Beccaloni G.W., Gaston K.J. (1995). Predicting the species richness of Neotropical forest butterflies: Ithomiinae (Lepidoptera: Nymphalidae) as indicators. Biological Conservation, 71: 77–86.

Beentje H.J., Adams B., Davis S.D., Hamilton A.C. (1994). Regional overview: Africa. In: Centres of plant diversity (eds. Davis S.D., HeywoodV. H., HamiltonA.C.). IUCN Publication Unit, Cambridge: 101–148.

Blair R.B. (1999). Birds and butterflies along an urban gradient: surrogatetaxa for assessing biodiversity? Journal of Ecological Applications, 9: 164–170.

Burgess, N.D., Balmford, A., Cordeiro, N.J., Fjeldsa°, J., Kuper, W., Rahbek, C., Sanderson, E.W., Scharlemann, J.P.W., Sommer, J.H. & Williams, P.H. (2007a) Correlations among species distributions, human density and human infrastructure across the high biodiversity tropical mountains of Africa. Biological Conservation, 134: 164–177.

CBD (Secretarial of the Convention on Biological Diversity) (2011). Year in Review 2010. Montreal, Canada, 60pp.

CBD (Secretarial of the Convention on Biological Diversity) (1992). Rio de Janeiro, pp. 30.

Ceballos G., Lavorel S., Orians G., Pacala S.Mace G.M., Masundire H., Baillie M. (2005). Millennium ecosystem assessment: current states and trends – biodiversity. Island Press, Washington, USA, pp. 46.

Chapin F.S. (2003). Effects of plant traits on ecosystem and regional processes: a conceptual framework for predicting the consequences of global change. Annals of Botany, 91: 455-463.

Cox C.B. (2001). The biogeographic regions reconsidered. Journal of Biogeography, 28: 511–523.

Crosskey R.W., White G.B. (1977). The Afrotropical Region. Journal of Natural History, 11: 541-544.

Daily G.C., Ehrlich P.R., (1995). Preservation of biodiversity in smallrainforest patches: rapid evaluations using butterfly trapping. Biodiversity and Conservation, 4: 35–55.

Dijkstra K.D., Clausnitzer V. (2013). The Dragonflies and Damselflies of Eastern Africa: Handbook for all Odonata from Sudan to Zimbabwe.Studies in Afrotropical Zoology, Volume 298. Royal Museum for Central Africa, Tervuren, 264 pp.

Dirzo R., Raven H. (2003). Global state of biodiversity and loss. Annual Review of Environmental Resources, 28: 137–167.

Duelli P., Obrist M.K. (2003). Regional biodiversity in an agricultural landscape: the contribution ofSemi-natural habitat islands. Basic and Applied Ecology, 4: 129-138.

Dugdale J.S., Kristensen N.P., Robinson G.S., Scoble M.J. (1999). Chapter 8. The Yponomeutoidea. In: Kristensen N.P. (ed.), Lepidoptera, Moths and Butterflies. Volume 1: Evolution, Systematics and Biogeography. Handbook of Zoology. Volume IV Arthropoda: Insecta. Part 35.Walter de Gruyer, Berlin: 119-130.

Edwards E.D., Gentili P., Horak M., Kristensen N.P., Nielsen E.S. (1999). Chapter 11. The Cossoid/Sesioid assemblage. In: Kristensen N.P. (ed.), Lepidoptera, Moths and Butterflies. Volume 1: Evolution, Systematics and Biogeography. Handbook of Zoology. Volume IV Arthropoda: Insecta. Part 35.Walter de Gruyer, Berlin: 181-197.

Ethiopian Biodiversity Institute (EBI) (2014). Ethiopia's Fifth National Report to the Convention on Biological Diversity. Ethiopian Biodiversity Institute, Addis Ababa, Ethiopia, 72 pp.

Ethiopian Biodiversity Institute (EBI) (2015). National Biodiversity Strategy and Action Plan of Ethiopia (NBSAP). Rela Printing Press, Addis Ababa, Ethiopia, 120 pp.

Friis I., Sebsebe Demissew, Breugel P.V. (2010). Atlas of the Potential Vegetation of Ethiopia. Addis Ababa: The Royal Danish Academy of Sciences and Letters (Natural habitats), 307 pp.

Foley F., Fries D., Asner P., Barford C., Bonan G., Carpenter R., Chapin S., Coe T., Daily C., Gibbs K., Helkowski H., Holloway T., Howard A., Kucharik J,, Monfreda C., Patz A., Prentice C.,Ramankutty N., Snyder K. (2005). Global consequences of land use. Science, 309: 570–574.

Food and Agriculture Organization (FAO) (2005). Global Forest ResourcesAssessment. FAO Forestry Paper, 147 pp.

Forest F., Crandall K.A., Chase M.W., Faith D.P. (2015). Phylogeny, extinction and conservation: embracing uncertainties in a time of urgency, Philosophical Transactions of the Royal Society Biological Science Series B, 370 (1662).

Fox R. (2013). The decline of moths in Great Britain: a review of possible causes. InsectConservation and diversity, 6: 5–19.

Gardner A., Barlow J., Chazdon R., Ewers M., Harvey A., Peres A., Sodhi S. (2009). Prospects fortropical forest biodiversity in a human-modified world. Ecology Letters, 12: 561–582.

Goldstein P.Z. (2017). Diversity and significance of Lepidoptera: A phylogenetic perspective. In: Foottit and Adler (Eds.), Insect biodiversity. Science and Society. Blackwell Publishing, Chichster, UK, 463 pp.

Golubkina N., Sheshnitsan S., Kapitalchuk M. (2014). Ecological Importance of Insects in Selenium Biogenic Cycling. International Journal of Ecology, 1-6.

Grimaldi D., Engel M. (2005). Evolution of the Insects. Cambridge University Press, New York, 763 pp.

Hamilton A.C. (1976). The significance of patterns of distribution shown by forest plants and animals in tropical Africa for the reconstruction of upper Pleistocene palaeoenvironments: a review. Paleoecology of Africa, 9: 63–97.

Hebert P.D.N., Penton E.H., Burns J.M., Janzen D.H., Hallwachs W. (2004). Ten species in one: DNAbarcoding reveals cryptic species in the neotropical skipper butterfly*Astraptes fulgerator*.Proceedings of the National Academy of Sciences of the United States of America, 101:14812–14817.

Hill J.K., Hamer K.C. (2004). Determining impacts of habitat modification ondiversity of tropical forest fauna: the importance of spatial scale. Journal of Applied Ecology, 41: 744-754.

Holloway J.D., Nielsen E.S. (1999) Chapter 21. Biogeography of the Lepidoptera. In: Kristensen N.P. (ed.), Lepidoptera, Moths and Butterflies. Volume 1: Evolution, Systematics and Biogeography. Handbook of Zoology. Volume IV Arthropoda: Insecta. Part 35.Walter de Gruyer, Berlin: 423-462.

Hooper U., Chapin I., Ewel S., Hector J., Inchausti A., Lavorel P., Lawton S., Lodge H., Loreau M., Naeem S. (2005). Effects of biodiversity on ecosystem functioning: a consensus of current knowledge.Ecological Monographs, 75: 3-35.

Jacobs J., Schloeder A. (2001). Impacts of conflict on biodiversity and protected areas in Ethiopia. Biodiversity Support Program, Washington, USA, 45pp.

Kerr J.T., Sugar A., Packer L. (2000). Indicator taxa, rapid biodiversityassessment, and nestedness in an endangered ecosystem.Conservation Biology. 14: 1726–1734.

Kitching I.J., Rawlins J.E. (1999). Chapter 19. The Noctuidea. In: Kristensen N.P. (ed.), Lepidoptera, Moths and Butterflies. Volume 1: Evolution, Systematics and Biogeography. Handbook of Zoology. Volume IV Arthropoda: Insecta. Part 35.Walter de Gruyer, Berlin: 356-401.

Kreft H., Jetz W. (2010). A framework for delineating biogeographical regions based on species distributions. Journal of Biogeography, 37: 2029–2053.

Kremen C. (2005). Managing ecosystem services: what do we need to know about their ecology? Ecology Letters, 8: 468-479.

Krizhanovskij O.L. (2002) Composition and distribution of the entomofaunas on the Earth. Institute of Zoology RAS, Moskow, 237 pp [in Russian].

Kristensen N.P., Scoble M.J., Karscholt O. (2007). Lepidoptera phylogeny and systematics: the state of inventory in moth and butterfly diversity. Zootaxa, 1668: 699 – 747.

Krüger M. (2008). The southern African lepidopteran fauna in a regional and global context. Abstracts CD, XXIII International Congress of Entomology, 6 - 12 July 2008, Durban, South Africa.

Larsen T.B. (2011). African Butterfly Research, Past... Present... Future In: Sáfián, S.Z. (ed.) (2011): Abstracts of the Workshop on Lepidoptera Research in the Afrotropical Region. 18–21 November 2011. Butterfly Conservation Society, Tema, Ghana, 29 pp.

Lemaire C., Minet J. (1999). Chapter 18. The Bombycoidea and their relatives. In: Kristensen N.P. (ed.), Lepidoptera, Moths and Butterflies. Volume 1: Evolution, Systematics and Biogeography. Handbook of Zoology. Volume IV Arthropoda: Insecta. Part 35.Walter de Gruyer, Berlin, 321-353.

Laurance F. (2007). Have we overstated the tropical biodiversity crisis? Trends in Ecology and Evolution, 22: 65–70.

Lenzen M., Moran D., Kanemoto K., Foran B., Lobefaro L., Geschke A. (2012). International trade drives biodiversity threats in developing nations. Nature, 486: 109-112.

Linder H.P. (2003). The radiation of the Cape flora, southern Africa. Biological Reviews, 78: 597–638.

Linder H.P., de KlerkH.M., Born J., Burgess N.D., Fjeldsa J., Rahbek C. (2012). The partitioning of Africa: statistically defined biogeographical regions in sub-Saharan Africa. Journal of Biogeography, 39: 1189–1205.

May M. (2010). Tropical arthropod species, more or less? Science, 329: 41-42.

Millennium Ecosystem Assessment. (2005).Ecosystems and human well-being: biodiversity synthesis. World Resources Institute, Washington, USA, 137 pp.

Miller S., Rogo L. (2001). Challenges and opportunities in understanding and utilisation of African insect diversity. Cimbebasia, 17: 197-218.

Mitter C., Davis D.R., Cummings M.P. (2017). Phylogeny and evolution of Lepidoptera. Annual Revue of Entomolology, 62:265–283.

McCarthy D.P., Donald P.F., Scharlemann J.P. (2012). Financial costs of meeting global biodiversityconservation targets: current spending and unmet needs.Science, 338(6109):946–949.

New T.R. (2004). Moths (Insecta: Lepidoptera) and conservation: background and perspective. Journal of Insect Conservation, 8: 79–94.

Ollerton J., Winfree R., Tarrant S. (2011). How many flowering plants are pollinated by animals? Oikos, 120: 321-326.

Pellens R., Grandcolas P. (2016). Biodiversity Conservation and Phylogenetic Systematics, Preserving our evolutionary heritage in anextinction crisis.Springer Cham Heidelberg, London. Volume 14:390 pp.

Pettersson M.W. (1991). Pollination by a guild of fluctuating moth populations: option forunspecialization in *Silene vulgaris*. Journal of Ecology, 79: 591-604.

Pimm S., Raven P., Peterson A., Sekercioglu H., Ehrlich R, (2006), Human impacts on the rates of recent, present, and future bird extinctions. Proceedings of the National Academy of Sciences, 103: 10941-10946.

Potts S.G., Biesmeijer J.C., Kremen C., Neumann P., Schweiger O., Kunin W.E. (2010). Global pollinator declines: trends, impacts and drivers. Trends in Ecology and Evolution, 25: 345-353.

Power A.G. (2010). Ecosystem services and agriculture: trade-offs and synergies. Philosophical Transactions of the Royal Society Biological Science, SeriesB, 365: 2959-2971.

Regier J.C., Mitter C., Zwick A., Bazinet A.L., Cummings M.P., Kawahara A.Y., Sohn J.C., Zwickl D.J., Cho S., Davis D.R., Baixeras J., Brown J., Parr C., Weller S., Lees D.C., Mitter K.T. (2013). A Large-Scale, Higher-Level, Molecular Phylogenetic Study of the Insect Order Lepidoptera (Moths and Butterflies). PLos ONE, 8 (3): e58568: 1–23.

Reckhaus H.D. (2017). Why every fly counts. Documentation about the value and endangerment of Insects. Springer International Publishing, Cham, Switzerland, 111 pp.

Richards, P.W. (1973). Africa, the 'odd man out'. In: Tropical forest ecosystems in Africa and South America: a comparative review (eds. Meggers B.J., Ayensu E.S., Duckworth W.D.). Smithsonian Institution Press, Washington, DC: 21–26

Sala O.E, Chapin, F.S., Armesto J.J., Berlow E., Bloomfield J., Dirzo R., Sanwald E.H., Huenneke L.F., Jackson R.B., Kinzig A., Leemans R., Lodge D.M., Mooney H.A., Oesterheld M., Poff, N.L.,Sykes M.T., Walker B.H., Walker M., Wall D.H (2000). Global biodiversity scenarios for the year 2100. Science, 287: 1770–1774.

Samways M.J. (2007). Insect conservation: asynthetic management approach.The Annual Review of Entomology, 52:465–487.

Sánchez-Bayo F., Wyckhuys K. (2019).Worldwide decline of the entomofauna: a review of its drivers.Biological Conservation, 232: 8–27.

Sbordoni V., Forestiero S. (1998) Butterflies of the World. Firefly Books Ltd, Richmond Hill, Canada, 312 pp.

Scheffers R., Joppa N., Pimm L. Laurance F. (2012). What we know and don't know about Earth's missing biodiversity. Trends in Ecology and Evolution, 27:501-510.

Scholtz C., Mansell M. (2017). Insect Biodiversity in the Afrotropical Region. In: Foottit and Adler (Eds.), Insect biodiversity. Science and Society. Blackwell Publishing, Chichster, UK, 93 pp.

Scoble M.J. (1992). The Lepidoptera: form, function, and diversity. Oxford University Press, Oxford, 404 pp.

Smith D., May M., Pellew R., Johnson H., Walter R. (1993). How much do we know about the current extinction rate? Trends in Ecology & Evolution, 8: 375-378.

Stein C., Auge H., Fischer M., Weisser W. Prati D. (2008). Dispersal and seed limitation affect diversity and productivity of montane grasslands. Oikos, 117: 1469-1478.

Summerville K.S., Crist T.O. (2004). Contrasting effects of habitat quantityand quality on moth communities in fragmented landscapes. Ecography, 27: 3-12.

Tesfaye Hundesa (1997). Major causes for the loss of wildlife in Ethiopia. Walia, 18: 3-6.

Travers S.E., Fauske G.M., Fox K., Ross A.A., Harris M.O. (2011). The Hidden Benefits of PollinatorDiversity for the Rangelands of the Great Plains: Western Prairie Fringed Orchids as a CaseStudy. Rangelands, 33: 20-26.

United Nations Environment Programme (UNEP) (2006). 2005 Annual Evaluation Report. https://www.unenvironment.org/resources/evaluation-synthesis-reports/unep-annual-evaluation-report-2005, 70 pp. [accessed 19 September 2019].

Van der Geest L.P.S., Evenhuis H.H. (1991). Tortricid Pests. Their biology, natural enemies and control. Elsevier, Amsterdam, 808 pp.

van Nieukerken E.J., Kaila L., Kitching I.J., Kristensen N.P., Lees D.C., Minet J., Mitter C., Mutanen M., Regier J.C., Simonsen T.J., Wahlberg N., Yen S.-H., Zahiri R., Adamski D., Baixeras J., Bartsch D., Bengtsson B.Å., Brown J.W., Bucheli S.R., Davis D.R., De Prins J., De Prins W., Epstein M.E., Gentili-Poole P., Gielis C., Hättenschwiler P., Hausmann A., Holloway J.D., Kallies A., Karsholt O., Kawahara A.Y., Koster S., Kozlov M.V., Lafontaine J.D., Lamas G., Landry J.-F., Lee S., Nuss M., Park K.-T., Penz C., Rota J., Schintlmeister A., Schmidt B.C., Sohn J.C., Solis M.A., Tarmann G.M., Warren A.D., Weller S., Yakovlev R.V., Zolotuhin V.V., Zwick A. (2011). Order Lepidoptera Linnaeus, 1758. In: Zhang, Z.-Q. (Ed.) Animal biodiversity: an outline of higher-level classification and survey of taxonomic richness.Zootaxa, 3148: 212-221.

Vegliante, F., Zilli A. (2004). Larval morphology of *Heterogynis* (Lepidoptera: Heterogynidae). Eur. J. Entomol. 101: 165–184.

Wahlberg N., Wheat W., Pena C. (2013). Timing and patterns in the taxonomic diversification of Lepidoptera (butterflies and moths). PLOS ONE, 8(11):e80875.

Wheeler Q.D., Miller K.B. (2017). The science of insect taxonomy: prospects and needs. In Foottit and Adler (Eds.), Insect Biodiversity. Wiley-Blackwell, Chichester, UK, 499 pp.

Wickramasinghe L.P., Harris S., Jones G., Jennings N.V. (2004). Abundance and species richness of nocturnal insects on organic and conventional farms: Effects of agricultural intensification on bat foraging. Conservation Biology, 18: 1283-1292.

Wikipedia (2019) Afrotropical realm. https://en.wikipedia.org/wiki/Afrotropical_realm [Accessed 5 December 2019].

Williams M.C. (2018) Afrotropical butterflies and skippers. A digital encyclopaedia. https://www.metamorphosis.org.za/?p=articles&s=atb [accessed 16October 2019].

Wilson J.D., Morris A.J., Arroyo B.E., Clark S.C., Bradbury R.B. (1999). A review of the abundanceand diversity of invertebrate and plant foods of granivorous birds in northern Europe in relationto agricultural change. Agriculture, Ecosystems and Environment, 75: 13-30.

World Population Review (2019). http://worldpopulationreview.com/countries/ethiopia-population/ [Accessed 15 October 2019]

Zavaleta S., Pasari R., Hulvey B., Tilman D. (2010). Sustaining multiple ecosystem functions in grassland communities requires higher biodiversity. Proceedings of the National Academy of Sciences, 107: 1443-1446.

Yalden D. (1983). The extent of high ground in Ethiopia compared to the rest of Africa. SINET Ethiopian Journal of Science, 6: 35-38.

Chapter 2. LEPIDOPTERA DIVERSITY OF ETHIOPIA: CURRENT KNOWLEDGE AND FUTURE PERSPECTIVES[1]

2.1 INTRODUCTION

Ethiopia is among the largest countries in the African continent, located in the horn of Africa, covering a total area of 1,127,127 km^2 (Gordon and Carillet 2003; EBI 2015; Tesfu et al. 2018). It belongs to the Afro-tropical Region (former Ethiopian Region) and, based on the bioclimatic classification of Burgess et al. (2004), comprises the zones “Sahelian Savanna”, “Somalian Xeric Bushland and Shrubland” and “Ethiopian Montane forest and Alpine Moorland” (Hacker 2019). The country’s topography is very diverse, with 20 mountains peaks above 4,000 meters. The highest mountain, Ras Dashen, peaks 4,620 m above sea level, the fourth highest in Africa, whilst the third lowest point in Africa, the Danakil Depression, reaches down to 125 m below sea level. The dominating topographic element is the vast and fertile central highland that accounts for 37 % of the land area of the country with an average elevation from 1,500 to 2,400 m that deserved the country to be known as ‘roof of Africa’. It is the largest block of land above 1,500 m in Africa (Clausnitzer and Dijkstra 2005), dissected by the Great Rift Valley and surrounded by lowlands along the periphery (Gordon and Carillet 2003). The mean annual rainfall ranges from 500 mm to 2,800 mm and the mean annual temperatures range from around 10°C to above 30°C. Because of these diverging abiotic parameters, the country is endowed with an amazingly diversity of plant, animal and microbial organisms (EBI 2015). According to Clausnitzer (2014), the rate of endemism in Ethiopia’s flora and fauna is exceptionally high as a result of vast highlands being isolated by the surrounding dry lowlands. Only the most eurytopic and mobile species (usually those of the lowlands) tend to be found in both Ethiopia and the rest of tropical Africa. In the same manner, Kravchenko et al. (2007) stated that the territory of Ethiopia hosts an extraordinarily diverse landscape including high mountains, lowlands, deserts and tropical rain forests that resulted in a hyper diverse fauna and flora. Likewise, in consequence of its rich biodiversity, Ethiopia is acknowledged as one of the 20-mega-biodiverse countries in the world (Mittermeier et al. 2011; Tesfu et al. 2018).

[1] * The present Chapter has published as: Tujuba T.F., Sciarretta A., Hausmann A., Abate GA. (2019). Lepidoptera of Ethiopia: current knowledge and future perspectives. *Zookeys,* 882: 87–125.

Lepidoptera represent the second largest insect order, which consists of approximately 140 different families and 160,000 species that have been described and recognised worldwide so far (Biodiversity Institute of Ontario 2006; Kristensen et al. 2007; Nieukerken et al. 2011). Lepidoptera comprise nearly 17% of all insect species, and some recent estimates suggest that the real number of Lepidoptera species would set up to 500,000 species (Brandao et al. 2009).

The aims of this Chapter is to give an updated and comprehensive review of the actual knowledge of Ethiopian Lepidoptera and to provide some estimates for the expected biodiversity of this major insect order in the country.

2.2 MATERIALS AND METHODS

The present review is based on all pertinent published scientific papers. In addition, records from up to date and relevant online databases were also included, particularly, records from the Natural History Museum of London website ("NHMUK": Beccaloni et al. 2003), the Barcode of Life Data Systems ("BOLD": Ratnasingham and Hebert 2007), the African moth website (Goff 2008), LepiMap (Navarro 2007), the African Butterfly Database (Sáfián et al. 2009), the Afromoth website (De Prins and De Prins 2019) and the Afrotropical Butterflies and Skippers digital encyclopaedia (Williams 2018). In all cases, records were included only when sample identifications were made at specific (or subspecific) level, and the provenience from Ethiopia was clearly indicated. Data from entomological collections but not publicly accessible were not considered.

The classification system and nomenclature (valid names and synonymies) used in De Prins and De Prins (2019) with some updates coming from more recent publications was here followed. For Rhopalocera, the Afrotropical Butterflies and Skippers digital encyclopaedia (Williams 2018) served as reference. These two outstanding references have also represented the fundamental database and resource for our compilation of the lepidopteran fauna of Ethiopia.

2.3 LEPIDOPTERA EXPLORATION IN ETHIOPIA: FROM EARLY EXPLORERS TO PRESENT

Many entomologists have contributed to our current knowledge of the Ethiopian Lepidoptera fauna. The following selection provides the most significant contributions made by past pioneers and current explorers.

Johann Christoph Friedrich Klug in 1829 was the first to mention Abyssinia, the former name of Ethiopia, in the description of a new Lepidoptera species, the butterfly *Pontia eupompe* (Klug, 1829) now *Colotis danae* ssp. *eupompe* (Nazari et al. 2011), indicating as locus typicus “in Arabia deserta, in Sinai monte, in Dongala et Habessinia”.

From the mid-nineteenth century, additional descriptions came from few authors such as Félix Edouard Guérin-Méneville (1849), Louis Reiche (1850), and Hippolyte Lucas (1852). However, the most significant advance in the nineteenth century was made by the French entomologist Achille Guenée, who published various contributions between 1852 and 1858. He described 31 new species belonging to the Noctuoidea and Geometroidea, based on material collected mainly by Georg Wilhelm Schimper in 1850. In all cases, the locus typicus was indicated as "Abyssinia" (Guénée 1852).

Other important contributions to the study of Ethiopian Lepidoptera were made subsquently, many of which have reported the description of new species from specimens collected in the country. For instance, George Hampson described 23 species from different families in the period between 1896 and 1930 (Hampson 1896, 1898, 1899, 1905, 1909, 1910, 1913, 1916, 1918, 1919, 1926, 1930). Edward Meyrick firstly reported Microlepidoptera from the country, with 40 new species, from the material collected during the expeditions carried out by Hugh Scott and Omer-Coper in 1926–1927 (Meyrick 1932). The most important contribution to the study of butteflies was made by Lionel Walter Rothschild and Karl Jordan, during the first decades of the twentieth century, with 34 new taxa (Rothschild 1902, 1926; Rothschild and Jordan 1900, 1903, 1905). Debauche (1937) reported 42 geometrid species from Ethiopia with eight new descriptions. Likewise, Emilio Berio published many papers dedicated to the Erebidae and Noctuidae of East Africa, describing from Ethiopia 12 and 37 species, respectively (Berio 1939a, 1940a, 1943, 1944, 1945, 1947, 1954, 1962, 1975, 1977), some of them from the localities of Adu-Abuna and Metemma, at that time part of Eritrea, but now in Tigray, Northern Ethiopia (Berio 1937, 1939b, 1939c, 1940b, 1973, 1976). Pierre-Claude Rougeot has explored the country several times in 1970s and described 55 new species belonging to various families (Rougeot 1974, 1975, 1977, 1984, Plantrou and Rougeot 1979; Laporte and Rougeot 1981; Rougeot and Laporte 1983). The two French entomologists Bernard Laporte and Claude Herbulot in their publications described from Ethiopia 137 new noctuid (specifically, eight species of Erebidae, two species of Nolidae, and 127 Noctuidae) and 22 new geometrid taxa, respectively (Herbulot 1983, 1993, 2002; Laporte 1974, 1975, 1976, 1978; Rougeot 1977, 1984; Laporte and Rougeot 1981; Rougeot and Laporte 1983; Rougeot et al. 1991).

With the new millennium, the country has awakened a renewed interest from entomologists, which led to the description of 255 new taxa in 18 years. In particular, major contributions to Ethiopian Lepidoptera were made by Hermann H. Hacker, with various colleagues, for Erebidae, Nolidae and Noctuidae (178 new taxa); David Agzassiz for Yponomeutidae (five new taxa); Jósef Razowski and Pasquale Trematerra for Tortricidae (34 new taxa described); Axel Hausmann, Andrea Sciarretta and Francesco Parisi for Geometridae (27 new taxa); Ulf Eitschberger and Tomas Melichar for Sphingidae, with eleven new taxa (Hacker and Fibiger 2007; Hacker and Zilli 2007; Haxaire and Melichar 2008; Hausmann et al. 2014, 2016; Hacker et al. 2008, 2012; Razowski and Trematerra 2010, 2012; Hacker and Mey 2010; Hacker 2011, 2013, 2014, 2016, 2019; Eitschberger and Ströhle 2011; Melichar and Řezáč 2015; Eitschberger and Melichar 2016, Melichar et al. 2016; Razowski et al. 2018; Agassiz 2019).

Many of these and other minor contributions resulted from dedicated expeditions, such as the "Joint Ethiopian-Russian Biological Expedition" lead by Vasiliy Kravchenko from Tel Aviv University, Israel; the "Ethiopian Insects Project", between the Ethiopian Wildlife Conservation Authority (EWCA), the Bavarian State Collection of Zoology (ZSM) and the Museum Thomas Witt (MWM) in Munich, Germany; the projects carried out by the Italian entomologists of the University of Molise with EWCA and Ethiopian Biodiversity Institute (Kravchenko et al. 2007; Sciarretta et al. 2014; Hausmann et al. 2016).

2.4 CURRENT STATE OF KNOWLEDGE ON ETHIOPIAN LEPIDOPTERA

Based on the results of our current review, 2,438 Lepidoptera taxa (species or subspecies) are known to occur in Ethiopia hitherto, belonging to 48 families (**Table 1**). Full list: is accessible at https://doi.org/10.5281/zenodo.3234617. This number includes 170 taxa, which are not reported by the scientific literature but have been extracted from the above-mentioned websites.

In particular, 929 species or subspecies were described from type specimens collected in Ethiopia, 131 of them, mostly butterflies, at subspecific level (**Appendix 1**).

Table 1. Ethiopian Lepidoptera families and number of taxa (species and subspecies) reported.

No.	Family	Total number of taxa	Common name
1	Bedelliidae	1	Narrow-winged moths
2	Blastobasidae	2	Scavenger Moths
3	Bombycidae	2	Silkworm Moths
4	Brahmaeidae	2	Brahmin Moths
5	Carposinidae	1	Fruitworm Moths
6	Choreutidae	2	Metalmark Moths
7	Cosmopterigidae	4	Cosmet Moths
8	Cossidae	17	Carpenterworm Moths
9	Crambidae	109	Grass Moths
10	Depressariidae	2	Flat-bodied Moths
11	Drepanidae	1	Hook-tips
12	Elachistidae	1	Grass Miner Moths
13	Epermeniidae	1	Fringe-tufted moths
14	Erebidae	523	Tiger Moths
15	Eupterotidae	8	Snout moths
16	Euteliidae	10	Euteliid Moth
17	Gelechiidae	10	Twirler Moths
18	Geometridae	306	Geometer Moths
19	Glyphipterigidae	1	Sedge Moths
20	Gracillariidae	13	Leafminer Moths
21	Hesperiidae	36	Skipper Butterflies
22	Hyblaeidae	1	Teak Moths
23	Lasiocampidae	38	Lappet Moths
24	Limacodidae	15	Slug Moths
25	Lycaenidae	116	Gossamer Winged Butterflies
26	Lyonetiidae	2	Lyonet Moths
27	Metarbelidae	4	Wood-borer Moths
28	Noctuidae	471	Owlet Moths
29	Nolidae	85	Tuft Moths
30	Notodontidae	28	Prominent Moths

31	Nymphalidae	178	Brush Footed Butterflies
32	Oecophoridae	1	Concealer Moths
33	Papilionidae	17	Swallowtail Butterflies
34	Pieridae	79	Yellow & Whites & Sulphurs
35	Plutellidae	5	Diamondback Moths
36	Psychidae	6	Bagworm Moths
37	Pterophoridae	39	Plume Moths
38	Pyralidae	31	Snout Moths
38	Saturniidae	53	Emperor Moths
40	Scythrididae	7	Flower Moths
41	Sesiidae	6	Clearwing Moths
42	Sphingidae	81	Hawk Moths
43	Thyrididae	9	Picture Winged Leaf Moths
44	Tineidae	38	Fungus Moths
45	Tortricidae	60	Leafroller Moths
46	Uraniidae	3	Swallowtail Moths
47	Yponomeutidae	6	Ermine Moths
48	Zygaenidae	8	Burnet Moths
Total		2438	

It is interesting to note that endemic taxa number 664, approximately 27% of the total Lepidoptera. This high number can be explained by the particular physical and biogeographical history of the country and a broad range of different ecosystems with great diversity of habitats.

Given these numbers, knowledge on the Ethiopian butterflies and moths appear to be particularly unsatisfactory, when compared to their (estimated) potential total numbers with other countries. For instance, the two most diverse European Mediterranean countries, i.e., France and Italy, with a combined land surface comparable to Ethiopia, have ca. 5,109 and 5,086 species of Lepidoptera, respectively (Stoch 2003; Wikipedia 2011).

To better evaluate the level of knowledge of the lepidopteran fauna in Ethiopia, and to roughly estimate the real biodiversity, we can compare it with neighboring Kenya, which for several aspects can be considered similar to Ethiopia, but probably it has been better investigated. So far, from Kenya approximately 4,815 lepidopteran taxa were reported, belonging to 63 families (Sáfián et al. 2009; De Prins and De Prins 2019). The currently known number of species in Kenya is almost twice that of Ethiopia, and 15 families are not recorded at all in the latter country. Is it really due to difference in faunal richness between the two countries or because of the different level of investigation? A better idea can come from the differences observed within the single families. When considering most groups of the 'Microlepidoptera', very few investigations were made in Ethiopia and the difference in species numbers between the two countries is huge. Considering only the most species-rich families of Microlepidoptera, the percentage of species present in Ethiopia, compared to the species numbers in Kenya, is 10% for Scytrididae, 13% for Gelechiidae, 17% for Thyrididae, 31% for Tortricidae, 34% for Pyralidae, 45% for Crambidae, 46% of Pterophoridae, up to 76% for Tineidae. However, if we look at the 'larger moths' (Macroheterocera) and butterflies, which are better investigated in both countries, the difference is decreasing from 40% for Saturniidae, 41% for Geometridae, 50% for Lycaenidae, 53% for Sphingidae, 55% for Erebidae up to 77% for Papilionidae, 79% for Noctuidae, 91% for Nymphalidae, peaking to 132% in Pieridae, where Ethiopia shows a higher number of species than Kenya.

Although the two countries certainly exhibit faunistic differences, due to biogeographic or climatic factors, it seems clear that the Ethiopian fauna is seriously understudied in many groups. By analysing comprehensive revisions of single genera or families accompanied by major collection campaigns in Ethiopia, we can have an idea of the potential biodiversity the country inhabits.

The geometrid genus *Prasinocima* Warren, 1897 was subject of an extensive review focused on Ethiopian species, based on an investigation carried out in 100 collection localities in the country for more than 15 years, which included an integrative taxonomic analysis based on morphology and DNA barcodes (Hausmann et al. 2016). As a result of this contribution, the species number was raised from eight previously known Ethiopian species to 40, of which 19 were new to science. After the publication, another seven new species for the Ethiopian fauna were described. Authors of the same article estimated the number of Ethiopian geometrids to exceed 700 species once the unidentified material in their hands is examined, which may suggest a more realistic total species number in excess of 1,000 for the whole country.

Another contribution came from the revision that Hacker carried out on the subfamily Nolinae (Nolidae; Hacker et al. 2012; Hacker 2014), where many of the published data concerned sub-Saharan Africa. For Ethiopia, only three species were previously reported. After Hacker's monograph, the number was raised to 61 species, with 27 newly described taxa from Ethiopia. For Kenya, he raised the figure from 12 to 73, a number not far from that of Ethiopia.

Although these are two examples of taxonomically particularly difficult groups, we can assume similar multiplicators for the so-called 'Microlepidoptera' resulting in an estimate for the entire order of Lepidoptera in Ethiopia which may exceed 10,000 species, of which a number of species new for science. This estimate is based on, and in concordance with the usual ratio of geometrid species number versus lepidopteran species number of roughly 1:10, and on the usual ratio of the Rhopalocera (400+ species in Ethiopia) versus lepidopteran species number of roughly 1:20, as it results from large museum material (e.g. ZSM) and from various fauna inventories (e.g.

Bavaria: Haslberger and Segerer 2016; Europe: Karsholt and Razowski 1996; North America: Hodges et al. 1983). For the moth fauna of Africa, 38,988 species group names of them are listed by Afromoths (2019), of which 5510 (14%) are geometrids. The total number, however, does not include Rhopalocera names, with 4405 species (Williams 2018) and Microlepidoptera taxonomy is under represented, hence also here the "10%-rule" for the Geometridae ratio seems to apply, at least roughly.

2.5 DATA FROM DNA BARCODING

In the framework of the international Barcode of Life initiative, DNA barcodes (658 bp 5' COI gene fragment, cf. Hebertet al. 2003) have been assembled for Ethiopian Lepidoptera since 2006 with the aim to establish a national DNA reference library for integrated taxonomic studies. So far, 3160 DNA barcodes have been generated from Ethiopian Lepidoptera (including many Ethiopian type specimens), belonging to 1012 genetic clusters (Barcode Index Numbers, 'BINs') which are a good proxy for real species numbers (Ratnasingham and Hebert 2013; Hausmann et al. 2013). Most DNA barcodes could be assembled in the Geometridae (2290 barcodes, 571 BINs), Noctuidae (314 barcodes, 165 BINs) and Erebidae (246 barcodes, 143 BINs). Species coverage is particularly good in the smaller families such as the Saturniidae (121 barcodes, 36 BINs) and Sphingidae (70 barcodes, 24 BINs), while it is still being very poor in the 'Microlepidoptera'. All images and most metadata and molecular data are accessible in the public database BOLD (Ratnasingham and Hebert 2007).

2.6 ACTUAL CONSTRAINTS AND FUTURE PERSPECTIVES OF RESEARCH ON LEPIDOPTERA DIVERSITY OF ETHIOPIA

Butterflies and moths are a major component of biodiversity playing a crucial role in the ecosystem as primary consumers, essential part of food chains and pollinators. However, humans are exerting unprecedented pressures on all of the earth's ecosystems, and such pressures may affect all species (Sanchez-Bayo and Wyckhuyes 2019). Nature conservation strategies have focused most of their attention on the "charismatic megafauna", i.e., on mammals, birds, and other vertebrates. The vast majority of invertebrate species – although accounting for more than 80% of the animal species - are too poorly known to allow an assessment of how they are affected by human activities, and what might be done to mitigate the damage that humans cause. In most cases, the best way that can be done is to conserve their habitats so that most inhabiting species will continue to thrive.

The greatest threats to butterflies and moths are habitat fragmentation and destruction, intensification of agricultural practice with over-use of pesticides and herbicides; climate change mainly affecting endemic species adapted to mountainous habitats, whereas scientific collecting is absolutely negligible (Hausmann 2001; Sanchez-Bayo and Wyckhuyes 2019). In general, human activity is enormously threatening the global diversity of life on the planet. Rough estimates suggest that we are currently undergoing not only unprecedented, but also accelerating rates of species extinction (UNEP 2006; Sanchez-Bayo and Wyckhuyes 2019).

In the same manner, Ethiopia is experiencing major biodiversity loss, mainly related to extensive destruction of habitats, deforestation, land degradation, intensive agricultural expansion, climate change, excessive pesticide and herbicide use, introduction of exotic plant species, among others (EBI 2015; Tesfu et al. 2018). The loss of primary or native forest areas, due to clear cutting and conversion into agroforests, farmland or settlements, are currently the major threat to the Ethiopian biodiversity in general and Lepidoptera in particular.

Despite Ethiopia being known for its rich heritage of biological diversity and many diverse ecosystems, the conservation of its habitats have received scant attention. The system of protected areas so far established includes 21 national parks, four sanctuaries, eight wildlife reserves, 20 controlled hunting areas, six open hunting areas, six community conservation areas and 58 national forest priority areas (Young 2012), covering 14% of the country (EBI 2015). However, most of its biodiversity, including Lepidoptera, is still unexplored because of significant lack of national research capacity. Hence, in parallel to conservation programs and sustainable utilisation of biological resources, efforts for the preparation of a comprehensive bio-inventory should receive highest priority. Such an instrument must be considered an essential baseline for policy makers, planners, donors and researchers working on biodiversity conservation in Ethiopia.

In order to upsurge biodiversity knowledge, capacity building in the area at various levels is needed. Lack of well-organised natural history museums, specialists, and scientific societies providing support and fostering citizen science, international research networks and projects are among the identified gaps. Currently, most of the type specimens and reference collections are deposited outside the country of origin. In this context, the Nagoya Protocol (UNSG 2010), although intending to strengthen nations to conserve their genetic resources, to some extent could lead to the opposite effect by hampering international collaboration. Joint protocols and agreements between national actors (research institutes, governing agencies, universities, NGO's) and international research bodies should be promoted in a collaborative way, favoring shared, non-commercial biodiversity research. Close collaboration with museums and universities possessing reference collections and skills, designing and organising projects are required to teach and train a generation of highly competent scientists and managers so that collections of Ethiopian insects could be built and properly managed. In absence of these minimum requirements, establishing a national entomological museum/collection could be ineffective in promoting the study and conservation of local biodiversity resources.

2.7 REFERENCES

Agassiz D. (2019). The Yponomeutidae of the Afrotropical region (Lepidoptera: Yponomeutoidea). Zootaxa, 4600 (1): 1–69.

Beccaloni G., Scoble M., Kitching I., Simonsen T., Robinson G., Pitkin B., Hine A., Lyal C. (2003). The Global Lepidoptera Names Index LepIndex). http://www.nhm.ac.uk/ourscience/data/lepindex/lepindex/ [accessed 25 March 2019]

Berio E. (1937). Eteroceri africani apparentemente nuovi. Annali del Museo Civico di Storia Naturale di Genova, 59: 370–393.

Berio E. (1939a). Lepidoptera. In: Missione biologica nel paese dei Borana. Raccolte Zoologiche: 9–15.

Berio E. (1939b). Contributi alla conoscenza dei lepidotteri eteroceri dell'Eritrea I. Lista delle specie condescrizioni delle nuove entità raccolte negli anni 1934 al 1937 dal sig. Francesco Vaccaro. Memoriedella Società Entomologica Italiana, 17: 47–62, pls 1, 2.

Berio E. (1939c). Contributi alla conoscenza dei lepidotteri eteroceri dell'Eritrea II. Eteroceri raccolti dal cap. Antonio Richini e famiglia nella zona di Adua. Bollettino della Società entomologica italiana, 71 (8): 164–165.

Berio E. (1940a). Diagnosi di eteroceri africani. Memorie della Società Entomologica Italiana, 19: 125–128.

Berio E. (1940b). Contributo alla conoscenza dei lepidotteri eteroceri dell'Eritrea VI. Eteroceri raccoltidal cap. Richini ad Adi-Abuna (Adua) nel Marzo 1940. Bollettino della Società entomologica italiana, 72 (10): 161–165.

Berio E. (1943). Descrizione dell'armatura genitale di alcune Hypotacha e diagnosi di una nuove specie(Lepidoptera: Noctuidae). Annali del Museo Civico di Storia Naturale di Genova, 62: 25–29.

Berio E. (1944). Missione biologica Sagan-Omo diretta dal Prof. E. Zavattari. Lepidoptera Agaristidae e Noctuidae Memorie della Società Entomologica Italiana, 23: 74–79.

Berio E. (1945). Reperti di nuove Noctuidae dell'Africa orientale. Memorie della Società Entomologica Italiana 24: 81–83.

Berio E. (1947). Diagnosi di alcune Erastriinae africane (Lepidoptera: Noctuidae). Memorie dellaSocietà Entomologica Italiana, 26: 12–15.

Berio E. (1954). Diagnosi di nuove Catocaline africane (Lepidoptera: Noctuidae). Bollettino della Società entomologica italiana, 84(3–4): 55–58.

Berio E. (1962). Descrizione di nuove Noctuidae africane (Euxoinae). Annali del Museo Civico di StoriaNaturale di Genova, 73: 196–208.

Berio E. (1973). Nuove specie e genere di Noctuidae Africane e Asiatiche e note sinonimichi. Parte II. Annali del Museo Civico di Storia Naturale di Genova, 79: 126 –171.

Berio E. (1975). Nuove genere e nuove specie di Noctuidae Africane (Lepidoptera). Annali del Museo Civico di Storia Naturale di Genova, 80(1974): 217–225.

Berio E. (1976). Nuovi generi e specie di Noctuidae dell'Africa equatoriale (Lepidoptera). Annali del Museo Civico di Storia Naturale di Genova, 81: 96–123.

Berio E. (1977). Diagnosi di nuovi taxa di Noctuidae del globo (Lepidoptera). Annali del Museo Civico di Storia Naturale Giacomo Doria, 81: 321–339.

Biodiversity Institute of Ontario (2006). All Leps Barcode of Life Project. http://www.lepbarcoding.org/ [accessed 28 April 2018].

Brandao S., Lyra L., Freitas L. (2009). Barcoding Lepidoptera: Current Situation and Perspectives on the Usefulness of a Contentious Technique. Neotropical Entomology,38(4): 44 –451.

Burgess N., D’Amico Hales J., Underwood E., Dinerstein E., Olson D., Itoua I., Schipper J., Ricketts T., Newman K. (2004). Terrestrial Ecoregions of Africa and Madagascar. Island Press, Washington, 497 pp.

Clausnitzer V. (2014). NABU’s Biodiversity Assessment at the Kafa Biosphere Reserve, Ethiopia, 162 pp.

Clausnitzer V., Dijkstra K.D. (2005). The dragonflies (Odonata) of Ethiopia, with notes on the status of its endemic species and the description of a new one Entomologische. Zeitschrift, 115: 117–130.

Debauche H.R. (1937). Entomological expedition to Abyssinia 1926–27: Lepidoptera, Geometridae. Annals and Magazine of Natural History, (10)20: 320–344, pls 7, 8.

De Prins J., De Prins W. (2019). Afromoths, online database of Afrotropical moth species (Lepidoptera). http://www.afromoths.net/ [accessed 25 March 2019]

Ethiopian Biodiversity Institute (EBI) (2015). National Biodiversity Strategy and Action Plan of Ethiopia (NBSAP). Rela Printing Press, Addis Ababa, 120 pp.

Eitschberger U., Melichar T. (2016). Revision und Neugliederung aller Arten, die momentan in der Gattung *Macropoliana* auct. (nec Carcasson, 1968) vereint, zusammengefaßt sind. Neue. Entomologische Nachrichten, 71: 1–639.

Eitschberger U., Ströhle M. (2011). Der Artkomplex von *Lophostethus dumolinii* (Angas, [1849]) im vergleich mit *Lophostethus negus* Jordan, 1926 Neue Entomologische Nachrichten, 67: 121–255.

Goff R. (2008).African moths. http://www.africanmoths.com [accessed 25 March, 2019]

Gordon F., Carillet J. (2003*).*Ethiopia and Eritrea*.* Lonely Planet, *Melbourne, 368 pp.*

Guénée M.A. (1852-1857). Histoire naturelle des Insectes. V–X. Species général des Lépidoptères. Librairie encyclopédique de Roret, Paris.

Guérin-Méneville F.E. (1849). Ordre des lepidopteres. Famille des diurnes. In: Lefebrvre T (Ed) Voyageen Abyssinie. Zoologie, 6(4): 364–386.

Hacker H.H. (2011). Neue *Metachrostis* Hübner (1829) Arten aus dem Yemen und aus Afrika (Lepidoptera, Noctuidae, Eublemminae). Esperiana, 16: 213–231, pls 28–30.

Hacker H.H. (2013). Additions to several revisions of Noctuid genera revised from 2001 to 2011, with descriptions of nine new species and three new subspecies from Africa, Arabian Peninsula and Iran, with faunistic notes (Noctuioidea). Esperiana, 18: 199–220, pls 13, 14.

Hacker H.H. (2014). Revision of the tribe Nolini of Africa and the Western Palaearctic Region (Lepidoptera, Noctuoidea, Noctuidae, Nolinae) Supplement 1. Esperiana, 19: 121–179.

Hacker H.H. (2016). Systematic and illustrated catalogue of the Macroheterocera and Cossoidea Leach, [1815], Zygaenoidea Latreille 1809, Thyridoidea Herrich-Schäffer 1846 and Hyblaeoidea Hampson, 1903 of the Arabian Peninsula, with a survey of their distribution (Lepidoptera). Esperiana, 20(1): 1–742; (2): 1–430.

Hacker H.H. (2019). Biogeography; Bolebiinae (Lepidoptera, Noctuodea, Erebidae) – Moths of Africa. Systematic and illustrated Catalogue of the Heterocera of Africa, Volume 1. Esperiana Verlag, Bad Staffelsein, Germany, 816 pp.

Hacker H.H., Fibiger M. (2007). Review of the African species of the genus *Feliniopsis* Roepke, 1938 (*Eutamsia* Fletcher, 1961) (Lepidoptera: Noctuidae). Esperiana Memoir, 3: 59–178, pls 10–20.

Hacker H.H., Mey W. (2010) Beiträge zur Taxonomie, Systematik und Faunistik von Noctuidae (Noctuoidea), hauptsächlich aus dem Museum für Naturkunde Berlin. Esperiana Memoir, 5: 457–468.

Hacker H.H., Zilli A. (2007). Revisional notes on the genus *Thiacides* Walker, 1855, with descriptions of Thiacidinae subfam. nov. and eleven species (Lepidoptera: Noctuidae). Esperiana Memoir, 3: 179–246, pls 21–30.

Hacker H.H., Legrain A., Fibiger M. (2008). Revision of the genus *Acontia* Ochsenheimer, 1816 and the tribus Acontiini Guenée, 1841 (Old World) (Lepidoptera: Noctuidae: Acontiinae). Esperiana, 14: 7–533, pls 1–38.

Hacker H.H., Schreier H.P., Goater B. (2012). Revision of the tribe Nolini of Africa and the Western Palaearctic Region (Lepidoptera, Noctuoidea, Noctuidae, Nolinae). Esperiana, 17: 1–612.

Hampson G.F. (1896). On the classification of the Schoenobiinae and Crambinae, two subfamilies of Moths of the family Pyralidae. Proceedings of the Zoological Society of London, 1895(4): 897–974.

Hampson G.F. (1898). Catalogue of the Lepidoptera Phalaenae in the collection of the British Museum. Syntomidae The Trustee of the British museum (Natural History), 1: i–xxi, 1–538, pls 1–17.

Hampson G.F. (1899). A revision of the moths of the subfamily *Pyraustinae* and family *Pyralidae*, part 1. Proceedings of the Zoological Society of London, 1898(4): 590–761, pls 49–50.

Hampson G.F. (1905). Descriptions of new genera and species of Syntomidae, Arctiadae, Agaristidae, and Noctuidae. The Annals and Magazine of Natural History (7th series), 15(89): 425–453.

Hampson G.F. (1909). Descriptions of new genera and species of Syntomidae, Arctiadae, Agaristidae and Noctuidae. Annals and Magazine of Natural History (8), 4(22): 344–388.

Hampson G.F. (1910). Descriptions of new African moths. The Annals and Magazine of Natural History (8th series), 6(31): 116–141.

Hampson G.F. (1916). Descriptions of new species of the family Arctiadae in the British Museum. Novitates Zoologicae, 23(2): 230–240.

Hampson G.F. (1913). Catalogue of the Lepidoptera Phalaenae in the collection of the British Museum (Nat. Hist.). XII. Noctuidae. The Trustees of the British Museum (N.A.T.H.ST.), London 12: i–xiii, 1–626.

Hampson G.F. (1918). Descriptions of new Pyralidae in the subfamily Pyraustinae (cont.). TheAnnals and Magazine of Natural History (9th series), 2 (9): 181–196; (11): 393–407.

Hampson G.F. (1919). Descriptions of new Pyralidae of the subfamilies Crambinae and Siginae. The Annals and Magazine of Natural History, (9) 4 (20): 53–68; (21): 137–154; (23): 305–326.

Hampson G.F. (1926). Descriptions of new genera and species of Lepidoptera Phalaenae of the subfamily Noctuinae (Noctuidae) in the British Museum (Natural History):1–641.

Hampson G.F. (1930). New genera and species of Phycitinae (Lepidoptera, Pyralidae) The Annals and Magazine of Natural History (10th series), 5: 50–80.

Haslberger A., Segerer A.H. (2016). Systematische, revidierte und kommentierte Checkliste der Schmetterlinge Bayerns (Insecta: Lepidoptera). Mitteilungen der Münchner Entomologischen Gesellschaft, Supplement 106: 1–336.

Hausmann A. (2001). Introduction. Archiearinae, Orthostixinae, Desmobathrinae, Alsophilinae, Geometrinae. In: A. Hausmann (ed.): TheGeometrid Moths of Europe 1. Apollo Books, Stenstrup, 282 pp.

Hausmann A., ParisiF., Sciarretta A. (2014). The geometrid moths of Ethiopia I: tribes Pseudoterpnini and Comibaenini (Lepidoptera: Geometridae, Geometrinae). Zootaxa,3768(4): 460–468.

Hausmann A., Parisi F., Sciarretta A. (2016). The Geometrinae of Ethiopia II: Tribus Hemistolini, genus *Prasinocyma* (Lepidoptera: Geometridae, Geometrinae). Zootaxa, 4065(1): 1–63.

Hausmann A., Godfray H.C.J., Huemer P., Mutanen M., Rougerie R., van Nieukerken E.J., Ratnasingham S., P.D.N.Hebert (2013). Genetic patterns in European geometrid moths revealed by the Barcode Index Number (BIN) system. PLoS ONE 10.1371/journal.pone.0084518.

Haxaire J., Melichar T. (2008). Un nouveau Sphingidae d'Ethiopie: *Rufoclanis numosae rostislavi* ssp. n. (Lepidoptera Sphingidae). The European Entomologist, 1(3–4): 111–115.

Hebert P.D., Cywinska A., Ball S.L., deWaard J.R. (2003). Biological identifications through DNA barcodes, Proceedings Royal Society London Biological Sciences SeriesB, 270: 313–321.

Herbulot C. (1983). Missions de MPC Rougeot en Ethiopie et en République de Djibouti. Lepidoptera Geometridae 2. Bulletin mensuel de la Société linnéenne de Lyon, 52(1): 10–21.

Herbulot C. (1993). Deux nouveaux *Prasinocyma* d'Ethiopie (Lepidoptera: Geometridae). Bulletin de la Société entomologique de Mulhouse, 23(2): 50.

Herbulot C. (2002). Huit nouveaux Geometridae d'Amérique du Sud, d'Afrique centrale et orientale et d'Asie du Sud-est (Lepidoptera). Lambillionea, 102(4): 451–458.

Hodges R.W., Dominick T., Davis D.R., Ferguson D.C., Franclemont J.G., Munroe E.G., Powell J.A. (1983).Check list of the Lepidoptera of America North of Mexico. E.W. Classey Ltd. and the Wedge Entomological Research Foundation, London, 284 pp.

International Commission on Zoological Nomenclature (ICZN) (1999). International Code of Zoological Nomenclature. Fourth Edition. The International Trust for Zoological Nomenclature, London, UK, 106 pp.

Karsholt O., Razowski J. (1996). The Lepidoptera of Europe. A Distributional Checklist. Apollo Books, Stenstrup, 380 pp.

Kravchenko D., Ronkay L., Speidel W., Witt T., Fibiger M., Rybalov L., Mohammed D., Habte T.,Müller J. (2007). Contribution to the Noctuidae fauna of Ethiopia. Atalanta, 38(3/4): 385–39.

Kristensen N., Scoble M., Karsholt O. (2007). Lepidoptera phylogeny and systematics: the state of inventorying moth and butterfly diversity. Zootaxa, 1668: 699–747.

Laporte B. (1974). Diagnoses de nouveaux genres et de plusieurs espèces inédites de Noctuidae trifides (Lépidoptères) d'Ethiopie. Bulletin mensuel de la Société linnéenne de Lyon, 43(6): 216–224; (7): 246–251, pls 1, 2.

Laporte B. (1975). Diagnoses de 17 nouvelles espèces de Noctuidae d'Ethiopie et du Kenya (Lépidoptères). Bulletin mensuel de la Société linnéenne de Lyon, 44(8): 277–287.

Laporte B. (1976). Diagnoses de nouveaux genres et de plusiers espèces inédites de Noctuidae trifinae (Lépidoptères) d'Ethiopie (3e note). Bulletin mensuel de la Société linnéenne de Lyon, 45(3): 131–136.

Laporte B. (1978). Nouvelles espèces de noctuelles trifides africaines (Lepidoptera: Noctuidae) Bulletin de la Société entomologique de France, 83: 62–65.

Laporte B., Rougeot P.C. (1981). Description d'une nouvelle espèce de *Batuana* (Lepidoptera: Noctuidae, Trifidae) d'Ethiopie. Bulletin mensuel de la Société linnéenne de Lyon, 50(4): 126–127.

Lucas H. (1852). Description de nouvelles espèces de Lepidopteres appartenant aux collections entomologiques de Musee de Paris Revue et. Magasin de Zoologie Pure et Appliquee, 4: 324–345; 422–432.

Melichar T., Řezáč M. (2015).A new species of the genus *Theretra* Hübner 1819 (Lepidoptera, Sphingidae) from Ethiopia. The European Entomologist, 7(2): 40–47.

Melichar T., Řezáč M., Milčíková A. (2016). Descriptions of three new taxa in the *Temnora pylas* (Cramer, 1779) species group (Lepidoptera, Sphingidae), with notes on several other taxa. The European Entomologist, 8(3): 105–131.

Meyrick E. (1932). Entomological Expedition to Abyssinia, 1926–7. Microlepidoptera. Transactions of the Entomological Society of London, 80(1): 107–120.

Mittermeier R.A., Turner W.R., Larsen F.W., Brooks T.M., Gascon C. (2011). Global Biodiversity Conservation: The Critical Role of Hotspots. Biodiversity Hotspots 3–22. doi: 10.1007/978–3–642–20992–5_1.

Natural History Museum (2014). The Global Lepidoptera Names Index. http://www.nhm.ac.uk/our-science/data/lepindex [accessed 25 Mar 2019]

Navarro R. (2007). LepiMap. http://lepimap.adu.org.za [accessed on 10 April 2019]

Nazari V., Larsen T.B., Lees D.C., Brattstro O., Bouyer T., Van de Poel G., Hebert P.D.N. (2011). Phylogenetic systematics of *Colotis* and associated genera (Lepidoptera: Pieridae): evolutionary and taxonomic implications.Journal of Zoological Systematics and Evolutionary Research 49(3): 204–215.

Nieukerken, E.J. van, Kaila L., Kitching I.J., Kristensen N.P., Lees D.C., Mine, J., Mitter C., Mutanen M., Regier J.C., Simonsen T.J., Wahlberg N., Yen S.H., Zahiri R., Adamski D., Baixeras J., Bartsch D., Bengtsson B.Å., Brown J.W., Bucheli S.R., Davis D.R., De Prins J., De Prins W., Epstein M.E., Gentili-Poole P., Gielis C., Hättenschwiler P., Hausmann A., Holloway J.D., Kallies A., Karsholt O., Kawahara A.Y., Koster S.J.C., Kozlov M.V., Lafontaine J.D., Lamas G., Landry J.F., Lee S., Nuss M., Park K.T., Penz C., Rota J., Schmidt B.C., Schintlmeister A., Sohn J.C., Solis M.A., Tarmann G.M., Warren A.D., Weller S., Yakovlev R.V., Zolotuhin V.V., Zwick A. (2011). Order Lepidoptera Linnaeus, 1758. In: Zhang Z. (Ed.)

Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness Zootaxa, 3148: 212–221.

Plantrou J., Rougeot P.C. (1979). Mission P.C. Rougeot en Ethiopie, I et II – 1978. *Charaxes* inedits du Sud ethiopien. (Lepidoptera: Nymphalidae. Bulletin de la Société Entomologique de France, 139:138–142.

Ratnasingham S., Hebert P.D.N. (2007). BOLD: The Barcode of Life Data System. www.barcodinglife.org [accessed 15 March 2019]

Ratnasingham S., Hebert P.D. (2013). A DNA-based registry for all animal species: The Barcode Index Number (BIN) System. PLOS ONE, 8 (8): e66213.

Razowski J., Trematerra P. (2010). Tortricidae (Lepidoptera) from Ethiopia. Journal of Entomological and Acarological Research, 42(2): 47–79.

Razowski J., Trematerra P. (2012).Tortricidae (Lepidoptera) from Ethiopia 2.Journal of Entomological and Acarological Research, 44:37–40.

Razowski J., Trematerra P., Colacci M. (2018). Tortricidae (Lepidoptera) from Ethiopia 3. SHILAP Revista de Lepidopterologia,46(181): 91–104.

Reiche L. (1850). Entomologie. In: Ferrets PVA, Galinier JG (1847–1850): Voyage en Abyssinie dans les provinces du Tigre, du Samen et de l'Ahmarra, Paulin Libraire Éditeur, Paris, 258–471.

Rothschild W. (1902). Some new African Lepidoptera discovered by Oscar Neumann. Novitates Zoologicae, 9: 595–598.

Rothschild W. (1926). On some African Papilios, with descriptions of new forms. Annals and Magazine of Natural History, (9)17; 113 (112–114).

Rothschild W., Jordan K. (1900). A monograph of *Charaxes* and the allied prionopterous genera. Novitates Zoologicae, 7: 287–524.

Rothschild W., Jordan K. (1903). Lepidoptera collected by Oscar Neumann in North-East Africa. Novitates Zoologicae, 10: 491–542.

Rothschild W., Jordan K. (1905). Lepidoptera collected by Oscar Neumann in North-East Africa (continuation). Novitates Zoologicae, 12:175–191.

Rougeot P.C. (1974). Sur deux nouvelles espèces d'Attacides d'Afrique orientale (Lepidoptera: Attacidae). Bulletin de la Société entomologique de France, 78(1973) ; (11–12): 334–336.

Rougeot P.C. (1975). Diagnoses de trois nouvelles espèces de lépidoptères hétérocères d'Afrique orientale. Lambillionea, 75(9–10) :68–71.

Rougeot P.C. (1977). Missions entomologiques en Ethiopie 1973–1975. Fascicule 1. Mémoires du Muséum national d'Histoire naturelle(A), 105: 1–150, pls 1–20.

Rougeot P.C. (1984). Missions entomologiques en Ethiopie 1976–1982. Fascicule II. Mémoires du Muséum national d'Histoire naturelle (A), 128: 1–93, pls 1–18.

Rougeot P.C., Laporte B. (1983). Lépidoptères du Haut-Simyen (Ethiopie du Nord). Bulletin mensuel de la Société linnéenne de Lyon, 52(7): 219–232.

Rougeot P.C., Bourgogne J., Laporte B. (1991). Les Lépidoptères Hétérocères d'Afrique orientale. Annales de la Société entomologique de France (NS), 27(4): 407–463.

Sáfián S., Collins S.C., Kormos B., Siklosi A. (2009).Checklist of the butterflies (Papilionoidea and Hesperoidea) of Ethiopia. African Butterfly Database. https://www.abdb-africa.org/ [Accessed 1 March 2019]

Sanchez-Bayo F., Wyckhuyes K.A. (2019). Worldwide decline of the entomofauna: a review of its drivers. Biological Conservation, 232: 8–27.

Sciarretta A., Hausmann A., Parisi F. (2014). Recent advances in the knowledge of Geometrid moths of Ethiopia. P. 259 In: Hausmann A (ed.). Proceedings of the eighth Forum Herbulot 2014. How to accelerate the inventory of biodiversity (Schlettau, 30 June – 4 July 2014) Spixiana 37(2).

Stoch F. (2003). Checklist of the Italian fauna online. http://www.faunaitalia.it/checklist/introduction.html [accessed 15 March 2019]

Tesfu F., Weldemariam T., Asersie A. (2018). Impact of human activities on biosphere reserve. A case study from Yayu Biosphere Reserve, Southwest Ethiopia. International Journal of Biodiversity Conservation, 10(7): 319–326. https://doi.org/10.5897/IJBC2016.1005

United Nations Environment Programme (UNEP) (2006). 2005 Annual Evaluation Report. https://www.unenvironment.org/resources/evaluation-synthesis-reports/unep-annual-evaluation-report-2005, 70 pp. [accessed 16 April 2019].

United Nations, Secretary-General (UNSG) (2010). Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity. (29 October 2010). Available at https://treaties.un.org/doc/Treaties/2010/11/20101127%2002-08%20PM/XXVII-8-b-Corr-Original.pdf [accessed 16 April 2019].

Wikipedia (2011). List of Lepidoptera of Metropolitan France. https://en.wikipedia.org/wiki/List_of_Lepidoptera_of_Metropolitan_France. [Accessed 15 March 2019]

Williams MC (2018). Afrotropical butterflies and skippers. A digital encyclopaedia. https://www.metamorphosis.org.za/?p=articles&s=atb [accessed 28 February 2019].

Young J (2012). Ethiopian protected areas. A 'Snapshot'. A reference guide for future strategic planning and project funding. Ethiopian Wild Life Authority, Addis Ababa, 46 pp.

Supplemental Data

The Supplemental Data to this manuscript is rather extensive. Therefore, it has been made accessible at DOI: https://doi.org/10.5281/zenodo

Chapter 3. ASSESSING LEPIDOPTERAN DIVERSITY AMONG VARIOUS LAND USE TYPES IN MT. CHOKE, ETHIOPIA

3.1 INTRODUCTION

There is a growing change of natural environments around the world, as a result of an alarming increase in human population in recent decades. Especially, huge areas of diverse tropical forest are lost or degraded every year with dramatic consequences for biodiversity. Most importantly, conversion of forests into agricultural fields and pastures is a major driver of biodiversity change globally (Foley et al. 2005, Millennium Ecosystem Assessment 2005; Fugère et al. 2016). This reduction of biological diversity will negatively affect vital ecosystem functions that regulate the Earth system upon which humans ultimately depend. Specially, insects are among the most severely and quickly affected taxa by changes in an ecosystem. Therefore, being the insects responsible for many processes in ecosystem, their loss can have negative effects on entire communities. Thus, a scientific understanding of insect responses to human activity is very important to evaluate functional consequences of human disturbance on ecosystems (Nichols et al. 2007).

Concurrently, insects diversity represent the most species rich taxa, provide a wide range of ecosystem processes and conditions to sustain human life (Chivian and Bernstein 2008). They are found in many habitats and niches, making ecological comparisons possible, and they can indicate areas of endemism and play a significant role in ecosystem functioning by influencing ecosystem dynamics through numerous mechanisms including nutrients cycling, pollinate plants, disperse seeds, maintain soil structure and fertility, control populations of other organisms and serving as source of food and hosts for multiple other organisms at higher trophic levels. They are enormously successful organisms, both in terms of numbers of species and abundance (Labandeira et al. 2002).

Because of their high diversity, many species have specialised larval host requirements (Kroon and Williamson 1999). Thus, they affect a significant proportion of plant species in all terrestrial ecosystems that support life. Scoble (1995) also noted that insects are major herbivores, thereby linking primary producers and consumers in ecosystems. A typical lepidopteran insect community has (1) a species diversity and composition that varies over broad spatial scales; (2) species dominance and evenness within a community that is determined at fine spatial scales; and

(3) changes in species richness across all spatial scales, with unique species encountered at each sampling level (Summerville and Crist 2004). The better-known groups of Lepidoptera (butterflies in particular) have often been advocated as useful indicators of environmental changes (Hill and Hamer 2004) or levels of disturbance (Daily and Ehrlich 1995).

Thus, studies on both the abiotic and the biotic components of ecosystems are required to investigate the existing condition of a given ecosystem. Especially, the study of entomological fauna is an essential element in the dynamics and functioning of the terrestrial and aquatic ecosystems. Its ecological role as well as the bio-indicator character of some can indicate the health status of these ecosystems and determine certain factors related to the degradation of these ecosystems. Most importantly, the quantitative measures of insect species and individual abundance provide standardized comparative values for evaluation of various habitats, communities, and ecosystem.

Specifically, insect ecological monitoring is important for several reasons: Many ecosystems and communities remain poorly understood and data gathered in the process of monitoring can add substantial to our knowledge of these systems. Moreover, information gathered from monitoring can be used as an early warning system for quick action against biodiversity loss and initiate political and management action to retard or prevent adverse changes. Monitoring also provides information that can be used to better understand the implications of a changing environment (An and Choi 2013; Spellerberg 2005).

Hence, Lepidoptera, scaly winged insects that account the second largest, diverse, widespread, and widely recognized insect's order in the class Insecta, contribute an essential part as the environmental indicators because they are sensitive and react quickly to subtle changes in environmental and habitat conditions (Hill and Hamer 2004; Munyuli 2012). Due to their short life cycle, narrow niches and relatively low mobility, they are more sensitive to land-cover and land-use changes than long-lived animals (Munyuli 2012). Most importantly, Lepidoptera are valuable indicators of environmental quality, considering their high degree of host-plant specialization and vulnerability to habitat deterioration (Erhardt and Thomas 1991). Given their presence in a broad range of habitats, the loss of Lepidoptera may directly influence the delivery of key ecosystem services such as pollination and natural pest control (Fox 2013).

The present study therefore was undertaken to assess the ecosystem status using Lepidopteran diversity as bioindicators in five different land-use types in Choke Mountains, Ethiopia. This environmental assessment considers the impacts of human activities on the abundance, distribution and composition of the lepidopteran fauna in the study area. The main impacts upon Lepidoptera diversity are considered to be disturbance and interference with their ecological performance. Thus, the study assessed preliminarily, the abundance and diversity of Lepidoptera fauna at species level.

The study sites were carefully selected as representatives of the ecosystems of the study area. Since, diversity, abundance and evenness along with plant composition were the parameters considered to determine the state of the ecosystems. The sampling was carried out over 1-year study period.

The specific objectives of this study include:

- Undertake baseline study on the diversity and abundance of Lepidoptera fauna around mountains Choke.
- Evaluate the potential impacts of human activities on Lepidoptera diversity in different habitats around mountains Choke.

3.2 MATERIAL AND METHODS

3.2.1 Description of the study area

This study was conducted in East Gojam Zone of Amhara National Regional State in Northern Ethiopia. Here the Choke Mountains are located between 6°00'–10°00'N and 36°00'–40°00'E (**Fig. 4**), and are part of the Blue Nile basin.

The mountain range is located on a plateau that rises from a block of meadows and valleys and has elevation ranging from approximately 800 to 4200 m above sea level. However, the data collection for this research was restricted to an altitude range from 2200 to 2900 m above sea level. The amount of annual rainfall varies from 900 to 1800 mm. The mean monthly temperature of the area was 17.6°C and the average annual rainfall in the last ten years was 1377 mm. During the hottest months (January–May), temperature reaches about 27 °C (Western Amhara Meteorological Service Center 2019). The area experiences unimodal rainfall and October to February is dry season where as March to September is wet season. Heavy rain is prominent in June, July and August. The agricultural production system in the area though varies with agro-ecology, most are characterized by subsistent mixed crop–livestock production system.

In the area, four types of habitat with different level of human impact, selected on the basis of the main land use, were selected: Forest Fragment of natural forest (FF), Bush Land (BL), Crop Fields (CF) and Mosaic Environment (ME). In each of them, four sampling sites were selected at a distance of at least 300 m from each other.

At the meantime, in order to have a synthetic description of Lepidoptera communities in the natural forests of corresponding altitudes, three sampling sites in relatively undisturbed Natural Forests (NF), falling in the territory of the Blue Nile basin, were selected: Wof Washa Natural Forest in Ankober (North Shewa Zone), Delima Natural Forest (Michakel district in East Gojam), and Bradi Natural Forest (Guangua district in Awi Zone). All these natural forests are categorized as Dry Evergreen Afromontane vegetation.

Map of Amhara Region with the sample sites in East Gojam, Awi and North Shewa Zones is presented in **Fig. 4**.

Altitude and geographical coordinates of sampling sites were measured with the Global Positioning System (GPS) using a Garmin GPS III instrument (Garmin Instruments Inc., Olathe, KS, USA). The locations of sampling sites are defined below in **Table 2**.

A brief description of each locality is reported here after. Unless differently indicated, the vegetation description derived by personal observations.

Table 2.Locations of collection sites and number of samples

Land use types		Latitude (N)	Longitude (E)	Altitude (m/a.s.l)	Number ofsampling nights
Natural Forest (NF)	Wof Washa	9°44'38.79"	39°44'50.30"	2900	12
	Delima	10°37'26.24"	37°40'50.60"	2377	12
	Bradi	10°51'4.35"	36°37'15.86"	2182	12
Forest Fragment (FF)		10°26'28.22"	37°43'47.78"	2600	12
Bush Land (BL)		10°25'19.57"	37°43'15.72"	2539	12

Mosaic Environment (ME)	10°26'32.12"	37°44'54.82"	2467	12
Crop Fields (CF)	10°27'1.33"	37°44'38.37"	2531	12

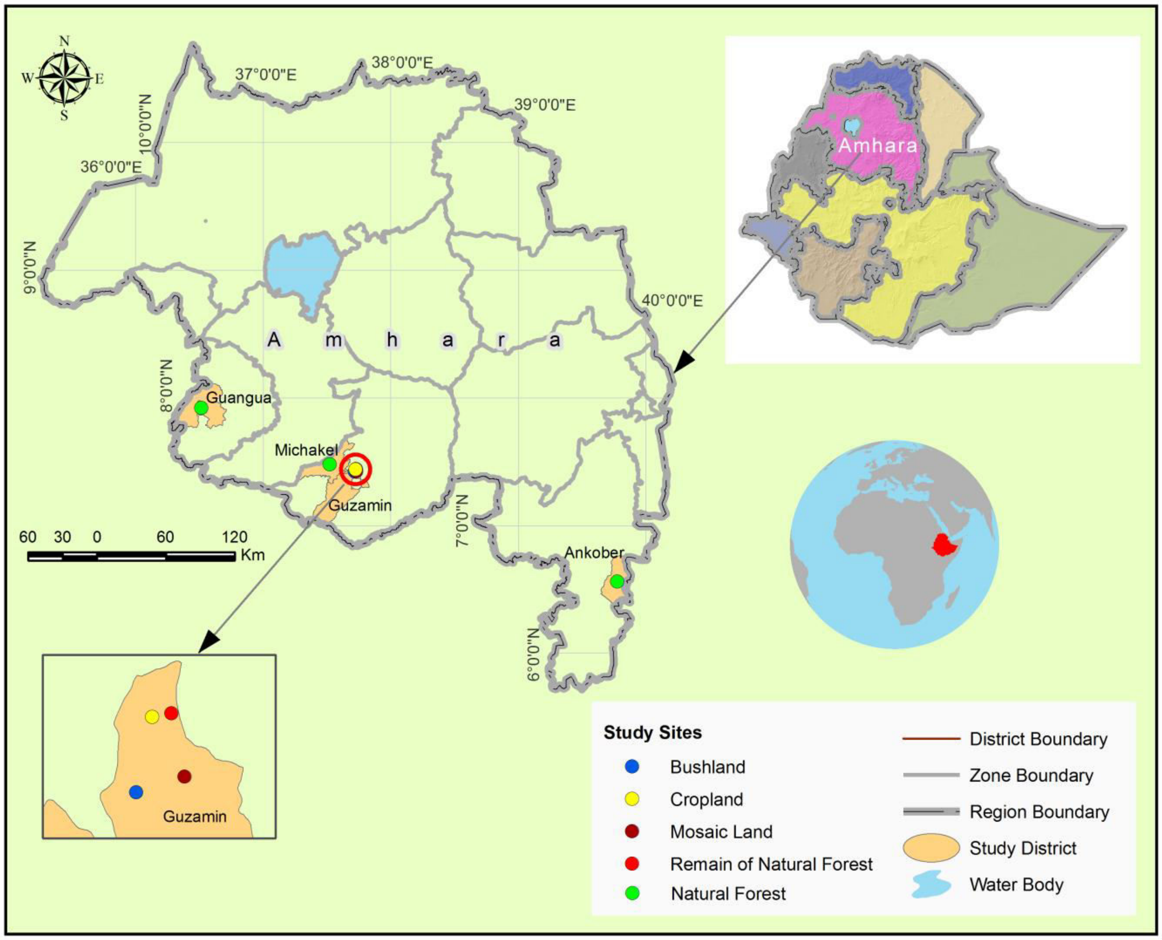

Figure 4. Map of the study area and location of the sampling sites.

Bradi Natural Forest

Bradi natural forest is located in Guangua district, Awi Zone in Amhara National Regional State, North Western Ethiopia, approximately 476 km from Addis Ababa. It is part of the Gojam Floristic Region, western Ethiopian highlands (Friis et al. 2010). This natural forest is located in the Blue Nile basin and categorized as Dry Evergreen Afromontane vegetation. The area encompasses about 458 hectares of land (**Fig. 5**). Floristic richness record of the area showed that a total of 110 species belonging to 62 woody species and 48 herbaceous species (**Appendix II**) that is dominated by *Rothmania urcelliformis*, *Vepris dainellii*, *Rytigynia neglecta*, *Albizia schimperiana* and *Croton macrostachyus*.

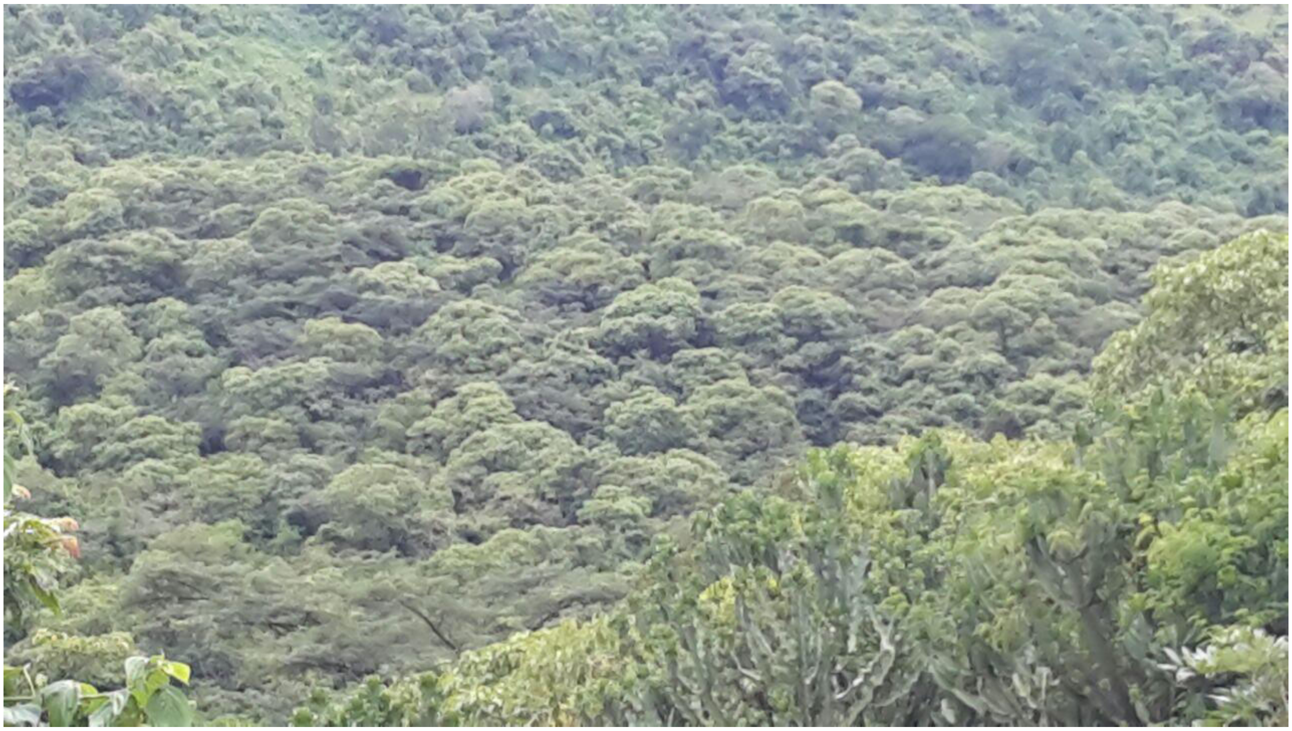

Figure 5. Partial view of Bradi Natural Forest (NF).

Wof Washa Natural Forest

Wof Washa Natural Forest is located in Ankober district that is situated in north Shewa Zone of Amhara National Regional State (**Fig. 6**). The District is perched on the eastern escarpment of the Ethiopian highlands and located at 172 km north of Addis Ababa, the Ethiopian capital. Elevation in Ankober District ranges from 1300 m asl near Addis Alem area to 3700 m asl at Kundi Mountain. Annual rainfall in the District ranges from 1000 to 1400 mm and cold temperature is prominent for most of the year.

Figure 6. Partial view of Wof Washa Natural Forest.

Delima Natural Forest

It is a dry ever green montane forest in Michakel district, East Gojam Zone. The study site is situated between three Kebeles (villages) of the district (latitudes 10º37’26”N and longitudes 37º40’50”E). The average annual rain fall and temperature is between 900 mm to 1800 mm and 18ºC and 25ºC, respectively. Michakel district is experiencing high levels of environmental degradation, with high rates of deforestation and only 7% of forest remaining. Forest is dominated by few species, mainly *Acacia abyssinica* Hochst. ex Benth.and *Croton macrostachyus* Hochst. ex Delile. Forest cover is observed to be low and shrub and bush cover dominate (**Fig.7**). The altitude of collections site is at 2377 m a.s.l.

Figure 7. Partial view of Delima Natural Forest.

Forest Fragment (FF)

It is a patchy forest remaining around the Melit church, located in the area of the Hinerata district of East Gojam zone about 10 km from Debre Markos (**Fig. 8**). The forest fragments have an extension of 200 ha and are surrounded by farmland, grazing land and village. Floristic record of the area showed a total of 60 species belonging to 40 shrub and/or tree species and the remaining 20 herbaceous and climber species (**Appendix II**). The most dominant vegetation in the area include *Acacia abyssinica* Hochst, *Euphorbia abyssinica* Gmel., *Rosa abyssincia* Lindley., *Olea europaea* L. subsp.*Cuspidate, Croton macrostachyus* Del. and *Solanum anguivi* Lam. Even though the coverage of the area is too small, because of spiritual reason the vegetation of this site is in good condition.

Figure 8. Partial view of Forest Fragments around Melit Church (FF).

Bush Land (BL)

The site is dominated by small to medium sized perennial bushes (i.e., plants that have persistent woody multiple stems above the ground. with shorter height, less than 6-10m) interspersed with grasses (**Fig. 9**). It is located at 10°25'19.57" to 37°43'15.72" and at an altitude of 2539 m asl. The local community commonly uses this kind of land as communal grazing land. Floristic record of the area in total is 36 species belonging to mostly shrub and/or tree species. *Rosa abyssinica* Lindley., *Myrsine africana* L., *Vernonia myriantha* Hook.f. and *Acacia mearnsii* De Wild. dominates the area.

Figure 9. Partial view of Bush Land (BL).

Crop Fields (CF)

The area is characterized by mixed crop–livestock production system, mainly subsistent farming. The dominant crops are tef (*Eragrostis tef*), maize (*Zea mays*) and wheat (*Triticum aestivum* and *T. durum*) (**Fig. 10**). Barley (*Hordeum vulgare*), potato (*Solanum tuberosum*), fava beans (*Phaseolus vulgaris*), chickpeas (*Cicer arietinum*), oat (*Avena sativa*), and sorghum (*Sorhum bicolor*) are also grown to a lesser extent, based on their agro ecological preferences. Since, agriculture activity fully rely of rain, sawing season for almost all crops is in the rain season (June - August). Strip of grasses, verges land is common between crop lands.

Figure 10. Partial view of Crop Fields (CF).

Mosaic Environment (ME)

This is an area where rural human settlements are surrounded by small plots of forest remainings, farm yards, dirt roads bordered by hedges, small eucalyptus plantations, strips of herbaceous plants, forming a mosaic of heterogeneous plots. Several food and cash crops are grown as a home garden. Complex, diversified and highly traditional rooted part of plant diversity conservation and utilization is found in home gardens. It is land use systems involving deliberate management of multipurpose trees and shrubs in intimate association with annual and perennial agricultural crops and invariably, livestock within the compounds of individual houses, the whole tree-crop animal unit being intensively managed by family labour.

Such systems are essentially man-made and reflect the wisdom of the traditional culture and ecological knowledge that have evolved over the years. The high diversity of species in home gardens plays wide socioeconomic and ecological roles, because it is related with the production of food and other products such as firewood, fodders, spices, medicinal plants and ornamentals. In total about 43 plant species were recorded (**Fig. 11**).

Figure 11. Partial view of Mosaic Environment (ME).

3.2.2 Lepidoptera sampling and preparation

For Lepidoptera sampling, since the majority of moths are night flying and are easily attracted by artificial light sources, light trap was used because of its effectiveness in attracting and preserving specimens in relatively good condition (Axmacher and Fiedler 2004).

Specimens were collected by using battery operated automatic light traps at the sites of FF, BL, CF, ME, whereas manual collection with a white sheet was made in natural forest in Wof Washa, Delima and Bradi Natural Forests.

The light traps used in this study were equipped with 12 Volt, 15 Ampere batteries, 20W UV fluorescent light tubes with a length of 50 cm, a plastic cover, four glass vanes and a collection box underneath containing the battery powering the device (**Fig. 12**). Moths, attracted to the light, hit the glass vanes and then slipped through a plastic funnel into the collection box. When sampling was completed, moths resting on the outside of the trap were also collected. A piece of Diethyl ether or Trichloroethylene-dipped tissue was dropped inside the trap to stun specimens.

Every month, Lepidoptera sample collection was made for four consecutive nights. A set of 4 traps were shifted every night between different sites simultaneously in each land-use types: Forest fragment (FF), Bush land (BL), Crop field (CF), Mosaic environment (ME), one after the other. The traps were in operation over a 4 hours period from 19:00 to 23:00.

Simultaneously, in three Natural Forest sites, the collection was made using an illuminated white sheet with similar lamp and battery used in the previously described trap, for three successive nights (**Fig. 13**). Since light trapping is highly dependent on weather conditions such as temperature, wind and moonlight, sampling activity was restricted to periods without strong moonlight, windy days and heavy rains.

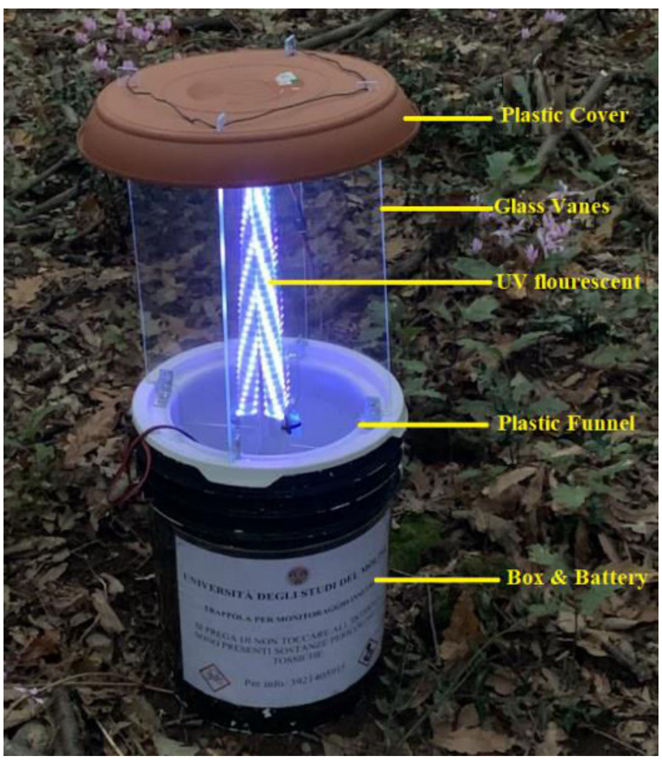

Figure 12. Partial View of the light trap used and description of its various components.

All the collected insect specimens were placed in boxes with cotton and transported to the laboratory, where pinned with entomological pins, relaxed in humid chambers (if the specimens had dried up) and prepared with open wings on spreading boards, made ready for taxonomy study.

Comparative morphological methods were used for the identification of sampled material. We studied morphological characters of adults, including genitalia and wing venation. When wing patterns alone did not allowed the attribution of the specimens to a given species, the genitalia were prepared using the method of Hardwick (1950). The identification of the specimens was done using all available publications and reference collections, as far as possible to species level.

Figure 13. Partial view of white sheet with a hanged lamp, used in natural forest sites.

3.2.3 VEGETATION SAMPLING

Plant species were sampled using a standard procedure with a square plot of 400 m^2 (20 m x 20 m). From each of the five land use categories in respect to each trap, 19 plot were sampled. The distance between two consecutive plots along a line transect was 300 m. Identification of plant specimens was performed both in the field and for more ambiguous specimens later at laboratory using taxonomic keys, descriptions and illustrations in the various volumes of the Flora of Ethiopia and Eritrea (Hedberg and Edwards 1989; Hedberg et al. 2006, 2009a, 2009b) by comparison with authenticated herbarium specimens and consulting with the experts of plant taxa.

A list of all sampled vascular plants were prepared, with the presence/absence indication for each of the five land-use category.

3.2.4 Data analysis

Collected material belonging to the following 14 families were included in the data analysis: Yponomeutidae, Limacodidae, Metarbelidae, Tortricidae, Uraniidae, Cossidae, Crambidae, Geometridae, Lasiocampidae, Notodontidae, Nolidae, Saturniidae, Sphingidae, and Erebidae. Based on the actual fauna knowledge (see thesis Chapter 2), they form approx. 55% of the Lepidoptera species known to date in Ethiopia and can therefore be considered as a representative sample of Lepidoptera fauna. All specimens belonging to these families were identified at species level and a code assigned. A file reporting, for each species, number of specimens in each sampling site was prepared for data analysis.

Many indices have been developed to measure and compare biodiversity (Magurran 1988). In this study, different widely used and accepted indices were calculated, specifically: Shannon's diversity (H'), Simpson's evenness, Berger–Parker dominance (BP) and Chao1 species richness.

The Shannon index (H') is the most commonly used measure for diversity and it is defined as:

$$H^{\wedge\prime} = -\sum_i \frac{n_i}{n}\ ln\frac{n_i}{n}$$

where n_i is the number of individuals of taxon *i*. It varies from 0 for communities with only a single taxon to high values for communities with many taxa, each with few individuals. A sample with higher value of H' is more diverse than samples with lower value of H'. Usually, the Shannon's index value varies from 1.5 to 3.5 and rarely exceeds 4.5 (Kent and Coker 1992).

Simpson diversity index is a measure of evenness of a community, i.e. which quantifies how close in numbers each species in an environment is. It ranges from 0 to 1, with evenness increasing when approaching to 1. It is calculated as 1-D, with D (dominance) calculated as:

$$D = \frac{\sum_i n_i \,(n_i - 1)}{n(n-1)}$$

where n_i is number of individuals of taxon *i*.

Berger-Parker index (BP) is a measure of the proportion of dominant species in a sample. It is simply the proportion of individuals in the dominant taxon relative to n and ranges between 0 and 1. According to Buschni and Woiski (2008), the index can also be calculated as percentage:

BP% = (abundance of a species/total abundances recorded) × 100.

If BP% > 5%, the species was termed a dominant species; if 2.5% <BP% < 5%, the species was termed an accessory species or species of intermediate abundance, and if BP% < 2.5%, the species was termed as an incidental species.

Chao-1 species richness is an estimate of total species richness, where rare species (species occurring with one individual: singleton, or with two individuals: doubleton) were noted. It is calculated as:

Chao-1 = S + F1 (F1 - 1) / (2 (F2 +1))

where F1 is the number of singleton species and F2 the number of doubleton species.

Biodiversity indices were calculated for each land-use category (NF, FF, BL, ME, CF). Approximate confidence intervals for all these indices were computed with a bootstrap procedure. The given number of random samples (by default 9999) were produced, each with the same total number of individuals as in the original sample. For each individual in the random sample, the taxon is chosen with probabilities proportional to the original abundances. A 95 percent confidence interval is then calculated (Hammer, 1999-2019).

All biodiversity analyses were carried out using the software Past version 3.25 (Hammer, 1999-2019). A regression analysis to assess the relationship between plant and Lepidoptera was done with Excel software.

3.3 RESULTS

Overall, 4,461 moth individuals belonging to the 14 families and 344 species (**Table 3**; **Plates I** and **II**) were sampled across the five ecological land-use categories. Of the 344 taxa found, 67% were given a species name, while in 97% of cases the determination was made at genus level. There were 41 singletons and 28 doubletons. The highest diversity was obtained from the Natural Forest (269 species) followed by Forest Fragment (174), then Bush Land (148), Crop Fields (138) and Mosaic Environment (136) (Fig. 14). The highest species-rich families were Geometridae (131 taxa), Erebidae (93 taxa), Tortricidae (40 taxa), Sphingidae (17). For some families, such as Geometridae, natural forest showed by far the highest number of taxa. For other families, such as Tortricidae, the number of species was evenly distributed among the different ecological types.

Looking at the number of specimens sampled in the five land-use types during the 1-year period, captures in Natural Forest were by far greater than in other land-use types that showed small differences from each other (**Fig. 14**).

The most numerous species overall was *Digama meridionalis deliae* Berio,1939 (Family Erebiidae) (4.93 % of all individuals), which was found to be most abundant in BL, FF and CF. Following this species, we have *Clepsis paragongyla* Razowski & Trematerra, 2019 (Tortricidae) (4.88%), most abundant in NF, FF and CF; *Chiasmia procidata* (Guenée, 1858) (Geometridae) (4.57%) in NF, FF and ME; *Thylacandra delimana* Razowski & Trematerra, 2019 (Tortricidae) (2.80%) in FF, NF and CF; *Xylopteryx emunctaria* (Guenée, 1858)(Geometridae) (2.58%) in FF, ME and NF (**Table 4**).

Table 3. Summary of family spectrum and number of species and specimens (individuals in parenthesis) of moths collected at the five different land-use types in Choke Mountain.

	Family	CP	BL	FF	ME	NF	Total
1	Yponomeutidae	3 (24)	2 (10)	3 (15)	3 (40)	3 (27)	5 (116)
2	Limacodidae	1 (5)	2 (15)	3 (17)	2 (13)	4 (25)	4 (75)
3	Metarbelidae	0 (0)	1 (2)	1 (4)	1 (1)	0 (0)	1 (7)
4	Tortricidae	24 (114)	20 (117)	26 (146)	29 (187)	32 (376)	40 (940)
5	Uraniidae	2 (6)	2 (9)	4 (11)	3 (5)	2 (12)	5 (43)
6	Cossidae	2 (3)	2 (3)	2 (3)	1 (1)	5 (10)	7 (20)
7	Crambidae	3 (5)	5 (22)	3 (5)	3 (13)	8 (51)	10 (96)
8	Geometridae	46 (172)	43 (128)	59 (207)	43 (186)	109 (692)	131 (1,385)
9	Lasiocampidae	6 (11)	5 (5)	6 (19)	4 (14)	8 (30)	10 (79)
10	Notodontidae	1 (1)	2 (2)	1 (1)	1 (1)	3 (14)	5 (19)
11	Nolidae	2 (4)	4 (17)	3 (16)	2 (9)	3 (14)	5 (60)
12	Saturniidae	0 (0)	6 (12)	1 (3)	1 (3)	7 (100)	8 (118)
13	Sphingidae	7 (16)	11 (79)	11 (32)	7 (18)	14 (73)	17 (218)
14	Erebidae	41 (226)	42 (238)	53 (276)	39 (135)	71 (407)	93 (1,383)
Total							344 (4,461)

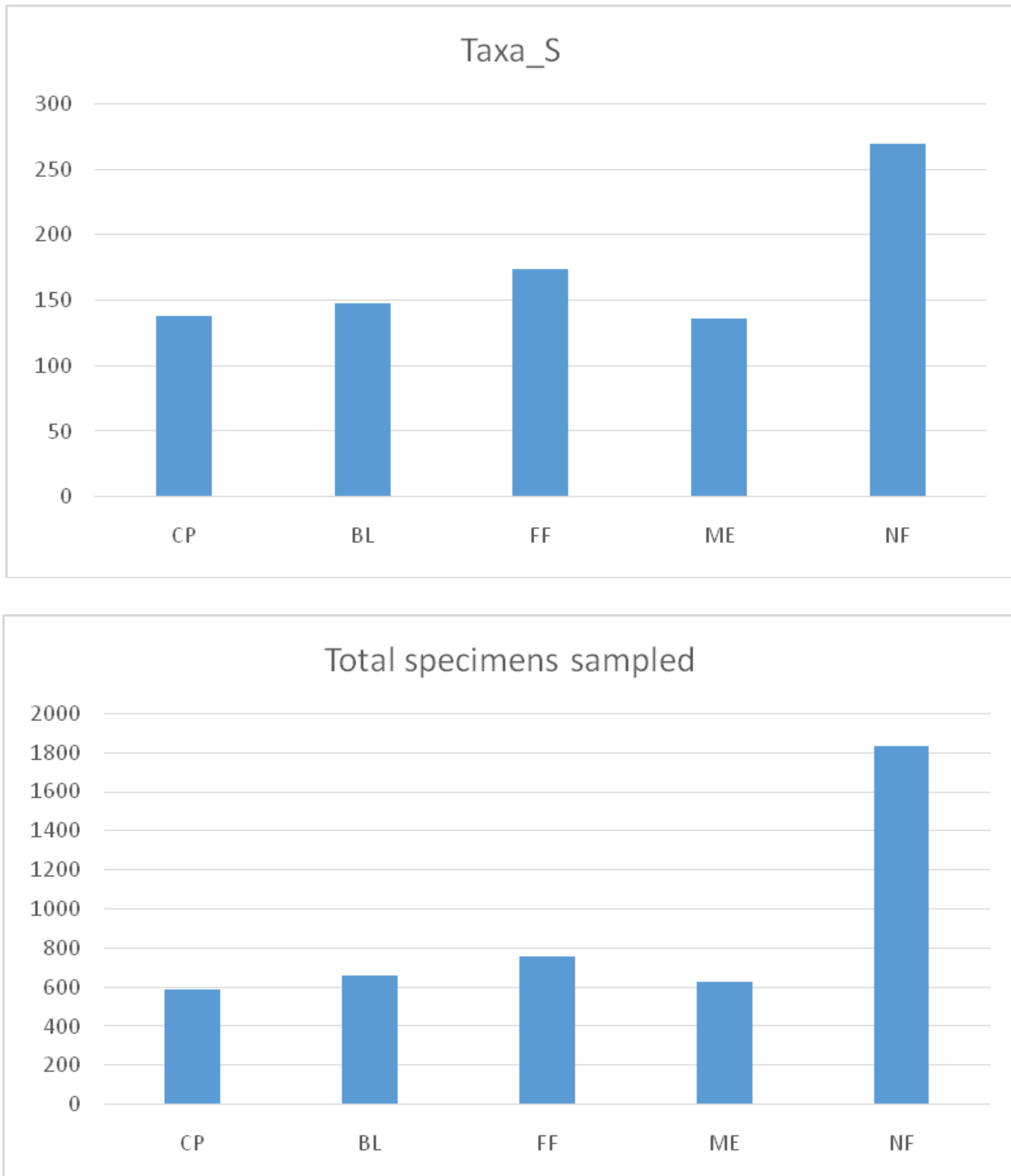

Figure 14. Number of species (above) and specimens (below) captured in the five land-use categories during the 1-year research.

Table 4. List of the most common species with BP% in the 5 land-use categories

S.no.	List of the most common species	BP%
NATURAL FOREST		
1	*Chiasmia procidata*	2.42%
2	*Clepsis paragongyla*	2.11%
3	*Gonimbrasia birbiri*	1.86%
4	*Aroterosia punctineata*	1.07%
5	*Xanthorhoe* sp.1	0.98%
FOREST FRAGMENT		
1	*Digama meridionalis deliae*	1.23%
2	*Clepsis paragongyla*	0.92%
3	*Xylopteryx emunctaria*	0.85%
4	*Aroterosia punctineata*	0.67%
5	*Metarctia carmel*	0.58%
BUSH LAND		
1	*Digama meridionalis deliae*	1.55%
2	*Clepsis paragongyla*	0.78%
3	*Chiasmia procidata*	0.72%
4	*Epichoristos fekensae*	0.67%
5	*Eilema dorsti*	0.60%
MOSAIC ENVIRONMENT		
1	*Thylacandra delimana*	1.09%
2	*Digama meridionalis deliae*	0.78%
3	*Xylopteryx emunctaria*	0.72%
4	*Epichoristos fekensae*	0.54%
5	*Chiasmia procidata*	0.34%
CROP FIELDS		
1	*Alpenus geminipuncta*	1.26%
2	*Clepsis paragongyla*	0.85%
3	*Digama meridionalis deliae*	0.85%
4	*Orthonama obstipata*	0.67%
5	*Yponomeuta fumigata*	0.45%

Values calculated for Shannon index in general were high and ranged between 4.8 for NF and 4.2 for CF (**Fig. 15**). Simpson index indicated very high values of evenness, with all categories above 0.97 (**Fig. 15**). The highest values of dominance were observed in CF and BL, with percentage of the dominant species around 10% (**Fig. 15**)

Estimated species richness by Chao-1 was highest within NF (365), followed by BL (256), FF (241) and lowest in CF (186) (**Fig. 15**). If compared to the sampled number of species, the highest increase was observed in BL (+73%) and ME (+71%).

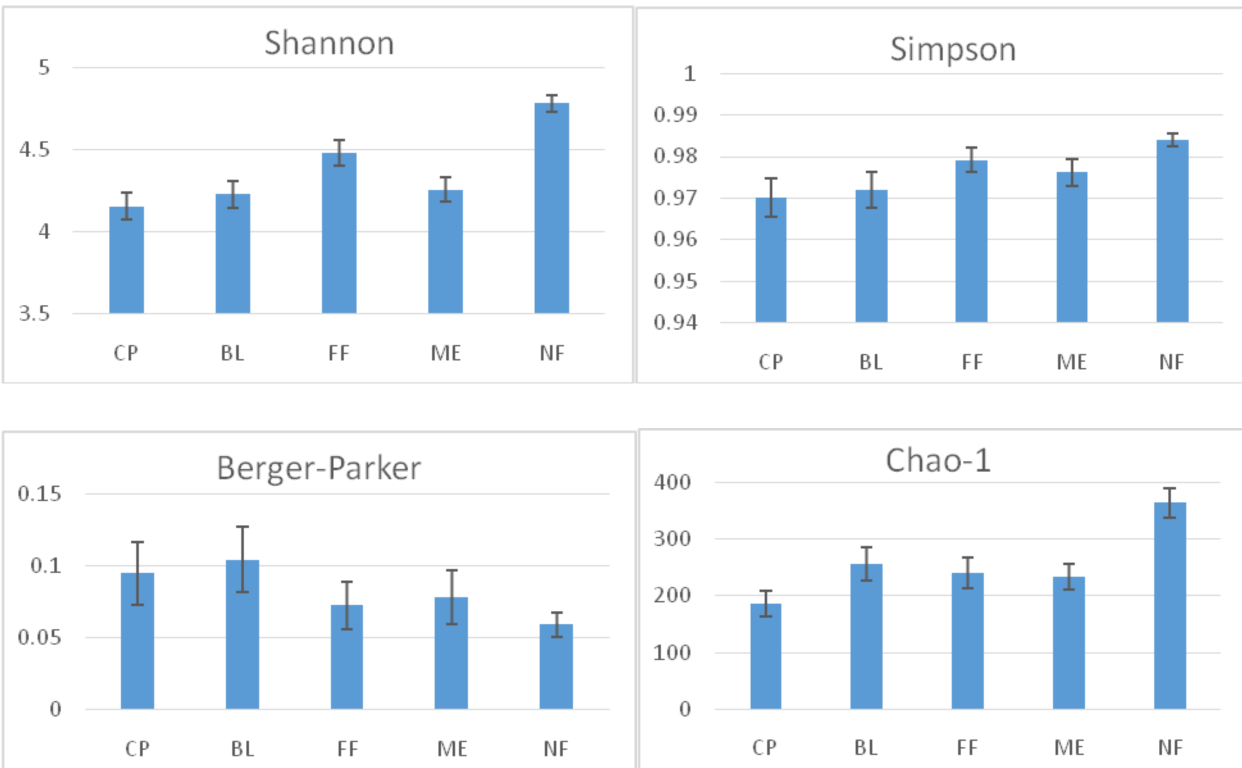

Figure 15. Shannon, Simpson, Berger-Parker and Chao-1 indexes, calculated for the five land-use categories during the 1-year research.

Biodiversity indices calculated on a monthly basis showed extremely variable trends (**Fig. 16**). Overall, NF possesses the highest species diversity followed by FF, BL, ME and CF is the lowest. In case of Shannon index, the most diverse sample (4.29) was recorded from CF in August and the lowest (1.57) in BL in December. All categories showed deep temporal fluctuations. For example, NF had the maximum in September (4.10), after rainy season, and the lowest in April (1.88), during dry season.

Simpson index was in general high (above 0.85) for most months, with some deep decreases observed for ME in November (0.67), BL in December (0.65) and NF in April (0.77). Berger-

Parker values had a trend opposite to the one observed for Simpson. Values were in most cases below 0.3, with some high peaks corresponding to ME in November (0.56), BL in December (0.57) and NF in April (0.42).

Chao-1 estimates were particularly high for NF in September (167) and October (176), and then decreased to reach the minimum in April (14) and again in July (24). CP showed the highest estimates in August (171), keeping, for the rest of the year, at much lower values. For BL a very high peak was observed in February (180), whereas for the rest of the year, estimates were constantly below 80. FF had two peaks, in September (139) and May (131), and values below 80 in the remaining months. ME had the peak of species in May (95) and lower levels for the rest of the year.

Figure 16. Monthly trends of the Biodiversity indices calculated for each land use type over the study period.

A total of 254 vascular plants were sampled: 178 from NF (Ankober, Bradi and DelimaNatural Forests), 62 from FF (Melit Church forest), 43 in ME, 35 in BL and 10 in CF (**Appendix II**). The same order was observed for lepidopteran species richness, both observed or estimated (**Fig. 17**). A very strong linear relationship in the number of species was observed between vascular plant and Lepidoptera, the one calculated with the estimate slightly lower, compared to that with the species sampled (**Figs. 18-19**).

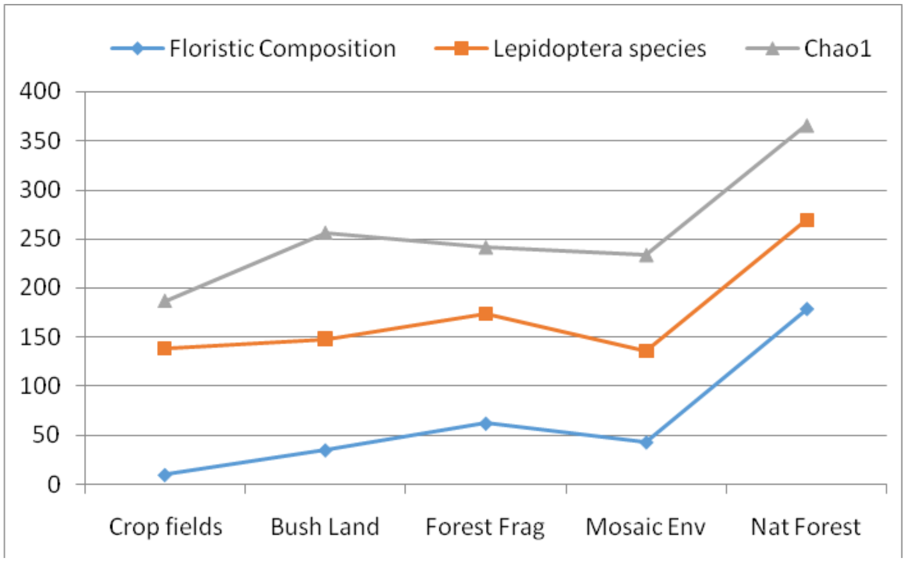

Figure 17. Number of vascular plant species, of Lepidoptera sampled species and estimated species with the Chao-1 index, calculated for the 5 land-use typologies.

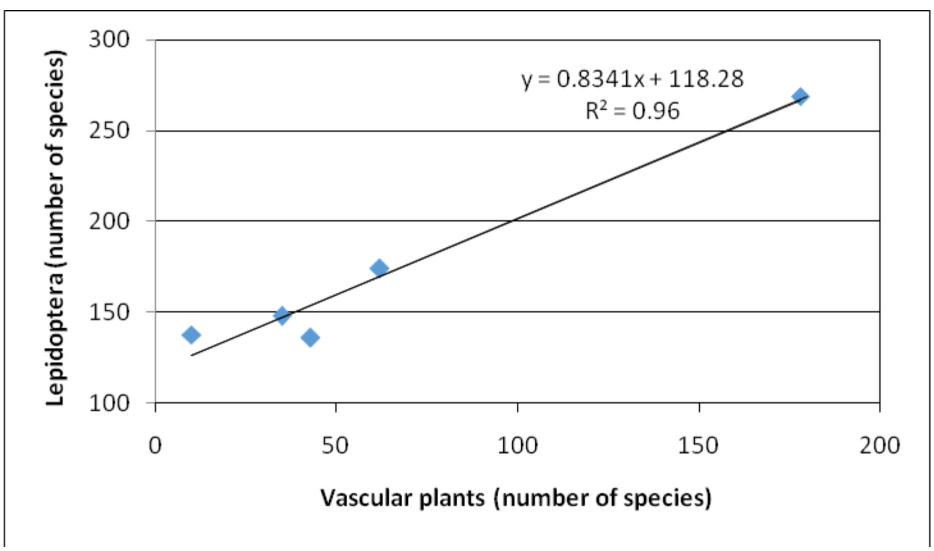

Figure 18. Relationship between sampled Lepidoptera and flora biodiversity calculated in the five land-use categories.

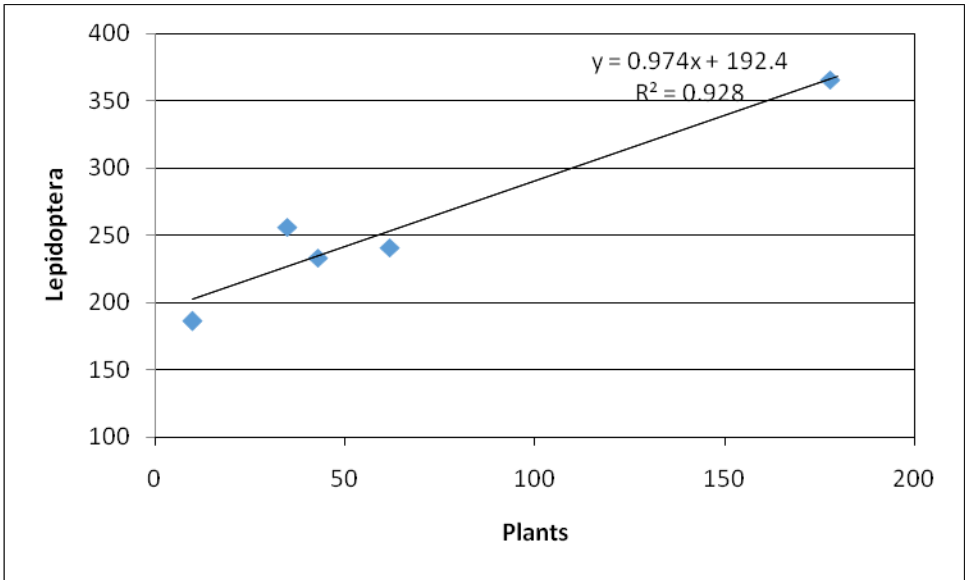

Figure 19. Relationship between Lepidoptera estimated species richness with Chao-1 index and flora richness calculated in the five land-use categories.

3.4 DISCUSSION

As expected, sampled diversity resulted significantly higher in the Natural Forest than in other habitat typologies, presumably, because it had the highest structural diversity, followed by Forest Fragment, then Bush Land, Mosaic Environment and Crop Fields. In all cases, the Shannon index was high (> 4) also for habitat with a high anthropic disturbance such as Mosaic Environment, or structure simplification, such as Crop Fields. Values of Simpson index, following the same trend of Shannon index, highlighted a high evenness structure of all investigated community, confirmed by the fact that no dominant species were observed in any of the land-use category investigated. The mean Berger–Parker index increased from undisturbed to disturbed areas, with Natural Forest values not significantly different from Forest Fragment and Mosaic Environment.

The monthly trend highlighted for the various indices showed strong differences among the various categories. There are periods when most biodiversity is hosted in habitats other than the Natural Forest. Indeed, in April, the Natural Forest showed the lowest Shannon index and in January Crop Fields had the highest index values.

About the abundance distribution within the community, Forest Fragment showed the most uniform trend throughout the year, unlike all other environments (including Natural Forest) which showed higher fluctuations. Maybe this was because Forest Fragment includes faunistic components of both open and wooded habitats.

The estimated species richness for all investigated land-use typologies is much higher than observed values, suggesting that further samplings are needed to keep a more complete picture of the hosted fauna. Although in absolute numbers Natural Forest had highest values, in percentage the highest increases of estimates were observed in Bush Land and Mosaic Environment, confirming the value, in terms of biodiversity, of habitats where the impact of human activities is significant.

Floristic and faunistic abundance are clearly related, both considering the observed and estimated Lepidoptera species richness. This result was not surprising, considering that Lepidoptera are phytophagous during larval stage and was reported, among others, by Siemann et al. (1998), Axmacher et al. (2009), Kittle et al. (2016), the second one referring in particular to the Afro-tropical Geometridae.

Two major threats to tropical forests are habitat fragmentation and modification as they change, among other factors, the total area of habitat, microclimate, and plant composition. In general, the effects of habitat loss are reflected in decline of populations and losses of species (Pimm 2008). The losses no longer affect only rare and specialized organisms but often apply to widely distributed species as well (Gaston and Fuller 2007).

However, results in Choke Mountains showed that a significant proportion of Lepidoptera diversity is hosted also in habitat where human modifications are more evident and a forestry component is limited, stressing the role of marginal habitats as refugees for many species. In these cases, population density will be highest in optimal habitats, but individuals will disperse into low quality habitat creating a gradient from high performing 'source' to low density 'sink' populations that are maintained by immigration from source populations (Pulliam 1988).

In this context, fragments of forest of a few hundred hectares play a very important role in protecting biodiversity, in areas (such as the one under investigation) where larger forests have almost disappeared. In any case, even environments subject to significant anthropic actions and with a reduced or absent tree cover have a non-marginal role in hosting species linked to shrubby or herbaceous plants.

African tropical forest ecosystems remain largely unknown in a time when biodiversity is being threatened by human activities. The present investigation focused on a tropical mountain area, Choke Mountains, highly fragmented and with a very high pressure due to grazing and extensive crop cultivation. The main driver of this pressure is the increase of human population that causes also social conflicts and economic expectations in the local communities and makes more difficult the preservation of biodiversity in the area (Belay Simane 2016).

Information on how biodiversity is represented in habitats with different human impacts can give an important contribution in improving the management of the environment and minimize conflicts among local communities, regional government and wildlife protection Authorities. Choke Mountains represent the main water source of the Blue Nile River. In this context, the maintenance of its water resources, also through the preservation of their environments, is of strategic importance and extends to a large part of East Africa.

3.5 REFERENCES

An S., Choi W. (2013). Forest moth assemblages as indicators of biodiversity and environmental quality in a temperate deciduous forest. European Journal of Entomology, 110 (3): 509–517.

Axmacher J.C., Fiedler K. (2004). Manual versus automatic moth sampling at equal light sources – a comparison of catches from Mt. Kilimanjaro. Journal of the Lepidopterists' Society, 58: 196–202.

Axmacher J.C., Brehm G., Hemp A., Tünte H., LyaruuH.V.M., Müller-Hohenstein K., Fiedler K. (2009). Determinants of diversity in afrotropical herbivorous insects (Lepidoptera: Geometridae): plant diversity, vegetation structure or abiotic factors? Journal of Biogeography, 36: 337–349.

Belay Simane (2016). Building community resilience to climate change. Lessons from Choke Mountain Agro-ecosystems, Abay/the Blue Nile Highlands. Addis Ababa University Press, Ethiopia. Pp. 302.

Buschini M.L., Woiski T.D. (2008) Alpha-beta diversity in trap-nesting wasps (Hymenoptera: Aculeata) in Southern Brazil.Acta Zoologica, 89(4): 351–358.

Chivian E., Bernstein A. (2008). How Our Health Depends on Biodiversity. [Downloaded from: https://www.bu.edu/sph/files/2012/12/Chivian_and_Bernstein_2010_How_our_Health_Depends_on_Biodiversity.pdf]

D'Abrera B. (1986). Sphingidae Mundi. Hawk Moths of the World. E.W. Classey, Farington: 1-226.

Daily G.C., Ehrlich P.R. (1995). Preservation of biodiversity in small rainforest patches: rapid evaluations using butterfly trapping. Biodiversity and Conservation, 4: 35–55.

Erhardt A., Thomas, J.A. (1991). Lepidoptera as indicators of changes in the semi-natural grasslands of lowland and upland Europe. In: Collins, N.M., Thomas, J.A. (Eds.), The Conservation of Insects and Their Habitats. Academic Press, London, pp. 213–237

Foley F., Fries D., Asner P., Barford C., Bonan G., Carpenter R., Chapin S., Coe T., Daily C., Gibbs K., Helkowski H., Holloway T., Howard A., Kucharik J,, Monfreda C., Patz A., Prentice C., Ramankutty N., Snyder K. (2005). Global consequences of land use. Science, 309: 570–574.

Fox R. (2013). The decline of moths in Great Britain: a review of possible causes. InsectConservation and diversity, 6: 5–19.

Friis I., Sebsebe Demissew, Breugel P.V. (2010). Atlas of the Potential Vegetation of Ethiopia. Addis Ababa: The Royal Danish Academy of Sciences and Letters (Natural habitats), 307 pp.

Fugère V., Kasangaki A., Chapman J. (2016). Land use changes in an afrotropical Biodiversity hotspot affect stream alpha and beta diversity. Ecosphere, 7(6):1-18.

Hammer, Ø. (1999-2019). PAST Paleontological Statistics. Reference Manual. Version 3.25. [Dowloaded from: https://folk.uio.no/ohammer/past/past3manual.pdf]

Hardwick D.F. (1950). Preparation of slide mounts of lepidopterous genitalia. Canadian Entomologist, 82:231–235.

Hedberg, I., Edwards S. (1989). Flora of Ethiopia (Vol. 3): Pittosporaceae to Araliaceae.Addis Ababa and Uppsala: The National Herbarium, pp. 732.

Hedberg I., Ensermu Kelbessa, Edwards S., Sebsebe Demissew, Persson, E. (2006). Flora ofEthiopia and Eritrea (vol. 5): Gentianaceae to Cyclocheilaceae. Addis Ababa and Uppsala:The National Herbarium, pp. 690.

Hedberg I., Friis I., Persson E. (2009a). Flora of Ethiopia and Eritrea (vol. 1): Lycopodiaceae to Pinaceae. Addis Ababa and Uppsala, The National Herbarium, pp. 305.

Hedberg I., Friis I., Persson E. (2009b). Flora of Ethiopia and Eritrea. General Part andIndex to Volumes 1-7 (vol. 8). Addis Ababa and Uppsala: The National Herbarium, pp. 331.

Hill J.K., Hamer K.C. (2004). Determining impacts of habitat modification on diversity of tropical forest fauna: the importance of spatial scale. Journal of Applied Ecology, 41: 744-754.

Kent M., Coker P. (1992). Vegetation Description and Analysis: A practical approach. Belhaven Press, London. pp. 263.

Kittle A.M., Kumara P.H., Pathirathna D.G., Sanjeewani H.K., Seneviratne H.T., Watson A.C. (2016). A comparison of floral and faunal diversity between two small, disturbed forest patches in Sri Lanka’s central highlands. Wildlanka, 4(3): 134–141.

Kroon P.A., Williamson G. (1999). Hydroxycinnamates in plants and food: current and future perspectives. Journal of the Science of Food and Agriculture, 79 (3): 355-361.

Labandeira C.C., Johnson K.R., Wilf P. (2002). Impact of the terminal Cretaceous event on plant-insect associations. Proc. Natl. Acad. Sci. USA 99: 2061–2066.

Labandeira C.C., Sepkoski J.J. (1993). Insect diversity and the fossil record. Science, 261:310–315.

Magurran A.E. (1988). Ecological diversity and its measurement. Princeton University Press, Princeton, pp. 185.

Millennium Ecosystem Assessment (2005). Ecosystems and human well-being: biodiversity synthesis. World Resources Institute, Washington, USA, pp. 137.

Munyuli M.B. (2012). Butterfly diversity from farmlands of central Uganda. Psyche. Article ID: 481509: 1-23.

Nicholsa E., Larsen T., Spector S., Davis A.L., Escobar F., Favila M., Vulinec K. (2007). Global dung beetle response to tropical forest modification and fragmentation: A quantitative literature review and meta-analysis. Biological Conservation, 137:1-19.

Pulliam, H.R. (1988). Sources, sinks, and population regulation. American Naturalist, 132: 652–661.

Samways M.J. (2006). Insect extinctions and insect survival. Conservation Biology, 20: 245–246.

Scoble, M.J. (1999). Geometrid Moths of the World: A Catalogue. CSIRO Publishing, Collingwood, Stenstrup, pp. 1016.

Siemann E., Tilman D., Haarstad J., Ritchie M.(1998). Experimental tests of the dependence of arthropod diversity on plant diversity. The American Naturalist, 152(5): 738-750.

Spellerberg I. (2005). Monitoring ecological change. Cambridge University Press.

Summerville K.S., Crist T.O. (2004). Contrasting effects of habitat quantityand quality on moth communities in fragmented landscapes. Ecography, 27: 3-12.

Chapter 4. REVISION OF THE GENUS *ORBAMIA* HERBULOT, 1966 (FAMILY GEOMETRIDAE) IN AFRICA[2]

4.1 INTRODUCTION

The present thesis section gives a taxonomic contribution to the knowledge of the Afrotropical Lepidoptera, the genus *Orbamia* (family Geometridae) that was selected as candidate for a revision at the genus level, due to the abundant material collected in the last hundred years from all over Africa, stored at the Bavarian State Collection of Zoology (Munich, Germany).

The genus *Orbamia* Herbulot 1966 is restricted to the Ethiopian region, where it was so far represented by five species (Scoble 1999; Hausmann 2006):*Orbamia octomaculata* (Wallengren 1872), *Orbamia pauperata* Herbulot 1966, *Orbamia renimacula* (Prout 1926), *Orbamia subaurata* (Warren 1899) and *Orbamia becki* Hausmann 2006. Although the external appearance of *Orbamia* is somewhat reminiscent of that of the tribe Boarmiini, Hausmann (2006) placed *Orbamia* in the tribe Cassymini, due to the long process extending from the base of the dorsal margin of the male genital valvae, similar to the equivalent present in *Zamarada*. Species of *Orbamia* are recognized by the following characters: wings with conspicuous, contrasting discal spots on all wings, antennae bipectinate in males and filiform in females, dorsal process in male genitalia strongly curved.

After 260 years of intensive work, all taxonomists worldwide have together achieved the formal descriptions of about 160,000 lepidopteran species (Van Nieukerken et al. 2011), of which some 24,000 are, geometrid moths (cf. Scoble 1999; Scoble and Hausmann 2007; Van Nieukerken et al. 2011). We conclude that conventional taxonomy with an actual description rate of 80-100 species per year works too slowly for addressing the biodiversity of our earth (‘taxonomic impediment’: De Carvalho et al. 2007; Wheeler 2008). In times of serious extinction rates, we cannot wait for another 250-600 years for the taxonomic assessment of biodiversity. In recent literature, several pleas for accelerated taxonomy have been made (Forum Herbulot 2014; Riedel et al. 2013a) and some taxonomists already published exemplary revisions with shortened descriptions (Riedel et al. 2013b; Meierotto et al. 2019).

---

[2]The present Chapter has been accepted for publication to Zookeys as: Tujuba T.F., Hausmann A. and Sciarretta A. (2020). Revision of the *Orbamia* Herbulot, 1966 group of genera with description of two new genera, ten new species and two new subspecies (Lepidoptera: Geometridae: Ennominae: Cassymini).

In this revision, we applied to the taxonomic revision such a model of accelerated taxonomy (cf. Forum Herbulot 2014; Riedel et al. 2013a; 2013b; Meierotto et al. 2019) which should lead in future to an automated, easy and rapid transfer of genetic data, images and metadata directly from Barcode of Life Data Systems ('BOLD': Ratnasingham and Hebert 2007) into manuscripts and which will allow continuous updates. Similarly, all nomenclatural information (valid names, synonyms, original descriptions with authorship and year, type localities, type specimens and their deposition) may in future be transferred in an automated way either from BOLD, from the Global Lepidoptera checklist (Hobern and Miller 2019) and/or from the Geometridae Mundi database once it will be completed by the Forum Herbulot initiative (cf. Löbel and Hausmann 2019). Similar to the approach of Meierotto et al. (2019) we believe that DNA barcodes in most cases are the best key for species diagnosis but that all descriptions should be linked with a brief description of characters in words, supplemented with photographs. In the future, such revisions may also be organized in a flexible way, i.e. with the possibility to subsequently publish updated versions (keeping visible also the previous versions) with more data, newly added species and revised taxonomic concepts. In the framework of the ongoing research project "GBOL III - Dark Taxa" (SNSB – Bavarian State Collection of Zoology, Munich) similar workflows are planned to be tested and established.

4.2 MATERIALS AND METHODS

In the present paper, the material housed at the Zoologische Staatssammlung München (ZSM), Munich, Germany, collected from 14 different African and Arabian countries, has been studied. Two relevant type specimens available in the ZSM and two from the Natural History Museum in London (NHMUK) were examined. Altogether some 298 specimens of the genera *Orbamia*, *Rabomia* gen .n. and *Morabia* gen. n. have been examined.

Comparative morphological methods and COI sequence divergences were used to delimit the taxa and estimate their taxonomic status. We studied morphological characters of adults (including genitalia and wing venation). The abdomens and genitalia were prepared using the method of Hardwick (1950). The analysis is furthermore based on 58 genitalia slides and 72 DNA barcodes.

For DNA analyses, one or two legs were removed from dried specimens and stored in an individual tube, in absolute ethanol. DNA extraction, amplification and sequencing of the "barcode" region of the mitochondrial cytochrome c oxidase I (COI) gene region (658 base pairs) were carried out in the Canadian Centre for DNA Barcoding (CCDB), Ontario, Canada, using standard high-through put protocols (Ivanova et al. 2006) as described by CCDB. Sequence divergence within and between species was calculated using the Kimura 2-parameter model (Kimura 1980). The Barcode Index Number (BIN) of each species is reported which was obtained from the BOLDSystems v4 database (Ratnasingham and Hebert 2007). BINs represent a species-level taxonomic registry of the animal kingdom based on the analysis of nucleotide variation patterns in the barcode region of the cytochrome c oxidase I (COI) gene (Ratnasingham and Hebert 2013). Genetic distances (when available) were calculated using the Kimura 2-parameter (K2P) distance model, using the analytical tools provided by BOLDSystems v4 platform. Intra-specific and inter-specific genetic distances were reported as maximum and minimum distances, respectively. This genetic information facilitates the species delimitation and form the basis of future phylogenetic works (Brehm 2015, 2018) and the neighbour-joining algorithm (Saitou and Nei 1987), as implemented in BOLD (http://www.boldsystems.org/).

Label data and photographs of types and other dissected specimens photographs are accessible on BOLD, dataset DS-ORBAMIA (doi: http://www.boldsystems.org/index.php/MAS_Management_Recordlist). All names and nomenclatural acts are registered in ZooBank. Geo-references were taken from specimen labels.

A Maximum Likelihood phylogenetic tree, with 50 Bootstrap Replications and Tamura-Nei model, based on all genetic sequences obtained from the examined specimens, was built with the software MEGA6 (Tamura et al. 2013).

A barcode Gap Analysisfrom BOLD data, tocompare the intra- and interspecific variation in terms of genetic distance, was carried out for all species within the genus.

4.3 RESULTS

4.3.1 SYSTEMATIC LIST

***Orbamia* Herbulot 1966**

Herbulot (1966): 221. Type species: *Orbamia octomaculata* Wallengren 1872

Differential features (COI sequences, photographs of adults and their genitalia see doi : Genetic data:
http://www.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxon=Orbamia+octomaculata&searchTax=Search+Taxonomy.The species listed here are all grouping into one cluster in the Neighbour Joining and Maximum Likelihood trees.

Adult: Male antennae bipectinate. Upperside of wings with conspicuous, contrasting discal spots on all wings. Underside with yellowish scales, with darker pattern towards termen. Male genitalia: Differing from those of the other two genera by longer uncus, naked dorsal process of valva, long and narrow cornutus. Female genitalia: Apophyses anteriores usually half-length apophyses posteriores, lamellae ante- and postvaginalis sclerotized (often oval), ductus bursae membranous, signum a small sclerite with transverse ridge.

***Orbamia octomaculata* (Wallengren 1872)**

BIN: BOLD: AAQ4039

Panagra octomaculata: Wallengren (1872): 60 (Holotype ♂ in NHRS, Stockholm; locus typicus: [South Africa, perhaps Gauteng]: „Caffraria orientalis interior“)

Examined material (ZSM): 25♂♀ from Tanzania, Zambia, Botswana, Mozambique, Malawi, Namibia, South Africa (ZSM G 20929/♀; ZSM G 20921/♂; ZSM G 20930/♂; ZSM G 20931/♂; ZSM G 20943/♂; ZSM G 13646/♂; ZSM G 13645/♀; ZSM G 20947/♀).

Differential features (COI sequences, photographs of adults and their genitalia see doi http://www.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxon=Orbamia+octomaculata+&searchTax=Search+Taxonomy): Adult: Forewing length: 11.5-13.5 mm. Upperside of wings: Ground colour pale brown with dark suffusion. Underside: Ground colour yellow or orange with much dark suffusion, terminal fascia on hind wing usually complete, on forewing restricted to apex. Male genitalia: Uncus long, triangular, valva strongly (rectangularly) bent, dorsal process with small spinule at tip, cornutus short and stout (1.4 - 1.7 mm). Female genitalia: Lamella antevaginalis U-shaped, long (0.75 mm), signum sclerotized, transversely flat, transverse ridge curved (0.4-0.5 mm).

***Orbamia marginata* Hausmann & Tujuba, sp. n. (Plates III, IV, V)**

BIN: BOLD: AAZ5266

Holotype: ♂, Tanzania, Bukwa region, 14 km W Namanyere, 1290 m, 07°27.289' S, 030°54.498' E, 14.xi.2005, leg. Ph. Darge, coll. ZSM (ZSM G 20909).

Paratypes: 2♂, Tanzania, Rukwa region, 14 km W Namanyere, 1290 m, 07°27.289' S, 030°54.498' E, 14.xi.2005, leg. Ph. Darge, coll. ZSM (ZSM G 20941); 1♂, Tanzania, Rukwa region, Luafi Game Reserve (W. Namanyere), 1260m, 07°26.985' S, 030°54.246' E, 31.i.2008, leg. Ph. Darge; 1♂, Tanzanie, Iringa region, Iyayi savanna, 1400m, 08°51.476' S, 034°31.296' E, 14.iv.2007, Ph. Darge; 1♂, Tanzania, Morogoro region, Udzungwa N.P. camp site, 3315m, 07°50.958' S, 036°50.958' E, 26.xi.2005, leg. Ph. Darge (all ZSM).

Etymology.The name refers to the uninterrupted black line at the hindwing margin.

Differential features (COI sequences, photographs of adults and their genitalia see doi http://www.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxon=Orbamia+marginata+&searchTax=Search+Taxonomy): Adult: Forewing length: 11.5-12.5 mm. Upper side of wings: Ground colour dirty grey with brown suffusion. Underside: Ground colour whitish beige with some dark suffusion, terminal fascia conspicuous, uninterrupted on all wings. Male genitalia: Uncus long, triangular, valva slightly bent, dorsal process with small spinule at tip, cornutus short and stout (1.6 mm). Female genitalia unknown.

***Orbamia becki* Hausmann 2006**

BIN: BOLD: AAD8768

Orbamia becki: Hausmann (2006): 42 (Holotype ♂ in ZSM: G 13627; - locus typicus: Yemen: Al Hudaydah, Jebel Burra)

Examined material (ZSM): 57♂♀ from Yemen, Ethiopia and Djibouti(ZSM G 13478/♂; ZSM G 13628/♀; ZSM G 13649/♀; ZSM G 13636/♂; ZSM G 13637/♀/ ZSM G 13651/♀; ZSM G 20927/♀).

Differential features (COI sequences, photographs of adults and their genitalia see doi http://www.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxon=Orbamia+becki+&searchTax=Search+Taxonomy): Adult: Forewing length: 9.5-12 mm. Upperside of wings: Ground colour pale brown. Underside: Ground colour whitish with yellowish tinge, on forewing with some dark suffusion, terminal fascia on all wings complete. Male genitalia very similar to those of *O. octomaculata*: Uncus stout, triangular, valva strongly (rectangularly) bent, dorsal process with small spinule at tip, cornutus short and stout (1.5 mm). Female genitalia very similar to those of *O. octomaculata*: Lamella antevaginalis U-shaped (0.6-0.7 mm), signum sclerotized, transversely oval, transverse ridge curved (0.3-0.5 mm).

Remarks: Allopatric vicariant of *O. octomaculata*. *O. becki* is the only species of this genus that has also been recorded outside Africa in Yemen, southern Arabia.

Orbamia renimacula **(Prout 1926)**

BIN: BOLD: AAE1536

Boarmia renimacula: Prout (1926): 184 (Holotype ♀ in NHMUK; - locus typicus: Senegal: Sédhiou)

Examined material (ZSM): 45♂♀ from Cameroon, Burkina Faso (Upper Volta), Guinea, Senegal, Togo, Mali, Gambia, Nigeria and Ivory Coast (ZSM G 13626/♂; ZSM G 61321/♀; ZSM G 13620/♂).

Differential features (COI sequences, photographs of adults and their genitalia see doi http://www.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxon=Orbamia+renimacula+&searchTax=Search+Taxonomy): Adult: Forewing length: 8.5 - 12 mm, one of the smallest *Orbamia* species.Upperside of wings: Ground colour pale grey with brown suffusion. Underside: Ground colour white with very slight yellowish tinge, and slight dark suffusion, terminal fascia on all wings complete, conspicuous, at forewing apex dilated. Male genitalia: Uncus narrow digitiform, saccus round, valva almost straight, dorsal process with fine, curved hook at tip, cornutus of medium length (2.0 mm). Female genitalia: Lamella postvaginalis weakly sclerotized, lamella antevaginalis U-shaped (0.6 mm), signum sclerotized, rhomboid, transverse ridge straight (0.25 mm).

Orbamia clarissima **Hausmann & Tujuba, sp. n. (Plates III, IV, V)**

BIN: BOLD: Not yet assigned!

Holotype: ♀, Kibwezi, B.E.A. [Kenya], 12 March 1917 (W. Feather), coll. ZSM (ZSM G 13618).

Paratypes: 1♂, Kibwezi, B.E.A. [Kenya], April 1922 (W. Feather)(ZSM G 14465);; 1♂, Kenya, Mutha, 5.IV.69, Watulege; 1♀, Kenya, Musthomo, 13.III.69, Watulege(ZSM G 13617); 1♂, Somalia m., Caonole Fluß, 21.1.1988, leg. Dr. Politzar (all ZSM).ZSM G 13647/♂

Etymology.The name refers to the very pale ground colour (lat. clarissimus, -a, -um = palest, clearest).

Differential features (doi to be assigned): Adult: Forewing length: 7.5-11 mm, one of the smallest *Orbamia* species. Upperside of wings: Ground colour whitish with slight grey brown suffusion. Underside: Ground colour white with slight orange tinge, mainly towards termen between veins, apical spots on all wings conspicuous, sharp. Male genitalia: Uncus long, digitiform, stout, valva straight, dorsal process with small spinule at tip, cornutus very short (1.0 mm) and tiny. Female genitalia: Apophyses stout, apophyses anteriores comparatively long (2/3 length of apophyses posteriores), lamella antevaginalis heart-shaped (length and width 0.45 mm), signum small, sclerotized, transverse ridge straight (0.15 mm).

Orbamia clarior **Hausmann & Tujuba, sp. n. (Plates III, IV, V)**

BIN: BOLD:ABW5825

Holotype: ♂, Kenya, South Ukanbasi, 6.V.1996, leg. Politzar(ZSM G 20944).

Etymology.The name refers to the comparatively pale ground colour.

Differential features (doi to be assigned): Forewing length: 10 mm. Upperside of wings: Ground colour comparatively dark brownish, transverse lines of forewing oblique. Underside: Ground colour whitish beige, orange between veins, apical spot on forewing conspicuous, sharp, on hindwing narrow, elongate, remanants of dark colouration in the analy angle. Male genitalia: Uncus of medium length, digitiform, stout, dilated towards base, valva straight, dorsal process with conspicuous spinule at tip, cornutus very long (2.7 mm). Female genitalia unknown.

Orbamia obliqua **Hausmann & Tujuba, sp. n. (Plates III, IV, V)**

BIN: BOLD: AAM4892

Holotype: ♂, Northwestern Zambia, Hillwood farm, S11 16.01 E2418.99, 17.ix.2009, 1420m, UV, J. Lenz legit, coll. ZSM (G 20905).

Paratype: 1♂, Tanzania, Morogoro province, Nguru mounts, IV.2004 (ex coll. Philippe Darge, coll. ZSM, G 20906).

Etymology.The name refers to the oblique position of the transverse lines of the forewing (lat. obliquus, -a, -um = oblique).

Differential features (COI sequences, photographs of adults and their genitalia see doi http://www.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxon=Orbamia+obliqua+&search

Tax=Search+Taxonomy): Adult: Forewing length: 11-12 mm. Upperside of wings: Ground colour pale grey with brown pattern, transverse lines oblique. Underside: Ground colour beige with slight yellowish tinge, and with strong dark suffusion, terminal area with pattern reduced to a dark apical spot and a dark shadow on the hindwing apex. Male genitalia: Uncus short, stout, hook-shaped, saccus projection shallow, valva straight, narrow at tip, dorsal process with a stout hook at tip, cornutus of medium length (1.9 mm). Female genitalia unknown.

Orbamia obliqua parva **Hausmann & Tujuba, subsp. n. (Plates III, IV, V)**

BIN: BOLD: AAM4892

Holotype: ♂, South Africa, Limpopo, Melkrivier Lapalala, Wilderness Kolobe camp, 1220m -23.9094°/282736°, 13.xi.2017, leg. A. Hausmann, coll. Ditsong Museum, Pretoria, gen.prp. ZSM G 20933.

Paratypes: 6♂, South Africa, Limpopo, Melkrivier Lapalala, Wilderness, Kolobe camp, 1220m -23.9094°/282736°, 13.xi.2017, leg. A. Hausmann; 2♂, RSA, Nourthwest prov. 7,5km North Zeerust, 1180m (lux), 25°27'S 26°05'E, 17.II.2006, leg. Hacker (ZSM G 20949); 1♂, South Africa, Gauteng, Mogale's Gate Biodiversity Centre, near Bush Camp, -25.938°, 27.639°, 1420 m, 14.ii.2012, leg. P. Hebert, J. deWaard, coll. University of Guelph (Canada), Centre for Biodiversity Genomics.

Etymology.The name refers to the small size of this subspecies (lat. parvus, -a, -um = small), being much smaller than the sympatric *O. octomaculata*.

Differential features: Adult: Forewing length: 9-11 mm. Upperside of wings: Ground colour pale grey, darker in the terminal area, pattern dark grey. Underside: Ground colour whitish beige, orange between veins, on forewing apex a sharp black spot, dark coloration on the hindwing terminal area restricted to a small stripe or shadow in the apex. Male genitalia: Uncus comparatively short, stout, hook-shaped, saccus projection shallow, valva straight, narrow at tip, dorsal process with a stout hook at tip, cornutus of medium length (1.6-1.9 mm). Female genitalia unknown.

Orbamia ocellata **(Warren 1897), stat. n.**

BIN: BOLD: AAP8312

Lepiodes ocellata: Warren (1897): 94 (Syntypes 5♂1♀ in NHMUK; locus typicus: South Africa: Bathurst; [northeastern Zambia]: Mpeta, Loangwa River [Luangwa], off the Zambesi [close to the border with northern Malawi]). Synonym of *O. octomaculata* according to Scoble (1999) but type series belonging to two different species. Herewith we designate the red-ring-labelled male specimen from Zambia, Mpeta, as lectotype to fix the identity of the name and to stabilize nomenclature. The taxon is herewith upgraded from synonymy to species rank (stat. n.), based on the below mentioned differences in DNA barcodes and genitalia. Pattern of upper- and underside of wings of the lectotype exactly matches that of the examined material from Tanzania, partly collected in closely adjacent localities to the type locality (e.g. Ruvuma and Iringa province).

Examined material: 1♂, Tanzania, Pwani region, Manadera, 166m, 06°14.300'S, 038°23.197'E, 07.XII.2008, leg. Ph.Darge (ZSM G 20908);1♀, Tanzanie, Tanga region, Savane prės, Usambara west. 475m, 11.v.2005 leg. Ph. Darge; 2♀, Tanzanie, Tanga region, West Usambara mts, MAGAM BA Forest, 1818m, 04°42.762'S, 038°17.283'E, 01.XII.2008, leg. Ph. Darge; 1♀, Tanzanie, Morongoi region, Mikesse Hills, 375m, 06°40.509'S, 037°58.120'E, 17.XI.2004, leg. Ph. Darge; 2♀, Tanzanie, Morogoro 1km E Mikumi, 550m, 5.III.2003, leg. M. Fibiger, H. Hacker, K.Larsen, H.P. Schreier; 1♀, Tanzania, Morogoro region, Uluguru mts, Bunduki Forest, 1275m, 07°01.079'S, 037°37.945'E, 23.XI.2007, leg. Ph.Darge; 1♀, Tanzania, Morogoro region, face West des, Nguru mts, Makuyu, savane arborėe, 620m, 25.IV.2005, leg. Ph. Darge (ZSM G 20942); 2♀, Tanzania, Morogoro region, West Nguru mts, Makuyu, alt. 620m, 06°16.081'S, 037°20.540'E, 19.XI.2007, leg. Ph. Darge; 1♂, Tanzania, Rukwa prov, Kisengere/ Kasambo, 1193m, 07°27.540'S, 030°52.812'E, 17.v.2004, leg. Ph. Darge;1♂, Tanzania, Rukwa prov., Mbizi mts, entre Kisungu et Muze, 1415m, 07°43.826'S, 031°32.482'E, 14.v.2004, leg. Ph. Darge; 1♀, Tanzanie, Iringa, Ulembwa, 2070m, 09°18.709'S, 034°38.078'E, 22.XII.2008, leg. Ph. Darge (ZSM G 20911); 2♀, Tanzanie, Pwani region, Savane de Mandera, 170m, 06°14.300'S, 038°23.197'E, 19.III.2006, leg. Ph. Darge; 1♂2♀, id., 15.I.2005;1♀, Tanzanie, Ruvuma region, Kitai Savnna, 1020m, 10°42.40'S, 035°12.339'E, 24.III.2006, leg. Ph. Darge (ZSM G 20946); 1♂, Tanzanie, Mbeya region, Igurusi savanna, 1150m, 08°46.684'S, 033°46.174'E, 06.IV.2006, leg. Ph. Darge;3♀, Tanzania, Ubenazomizi region, savannas and deciduous forest, 450m, 06°40.577'S, 037°58.994'E, 13.XII.2002, leg. Ph. Darge and Th. Ebode; 1♀, Tanzanie, Ruvuma region, Kitai Savanna, 1020m.

Differential features (COI sequences, photographs of adults and their genitalia see doi http://www.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxon=Orbamia+ocellata+&searchTax=Search+Taxonomy): Adult: Forewing length: 8.5-12 mm. Upperside of wings: Ground colour pale grey with slight brown suffusion, pattern brown with slight orange tinge. Underside: Ground colour whitish, orange between veins, apical spots on forewing conspicuous, sharply bordered, on hindwing terminal fascia usually diffuse, rarely restricted to apex. Male genitalia: Uncus narrow, digitiform, valva straight, broad, dorsal process with conspicuous, stout hook at tip, cornutus narrow and very long (2.8-3.0 mm). Female genitalia: Apophyses stout, apophyses anteriores comparatively long (2/3 length of apophyses posteriores), lamella ante- and postvaginalis fused, oval, comparatively broad (length 0.7 mm, width 0.5 mm), signum weakly sclerotized, small, transverse ridge straight (0.2 mm).

***Orbamia abiyi* Hausmann & Tujuba, sp. n. (Plates III, IV, V)**

BIN: BOLD: AAK5536

Holotype: ♂, North Zambia, Mutinondo, 1390m, wet Miombo, 29.XII. 2010, S12°23'30.9'' E31°19'23.8'', light trap, J. Lenz legit (ZSM G 20912)

Paratypes: 1♂1♀, North Zambia, Mutinondo, 1390m, wet Miombo, 29.XII.2010, S12°23'30.9'' E31°19'23.8'', light trap, J. Lenz legit (ZSM G 20913/♀); 1♂, S. Ethiopia SN, Arba Minch, below Hotel Bekele Molla, thornbush, 1310, 10°26'N 39039°53'E, 29.IV.2008, leg. Hacker & Schreier(ZSM G 20556); 1♂, Tanzania, Morogoro region, Mikesse Hills, 420 m, 06°40.154'S, 037°57.577'E, 21.XII.2005, Ph. Darge; 1♀, Tanzania, Rukwa prov., Mbizi mts, entre Kisungu et Muze, 1415m, 07°43.826'S, 031°32.482'E, 14.v.2004, leg. Ph. Darge; 1♂, Namibia, Kavango district, 17°52'N 19°39'E, 16km W Rundu, (Okavango) Kavango river area, 28.II.2006, leg. H. Hacker & H.P. Schreier (ZSM G 20932); 2♂, Rwanda, S.E. Rusumo, 1300 m, 29.XII.1975, leg. B. Turlin (ZSM G 13625; BC ZSM Lep); 1♂, id., 25.3.1975 (ZSM)

Etymology. The name honor's his Excellency Dr Abiy Ahmed Ethiopian Prime Minister, the 2019 Nobel Peace Prize Laureate, for his tremendous contributions to Ethiopia and the Horn of African geopolitics.

Differential features (COI sequences, photographs of adults and their genitalia see doi http://www.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxon=Orbamia+abiyi+&searchTax=Search+Taxonomy): Adult: Forewing length: 10-12 mm. Upperside of wings: Ground colour pale grey with slight brown suffusion, pattern brown with very slight orange tinge. Underside: Ground colour whitish, orange between veins, apical spots on forewing conspicuous, sharply bordered, on hindwing terminal fascia usually diffuse, in Tanzania hindwing terminal fascia uninterrupted. Male genitalia: Uncus narrow, digitiform, valva straight, broad, dorsal process with conspicuous, stout hook at tip, cornutus narrow and long (2.2-2.3 mm). Female genitalia: Lamella

ante- and postvaginalis fused, oval (length 0.75-0.85 mm), signum weakly sclerotized, small, transverse ridge straight (0.17 - 0.2 mm).
Remarks: Populations from western Ethiopia with darker upperside of wings, on hindwing underside dark pattern reduced to apex. See also remarks to the following species.

Orbamia emanai **Hausmann & Tujuba, sp. n. (Plates III, IV, V)**
BIN: BOLD: ABW6858
Holotype:♂, NWEthiopia, 30 km SE Bahir Dar, Tis Isat, Blue Nile falls, 1640m, 11°29'08''N 37°35'28''E, 25.VI.2008,leg. Hacker & Schreier. ZSM Lep G 20556.
Paratypes: 30♂8♀, NW Ethiopia, 30km SE Bahir Dar, Tis Isat, Blue Nile falls, 1640m, 11°29'08''N 37°35'28''E, 25.VI.2008, leg. Hacker & Schreier; 1♂, S. Ethiopia S.N., 12 km W Jinka, border of Mago N.P., 930 M (LUX), 05°18'47''N 36°44'07''E, 6.V.2008, leg. Hacker & Schreier (ZSM G 20910/♀; ZSM G 20916/♀).
Additional material (exactly barcode-sharing): 8♂2♀, Botswana, Central distr. 15km NW Francistown, river Tati, 1030 m, 21°02'S, 27°32'E, 19.II.2006, Hacker & Schreier (ZSM G 20919/♀; ZSM G 20920/♂); 1♀, Botswana, Kgatleng distr., 30km NNE Gaborone, 980m (lux), 19.II.2006, leg Hacker & Schreier; 2♂, Botswana, Central district 10 km SSE Nata, Sua pan, 930m (lux) 20°09'S 26°26'E, 20.II.2006, leg Hacker & Schreier.
Etymology.Named after Emana Getu, a senior professor of Entomology, at Addis Ababa University for his immense contributions to the field of entomology.
Differential features (COI sequences, photographs of adults and their genitalia see doi http://www.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxon=Orbamia+emanai+&searchTax=Search+Taxonomy): Adult: Forewing length: 9-12 mm. Upperside of wings: Ground colour comparatively dark. Underside: Ground colour pale grey, on hindwing with slight orange tinge, on forewing orange between veins, apical spots on forewing conspicuous, sharply bordered, on hindwing slightly darker at apex only. Male genitalia: Uncus narrow, digitiform, valva straight, broad, dorsal process with conspicuous, stout hook at tip, cornutus narrow and very long (2.5-3.0 mm). Female genitalia: Lamella ante- and postvaginalis fused, oval (length 0.8-0.85 mm), signum weakly sclerotized, small, transverse ridge straight (0.17-0.2 mm).
Remarks: Morphological differences to the previous species small, but the genetic divergence correlates with darker wing colour, and a few characters in male genitalia (longer cornutus). Distribution areas of both species overlapping.

Orbamia emanai lenzi **Hausmann & Tujuba, subsp. n. (Plates III, IV, V)**

BIN: BOLD: ABW6858

Holotype: ♂, Zambia, North Zambia, Mutinondo, 1390 m, wet Miombo, 01.I. 2011, S12°23'30.9'' E31°19'23.8'', light trap, J. Lenz legit, gen.prp. ZSM G 20917 (coll. ZSM G 20918).

Paratypes: 1♀, Zambia, North Zambia, Mutinondo, 1390m, wet Miombo, 01.I.2011, S12°23'30.9'' E31°19'23.8'', light trap, J. Lenz legit (ZSM G 20922); 1♂, id., 29.XII.2010; 1♂, Zambia, Northwest prov., Chiwona riverine forest, 1330 m, -12.412°S, 24.1910°E, 12.IX.2015, leg Sàfiàn Szabolcs; 1♂, S. Africa, S. Malawi, Nsanje distr. 25km S Blantyre, Mwabvi reserve, S16 39.20 E35 03.03, 10.XII.2010, 127m, Ustjuzhanin & Kovtunovich (ZSM G 20907).

Etymology.Named after Jürgen Lenz, Harare - Leipzig, active and experienced researcher and collector of geometrids in Africa, mainly Zambia and Zimbabwe.

Differential features: Adult: Forewing length: 10-11mm. Upperside of wings: Ground colour much paler than in the nominotypical subspecies, very pale grey, with slight brown suffusion, mainly in the terminal area, pattern grey brown. Underside: Ground colour whitish beige, orange on veins, apical spots on forewing conspicuous, sharply bordered, on hindwing terminal fascia usually diffuse over more or less the whole termen. Male genitalia: Uncus narrow, digitiform, valva straight, broad, dorsal process with conspicuous, stout hook at tip, cornutus narrow and long (2.7 mm). Female genitalia: Lamella ante- and postvaginalis fused, oval (length 0.75-0.85 mm), signum weakly sclerotized, small, transverse ridge straight (0.17-0.2 mm).

Remarks: BIN-sharing but at 2.2% distance, much paler than the nominotypical subspecies, but little difference in genitalia.

Orbamia pauperata **Herbulot 1966**

BIN: So far, without BIN, holotype with short barcode fragment (BC ZSM Lep 81698).

Orbamia pauperata: Herbulot (1966): 221 (Holotype § in ZSM: gen. prep. 14466; - locus typicus: Madagascar: Betioky, southern shore of Tsimanampetsotsa)

Examined material: 2♂3♀ from Madagascar, including holotype (ZSM G 13619/♀).

Differential features (COI sequences, photographs of adults and their genitalia see doi http://www.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxon=Orbamia+pauperata+&searchTax=Search+Taxonomy): Adult: Forewing length: 10-12 mm. Upperside of wings: Ground colour pale grey. Underside: Ground colour beige, without yellow tinge, apical spot present on forewing. Male genitalia: Uncus digitiform, saccus shortly projecting, round, valva short, broad, tapered at tip, dorsal process stoutly sclerotized, with a conspicuous, very long spine at tip, aedoeagus short (1.2 mm), cornutus very short (0.7 mm) and S-shaped at tip. Female genitalia: Lamella ante- and postvaginalis developed as two separate, narrow, transverse sclerites, posteriorly bilobous, signum rhomboid, transverse ridge straight (0.25 mm).

Remarks: Phylogenetically the most isolated species within this genus, based on large differences in morphology and genetics, the latter, however, just based on a short barcode fragment of the holotype.

Orbamia balensis **Hausmann & Tujuba, sp. n. (Plates III, IV, V)**

BIN: BOLD: AEA2800

Holotype : ♂, Ethiopia Oromia, Bale 8 km S. Dolo Mena, 1200 m, IV.2017, leg. R. Beck, coll. ZSM (ZSM G 20914).

Paratypes : 2♂2♀, Ethiopia Oromia, Bale 8km S. Dolo Mena, 1200m, IV.2017, leg. R. Beck (ZSM G 20948/♀); 1♀, Äthiopien, prov. Oromia, Dolo Mena, 30km, S., 1080 m (savanne) 06°13.530'N, 39°46.822'O, 14.IV.2019, Robert Beck (ZSM).

Etymology.The name refers to the type locality in the Bale mountains national park.

Differential features (COI sequences, photographs of adults and their genitalia see doi http://www.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxon=Orbamia+balensis+&searchTax=Search+Taxonomy): Adult: Forewing length: 11-13. Upperside of wings: Ground colour comparatively dark, with much dark brown suffusion, pattern not well contrasted. Underside: Ground colour beige, with pale orange tinge on veins, apical spots on forewing conspicuous, sharply bordered, on hindwing slightly darker at apex only, remnants of dotted terminal fascia on all wings. Male genitalia: Uncus stout, very long, saccus broad, valva straight, ´very broad at base, narrow at tip, dorsal process stoutly sclerotized, with conspicuous, stout hook at tip, cornutus narrow and short (1.1 mm). Female genitalia: Lamella ante- and postvaginalis fused, heart-shaped, short (length 0.6 mm), signum small, transverse ridge straight (0.2 mm).

Rabomia **Hausmann & Tujuba gen. n.**

Type species: *Ectropis*? *subaurata* Warren, 1899, comb. n.

Etymology: The name is an anagram of the sister genus *Orbamia*, similarly to the anagram used by Herbulot (1966) when transforming the name *Boarmia* to *Orbamia*.

Differential features: Genetic data: The species listed here are all grouping into one cluster in the Neighbour Joining and Maximum Likelihood trees. Adult: Male antennae ciliate-fasciculate, female antennae filiform. Palpi of both sexes broad, bushy scaled, length in male 1.0, in female 1.5 times diameter of eye. Hindtibia of both sexes with two pairs of unequal spurs. Upperside of wings with inconspicuous, elongate discal spots, postmedial line of forewings sharp, strongly curved. Underside yellow, black terminal fascia conspicuous. Male genitalia: Uncus with three short sclerotized spines, lateral lobes below uncus swallen, saccus triangular, dorsal process of valva naked, with curved spinule at tip, aedeagus comparatively broad, with bundle of small cornuti at base, vesica condensed to a broad cornutus-like sclerite at tip. Female genitalia: Lamellae ante- and postvaginalis sclerotized (elongate rhomboid), posteriorly rounded, ductus bursae sclerotized, long, helicoid, longitudinally furrowed, corpus bursae membranous, signum large, star-shaped.
Genetic data: The species listed here are all grouping into one cluster in the Neighbour Joining and Maximum Likelihood trees.
Remarks: In some morphological features (e.g. female signum and ductus bursae) transitional to genus *Dorsifulcrum* Herbulot, 1979, but genetically clustering separately, underside of wings with black fascia only in the terminal area.

Rabomia subaurata **(Warren 1899), comb. n.**
BIN: BOLD: AAM3217
Ectropis? *subaurata*: Warren (1899): 306 (Holotype $ in NHMUK; - locus typicus: [Zambia]: Mpeta, Loangwa River, off the Zambesi)
Examined material (ZSM): 10♂♀ from Zambia, Malawi, (southernmost) Democratic Republic of the Congo (Elisabethville [Lubumbashi]).Gen. prep.: ZSM G 20923/♂; ZSM G20924 ♀;
Differential features (COI sequences, photographs of adults and their genitalia see doi http://www.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxon=Rabomia+subaurata+&searchTax=Search+Taxonomy): Adult: Forewing length: 13-14 mm. Upperside of wings: Ground colour comparatively dark grey.
Underside: Ground colour yellow, discal spots small, terminal fascia narrow at centre of forewing termen interrupted by a large yellow area. Male genitalia: Valva long and narrow, sacculus narrowly projecting at tip, at the base of aedeagus a bundle of eight comparatively long (0.3 mm) microcornuti. Female genitalia: Star-shaped signum large, diameter 0.7-0.9 mm.

***Rabomia obscurior* Hausmann & Tujuba, sp. n. (Plates III, IV, V)**

BIN: BOLD: ABV9564

Holotype: ♀, Burkina Faso (‘Upper Volta’), Bobo Dioulesso, 6.10.81, leg. Dr Politzar, coll. ZSM (G 20915).

Paratypes: 1♀, Burkina Faso (‘Upper Volta’), Bobo Dioulesso, 13.11.85, leg. Dr Politzar; 1♀: Burkina Faso (‘Upper Volta’), Bobo Folonso, 28.7.79, leg. Dr Politzar; 1♂, id., 10.11.74; 1♂, Nigeria, Kaduna, 3.vii.1970, leg. Politzar, coll. ZSM (G 20926); 1♀, id., 28.vi.1970; 1♀, id., 26.vi.1970; 1♀, id., 8.vii.1970; 1♂, North Nigeria, Kogin Kano Game Reserve, 15.vi.1974, leg. Dr Politzar; 1♀, Cameroon, Yala Yarna, 40 km N of Ngaoundéré, 735 m, 22.vii.1974, leg. Gilles Clément (ZSM G 20925).

Etymology.The name refers to the darker coloration of wings (lat. obscurior = darker).

Differential features: Adult: Forewing length: 12-14 mm. Upperside of wings: Ground colour with darker suffusion than in *R. subaurata*, medial fascia dark and conspicuous on all wings, sometimes anastomosing with postmedial line on forewing. Underside: Ground colour yellow, discal spots larger than in *R. subaurata*, terminal fascia much broader, at centre of forewing termen interrupted by a small yellow spot or even uninterrupted. Male genitalia: Valva long and narrow, sacculus edged at tip, only shortly projecting, at the base of aedeagus a bundle of twelve comparatively short (0.15-0.2 mm) microcornuti. Female genitalia: Star-shaped signum large, diameter 0.8-1.0 mm.

***Morabia* Hausmann & Tujuba gen. n.**

Type species: *Morabia politzari* Hausmann & Tujuba, sp. n.

Etymology: The name is an anagram of the sister genus *Orbamia*, similarly to the anagram used by Herbulot (1966) when transforming the name *Boarmia* to *Orbamia*.

Differential features: Genetic data: The species listed here are all grouping into one cluster in the Neighbour Joining and Maximum Likelihood trees. Adult: Male antennae ciliate-fasciculate, female antennae filiform. Palpi of both sexes broad, bushy scaled, length 1.0-1.5 times diameter of eye. Hindtibia of both sexes with two pairs of unequal spurs. Upperside of wings with discal spots vestigial, medial line zigzagging, terminal line conspicuous, zigzagging on all wings. Underside beige, with a few yellowish scales and a sharp black spot in forewing apex. Male genitalia: Uncus very short, rounded saccus shallowly projecting, dorsal process of valva strongly setose, valva long and narrow, curved, strongly setose, mainly at centre, aedeagus with long and stout cornutus. Female genitalia: Apophyses long and fine. Lamellae ante- and postvaginalis membranous, ductus bursae straight, anteriorly membranous, posteriorly dilated and towards antrum strongly sclerotized, corpus bursae membranous, pyriform, signum absent.

Morabia politzari **Hausmann & Tujuba, sp. n. (Plates III, IV, V)**

BIN: BOLD: ABX0432

Holotype: ♀, Kenya, Sokoke Forest, 31.7.94, leg. Dr. Politzar, coll. ZSM Lep 74389.

Paratypes: 1♂, Kenya, Watama, 2.viii.1973, leg. Politzar, coll. ZSM (G 20934); 1♀, id., 30.vii.1973; 1♀, Kenya, Sokoke Forest, 31. Vii. 1994, leg. Politzar; 1♀, id, 2.vii.1994; 3♀, Tanzanie Bagamoyo dist. Vigwaza, 231 m, 06°42.895'S, 038°52.521'E, 30.III 2014, leg. Ph. Darge; 1♀, Tanzanie, Pwani region, Ruvu forest reserve, 220m, 06°57.273'S, 038°49.361'E, 03.III.2014, leg. Ph. Darge (ZSM); 1♀, Coll. Mus. Tervuren, E.ville [DR Congo], 16.X.1955, Seydel (ZSM G 20935).

Etymology.The name refers to Dr. Heinz Politzar (1938-2007) for his great merits in collecting and studying African Lepidoptera (see Hacker and Hausmann, 2010).

Differential features (COI sequences, photographs of adults and their genitalia see doi http://www.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxon=Morabia+politzari+&searchTax=Search+Taxonomy): Adult: Forewing length: 12-14.5 mm. Upperside of wings: Ground colour whitish beige. Underside: Ground beige, with slight yellow or orange tinge, mainly on forewing, discal spots small, both wings with sharp, black apical spot. Male genitalia: Uncus very short, rounded, saccus shallowly projecting, dorsal process of valva strongly setose, valva long and narrow, curved, strongly setose, mainly at centre, aedeagus (length 2.5 mm) with long and stout cornutus (1.9 mm), sigmoid at tip. Female genitalia: Lamellae ante- and postvaginalis membranous, ductus bursae straight, anteriorly membranous, posteriorly dilated and towards antrum strongly sclerotized, corpus bursae membranous, pyriform, signum absent.

Morabia brunnea **Hausmann & Tujuba, sp. n. (Plates III, IV, V)**

BIN: BOLD: ABW6916

Holotype: 1♂, Zambia, North Zambia, Mutinondo, 1390m, wet Miombo, 27.XII. 2010, S12°23'30.9'' E31°19'23.8'', light trap, J. Lenz legit, coll. ZSM (G 20945).

Etymology.The name refers to the unusual, brownish ground colour of the wings (lat. brunneus, -a, um = brown).

Differential features (COI sequences, photographs of adults and their genitalia see doi http://www.boldsystems.org/index.php/Taxbrowser_Taxonpage?taxon=Morabia+brunnea+&searchTax=Search+Taxonomy): Adult: Forewing length: 17.5 mm. Upperside of wings: Ground colour warm brown, pattern as in *M. politzari*. Underside: Ground pale brownish yellow, discal spots conspicuous, both wings with sharp, black apical spot and diffuse brown terminal fascia. Male genitalia: Uncus very short, rounded, strongly setose, saccus shallowly projecting, dorsal process of valva strongly setose, valva long and narrow, curved, strongly setose, mainly at centre, aedeagus longer (3.5 mm) than in the preceding species, S-shaped, with stout, S-shaped cornutus, longer than in the preceding species (2.3 mm). Female genitalia unknown.

4.3.2 GENETICANALYSIS

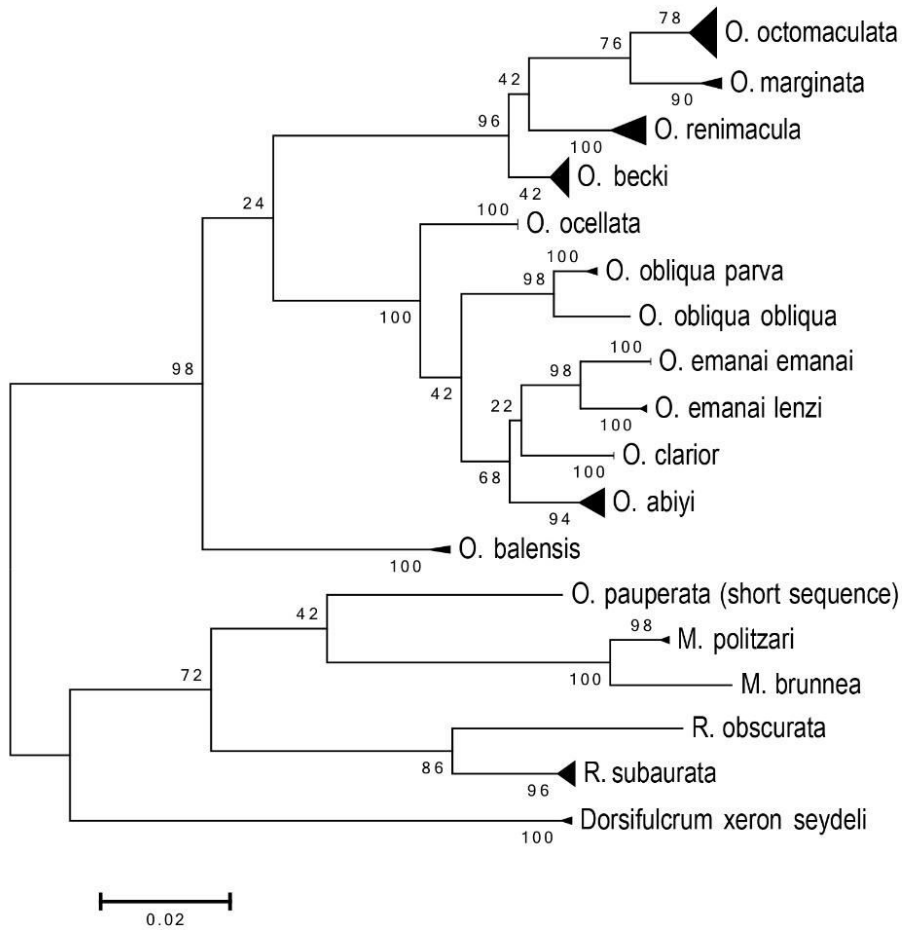

Figure 20. Maximum likelihood tree, 50 bootstrap replications, Tamura-Nei model, uniform rates, built with Mega 6 software (Scale bar = 2%)

Based on the genetic tree, all *Orbamia* species formed a single cluster, with the exception of *O. pauperata*, for which only a short DNA sequence was available, whereas the two new genera formed a different cluster joining with *Dorsifulcrum xeron*Herbulot, 1979(**Fig. 20**).

The interspecific variation calculated within the *Orbamia* genus ranged between 1.89 (between *O. becki* and *O. marginata*) and 7.65 (between *O. balensis* and *O. ocellata*) and was always higher than the intraspecific variability. The interspecific variation for the two *Rabomia* species was 5.19 and for the two *Morabia* species was 2.66 (**Table 5**).

Table 5. Barcode Gap Analysis from BOLD data, showing intraspecific variation ('Mean Intra-Sp' and 'Max. Intra-Sp.) and distances from Nearest Neighbour Species (NN).

Species	Mean Intra-Sp	Max. Intra-Sp	Nearest Species	Distance NN
Orbamia abiyi	0.51	0.93	*Orbamia clarior*	2.1
Orbamia balensis	0.61	0.61	*Orbamia ocellata*	7.65
Orbamia becki	0.97	2.68	*Orbamia marginata*	1.89
Orbamia clarior	0	0	*Orbamia abiyi*	2.1
Orbamia ocellata	0	0	*Orbamia clarior*	2.81
Orbamia emanai	1.43	2.17	*Orbamia clarior*	2.47
Orbamia marginata	0.53	0.62	*Orbamia becki*	1.89
Orbamia obliqua	1.35	1.87	*Orbamia abiyi*	3.63
Orbamia octomaculata	0.69	1.27	*Orbamia marginata*	2.34
Orbamia renimacula	0.42	1.08	*Orbamia becki*	2.18
Rabomia obscurata	N/A	0	*Rabomia subaurata*	5.19
Rabomia subaurata	0.41	0.62	*Rabomia obscurata*	5.19
Morabia brunnea	N/A	0	*Morabia politzari*	2.66
Morabia politzari	0.25	0.26	*Morabia brunnea*	2.66

4.4 DISCUSSION

The taxonomical analysis carried out was based on both morphological and genetic COI data. With the present revision, the genus *Orbamia* Herbulot, 1966, previously consisting of five species (Scoble 1999; Hausmann 2006), raised to 13 species. In addition, two new related genera have been described: *Rabomia* Hausmann & Tujuba gen. n. (type species: *Rabomia subaurata* (Warren, 1899), comb. n.) and *Morabia* Hausmann & Tujuba gen. n. (type species: *Morabia politzari* Hausmann & Tujuba, sp. n.).

All specimens come from Afrotropical Region and ranged from Yemen, in the North, to South Africa. In Ethiopia *O. becki*, distributed in Yemen, Ethiopia and Djiboutiwas the only species previously known. Three additional taxa have been here described: *O. balensis*, an endemic species from Bale Mountains; *O. emanai*, also reported from Botswana; *O. abiyi*, distributed in Zambia, Ethiopia, Tanzania and Namibia.

Both morphological and genetical analysis consistently supported the described results. In adults, most species showed an appearance quite homogeneous and typical of the genus; here the apical and discal spots on upper- and underside wings are the main diagnostic characters. Male genitals showed clear interspecific differences, especially in the aedeagus and in the shape of the dorsal process of valva. Female genitalia differs for the morphology of ductus bursae and bursa copulatrix. The barcoding gap confirmed that there is no overlap between intra- and interspecific genetic distances of the species examined, supporting the consistency of established taxa (Meyer and Paulay 2005). Multigene analysis of Geometridae revealed evidence for assignation of genus *Orbamia* to Cassymini and for sister group relationship with the African genus *Pycnostega* (Murillo-Ramos et al. 2019; Brehm et al. 2019). Maximum likelihood analysis of COI barcode data underpins the monophyly of the genus *Orbamia* as conceived and circumscribed here

The description of two new genera distinct from *Orbamia* is justified by both morphology of genitalia and genetic results, altought the adults fits the *Orbamia* habitus. The maximum likelihood analysis of COI barcode data supports the monophyly of the genus *Rabomia* gen. n. and sister group relationship with *Dorsifulcrum*. However, phylogenies at genus level need to be considered with caution, when they are inferred from COI data. More research is needed to investigate the potential (re-)assignment of *Dorsifulcrum* to the Cassymini after having been excluded from that tribe in Brehm et al. (2019). The genus *Rabomia* presents some morphological features in female genitalia that is transitional to the genus *Dorsifulcrum* Herbulot, 1979 (e.g. female signum and ductus bursae). In adults, underside of wings has black fascia limited only to the terminal area.

The maximum likelihood analysis of COI barcode data suggests the monophyly of the genus *Morabia* gen. n. and an isolated position from *Rabomia* gen. n. +*Dorsifulcrum* and from genus *Orbamia* (with genetic distances above 10%). *Morabia* has relevant differences in upperside of wings with discal spots vestigial, medial line zigzagging, terminal line conspicuous, zigzagging on all wings.

4.5 REFERENCES

Brehm G. (2015). Three new species of *Hagnagora* Druce, 1885 (Lepidoptera, Geometridae, Larentiinae) from Ecuador and Costa Rica and a concise revision of the genus. Zookeys, 537: 131–156.

Brehm G. (2018). Revision of the genus *Callipia* Guenée, 1858 (Lepidoptera, Geometridae),with the description of 15 new taxa. European Journal of Taxonomy, 404: 1–54.

Brehm G., Murillo-Ramos L., Sihvonen P., Hausmann A., Schmidt B.C., Õunap E., Moser A., Mörtter R., Bolt D., Bodner F., Lindt A., Parra L.E., Wahlberg N. (2019). New World geometrid moths (Lepidoptera: Geometridae): Molecular phylogeny, biogeography, taxonomic updates and description of 11 new tribes. Arthropod systematics & phylogeny, 77 (3): 457-486.

De Carvalho M.R., Bockmann F.A., Amorim D.S., Brandao CRF, de Vivo M., de Figueiredo J.L., Britski H.A., de Pinna M.C.C., Menezes N.A., Marques F.P.L., Papavero N., Cancello E.M., Crisci J.V., McEachran J.D., Schelly R.C., Lundberg J.G., Gill A.C., Britz R., Wheeler Q.D., Stiassny M.L.J., Parenti L.R., Page L.M., Wheeler W.C., Faivovich J., Vari R.P., Grande L., Humphries C.J., DeSalle R., Ebach M.C., Nelson G.J. (2007). Taxonomic impediment or impediment to taxonomy? A commentary on systematics and the cybertaxonomic-automation paradigm. Evolutionary Biology, 34 (3–4): 140–143. doi:10.1007/s11692-007-9011-6.

Forum Herbulot (2014). Forum Herbulot 2014 statement on accelerated biodiversity assessment statement (Community Consensus Position). In Hausmann A. (ed.): Proceedings of the eighth Forum Herbulot 2014. How to accelerate the inventory of biodiversity (Schlettau, 30 June – 4 July 2014). Spixiana 37 (2): 241-242.

Hacker H., Hausmann A. (2010). Obituary to Dr. Karlheinz Politzar. Esperiana Memoir, 5: 35-37.

Hardwick D.F. (1950). Preparation of slide mounts of lepidopterous genitalia. Canadian Entomologist, 82: 231–235.

Hausmann A. (2003). Die afrotropischen Arten der Gattung *Hypochrosis* Guenée, [1858] mit Beschreibung einer neuen Gattung (*Cherbulois* gen. nov.) und 17 neuer Arten (Lepidoptera, Geometridae, Ennominae). Spixiana, 26 (2): 97–128.

Hausmann A. (2006). The geometrid moths of Yemen – With 50 new records for the country and description of 20 new taxa (Lepidoptera: Geometridae). Esperiana, 12: 9-62, 10 colour plates.

Hausmann A., Parisi F., Sciarretta A. (2016). The Geometrinae of Ethiopia II: Tribus Hemistolini, genus *Prasinocyma* (Lepidoptera: Geometridae, Geometrinae). Zootaxa, 4065 (1): 1-63, DOI: doi.org/10.11646/zootaxa.4065.1.1

Herbulot C. (1966). Nouveaux Geometridae du Sud-ouest de Madagascar. Bulletin. Mensuel Sociėtė. Linneenne de Lyon, 35: 216-221.

Hobern D., Miller J. (2019). An alliance for biodiversity knowledge: Rethinking international collaboration in biodiversity informatics. Biodiversity Information Science and Standards, 3: e37324.

Kimura M. (1980). A simple method for estimating evolutionary rates of base substitutions through comparative studies of nucleotide sequences. Journal of Molecular and Evolution, 16(2): 111-120.

Ivanova N.V., Dewaard JR, Hebert P.D.N. (2006).An inexpensive, automation-friendly protocol for recovering high-quality DNA. Molecular Ecology Notes, 6: 998–1002.

Löbel H., Hausmann A. (2019). "Geometridae mundi", a new way of summarizing the diversity of global Geometrid species. In Hausmann A. (ed.): Proceedings of the tenth Forum Herbulot 2018. Integrative taxonomy, a multidisciplinary approach to answer complicated taxonomic questions (Stuttgart, 11–16 June 2018). Spixiana 42 (2): 297.

Meierotto S., Sharkey M.J., Janzen D.H., Hallwachs W., Hebert P.D.N., Chapman E.G., Smith M.A. (2019). A revolutionary protocol to describe understudied hyperdiverse taxa and overcome the taxonomic impediment. Deutsche Entomologische Zeitschrift, 66(2): 119-145.

Meyer C.P., Paulay G. (2005). DNA Barcoding: Error Rates Based on Comprehensive Sampling. PLoS Biology, 3(12): e422. https://doi.org/10.1371/journal.pbio.0030422

Prout L.B. (1926). New Geometridae in the Tring Museum. Novitates Zoologicae, 33: 179–188.

Ratnasingham S., Hebert P.D.N. (2007). BOLD: the barcode of life data systems. Molecular Ecology Notes, 7: 355–364.

Ratnasingham S., Hebert P.D.N. (2013). A DNA-based registry for all animal species: The Barcode Index Number (BIN) System. PLOS ONE, 8(8), e66213.

Riedel A., Sagata K., Suhardjono Y.R., Tänzler R., Balke M. (2013a). Integrative taxonomy on the fast track - towards more sustainability in biodiversity research. Frontiers in Zoology, 10 (15). doi: https://doi.org/10.1186/1742-9994-10-15

Riedel A., Sagata K., Surbakti S., Tänzler R., Balke M. (2013b). One hundred and one new species of *Trigonopterus* weevils from New Guinea. Zookeys, 280: 1-150. doi: 10.3897/zookeys.280.3906

Saitou N., Nei M. (1987). The neighbor-joining method: a new method for reconstructing phylogenetic trees. Molecular Biololgy and Evolution, 4(4): 406-25.

Scoble M.J. (1999). Geometrid Moths of the World: A Catalogue. CSIRO Publishing, Collingwood, Stenstrup, 1016 pp.

Scoble M.J., Hausmann A. (2007). Online list of valid and available names of the Geometridae of theworld. Available at http://www.lepbarcoding.org/geometridae/species_checklists.php.

Tamura K., Stecher G., Peterson D., Filipski A., Kumar S. (2013). MEGA6: Molecular Evolutionary Genetics Analysis Version 6.0. Molecular Biology and Evolution, 30 (12): 2725-2729.

Van Nieukerken E.J., Kaila L., Kitching I.J., Kristensen N.P., Lees D.C., Minet J., Mitter C.,Mutanen M., Regier J.C., Simonsen T.J., Wahlberg N., Yen S., Zahiri R., Adamski D., Baixeras J.,Bartsch D., Bengtsson B.Å., Brown J.W., Bucheli S.R., Davis D.R., De Prins J., De Prins W.,Epstein M.E., Gentili-Poole P., Gielis C., Hättenschwiler P., Hausmann A., Holloway J.D.,Kallies A., Karsholt O., Kawahara A.Y., Koster J., Kozlov M., Lafontaine J.D., Lamas G., Landry J.,Lee S., Nuss M., Park K., Penz C., Rota J., Schintlmeister A., Schmidt B.C., Sohn J., Solis M.A.,Tarmann G.M., Warren A.D., Weller S., Yakovlev R.V., Zolotuhin V.V., Zwick A. (2011).Order Lepidoptera Linnaeus, 1758. In: Zhang, Z.-Q. (Ed.), Animal biodiversity: an outline ofhigher-level classification and survey of taxonomic richness. Zootaxa, 3148: 212–221.

Wallengren H.D.J. (1872). Bidrag till Södra Afrikas Fjärilfauna. Öfversigt af Kongliga Vetenskaps-Akademiens Förhandlingar, 29(3): 41–61.

Warren W. (1899). New Drepanulidae, Thyrididae, and Geometridae from the Aethiopian region. - Novitates Zoologicae, 6(3): 287–312.

Wheeler Q.D. (2008). Taxonomic shock and awe. In Q.D. Wheeler (ed.). The New Taxonomy. 76. Boca Raton: CRC Press. pp. 211–226.

Acknowledgements

I am overwhelmed with pleasure and proud to express my deep sense of gratitude and special thanks to my supervisor, Prof. Andrea Sciarretta, for his tremendous guidance, constructive criticism, valuable suggestions, continuous encouragement, for provision of important reference materials and invaluable expertise from the initial proposal development to the final manuscript of the thesis. He has always been supportive intellectually, emotionally, and financially. I thank and appreciate him for his honestly free and friendly approach throughout the study period.

I am grateful to University of Molise for granting me the International PhD scholarship in Agricultural technology and Biotechnology. I also thank my Institute, Ethiopian Biodiversity Institute (EBI) for partial sponsorship and assistance throughout the PhD work. I would like to acknowledge University of Brescia for partial financial support for the fieldwork.

My sincere thanks go to all my friends and colleagues at Ethiopian Biodiversity Institute (Dr Misikire Tessema, Dr Feleke Woldeyes, Dr Gemedo Dalle, Dr Melese Mariyo, Mr Abraham Assefa, Mr Ashenafi Ayenew and Dr Abeje Kasie) for their cooperation at various stages of the study and my Laboratory mates at University of Molise (Dr Marco Colacci, Dr Pasquale Calabrese, and Dr Lorenzo Goglia) for their unconditional friendship and support they have always given me. Thank you for your continuous understanding and encouragement.

My heart felt gratitude to Professor Axel Hausmann for hosting me as a visiting scholar to Bavarian State Collection of Zoology (Munich, Germany) and his keen interest to share life long experience and provided me tremendous hand on trainings on advanced morphological and molecular studies on family Geometridae; Prof. David Agassiz (Natural History Museum of London), Dr. Graziano Bassi (Natural History Museum of Geneva), and Dr. Herman H. Hacker (Bamberg, Germany) for the determination of families Ypomoneutidae, Crambidae, and Erebidae/Nolidae respectively. My special thanks go to Prof. Pasquale Trematerra (University of Molise, Italy) for contributing over hundred species to science and Ethiopian Lepidoptera diversity (family Tortricidae) in the last ten years and recently dedicating one new species to me: *Epichoristodes fekensae.*

I gratefully acknowledge PhD program coordination office, especially, Prof. Giuseppe Maiorano and the reviewers (Dr. Alberto Zilli, Natural History Museum of London and Dr. Stefano Scalercio, Council for agricultural research and economics, Research Centre for Forestry and Wood, Rende, Cosenza) who provided invaluable inputs and comments for their constructive criticisms. I would like to thank Dr Getnet Atnafu and Department of Natural and Computational sciences, Debre Markos University, for their hospitality as doctoral student exchange. Many thanks to Mr Getachew Nigussie who was my potential field assistant and other local security guards who supported me during my field work.

Finally, I would like to extend a special thanks to my families and friends for all their encouragement and support during the period of this study.

List of publications

Scientific articles:

Tesfu Fekensa Tujuba, Weldemariam Tesfahunegny, Asersie Mekonnen (2018). Impact of human activities on biosphere reserve: A case study from Yayu Biosphere Reserve, Southwest Ethiopia. *International Journal of Biodiversity and Conservation*, 10(7): 319-326.

Tujuba T.F., Sciarretta A., Hausmann A., Abate G.A. (2019). Lepidoptera of Ethiopia: current knowledge and future perspectives. *Zookeys,* 882: 87–125.

Tujuba T.F., Hausmann A., Sciarretta A. (2020). Revision of the *Orbamia* Herbulot, 1966 group of genera with description of two new genera, ten new species and two new subspecies (Lepidoptera: Geometridae: Ennominae: Cassymini). *Zookeys* (accepted)

Congress abstracts:

Lepidopteran Biodiversity Assessment along various land use types in Mount Choke, Ethiopia. IX Annual Meeting European PhD Network "Insect Science" - 14-16 November 2018, Scuola di Agraria – University of Firenze.

The current state of Ethiopian Lepidoptera biodiversity. (2019). XXI European Congress of Lepidopterology – 3-7 June 2019, Campobasso, Italy.

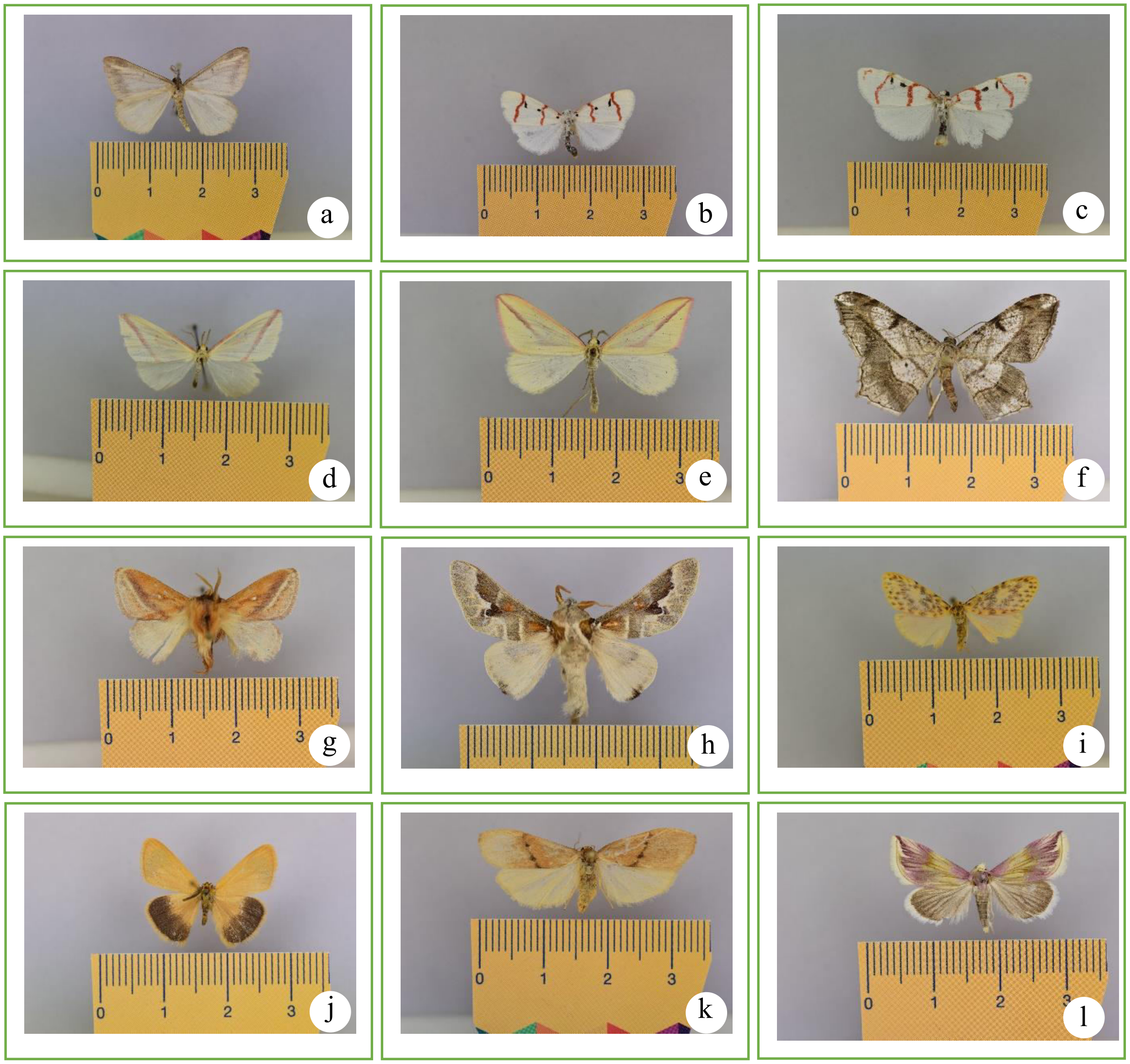

Plate I. Chapter 3. Examples of Lepidoptera collected in Choke Mountains: *Chiasma procidata* (Guenée, 1858) (a); *Cyana abyssinica* Karisch, 2003 (b); *Cyana ethiopica* Karisch, 2013 (c); *Rhodometra sacraria* (Linnaeus, 1767) (d); *R. labdoides* Herbulot, 1997 (e); *Chiasma simplicinea* (Warren, 1905) (f); *Sena scotti* (Tams, 1931) (g); *Streblote panda aethiopica* Hübner, 1822 (h); *Afrasura indecisa orientalis* Durante, 2009 (i); *Bracharoa reducta* Hering, 1926 (j); *Aroterosia punctilucata* (Hampson 1901) (k); *Eublemma pulcherrima* Wiltshire, 1982 (l).

Cont'd … **Plate II.** Chapter 3. *Eyralpenus scioana* (Oberthür, 1880) (m); *Digama meridionalis deliae* Berio, 1939 (n); *Eilema dorsti* Toulgoët, 1977 (o); *Xylopteryx emunctaria* (Guenée, 1858) (p); *Alpenus geninipucta* (Hampson, 1916) (q); *Seydelia geometrica* (Oberthür, 1883) (r); *Eyralpenus sublutea* (Bartel, 1903) (s); *Bunaeopsis oubie* (Guérin-Méneville, 1849) (t);

Gonimbrasia fucata (Rougeot, 1978) (u); *Eudocima materna* (Linnaeus, 1767) (v); *Acherontia atropos* (Linnaeus, 1758) (w); *Epiphora fournierae* (Le Moult, 1945) (x); *Gonimbrasia birbiri* Bouvier, 1929 (y); *Eligma neumanni* Rothschild, 1924 (z); *Dovania neumanni* Jordan, 1926 (zz).

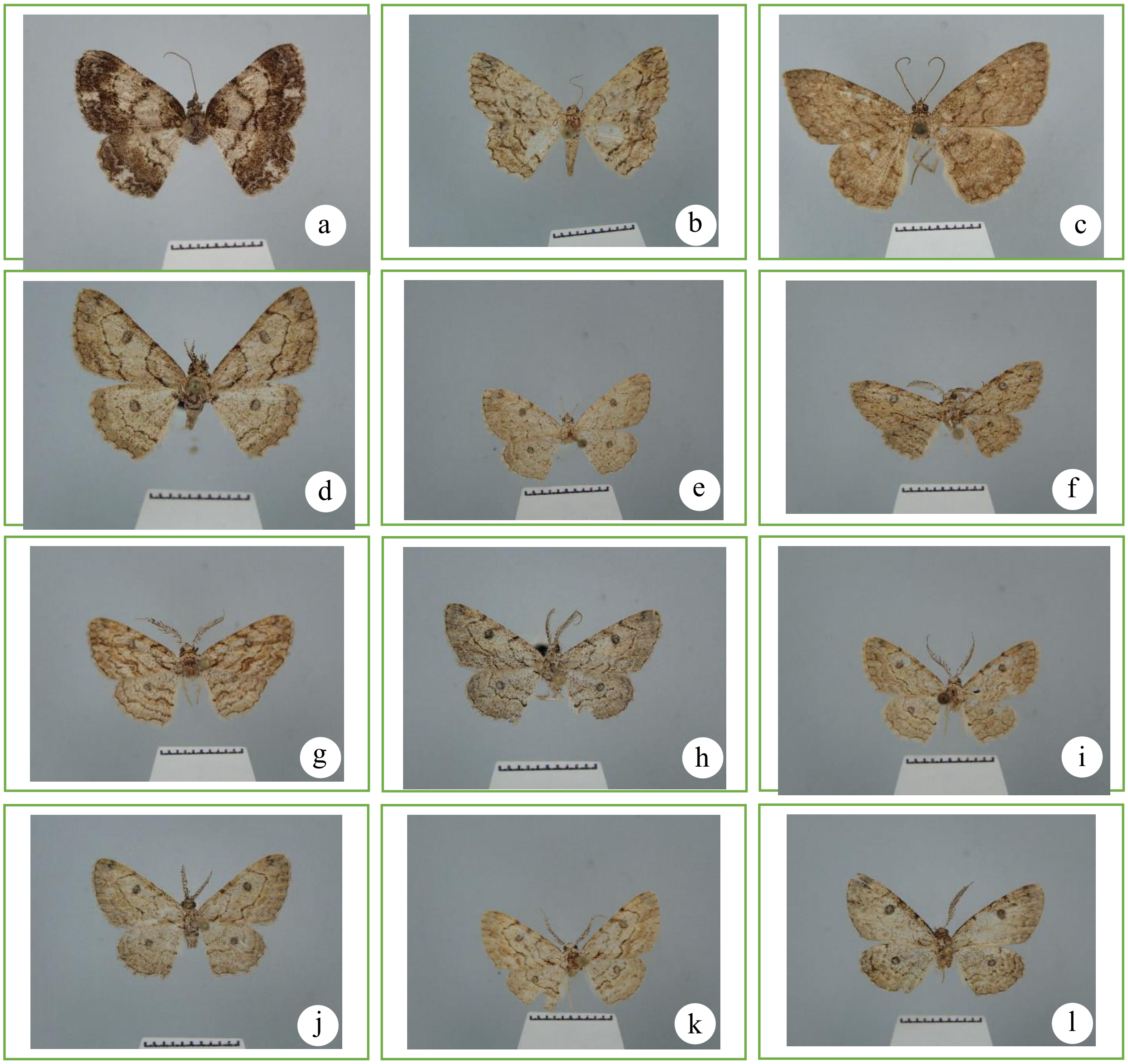

Plate III. Chapter IV. *Orbamia* revision. Adult holotypes: *Rabomia obscurior* BC ZSM Lep. G 20915 ♀ (a); *Morabia politzari* BC ZSM Lep. 74389 ♀ (b); *Morabia brunnea* BC ZSM Lep. G 20945 ♂ (c); *Orbamia marginata* BC ZSM Lep. G 20909 ♂ (d); *Orbamia clarissima* BC ZSM Lep. G 13618 ♂ (e); *Orbamia clarior* BC ZSM Lep. G 20944 ♂ (f); *Orbamia obliqua* BC ZSM Lep. G 20905 ♂ (g); *Orbamia obliquaparva* BC ZSM Lep. G 20933 ♂ (h); *Orbamia abiyi* BC ZSM Lep. G 20912 ♂ (i); *Orbamia emanai* BC ZSM Lep. G 20556 ♂ (J); *Orbamia emanai lenzi* BC ZSM Lep. G 20918 ♂ (k); *Orbamia balensis*BC ZSM Lep. G 20914 ♂ (l).

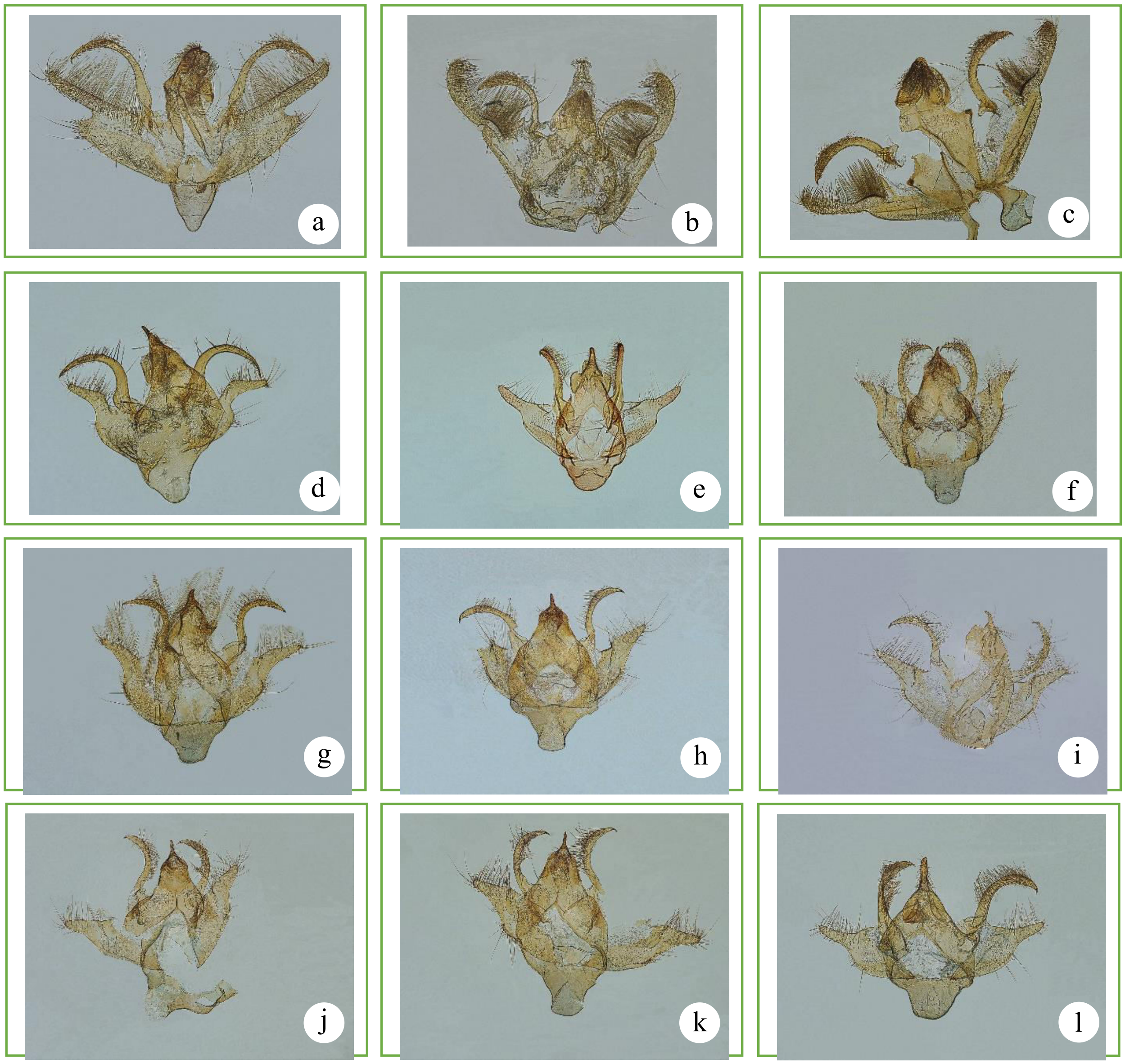

Plate IV. Chapter 4. *Orbamia* revision. Male genitalia: *Rabomia obscurior* ZSM G 20926 (a); *Morabia politzari* ZSM G 20934 (b); *Morabia brunnea* ZSM G 20945 (c); *Orbamia marginata* ZSM G 20941 (d); *Orbamia clarissima* ZSM G 14465 (e); *Orbamia clarior* ZSM G 20944 (f); *Orbamia obliqua* ZSM G 20905 (g); *Orbamia obliquaparva* ZSM G 20933 (h); *Orbamia abiyi* ZSM G 20908 (i); *Orbamia emanai* ZSM G 20917 (J); *Orbamia emanai lenzi* ZSM G 20918 (k); *Orbamia balensis* ZSM G 20914 (l).

Plate V. *Orbamia* revision. Male aedeagus: *Rabomia obscurior* ZSM G 20926 (a); *Morabia politzari* ZSM G 20934 (b); *Morabia brunnea* ZSM G 20945 (c); *Orbamia marginata* ZSM G 20941 (d); *Orbamia clarissima* ZSM G 14465 (e); *Orbamia clarior* ZSM G 20944 (f); *Orbamia obliqua* ZSM G 20905 (g); *Orbamia obliquaparva* ZSM G 20933 (h); *Orbamia abiyi* ZSM G 20908 (i); *Orbamia emanai* ZSM G 20917 (J); *Orbamia emanai lenzi* ZSM G 20918 (k); *Orbamia balensis* ZSM G 20914 (l).

Appendix I. Lepidoptera taxa originally described from Ethiopia. List of Lepidoptera taxa originally described from Ethiopia (only valid names are listed). The type locality is reported with the corrected spelling or current locality name in square brackets. The endemic taxa from Ethiopia are indicated with E. Synonymies are not reported. De Prins and De Prins (2019) and Williams (2018) have been used as a basic reference for the preparation of the list.

	Family	**Taxon**	**Author**	**Type Locality**	
1	**Blastobasidae**	*Blastobasis eridryas*	Meyrick, 1932	Mt Chillálo	E
2	**Brahmaeidae**	*Dactyloceras richinii*	Berio, 1940	Adi Abuna [in Tigray, Ethiopia]	
3	**Carposinidae**	*Carposina candace*	Meyrick, 1932	Jem-Jem Forest	E
4	**Choreutidae**	*Choreutis argyrastra*	Meyrick, 1932	Mt Zukwala/Cuqala	E
5		*Telosphrantis aethiopica*	Meyrick, 1932	Mt Chillálo	E
6	**Cosmopterigidae**	*Ascalenia secretifera*	Meyrick, 1932	Mt Chillálo	E
7		*Cosmopterix derrai*	Koster, 2016	14 km S of Debre Tabor, Alemsaga Forest	E
8		*Cosmopterix epismaragda*	Meyrick, 1932	Jem-Jem Forest	E
9	**Cossidae**	*Aethalopteryx obscurascens*	(Gaede, 1930)	Centr. Abyss., Maraquo	
10		*Afroarabiella strohlei*	Yakovlev & Witt, 2016	Turmi, Mango Lodge	E
11		*Azygophleps brehmi*	Yakovlev & Witt, 2016	Bale Mountains, Karcha near Rira	E
12		*Camellocossus abyssinica*	(Hampson, 1910)	Abyssinia [Ethiopia]	
13		*Camellocossus lalibela*	Yakovlev & Witt, 2017	Arba Minch	E
14		*Camellocossus strohlei*	Yakovlev & Witt, 2017	Arba Minch	E
15		*Macrocossus sidamo*	Rougeot, 1977	near Kébré-Mengist [Kebre Mengist]	E
16		*Oreocossus ungemachi*	Rougeot, 1977	Ioubdo, Birbir	E
17		*Strigocossus kushit*	Yakovlev, 2011	Ethiopia SE, Bale, 11 km SW Goba, Bale Mts	E

18	**Crambidae**	*Adelpherupa aethiopicalis*	Maes, 2002	SW Abyssinia [Ethiopia], Djimma [Jimma]	E
19		*Agathodes dufayi*	Rougeot, 1977	Koffolé [Kofale]	E
20		*Alphacrambus cristatus*	Bassi, 1995	Maraqo	E
21		*Ancylolomia jacquelinae*	Rougeot, 1984	Arba Minch	E
22		*Ancylolomia shafferi*	Rougeot, 1977	Koffolé [Kofale]	E
23		*Ancylolomia shefferialis*	Rougeot, 1984	Bahar Dar	E
24		*Chilo luniferalis*	Hampson, 1896	Abyssinia [Ethiopia]	E
25		*Classeya aphrodite*	Błeszyński, 1964	Dire Dawa	E
26		*Crambus arnaudiae*	Rougeot, 1977	Koffolé [Kofale]	E
27		*Crambus bachi*	Bassi, 2012	Bahar Dar, Lake Tana	E
28		*Crambus bellinii*	Bassi, 2014	Bale Mts, Sanetti Plateau	
29		*Crambus boislamberti*	Rougeot, 1977	Dinsho Reserve	E
30		*Crambus dedalus*	Bassi, 2000	Karsan, Kollubi	E
31		*Crambus descarpentriesi*	(Rougeot, 1977)	Koffolé [Koffale]	E
32		*Crambus jupiter*	Błeszyński, 1963	Ethiopia SW, Gamu-Gofa, Konso	E
33		*Crambus netuncus*	Bassi, 2012	Near Debra Libanos	E
34		*Crambus richteri*	Błeszyński, 1963	Kaffa, Ghimira	E
35		*Dembea venulosella*	Ragonot, 1888	Abyssinia [Ethiopia]	
36		*Euchromius donum*	Schouten, 1988	Haro-Ali, Gurra	E
37		*Euclasta sidamona*	Rougeot, 1977	Koffolé [Koffale]	E
38		*Euctenospila castalis*	Warren, 1892	Abyssinia [Ethiopia]	
39		*Leucinodes ethiopica*	Mally, Korycinska, Agassiz, Hall, Hodgetts & Nuss, 2015	Dire Dawa Region, Dire Dawa District, Dire Dawa	
40		*Lygropia nigricornis*	Hampson, 1898	Abyssinia [Ethiopia]	
41		*Noorda trimaculalis*	Amsel, 1965	Ethiopia SW, Gammu-Gofa, Konso	E

42		*Noorda unipunctalis*	Amsel, 1963	Konso	E
43		*Pagyda pulvereiumbralis*	(Hampson, 1918)	Diré Daouá [Dire Dawa]	
44		*Pediasia ferruginea*	Błeszyński, 1963	Kaffa, Gembi	
45		*Pediasia simiensis*	Błeszyński, 1962	Soddu Province, Wolamo [Walita]	E
46		*Prionapteryx selenalis*	(Hampson, 1919)	Taddecha Mullka	E
47		*Prionotalis friesei*	Błeszyński, 1963	Ethiopia SW, Gamu-Gofa, Konso	E
48		*Tegostoma richteri*	Amsel, 1963	Awash	E
49	**Depressariidae**	*Odites aethiopicus*	Lvovsky, 2001	Kaffa, Gembi	
50	**Elachistidae**	*Elachista delocharis*	Meyrick, 1932	Jem-Jem Forest	E
51	**Erebidae**	*Achaea monodi*	Laporte, 1975	near Kebré-Mengist [Kibre Mengist]	E
52		*Afrasura rivulosa ethiopica*	Durante, 2009	Menegesha-Suba state Forest	E
53		*Afrasura indecisa orientalis*	Durante, 2009	Menegesha-Suba state Forest	E
54		*Afrasura terlinea*	Durante, 2009	Langano Lake	E
55		*Afrojavanica kostlani*	(Gaede, 1923)	Adis-Abeba	
56		*Alpenus geminipuncta*	(Hampson, 1916)	Abyssinia [Ethiopia]	E
57		*Amata alicia*	(Butler, 1876)	Abyssinia [Ethiopia]	
58		*Amata magrettii*	Berio, 1937	Metema [in Tigray, Ethiopia]	E
59		*Amata rufina*	(Oberthür, 1878)	Abyssinia [Ethiopia]	
60		*Amata shoa*	(Hampson, 1898)	Abyssinia [Ethiopia]	
61		*Amata velatipennis*	Walker, 1865	Marako	
62		*Amphicallia kostlani*	Strand, 1911	Gipfel des Sugyala	E
63		*Amsacta nigrisignata*	Gaede, 1923	Addis Ababa	E
64		*Amsactarctia radiosa*	(Pagenstecher, 1903)	Darassum	
65		*Anomis sabulifera*	(Guenée, 1852)	Abyssinia [Ethiopia]	
66		*Antiophlebia bourgognei*	Laporte, 1975	Arba Minch	E
67		*Aroa quadriplagata*	Pagenstecher, 1903	Galata	E

68		*Asura xanthophaea*	Toulgoët, 1977	Ethiopia	E
69		*Beriodesma smithii*	(Holland, 1897)	River Darde	
70		*Brunia birketsmithi*	(Toulgoët, 1977)	Kébré-Mengist [Kibre Mengist]	E
71		*Brunia dorsti*	(Toulgoët, 1977)	Kébré-Mengist [Kibre Mengist]	E
72		*Callophisma viettei*	Laporte, 1975	Arba Minch	E
73		*Carcinarctia rougeoti*	Toulgoët, 1977	Bale Reserve, Dinsho	E
74		*Casama impura*	(Hering, 1926)	Abyssinia [Ethiopia]	
75		*Cautatha abyssinia*	Hacker, Fiebig & Stadie, 2019	Reg. South Nations, Bonga Guesthouse	
76		*Cautatha bifasciata*	Hacker, Fiebig & Stadie, 2019	Reg. South Nations, road Shishinda-Bonga, 6 km, w Wushwush	E
77		*Cerocala confusa*	Warren, 1913	Abyssinia [Ethiopia]	E
78		*Clytie thibauti*	Laporte, 1991	Kibre Mengist	E
79		*Corgatha hyperxantha*	Hacker, Fiebig & Stadie, 2019	Reg. South Nations, Bonga Guesthouse	E
80		*Corgatha minutulana*	Hacker, 2019	Southern Prov., 6 km ENE Weyto, Segen river	
81		*Cortyta canescens septentrionalis*	Hacker, 2016	12 km W of Jinka, near border of Mago National Park	
82		*Crambiforma leucostrepta*	Hampson, 1926	Harrar	E
83		*Crypsotidia digitata*	Kühne, 2005	Harar	E
84		*Crypsotidia gigantea*	Kühne, 2005	Harar	
85		*Ctenusa curvilinea*	Hampson, 1913	Taddecha Mullka	
86		*Cyana abyssinica*	Karisch, 2003	Akaki River, Addis Ababa	E
87		*Cyana ethiopica*	Karisch, 2013	near Kebré-Mengist [Kibre Mengist]	E
88		*Dasychira grisea*	Pagenstecher, 1903	Bone	E
89		*Dasychira plesia*	Collenette, 1938	Abyssinia [Ethiopia]	
90		*Digama meridionalis deliae*	Berio, 1939	Adu-Abuna [in Tigray,	E

				Ethiopia]	
91		*Donuctenusa fiorii*	Berio, 1940	Ogaden, Uarder [Warder]	E
92		*Enargeiosia elegans*	(Butler, 1877)	Atbara	
93		*Eublemma accedens aethiopica*	Hacker, 2019	Ethiopia, 3 km N Turmi, Mango Camping Site	
94		*Eublemma aethiopiana*	Hacker, 2019	Jinka, Mago Nat. Park, Magoriverside	
95		*Eublemma baccatrix*	Hacker, 2019	Southern Prov., 2.6 km EE Wondo Genet	
96		*Eublemma collacteana*	Hacker, 2019	12 km W Jimma, border Mago Nat. Park	
97		*Eublemma costivinata*	Berio, 1945	Borana Nagelli [Borena Nagelle]	E
98		*Eublemma diredaoua*	Hacker, 2019	Dire Daoua, Abyssinia	E
99		*Eublemma ferruginata*	Hacker, 2019	20 ESE Sashamane, Wendo Genet	
100		*Eublemma heteropaura*	Hacker, 2019	Oromia, 7 km NW Yabelo	
101		*Eublemma joergmuelleri*	Hacker & Schrier, 2019	Ethiopia, Awash N.P., Headquarter	E
102		*Eublemma perturbata*	Hacker, 2019	Oromia prov., 6.5 km ne Shebe	
103		*Eublemma plectoversa*	Hacker, 2019	8 km N Turmi	
104		*Eublemma schreieri*	Hacker, 2019	Oromia, 1km W vill. Aluweya	
105		*Eublemma sidamonia*	Hacker, Fiebig & Stadie, 2019	Sidamo, Yabello, vic. 6km SO near Deritu village	E
106		*Eublemma siticulina*	Hacker, 2019	Dire Daoua, Abyssinia	E
107		*Eublemma uhlenhuthi*	Wiltshire, 1988	Abyssinia, Dire Daoua[dire-dawa]	
108		*Euproctis chrysophaea*	(Walker, 1865)	Abyssinia [Ethiopia]	
109		*Eyralpenus scioana*	(Oberthür, 1880)	Scioa [Shoa]	
110		*Galtara doriae*	(Oberthür, 1880)	Mahal Uonz, between Harrar and Addis Abeba [Awash River]	

111		*Kenyarctia melanogastra*	(Holland, 1897)	Gof [Gofa]	
112		*Hypena abyssinia*	Guenée, 1854	Abyssinia [Ethiopia]	
113		*Hypena padelekorum*	Lödl, 1995	Djem-Djem [Jem Jem] Forest	E
114		*Hypena philippi*	Laporte, 1991	Arba Minch	E
115		*Hyposada zavattarii*	Berio, 1944	Gondaraba	
116		*Hypotacha fiorii*	Berio, 1943	Diredaua [Dire Dawa]	
117		*Hypotacha glaucata*	(Holland, 1897)	Sjeikh Husein [Shek Hussein]	
118		*Ischnarctia cinerea*	(Pagenstecher, 1903)	Gogoru	
119		*Laelia dabano*	Collenette, 1934	Dabano River	
120		*Lithacodia awassensis*	Berio, 1984	Awassa Lake	E
121		*Lithacodia persubtilis*	Berio, 1984	Kebré-Mengist	E
122		*Marcipa rougeoti*	Pelletier, 1975	Kebré-Mengist	E
123		*Metachrostis debivar*	(Berio, 1947)	Ogaden, Ualual [Walwal]	E
124		*Metachrostis phaeographa*	Hacker, 2011	12 km W of Jinka, border Mago National Park	
125		*Metarctia carmel*	Kiriakoff, 1957	SW Abyssinia [Ethiopia], Kambatta	E
126		*Metarctia gada*	Rougeot, 1977	Dinsho Reserve, Réserve de Balé	E
127		*Metarctia haematricha*	Hampson, 1905	Kutai Metha	
128		*Metarctia kumasina*	Strand, 1920	Zegi Tsana [Zegie Tana]	
129		*Metarctia negusi*	Kiriakoff, 1957	Abyssinia [Ethiopia]	E
130		*Metarctia noctis*	Druce, 1910	Diré Daouá [Dire Dawa]	E
131		*Metarctia saalfeldi*	Kiriakoff, 1960	Villagio	E
132		*Metarctia unicolor*	(Oberthür, 1880)	Oromo Country, Fin-Fekéré	
133		*Micralarctia punctulatum purus*	(Butler, 1878)	Abyssinia [Ethiopia]	
134		*Oediblemma peregrina*	Hacker, Fiebig & Stadie, 2019	Reg. South Nations, Sheiko Forest Road Teppi Mizan Teferi	E

135		*Ophiusa dianaris*	(Guenée, 1852)	Abyssinia [Ethiopia]	
136		*Pantydia dufayi*	Laporte, 1975	Near Koffolé [Koffalé]	
137		*Paramarbla abyssinica*	Collenette, 1956	Birbir, Joubdo [Yubdo]	E
138		*Paraonagylla zavattarii*	Berio, 1939	Neghelli [Nagelle]	E
139		*Pericyma schreieri*	Hacker, 2016	Gamu-Gofa Province, 3 km N of Turmi	
140		*Phytometra angensteini*	Hacker, 2019	Arba Minch	E
141		*Plecopterodes melliflua*	(Holland, 1897)	Sjeikh Husein [Shek Hussein]	
142		*Plecopterodes molybdena*	Berio, 1954	Gorgorà, Lake Tana	E
143		*Podomachla antinorii*	(Oberthür, 1880)	Mahal Uonz [Awash River]	
144		*Polymona rufifemur ellisoni*	Collenette, 1938	Abyssinia [Ethiopia]	
145		*Proluta ethiopica*	(Hacker, 2011)	Arba Minch Region, Omo Province, Gemu Gofa	
146		*Pseudomicrodes varia*	Berio, 1944	Elolo	
147		*Pteredoa atripalpia*	Hampson, 1910	Atbara River	
148		*Rhabdophera exarata*	(Mabille, 1890)	Abyssinia [Ethiopia]	
149		*Ruanda nuda*	(Holland, 1897)	River Darde	
150		*Seydelia geometrica*	(Oberthür, 1883)	Scioa [Shoa]	
151		*Spilosoma mediopunctata*	(Pagenstecher, 1903)	Arbarone	
152		*Spilosoma quadrimacula*	Toulgoët, 1977	Lalokéli	E
153		*Stenilema aurantiaca*	Hampson, 1909	Abyssinia [Ethiopia]	
154		*Stenilema hailesellassiei*	(Birket-Smith, 1965)	Addis Ababa, University College Campus	E
155		*Stracena aegrota*	Le Cerf, 1922	Harar	E
156		*Stracilla translucida*	(Oberthür, 1880)	Scioa [Shoa], Mahal Uonz	
157		*Syngatha eremita*	Hacker, Fiebig & Stadie, 2019	Reg. South Nations, Bonga Guesthouse	E
158		*Syngatha parascotoides*	Hacker, 2019	12 km W Jinka, border Mago National Park	
159		*Syngatha simplicicata*	Hacker, Fiebig &	Reg. South Nations, Sheiko Forest Road Teppi Mizan	E

			Stadie, 2019	Teferi	
160		*Tegiapa ambiguosa*	Hacker, Fiebig & Stadie, 2019	Reg. South Nations, road Shishinda-Bonga, 6 km W Wushwush	
161		*Tegiapa obliqua*	Hacker, Fiebig & Stadie, 2019	Sidamo, Yabello vic., 10km W road to Konso	
162		*Tegiapa schreieri*	Hacker, 2019	Oromia Prov., 6 km ESE Jimma	
163		*Teracotona abyssinica*	(Rothschild, 1933)	Central Abyssinia [Ethiopia], Maraco [Marako]	
164		*Teracotona neumanni*	Rothschild, 1933	SW Abyssinia [Ethiopia], Kambatta	E
165		*Teracotona postalbida*	(Gaede, 1926)	Abyssinia [Ethiopia]	E
166		*Teracotona clara rubiginea*	(Toulgoët, 1977)	Fisha Genet	E
167		*Teracotona seminigra*	(Hampson, 1905)	Zegi Tsana [Tana]	E
168		*Thyretes negus*	Oberthür, 1878	Abyssinia [Ethiopia]	
169		*Tigreana nathaliannae*	Laporte, 1991	Wollo, Ataye	E
170		*Tigreana sandrae*	Laporte, 1991	Wollo Ataye	E
171		*Trigonodes exportata*	Guenée, 1852	Abyssinia [Ethiopia]	
172		*Tytroca alabuensis alabuensis*	Wiltshire, 1970	Alabu	
173		*Tytroca balnearia mutabilis*	Hacker, 2016	15 km N of Arba Minch, 2 km after junction to Chencha	E
174		*Tytroca heterophysa*	Hacker, 2016	Omo Region, Gemu Gofa Province, Arba Minch	E
175		*Ulotrichopus phaeoleucus griseus*	Kühne, 2005	Addis Ababa	
176		*Utetheisa amhara*	Jordan, 1939	Abyssinia [Ethiopia]	
177		*Zekelita heteroleuca*	Hacker, 2016	Southern Province, 11.2 km W of Bonga	E
178		*Zekelita lehmanni magnificaria*	Hacker, 2016	10.5 km W of Weyto	E
179		*Zekelita nilotica*	Hacker, 2016	30 km SE of Bahir Dar, Tisisat above Blue Nile falls	E

180	**Eupterotidae**	*Phiala abyssinica*	Aurivillius, 1904	Zegi Tsana [Tana]	E
181		*Phiala bergeri*	Rougeot, 1975	Bale	E
182		*Rhodopteriana abyssinica*	(Rothschild, 1917)	Harrar [Harar]	
183		*Rhodopteriana sidamoensis*	Darge, 2013	Sidamo Province, near Mega	E
184	**Euteliidae**	*Eutelia favillatrix*	(Guenée, 1852)	Abyssinia [Ethiopia]	
185		*Stenosticta schreieri*	Hacker, 2010	3 km N Turmi, Mango Camping Site	E
186	**Gelechiidae**	*Aphanostola maxima*	Bidzilya & Mey, 2016	Lake Tana, Bahir Dar	E
187		*Chrysoesthia parilis*	(Vári, 1963)	Little Akaki River, near Addis Ababa	E
188		*Stegasta sattleri*	Bidzilya & Mey, 2011	Addis Ababa	
189		*Stomopteryx ochrosema*	Meyrick, 1932	Addis Alam [Alem], ca. 20 miles W. of Addis Ababa	E
190	**Geometridae**	*Chiasmia abyssinica*	Krüger, 2001	Harrar [Harar]	E
191		*Chiasmia procidata*	(Guenée, 1858)	Abyssinia [Ethiopia]	
192		*Chiasmia streniata*	(Guenée, 1858)	Abyssinia [Ethiopia]	
193		*Chiasmia trinotatula*	Krüger, 2001	Kabarutar, 56 miles W of Lake Tana	E
194		*Cleora oculata sidamo*	Herbulot, 1977	Kébré-Mengist [Kibre Mengist]	E
195		*Cleora pavlitzkiae etesiae*	Fletcher, 1967	Harar	
196		*Coenina dentataria*	Swinhoe, 1904	Abyssinia [Ethiopia]	
197		*Comibaena theodori*	Hausmann & Parisi, 2014	Kaffa Province, 10 km N of Bonga	E
198		*Drepanogynis nigerrima*	(Swinhoe, 1904)	Abyssinia [Ethiopia]	E
199		*Epigynopteryx flavedinaria*	(Guenée, 1857)	Abyssinia [Ethiopia]	
200		*Epigynopteryx rougeoti*	Herbulot, 1977	Dinsho Marshes	E
201		*Epigynopteryx scotti*	Fletcher, 1959	Ethiopia N, Simien, near Mindigabsa	E
202		*Erastria marginata*	(Swinhoe, 1904)	Abyssinia [Ethiopia]	E
203		*Eupithecia angulata*	Fletcher, 1951	Harar	E

204		*Eupithecia dinshoensis*	Herbulot, 1983	Dinsho Col	E
205		*Eupithecia incommoda*	Herbulot, 1983	Dinsho Reserve	E
206		*Eupithecia inquinata*	Fletcher, 1950	Lekamti [Naqamte]	
207		*Eupithecia ochralba*	Herbulot, 1983	Dinsho Reserve	E
208		*Eupithecia pseudoabbreviata*	Fletcher, 1951	Harar	E
209		*Eupithecia rougeoti*	Herbulot, 1983	Dinsho Reserve	E
210		*Eupithecia urbanata*	Fletcher, 1956	Harar	E
211		*Geodena brunneomarginata*	Karisch, 2003	Shoa, 50 km W of Adis Ababa	E
212		*Hemistola aetherea*	Debauche, 1937	Addis Ababa	E
213		*Henicovalva negus*	Krüger, 2017	Dire Daoua [Dawa]	E
214		*Heterostegane serrata*	(Fletcher, 1958)	Diré Daouá [Dire Dawa]	
215		*Hydrelia candace*	Prout, 1929	Addis Ababa	E
216		*Hypochrosis chiarinii*	(Oberthür, 1883)	Scioa [Shoa]	
217		*Idaea glomerata*	(Prout, 1937)	Abyssinia [Ethiopia]	E
218		*Lomographa indularia*	(Guenée, 1858)	Abyssinia [Ethiopia]	
219		*Mimoclystia pudicata cecchii*	(Oberthür, 1883)	Scioa [Shoa], Let-Marefia [Jet Marafia]	E
220		*Nothofidonia xenoleuca*	Prout, 1928	Wolisso, between Hauash [Awash] and Omo	E
221		*Odontopera briela*	(Debauche, 1937)	Mt Chillálo [Chilalo]	E
222		*Odontopera integraria*	Guenée, 1858	Abyssinia [Ethiopia]	
223		*Odontopera protecta*	Herbulot, 1983	Dinsho Reserve	E
224		*Omphacodes pulchrifimbria pulchritacta*	Prout, 1923	Abyssinia [Ethiopia] Central Moraqui [Marako]	
225		*Oreometra ras*	Herbulot, 1983	near Mount Batu	E
226		*Piercia zukwalensis*	Debauche, 1937	Mt Zukwala/Cuqala	
227		*Pingasa abyssiniaria*	(Guenée, 1858)	Harar	
228		*Platypepla bifida*	Herbulot, 1984	near Kébré-Mengist [Kibre	E

				Mengist]	
229		*Platypepla uhlenhuthi*	Krüger, 2001	Diré Daouá [Dire Dawa]	E
230		*Prasinocyma aquamarina*	Hausmann, Sciarretta & Parisi, 2016	Bale Mts, 10 km S Rira	E
231		*Prasinocyma aetheraea*	(Debauche, 1937)	Addis Ababa	E
232		*Prasinocyma albivenata*	Herbulot, 1983	Dinsho Marsh	E
233		*Prasinocyma amharensis*	Hausmann, Sciarretta & Parisi, 2016	SW Debre Sina & Sembo, Umg. Debre Sina	E
234		*Prasinocyma angolica pseudopedicata*	Hausmann, Sciarretta & Parisi, 2016	7 km NW Yabello	E
235		*Prasinocyma angulifera*	Hausmann, Sciarretta & Parisi, 2016	southern Bale Mts, Harenna Forest	E
236		*Prasinocyma batesi distans*	Hausmann, Sciarretta & Parisi, 2016	Addis Ababa	E
237		*Prasinocyma baumgaertneri*	Hausmann, Sciarretta & Parisi, 2016	Harenna Forest	E
238		*Prasinocyma beryllaria*	Hausmann, Sciarretta & Parisi, 2016	13 km W Yabello Motel	E
239		*Prasinocyma bongaensis*	Hausmann, Sciarretta & Parisi, 2016	Bonga, 12 km E	E
240		*Prasinocyma discipuncta*	Hausmann, Sciaretta & Parisi, 2016	16 km SW Kibre Mengist	E
241		*Prasinocyma fallax*	Hausmann, Sciarretta & Parisi, 2016	SW. Debre Sina & Sembo, Umg. Debre Sina	E
242		*Prasinocyma fusca*	Hausmann, Sciarretta & Parisi, 2016	Harenna Forest	E
243		*Prasinocyma gajdacsi*	Prout, 1930	Adis Abeba [Addis Ababa]	E
244		*Prasinocyma gemmifera*	Hausmann, Sciaretta & Parisi, 2016	Wushwush, 7.4 km w	E
245		*Prasinocyma germinaria*	(Guenée, 1857)	Abyssinia [Ethiopia]	
246		*Prasinocyma getachewi*	Hausmann, Sciarretta & Parisi, 2016	Arba Minch	E
247		*Prasinocyma hailei*	Debauche, 1937	Addis Ababa	E
248		*Prasinocyma immaculata*	Herbulot, 1993	Debre Zeit	E

		thiaucourti			
249		*Prasinocyma leveneorum*	Hausmann, Sciarretta & Parisi, 2016	Harenna Forest, Karcha clearing	E
250		*Prasinocyma lutulenta*	Hausmann, Sciarretta & Parisi, 2016	Arba Minch	E
251		*Prasinocyma magica*	Hausmann, Sciarretta & Parisi, 2016	Mago National park	E
252		*Prasinocyma monikae*	Hausmann, Sciarretta & Parisi, 2016	13 km W Yabello, Motel	E
253		*Prasinocyma pedicata aethiopica*	Hausmann, Sciarretta & Parisi, 2016	16 km SW Kibre Mengist	E
254		*Prasinocyma robusta*	Hausmann, Sciarretta & Parisi, 2016	13 km W Yabello, Motel	E
255		*Prasinocyma septentrionalis*	Hausmann, Sciarretta & Parisi, 2016	Arba Minch	E
256		*Prasinocyma shoa shoa*	Herbulot, 1993	Debre Zeit	E
257		*Prasinocyma shoa yabellensis*	Hausmann, Sciarretta & Parisi, 2016	13 km W Yabello, Motel	E
258		*Prasinocyma stefani*	Hausmann, Sciarretta & Parisi, 2016	Bonga, 12 km E	E
259		*Prasinocyma tranquilla*	Prout, 1917	NW of Harar, Diredaua [Dire Dawa]	E
260		*Prasinocyma trematerrai simienensis*	Hausmann, Sciarretta & Parisi, 2016	Semien Mountains, chennek Camp	E
261		*Prasinocyma trematerrai trematerrai*	Hausmann, Sciarretta & Parisi, 2016	Dinsho	E
262		*Problepsis fiebigi*	Stadie & Stadie, 2016	Omo Region, Province of Gemu Gofa, Arba Minch	E
263		*Problepsis neumanni*	Prout, 1932	Djiren, Djimma [Jimma]	E
264		*Problepsis sihvoneni*	Stadie & Stadie, 2016	Sidamo, 13 km W of Yabello, Motel	E
265		*Protosteira decolorata*	Herbulot, 1984	Semyen, Sankaber	E
266		*Rhodometra labdoides*	Herbulot, 1997	Choa [Shoa], Debré Zeit	E
267		*Rhodometra plectaria*	(Guenée, 1857)	Abyssinia [Ethiopia]	

268		*Rougeotiella pseudonoctua*	Herbulot, 1983	Kébré-Mengist [Kibre Mengist]	E
269		*Scopula erymna*	Prout, 1928	Gurra, Dagaje	E
270		*Scopula scotti*	Debauche, 1937	Addis Ababa	
271		*Scopula silonaria*	(Guenée, 1858)	Abyssinia [Ethiopia]	
272		*Scopula simplificata*	Prout, 1928	NE Africa, Ganale River	E
273		*Sesquialtera lonchota*	Prout, 1931	Diré Daouá [Dire Dawa], NW of Harrar	E
274		*Somatina pythiaria*	(Guenée, 1857)	Abyssinia [Ethiopia]	
275		*Tephronia aethiopica*	Herbulot, 1983	Shoa, Menagesha Forest	E
276		*Traminda neptunaria*	(Guenée, 1857)	Abyssinia [Ethiopia]	
277		*Trimetopia aetheraria*	Guenée, 1858	Abyssinia [Ethiopia]	E
278		*Xanthisthisa copta*	Herbulot, 1977	Boré Forest	E
279		*Xanthisthisa terna*	Herbulot, 1984	Shoa, Menagesha Forest	E
280		*Xanthorhoe abyssinica*	Herbulot, 1983	Chensha	E
281		*Xanthorhoe alta*	Debauche, 1937	Mt Chillálo, Albaso	E
282		*Xanthorhoe cadra*	(Debauche, 1937)	Mt Chillálo, from forest of Kosso-trees	E
283		*Xanthorhoe cuneosignata*	Debauche, 1937	Mt Chillálo, Albaso	E
284		*Xanthorhoe excelsissima*	Herbulot, 1977	Mt Batu	E
285		*Xenimpia sabae amarei*	Hausmann, 2006	Arba Minch, Region of Omo, Gemu Gofa,	E
286		*Xylopteryx emunctaria*	(Guenée, 1858)	Abyssinia [Ethiopia]	
287		*Xylopteryx gada*	Herbulot, 2000	Balé, Harena Forest	E
288		*Xylopteryx raphaelaria*	(Oberthür, 1880)	Scioa [Shoa]	E
289		*Zamarada excavata pollex*	Fletcher, 1974	Jlubador [Ilubabor] Gore	E
290		*Zamarada hyalinaria*	(Guenée, 1857)	Abyssinia [Ethiopia]	
291		*Zamarada melasma*	Fletcher, 1974	Dire Daoua [Dire Dawa]	
292		*Zamarada secutaria*	(Guenée, 1857)	Abyssinia [Ethiopia]	
293		*Zamarada shoa*	Herbulot, 2002	Shoa, 50 km W of Addis	E

				Ababa	
294		*Zamarada torrida*	Fletcher, 1974	Dire Daoua [Dire Dawa]	
295	**Glyphipterigidae**	*Ussara semicoronis*	Meyrick, 1932	Jem-Jem Forest	E
296	**Gracillariidae**	*Acrocercops heteroloba*	Meyrick, 1932	Jem-Jem Forest	E
297		*Acrocercops orianassa*	Meyrick, 1932	Mt Zukwala/Cuqala	
298		*Caloptilia macropleura*	(Meyrick, 1932)	Jem Jem Forest	
299		*Metacercops hexactis*	(Meyrick, 1932)	Jem-Jem Forest	E
300		*Metriochroa carissae*	Vári, 1963	Addis Ababa, Little Akaki River	E
301		*Metriochroa scotinopa*	Vári, 1963	Dabra Zeit [Debre Zeit]	E
302		*Porphyrosela homotropha*	Vári, 1963	Addis Ababa, Little Akaki River	E
303		*Stomphastis heringi*	Vári, 1963	Near Addis Ababa, Little Akaki River	E
304		*Stomphastis horrens*	(Meyrick, 1932)	Jem-Jem Forest	E
305	**Hesperiidae**	*Abantis meneliki*	Berger, 1979	Harrar	
306		*Apallaga menageshae*	Libert, 2014	Mt Menagesha, NW Addis Abeba	
307		*Coeliades chalybe immaculata*	Carpenter, 1935	Alanga River	E
308		*Coeliades menelikmenelik*	(Ungemach, 1932)	Lilmo, dans la pays de Sayo	
309		*Eretis mixta*	Evans, 1937	Dire Daouna [Dire Dawa]	
310		*Metisella formosus mittoni*	Carcasson, 1961	Mega	E
311		*Sarangesa lucidella helena*	Evans, 1947	Harar	E
312	**Lasiocampidae**	*Beralade perobliqua monostrigata*	Berio, 1940	Adi-Abuna [in Tigray, Ethiopia]	E
313		*Bombycopsis abyssinica*	Joannou & Krüger, 2009	Addis Abeba	E
314		*Mallocampa toulgoeti*	Rougeot, 1977	Kébré-Mengist [Kibre Mengist]	E
315		*Odontocheilopteryx eothina*	Tams, 1931	Djoubdo [Yubdo], Birbir	E

316		*Odontocheilopteryx lajonquieri*	Rougeot, 1977	near Kébré-Mengist [Kibre Mengist]	E
317		*Pallastica hararia*	Zolotuhin & Gurkovich, 2009	Harar	E
318		*Sena donaldsoni rougeoti*	Lajonquière, 1977	Arba Minch	E
319		*Sena scotti*	(Tams, 1931)	Djem-Djem [Jem-Jem] Forest	
320		*Stoermeriana abbayensis*	(Rougeot, 1984)	Bahar-Dar, marais du Nil Bleu, Abbay	E
321		*Stoermeriana chavailloni*	(Rougeot, 1984)	Melka-Kontouré	E
322		*Stoermeriana das*	(Hering, 1928)	Eli	E
323		*Stoermeriana laportei*	(Rougeot, 1977)	Kébré-Mengist [Kibre Mengist]	E
324		*Stoermeriana murinuscolor*	(Rougeot, 1984)	Shoa, Menagesha Forest	E
325		*Stoermeriana saanayetae*	(Rougeot, 1984)	Awassa Lake	E
326		*Stoermeriana tamsi*	(Rougeot, 1977)	Dinsho Marshes, Balé	E
327		*Stoermeriana viettei*	(Rougeot, 1977)	Dinsho Marshes	E
328	**Limacodidae**	*Crothaema flava*	Berio, 1940	Adi-Abuna [in Tigray, Ethiopia]	E
329		*Hamartia johanni*	Rougeot, 1977	Kébré-Mengist [Kibre Mengist]	E
330		*Hamartia medora moulini*	Rougeot, 1977	Kébré-Mengist [Kibre Mengist]	E
331		*Jordaniana lactea*	(Pagenstecher, 1903)	Ganale	
332	**Lycaenidae**	*Anthene amarah*	(Guérin-Méneville, 1849)	Dire Dawa	
333		*Anthene butleri butleri*	(Oberthür, 1880)	Mantek; Mahal-Uonz	
334		*Anthenechojnackii*	Libert, 2010	10 km NW of Neghelli	E
335		*Anthene confusa*	Libert, 2010	Touloudimtou [Tullu Dimtu]	
336		*Anthene contrastata*	(Ungemach, 1932)	Bedelle	E
337		*Anthene definita nigrocaudata*	(Pagenstecher, 1902)	Ginir	E
338		*Anthene dulcis*	(Pagenstecher, 1902)	Gambe beim Abasse-See	

339		*Anthene hodsoni*	(Talbot, 1935)	Kibish River	
340		*Anthene opalina janna*	Gabriel, 1949	Fich-Babile Road	
341		*Anthene opalina opalina*	Stempffer, 1946	Callafo[Kalafo], Webi Shebeli, Ogaden	
342		*Anthene pitmani aethiopana*	Libert, 2010	Ghibe River, Addis Abeba-Jimma road	
343		*Anthene princeps*	(Butler, 1876)	Atbara	
344		*Anthene saddacus*	(Talbot, 1935)	Ethiopia	E
345		*Anthene suquala*	(Pagenstecher, 1902)	Suquala	
346		*Axiocerses maureli*	Dufrane, 1954	Harrar	E
347		*Azanusjesous*	(Guérin-Méneville, 1849)	Abyssinie [Ethiopia]	
348		*Cacyreus ethiopicus*	(Tite, 1961)	25 km north of Quiha	E
349		*Cacyreus fracta ghimirra*	Talbot, 1935	Shoa Ghimirra province	E
350		*Chilades elicola*	(Strand, 1911)	Eli, Ethiopia	
351		*Deudorix lorisona baronica*	Ungemach, 1932	Baro River	E
352		*Deudorix ungemachi*	Libert, 2004	Ethiopia	E
353		*Eicochrysops antoto*	(Strand, 1911)	Umgebung unterhalb Antotos [Entoto]	E
354		*Eicochrysops meryamae*	Rougeot, 1983	Province de Gondar, environs de Debarek	E
355		*Eicochrysops messapus sebagadis*	(Guérin-Méneville, 1849)	Abyssinie [Ethiopia]	
356		*Euchrysops abyssinicus*	(Aurivillius, 1922)	Tchafianani; Debasso	E
357		*Euchrysops cyclopteris*	(Butler, 1876)	Atbara	
358		*Euchrysops mauensis Abyssinia [Ethiopia]e*	Storace, 1950	Bahrdàr [Bahar Dar] sulle rive meridionali del Lago Tana	E
359		*Euchrysops nandensis*	(Neave, 1904)	Lake Tana	
360		*Hypolycaena ogadenensis*	Stempffer, 1946	Dagahbur, Ogaden	E
361		*Iolaus crawshayi maureli*	Dufrane, 1954	Harrar [Harar]	
362		*Iolaus piaggiae*	Oberthür, 1883	Kolla di Giagaguè-Agher	E

363		*Lachnocnema abyssinica*	Libert, 1996	Dire Daouna [Dawa]	
364		*Lepidochrysops abyssiniensis abyssiniensis*	(Strand, 1911)	Eli	E
365		*Lepidochrysops abyssiniensis oculus*	(Ungemach, 1932)	Ouama	E
366		*Lepidochrysops guichardi*	Gabriel, 1949	10 miles West of Addis Ababa	E
367		*Lepidochrysops lunulifer*	(Ungemach, 1932)	Didessa	E
368		*Lepidochrysops negus*	(Felder & Felder, 1865)	Africa septentrionali-orientalis: Bogo	
369		*Lepidochrysops pterou lilacina*	(Ungemach, 1932)	Didessa	E
370		*Lepidochrysops subvariegata*	Talbot, 1935	Dirre Dawa	E
371		*Leptomyrina boschi*	Strand, 1911	Abyssinie [Ethiopia]n	E
372		*Lycaena phlaeas pseudophlaeas*	(Lucas, 1866)	Abyssinie [Ethiopia]	E
373		*Myrina silenus nzoiae*	Stoneham, 1937	Western Kenya to Ethiopia and Eritrea	
374		*Pentila pauli ras*	Talbot, 1935	S.W. Abyssinia [Ethiopia], Pokodi [Bokoji]	E
375		*Stugeta bowkeri ethiopica*	(Stempffer & Bennett, 1958)	Harrar [Harar]	E
376		*Tarucus ungemachi*	Stempffer, 1942	Rivière Baro Abyssinie [Ethiopia] occidentale	
377		*Thermoniphas colorata*	(Ungemach, 1932)	Youbdo	
378		*Tuxentius cretosus*	(Butler, 1876)	Atbara	
379		*Tuxentius kaffana*	(Talbot, 1935)	Nado's Province, Yeki; Mocha District, Gamadura	E
380		*Uranothauma antinorii*	(Oberthür, 1883)	Torrente di Sciotalit	
381		*Uranothauma nubifer distinctesignatus*	(Strand, 1911)	[Ethiopia]	E
382		*Zintha hintza resplendens*	(Butler, 1876)	Atbara	E
383	**Metarbelidae**	*Aethiopina semicirculata*	Gaede, 1929	Abyssinia [Ethiopia]	E

384		*Salagena fetlaworkae*	Rougeot, 1977	near Koffolé [Koffale]	E
385		*Teragra lemairei*	Rougeot, 1977	Dinsho Marches	E
386		*Teragra villiersi*	Rougeot, 1977	near Koffolé [Koffale]	E
387	**Noctuidae**	*Abrostola obliqua*	Dufay, 1958	Abyssinia [Ethiopia]	E
388		*Abrostola rougeoti*	Rougeot, 1977	near Koffolé [Koffale]	E
389		*Acontia albatrigona*	Hacker, Legrain & Fibiger, 2008	Arba Minch Region, Omo, Province Gemu, Gofa	
390		*Acontia amarei*	Hacker, Legrain & Fibiger, 2010	Gamu-Gofa Province, 10.5 km W of Weyto	E
391		*Acontia amhara*	Hacker, Legrain & Fibiger, 2008	Gamu-Gofa Province, 8 km N of Turmi	E
392		*Acontia proesei*	Hacker, Legrain & Fibiger, 2008	Valley of the river Tekezé, 30 km N of Gashena	E
393		*Acontia robertbecki*	Hacker, Legrain & Fibiger, 2010	Arba Minch Region, Gemu Gofa Province	E
394		*Acontia ruficincta*	Hampson, 1910	Atbara	E
395		*Acontia secta*	Guenée, 1852	Abyssinia [Ethiopia]	
396		*Acontia uhlenhuthi*	Hacker, Legrain & Fibiger, 2008	Diré Daouá [Dire Dawa]	E
397		*Acontiola boursini*	(Berio, 1940)	Lekemti [Naqamte]	
398		*Acrapex abbayei*	Laporte, 1984	Dinsho Reserve	E
399		*Acrapex apexangula*	Laporte, 1984	near Koffolé [Koffale]	E
400		*Acrapex ausseili*	Laporte, 1984	Fisha Genet	E
401		*Acrapex franeyae*	Laporte, 1984	Dinsho Reserve	E
402		*Acrapex genrei*	Laporte, 1984	Dinsho Reserve	E
403		*Acrapex girardi*	Laporte, 1984	Dinsho Reserve	E
404		*Acrapex guiffrayorum*	Laporte, 1984	Dinsho Reserve	E
405		*Acrapex mastawatae*	Laporte, 1984	Arba Minch	E
406		*Acrapex matilei*	Laporte, 1984	Dinsho Reserve	E
407		*Acrapex satanas*	Laporte, 1984	Dinsho Reserve	E

408		*Acrapex soyema*	Le Ru, 2017	Gibe, Soyema Bridge	E
409		*Acrapex ulmii*	Laporte, 1991	Koffole [Koffale]	E
410		*Acrapex zaouditou*	Laporte, 1991	Koffole [Koffale]	E
411		*Aedia albirena*	(Hampson, 1926)	Taddecha Mullha	
412		*Aedia konsonata*	Hacker, 2016	Konso	E
413		*Aedia marmoreata*	Hacker, 2016	12 km W of Jinka	
414		*Aegocera ferrugo*	Jordan, 1926	Hora Daka	E
415		*Agrotis baleense*	Laporte, 1977	Dinsho, Bale Reserve	
416		*Agrotis cinchonina*	Guenée, 1852	Abyssinia [Ethiopia]	E
417		*Agrotis debivari*	(Berio, 1962)	Africa Orientale Italiana, Debivar	E
418		*Agrotis separata*	Guenée, 1852	Abyssinia [Ethiopia]	E
419		*Amazonides berioi*	(Laporte, 1984)	Lekemti [Naqamte]	E
420		*Amazonides berliozi*	Laporte, 1974	Dinsho Col	E
421		*Amazonides dubiomeodes*	Laporte, 1977	Kébré-Mengist [Kibre Mengist]	E
422		*Amazonides ezanai*	(Laporte, 1984)	Kébré-Mengist [Kibre Mengist]	E
423		*Amazonides fumigera*	Laporte, 1977	Dinsho Marshes	E
424		*Amazonides koffoleense*	Laporte, 1977	Koffolé [Koffale]	E
425		*Amazonides laheuderiae*	Laporte, 1984	Abba Hoye-Gara	E
426		*Amazonides pseudoberliozi*	Rougeot & Laporte, 1983	Simyen, Sankaber	E
427		*Amazonides putrefacta*	(Guenée, 1852)	Abyssinia [Ethiopia]	
428		*Amazonides ungemachi*	(Laporte, 1984)	Ioubdo, Birbir, Nole Kabe	E
429		*Amazonides zarajakobi*	Laporte, 1984	Dinsho Marshes	E
430		*Amphia hepialoides*	Guenée, 1852	Abyssinia [Ethiopia]antio	E
431		*Aporophoba subaustralis*	Berio, 1977	Addis Ababa	E
432		*Apospasta albirenalis*	Laporte, 1974	Mt Batu	E
433		*Apospasta diffusa*	Laporte, 1974	Dinsho Col	E

434		*Apospasta erici*	Laporte, 1984	Dinsho Reserve	E
435		*Apospasta incongrua*	Laporte, 1974	Dinsho Col	E
436		*Apospasta maryamae*	Laporte, 1974	Dinsho Marshes	E
437		*Apospasta niger*	Laporte, 1974	Dinsho Marshes	E
438		*Apospasta rougeoti*	Laporte, 1991	Boré Forest	
439		*Apospasta rufa*	Laporte, 1991	Choa [Shoa], Menageshah [Menegasha] Forest	E
440		*Apospasta sabulosa*	Fletcher, 1959	Simien, Lori	E
441		*Apospasta thomasi*	Laporte, 1991	Addis Ababa	E
442		*Ariathisa abyssinia*	(Guenée, 1852)	Abyssinia [Ethiopia]	
443		*Aspidifrontia ungemachi*	(Laporte, 1978)	Metti	E
444		*Athetis aeschrioides*	Berio, 1940	Adi-Abuni [in Tigray, Ethiopia]	
445		*Athetis carayoni*	Laporte, 1977	Dinsho col	E
446		*Athetis viettei*	Laporte, 1991	Choa [Shoa], Melka-Kontoure [Melka Konture]	E
447		*Axylia aregashae*	Laporte, 1984	near Kébré-Mengist [Kibre Mengist]	E
448		*Axylia bryi*	Laporte, 1984	Dinsho Marshes	E
449		*Axylia destefanii*	Berio, 1944	El-Dire	
450		*Axylia gabriellae*	Laporte, 1975	Boré Forest	E
451		*Axylia marthae*	Laporte, 1984	near Koffolé [Koffale]	E
452		*Axylia orbicularis*	Laporte, 1984	near Kébré-Mengist [Kibre Mengist]	E
453		*Axylia sanyetiensis*	Laporte, 1984	near Mt Batu	E
454		*Axylia vespertina*	Laporte, 1984	near Kébré-Mengist [Kibre Mengist]	E
455		*Batuana abbahoyegarana*	Rougeot, 1983	Abba Hoye-Gara, Wollo	E
456		*Batuana exspectata*	Laporte & Rougeot, 1981	Gojam, Mt Choke	E
457		*Batuana lobeliarum*	Laporte, 1976	near Dinsho	E

458		*Batuana rougeoti*	Laporte, 1976	near Mt Batu	E
459		*Berionycta beckroberti*	Kiss, 2017	15 km E of Yabello	E
460		*Berionycta behouneki*	Kiss, 2017	13 km W of Yabello	E
461		*Berionycta berioi*	Kiss, 2017	12 km NNE of Arba Minch	E
462		*Berionycta nigra*	Kiss, 2017	15 km E of Yabello	E
463		*Berionycta orbicularis*	Kiss, 2017	15 km E of Yabello	E
464		*Berionycta ponticamima*	Kiss, 2017	15 km E of Yabello	E
465		*Capillamentum gelleyi*	Laporte, 1984	Addis Ababa	E
466		*Caradrina atriluna*	Guenée, 1852	Abyssinia [Ethiopia]	
467		*Caradrina torpens*	Guenée, 1852	Abyssinia [Ethiopia]	E
468		*Carcharoda erlangeri*	Rothschild, 1924	Waute Merehan [Mreham]	E
469		*Cirrodes rosaceus*	Rothschild, 1924	Waute Merehan [Mreham]	E
470		*Claudaxylia dinshoense*	Laporte, 1984	Dinsho Reserve	E
471		*Compsotata corneliae*	Behounek & Beck, 2012	Bale Mountains, Province of Bale, Hangasso	E
472		*Conservula ludocaroli*	(Laporte, 1991)	Debre Zeit	E
473		*Conservula scriptura*	(Rougeot & Laporte, 1983)	Simyen, Sankaber	E
474		*Cucullia simoneaui*	Laporte, 1976	Bale Reserve, Dinsho	E
475		*Cucullia tedjicolora*	Laporte, 1977	Kébré-Mengist [Kibre Mengist]	E
476		*Eucladodes achrorophilus*	Laporte, 1976	Near Mt Batu	E
477		*Eucladodes baleensis*	Laporte, 1976	Bale Reserve	E
478		*Euplexia imperator*	Laporte, 1984	Dinsho Marshes	E
479		*Euplexia mercieri*	Laporte, 1984	Arussi, near Koffolé [Koffale]	E
480		*Euplexia pinoni*	Laporte, 1984	Kébré-Mengist [Kibre Mengist]	E
481		*Euplexia shoana*	Laporte, 1984	Shoa, near Hosana	E
482		*Euxoa dodolaense*	Laporte, 1984	Road to Dodola	E
483		*Euxoa montigenarum*	Rougeot & Laporte,	Simyen, Sankaber	E

			1983		
484		*Euxoa semyenensis*	Laporte, 1991	Sankaber	E
485		*Euxoa waliarum*	Rougeot & Laporte, 1983	Simyen, Sankaber	E
486		*Feliniopsis duponti*	Laporte, 1974	near Kebré-Mengist [Kibre Mengist]	
487		*Feliniopsis germainae*	Laporte, 1975	near Kebré-Mengist [Kibre Mengist]	E
488		*Feliniopsis insolita*	Hacker & Fibiger, 2007	Addis Ababa,Sholla	E
489		*Feliniopsis jinka*	Hacker, 2010	Gamu-Gofa Province, 10 km W of Jinka	
490		*Feraxinia jemjemensis*	(Laporte, 1984)	Kébré-Mengist [Kibre Mengist]	E
491		*Heliophobus africana*	Berio, 1977	Addis Ababa	E
492		*Heliothis saskai*	(Berio, 1975)	Addis Ababa	E
493		*Hemituerta mahdi*	(Pagenstecher, 1903)	Hanadscho [Dinsho district]	
494		*Heraclia viettei*	Kiriakoff, 1973	Nole Kaba	E
495		*Hermonassoides abyssinica*	(Berio, 1975)	Addis Ababa	E
496		*Hermonassoides dinshoensis*	(Laporte, 1977)	Dinsho Marshes	E
497		*Hermonassoides marmorata*	(Laporte, 1977)	Fisha Genet	E
498		*Hermonassoides mauricei*	(Laporte, 1975)	Koffale	
499		*Hermonassoides mendeboense*	(Laporte, 1984)	Dinsho	E
500		*Hermonassoides minosi*	(Laporte, 1991)	Managesha Forest	E
501		*Hermonassoides scipioni*	(Laporte, 1977)	Dinsho, Bale Reserve	E
502		*Hiccoda clarae*	Berio, 1947	Ogaden, Uarder [Warder]	E
503		*Hyperfrontia direae*	Berio, 1962	Dire-Daoua [Dire Dawa]	E
504		*Hyperfrontia limbata*	Berio, 1962	El-Dire	E

505		*Koffoleania michaellae*	Laporte, 1977	near Koffolé [Koffale]	E
506		*Leucania aedesiusi*	Rougeot & Laporte, 1983	Simyen, Sankaber	E
507		*Leucania argyrina*	Laporte, 1984	Bahar Dar	E
508		*Leucania claudicans*	Guenée, 1852	Abyssinia [Ethiopia]	E
509		*Leucania cyprium*	(Laporte, 1984)	Dinsho Marshes	E
510		*Leucania fasilidasi*	(Laporte, 1984)	Dinsho Marshes	E
511		*Leumicamia oreias*	(Fletcher, 1959)	Simien, above Lori	E
512		*Leumicamia palustris*	Laporte, 1976	Dinsho Marshes	E
513		*Leumicamia venustissima*	(Laporte, 1974)	Bale Reserve	E
514		*Lophotarsia girmai*	Laporte, 1975	Arba Minch	E
515		*Lophotarsia leucoplagoides*	(Berio, 1941)	El-Dire	E
516		*Lophotarsia theresae*	Beck & Behounek, 2013	Bale Mountains National Park, region Oromia/Sidamo, Province of Bale, 4 km W of Sura	E
517		*Maghadena ingridae*	Laporte, 1977	Dinsho Reserve, Balé	E
518		*Maliattha eburnea*	Hacker, 2016	Oroma Province, 6 km ESE of Jimma	
519		*Matopo berhanoui*	Laporte, 1984	Melka-Kontouré [Konture]	E
520		*Mentaxya bruneli*	Laporte, 1975	near Kebré-Mengist [Kibre Mengist]	E
521		*Mentaxya fouqueae*	Laporte, 1974	Boré Forest	
522		*Mentaxya inconstans*	Laporte, 1984	Dinsho Marshes	E
523		*Mentaxya lacteifrons*	Laporte, 1984	Kébré-Mengist [Kibre Mengist]	E
524		*Michelliana afroalpina*	Laporte, 1976	near Mt Batu	E
525		*Micraxylia antemedialis*	Laporte, 1975	near Kebré-Mengist [Kibre Mengist]	E
526		*Micraxylia hypericoides*	Berio, 1962	Oromo e Sidamo, Neghelli [Neghelle]	E

527		*Micraxylia lividoradiata*	(Berio, 1940)	Adi-Abuna [in Tigray, Ethiopia]	E
528		*Mythimna altiphila*	Hreblay & Legrain, 1996	Addis Abeba [Ababa]	
529		*Mythimna amlaki*	Laporte, 1984	Near Mt Batu	E
530		*Mythimna bisetulata*	(Berio, 1940)	Adi-Abuna [in Tigray, Ethiopia]	E
531		*Mythimna germanae*	Laporte, 1991	Melka Kontouré	E
532		*Neostichtis teruworkae*	Laporte, 1984	Near Hosana	E
533		*Nocthadena griseoviridis*	Laporte, 1976	Near Mt Batu	E
534		*Numeniastes selenis*	Fletcher, 1963	Harar	
535		*Nyodes biardi*	Laporte, 1984	Shashemane	E
536		*Ochropleura sidamona*	Laporte, 1977	Fisha-Genet	
537		*Odontestra richinii*	Berio, 1940	Adi-Abuna [in Tigray, Ethiopia]	E
538		*Odontestra variegata*	Berio, 1940	Adi-Abuna [in Tigray, Ethiopia]	
539		*Odontestra vitta*	Berio, 1975	Addis Ababa	E
540		*Oligia adactricula*	Guenée, 1852	Abyssinie [Ethiopia]	E
541		*Oligia arbaminchensis*	Laporte, 1991	Arba Minch	E
542		*Oligia genettae*	Laporte, 1991	Kebre-Mengist [Kibre Mengist]	E
543		*Omphalestra nellyae*	(Berio, 1939)	Adua [in Ethiopia]	E
544		*Ozarba alberti phaeoxantha*	Hacker, 2016	Dire Dawa	
545		*Ozarba didymochra*	Hacker, 2016	Gamu-Gofa Province, 8 km E of Weyto	E
546		*Ozarba fuscundosa*	Hacker, 2016	Oromia, 3 km NNE of Finchawa	
547		*Ozarba grisescens*	Berio, 1947	Harrar [Harar], Dire Daua [Dire Dawa]	
548		*Ozarba latizonata*	Hacker, 2016	Gamu-Gofa Province, 8 km E of Weyto	

549		*Ozarba naumanni*	Hacker, 2016	Gamo Gofa Province, Konso	E
550		*Ozarba permutata*	Hacker, 2016	20 km ESE of Sashemene, Wondo Genet	
551		*Ozarba rubrofusca*	Berio, 1947	Ogaden, Uarder [Werder]	E
552		*Ozarba tenuis*	Hacker, 2016	Province of Gamo Gofa, 8 km N of Turmi	E
553		*Ozarba uhlenhuthi*	Hacker, 2016	Dire Dawa	E
554		*Phyllophila corgatha*	Berio, 1984	Arba Minch	E
555		*Phyllophila richinii*	Berio, 1940	Adi-Abuna [in Tigray, Ethiopia]	E
556		*Pseudozarba nilotica*	Hacker, 2016	30 km SE of Bahir Dar, Tisisat above Blue Nile Falls	E
557		*Pusillathetis fiorii*	Berio, 1976	Uarder [Warder in Ogaden]	
558		*Ramesodes oblonga*	Berio, 1976	Adi Abuna [in Tigray, Ethiopia]	
559		*Rhodochlaena dinshoense*	Laporte, 1974	Dinsho Marshes	E
560		*Rougeotia abyssinica*	(Hampson, 1918)	Kutai Mecha	E
561		*Rougeotia aethiopica*	Laporte, 1974	Dinsho swamp	E
562		*Rougeotia ludovici*	Laporte, 1974	Bale Reserve	E
563		*Rougeotia ludovicoides*	Laporte, 1977	Dinsho Marshes	E
564		*Rougeotia obscura*	Laporte, 1974	Dinsho Col	E
565		*Rougeotia roseogrisea*	Laporte, 1974	Near Mt Batu	E
566		*Rougeotia rougeoti*	Laporte, 1984	Mt Batu Forest	E
567		*Schinia ennatae*	(Laporte, 1984)	Addis Ababa	E
568		*Schinia magdalenae*	(Laporte, 1976)	Bale Reserve, Dinsho	E
569		*Schinia ungemachi*	(Berio, 1945)	Oromo Sidamo, Uollega [Wollega]	E
570		*Schinia xanthiata*	(Berio, 1940)	Adi-Abuna [in Tigray, Ethiopia]	E
571		*Sciomesa boulardi*	(Laporte, 1984)	near Koffolé [Koffale]	E
572		*Sciomesa excelsa*	(Laporte, 1976)	Near Mt Batu	E

573		*Sciomesa franciscae*	Laporte, 1991	Choa, Hosana	E
574		*Sciomesa secata*	Berio, 1977	Addis Ababa	E
575		*Sesamia enanouae*	Laporte, 1991	Gojam, Bahr-Dar, marais du Nil Bleu	E
576		*Sesamia roumeti*	Laporte, 1991	Gojam, Bahr-Dar	E
577		*Solgaitiana petrosi*	Laporte, 1984	Kébré-Mengist [Kibre Mengist]	E
578		*Spodoptera excelsa*	Rougeot & Laporte, 1983	Simyen, Sankaber	E
579		*Subnoctua arbaminchensis*	Laporte, 1984	Arba Minch	E
580		*Thiacidas robertbecki*	Hacker & Zilli, 2007	Awassa, Awassa Lake, Bale Region	E
581		*Tholeropsis decimata*	Berio, 1977	Addis Ababa	E
582		*Tholeropsis uncinata*	Berio, 1977	Addis Ababa	E
583		*Thysanoplusia asapheia*	(Dufay, 1977)	near Koffolé [Koffale]	
584		*Thysanoplusia dolera*	Dufay, 1977	near Koffolé [Koffale]	E
585		*Timora flavocarnea*	Hampson, 1903	Abyssinia [Ethiopia]	
586		*Timora zavattarii*	Berio, 1944	El-Dire	E
587		*Tracheplexia annabellae*	Laporte, 1991	Menagesha Forest	E
588		*Tracheplexia colettae*	Laporte, 1991	Gemu-Gofa, Arba-Minch	E
589		*Tracheplexia leguerni*	Laporte, 1984	Fort Wosha	E
590		*Tracheplexia petryvesi*	Laporte, 1991	Menagesha Forest	E
591		*Tracheplexia richinii*	Berio, 1973	Adiu Abuna [in Tigray, Ethiopia]	
592		*Tycomarptes adami*	Laporte, 1974	Dinsho Col	E
593		*Tycomarptes aethiopica*	Laporte, 1974	Mt Batu	E
594		*Tycomarptes berioi*	Laporte, 1974	Boré Forest	E
595		*Tycomarptes bipuncta*	Laporte, 1974	Boré Forest	E
596		*Tycomarptes bipunctatoides*	Laporte, 1974	near Koffolé [Koffale]	E

597		*Tycomarptes gelladarum*	Rougeot & Laporte, 1983	Simyen, Sankaber	E
598		*Tycomarptes inferior*	(Guenée, 1852)	Abyssinia [Ethiopia]	
599		*Tycomarptes journiaci*	Laporte, 1977	Near Mt Batu	E
600		*Tycomarptes limoni*	Laporte, 1974	near Koffolé [Koffale]	E
601		*Tycomarptes semyensis*	Rougeot & Laporte, 1983	Simyen, Sankaber	E
602		*Tycomarptes thibauti*	Laporte, 1974	Boré Forest	E
603		*Vietteania chojnackii*	(Laporte, 1984)	Dinsho Marshes	E
604	**Nolidae**	*Arcyophora zanderi*	Felder & Rogenhofer, 1875	Abyssinia [Ethiopia]	
605		*Bryophilopsis martinae*	Laporte, 1991	Gemu-Gofa, Konso	E
606		*Characoma adiabunensis*	Berio, 1940	Adi-Abuna [in Tigray, Ethiopia]	E
607		*Earias richinii*	Berio, 1940	Adi-Abuni [in Tigray, Ethiopia]	
608		*Eligma neumanni*	Rothschild, 1924	Blue Nile, Abera Koritscha, Uata Dera	E
609		*Escarpamenta damarana abyssinica*	Hacker, 2013	6 km E of Weyto, Weyto River	E
610		*Evonima littoralis abyssinica*	Hacker, 2012	Southern Province, Jinka, Mago National Park, 350 m SW of Headquarter,	E
611		*Gigantoceras villiersi*	Laporte, 1975	Arba Minch	E
612		*Meganola cerographa*	Hacker, 2012	Oromia District, 6.5 km N of Bonga	E
613		*Meganola coffeana*	Hacker, 2012	Oromia Province, 6.5 km NE of Shebe	
614		*Meganola ethiopica*	Hacker, 2012	Addis Ababa	E
615		*Meganola harenna*	Hacker, 2014	Harenna Forest, Karcha Camp Ground	E
616		*Meganola leucometabola*	Hacker, 2012	Oromia Province, 6.5 km N of Bonga	
617		*Meganola longisigna*	Hacker, 2012	Oromia Region, 1km W. of	

				village Aluweya	
618		*Meganola lupii*	Hacker & Hausmann, 2012	Oromia Province, 13 km S. of Agere Maryam	E
619		*Meganola pachygrapha*	Hacker, 2012	Oromia Province, 6.5 km N of Bonga	
620		*Meganola poliovittata*	Hacker, 2012	Oromia Province, 6 km ESE of Jimma	E
621		*Meganola pyrrhomorpha*	Hacker, 2012	Oromia Province, 6.5 km N of Bonga	E
622		*Meganola simillima*	Hacker, 2012	Oromia District, 13 km S of Agere Maryam	E
623		*Meganola stadiensis*	Hacker, 2014	Harenna Forest, Karcha Camp Ground	E
624		*Meganola stigmatolalis*	Hacker, 2012	Southern Province, 23 km WSW of Welkite, Gibe River	
625		*Meganola unilineata*	Hacker, 2012	Southern Province, 11.2 km W of Bonga	E
626		*Neaxestis mesogonia*	Hampson, 1905	Atbara R.	
627		*Nola abyssinica*	Hacker, 2012	Oromia Province, 13 km S of Agere Maryam	
628		*Nola afrotaeniata*	Hacker, 2012	12 km W Jinka, border Mago National Park	
629		*Nola amhara*	Hacker, 2012	Addis Ababa	
630		*Nola angensteini*	Hacker, 2012	Afar Region, NE of Mile Serdo Wildlife Refuge, Tendaho	
631		*Nola balealpina*	Hacker, 2012	Oromia Province, Bale Mountains National Park, Disho	E
632		*Nola calochromata*	Hacker, 2014	Harenna Forest, Harenna Forest Road	E
633		*Nola destituta*	Hacker, 2012	Oromia Province, 8 km W of Nazret	E
634		*Nola jarzabekae*	Hacker, 2012	Oromia Province, Abiyata-Shala-Hayak National Park	E

635		*Nola omphalota euroetes*	Hacker, 2012	Oromia Province, 6 km ESE of Jimma	
636		*Nola socotrensis vansoni*	Hacker, 2012	12 km W Jinka, border Mago NP	
637		*Nola sphaeromorpha*	Hacker, 2012	Oromia Province, 13 km S of Agere Maryam,	E
638		*Nolidia platygrapha*	Hacker, 2012	Amhara Region, W of Mirab, Gojam Zone, 15 km NW of Bahar Dar	E
639	**Notodontidae**	*Afroplitis quadratus*	(Viette, 1954)	River Baro	E
640		*Antheua birbirana*	Viette, 1954	middle course of Birbir, Youbdo	E
641		*Antheua gaedei*	Kiriakoff, 1962	Addis Ababa	E
642		*Antheua trivitta*	(Hampson, 1910)	Abyssinia [Ethiopia]	E
643		*Antistaura decorata*	Kiriakoff, 1965	Derdaua, North-East of Harrar	E
644		*Boscawenia nora*	(Pagenstecher, 1903)	Ganale	E
645		*Desmeocraera kiriakoffi*	Thiaucourt, 1977	near Kébré-Mengist [Kibre Mengist]	E
646		*Eutimia smithii*	Holland, 1897	Dombalok	E
647		*Polelassothys callista abyssinica*	Viette, 1954	Moy. Dedissa [Didessa]	E
648		*Psalisodes saalfeldi*	Kiriakoff, 1979	Al Abed	E
649		*Scalmicauda azebae*	Thiaucourt, 1977	near Kébré-Mengist [Kibre Mengist]	E
650		*Thaumetopoea apologetica abyssinica*	Strand, 1911	Addis Ababa	
651		*Tricholoba rougeoti*	Thiaucourt, 1977	Arba Minch	E
652	**Nymphalidae**	*Acraea aganice orientalis*	(Ungemach, 1932)	Bouré	
653		*Acraea alcinoe nado*	(Ungemach, 1932)	Bouré	E
654		*Acraea chilo chilo*	Godman, 1880	Kalamet, Sebka Valley	
655		*Acraea doubledayi*	Guérin-Méneville, 1849	Abyssinie [Ethiopia]	
656		*Acraea epaea homochroa*	(Rothschild & Jordan,	Banka, Malo	E

			1905)		
657		*Acraea kakana*	Eltringham, 1911	Adie Kaka, Kafa	E
658		*Acraea oscari*	Rothschild, 1902	Banka, Malo	E
659		*Acraea poggei ras*	(Ungemach, 1932)	Oullaga [Wollega]	E
660		*Acraea zetes sidamona*	Rothschild & Jordan, 1905	Alata, Sidamo	E
661		*Acraea zoumi*	Pierre, 1995	Ethiopia	E
662		*Amauris echeria steckeri*	Kheil, 1890	Abessynia	
663		*Amauris hecate stictica*	Rothschild & Jordan, 1903	Anderatscha	E
664		*Amauris niavius aethiops*	Rothschild & Jordan, 1903	Anderatscha	
665		*Amauris ochlea darius*	Rothschild & Jordan, 1903	Anderatscha	
666		*Antanartia abyssinica*	(C. & R. Felder, [1867])	Ethiopia	E
667		*Antanartia schaeneia diluta*	Rothschild & Jordan, 1903	Kaffa	E
668		*Argynnis hyperbius neumanni*	Rothschild, 1902	Kaffa	E
669		*Aterica galene incisa*	Rothschild & Jordan, 1903	between Kankati and Djibbe, Djimma [Jimma]	E
670		*Bicyclus pavonis*	(Butler, 1876)	Abyssinia [Ethiopia]	
671		*Bicyclus safitza aethiops*	(Rothschild & Jordan, 1905)	Lake Abassi	E
672		*Charaxes etesipe abyssinicus*	Rothschild, 1900	Sciotalit, Sxioa [Shoa]	E
673		*Charaxes eurinome birbirica*	(Ungemach, 1932)	Youbdo	
674		*Charaxes figini*	van Someren, 1969	Eritaea, Setit, El Eghin [Ethiopia]	
675		*Charaxes galawadiwosi*	Plantrou & Rougeot, 1979	Arba-Minch	E
676		*Charaxes hansali hansali*	Van Someren, 1971	Africa septentrionali-	

				orientalis: Bogos	
677		*Charaxes jahlusa ganalensis*	Carpenter, 1937	Salakle, Ganale river”	
678		*Charaxes junius junius*	Oberthür, 1883	Scioa [Shoa]	E
679		*Charaxes junius somalicus*	Rothschild, 1900	Harrar Highlands, Somaliland	
680		*Charaxes kirki daria*	Rothschild, 1903	Jabalo	E
681		*Charaxes lactetinctus ungemachi*	Le Cerf, 1927	Youbdo (Birir)	
682		*Charaxes larseni*	Rydon, 1982	Jambo area, Nanji Hill	E
683		*Charaxes numenes neumanni*	Rothschild, 1902	Wori to Gamitscha, Kaffa	E
684		*Charaxes pelias pagenstecheri*	Poulton, 1926	S Ethiopia	
685		*Charaxes phoebus*	Butler, 1866	Abyssinia [Ethiopia]	E
686		*Charaxes rectans*	Rothschild & Jordan, 1903	Upper Urga, Kollu, Schoa [Shoa]	
687		*Charaxes saturnus pagenstecheri*	Poulton, 1926	S. Abyssinia [Ethiopia]	E
688		*Charaxes sidamo*	Plantrou & Rougeot, 1979	Kébré-Mengist [Kibre Mengist]	E
689		*Charaxes tiridates marginatus*	Rothschild & Jordan, 1903	Scheko	E
690		*Eronia cleodora cleodora*	Hübner, [1823]	Ethiopia	
691		*Eronia leda*	(Boisduval, 1847)	Marako	
692		*Euphaedra caerulescens submarginalis*	Hecq, 1997	[Ethiopia?]	E
693		*Euphaedra castanoides deficiens*	Hecq, 1997	West, Didessa River	E
694		*Euphaedra medon abouna*	Ungemach, 1932	Youbdo	E
695		*Euphaedra neumanni*	Rothschild, 1902	Scheko [Sheko]	
696		*Euphaedra sarita abyssinica*	Rothschild, 1902	Kankati forest, Djimma	E
697		*Eurytela hiarbas abyssinica*	Rothschild & Jordan,	Banka	E

			1903		
698		*Euxanthe eurinome birbirica*	Ungemach, 1932	Youbdo	
699		*Hypolimnas salmacis platydema*	Rothschild & Jordan, 1903	Scheko	E
700		*Junonia terea fumata*	(Rothschild & Jordan, 1903)	Gillet Mountains	
701		*Lasiommata maderakal*	(Guérin-Méneville, 1849)	Abyssinie [Ethiopia]	
702		*Melitaea abyssinica*	Oberthür, 1909	Abyssinie [Ethiopia]	E
703		*Neptis nemetes obtusa*	Rothschild & Jordan, 1903	Scheko	E
704		*Phalanta eurytis microps*	(Rothschild & Jordan, 1903)	Walenso [Woliso], Gillet Mts	E
705		*Phalanta phalantha aethiopica*	(Rothschild & Jordan, 1903)	Gillet Mts	
706		*Pseudacraea boisduvalii sayonis*	Ungemach, 1932	Oumbi	E
707		*Pseudacraea eurytus mimoras*	Ungemach, 1932	Oumbi	E
708		*Pseudacraea lucretia walensensis*	(Sharpe, 1896)	Waenso [Woliso]	E
709		*Sevenia boisduvali kaffana*	(Rothschild & Jordan, 1903)	Godjeb to Bonga, Kaffa	E
710		*Telchinia aurivillii schecana*	Rothschild & Jordan, 1905	Scheko [Sheiko]	E
711		*Telchinia bonasia banka*	Eltringham, 1912	Banka, Malo	
712		*Telchinia guichardi*	Gabriel, 1949	Lekempti	E
713		*Telchinia jodutta aethiops*	Rothschild & Jordan, 1905	Dereta Mts	E
714		*Telchinia necoda*	Hewitson, 1861	Abyssinia [Ethiopia]	E
715		*Telchinia peneleos gelonica*	(Rothschild & Jordan, 1905)	Upper Gelo River	E

716		*Telchinia perenna kaffana*	(Rothschild, 1902)	Kaffa	E
717		*Telchinia pharsalus rhodina*	Rothschild, 1902	Kaffa	E
718		*Telchinia rangatana maji*	Carpenter, 1935	Maji Province	E
719		*Telchinia safie antinorii*	(Oberthür, 1880)	Mahal-Uonz	E
720		*Telchinia safie safie*	(C. & R. Felder, 1865)	Abyssinia [Ethiopia] Meridionalis	E
721		*Telchinia ungemachi*	(Le Cerf, 1927)	Youbdo (Birbi)	E
722		*Tirumala formosa neumanni*	(Rothschild & Jordan, 1903)	Kaffa	E
723		*Vanessa abyssinica abyssinica*	Vane-Wright & Hughes, 2007	Ethiopia	
724		*Ypthima impura paupera*	Ungemach, 1932	Soubé-Boro	
725		*Ypthima simplicia*	Butler, 1876	Atbara	
726	**Papilionidae**	*Graphium almansor birbiri*	(Ungemach, 1932)	Baro	E
727		*Graphiumangolanus baronis*	(Ungemach, 1932)	Baro	
728		*Papilio arnoldiana*	Vane-Wright, 1995	S.W. Abyssinia [Ethiopia], Grine	E
729		*Papilio dardanus antinorii*	Oberthür, 1883	Abissinia, Feleklek and Sciotalit	E
730		*Papilio echerioides leucospilus*	Rothschild, 1902	Gara Mulata near Harar”	E
731		*Papilio echerioides oscari*	Rothschild, 1902	Kaffa and Djima [Jimma]	E
732		*Papilio microps*	Storace, 1951	Shoa, Abyssinia [Ethiopia] centrale	
733		*Papilio nireuspseudonireus*	Felder & Felder, 1865	Africa Septentrionali Oriental, Bogos	
734		*Papilio rex abyssinicana*	Vane-wright, 1995	S. W. Abyssinia [Ethiopia], Ganji River	E
735		*Papilio wilsoni*	Rothschild, 1926	Nubar Hills, Taldi	E
736	**Pieridae**	*Appias sylvia abyssinica*	Talbot, 1932	Joubda (Birbir)	E
737		*Belenois gidica abyssinica*	(Lucas, 1852)	Abyssinie [Ethiopia]	E

738		*Belenois gidica hypoxantha*	(Ungemach, 1932)	Gambela	E
739		*Belenois raffrayi*	(Oberthür, 1878)	Lac de Tzana [Lake Tana]	
740		*Belenois subeida hailo*	(Ungemach, 1932)	Nolé Kaba [in Wollega]	E
741		*Belenois thysa tricolor*	Talbot, 1943	Abyssinia [Ethiopia]	
742		*Belenois zochalia gada*	(Ungemach, 1932)	Nole-Kaba [in Wollega]	E
743		*Colias electo meneliki*	Berger, 1940	Gondar	
744		*Colias erate marnoana*	Rogenhofer, 1884	Ethiopia	
745		*Colotis antevippe zera*	(Lucas, 1852)	Abyssinie [Ethiopia]	
746		*Colotis celimene celimene*	(Lucas, 1852)	Abyssinie [Ethiopia]	
747		*Colotis danae eupompe*	(Klug, 1829)	in Arabia deserta, in Sinai monte, in Dongala et Habessinia	
748		*Colotis euippe exole*	(Reiche, 1850)	Abyssinie [Ethiopia]	
749		*Colotis hetaera aspasia*	(Ungemach, 1932)	Baro	
750		*Colotis phisadia ocellatus*	(Butler, 1886)	Somali-land [False locality]	E
751		*Colotis ungemachi*	(Le Cerf, 1922)	N Ethiopia	E
752		*Dixeia charina septentrionalis*	(Bernardi, 1958)	Djemdjem	E
753		*Eronia leda pupillata*	Strand, 1911	Marako	E
754		*Euchloe belemia abyssinica*	Riley, 1928	Mt. Chillalo	E
755		*Eurema desjardinsii regularis*	(Butler, 1876)	Atbara	
756		*Leptosia alcesta pseudonuptilla*	Bernardi, 1959	Haute-Orguessa	
757		*Mylothris erlangeri*	Pagenstecher, 1902	Gewidscha	E
758		*Mylothris mortoni balkis*	Ungemach, 1932	Alenga	E
759		*Mylothris mortoni mortoni*	Blachier, 1912	Kaffa, dans l'Abyssinie [Ethiopia] meridionale"	E
760		*Mylothris rueppellii*	(Koch, 1865)	Abessynica	
761		*Mylothris sagala swaynei*	Butler, 1899	Harar Highlands	E

762		*Mylothris yulei amhara*	Ungemach, 1932	Alenga	E
763		*Pieris brassicoides*	Guérin-Méneville, 1849	Abyssinie [Ethiopia]	
764		*Pontia daplidice aethiops*	(De Joannis & Verity, 1913)	Abyssinie [Ethiopia]	E
765	**Plutellidae**	*Lepocnemis metapelista*	Meyrick, 1932	Jem-Jem Forest	E
766		*Plutella dryoxyla*	Meyrick, 1932	Mt Chillálo	E
767		*Plutella oxylopha*	Meyrick, 1932	Mt Chillálo	E
768		*Plutella stichocentra*	Meyrick, 1932	Mt Chillálo	E
769	**Psychidae**	*Acanthopsyche chrysora*	Bourgogne, 1980	Arba Minch	E
770		*Oiketicoides aethiopica*	Bourgogne, 1991	Wollo, Lalibela	E
771		*Taleporia aethiopica*	Strand, 1911	Mahenge	E
772	**Pterophoridae**	*Cosmoclostis gorbunovi*	Ustjuzhanin & Kovtunovich, 2011	West Shewa, 2 km S of Ambo	E
773		*Hellinsia aethiopicus*	(Amsel, 1963)	Gembi	
774		*Hellinsia ambo*	Ustjuzhanin & Kovtunovich, 2011	West Shewa, 2 km S of Ambo	
775		*Hellinsia bigoti*	(Rougeot, 1983)	Simyen, Sankaber	E
776		*Hellinsia negus*	(Gibeaux, 1994)	Wondo-Genet	E
777		*Merrifieldia lonnvei*	Gielis, 2011	Amhara Region, S of Debub, Gondar zone, 8 km NW of Addis Zemen, Highway 3	E
778		*Paracapperia esuriens*	Meyrick, 1932	Jem Jem Forest	
779		*Platyptilia daemonica*	Meyrick, 1932	Jem Jem Forest	E
780		*Platyptilia gondarensis*	Gibeaux, 1994	Gondar Province	
781		*Platyptilia implacata*	Meyrick, 1932	Jem Jem Forest	E
782		*Pterophorus lindneri*	(Amsel, 1963)	Gore	E
783		*Stenoptilia aethiopica*	Gibeaux, 1994	Sidamo, Wondo-Genet	
784		*Stenoptilia amharae*	Gielis, 2011	Amhara Region, Semien North, Gondar zone, 17 km NEE of Debark, Simien Mts National Park	E

785		*Stenoptilia rougeoti*	Gibeaux, 1994	Bale, marais de Dinsho	E
786		*Stenoptilia tyropiesta*	Meyrick, 1932	Mt Chillálo	E
787	**Pyralidae**	*Aglossodes dureti*	(Rougeot, 1977)	Arba Minch	E
788		*Aglossodes navattae*	Rougeot, 1977	Arba Minch	E
789		*Bostra excelsa*	Rougeot, 1984	near Mt Batu	E
790		*Bostra pseudoexcelsa*	Rougeot, 1984	Arba Minch	E
791		*Dembea venulosella*	Ragonot, 1888	Abyssinia [Ethiopia]	
792		*Ematheudes pollex*	Shaffer, 1998	Kosogay Wagra	E
793		*Emmalocera erythrinella*	(Ragonot, 1888)	Abyssinia [Ethiopia]	
794		*Endotricha ellisoni*	Whalley, 1963	Harar	
795		*Harraria rufipicta*	Hampson, 1930	Harrar [Harar]	E
796		*Loryma albilinealis*	Hampson, 1917	Diré Daouá [Dire Dawa]	E
797		*Megarthridia christyi*	Rougeot, 1984	Arba Minch	E
798		*Nussia rougeoti*	Leraut, 2015	Koffolé [Koffale]	
799	**Saturniidae**	*Aurivillius cadioui*	Bouyer, 2008	100 kn E of Addis Ababa	E
800		*Bunaeopsis oubie*	(Guérin-Méneville, 1849)	Abyssinia [Ethiopia]	E
801		*Eosia digennaroi*	Bouyer, 2008	Bale, S of Omar	
802		*Epiphora antinorii*	(Oberthür, 1880)	Scioa [Shoa], Mahal Uonz [Awash River]	
803		*Epiphora bauhiniae atbarina*	(Butler, 1877)	Atbara	
804		*Epiphora fournierae*	Rougeot, 1974	Road Koffolé-Arussi [Koffale- Arsi]	
805		*Gonimbrasia belina abayana*	Rougeot, 1977	Arba Minch	E
806		*Gonimbrasiabirbiri*	Bouvier, 1929	Joubdo (Birbir)	E
807		*Gonimbrasia belina felderi*	Rothschild, 1895	Bogos	E
808		*Gonimbrasia ellisoni*	Lemaire, 1962	Harar	E
809		*Gonimbrasia fletcheri*	Rougeot, 1960	Ethiopia	E

810		*Gonimbrasia fucata*	Rougeot, 1978	Ethiopia	E
811		*Goodia smithii*	(Holland, 1897)	East Africa [Ethiopia]	E
812		*Gynanisa arba*	Darge, 2008	Arba Minch	E
813		*Heniocha digennaroi*	Bouyer, 2008	Sidamo, Neguele Borana	E
814		*Holocerina digennariana*	Darge, 2008	Shashemene (Arsi)	E
815		*Ludia hansali*	Felder, 1874	Bogos	
816		*Ludia pupillata*	Strand, 1911	Antottos	E
817		*Micragone leonardi*	Bouyer, 2008	Sidamo, Dilla	E
818		*Nudaurelia fasciata*	Gaede, 1927	[Ethiopia]	E
819		*Nudaurelia ungemachti*	Bouvier, 1926	Djemdejm [Jem Jem]	E
820		*Pseudobunaea heyeri citrinarius*	Gaede, 1927	Harrar [Harar]	
821		*Pseudobunaea megana*	Darge, 2012	Sidamo Province, near Mega	E
822		*Urota melichari*	Bouyer, 2008	Sidamo Province, 15 km S of Negele	E
823	**Scythrididae**	*Scythris ethiopica*	Bengtsson, 2014	Lake Tana, Bahir Dar	E
824	**Sesiidae**	*Agriomelissa aethiopica*	(Le Cerf, 1917)	Abyssinia [Ethiopia]	E
825		*Jerbeia darkovi*	Gorbunov, 2018	Oromia, 21.8 km NW (289.5°) of Dembi Dolo	E
826		*Melittia abyssiniensis*	Hampson, 1919	Harar	E
827		*Melittia ambo*	Gorbunov, 2015	West Shewa, 3 km S of Ambo	E
828	**Sphingidae**	*Ceridia heuglini*	(Felder C. & Felder R., 1874)	Abyssinia [Ethiopia]	
829		*Ceridia quirini*	Sulak, Naumann & Witt, 2016	Oromia Region, road between Deritu and Dubuluk, near Deritu	E
830		*Chaerocina ellisoni*	Hayes, 1963	Harar	E
831		*Covelliana berioi*	Eitschberger & Melichar, 2016	near Debark Gondar	E
832		*Covelliana robertbecki*	Eitschberger & Melichar, 2016	Ethiopia Central, Oromia, southern Bale Mts, Harenna Forest	E

833		*Dovania dargei*	Pierre, 2000	Metu	E
834		*Dovania neumanni*	Jordan, 1926	SW Abyssinia [Ethiopia], Dhimma [Jimma]	E
835		*Falcatula tamsi*	Carcasson, 1968	Harrar [Harar]	E
836		*Leucophlebia neumanni*	Rothschild, 1902	Gelo River to Akobo River	
837		*Lophostethus dumolinii riedeli*	Eitschberger & Ströhle, 2011	Arba Minch	E
838		*Lophostethus negus*	Jordan, 1926	SW Abyssinia [Ethiopia], Kambatta	E
839		*Macropoliana chrismonika*	Eitschberger & Melichar, 2016	Ethiopia W, 12 km E of Bonga	E
840		*Macropoliana haileselassiei*	Eitschberger & Melichar, 2016	Sidamo Province, 20 km S of Angere Maryam	E
841		*Macropoliana kingstoni*	Eitschberger, 2016	Oromia Region, 25 km E of Bonga/Mera	E
842		*Macropoliana stroehlei*	Eitschberger, 2016	Near Dorze	E
843		*Nephele xylina*	Rothschild & Jordan, 1910	Abyssinia [Ethiopia]	
844		*Platysphinx dorsti*	Rougeot, 1977	Kébré-Mengist [Kibre Mengist]	E
845		*Praedora melichari*	Haxaire, 2011	Sidamo Province, near Bitata	E
846		*Pseudoclanis bianchii*	(Oberthür, 1883)	Scioa [Shoa]	E
847		*Rufoclanis numosae rostislavi*	Haxaire & Melichar, 2008	Gamo Gofa Province, Dagabule National Park	E
848		*Temnora arida*	Melichar & Řezáč & Ilčíková, 2016	Dorze, Guge Mts	
849		*Temnora robusta*	Melichar, Řezáč & Ilčíková, 2016	Kaffa Prov., 40 km SW Jima,	
850		*Theretra ankae*	Melichar & Řezáč, 2015	Asosa	E
851	**Thyrididae**	*Arniocera cyanoxantha*	(Mabille, 1893)	Abyssinia [Ethiopia]	
852		*Arniocera guttulosa*	Jordan, 1915	Harar	E
853		*Lamprochrysa amata*	(Druce, 1910)	Diré Daoua [Dire Dawa]	E

854	**Tineidae**	*Afrocelestis minuta*	(Gozmány, 1965)	Gamu-Gofa, Konso	
855		*Ateliotum convicta*	(Meyrick, 1932)	Jem Jem Forest	E
856		*Ceratophaga luridula*	(Meyrick, 1932)	Mt Chillálo, moorland	E
857		*Ceratophaga nephelotorna*	(Meyrick, 1932)	Jem-Jem Forest	E
858		*Criticonoma spinulosa*	Gozmány, 1965	Gamu-Gofa, Konso	E
859		*Crypsithyris stenovalva*	(Gozmány, 1965)	Gamu-Gofa, Konso	E
860		*Dryadaula glycinoma*	(Meyrick, 1932)	Jem-Jem Forest	E
861		*Ectabola pygmina*	(Gozmány, 1965)	Marako	
862		*Edosa torrifacta*	(Gozmány, 1965)	Harrar [Harar]	E
863		*Hapsifera gypsophaea*	Gozmány, 1965	Gamu-Gofa, Konso	E
864		*Hapsifera pachypsaltis*	Gozmány, 1965	Kaffa, Ghimira	
865		*Hapsifera richteri*	Gozmány, 1965	Ethiopia SW, Gamu-Gofa, Konso	E
866		*Leptozancla zelotica*	(Meyrick, 1932)	Jem-Jem Forest	E
867		*Monopis addenda*	Gozmány, 1965	Kaffa, Gembi [Gimbi]	
868		*Monopis leopardina*	Gozmány, 1965	Kaffa, Abaro	E
869		*Monopis triplacopa*	Meyrick, 1932	Jem-Jem Forest,45 miles W. of Addis-Ababa,	E
870		*Perissomastix lucifer*	Gozmány, 1965	Muger Valley	E
871		*Scalmatica separata*	Gozmány, 1965	Konso, Gamu-Gofa	E
872		*Silosca mariae*	Gozmány, 1965	Djerrer Valley	
873		*Tinissa spaniastra*	Meyrick, 1932	Jem-Jem Forest, , 45 miles from Addis Ababa	
874	**Tortricidae**	*Acleris baleina*	Razowski & Trematerra, 2010	Bale Mountains, Sanetti Plateau	E
875		*Acleris harenna*	Razowski & Trematerra, 2010	Bale Mountains, Harenna Forest, Karcha Camp	E
876		*Ancylis colaccii*	Razowski & Trematerra, 2012	Wellega Zone, Didessa River	E
877		*Bubonoxena alatheta*	Razowski & Trematerra, 2010	Bale Mountains, Harenna Forest, Karcha Camp	E

878		*Choristoneura palladinoi*	Razowski & Trematerra, 2010	Bale Mountains, Harenna Forest	E
879		*Coccothera carolae*	Razowski & Trematerra, 2010	Bale Mountains, Harenna Forest	
880		*Coccothera triorbis*	Razowski & Trematerra, 2010	Bale Mountains, Harenna Forest	E
881		*Coniostola separata*	Razowski & Trematerra, 2010	Bale Mountains, Harenna Forest, Karcha Camp	E
882		*Cosmetra anepenthes*	(Razowski & Trematerra, 2010)	Bale Mountains, Harenna Forest, Karcha Camp	E
883		*Cosmetra latiloba*	(Razowski & Trematerra, 2010)	Bale Mountains, Harenna Forest, Karcha Camp	E
884		*Cydia calliglypta*	(Meyrick, 1932)	Jem-Jem Forest, edge of forest	E
885		*Cydia dinshoi*	Razowski & Trematerra, 2010	Bale Mountains, Dinsho Lodge	E
886		*Cydia lathetica*	Razowski & Trematerra, 2010	Bale Mountains, Dinsho Lodge	E
887		*Cydia tytthaspis*	Razowski & Trematerra, 2010	Bale Mountains, Harenna Forest, Karcha Camp	E
888		*Eccopsis aegidia*	(Meyrick, 1932)	Jem-Jem Forest	
889		*Eccopsis brunneopostica*	Razowski & Trematerra, 2010	Bale Mountains, Harenna Forest, Karcha Camp	E
890		*Eccopsis maschalista*	(Meyrick, 1932)	Jem-Jem Forest	E
891		*Eccopsis subincana*	Razowski & Trematerra, 2010	Bale Mountains, Harenna Forest	E
892		*Endothenia albapex*	(Razowski & Trematerra, 2010)	Bale Mountains, Harenna Forest	E
893		*Endothenia ethiopica*	Razowski & Trematerra, 2010	Bale Mountains, Harenna Forest, Karcha Camp	E
894		*Epichoristodes spilonoma*	(Meyrick, 1932)	Jem Jem Forest	
895		*Eucosma vulpecularis*	Meyrick, 1932	Jem-Jem Forest	E
896		*Eucosmocydia zegieana*	Razowski & Trematerra, 2018	Amhara, Zegie Peninsula	E

897		*Grapholita insperata*	Razowski & Trematerra, 2010	Bale Mountains, Dinsho Lodge	E
898		*Gypsonoma giorgiae*	Razowski & Trematerra, 2012	Ilubabor zone, Bedelle, Dabeda River	E
899		*Lozotaenia karchana*	Razowski & Trematerra, 2010	Bale Mountains, Harenna Forest, Karcha Camp	E
900		*Lozotaenia sciarrettae*	Razowski & Trematerra, 2010	Bale Mountains, Harenna Forest, Karcha Camp	E
901		*Megaherpystis oromiae*	Razowski & Trematerra, 2018	Oromia, Suba Forest	E
902		*Megaherpystis subae*	Razowski & Trematerra, 2018	Oromia, Suba Forest	E
903		*Megalota lygaria*	Razowski & Trematerra, 2010	Bale Mountains, Harenna Forest	E
904		*Metamesia physetopa*	(Meyrick, 1932)	Jem-Jem Forest and Mt Chillálo	
905		*Multiquaestia aequivoca*	Razowski & Trematerra, 2010	Bale Mountains, Harenna Forest	E
906		*Olethreutes didessae*	Razowski & Trematerra, 2012	Wellega zone, Didessa River	E
907		*Olethreutes polymorpha*	(Meyrick, 1932)	Jem-Jem Forest	E
908		*Parabactra addisalema*	Razowski & Trematerra, 2018	Oromia, Addis Alem, Ambo Park	E
909		*Paraeccopsis addis*	Aarvik, 2014	Addis Ababa	E
910		*Phtheochroa lonnvei*	Aarvik, 2010	Oromia Province, Bale zone, 43 km SW of Goba, Bale Mts National Park, Darwin Camp	E
911		*Plutographa xanthala*	Razowski & Trematerra, 2010	Bale Mountains, Dinsho Lodge	E
912		*Procrica dinshona*	Razowski & Trematerra, 2010	Bale Mountains, Dinsho Lodge	
913		*Procrica ophiograpta*	(Meyrick, 1932)	em-Jem Forest and Mt Chillálo	
914		*Procrica parisii*	Razowski & Trematerra, 2010	Bale Mountains, Dinsho Lodge	E

915		*Russograptis albulata*	Razowski & Trematerra, 2010	Bale Mountains, Harenna Forest	E
916		*Thaumatographa amarana*	Razowski & Trematerra, 2018	Amhara, Zegie Peninsula	E
917		*Thaumatovalva spinai*	Razowski & Trematerra, 2010	Omo Valley, Dowro Zone, Tarcha	
918		*Tortrix diametrica*	Meyrick, 1932	Jem-Jem Forest	E
919		*Trachybyrsis chionochlaena*	Meyrick, 1932	Mt Chillálo	E
920	**Uraniidae**	*Arussiana herbuloti*	Rougeot, 1977	near Koffolé [Koffale]	
921	**Yponomeutidae**	*Yponomeuta ocypora*	(Meyrick, 1932)	Jem-Jem Forest	E
922		*Yponomeuta ioni*	Agassiz, 2019	Arba Minch, Chenche	E
923		*Yponomeuta ocypora*	Meyrick, 1932	Amhara, Zege Peninsula	
924		*Yponomeuta oromiensis*	Agazzia, 2019	Oromia, Shebe	E
925	**Zygaenidae**	*Alteramenelikia jordani*	(Alberti, 1954)	Abyssinia [Ethiopia]	
926		*Astyloneura bicoloria*	Röber, 1929	Abyssinia [Ethiopia]	E
927		*Epiorna abessynica*	(Koch, 1865)	Abyssinia [Ethiopia]	
928		*Saliunca anhyalina*	Alberti, 1957	Abyssinia [Ethiopia]	E
929		*Saliunca homochroa*	(Holland, 1897)	Darde River	

Appendix II. Summary list of floristic composition of each land use types (Presence=1; Absence=0)

No	Scientific Name	FF	ME	BL	CF	NF
1	*Calpurnia aurea* (Ait.) Benth.	1	0	0	0	1
2	*Calpurnia aurea* Fresen.	1	0	0	0	1
3	*Carissa spinarum* L.	1	0	1	0	1
4	*Dovyalis abyssinica* (A. Rich.) Warb.	1	0	0	0	1
5	*Embelia schimperi* Vatke	1	0	0	0	0
6	*Urera hypselodendron* (Hochst. ex A.Rich.) Wedd.	1	0	1	0	0
7	*Phytolacca dodecandra* L'Hérit	1	0	0	0	0
8	*Vernonia myriantha* Hook.f.	1	1	1	0	1
9	*Zehneria scabra* (Linn.f.) Sond.	1	0	0	0	0
10	*Croton macrostachyus* Del.	1	1	0	0	1
11	*Euphorbia abyssinica* Gmel.	1	1	1	0	1
12	*Clausena anisata* (Willd.) Benth	1	0	1	0	1
13	*Buddleja polystachya* Fresen	1	1	0	0	1
14	*Rumex nervosus* Vahl	1	0	0	0	1
15	*Laggera tomentosa* (Sch. Bip. ex A. Rich.) Oliv. & Hiern	1	0	1	0	0
16	*Maytenus arbutifolia* (A.Rich.) Wilczek	1	0	0	0	0
17	*Dombeya torrida* (J.F. Gmel.) P. Bamps	1	1	0	0	0
18	Apodytes dimidiata E. Mey. ex Arn	1	0	0	0	1
19	*Brucea antidysenterica* J. F. Mill.	1	0	1	0	1
20	*Rhamnus* staddo A. Rich.	1	0	0	0	0
21	*Prunus africana* (Hook.f.) Kalkm.	1	0	0	0	0
22	*Bersama abyssinica* Fresen.	1	0	1	0	1
23	*Vernonia amygdalina* Del.	1	1	0	0	1
24	*Vernonia auriculifera* Hiern.	1	0	0	0	0
25	*Vernonia leopoldi* (Sch. Bip. ex Walp.) Vatke	1	0	0	0	1
26	*Schefflera abyssinica* (Hochst. ex A. Rich.) Harms	1	0	0	0	0
27	*Rosa abyssincia* Lindley.	1	1	1	0	0
28	*Juniperus procera* Hochst. ex Endl.	1	1	0	0	1
29	*Dodonaea angustifolia* L. f.	1	0	0	0	0
30	*Maesa lanceolata* Forssk.	1	0	1	0	1
31	*Allophylus abyssinicus* (Hochst.) Radlkofer	1	0	1	0	0
32	*Pavetta abyssinica* Fresen.	1	0	0	0	0
33	*Sida schimperiana* Hochst. ex A. Rich.	1	0	1	0	0
34	*Pennisetum sphacelatum* (Nees)Th. Dur. & Schinz	1	0	1	0	0
35	*Arundinaria alpina* K. Schum.	1	0	0	0	1
36	*Arundo donax* L.	1	1	0	0	0

37	*Pavonia urens* Cav	1	1	1	0	0
38	*Teclea nobilis* Del.	1	0	0	0	1
39	*Acanthus eminens* C.B. Clarke	1	1	1	0	0
40	*Echinops kebericho* Mesfin	1	1	0	0	1
41	*Echinops macrochaetus* Fresen.	1	1	1	0	0
42	*Acacia abyssinica* Hochst.	1	1	1	0	1
43	*Myrsine africana* L.	1	0	1	0	0
44	*Osyris quadripartita* Decn.	1	0	1	0	0
45	*Verbascum sinaiticum* Benth.	1	0	0	0	0
46	*Rubus steudneri* Schweinf.	1	0	0	0	0
47	*Gomphocarpus purpurascens* A. Rich.	1	0	0	0	0
48	*Solanecio gigas* (Vatke) C. Jeffrey	1	0	0	0	1
49	*Solanum anguivi* Lam.	1	0	0	0	1
50	*Dracaena steudneri* Engl.	1	0	0	0	0
51	*Adiantum raddianum* C. Presl	1	0	0	0	0
52	*Olea europaea* L. subsp. *cuspidata*	1	1	0	0	0
53	*Justicia schimperiana* (Hochst. ex Nees) T. Anders.	1	1	0	0	0
54	*Rhamnus prinoides* L'Herit.	1	1	0	0	0
55	*Myrica salicifolia* A. Rich.	1	0	0	0	0
56	*Olinia rochetian*a A. Juss.	1	0	0	0	0
57	*Periploca linearifolia* Quart.-Dill. & A. Rich.	1	0	0	0	0
58	*Arisaema enneaphyllum* Hochst. ex A.Rich	1	0	0	0	0
59	*Bidens macroptera* (Sch.-Bip. ex Chiov.) Mesfin	1	0	0	0	0
60	*Pennisetum sphacelatum* (Nees) Th. Dur. & Schinz	1	0	1	0	0
61	*Arundinaria alpina* K. Schum.	1	0	0	0	1
62	*Arundo donax* L.	1	1	0	0	0
63	*Acacia mearnsii* De Wild.	0	1	1	0	0
64	*Girardinia bullosa* Wedd.	0	1	1	0	0
65	*Datura stramonium* L.	0	1	0	0	0
66	*Stephania abyssinica* (Dillon & A. Rich.) Walp.	0	1	1	0	0
67	*Maytenus arbutifolia* (A. Rich.) Wilczek	0	1	0	0	1
68	*Rumex nepalensis* Spreng.	0	1	0	0	1
69	*Ricinus communis* L.	0	1	0	0	1
70	*Brassica carinata* A. Br.	0	1	0	0	0
71	*Ensete ventricosum* (Welw.)	0	1	0	0	1
72	*Eucalyptus globulus* Labill.	0	1	0	0	0
73	*Galinsoga quadriradiata* Ruiz & Pavon	0	1	0	0	0
74	*Haplocarpha schimperi* (Sch. Bip.) Beauv.	0	1	0	0	0
75	*Erythrina brucei* Schweinf.	0	1	1	0	1
76	*Solanum marginatum* L.f.	0	1	1	0	0
77	*Zea mays* L.	0	1	0	1	0

78	*Grevillea robusta* R. Br.	0	1	0	0	0
79	*Cupressus lusitanica* Mill.	0	1	1	0	0
80	*Senna petersiana* (Bolle) Lock	0	1	0	0	0
81	*Cymbopogon citratus* (DC.) Stapf.	0	1	0	0	0
82	*Ocimum basilicum* L.	0	1	0	0	0
83	*Ruta chalepensis* L.	0	1	0	0	0
84	*Carduus macracanthus* Sch. Bip. ex. Kazmi	0	1	1	0	0
85	*Acacia nilotica* (L.) Willd. ex. Del.	0	1	1	0	0
86	*Opuntia ficus-indica* (L.) Miller.	0	1	0	0	0
87	*Artemisia absinthium* L.	0	1	0	0	0
88	*Cotula abyssinica* Sch. Bip. ex A. Rich.	0	0	0	0	0
89	*Chamaecytisus proliferus* (L.f.) Link	0	0	0	0	0
90	*Ficus vasta* Forssk	0	0	1	0	0
91	*Kalanchoe petitiana* A. Rich.	0	0	1	0	0
92	*Galiniera saxifraga* (Hochst.) Bridson	0	0	1	0	0
93	*Jasminum abyssinicum Hochets. Ex DC.*	0	0	1	0	0
94	*Rhus quartiniana* A. Rich.	0	0	1	0	0
95	*Clematis simensis* Fresen.	0	0	1	0	0
96	*Cassipourea malosana* (Baker) Alston.	0	0	1	0	0
97	*Eragrostis tef* (Zucc.)	0	0	0	1	0
98	*Avena abyssinica* Hochst.	0	0	0	1	0
99	*Triticum aestivum L.*	0	0	0	1	0
100	*Hordeum vulgare* L.	0	0	0	1	0
101	*Pisum sativum* L.	0	0	0	1	0
102	*Vicia faba* L.	0	0	0	1	0
103	*Linum usitatissimum* L.	0	0	0	1	0
104	*Lupinus albus* L.	0	0	0	1	0
105	*Guizotia abyssinica* (L.f.) Cass.	0	0	0	1	0
106	*Acacia abyssinica* Hochst. ex Benth.	0	0	0	0	1
107	*Acacia lahai* Steud. & Hochst. ex Benth.	0	0	0	0	1
108	*Acanthus eminens* C. B. Clarke	0	0	0	0	1
109	*Acanthus polystachius* Delile	0	0	0	0	1
110	*Acanthus pubescens* (Oliv.) Engl.	0	0	0	0	1
111	*Acanthus sennii* Chiv.	0	0	0	0	1
112	*Achyranthes aspera* L.	0	0	0	0	1
113	*Achyrospermum schimperi* (Hochst. ex Briq.)	0	0	0	0	1
114	*Adiantum poiretii* Wikstr.	0	0	0	0	1
115	*Aerangis brachycarpa* (A. Rich.) Th. Dur. & Schinz	0	0	0	0	1
116	*Albizia gummifera* (J. F. Gmel.) C. A. Sm.	0	0	0	0	1
117	*Albizia schimperiana* Oliv.	0	0	0	0	1
118	*Allophylus abyssinicus* (Hochst.) Radlk.	0	0	0	0	1

119	*Apodytes dimidiata* E. Mey.	0	0	0	0	1
120	*Asplenium aethiopicum* (Burm.f.) Bech.	0	0	0	0	1
121	*Asplenium erectum* Bory ex Willd.	0	0	0	0	1
122	*Basella alba* L.	0	0	0	0	1
123	*Bersama abyssinica* Fresen. subsp. abyssinica	0	0	0	0	1
124	*Bidens pillosa* L.	0	0	0	0	1
125	*Bidens prestinaria* (Sch. Bip.) Cufod.	0	0	0	0	1
126	*Bothriocline schimperi* Sch. Bip. ex Walp.	0	0	0	0	1
127	*Brillantaisia grotanellii* Pic. Serm.	0	0	0	0	1
128	*Canarina eminii* Schweinf.	0	0	0	0	1
129	*Canthium oligocarpum* Hiern	0	0	0	0	1
130	*Cardamine africana* L.	0	0	0	0	1
131	*Carduus leptacanthus* Fresen.	0	0	0	0	1
132	*Carum piovanii* Chiov.	0	0	0	0	1
133	*Cayratia ibuensis* (Hook, f.) Susseng.	0	0	0	0	1
134	*Celosia anthelminthica* Asch, in Schweinf.	0	0	0	0	1
135	*Celtis africana* Burm. f.	0	0	0	0	1
136	*Centella asiatica* (L.) Urban	0	0	0	0	1
137	*Chloris gayana* Kunth	0	0	0	0	1
138	*Chloris pycnothrix* Trin.	0	0	0	0	1
139	*Clausena anisata* (Willd.) Benth.	0	0	0	0	1
140	*Clerodendrum myricoides* (Hochst.) Vatke	0	0	0	0	1
141	*Clutia abyssinica* Jaub. & Spach. var. abyssinica	0	0	0	0	1
142	*Clutia lanceolata* Forssk.	0	0	0	0	1
143	Commelina sp.	0	0	0	0	1
144	*Cordia africana* Lam.	0	0	0	0	1
145	*Crotalaria rosenii* (Pax) Milne-Redh. ex Polhill	0	0	0	0	1
146	*Cynodon dactylon* (L.) Pers.	0	0	0	0	1
147	*Cynoglossum amplifolium* Hochst.	0	0	0	0	1
148	*Cyperus metzii* (Steud.) Mattf. & Kuk.	0	0	0	0	1
149	*Cyphostemma cyphopetalum* (Fresen.)	0	0	0	0	1
150	*Deinbollia kilimandscharica* Taub.	0	0	0	0	1
151	*Dichondra repens* J. R. & G. Forst.	0	0	0	0	1
152	*Dicliptera maculata* Nees	0	0	0	0	1
153	*Dicliptera verticillata* (Forssk.) C. Chr.	0	0	0	0	1
154	*Dicrocephala integrifolia* (L.F.) Kuntze	0	0	0	0	1
155	*Discopodium penninervium* Hochst.	0	0	0	0	1
156	*Dombeya quinqueseta* (Del.) Excell	0	0	0	0	1
157	*Dombeya rotundifolia* (Hochst.) Planch	0	0	0	0	1
158	*Dovyalis verrucosa* (Hochst.) Warb.	0	0	0	0	1
159	*Dracaena steudneri* Engler	0	0	0	0	1

160	*Drymaria cordata* (L.) Schultes	0	0	0	0	1
161	*Drynaria volkensii* Hieron.	0	0	0	0	1
162	*Dumasia villosa* DC.	0	0	0	0	1
163	*Ehretia cymosa* Thonn.	0	0	0	0	1
164	*Ehrharta erecta* Lam. var. abyssinica (Hochst.) Pilg.	0	0	0	0	1
165	*Ekebergia capensis* Sparrm.	0	0	0	0	1
166	*Eleusine indica* (L.) Gaertn.	0	0	0	0	1
167	*Englerina woodfordioides* (Schweinf.) M. Gilbert	0	0	0	0	1
168	*Ensete ventricosum* (Welw.) Cheesman	0	0	0	0	1
169	*Erythrococca trichogyne* (Muell Arg.) Prain	0	0	0	0	1
170	*Eugenia bukobensis* Engl.	0	0	0	0	1
171	*Euphorbia ampliphylla* Pax	0	0	0	0	1
172	*Euphorbia schimperiana* Scheele	0	0	0	0	1
173	*Ficus sur* Forssk.	0	0	0	0	1
174	*Ficus thonningii* Blume	0	0	0	0	1
175	*Flacourtia indica* (Burm. f.) Merr.	0	0	0	0	1
176	*Galiniera saxifraga* (Hochst. Bridson	0	0	0	0	1
177	*Galinsoga parviflora* Cav.	0	0	0	0	1
178	*Girardinia bullosa* (Stedudel) Wedd.	0	0	0	0	1
179	*Grewia ferruginea* Hochst. ex A. Rich.	0	0	0	0	1
180	*Guizotia abyssinica* (L. f) Cass.	0	0	0	0	1
181	*Habenaria macrantha* A. Rich	0	0	0	0	1
182	*Hagenia abyssinica* (Brace) J. F. Gmel.	0	0	0	0	1
183	*Hibiscus macranthus* Hochst. ex A. Rich.	0	0	0	0	1
184	*Huperzia dacrydioides* (Baker) Pic. Serm.	0	0	0	0	1
185	*Hygrophila schulli* (Hamilt.) M.R. & S.M Almeida	0	0	0	0	1
186	*Hypericum revolutum* Vahl.	0	0	0	0	1
187	*Hypoestes triflora* (Forssk.) Roem & Shult.	0	0	0	0	1
188	*Impatiens ethiopica* Grey-Wilson	0	0	0	0	1
189	*Justicia diclipteroides* Lindau	0	0	0	0	1
190	*Justicia ladanoides* Lam.	0	0	0	0	1
191	*Kalanchoe citrina* Schweinf.	0	0	0	0	1
192	*Kalanchoe densiflora* Rolfe var. subpilosa Cufod.	0	0	0	0	1
193	*Laggera braunii* Vatke	0	0	0	0	1
194	*Lepidotrichilia volkensii* (Gurke) Leroy	0	0	0	0	1
195	*Lepisorus schraderi* (Mett.) Ching.	0	0	0	0	1
196	*Leucas deflexa* Hook. f.	0	0	0	0	1
197	*Lippia adoensis* Hochst. ex Walp. var. adoensis	0	0	0	0	1
198	*Malva verticillata* L.	0	0	0	0	1
199	*Maytenus addat* (Loes.) Sebsebe	0	0	0	0	1
200	*Maytenus obscura* (A. Rich.) Cuf.	0	0	0	0	1

201	*Maytenus undata* (Thunb.) Blakelock	0	0	0	0	1
202	*Melanthera scandens* (Schumach. & Thonn.)	0	0	0	0	1
203	*Microglossa pyrifolia* (Lam.) Kuntze	0	0	0	0	1
204	*Millettia ferruginea* (Hochst.) Bak.	0	0	0	0	1
205	*Mimusops kummel* A. DC.	0	0	0	0	1
206	*Momordica foetida* Schumach.	0	0	0	0	1
207	*Nuxia congesta* R. Br. ex Fresen.	0	0	0	0	1
208	*Nuxia congesta* R. Br. ex Fresen.	0	0	0	0	1
209	*Oncinotis tenuiloba* Stapf.	0	0	0	0	1
210	*Oplismenus hirtellus* (L.) P. Beauv.	0	0	0	0	1
211	*Orobanche minor* Smit	0	0	0	0	1
212	*Otostegia tomentosa* A. Rich.	0	0	0	0	1
213	*Oxyanthus speciosus* DC.	0	0	0	0	1
214	*Paveta abyssinica* Fresen. var. abyssinica	0	0	0	0	1
215	*Peperomia tetraphylla* (Forster) Hook. & Arn.	0	0	0	0	1
216	*Phaulopsis imbricata* (Forssk.) Sweet	0	0	0	0	1
217	*Phyllanthus limmuensis* Cufod.	0	0	0	0	1
218	*Phyllanthus rotundifolius* Willd.	0	0	0	0	1
219	*Plectranthus punctatus* L	0	0	0	0	1
220	*Polyscias fulva* (Hiern) Harms	0	0	0	0	1
221	*Polystachya caduca* Rchb.f.	0	0	0	0	1
222	*Polystachya cultriformis* (Thouars) Spreng.	0	0	0	0	1
223	*Protea gaguedi* J. F. Gmel.	0	0	0	0	1
224	*Prunus africana* (Hook. f.) Kalkm.	0	0	0	0	1
225	*Pycnostachys meyeri* Gurke	0	0	0	0	1
226	*Rhus glutinosa* A. Rich. subsp. glutinosa	0	0	0	0	1
227	*Rhus natalensis* Krauss	0	0	0	0	1
228	*Ritchiea albersii* Gilg	0	0	0	0	1
229	*Rosa abyssinica* Lindley	0	0	0	0	1
230	*Rothmannia urcelliformis* (Hiern) Robyns	0	0	0	0	1
231	*Rubus apetalus* Poir.	0	0	0	0	1
232	*Rytigynia neglecta* (Hiern) Robyns	0	0	0	0	1
233	*Salix subserrata* Willd.	0	0	0	0	1
234	*Sanicula elata* Buch. -Ham. ex D. Don	0	0	0	0	1
235	*Sapium ellipticum* (Krauss) Pax	0	0	0	0	1
236	*Satureja abyssinica* Benth. Briq.	0	0	0	0	1
237	*Sauromatum venosum* (Ait.) Kunth	0	0	0	0	1
238	*Selaginella caffrorum* (Milde) Hieron.	0	0	0	0	1
239	*Selaginella goudotiana* Spring	0	0	0	0	1
240	*Sida rhombifolia* L.	0	0	0	0	1
241	*Sida ternata* L. f.	0	0	0	0	1

242	*Sida urens* L.	0	0	0	0	1
243	*Solanum giganteum* Jasq	0	0	0	0	1
244	*Solanum sinaicum* Boiss	0	0	0	0	1
245	*Steganotaenia araliacea* Hochst. ex A. Rich.	0	0	0	0	1
246	*Stereospermum kunthianum* Cham.	0	0	0	0	1
247	*Swertia abyssinica* Hochst.	0	0	0	0	1
248	*Syzygium guineense* (Willd.) DC. subsp. guineense	0	0	0	0	1
249	*Tagetes minuta* L.	0	0	0	0	1
250	*Thalictrum rhynchocarpum* Dill. & A. Rich.	0	0	0	0	1
251	*Triumfetta annua* L.	0	0	0	0	1
252	*Urtica simensis* Steudel	0	0	0	0	1
253	*Vepris dainellii* (Pich. Serm.) Kokwaro	0	0	0	0	1
254	*Vernonia auriculifera* Hiern.	0	0	0	0	1