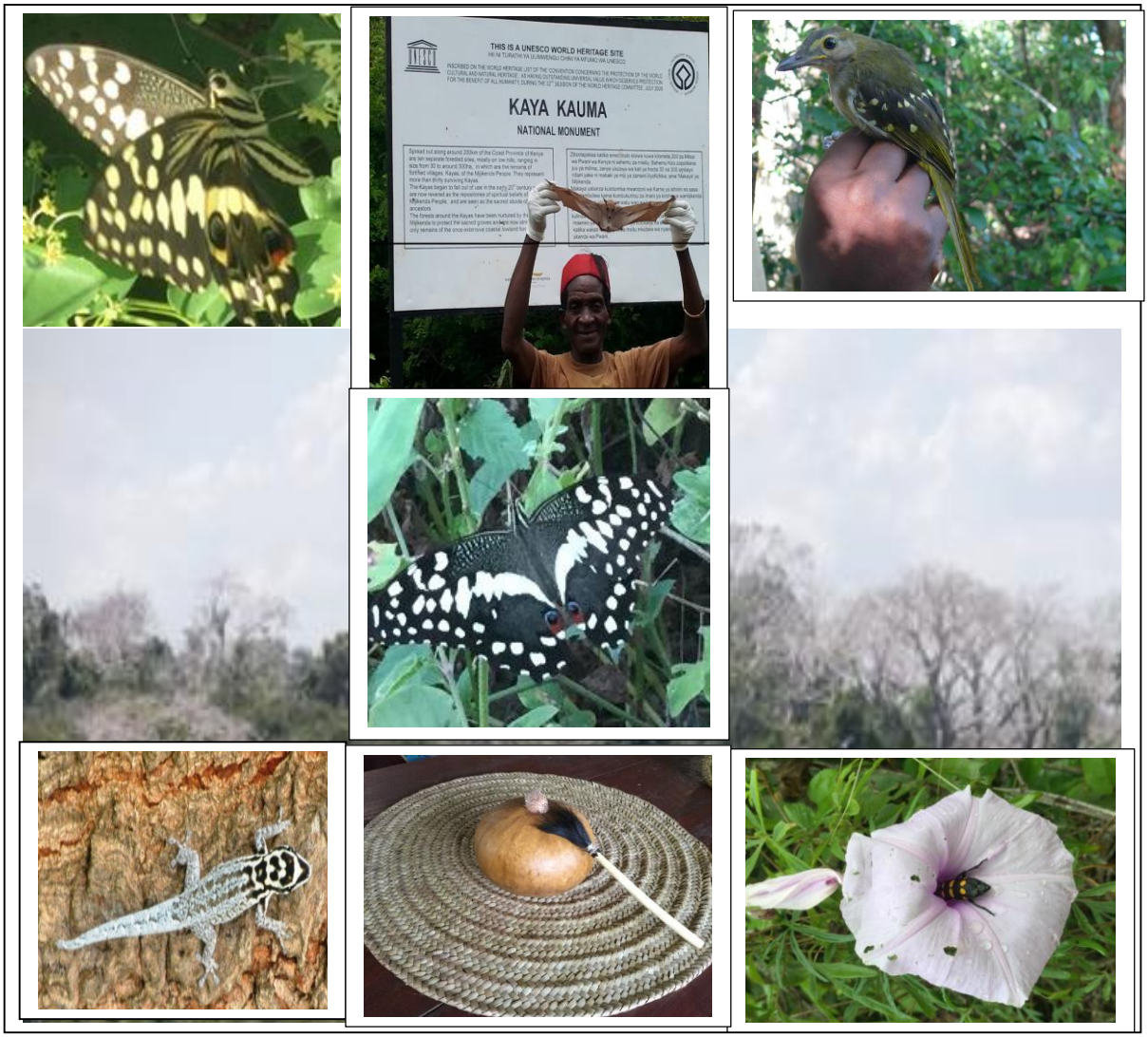
DEVELOPMENT OF A STRATEGIC MANAGEMENT PLAN FOR SUSTAINABLE USE OF SACRED MIJIKENDA KAYA FORESTS



Report on Biodiversity Survey of Kaya Kauma, 2019

E.N. Kioko, J.M. Jefwa, M. A. Nyangila and E. N. Mbua (EDITORS)

NATIONAL MUSEUMS OF KENYA
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EXECUTIVE SUMMARY

Kaya Kauma is part of a mosaic of sacred forest fragments, along the Kenya coast that mesh into an ecosystem that harbor a rich diversity of flora and fauna. Kaya forests are protected through long standing local community rich and environmentally friendly traditions, taboos, beliefs and cultures. A 6-day biodiversity survey was undertaken in Kaya Kauma, from 21st -26th November 2018. The results for the five components as follows:

An invertebrate biodiversity survey was carried out using standard entomological methods and focused on the forest, forest edge and farmlands. The study recorded a total of 251 species and 1746 invertebrate individuals distributed across 18 Orders in Kaya Kauma forest, forest edge and surrounding farmlands. The forest recorded 162 species and 827 individuals, the forest edge 93 species and 536 individuals and 115 species and 379 individuals in the farmlands. The order Lepidoptera had the highest number of species (86), followed by Coleoptera (46), Hymenoptera (45), Diptera (16), Orthoptera (17), Hemiptera (12), Mantodea (7), Odonata (5), Blattodea (4), Neuroptera (2), Spirostreptida (2), Stylommatophora (2), Aranaea (1), Geophilomorpha (1), Isopoda (1), Phasmatodea (1), Polydesmida (1), Solifugae (1), Diplopoda (Pachylobidae) (1). Invertebrate conservation strategies are recommended for the Kaya Kauma.

Kaya Kauma forest is an important habitat for birds. A total of seventy-four (74) species from thirty-six (36) families were recorded during this survey carried out in November of 2018. There were up to twenty-seven (27) forest dependent species, two (2) of which were true forest bird species that exclusively live and breed in the forest. The Kaya is home to two (2) species classified by the IUCN as Near Threatened. They were; Southern Banded Snake Eagle (*Circaetus fasciolatus)* and Fischer's Turaco (*Tauraco fischeri)*. The kaya forest and its surroundings are habitat for long and short-distance migratory species. Long distance migrants that migrate between to Europe and Asia were; Eurasian Bee-eater (*Merops apiaster)*, Eurasian Golden Oriole (*Oriolus oriolus)* while those that migrate within Africa were; White-throated Bee-eater (*Merops albicollis)* and Northern Carmine Bee-eater (*Merops nubicus).*

Kaya Kauma is a harbor a considerable high number of mammals. A total of 42 mammal species were recorded during this survey. Out of the 42 mammal species recorded, 17 species were captured in traps while 25 species were observed opportunistically. A troop of olive baboons *Papio*

anubis were observed during the survey and colobus monkeys (*Colobus guereza)* made calls in the morning. Green vervet monkeys (*Chlorocebus pygerythrus)* were observed raiding mango fruits and groups of more than ten individuals were seen along pawpaw farmlands. Three shrews (*Crocidura* species) were captured in a herpetology pitfall trap and eight dik-dik scats were observed inside the forest.

A survey of amphibians and reptiles (herpetofauna) carried out in Kaya Kauma recorded a total of 23 species comprising of 5 amphibians and 18 reptile species occurring in the forest and its surroundings. The study was preliminary given that the survey period was short and conducted only in one season, therefore, more species can be discovered with more sampling effort. Diversity of herpetofauna in Kaya Kauma is compared with neighbouring Kaya Jibana and in addition a brief species account is provided. We recommend on possible non consumptive utilization of herpetofauna in Kaya Kauma as a way to motivate the continued conservation of the biodiversity in the area.

CHAPTER ONE:

GENERAL INTRODUCTION

1.1 Background

The coastal areas of East Africa especially Kenya and Tanzania are recognized as an areas of global biodiversity importance and are considered as one of the 25 world's biodiversity hotspots due to the concentration of many narrowly endemic plants and animal species in exceptionally small areas (Burges, 1998; Lehman & Kioko, 2000; Meyers et al., 2000; Mittermier et al., 2004).However, the intensity and nature of human activities increasingly threatens their productivity and biological diversity. This is partly due to the population increase, climate change among other factors.

Within the coastal forests in Kenya are the Kaya forests that are a relict forest patches protected by the traditions of the nine MijiKenda ethnic groups who regard them as sacred places and burial grounds (Spear, 1978; Nyamwero et al., 2008). These Kaya forests for many years remained protected through long standing local community rich and environmentally friendly traditions, taboos, beliefs and cultures. These taboos, traditions and other religious observations serve to regulate access and conduct at these forests, threatening dire punishment from the spirit world for those who flouted the rules (Githitho, 2008).

Kaya Kauma is one of the Kaya forests in Coastal Kenya situated in Kilifi County. It is primarily a Kaya of the Kauma people and occupies an area of over 100 hectares within the geographic co-ordinates of 03°:37'14''south and 39°44'10''east (Ang *et al.* 2008). Kaya Kauma is a primary Kaya forest sitting at 120 m above the sea level. Its size is over 100 ha in area (Ang *et al.* 2008). Kauma form the largest community living adjacent to the Kaya Kauma forest accounting for 75% population and the remaining 25% is composed of eight Mijikenda communities (Rajat *et al.*, 2017).

The Kaya forests are botanically diverse and have high conservation value. More than half of the Kenya's rare plants are found in the coast region, many within the Kaya Forests (Rodgers and Burgess, 2002; Younge et al, 2002). However, biodiversity studies on other taxa within the Kaya forests has remained few. For example, invertebrates' surveys within the Kaya forests began in 1994 in Kaya Muhaka and Kaya Kinondo (Lehman & Kioko, 2000). Other studies that followed

include Rogo & Odulaja, 2001, Kaya Mrima, Kinondo and Jibana in 2009 (Lange, 2011) and more in Kaya Muaka (Chiawo 2011). Herpetological surveys within the Kaya forests only began in 2009 (Malonza &Nyamache, 2010) when Kaya Mrima, Kinondo and Jibana were visited. In addition, Malonza et al., 2016 surveyed additional 9 Kaya forests. Much more still remains to be done to understand the biodiversity of Kaya forests.

Conservation of the coastal forests including the sacred Kaya forests is becoming a big challenge given their location in the centre of the country's tourism industry. The rising need for land for, infrastructure, agriculture, fishing, mining (iron ore and titanium) logging for timber, woodcarving and the rapid socio-cultural changes continue to be major threats leading to the loss of smaller Kayas and groves (Younge et al, 2002; Nyamwero et al, 2008; Tabor et al., 2010). Considering the magnitude of these threats, efforts should be made to conserve them. For this to be realized however there is a need to conduct comprehensive surveys of all the biodiversity found in these forests and document their diversity, conservation status and economic values as a baseline to such initiatives.

The current study aimed at documenting the biodiversity of both flora and fauna. The study covered five specific taxa; invertebrates' zoology, birds, mammals, amphibians and reptiles and plants. Data from the research survey sheds more light on significance of this Kaya Kauma forest conservation of its biodiversity

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CHAPTER TWO

DIVERSITY AND ABUNDANCE OF INVERTEBRATES IN KAYA KAUMA, KILIFI COUNTY

Esther N. Kioko and Morris N. Mutua

Invertebrate Zoology Section, Zoology Department National Museums of Kenya, P.O. Box, 40658, 00100 Nairobi; Email address: ekioko@museums.or.ke; mmutua17@yahoo.com

2.1 Summary

Within the coastal forests in Kenya are the Kaya forests. Kaya is a Mijikenda word for their small central residential village protected by the surrounding forest. These Kaya forests for many years remained protected through long standing local community rich and environmentally friendly traditions, taboos, beliefs and cultures. In the recent times though, decline in community adherence to these taboos, traditions and beliefs has been witnessed threatening the survival of these long standing forests. There is need for strategic management plans for the Kaya forests and this calls for studies of the biodiversity in these forests. The biodiversity study will provide the baseline data on species for proper management of these forests.

This study was undertaken to describe the Invertebrate biodiversity of Kaya Kauma. The studies were carried out using standard entomological methods and focused on the forest, forest edge and farmlands. The study recorded a total of 251 species and 1746 invertebrate individuals distributed across 18 Orders in Kaya Kauma forest, forest edge and surrounding farmlands. The forest recorded 162 species and 827 individuals, the forest edge 93 species and 536 individuals and 115 species and 379 individuals in the farmlands. The order Lepidoptera had the highest number of species (86), followed by Coleoptera (46), Hymenoptera (45), Diptera (16), Orthoptera (17), Hemiptera (12), Mantodea (7), Odonata (5), Blattodea (4), Neuroptera (2), Spirostreptida (2), Stylommatophora (2), Aranaea (1), Geophilomorpha (1), Isopoda (1), Phasmatodea (1), Polydesmida (1), Solifugae (1), Diplopoda (Pachylobidae) (1). Invertebrate conservation strategies are recommended for the Kaya Kauma.

2.2 Introduction

The coastal areas of East Africa contain some of the world's richest ecosystems and provide valuable resources for many people (Burges *et al* 1998; Lehman & Kioko, 2000; Meyers *et al*., 2000; Mittermier *et al*., 2004, Lehmann, 2008). However, the intensity and nature of human activities increasingly threatens their productivity and biological diversity. This is partly due to the population increase, climate change among other factors.

According to IUCN/WCMC (1992), Kenya has the most diverse forests in East Africa. Within the coastal forests in Kenya are the Kaya forests. Kaya is a Mijikenda word for their small central residential village protected by the surrounding forest (Spear, 1978). The Mijikenda are nine closely related people, Kauma, Giriama, Chonyi, Jibana, Kambe, Ribe, Rabai, Duruma and Digo. The Kaya forest patches are protected by their traditions which regard them as sacred places and burial grounds. These Kaya forests for many years remained protected through long standing local community rich and environmentally friendly traditions, taboos, beliefs and cultures. These taboos, traditions and other religious observations serve to regulate access and conduct at these forests, threatening dire punishment from the spirit world for those who flouted the rules (Githitho, 2008). Few of the Kayas are still used for ceremonies and as burial groves (Robertson & Luke, 1993). 23 Kayas and sacred grooves are gazetted as National Monuments since 1992 and are protected and managed by the National Museums of Kenya and the Coastal Forest Conservation Unit (CFCU) in collaboration with the local community (the Kaya Elders) and other stakeholders. Access to the Kaya forests and activity within them has been kept minimal leaving the forests as "intact islands" preserving considerable biodiversity despite their small sizes (Githitho, 2008).

The Kaya forests have a diversity of plants with more than half of the Kenya's rare plants found in the coast region, many within the Kaya Forests (Rodgers and Burgess, 2002). However biodiversity studies on other taxa within the Kaya forests has remained few. For invertebrates, surveys within the Kaya forests began in 1994 in Kaya Muhaka and Kaya Kinondo (Lehman & Kioko, 2000). Other studies that followed include Rogo & Odulaja, 2001, Kaya Mrima, Kinondo and Jibana in 2009 (Lange & Mutua, 2011) and more in Kaya Muaka (Chiawo 2011). Much more still remains to be done to understand the invertebrate diversity and their habitats in the Kaya forests. Additionally, conservation status of endemic and/or rare insects and other invertebrates in the Kayas still remains largely unknown. Also, the current decline in the long standing local community rich and environmentally friendly traditions, taboos, beliefs and cultures is threatening

the survival of these long standing pristine Kaya forests. Comprehensive biodiversity surveys are therefore necessary as the Kayas are facing great threats from the rising need for land mainly for; infrastructure, agriculture, fishing, mining (iron ore and titanium) logging for timber, woodcarving and the rapid socio-cultural changes which continue to be major the threats leading to the loss of smaller Kayas and groves (Tabor *et al*., 2010). This study aimed at documenting the diversity and abundance of invertebrates in Kaya Kauma located in Kilifi County.

2.3 Materials and Methods

Study area

The study was carried out along three transects in Kaya Kauma located in North Coast in Kilifi County (Figure 1).

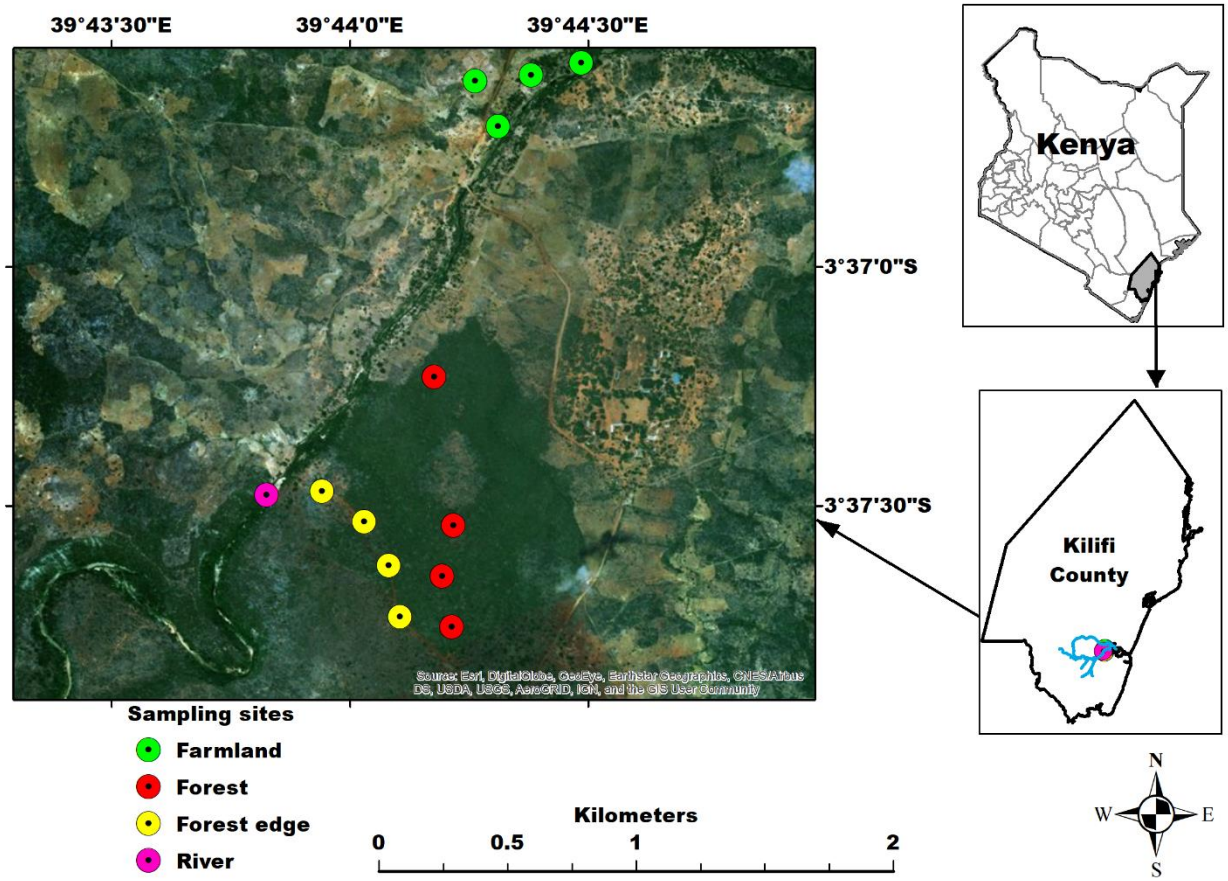


Figure 1 Map of Kenya showing Kilifi County and the invertebrate sampling points

The sampling for invertebrates was carried out between 21st to 26th November 2018. Four sampling points were identified in each transect with an equidistance of 200 metres between the points.

Table 1: Sampling transects and points

Location	Habitat	Transect	Point	Latitude	Longitude	Altitude (m)
Kaya kauma	Forest	1	1	3.62568	39.73695	101
Kaya kauma	Forest	1	2	3.62745	39.73655	103
Kaya kauma	Forest	1	3	3.62922	39.73688	115
Kaya kauma	Forest	1	4	3.62049	39.73627	42
Kaya kauma	Forest edge	2	1	3.62448	39.73236	57
Kaya kauma	Forest edge	2	2	3.62555	39.73382	81
Kaya kauma	Forest edge	2	3	3.62708	39.73468	90
Kaya kauma	Forest edge	2	4	3.62887	39.73507	107
Kaya kauma	Farmland	3	1	3.60953	39.74143	8
Kaya kauma	Farmland	3	2	3.60995	39.73967	16
Kaya kauma	Farmland	3	3	3.61175	39.73852	36
Kaya kauma	Farmland	3	4	3.61016	39.7377	18
Nzovuni	River	0	0	3.62462	39.73042	10

Sampling Methods

Different methods were in-cooperated in the survey which ensured proper representation of species occurring in the Kaya Kauma forest, forest edge and surrounding farmlands on the identified transects. They included;

- **Pitfall trapping**

These traps were basically used for trapping flightless ground living arthropods, especially ground beetles. The traps (usually 125ml containers) were placed in a hole with the upper rim flush with the ground surface. A killing agent and preservative (ethanol) was added in the traps to avoid decay of caught specimens. In each transect, a total of 32 traps were laid and left for 48hours to trap whereby they were harvested on expiry of this duration. Collected samples were transferred into jars containing 70% for temporally preservation and storage waiting further processing.

- **Pan traps**

Pan traps will be mainly used to collect pollinators such bees, some species of beetles, flies and also to collect crop pests e.g. aphids, fruit flies etc. The traps are usually small bowls painted with two different colors yellow and blue to mimic flowers. 32 traps were spread randomly within the transect and filled half way with water mixed with odorless detergent to break the water surface tension. The bowls /traps were inspected every evening to harvest trapped insects which were stored in well labeled vials containing 70% ethanol.

- **Baited Butterfly traps**

These traps were specifically used to capture fast-flying butterflies, such as *Charaxes, that* dwell in tree canopies and cannot otherwise be reached. The traps were hoisted over a high tree branch with a rope, and lowered to remove the catch. Fermenting fruits (bananas & pineapples) were used as a bait to lure butterflies and rose beetles into these traps. 12 traps were set in every transect and left for two days before transferring to another transect. Harvesting was done every evening. Collected butterflies were humanely killed and stored in well labeled butterfly envelops.

- **Time Limited searches/Sweepnet**

Time limited searches involved walking along a transect within a time limit, collecting invertebrates under tree logs, rocks, on vegetation etc. It also entailed use of a sweep net to collect flying insects like butterflies, flies, dragonflies and bees. This was best done between 10am –noon when most insects were active feeding and hopping from place to the other. Collected specimens were killed and preserved for further processing.

2.4 Results

A total of 251 species and 1746 invertebrates' individuals distributed across 18 Orders were documented in Kaya Kauma forest, forest edge and surrounding farmlands. The documentation was as follows; 162 species and 827 individuals in the forested area, 93 species and 536 individuals in the forest edge, and 115 species and 379 individuals in the farmlands.

The order Lepidoptera had the highest number of species (86), followed by Coleoptera (46), Hymenoptera (45), Diptera (16), Orthoptera (17), Hemiptera (12), Mantodea (7), Odonata (5), Blattodea (4), Neuroptera (2), Spirostreptida (2), Stylommatophora (2), Aranaea (1), Geophilomorpha (1), Isopoda (1), Phasmatodea (1), Polydesmida (1), Solifugae (1).

Figure 2 The Christmas butterfly (Lepidoptera) and Blister beetle (Coleoptera) foraging

Invertebrate species cumulative curve

Invertebrates were recorded on a daily basis. The cumulative number of species was plotted against the sampling effort which was based on daily species count. This linear regression approach, also called species incidence, helps to provide a species list for an area with an approximate assessment of completeness of sampling (Sutherland 1996, Pomeroy and Tengecho, 1986). The graph showing species accumulation indicates that with additional effort, more species are likely to be detected, since the graph did not, reach asymptote (flattening toward a direction where new species are not likely to be encountered) (Figure 3). Therefore, another sampling based on seasonality (dry/wet season) is likely to discover additional species.

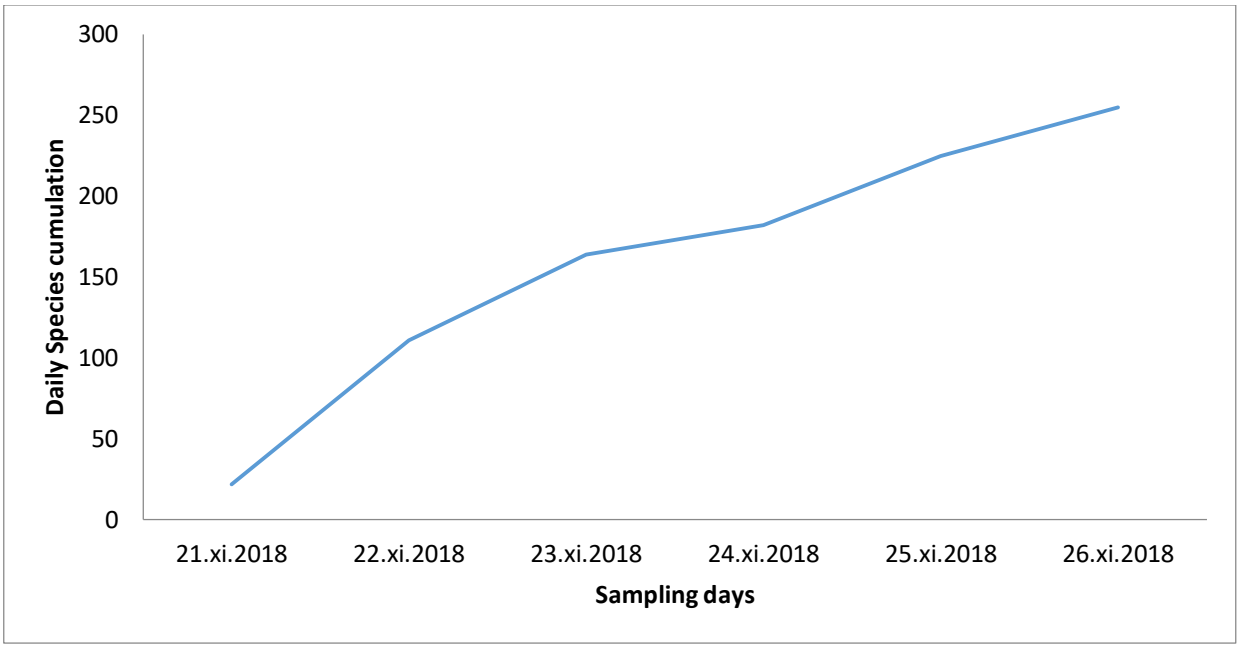
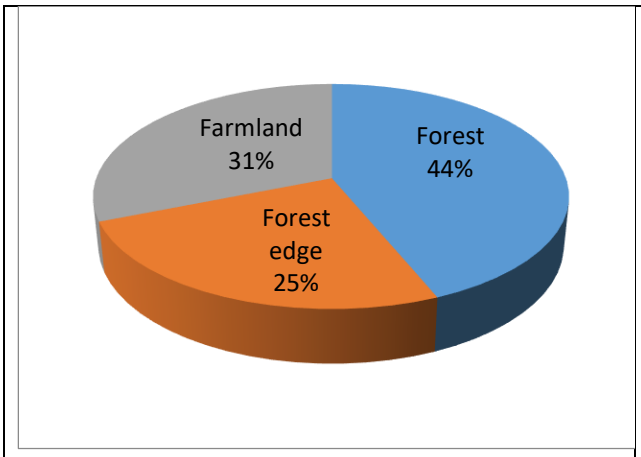


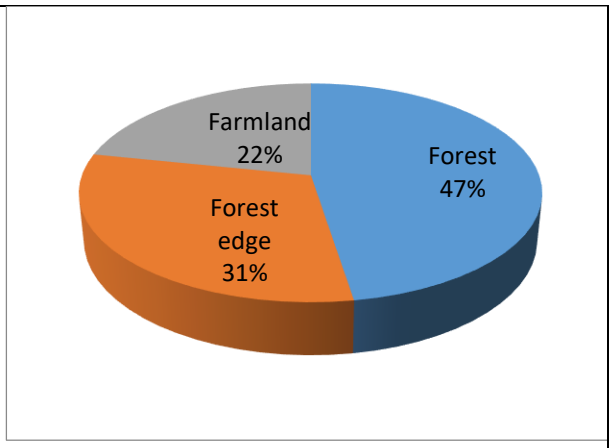
Figure 3 Species cumulative curve

Species composition and abundance in the different habitats

The forest had the highest species composition 44%, followed by the farmland 31%, while the forest edge had the least 25%. The forest also supported the highest number of individuals (47%), followed by the forest edge (31%), while the farmland had the list number of individuals (22%) (Figure 4).



Species composition

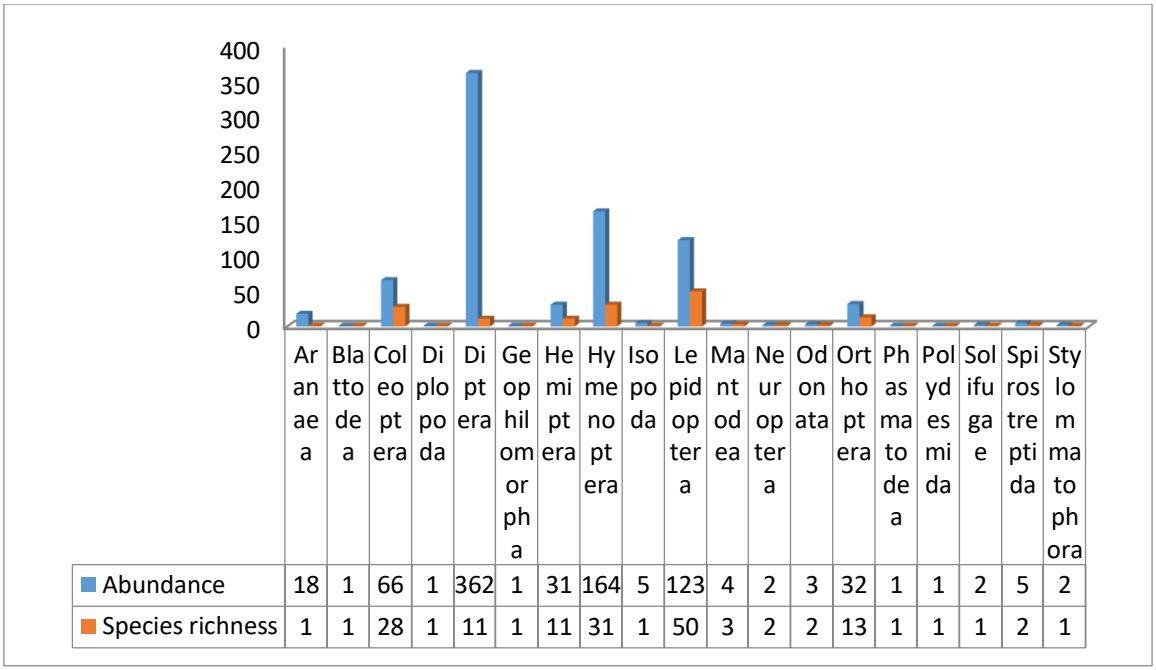


Abundance

Figure 4 Species composition and abundance in the sampled habitats

Species richness and abundance in the forest transect

The order Lepidoptera (butterflies and moths) recorded the highest number of species (50), followed by Hymenoptera (31) and Coleoptera (28) while the order Diptera had the highest abundance (362) followed by Hymenoptera (164) and Lepidoptera (123) (Figure 5).

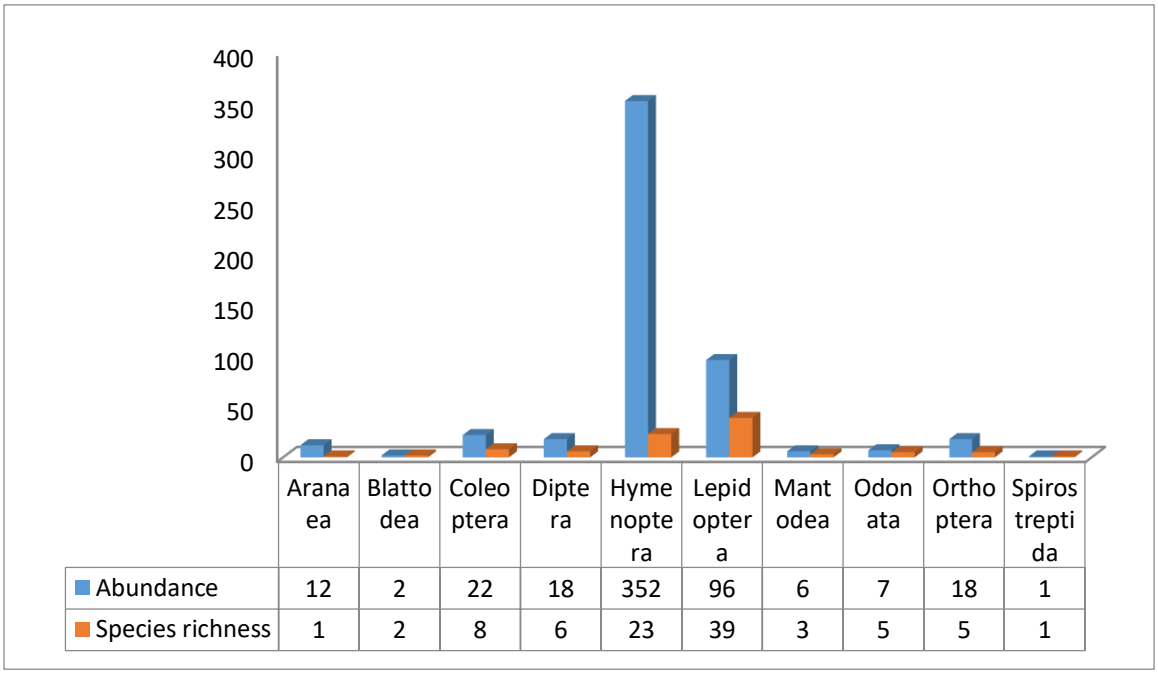


	Aranaea	Blattodea	Coleoptera	Diplopoda	Diptera	Geophilomorpha	Hemiptera	Hymenoptera	Isopoda	Lepidoptera	Mantodea	Neuroptera	Odonata	Orthoptera	Phasmatodea	Polydesmida	Solifugae	Spirostreptida	Stylommatophora
Abundance	18	1	66	1	362	1	31	164	5	123	4	2	3	32	1	1	2	5	2
Species richness	1	1	28	1	11	1	11	31	1	50	3	2	2	13	1	1	1	2	1

Figure 5 Species richness and abundance in the forest

Species richness and abundance in the Forest edge transect

The order Lepidoptera recorded the highest number species (39) followed by Hymenoptera (23), while the orders Aranaea and Spirostreptida had the least (1 each). The order Hymenoptera had the highest abundance (352), followed by order Lepidoptera (96), while the order Spirotreptida had the least (1) (Figure 6)

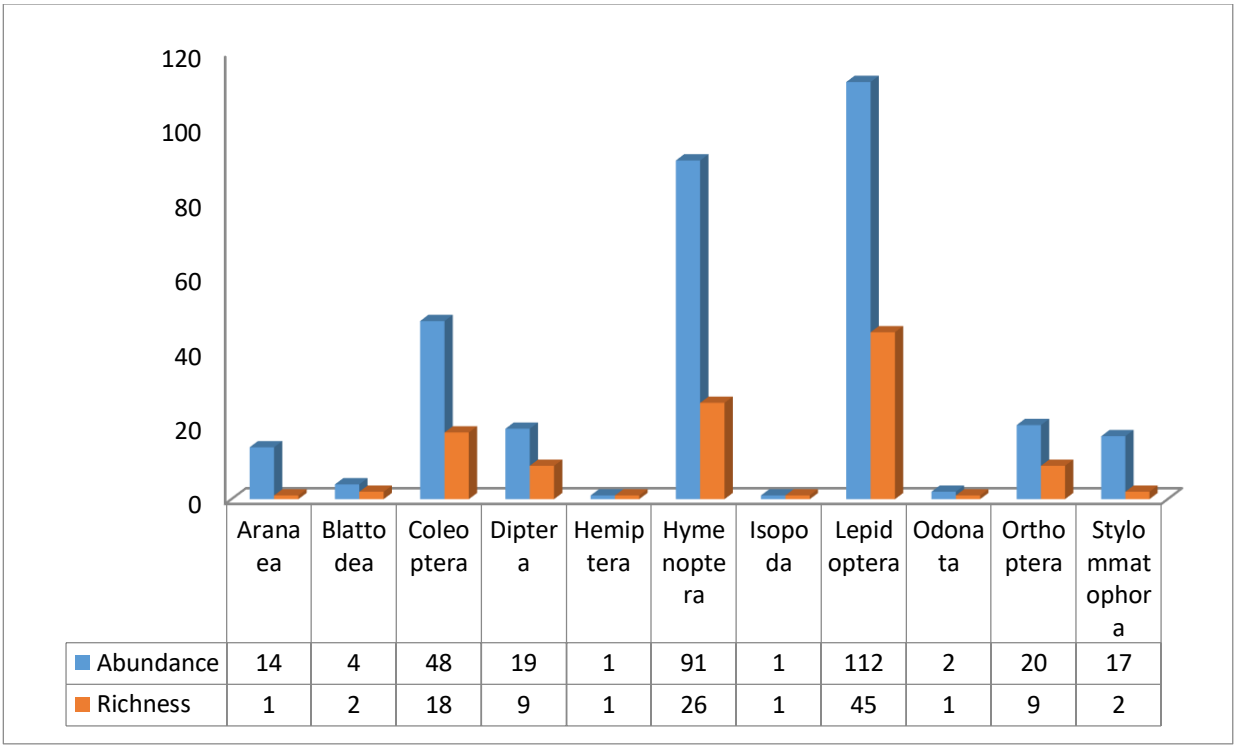


	Aranaea	Blattodea	Coleoptera	Diptera	Hymenoptera	Lepidoptera	Mantodea	Odonata	Orthoptera	Spirostrepti da
Abundance	12	2	22	18	352	96	6	7	18	1
Species richness	1	2	8	6	23	39	3	5	5	1

Figure 6 Species richness and abundance in the Forest edge

Species richness and abundance in the farmlands transect

The order Lepidoptera recorded the highest number of species (45), while Orders Aranaea, Hemiptera and Isopoda had the least (1 each). The order Lepidoptera had the highest abundance while the orders Hemiptera and Isopoda had the least (1 each) (Figure 7)



	Araneae	Blattodea	Coleoptera	Diptera	Hemiptera	Hymenoptera	Isopoda	Lepidoptera	Odonata	Orthoptera	Stylommatophora
Abundance	14	4	48	19	1	91	1	112	2	20	17
Richness	1	2	18	9	1	26	1	45	1	9	2

Figure 7 Species richness and abundance in the farmlands

2.5 Discussions

This study is the first invertebrate survey done in Kaya Kauma and has recorded that Kaya Kauma forest and the surrounding farmlands support a great number of invertebrates, 251 species. Some of the specimens were not fully identified to species level owing to taxonomic uncertainties and they will still be reviewed with time and as expertise becomes available and the current species lists is likely to increase. This high number of invertebrate biodiversity for Kaya Kauma confirms the prevalent view among conservationists and scientists that Kaya forests are truly biodiversity hotspots despite their relatively small sizes.

Despite the short time of the study of only six days, 79 butterfly species were recorded in Kaya Kauma which makes it the second highest Kaya Forest so far in butterfly diversity in reference to 112 species recorded for Kaya Muhaka and 45 species for Kaya Kinondo with surveys done over a longer period of time (Lehmann and Kioko, 2000). It was observed that among these butterflies, a number of coastal endemic species were included, pointing to the great value of this Kaya in the conservation of coastal endemic species. Four coastal endemic butterfly species, *Acraea rabbaiae*

(Clear wing Acraea), *Acraea satis* (Coast Acraea), *Graphium kirbyi* (Kirby's swallowtail) and *Baliochila minima,* (Minimal buff) were recorded along the forest transect. *Neptidopsis fulgurata* (Malagasy sailer), a coastal endemic species was recorded in the forest edge along Nzovuni River. *Graphium philonoe* (White-dappled swallowtail), mainly a butterfly of the coastal forests, but one of the transitional species, usually being more common in the open parts of forests and along the margins was recorded in all three habitats; forest, forest edge and the farmland.

Comparing the records from Kaya Kauma to what is held at the National Museums of Kenya (NMK) reference collection, Kaya Kauma recorded a number of other insects that are endemic to the coastal region. *Ceroctis calicera,* a meloid beetle and *Dioncomena superba,* a member of Katydids group belonging to the family Tettigoniidae, have all specimens housed at NMK having coastal distribution.

Kaya Kauma forest harbours some quite rare insects based on information sourced from NMK invertebrates scientific reference collection. One such insect is *Dromica nobilitata,* a tiger beetle in the family Cicindelidae. Only one specimen is at the NMK insect reference collection and was collected in 1982 at Shimba Hills. Another such rare collection was that of *Catasigerpes margarethae,* a praying mantid in the family Mantidae. Only two specimens are in the NMK insect collection and were collected in 1969 at Arabuko-Sokoke forest.

Invertebrate species of economic importance were documented. This included some fascinating and conspicuous butterfly species. These are a potential for butterfly farming in the area. The local communities or CBOs could be encouraged to visit the Kipepeo buttefly frming project in Arabuko Sokoke forest to learn about the enterprise. Apiculture is also a potential insect based enterprise as honey bees (*Apis mellifera)* were recorded in this study. The Kaya Kauma forest community should be trained on better methods of bee keeping, honey harvesting and post-hrvest processes for management of apiculture for better livelihoods.

Most of the invertebrate species from this study play a critical role in ecosystem like being part of the food chains, degradation/decomposition of organic matter in the ecosystems (millipedes (Diplopoda), dung beetles (*Onthophagus sp*). Agents of pollination (social and solitary bees, butterflies, beetles, flies) parasitic wasps which are potential biological control agents and some of the species are major ecological bio-indicators for long term management and monitoring programmes in ecosystems (such as the butterfly species).

2.6 Conclusion and Recommendations

This study has provided baseline information on the current status of invertebrates' diversity in both Kaya Kauma forest and the surrounding farmlands. The data generated from this survey is essential and will be used in the development of Kaya Kauma strategic management plan that will guide the conservation of this unique Kaya forest.

Further studies are necessary to document the conservation areas broadest invertebrates' fauna and therefore propose more work in the following areas;

- More comprehensive surveys should be conducted to build on the already established checklist.
- More effort (targeting both diurnal & nocturnal species) should be dedicated to the description of new species since appears viable.
- Documentation and monitoring of endemic species as they could be good indicator species in conservation studies.
- Selection of key indicator invertebrates' species to establish conservation status and set monitoring tools
- Long term monitoring work in the already established permanent transects
- Red Listing of the ecosystems' endemic threatened or endangered species.
- Creating awareness and training the local communities on better ways of utilizing natural resources within the ecosystem focusing on insect based enterprises such as butterfly farming, bee keeping and silk farming.

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2.8 Appendices

Appendix 2.1: Invertebrates and their distributions amongst the different sampled habitats

No.	Order	Family	Genus/species	Farmland	Forest	Forest edge	River
1	**Aranaea**			14	18	12	0
2	**Blattodea**	Blattidae	*Ectobius sp*	3	0	0	0
3	**Blattodea**	Blaberidae	*Nauphoeta sp*	1	0	1	0
4	**Blattodea**	Blattellidae	*Blattella germanica*	0	1	0	0
5	**Blattodea**	Blattidae	*Pseudoderopeltis rhombifolia*	0	0	1	0
6	**Coleoptera**	Chrysomelidae	*Monolepta sp*	2	0	0	0
7	**Coleoptera**	Chrysomelidae	*Lema sp*	4	0	0	0
8	**Coleoptera**	Carabidae	*Harpalus sp*	5	3	0	0
9	**Coleoptera**	Carabidae	*Anisodactylus australis*	1	0	0	0
10	**Coleoptera**	Carabidae	*Pheropsophus raffrayi*	1	2	0	0
11	**Coleoptera**	Meloidae	*Ceroctis calicera*	1	0	0	0
12	**Coleoptera**	Scarabaeidae	*Anomala sp*	1	0	0	0
13	**Coleoptera**	Carabidae	*Bradybaenus opulentus*	6	0	0	0
14	**Coleoptera**	Tenebrionidae	*Gonocephlum sp*	2	0	0	0

15	**Coleoptera**	Nitidulidae	*Lasiodactylus sp*	2	0	0	0
16	**Coleoptera**	Meloidae	*Mylabris aperta*	6	0	0	0
17	**Coleoptera**	Chrysomelidae	*Chrysolina rubripennis*	4	0	0	0
18	**Coleoptera**	Carabidae	*Chlaenius sp*	4	1	2	0
19	**Coleoptera**	Coccinelidae	*Micraspis sp*	2	0	0	0
20	**Coleoptera**	Meloidae	*Coryna apicicornis*	4	10	12	0
21	**Coleoptera**	Meloidae	*Coryna kersteni*	1	3	2	0
22	**Coleoptera**	Coccinelidae	*Cheilomenes lunata*	1	0	0	0
23	**Coleoptera**	Buprestidae	*Chrysobothris dorsata*	1	0	0	0
24	**Coleoptera**	Scarabaeidae	*Genyodonta flavomaculata*	0	1	0	0
25	**Coleoptera**	Carabidae	*Chlaenius kurkirordias*	0	1	0	0
26	**Coleoptera**	Scarabaeidae	*Rhonotaenia balteata*	0	1	0	0
27	**Coleoptera**	Scarabaeidae	*Mausoleopsis amabilis*	0	2	0	0
28	**Coleoptera**	Rhynchophoridae	*Stenophida rufipes*	0	3	0	0
29	**Coleoptera**	Tenebrionidae	*Sepidium muscosum*	0	1	0	0
30	**Coleoptera**	Curculionidae	*Nematocerus sp*	0	2	0	0
31	**Coleoptera**	Scarabaeidae	*Anachalcos convexus*	0	3	0	0
32	**Coleoptera**	Scarabaeidae	*Trochalus sp*	0	1	0	0
33	**Coleoptera**	Carabidae	*Thermophilum hexastictum*	0	1	0	0
34	**Coleoptera**	Tenebrionidae	*Pycnocerus passerini*	0	1	0	0
35	**Coleoptera**	Scarabaeidae	*Onthophagus sp*	0	2	0	0
36	**Coleoptera**	Tenebrionidae	*Zophosis punctatafasciata*	0	2	0	0
37	**Coleoptera**	Carabidae	*Crepidogaster hubenthali*	0	5	0	0
38	**Coleoptera**	Carabidae	*Cypholoba bihamata*	0	3	2	0
39	**Coleoptera**	Cerambycidae	*sp1*	0	1	0	0
40	**Coleoptera**	Cerambycidae	*Philematium sansibaricum*	0	4	0	0
41	**Coleoptera**	Cleridae	*sp1*	0	1	0	0
42	**Coleoptera**	Scarabaeidae	*Sisyphus seminulum*	0	1	0	0
43	**Coleoptera**	Meloidae	*Coryna arrussina*	0	1	1	0
44	**Coleoptera**	Cantharidae	*Lycus constrictus*	0	2	0	0
45	**Coleoptera**	Cicindelidae	*Dromica nobilitata*	0	1	0	0
46	**Coleoptera**	Histeridae	*Hister sp*	0	1	0	0
47	**Coleoptera**	Chrysomelidae	*Hypercantha seminigra*	0	5	0	0
48	**Coleoptera**	Chrysomelidae	*Aspidomorpha dissentanea*	0	1	0	0
49	**Coleoptera**	Scarabaeidae	*Sisyphus sp*	0	0	1	0
50	**Coleoptera**	Carabidae	*Amophomerus opacus*	0	0	1	0
51	**Coleoptera**	Cerambycidae	*Anauxesis vittata*	0	0	1	0
52	**Diplopoda**	Pachylobidae	*Epilobolus sp*	0	1	0	0

53	**Diptera**	Sarcophagidae	*Sarcophaga sp*	23	10	2	0
54	**Diptera**	Bombyliidae	*Bombylius sp*	1	0	0	0
55	**Diptera**	Asilidae	*Ommatius sp*	2	0	0	0
56	**Diptera**	Chamaemyiidae	*sp1*	32	0	0	0
57	**Diptera**	Sarcophagidae	*Sarcophaga hirtipes*	1	0	0	0
58	**Diptera**	Stratiomyidae	*Ptecticus sp*	0	6	0	0
59	**Diptera**	Calliphoridae	*Bengalia sp*	2	39	1	0
60	**Diptera**	Calliphoridae	*Chrysomya chloropyga*	1	0	1	0
61	**Diptera**	Muscidae	*Musca domestica*	3	4	0	0
62	**Diptera**	Platystomatidae	*sp1*	4	1	0	0
63	**Diptera**	Platystomatidae	*Peltacanthina sp*	0	32	1	0
64	**Diptera**	Platystomatidae	*Peltacanthina simillima*	0	260	12	0
65	**Diptera**	Asilidae	*Alcimum rubiginosus*	0	1	1	0
66	**Diptera**	Drosophilidae	*Drosophila melanogaster*	0	4	0	0
67	**Diptera**	Diopsidae	*Diopsis sp*	0	1	0	0
68	**Diptera**	Tachinidae	*sp1*	0	3	0	0
69	**Geophilomorpha**			0	1	0	0
70	**Hemiptera**	Pyrrhocoridae	*Dysdercus cardinalis*	1	0	0	0
71	**Hemiptera**	Pentatomidae	*sp1*	0	1	0	0
72	**Hemiptera**	Pentatomidae	*Anaplogonius nigricollis*	0	11	0	0
73	**Hemiptera**	Coreidae	*Plectronemis bicolor*	0	2	0	0
74	**Hemiptera**	Reduviidae	*Ectomoris sp*	0	1	0	0
75	**Hemiptera**	Reduviidae	*Polytoxus sp*	0	7	0	0
76	**Hemiptera**	Pentatomidae	*Dalsira sp*	0	1	0	0
77	**Hemiptera**	Coreidae	*Cletus sp*	0	3	0	0
78	**Hemiptera**	Coreidae	*Mydonia tuberculosa*	0	1	0	0
79	**Hemiptera**	Lygaeidae	*Dieuches armipes*	0	2	0	0
80	**Hemiptera**	Pentatomidae	*Caystrus basalis*	0	1	0	0
81	**Hemiptera**	Cydnidae	*Plonisa plagiata*	0	1	0	0
82	**Hymenoptera**	Apidae	*Macrogalea candida*	18	2	1	0
83	**Hymenoptera**	Apidae	*Apis melifera*	8	5	5	0
84	**Hymenoptera**	Apidae	*Xylocopa calens*	1	1	0	0
85	**Hymenoptera**	Vespidae	*Belanogaster sp*	1	2	1	0
86	**Hymenoptera**	Sphecidae	*Ammophila sp*	1	1	0	0
87	**Hymenoptera**	Anthophoridae	*Anthophora sp*	1	0	0	0
88	**Hymenoptera**	Formicidae	*Camponotus maculatus*	2	0	1	0
89	**Hymenoptera**	Formicidae	*Ocymyrmex waetzaeckeri*	11	16	10	0
90	**Hymenoptera**	Pompilidae	*Pompilius diversus*	13	10	14	0

91	**Hymenoptera**	Eumenidae	*Ancistrocerus sp*	2	3	2	0
92	**Hymenoptera**	Pompilidae	*Synergris analis*	1	2	0	0
93	**Hymenoptera**	Apidae	*Braunsapis sp*	1	0	0	0
94	**Hymenoptera**	Halictidae	*Lasioglossum sp*	6	3	1	0
95	**Hymenoptera**	Mutiliidae	*Trogaspidia niveitegulata*	2	0	0	0
96	**Hymenoptera**	Pompilidae	*sp1*	1	7	1	0
97	**Hymenoptera**	Sphecidae	*Tachysphex pentheri*	1	2	1	0
98	**Hymenoptera**	Halictidae	*Pseudapis sp*	1	1	0	0
99	**Hymenoptera**	Pompilidae	*Pseudagenia subpictiolatus*	2	0	1	0
100	**Hymenoptera**	Ichneumonidae	*sp2*	2	2	0	0
101	**Hymenoptera**	Apidae	*Ceratina sp*	1	0	0	0
102	**Hymenoptera**	Sphecidae	*Tachysphex sp*	1	0	2	0
103	**Hymenoptera**	Formicidae	*Pachycondyla tarsata*	5	60	278	0
104	**Hymenoptera**	Pompilidae	*sp2*	1	5	2	0
105	**Hymenoptera**	Apidae	*Anthophora torrida*	1	0	0	0
106	**Hymenoptera**	Formicidae	*Pheidole sp*	6	13	5	0
107	**Hymenoptera**	Scoliidae	*Cathimeris sp*	1	0	0	0
108	**Hymenoptera**	Pompilidae	*Pompilius sp*	0	1	1	0
109	**Hymenoptera**	Vespidae	*Polistes fastidiosus*	0	2	0	0
110	**Hymenoptera**	Formicidae	*Pachycondyla cribrinodis*	0	5	0	0
111	**Hymenoptera**	Megachilidae	*Megachile sp*	0	3	0	0
112	**Hymenoptera**	Formicidae	*Pachycondyla sp*	0	4	0	0
113	**Hymenoptera**	Apidae	*Thyreus carinata*	0	1	0	0
114	**Hymenoptera**	Mutiliidae	*Trogaspidia sp*	0	2	1	0
115	**Hymenoptera**	Formicidae	*Polyharchis gagates*	0	4	18	0
116	**Hymenoptera**	Halictidae	*Lipotriches sp*	0	1	0	0
117	**Hymenoptera**	Pompilidae	*Cyphononyx atropos*	0	1	0	0
118	**Hymenoptera**	Braconidae	*Gatrothacea sp*	0	3	0	0
119	**Hymenoptera**	Sphecidae	*Stizus marshalli*	0	1	0	0
120	**Hymenoptera**	Apidae	*Meliponula sp*	0	1	0	0
121	**Hymenoptera**	Ichneumonidae	*sp1*	0	1	0	0
122	**Hymenoptera**	Formicidae	*Polyharchis sp*	0	0	9	0
123	**Hymenoptera**	Sphecidae	*Liris sp*	0	0	1	0
124	**Hymenoptera**	Sphecidae	*sp1*	0	0	1	0
125	**Hymenoptera**	Formicidae	*Dorylus sp*	0	0	3	0
126	**Hymenoptera**	Eumenidae	*sp1*	0	0	1	0
127	**Isopoda**	Cylistidae	*Cylisticus convexus*	1	5	0	0
128	**Lepidoptera**	Nymphalidae	*Charaxes cithaeron*	0	1	2	0

129	**Lepidoptera**	Nymphalidae	*Charaxes jahlusa*	0	6	8	0
130	**Lepidoptera**	Nymphalidae	*Bicyclus sp*	0	7	2	0
131	**Lepidoptera**	Nymphalidae	*Charaxes etesipe*	0	0	2	0
132	**Lepidoptera**	Nymphalidae	*Charaxes saturnus*	0	1	1	0
133	**Lepidoptera**	Nymphalidae	*Charaxes kirki*	0	0	1	0
134	**Lepidoptera**	Nymphalidae	*Charaxes castor*	1	0	0	0
135	**Lepidoptera**	Nymphalidae	*Charaxes varanes*	11	3	5	0
136	**Lepidoptera**	Nymphalidae	*Melanitis leda*	4	2	0	0
137	**Lepidoptera**	Arctiidae	*sp1*	1	0	0	0
138	**Lepidoptera**	Nymphalidae	*Henotesia perspicua*	2	1	0	0
139	**Lepidoptera**	Papilionidae	*Graphium philonoe*	4	2	1	0
140	**Lepidoptera**	Nymphalidae	*Charaxes brutus*	1	5	3	0
141	**Lepidoptera**	Nymphalidae	*Byblia ilithyia*	2	2	0	0
142	**Lepidoptera**	Nymphalidae	*Acraea cuva*	2	0	0	0
143	**Lepidoptera**	Nymphalidae	*Acraea neobule*	2	2	2	0
144	**Lepidoptera**	Nymphalidae	*Junonia oenone*	6	1	1	0
145	**Lepidoptera**	Noctuidae	*Sphingimorpha sp*	3	0	0	0
146	**Lepidoptera**	Nymphalidae	*Bicyclus safitza*	6	1	0	0
147	**Lepidoptera**	Papilionidae	*Papilio philonoe*	1	0	0	0
148	**Lepidoptera**	Papilionidae	*Papilio constantinus*	1	2	4	0
149	**Lepidoptera**	Pieridae	*Colotis ione*	7	5	9	0
150	**Lepidoptera**	Pieridae	*Eronia cleodora*	1	6	0	0
151	**Lepidoptera**	Noctuidae	*sp1*	3	5	0	0
152	**Lepidoptera**	Nymphalidae	*Acraea eponina*	5	0	0	0
153	**Lepidoptera**	Nymphalidae	*Eurytela dryope*	5	4	1	0
154	**Lepidoptera**	Pieridae	*Catopsilia florella*	5	5	2	0
155	**Lepidoptera**	Noctuidae	*sp2*	1	3	0	0
156	**Lepidoptera**	Nymphalidae	*Danaus chrysippus*	6	1	0	0
157	**Lepidoptera**	Pieridae	*Belenois gidica*	1	0	0	0
158	**Lepidoptera**	Pieridae	*Colotis auxo*	1	1	0	0
159	**Lepidoptera**	Pieridae	*Colotis danae*	2	0	0	0
160	**Lepidoptera**	Pieridae	*Colotis euippe*	2	2	1	0
161	**Lepidoptera**	Lycaenidae	*Pentila pauli*	1	0	1	0
162	**Lepidoptera**	Nymphalidae	*Junonia natalica*	1	0	1	0
163	**Lepidoptera**	Nymphalidae	*Acraea anemosa*	2	1	3	0
164	**Lepidoptera**	Arctiidae	*sp2*	1	0	0	0
165	**Lepidoptera**	Pieridae	*Belenois creona*	1	0	0	0
166	**Lepidoptera**	Papilionidae	*Papilio demodocus*	3	16	4	0

167	**Lepidoptera**	Pieridae	*Nephronia thalassina*	1	0	1	0
168	**Lepidoptera**	Pieridae	*Colotis antevippe*	1	0	0	0
169	**Lepidoptera**	Nymphalidae	*Hypolimnas misippus*	1	0	1	0
170	**Lepidoptera**	Papilionidae	*Papilio nireus*	1	2	2	0
171	**Lepidoptera**	Hesperiidae	*Eretis lugens*	1	1	0	0
172	**Lepidoptera**	Lycaenidae	*Axiocerces punicea*	1	0	0	0
173	**Lepidoptera**	Pieridae	*Colotis evagore*	1	0	0	0
174	**Lepidoptera**	Lycaenidae	*Zizula hylax*	6	0	5	0
175	**Lepidoptera**	Lycaenidae	*Leptotes pirithous*	1	0	1	1
176	**Lepidoptera**	Lycaenidae	*Actizera stellata*	1	0	0	0
177	**Lepidoptera**	Hesperiidae	*Pelopidas mathias*	1	0	0	0
178	**Lepidoptera**	Hesperiidae	*Borbo sp*	1	0	0	0
179	**Lepidoptera**	Papilionidae	*Graphium kirbyi*	0	1	0	0
180	**Lepidoptera**	Nymphalidae	*Euxanthe wakefieldi*	0	2	0	0
181	**Lepidoptera**	Papilionidae	*Papilio dardanus*	0	6	2	0
182	**Lepidoptera**	Nymphalidae	*Acraea satis*	0	1	0	0
183	**Lepidoptera**	Nymphalidae	*Euphaedra neophron*	0	6	6	0
184	**Lepidoptera**	Nymphalidae	*Pardopsis punctatissima*	0	2	0	0
185	**Lepidoptera**	Nymphalidae	*Hypolimnas deceptor*	0	1	0	0
186	**Lepidoptera**	Nymphalidae	*Salamis anacardii*	0	1	0	0
187	**Lepidoptera**	Pieridae	*Colotis daira*	0	1	0	0
188	**Lepidoptera**	Nymphalidae	*Hamanumida daedalus*	0	1	1	0
189	**Lepidoptera**	Noctuidae	*sp3*	0	2	0	0
190	**Lepidoptera**	Sphingidae	*Macroglossum trochilus*	0	1	0	0
191	**Lepidoptera**	Nymphalidae	*Pseudacraea boisduvali*	0	1	0	0
192	**Lepidoptera**	Nymphalidae	*Bicyclus campinus*	0	2	1	0
193	**Lepidoptera**	Lycaenidae	*Pentila tropicalis*	0	1	0	0
194	**Lepidoptera**	Nymphalidae	*Acraea rabbaiae*	0	1	0	0
195	**Lepidoptera**	Pieridae	*Dixeia charina*	0	1	0	0
196	**Lepidoptera**	Lycaenidae	*Baliochila minima*	0	1	0	0
197	**Lepidoptera**	Papilionidae	*Graphium colonna*	0	1	0	0
198	**Lepidoptera**	Nymphalidae	*Eurytela hiarbas*	0	1	0	0
199	**Lepidoptera**	Papilionidae	*Graphium sp*	0	1	0	0
200	**Lepidoptera**	Nymphalidae	*Byblia anvatara*	0	1	0	0
201	**Lepidoptera**	Pieridae	*Colotis vesta*	0	1	0	0
202	**Lepidoptera**	Pieridae	*Colotis eucharis*	0	0	1	0
203	**Lepidoptera**	Nymphalidae	*Charaxes candiope*	0	0	2	0
204	**Lepidoptera**	Nymphalidae	*Charaxes zoolina*	0	0	1	0

205	**Lepidoptera**	Nymphalidae	*Neptidopsis fulgurata*	0	0	3	1
206	**Lepidoptera**	Lycaenidae	*Hypolycaena philippus*	0	0	1	0
207	**Lepidoptera**	Lycaenidae	*Azanus ubaldus*	0	0	1	0
208	**Lepidoptera**	Nymphalidae	*Charaxes violetta*	0	0	1	0
209	**Lepidoptera**	Pieridae	*Colotis regina*	0	0	1	0
210	**Lepidoptera**	Pieridae	*Belenois aurota*	0	0	1	0
211	**Lepidoptera**	Nymphalidae	*Phalanta phalantha*	0	0	1	0
212	**Lepidoptera**	Pieridae	*Pinacopteryx eriphia*	0	0	1	0
213	**Lepidoptera**	Hesperiidae	*Spialia colotes*	0	0	0	1
214	**Mantodea**	Mantidae	*Parrasphedalus sp*	0	1	0	0
215	**Mantodea**	Mantidae	*Sphodromantis centralis*	0	1	0	0
216	**Mantodea**	Mantidae	*Polyspilota sp*	0	2	0	0
217	**Mantodea**	Mantidae	*Sphodromantis sp*	0	0	1	0
218	**Mantodea**	Mantidae	*Catasigerpes margarethae*	0	0	2	0
219	**Mantodea**	Mantidae	*Charieis sp*	0	0	2	0
220	**Mantodea**	Hymenopodidae	*Danuria sp*	0	0	1	0
221	**Neuroptera**	Myrmeleontidae	*sp1*	0	1	0	0
222	**Neuroptera**	Myrmeleontidae		0	1	0	0
223	**Odonata**	Libellulidae	*Trithermis sp*	2	2	2	0
224	**Odonata**	Libellulidae	*Orthetrum sp*	0	1	2	0
225	**Odonata**	Aeshinidae	*Anax sp*	0	0	1	1
226	**Odonata**	Libellulidae	*Orthetrum caffrum*	0	0	1	0
227	**Odonata**	Libellulidae	*Orthetrum julia*	0	0	1	0
228	**Orthoptera**	Gryllidae	*Gryllus sp*	6	11	6	0
229	**Orthoptera**	Tettigonidae	*Thyridorphoptrum sp*	1	0	0	0
230	**Orthoptera**	Pyrgomophidae	*Chrotogonus hemipterus*	1	1	0	0
231	**Orthoptera**	Acrididae	*Aiolopus simulatrix*	1	0	0	0
232	**Orthoptera**	Gryllidae	*Gryllulus sp*	7	3	8	0
233	**Orthoptera**	Acrididae	*Acrida sp*	1	2	0	0
234	**Orthoptera**	Acrididae	*Cyrtacanthacris tatarica*	1	1	0	0
235	**Orthoptera**	Acrididae	*sp2*	1	1	0	0
236	**Orthoptera**	Acrididae	*Acrotylus sp*	1	0	0	0
237	**Orthoptera**	Gryllidae	*Phaeophilacris sp*	0	2	0	0
238	**Orthoptera**	Gryllidae	*Gymnogryllus sp*	0	4	2	0
239	**Orthoptera**	Tettigonidae	*Apteroscirtus sp*	0	1	0	0
240	**Orthoptera**	Acrididae	*sp3*	0	1	1	0
241	**Orthoptera**	Tettigonidae	*Dioncomena superba*	0	1	0	0
242	**Orthoptera**	Acrididae	*sp1*	0	3	0	0

243	**Orthoptera**	Acrididae	*sp4*	0	1	0	0
244	**Orthoptera**	Tettigonidae	*Eugasteroides loricatus*	0	0	1	0
245	**Phasmatodea**	Phasmidae	*Gratidia sp*	0	1	0	0
246	**Polydesmida**	Polydesmidae	*sp1*	0	2	0	0
247	**Solifugae**			0	2	0	0
248	**Spirostreptida**	Spirostreptidae	*sp1*	0	3	3	0
249	**Spirostreptida**	Spirostreptidae	*sp2*	0	2	0	0
250	**Stylommatophora**	Halolimnohelicidae	*Halolimnohelix sp*	16	2	0	0
251	**Stylommatophora**	Ceractuidae	*Cerastua sp*	1	0	0	0

CHAPTER THREE:

SURVEY OF BIRDS OF KAYA KAUMA FOREST, KILIFI COUNTY

Alex[1] and John Musina[2]

[1] Arabuko Sokoke Guides Association, P.O. Box xxx Gede.

[2]Zoology Dept. of the National Museums of Kenya, P.O. Box 40658 00100 GPO Nairobi. Email: mhornbill@yahoo.com.

3.1 Summary

Kaya Kauma is part of a mosaic of sacred forest fragments, along the Kenya coast that mesh into an ecosystem that harbor important habitats for birds. The kaya is also a significant stop-over and dispersal site for migratory birds. An ornithological survey of this site was carried out in November 2018. Timed Species Counts (TSCs) and opportunistic birding were used to estimate the relative abundance of birds. A total of seventy-four (74) species from thirty-six (36) families were recorded, of which two (2) species, Southern Banded Snake Eagle (*Circaetus fasciolatus)* and Fischer's Turaco (*Tauraco fischeri*) are classified by the IUCN as Near Threatened. Twenty-seven (27) forest dependent species were observed. Two (2) of which were true forest birds characteristic of the interior of undisturbed forest and breed exclusively in the forest. These species would go extinct in the absence of the forest. These were; Black-headed Apalis (*Apalis melanocephala)* and Olive Sunbird (*Cyanomitra olivacea)*. Eleven (11) migratory species were recorded. Three (3) were long distance palaearctic migrants migrating between Africa and Eurasia. They were; Eurasian Bee-eater *Merops apiaster*, Eurasian Golden Oriole (*Oriolus oriolus)* and Spotted Flycatcher (*Muscicapa striata)*. Two (2) species were afrotropic migrants, meaning that they migrate within Africa. These were; White-throated Bee-eater (*Merops albicollis)* and Northern Carmine Bee-eater, (*Merops nubicus)*. Kaya Kauma is rich in avifaunal diversity occurring in the kaya forest and the surrounding farmlands. These habitat types play a fundamental role as stop-over or wintering sites for migratory birds. We recommend an integrated community-based species and habitat monitoring program – involving specifically the Kaya elders as part of the local community. We also recommend urgent conservation measures to reduce the ever increasing threat of clearing of vegetation for farming along the riparian gallery forests. We also

propose an elaborate plan to manage water abstraction from Nzovuni River and to control and if possible eradicate the House Crow.

3.2 Introduction

Kaya is a sacred forest of the Mijikenda people in the coastal region of Kenya. The forest is considered to be an intrinsic source of ritual power and the origin of cultural identity. It is also a place of prayer for members of the particular ethnic group. The concept of Kaya forest started way back in the 16th century and got over in the 1940. The remains of these forests are still there though.

By and large, these forest habitats along the Kenya coast, form part of the East African coastal forests biodiversity hotspot, an area known for globally significant levels of avian species richness and endemism. (Myers *et al.*, 2000). The richness of biodiversity in the Kaya forests was recognized in the 1980s (Olson, 2010) and the sacred forests are prominent on hills and other strategic sites that blend culture and nature.

Traditional restrictions were placed on access and the utilization of natural forest resources resulting to the kayas preserving and sustaining biodiversity. Kaya forest patches are small in size, ranging in area from 10 to 400 hectares. As part of the East African Coastal Biome endemic bird area, these forests harbor rare and endemic species of birds.

This study aimed at documenting the different bird species found in the Kaya Kauma forest. Kaya Kauma is situated in the Jaribuni location, Ganze Division in the Kilifi County of the Coastal Province. It is primarily a Kaya of the Kauma people and occupies an area of over 100 hectares within the geographic co-ordinates of 03°:37’14’’south and 39°44’10’’east. Kaya Kauma is a primary Kaya forest sitting at 120 m above the sea level. Its size is over 100 ha in area (Ang *et al.* 2008).

The forest type exhibits a deciduous forest which slopes down in the north to Nzovuni River. Kauma forest slopes down at the back of Jaribuni village to Nzovuni River on the west. The surrounding areas have scrubby vegetation and are inhabited by villages and farmland.

The forest type is deciduous forest and the soil exhibits a rich content of iron-ore. The forest type exhibits a deciduous forest which slopes down in the north to Nzovuni River. Kauma form the

largest community living adjacent to the Kaya Kauma accounting for 75% population and the remaining 25% is composed of eight Mijikenda communities (Rajat *et al.*, 2017).

Kaya Kauma is relatively well conserved with no illegal activities or logging of trees and poaching of mammals. This is because social taboos prohibited the cutting and removal of trees and other forest vegetation for all but a few select purposes. This forest site, still stands as a home for ancestors and is maintained by a council of elders (Abungu *et al.*, 2012). It is because of the forests' protected status, that it acts as a repository of biodiversity, harboring many rare species of birds.

3.3 Materials and methods

We used both qualitative and quantitative methods to build a species list and to derive species richness and diversity in all the transects that we surveyed. Two main habitat types were identified within Kaya Kauma; forest and forest edge. The habitat types were characterized according to the main vegetation type present.

Qualitative Methods

Opportunistic Birding

We searched for birds in the forest and farmland. We recorded the species we saw or heard, the habitat in which they occurred and the duration we spent birding. We used these data to build a comprehensive species list for the site.

Quantitative Methods

Timed Species Counts (TSCs)

Timed Species Counts were performed over a fixed time period of 60 min and over fixed routes (1 km long transect) to sample two broad habitat types representative of Kaya Kauma: forest and farmland. Observers walked slowly and quietly along the transect, recording all birds seen ("***s***") or heard ("***h***") within the survey unit on a standard survey form. The TSCs were carried right after sunrise for four hours (c. 0600 h – 1000h). At each TSC, the weather condition, the habitat type and the start and end coordinates were recorded.

3.4 Results

Overall, seventy-four (74) bird species from thirty-six (36) families were recorded (Figure 8; Appendix 3.1). As shown in (Figure 8) below, the sampling effort was sufficient to record most of the bird species present because the species richness curve almost leveled off.

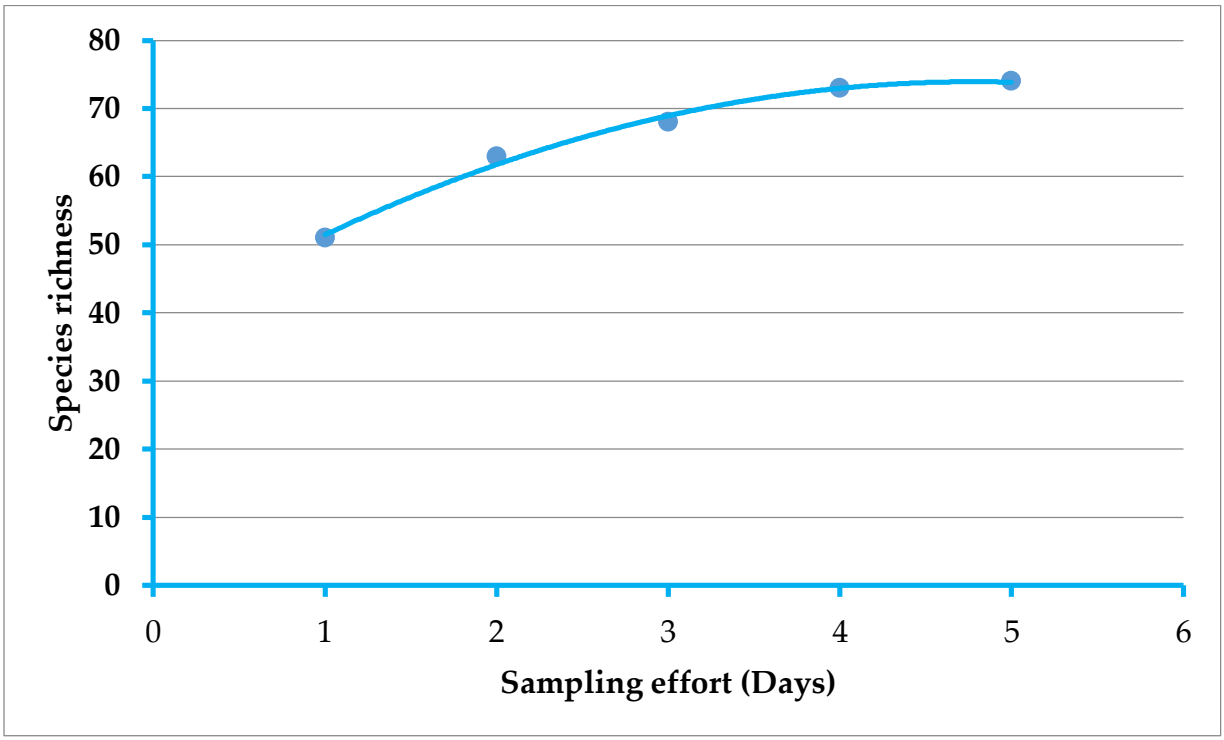

Figure 8 Species accumulation curve as an estimate of bird species richness in two habitat types, forest and forest edge, of Kaya Kauma.

In total, two hundred and ninety-one (291) individuals were counted with the highest number of ninety-two (92) individuals recorded on Day 1 and the lowest number of thirty-seven (37) on Day 5 (Figure 9). The Tropical Boubou was the most abundant with eighteen (18) individuals counted (Appendix 3.2).

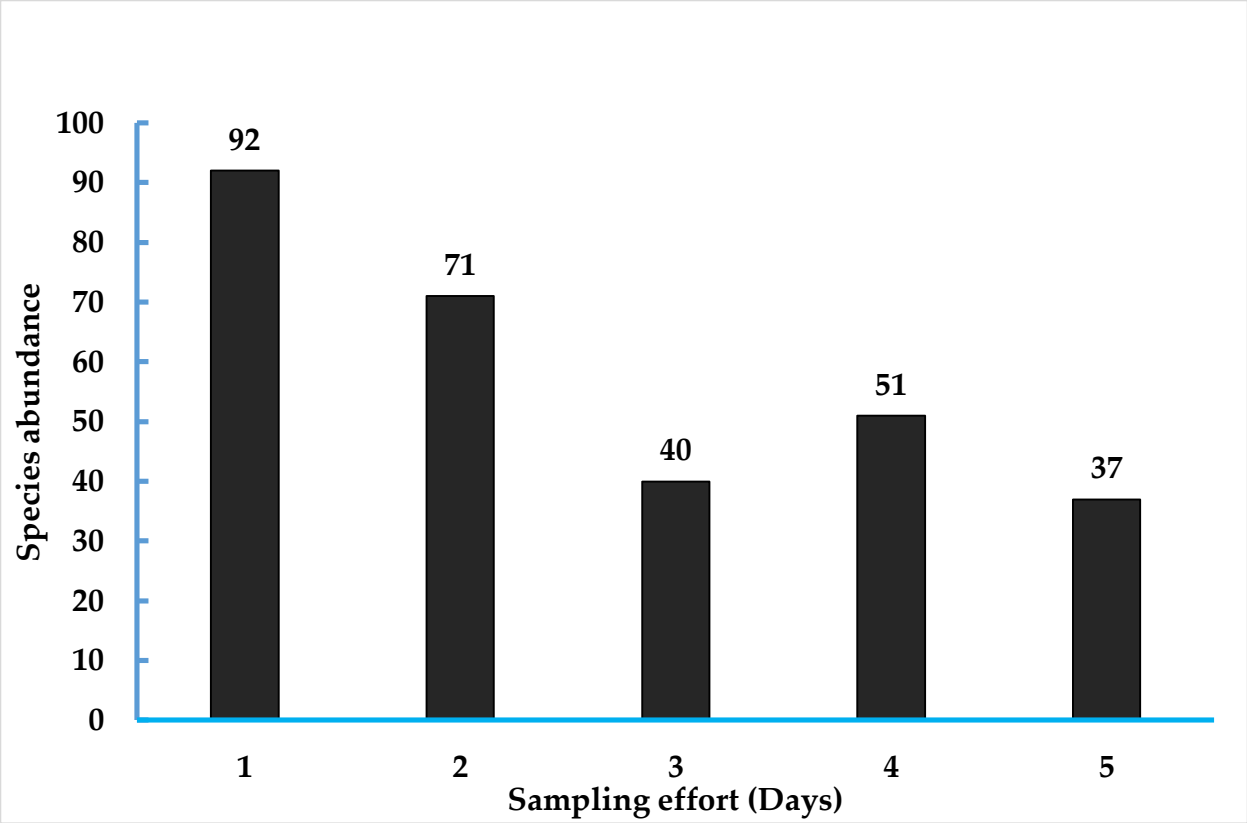

Figure 9 Bird species abundance recorded in Kaya Kauma Forest from 24th - 28th November 2018.

Two (2) species classified by the IUCN as Near Threatened were recorded. These were; Southern Banded Snake Eagle, *Circaetus fasciolatus* and Fischer's Turaco (*Tauraco fischeri)* (Figure 10).

Figure 10 A forest specialist, Fischer's Turaco, Tauraco fischeri, is Near Threatened in the IUCN redlist.

A total of eleven (11) migratory species were recorded. Out of this, three (3) were long distance palaearctic migrants, that is, they migrate between Africa and Eurasia. These were; Eurasian Bee-eater *Merops apiaster*, Eurasian Golden Oriole *Oriolus oriolus* and Spotted Flycatcher *Muscicapa striata*. In addition, two (2) species were afrotropic migrants, meaning that they migrate within Africa. These were; White-throated Bee-eater, *Merops albicollis* and Northern Carmine Bee-eater, *Merops nubicus*.

The forest habitat had sixty-three (63) species while the forest edge had fifty-eight (58) species. However, more than half of the species found in the forest were also recorded in the forest edge (Fig. 11).

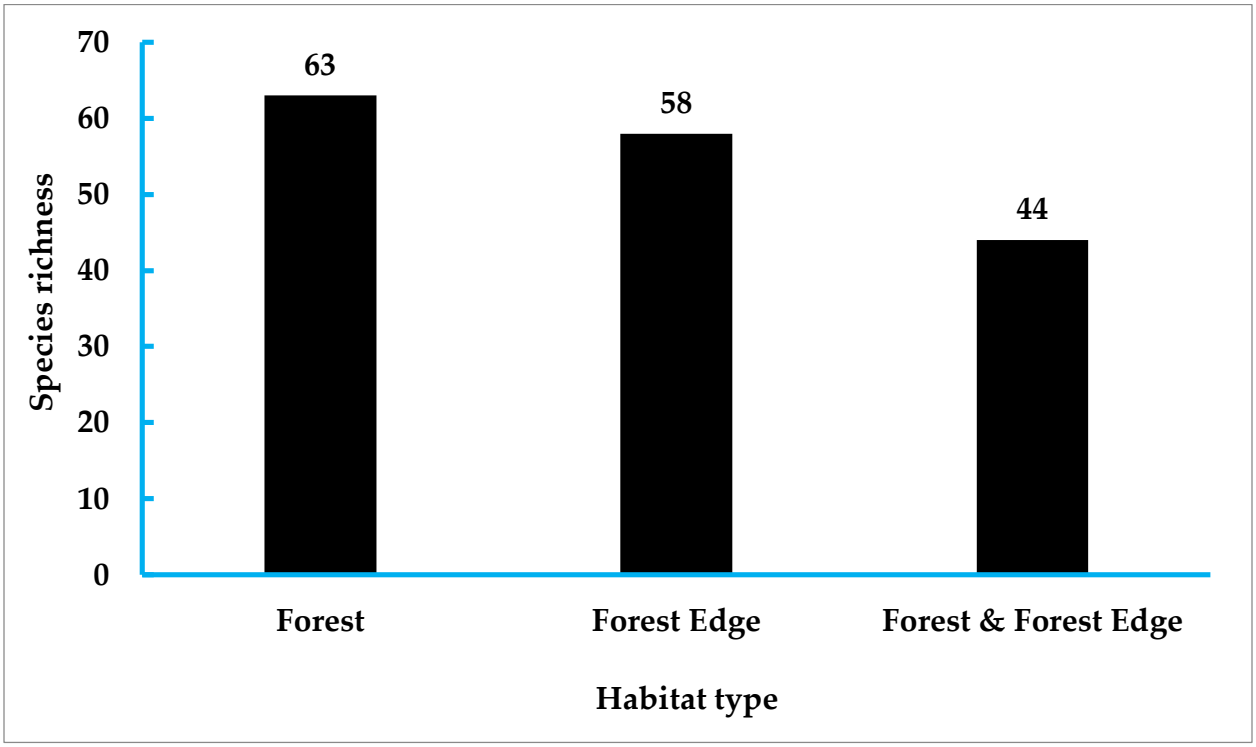

Figure 11 Bird species richness recorded in the forest and forest edge of Kaya Kauma.

According to Bennun & Dranzoa (1996), forest specialists are true forest birds, characteristic of the interior of undisturbed forest. They may persist in secondary forest and forest patches if their particular ecological requirements are met. They are rarely seen in non-forest habitats and breed exclusively in the forest. In this study, twenty-seven (27) species were forest dependent, two (2)

of which were forest specialists. They were; Black-headed Apalis *Apalis melanocephala* and Olive Sunbird *Cyanomitra olivacea*. In addition, fifteen (15), were forest generalists and ten (10) were forest visitors from the neighboring farmlands (*see* Figures 12,13 & 14; Appendix 3.1)

Figure 12 Some of the forest dependent birds found in Kaya Kauma. The Yellow-bellied Greenbul, *Chlorocichla flaviventris centralis* (left) and Eastern Bearded Scrub Robin, *Cercotrichas quadrivirgata*.

Figure 13 A forest generalist, Eastern Nicator (*Nicator gularis*) was frequent both in the forest and the forest edge.

Figure 14 White-browed Coucal Centropus superciliosus and Dark-backed Weaver Ploceus bicolor frequently visit forest edges and farmlands.

3.5 Discussion

Even though Kaya Kauma seems not to face imminent threats from human activities such as logging and charcoal burning, the encroaching farmlands put forest and the bird species at risk. The once large continuum of high altitude forest - riparian gallery forest along Nzovuni river is now fragmented. Bird populations that once freely moved between these two major habitat types are now split into isolated units - meaning that species may have limited interchange with each other (e.g. Lens *et al.*, 1999).

In addition, expansion of agricultural activities means that the remnant kaya forest fragment at the top has relatively more edge and less interior. Therefore, some forest specialists are likely to have gone locally extinct. As these fragments diminish so do they become vulnerable to habitat degradation and easier for predators or parasites to penetrate. In fact, in this study only two **true** forest species were recorded.

The high number of species found both in the forest and the forest edge could be due to the limited dispersal capabilities of these species through the modified nearby farmland habitats.

Threats

Habitat degradation has negative effects on the birds of Kaya Kauma. Clearly, the number of forest-specialist species has declined as the structure of the surrounding habitat is modified (see Bennun & Njoroge ,1999). In the high altitude kaya, threats might be inconspicuous but in the surrounding low altitude riparian gallery forests, agriculture, grazing and selective logging have opened the kaya forest edges. The forest edges consequently increase species diversity at the expense of the sensitive forest-interior birds, especially the threatened species (Collar *et al.* 1994; Bennun & Njoroge 1996).

The exploitation of the riparian gallery forests for poles, fuel wood and to a minimal extent for medicinal plants have a negative effect on birds. For instance, collection of fallen wood, harvesting deadwood affects insect populations, and thus birds too (Davies & Hoffman, 2004). Hole-nesting birds such as Mombasa Woodpecker and Trumpeter Hornbill rely heavily on standing deadwood or old, over-mature trees where nest-sites can be found or excavated.

Some invasive species such as the House Crow have negatively affected the bird diversity of Kaya Kauma. They compete for food and nesting sites with native species and to some extent predating chicks. This has drastically reduced the nesting success of some native species.

Potential socio-economic mitigation

Sustainability usually means a particular trade-off between economic benefits and biodiversity loss. Deciding whether such a trade-off is acceptable or not requires detailed ecological knowledge about the species of conservation concern and a monitoring program to assess the effects of forest-use, both local (e.g. Hall & Rodgers, 1986) and commercial.

The high altitude sacred forest and the riparian gallery forest can in themselves be used as management and conservation tools (Bennun & Njoroge, 1999; e.g. Bennun, 1999). At one level, the birds in these habitats are likely to be the easiest group to monitor if changes in biodiversity need to be assessed. The Kenya Forest Service should initiate a long term monitoring program enhanced through partnership with other stakeholders.

At another level, birds provide an excellent focus for conservation education and action. Some of the possible conservation actions include management strategies to mitigate the effects of

fragmentation and degradation of the riparian gallery forests. For instance, there is need to restore or maintain habitat corridors between the highland forest and the lowland by protecting the riparian land. The ultimate aim is to effectively protect both habitats from disturbance.

Birdwatching has great tourism potential in Kenya. The activity can provide a source of local employment and revenue generation. Kaya Kauma and the surrounding are potential birdwatching sites.

3.6 Conclusions and recommendations

After this survey, we made the following conclusions:

- That there is a connection between the kaya forest, the riparian gallery forest and the farmlands. Some birds simply use all the habitats to find food or roost.
- That the condition of the kaya forest upstream expressly determines the condition of the lowland habitats. Therefore, any interference with the catchment area vegetation will affect birds in other habitats.
- That birds found in the two habitat types are in danger of anthropogenic activities.
- The riparian vegetation along the rivers is an important corridor and provides feeding and dispersal sites for some species.
- That the House Crow is a pest with serious negative impacts on native species.

We therefore recommend the following;

- An integrated monitoring scheme for the forest with a possible starting point being regular surveys inside the forest and at the forest edge. Kenya Forest Service can achieve this by forging closer cooperation with research organizations active in the area such as the National Museums of Kenya (NMK).
- Urgent conservation measures to stop the imminent destruction of the riparian gallery forests.
- Control the population and if possible eradicate the House Crow.

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3.8 Appendices

Names and Sequence: According to the *Checklist of the Birds of Kenya*, 4th Ed, Bird Committee of EANHS, 2009.

Location: Kaya Kauma forest, the riparian gallery forests along Nzovuni river and the surrounding farmland.

Forest dependency categories (Bennun *et al.*, **1996**):

i) Forest specialist species (**FF species**): These are true forest birds, characteristic of the interior of undisturbed forest. They may persist in secondary forest and forest patches if their particular ecological requirements are met. They are rarely seen in non-forest habitats and breed exclusively in the forest.

ii) Forest generalist species (**F species**): May occur in undisturbed forest but are also regularly found in forest strips, edges and gaps, where they are likely to be more common than in the interior forest. They breed within the forest.

iii) Forest visitors (**f species**): these are often recorded in the forest but are not dependent on it. They are almost more common in non-forest habitats where they breed.

Migratory Status: **AM**= Afrotropical Migrant; **OM**= Migrant from the Oriental region; **PM** = Migrant from Palaearctic region; **MM**= Migrant from Malagasy region; **in lower case** migrants of that category may occur alongside resident, non-migratory individuals.

IUCN categories: **NT** = Near Threatened

Appendix 3.1 A checklist of birds of Kaya Kauma, November 2018.

	Common Name	Scientific Name	IUCN Status	Migratory Status	Forest Dependency
	Numididae: guineafowl				
1	Helmeted Guineafowl	*Numida meleagris*			
	Phasianidae: quails, francolins, spurfowl and allies				

2	Crested Francolin	*Francolinus sephaena*			
	Ciconiidae: storks				
3	Woolly-necked Stork	*Ciconia episcopus*			
	Threskiornithidae: ibises and spoonbills				
4	Hadada Ibis	*Bostrychia hagedash*			
	Ardeidae: herons, egrets and bitterns				
5	Black-headed Heron	*Ardea melanocephala*			
	Accipitridae: diurnal birds of prey other than falcons				
6	Southern Banded Snake Eagle	*Circaetus fasciolatus*	NT		F
7	African Goshawk	*Haliaeetus vocifer*			F
8	Great Sparrowhawk	*Accipiter melanoleucus*			F
9	Lizard Buzzard	*Kaupifalco monogrammicus*			f
10	Wahlberg's Eagle	*Aquila wahlbergi*		Am	
	Columbidae: pigeons and doves				
11	Red-eyed Dove	*Streptopelia semitorquata*			f
12	Ring-necked Dove	*Streptopelia capicola*			f
13	Emerald-spotted Wood Dove	*Turtur chalcospilos*			f
14	Tambourine Dove	*Turtur tympanistria*			F
15	African Green Pigeon	*Treron calvus*			F
	Psittacidae: lovebirds and parrots				
16	Brown-headed Parrot	*Poicephalus cryptoxanthus*			F
	Musophagidae: turacos				
17	Fischer's Turaco	*Tauraco fischeri*	NT		F
	Cuculidae: cuckoos and coucals				
18	Jacobin Cuckoo	*Clamator jacobinus*		*am, pm, om*	
19	Thick-billed Cuckoo	*Pachycoccyx audeberti*			f
20	Klaas's Cuckoo	*Chrysococcyx klaas*			f
21	Yellowbill	*Ceuthmochares aereus*		Am	F
22	White-browed Coucal	*Centropus superciliosus*			
	Strigidae: typical owls				
23	Verreaux's Eagle Owl	*Bubo lacteus*			
24	African Wood Owl	*Strix woodfordii*			F

	Apodidae: Swifts				
25	African Palm Swift	*Cypsiurus parvus*			
26	Little Swift	*Apus affinis*			
	Coliidae: mousebirds				
27	Speckled Mousebird	*Colius striatus*			
	Coraciidae: rollers				
28	Lilac-breasted Roller	*Coracias caudatus*		Am	
29	Broad-billed Roller	*Eurystomus glaucurus*		am, mm	
	Meropidae: bee-eaters				
30	White-throated Bee-eater	*Merops albicollis*		AM	f
31	Eurasian Bee-eater	*Merops apiaster*		PM	f
32	Northern Carmine Bee-eater	*Merops nubicus*		AM	
	Phoeniculidae: wood-hoopoes				
33	Green Wood-hoopoe	*Phoeniculus purpureus*			
	Bucerotidae: hornbills				
34	Crowned Hornbill	*Tockus alboterminatus*			f
35	Trumpeter Hornbill	*Bycanistes bucanitor*			F
	Capitonidae: barbets and tinkerbirds				
36	Red-fronted Tinkerbird	*Pogoniulus pusillus*			
	Indicatoridae: honeyguides				
37	Greater Honeyguide	*Indicator indicator*			f
	Picidae: wrynecks and woodpeckers				
38	Mombasa Woodpecker	*Campethera mombassica*			F
	Malaconotidae: helmetshrikes, bushshrikes, tchagras and puffbacks				
39	Retz's Helmetshrike	*Prionops retzii*			f
40	Grey-headed Bushshrike	*Malaconotus blanchoti*			
41	Gorgeous Bushshrike	*Chlorophoneus viridis*			F
42	Black-crowned Tchagra	*Tchagra senegalus*			
43	Black-backed Puffback	*Dryoscopus cubla*			F
44	Tropical Boubou	*Laniarius aethopicus*			f
	Oriolidae: orioles				
45	Eurasian Golden Oriole	*Oriolus oriolus*		PM	f

46	Black-headed Oriole	*Oriolus larvatus*			f
	Dicruridae: drongos				
47	Common Drongo	*Dicrurus adsimilis*			
	Corvidae: crows and allies				
48	House Crow	*Corvus splendens*			
	Hirundinidae: saw-wings, swallows and martins				
49	Lesser Striped Swallow	*Cecropis abyssinica*			
	Cisticolidae: cisticolas and allies				
50	Tawny-flanked Prinia	*Prinia subflava*			f
51	Black-headed Apalis	*Apalis melanocephala*			FF
52	Grey-backed Camaroptera	*Camaroptera brachyuran*			f
	Pycnonotidae: bulbuls				
53	Common Bulbul	*Pycnonotus barbatus*			
54	Zanzibar Greenbul	*Andropadus importunus*			
55	Yellow-bellied Greenbul	*Chlorocichla flaviventris*			F
56	Northern Brownbul	*Phyllastrephus strepitans*			f
57	Eastern Nicator	*Nicator gularis*			F
	Timaliidae: illadopses, babblers and chatterers				
58	Scaly Babbler	*Turdoides squamulata*			
	Sturnidae: starlings and oxpeckers				
59	Black-bellied Starling	*Lamprotornis corruscus*			F
60	African Bare-eyed Thrush	Turdus tephronotus			
	Muscicapidae: chats, wheatears and Old World flycatchers				
61	White-browed Robin Chat	*Cossypha heuglini*			
62	Red-capped Robin Chat	*Cossypha natalensis*		Am	F
63	Bearded Scrub Robin	*Cercotrichas quadrivirgata*			f
64	Spotted Flycatcher	*Muscicapa striata*		PM	
	Nectariniidae: sunbirds				
65	Collared Sunbird	*Hedydipna collaris*			F
66	Olive Sunbird	*Cyanomitra olivacea*			FF
	Passeridae: sparrow weavers, Old World sparrows and petronias				
67	Grey-headed Sparrow	*Passer griseus*			

	Ploceidae: weavers, bishops and widowbirds				
68	Grosbeak Weaver	*Amblyospiza albifrons*			f
69	Dark-backed Weaver	*Ploceus bicolor*			F
	Estrildidae: waxbills				
70	Red-cheeked Cordon-bleu	*Uraeginthus bengalus*			
71	Peters's Twinspot	*Hypargos niveoguttatus*			F
72	Bronze Mannikin	*Spermestes cucculatus*			
	Motacillidae: wagtails, longclaws and pipits				
73	African Pied Wagtail	*Motacilla aguimp*			
	Fringillidae: canaries, citrils, seedeaters and relatives				
74	Yellow-fronted Canary	*Crithagra mozambica*			

Appendix 3.2 Birds species and their abundance recorded in Kaya Kauma Forest in November, 2018.

No.	Common Name	Scientific Name	24	25	26	27	28	Total
	Numididae: guineafowl							
1	Helmeted Guineafowl	*Numida meleagris*	1	0	0	0	0	**1**
	Phasianidae: quails, francolins, spurfowl and allies							
2	Crested Francolin	*Francolinus sephaena*	3	1	0	1	1	**6**
	Ciconiidae: storks							
3	Woolly-necked Stork	*Ciconia episcopus*	0	1	0	0	0	**1**
	Threskiornithidae: ibises and spoonbills							
4	Hadada Ibis	*Bostrychia hagedash*	1	0	0	0	1	**2**
	Ardeidae: herons, egrets and bitterns							
5	Black-headed Heron	*Ardea melanocephala*	1	0	0	0	0	**1**
	Accipitridae: diurnal birds of prey other than falcons							
6	Southern Banded Snake Eagle	*Circaetus fasciolatus*	1	0	1	0	0	**2**
7	African Goshawk	*Haliaeetus vocifer*	0	1	0	0	0	**1**
8	Great Sparrowhawk	*Accipiter melanoleucus*	1	0	0	0	0	**1**
9	Lizard Buzzard	*Kaupifalco monogrammicus*	0	0	0	0	1	**1**

10	Wahlberg's Eagle	*Aquila wahlbergi*	0	1	0	0	0	**1**
	Columbidae: pigeons and doves							
11	Red-eyed Dove	*Streptopelia semitorquata*	2	1	0	1	1	**5**
12	Ring-necked Dove	*Streptopelia capicola*	2	1	1	0	1	**5**
13	Emerald-spotted Wood Dove	*Turtur chalcospilos*	3	1	2	2	1	**9**
14	Tambourine Dove	*Turtur tympanistria*	3	2	0	0	1	**6**
15	African Green Pigeon	*Treron calvus*	1	0	0	0	0	**1**
	Psittacidae: lovebirds and parrots							
16	Brown-headed Parrot	*Poicephalus cryptoxanthus*	2	1	1	1	0	**5**
	Musophagidae: turacos							
17	Fischer's Turaco	*Tauraco fischeri*	2	2	0	2	1	**7**
	Cuculidae: cuckoos and coucals							
18	Jacobin Cuckoo	*Clamator jacobinus*	0	0	0	1	0	**1**
19	Thick-billed Cuckoo	*Pachycoccyx audeberti*	1	1	0	0	0	**2**
20	Klaas's Cuckoo	*Chrysococcyx klaas*	0	1	0	0	0	**1**
21	Yellowbill	*Ceuthmochares aereus*	0	0	1	0	1	**2**
22	White-browed Coucal	*Centropus superciliosus*	3	2	0	0	1	**6**
	Strigidae: typical owls							
23	Verreaux's Eagle Owl	*Bubo lacteus*	0	0	1	0	0	**1**
24	African Wood Owl	*Strix woodfordii*	0	0	1	0	0	**1**
	Apodidae: Swifts							
25	African Palm Swift	*Cypsiurus parvus*	2	2	0	2	1	**7**
26	Little Swift	*Apus affinis*	1	0	0	0	0	**1**
	Coliidae: mousebirds							
27	Speckled Mousebird	*Colius striatus*	1	3	1	1	0	**6**
	Coraciidae: rollers							
28	Lilac-breasted Roller	*Coracias caudatus*	1	1	0	0	1	**3**
29	Broad-billed Roller	*Eurystomus glaucurus*	1	1	0	0	0	**2**
	Meropidae: bee-eaters							
30	White-throated Bee-eater	*Merops albicollis*	0	1	1	0	1	**3**
31	Eurasian Bee-eater	*Merops apiaster*	0	1	0	0	0	**1**
32	Northern Carmine Bee-eater	*Merops nubicus*	1	0	0	0	0	**1**

	Phoeniculidae: wood-hoopoes							
33	Green Wood-hoopoe	*Phoeniculus purpureus*	1	1	1	0	0	**3**
	Bucerotidae: hornbills							
34	Crowned Hornbill	*Tockus alboterminatus*	0	1	0	1	0	**2**
35	Trumpeter Hornbill	*Bycanistes bucanitor*	1	1	0	0	1	**3**
	Capitonidae: barbets and tinkerbirds							
36	Red-fronted Tinkerbird	*Pogoniulus pusillus*	1	2	0	1	1	**5**
	Indicatoridae: honeyguides							
37	Greater Honeyguide	*Indicator indicator*	2	1	0	0	1	**4**
	Picidae: wrynecks and woodpeckers							
38	Mombasa Woodpecker	*Campethera mombassica*	2	0	1	0	1	**4**
	Malaconotidae: helmetshrikes, bushshrikes, tchagras and puffbacks							
39	Retz's Helmetshrike	*Prionops retzii*	0	0	1	0	1	**2**
40	Grey-headed Bushshrike	*Malaconotus blanchoti*	1	0	1	0	0	**2**
41	Gorgeous Bushshrike	*Chlorophoneus viridis*	0	1	0	2	1	**4**
42	Black-crowned Tchagra	*Tchagra senegalus*	1	0	2	0	1	**4**
43	Black-backed Puffback	*Dryoscopus cubla*	1	1	0	0	1	**3**
44	Tropical Boubou	*Laniarius aethopicus*	6	3	3	5	1	**18**
	Oriolidae: orioles							
45	Eurasian Golden Oriole	*Oriolus oriolus*	1	2	0	0	1	**4**
46	Black-headed Oriole	*Oriolus larvatus*	2	2	0	0	1	**5**
	Dicruridae: drongos							
47	Common Drongo	*Dicrurus adsimilis*	2	0	2	2	0	**6**
	Corvidae: crows and allies							
48	House Crow	*Corvus splendens*	1	3	1	1	1	**7**
	Hirundinidae: saw-wings, swallows and martins							
49	Lesser Striped Swallow	*Cecropis abyssinica*	1	0	0	0	0	**1**
	Cisticolidae: cisticolas and allies							
50	Tawny-flanked Prinia	*Prinia subflava*	0	0	0	0	1	**1**
51	Black-headed Apalis	*Apalis melanocephala*	0	0	0	2	1	**3**
52	Grey-backed Camaroptera	*Camaroptera brachyura*	3	3	0	4	0	**10**
	Pycnonotidae: bulbuls							

53	Common Bulbul	*Pycnonotus barbatus*	2	3	2	2	0	**9**
54	Zanzibar Greenbul	*Andropadus importunus*	3	3	3	4	0	**13**
55	Yellow-bellied Greenbul	*Chlorocichla flaviventris*	3	0	2	3	0	**8**
56	Northern Brownbul	*Phyllastrephus strepitans*	2	2	3	2	1	**10**
57	Eastern Nicator	*Nicator gularis*	4	3	1	2	1	**11**
	Timaliidae: illadopses, babblers and chatterers							
58	Scaly Babbler	*Turdoides squamulata*	1	2	0	0	0	**3**
	Sturnidae: starlings and oxpeckers							
59	Black-bellied Starling	*Lamprotornis corruscus*	2	2	3	2	1	**10**
	Muscicapidae: chats, wheatears and Old World flycatchers							
60	African Bare-eyed Thrush	*Turdus tephronotus*	1	1	0	0	0	**2**
61	White-browed Robin Chat	*Cossypha heuglini*	2	1	0	0	0	**3**
62	Red-capped Robin Chat	*Cossypha natalensis*	0	0	0	2	0	**2**
63	Bearded Scrub Robin	*Cercotrichas quadrivirgata*	4	2	1	1	1	**9**
64	Spotted Flycatcher	*Muscicapa striata*	0	1	0	0	0	**1**
	Nectariniidae: sunbirds							
65	Collared Sunbird	*Hedydipna collaris*	1	1	1	2	0	**5**
66	Olive Sunbird	*Cyanomitra olivacea*	3	1	0	0	1	**5**
	Passeridae: sparrow weavers, Old World sparrows and petronias							
67	Grey-headed Sparrow	*Passer griseus*	0	1	0	0	1	**2**
	Ploceidae: weavers, bishops and widowbirds							
68	Grosbeak Weaver	*Amblyospiza albifrons*	1	0	0	0	1	**2**
69	Dark-backed Weaver	*Ploceus bicolor*	2	0	0	0	0	**2**
	Estrildidae: waxbills							
70	Red-cheeked Cordon-bleu	*Uraeginthus bengalus*	1	0	0	0	1	**2**
71	Peters's Twinspot	*Hypargos niveoguttatus*	0	0	0	1	1	**2**
72	Bronze Mannikin	*Spermestes cucculatus*	0	0	1	0	0	**1**
	Motacillidae: wagtails, longclaws and pipits							
73	African Pied Wagtail	*Motacilla aguimp*	0	1	0	0	0	**1**
	Fringillidae: canaries, citrils, seedeaters and relatives							
74	Yellow-fronted Canary	*Crithagra mozambica*	0	1	1	0	1	**3**

CHAPTER FOUR:

SMALL MAMMAL SURVEY IN THE KAYA KAUMA FOREST, KILIFI COUNTY

Aziza Zuhura: Mammalogy section, Zoology Department, National Museums of Kenya, P.O. Box 40658 00100 GPO Nairobi. Email- azizazuhura@yahoo.com

4.1 Introduction

The coastal forests in Kenya, were once probably a contiguous ecosystem, which extended from Lamu in the North to Lungalunga in the South. Currently these forests exist as small isolated patches of forest in the midst of rapidly increasing human population, fragmented by wood carving, firewood collection, charcoal burning, timber and poles extraction, encroachment for settlement and agriculture (Burgess, *et al*., 1988; Burgess, *et al*., 2000; Burgess, *et al*., 2013; Hamilton, 1981; Howell, 1981). Some of the remaining costal natural forests include the Kayas. A Kaya is a Mijikenda word for homestead; which was a fortified village in the past built in the forest, and used by locals as hideouts from external attack by armed tribes from Somali origin (Spear, 1978). However, when Kenya gained independence in 1963, Kaya forests were converted to sacred sites for conducting cultural ceremonies by Mijikendas (Spear, 1978; Waiyaki, 1995). The extraction of forest products in the Kayas in the past was regulated by council of elders by issuance of permits, but this traditional method of forest protection has broken down (Waiyaki, 1995; Ng'weno, *et al*., 2004; Musila, *et al*., 2005). Some Kaya forests (Kayas; Giriama, Kinondo, Jibana, Kambe, Ribe, Rabai (includes Mudzimuvya and Bomu/Fimboni), Duruma (includes Gandini and Mtswakara) are internationally recognized as World Heritage Sites (NMK, 2008). Although the remaining coastal forests, Kayas included are highly threatened, they have been shown to hold diverse and unique flora and fauna, which led to the listing of most of these forest patches as Key Biodiversity Areas (KBAs (Langhammer, *et al*., 2007) within the Coastal Forests of Eastern Africa Hotspot (Burgess, *et al*., 2003). However, limited if any research has been in the remaining Kenyas Kayas, and thus the need for improved scientific understanding of both flora and fauna, as well exploitation by local people.

Main goal

The main goal of this exercise was to document diversity of mammal species found in and around Kaya Kauma.

Specific objectives were,

1. Document the mammal species found in Kaya Kauma and its surrounding areas
2. Collection some museums specimens to deposit at the Mammalogy Section-National Museums of Kenya
3. Provide recommendations for improved conservation of Kaya Kauma and her mammal biodiversity

4.2. Material and methods

Study Area

The study was undertaken in and around Kaya Kauma forest in between 21st 27th November 2018, towards the start of the dry season. The Kaya is found in Ganze, Kilifi County five kilomters from the Jaribuni town centre (latitude -3.6167, longitude 39.7333). The size of Kaya gazetted by Government of Kenya in 1997, is is about 78 acres in size. The vegetation of the Kaya consists of a broadleaved mature forest around the top of a small hill, as well as some large indigenous trees, and also some open areas which are maintained by clearance of grass and bushes. A big seasonal river (Rive Nzovuni) flows near the Kaya.

Figure 15 The farmland in Jaribuni village where we trapped rodents.

Capture methods

Small mammals were captured using 20 Sherman's traps live-trap 7.5 X 9.0 X 23.0 cm, HB Sherman Trap Inc, Tallahassee, USA) Odhiambo, *et al*. 2005; Monadjem *et al*. 2011), and 20 wooden snaps (Fig 4) kill traps (Stanley and Kihaule, 2016). The traps were set at intervals of 5-10m from each other The Sherman's traps were baited with oats flakes, while the snap traps were baited with a single raw peanut seed. The traps were checked once in the morning (8-9 am), then re-baited and left in their original position and checked again the following days. Other specimens captured in pitfall traps of herpetologist research were also handed over to mammal team. Mist-nets were also used to capture bats (fig. 16). The nets were operated for two hours (1900-2100 pm) for two nights in one area and then moved to a new location. All animals captured in the traps were removed, put in cloth bags and killed with chloroform, identified and processed for biometric data. Measurements were taken on each individual and included; **TL** (tail length), **HB** (length of head and body, **HF** (length of hind foot), **EL** (length of left ear), **WT-** weight (mass of the individuals). All trapped rodents were identified to Genera or species using Kingdon (2015). Vouchers of wet specimens collected were deposited with Mammalogy Section-National Museums of Kenya, Nairobi), and preserved by opening the stomach of the the specimen and dipping the whole

specimens in 70% alcohol solution. Stuffed skins were also prepared through the process of taxidermy, dried then disinfected and stored in the collection cabinets (fig. 21).

Figure 16 The author and community member Mzee Hillary putting up mist net in front of Kaya Kauma entrance foot path and setting traps at Jaribuni village.

4.3 Results

A total of 52 individuals (of ten species) of sighting and collections of mammals were recorded during this survey, including 19 captured in traps and 33 that were observed opportunistically (table 2). Species accumulation curves showed how many new species were added each new sampling day. The Jacknife 1 species estimator was higher than the mean observed species (Fig. 17) and neither of the two curves reached asymptote indicating that sampling of mammals in Kaya Kauma and its surroundings is far from complete. A troop of Papio cynocephalus (Linnaeus, 1766) Yellow Baboon were seen during this survey and some *Cercopithecus mitis albotorquatus* Pousargues, 1896, Pousargues's Monkey made calls in the morning and some records were received from local people. Individuals of Chlorocebus pygerythrus (F. Cuvier, 1821) Vervet Monkey were seen raiding mango fruits from trees in Kaya Kauma and groups of more than ten individuals were seen in a farm planted with pawpaws. Three shrews (*Crocidura* species) were captured in a herpetology pitfall trap and a Lepus capensis Linnaeus, 1758 Cape Hare was seen in community areas around the Kaya. Several (8) Nesotragus moschatus Von Dueben, 1846 Suni scats were seen while setting traps inside the Kaya.

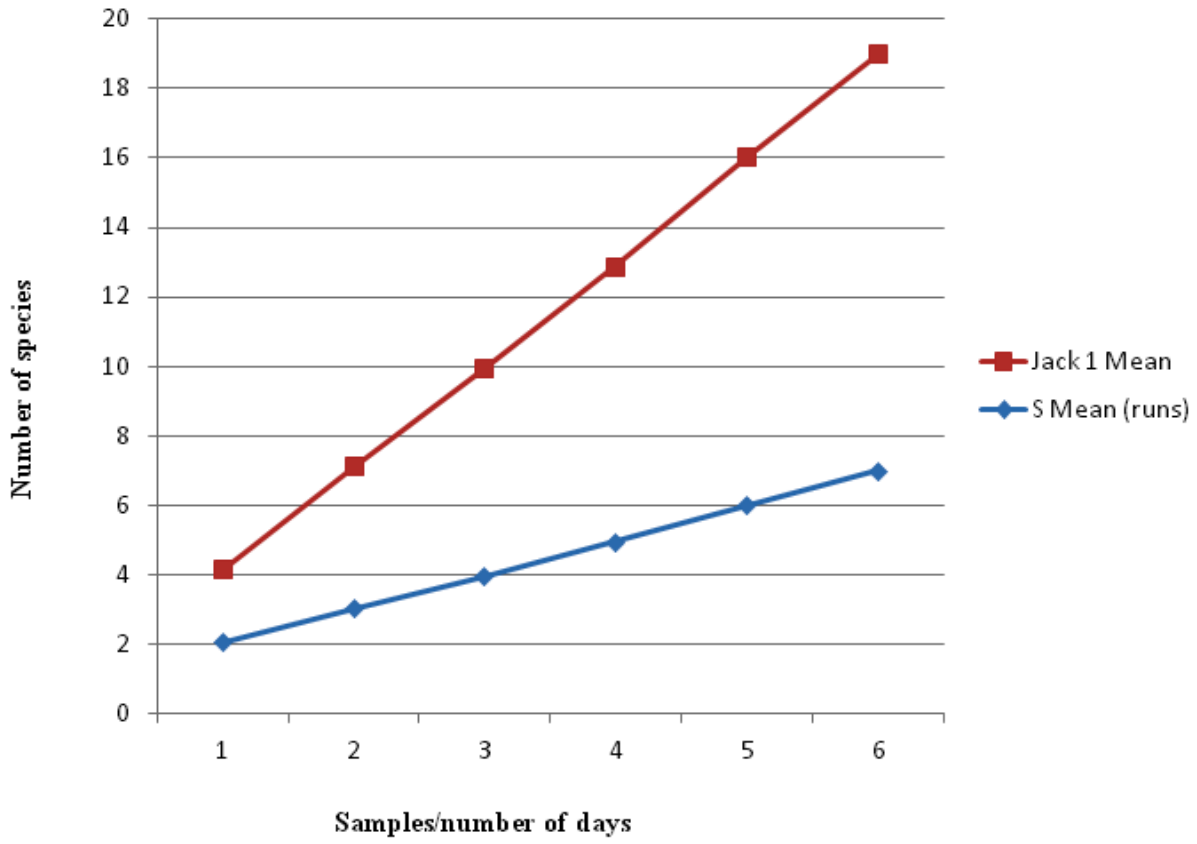

Figure 17 Species accumulation curve for the six sampling days showing observed species and Jacknife 1 species richness estimator.

Figure 18 A rodent captured in a pit-fall trap run by herpetologist colleagues.

Figure 19 Left, bat and rodent specimens ready to be skinned and. Right, portrait of a horseshoe bat.

Figure 20 One of the community elders Mzee Hillary with a bat at Kaya Kauma

Table 1 Mammal species and the methods used to record their presence.

	Order and Species	**Methods of capture**	**Number captured/recorded**
	ORDER PRIMATES (Monkeys)		
1	*Chlorocebus pygerythrus* (F. Cuvier, 1821) Vervet Monkey	opportunistic	10
2	*Cercopithecus mitis albotorquatus* Pousargues, 1896, Pousargues's Monkey	opportunistic	15
	ORDER RODENTIA (Rodents)		
3	Genus *Mastomys* sp.	snap kill trap	4
	ORDER CHIROPTERA (Bats)		
4	*Epomophorus wahlbergi (*Sundevall, 1846). Wahlberg's Epauletted Fruit Bat	mist net	4
5	Genus *Rhinolophus hildebrandtii*	mist net	2
6	Genus *Miniopterus* (Long-fingered Bats)	mist net	2
	ORDER SORICOMORPHA (Forest shrews)		
7	Genus *Crocidura* sp. White-toothed shrews	snap kill trap and bucket pitfaa	7
8	**ORDER CETARTIODACTYLA** (Even-toed Ungulates, Whales and Dolphins)		
9	*Nesotragus moschatus* Von Dueben, 1846 Suni	Scat/indirect method	8
	TOTAL		**52**

a

b

Figure 21 Small mammal specimens skinned (a) and remains preserved as wet collection (b), and deposited at Mammalogy section- National Museums of Kenya, Nairobi.

4.4. Discussion and recommendations

Although the size of the area of Kaya Kauma is 78 acres, we found a number of small and large mammals in the Kaya. Some relatively large mammals several species occurred in the area,

including three species of monkey. Bats, especially *Epomophorus wahlbergi*, were common, and the males were heard each night especially past 8 pm, singing from tall trees. Fruit bats are relatively easy to capture in mist nets, compared to insectivorous bats, which may be the reason why four individuals were captured the first night. Other species of fruits bats may have existed in and outside the station but may have remained unrecorded. Only two individuals of insectivorous bat species were captured in mist nets. Some species of insectivorous bats have the ability to detect the presence of nets and avoid them (MacSwiney et al. 2008), suggesting that many other species of bat may have existed in Kaya Kauma, but which we were unable to record.

Few individuals of rodent species were captured in our survey, although the ground was well covered in grass and weeds, providing a suitable habitat for survival and predator avoidance. Hence, it is unclear why so few individuals were captured despite the large number of traps (40) used. Before the slight rain received in the area during the survey, there was a long dry period, which may have reduced populations of rodents and shrews to low levels. In addition, since this survey was very short, confined to only three days in the dry season, there is a need to conduct the same survey during the wet season, in order to improve our understanding about the species found in and around Kaya Kauma. Kaya Kauma may not have many large mammals, because of its small size, but there may be many small ones, such as bats, rodents and shrews. Large mammals, which possibly existed in the past, may have been depleted by hunting by local people. Kaya Kauma was was an island in the midst of human-dominated landscape, and was being exploited by local people mainly for firewood, grazing and extraction of building poles. The following is recommended for improved conservation of forest habitat and species found in the Kaya;

1. The boundaries of the Kaya should be well marked and increased patrolling done to control for community encroachment and unsustainable forest exploitation
2. National and County Governments should work with local people to develop an alternative forms of livelihood which can increase income generation to reduce dependence on the exploitation of the Kaya resources
3. Construct a community museum in the area to promote the conservation of cultural traditions of the Mijikenda sub-tribe of the area and promote the continuous use of the Kaya Kauma for traditional ceremonies

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CHAPTER FIVE:

AMPHIBIANS AND REPTILES SURVEY IN THE KAYA KAUMA FOREST, KILIFI COUNTY

Beryl A. Bwong

Herpetology Section, Zoology Department National Museums of Kenya, P.O. Box, 40658, 00100 Nairobi; Email address: akothbwong@gmail.com

5.1 Summary

We report on a rapid survey of amphibians and reptiles (herpetofauna) carried out in Kaya Kauma forest in Kilifi County from 21st -26th of November 2018. A total of 23 species comprising of 5 amphibians and 18 reptile species were recorded to occur in Kaya Kauma and its surroundings. Diversity of herpetofauna in Kaya Kauma is compared with neighbouring Kaya Jibana and in addition a brief species account is provided. We make recommendations on possible non consumptive utilization of herpetofauna in Kaya Kauma as a way to motivate the continued conservation of the Kaya. The current study is preliminary given that the survey period was short and conducted only in one season. As indicated bythe species accumulation curves, more species can be discovered with more sampling effort. We therefore recommend more studies covering longer sampling period in both wet and dry periods.

5.2 Introduction

The coastal forests of Kenya and Tanzania are recognized as an area of global biodiversity importance and are considered as one of the 25 world's biodiversity hotspots due to the concentration of many narrowly endemic plants and animal species in exceptionally small areas (Burges, 1998; Meyers et al., 2000; Mittermier et al., 2004). Within the coastal forests in Kenya are the Kaya forests that are a relict forest patches protected by the traditions of the nine MijiKenda ethnic groups who regard them as sacred places and burial grounds (Nyamwero et al., 2008; http://www.museums.or.ke/sacred-mijikenda-kaya-forests/). The Kayas constitute some of the few patches of undisturbed vegetation of a once extensive and diverse lowland forest of Zanzibar-

Inhambane Regional Mosaic (White, 1983). Access to the Kaya forests and activity within them has been kept minimal leaving the forests as "intact islands" preserving considerable biodiversity despite their small sizes (Githitho, 2008).

The Kaya forests are botanically diverse and have high conservation value. More than half of the Kenya's rare plants are found in the coast region, many within the Kaya Forests (Younge et al, 2002). However, biodiversity studies on other taxa within these forests have remained unstudied until recently. For example, herpetological surveys within the Kaya forests only began in 2009 (Malonza &Nyamache, 2010) when Kaya Mrima, Kinondo and Jibana were visited. In addition, Malonza et al., 2016 surveyed additional 9 Kaya forests in Kwale County. However, a lot still remains to be done as far as herepetological surveys in the entire coastal forests are concerned; For example, gaps regarding fussorial herpetofauna of most forests still exist and new records emerge even in some forests considered to be well studied such as Tana River forests and Shimba hills National reserve (Malonza *et al*., 2006; Malonza & Measey 2005, Bwong *et al*., 2017). In addition, conservation status of endemic and/or rare herpetofauna remains unknown for most areas.

Conservation of the coastal forests including the sacred Kaya forests is becoming a big challenge given their location in the centre of the country's tourism industry. The rising need for land for, infrastructure, agriculture, fishing, mining (iron ore and titanium) logging for timber, woodcarving and the rapid socio-cultural changes continue to be major threats leading to the loss of smaller Kayas and groves (Younge *et al*, 2002; Nyamwero et al, 2008; Tabor *et al*., 2010). Considering the magnitude of these threats, efforts should be made to conserve them. One such initiative is the sustainable utilization of these forests by the local community. For this to be realized however there is a need to conduct comprehensive surveys of all the biodiversity found in these forests and document their diversity, conservation status and economic values as a baseline to such initiatives. The current study aimed at documenting the diversity of amphibians and reptiles in Kaya Kauma located in Kwale County, in order to shed more light on significance of this Kaya in herpetofauna conservation and their possible non-consumptive utilization. A combination of ecological census techniques following Karns, 1986; Heyer et al, 1996; Sutherland, 1996 was employed to document the diversity and distribution of amphibians and reptiles.

5.3 Materials and methods

Study area

Kaya Kauma is located in Jaribuni Location, in Kilifi County in the north coast between S03°37′14" and E39°44′10". This is mostly woodland consisting of low hills commonly know as foot plateau west of the coastal range (Githitho, 2008; http://www.museums.or.ke/sacred-mijikenda-kaya-forests). The forest is bordered by Nzovuni River to the west.

Sampling methods

Field study was conducted for five days from 21st-26th November 2018. The forest was relatively dry during the sampling period however a few drizzling episodes were experienced. Three transects were randomly selected to represent the major habitats; forest, forest edge and farmlands (Figs. 22 a-c). The following sampling methods were used in all the study sites to collect data on the diversity and distribution of herpetofauna in Kaya Kauma and its environs.

Figure 22 Kaya Kauma forest (a), Kaya Kauma forest edge (b) and farmlands

Time limited Survey (TLS)

This involved two observers searching the study sites for two to three hours per day divided into blocks of 30 minutes each (Heyer *et al.*, 1994; Sutherland, 1996; Rödel & Ernst, 2004). All possible amphibian and reptiles' micro-habitats such as; under stones, decomposing logs, tree stumps, bushes were searched. Digging within loose soils for burrowing species was also done. Sampling was done mainly in the morning session when most reptiles are most active basking, resting or foraging and also at night targeting nocturnal species. Night sampling was conducted for 4 nights beginning 1800hrs to 2000hrs.

Pitfall traps with drift fences

Pitfall traps with X-shaped drift fence (Fig. 23), a modification of that used by Corn (1994), with segments of 5 m length were also set up in each study site. The pitfall traps were made using 10 litre plastic buckets placed flush with the ground. The drift fence consisted of a transparent plastic sheeting 0.5 m high stapled on wooden pegs. The lower end of the fence was buried in the ground and positioned to run across the buckets. A trap station consisting of five buckets was set up in each site; trap station I was set within the forest (S03°37.517′ and E039°44.292′); station II was set on the forest edge (S03°37.339′ and E039°44.292′) while station III were set on a fallow farmland (S03°37.055′ and E039°43.971′). Pit fall trapping with drift fences was mainly used to capture species which may not be captured through other methods. Traps were left for 5 trap nights at each site and checked once on a daily basis.

Figure 23 Pitfall traps with transparent drift fence sampling technique

All amphibians and reptiles found were recorded and where possible the following data taken, species, sex, longitude and latitude positions, microhabitat and a photograph. A representative number of amphibians and reptiles were collected, euthanized in a humane manner according to standard protocols as outlined by Karns (1986). Amphibian specimens were euthanized with MS222 and reptiles with pentobarbital solution and then fixed in 10% formaldehyde, preserved and later deposited at the Herpetological collection at the National Museums of Kenya. Specimens were identified using published taxonomic keys, Channing & Howell, 2006 and Frost *et al*,. 2006 for amphibians and Spawls *et al*., 2018 for reptiles.

Interviews with local community

Given that some reptiles (especially snakes and chameleons) are quite cryptic and secretive, rapid surveys like the one performed during the current study often fail to record even the most common species. Therefore, we also interviewed a few members of the local community we interacted with during the survey such as field assistants and farmers. The interviewees were asked to describe the herpetofauna they encounter within the area and then description confirmed by photos from the field guides (Spawls, *et al*., 2006). We only listed those species that were positively identified in the field guide.

Species richness analysis

The observed species richness was estimated using the Estimate SWin10 program (Colwell, 2013). Jacknife 1 species richness estimator was compared with observed species richness (*Sobs*). Species accumulation curves were calculated and generated using the software programme EstimateS using 1000 randomizations. The species richness was plotted as a function of the accumulated number of samples (number of sampling days).

Similarity comparison

Similarities of herpetofauna between Kaya Kauma and Kaya Jibana Kaya forest was calculated using Sørensen similarity index which is based on the probability that two randomly chosen individuals, one from each site, both belong to a species shared by both sites (but not necessarily to the same species). It was calculated as: $C_s = 2j/ (a+b)$, where j equals the number of species shared between two sites, and a and b are the number of species in each site. The index ranges from 0, when adjacent communities share no species in common, to 1, when adjacent communities are identical. Kaya Jibana was chosen for this comparison because it is the only Kaya in Kilifi County where studies on herpetofauna have been conducted (Malonza & Nyamache, 2010).

5.4 Results and discussion

A total of 23 species; 5 amphibian and 18 reptile species were recorded in Kaya Kauma and its surroundings; these comprise 4 amphibian and 9 reptile families. Twenty species (5 amphibians and 15 reptiles) were recorded using both TLS and pitfall traps (Table 3) while three species (*Pythons sebae* Gmelin, 1789, *Causus resimus* **(**Peters 1862) and *Psamophis punctatus* Duméril & Bibron, 1854*)* were recorded through interviews with the local community. More species were recorded in the forest edge (16), followed by the farmland (11) and forest transect (8). A single amphibian species Guttural toad (*Sclerophrys gutturalis* (Power, 1927)) (Fig. 3) was recorded in the forest transect. The remaining amphibians were recorded on the forest edge (5) and farmland (3) respectively.

Table 2 List of amphibians recorded during the three study sites

SPECIES	Forest transect	Forest edge transect	Farmland transect
Amphibians			
Sclerophrys gutturalis	1	1	1
Phrynobatrachus acridoides	0	1	1

Ptychadena anchietae	0	1	1
Hyperolius argus	0	1	0
Hyperolius tuberilinguis	0	1	0
Total	**1**	**5**	**3**
Reptiles			
Chamaleo dilepis	0	0	1
Heliobolus spekii	0	1	1
Lygodactilus mombasica	1	1	1
Hemidactylus barbouri	1	1	0
Hemidactylus platycephalus	1	1	1
Hemidactylus angulatus	0	1	1
Trachylepis maculilabris	0	1	0
Trachylepis planifrons	1	1	1
Broadleysaurus major	1	0	0
Varanus niloticus	0	1	0
Cordylus tropidosternum	1	0	0
Philothamnus hoplogaster	0	1	0
Psamophis biseriatus	1	0	1
Psamophis orientalis	0	1	1
Hemirhageris hildebrandtia	0	1	0
Total	**8**	**16**	**11**

Coast Puddle frog (*Phrynobatrachus acridoides* (Cope, 1867)*)* and Savannah Ridged frog (*Ptychadena anchietae* (Bocage, 1867)) were abundant wherever they occurred however only 3 Guttural toads were recorded during the study period. In addition, the two frogs (Coast puddle frog and Savanna ridged frog) were recorded both during the day and at night while Guttutral toad was only recorded at night. The two reed frogs *Hyperolius argus* Peters, 1854 and *H. tuberilinguis* Smith, 1849 were identified by the male advertisement calls. The two species were calling in aquatic vegetation during the night however the calling site was inaccessible. The most commonly encountered reptiles were the Mombasa dwarf Gecko (*Lygodactylus mombasicus* Loveridge, 1935*)* and Speke's sand lizard (*Heliobolus spekii* Günther, 1872) (Fig. 24b and 24e). Both species were recorded in all the three study sites during the day. At night however it was Barbour's Gecko (*Hemidactylus barbouri* Loveridge, 1942*)* that was common along the path both in the forest and at the forest edge. Snakes were all recorded during the Time-limited searches.

In terms of sampling methods only two specimens of Speke's Sand Lizard were recorded using pitfall traps. The two were recorded in trap station III in the farmlands. Even though no amphibians

or reptiles were recorded in traps I and II several invertebrates (all the three trap stations) and rodents (traps II and III) were recorded.

Fig.24a

Fig.24b

24c

24d

Figure 24 Scherophrys gatturalis (24a), Ptychadena anchietae (24b), Female Phrynobatrachus acridoides (24c), Male P. acridoides (24d)

Fig.25a

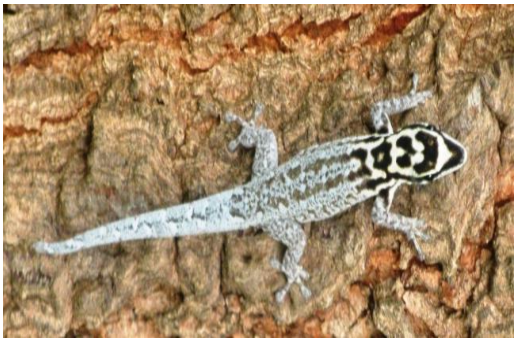

Fig.25b

Fig.25c

Fig.25d

Fig.25e

Fig.25f

Fig. 25g

Figure 25 Trachylepis planifrons (24a), Lygodactylus mombasicus (24b), Chamaeleo dilepis (24c), Hemidactylus plqtycephalus (24d), Heliobolus spekii (24e), Hemirrhagaris hilderbrandtia (24f), Psamophis biseriatus (24g)

Species richness

Species accumulation curves showed how many new species were added each new sampling day. The Jacknife 1 species estimator was higher than the mean observed species (Fig. 26) and neither of the two curves reached asymptote indicating that sampling of amphibians and reptiles in Kaya Kauma and its surroundings is far from complete. Kaya Kauma and its surrounding is a suitable habitat for many amphibians and reptiles species that have been recorded in neighbouring areas such as Arabuko Sokoke forest, Gedi forest and Kaya Jibana (Drewes, 1992; Chira, 1993; Malonza & Nyamache, 2010). For example, amphibians such as *Boulengerula changamwensis, Arthroleptis stenodactylus, A. xenodactyloides, Mertenosphryne micranotis* and coastal Hyperoliid species most of which are explosive breeders targeting the beginning of the rainy season may be recorded in favourable seasons. Reptile species with coastal affiliation such as the *Hemidactylus mrimaenesis, Nucras boulengeri, Dendroaspis anguticeps, Thelotornis mossambicanus* and burrowing species like *Melanosep ssp*. should be present in Kaya Kauma. In addition, a single specimen of the rare Broadley's dwarf Gecko (*Lygodactylus broadleyi*) was recorded in Pwani University during the current study period and given its range along the coast, this species should also be present in Kaya Kauma. More sampling therefore is needed to document the full diversity of amphibians and reptiles in Kaya Kauma.

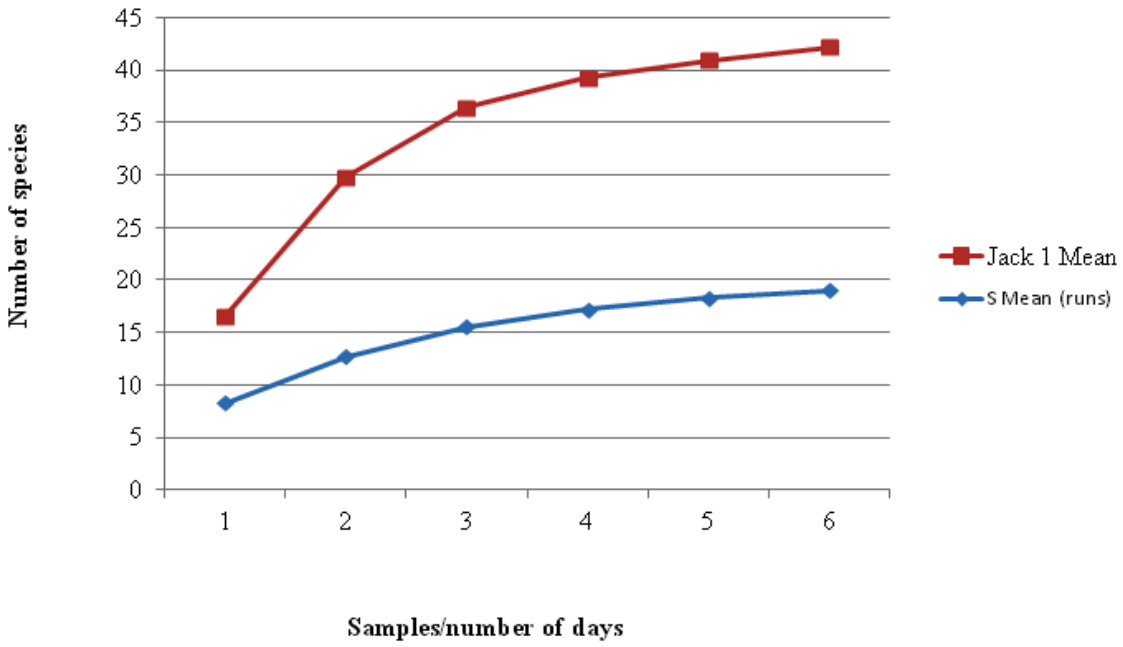

Figure 26 Species accumulation curve for the six sampling days showing observed species and Jacknife 1 species richness estimator.

Similarity comparison

A total of 24 amphibians and reptiles have been recorded from Kaya Jibana (Malonza & Nyamache 2010) comprising of 11 amphibians and 13 reptiles. Both Kaya Kauma and Jibana share 3 amphibian and eight reptile species. However, the two Kaya have a similarity index of just 50% even though the forests are within the same County. This can be explained by differences in sampling efforts between the two Kayas. The relatively high number of reptile species recorded in Kaya Kauma despite its small size compared to Kaya Jibana and also sampling efforts difference, points to the significance of Kaya Kauma as a herpetofauna refuge in the area which is rapidly being converted to agricultural land.

Species account

The species account presented below consists of species recorded during the survey plus those obtained through interviews with local community. The account entries consist of: *Species name* which comprise both scientific and common names; *Distribution*: mentions the exact locality

within where the species was been recorded. *Habitat*: describes the general habitat in which the species occurs.

Amphibians

Family Bufonidae

***Sclerophrys gutturalis* (Power, 1927) Guttural Toad**

Habitat: Savannah, grassland and agricultural area.

Distribution: Two samples were collected within the forest (S03°37.517′ and E039°44.292′) while the third one was recorded in the farmland at Mhoni Village.

Phrynobatrachidae

***Phrynobatrachus acridoides* (Cope, 1867) Coast Puddle Frog**

Habitat: dry and humid savannah, shrub land, grassland and coastal habitat.

Distribution: Samples were collected along River Nzovuni site one near the forest edge (S03°37.339′ and E039° 43.971′) and the second site was in Mhoni village in the farmland (S03°36.818 ′and E039°44.266′). Additional two samples were collected in a water puddle near a broken water pipe in the forest.

Ptychadenidae

***Ptychadena anchietae* (Bocage, 1868) Savannah Ridged Frog**

Habitat: woodland, Savannah, residential and agricultural areas.

Distribution: Samples were collected along River Nzovuni site one near the forest edge (S03°37.339′ and E039° 43.971′) and the second site was in Mhoni village in the farmland (S03°36.818 ′and E039°44.266′).

Hyperoliidae;

***Hyperolius argus* Peters, 1854 Argus Reed Frog**

Habitat: Moist coastal savannah mainly in open areas.

Distribution: Several individuals were heard calling in papyrus vegetation by Nzovuni River (S03°37.339′ and E039° 43.971). However due to inaccessibility of the area, none was collected.

***Hyperolius tuberilinguis* Smith, 1849: Tinker Reed Frog**

Habitat Dry and moist savannah areas of the coast

Distribution: Several individuals were heard calling in papyrus vegetation by Nzovuni River (S03°37.339′ and E039° 43.971). However due to inaccessibility of the area, none was collected.

Reptiles

Geckonidae

***Hemidactylus barbouri* Loveridge, 1942 Barbour's Gecko**

Habits: Terrestrial, nocturnal, and solitary. Found under piles of debris, palm fronds

Distribution: These were mainly found on the ground within the forest and also along the forest edge.

***Hemidactylus angulatus* Hallowell, 1852 Angulate Gecko; East African House Gecko**

Habitat: Wide-spread in dry and moist savannah habitats and even inhabit buildings

Distribution: One sample was collected at the edge of Kaya Kauma (S03°37.529′ and E039° 44.018′) while the second one was collected in Mhoni village not far from River Nzovuni (S03°36.818′ and E039°44.266′).

***Hemidactylus platycephalus* Peters, 1845 Baobab Gecko**

Habitat: Widespread and common in moist and dry habitats.

Distribution: Was recorded within the forest, on the forest edge especially on Baobab trees and also in the farmlands on Palm and mango trees.

***Lygodactylus mombasicus* Loveridge, 1935**

White-headed dwarf Gecko; Black-and-white headed dwarf Gecko

Habitat: Moist savannah and coastal mosaic vegetation

Distribution; Was recorded in the forest, forest edge and also in the farmlands where it was found on pawpaw, mango and palm trees.

Chamaeleonidae

***Chamaeleo dilepis* Leach, 1819 Flap-necked Chameleon**

Habitat: Moist and dry savannah forest, thickets and woodland

Distribution: Two samples were recorded in the farmlands (S03°37.055′ and E039°44.295′) near the forest edge and another one in Mhoni village (S03°36.631′ and E039°44.281′)

Scincidae

Trachylepis maculilabris (Gray, 1845) **Speckle-lipped Skink**

Habitat:

Distribution: These were mainly collected in the forest edge especially close to the river (S03°37.475′ and E039°43.880′; S03°37.387′ and E039°43.918; S03°37.339′ and E039°43.971′).

***Trachylepis planifrons* (Peters, 1878) Tree Skink**

Habitat: Coastal thickets, dry and moist savannah, semi-arid areas with bushes

Distribution: This was quiet common also in all the sites mostly during the day but one was observed sleeping during night sampling. S03°37.424′ and E039°43.970′; S03°36.599′ and E039°44.320′; S03°37.644′ and E039°44.016′; S03°37.475′ and E039°43.880′; S03°36.631′ and E039°44.281′;

Lacertidae

***Heliobolus spekii* Günther, 1872 Speke's sand Lizard**

Habitat: Moist and dry savannah, arid and semi-arid lands in the *Acacia-Commiphora* vegetation.

Distribution: These were quiet common in the forest edge and farmland but not in the forest. They were mostly seen dashing along the paths. Two specimens were collected in pitfall traps in the farmlands. Recorded at; S03°37.055′ and E039°44.295′; S03°37.339 and E039°43.971′; S03°37.424′ and E039°43.970′; S03°37.285′ and E039°44.017′.

Cordylidae

***Cordylus tropidosternum* (Cope, 1869) Tropical girdled Lizard; Spiny-tailed Lizard**

Habitat: moist coastal forest and woodland

Distribution; A single specimen was collected on a tree trunk inside the forest (S03°37.517′ and E039°44.292′) around 0830hrs.

Gerrhosauridae

***Broadleysaurus major* (Duméril, 1851) Great plated Lizard**
Habitat: dry and moist savannah, bushland and woodland areas

Distribution; A single specimen was recorded inside the forest on the ground (S03°37.517′ and E039°44.292′) feeding on insects around 0830hrs.

Varanidae;

***Varanus niloticus* (Linneaus, 1766) Nile Monitor Lizard**
Habitat: Associated with permanent water bodies such as rivers, swamps, marshes, lakes, dams

Distribution: Were recorded mostly around river Nzovuni (S03°37.387′ and E039°44.918′) during the day.

Family Pythonidae

***Python sebae* (Gmelin, 1789) Central African Rock Python**
Habitat: Coastal thickets, Savannah and woodland.

Distribution; Common along Nzovuni River as was reported by farmers.

Family Lamprophiidae

***Psammophis punctulatus* Duméril & Bibron, 1854 Speckled sand Snake**
Habitat: Dry savannah and semi-desert.

Distribution: Reported as common by the local field assistant though not recorded during the survey.

***Psammophis biseriatus* Peters, 1881 Link-marked sand Snake**
Habitat: Arid and semi-arid lands, dry savannah.

Distribution: A juvenile was recorded basking a shrub on the forest transect (S03°37.539′ and E039°44.214′). An adult specimen was recorded collected in Mhoni village farmlands.

***Psammophis orientalis* Broadley, 1977 Eastern Stripe-bellied sand Snake**

Habitat: Moist coastal strip

Distribution: Three specimens were recorded (during the day) on the forest edge neighbouring Nzovuni River (S03°37.387′) and E039°43.918′). These species was also reported as common in Mhoni Village in the farmlands.

***Hemirhagerrhis hildebrandtii* Peter's 1878 Hildebrandt's bark Snake**

Habitat: Moist and dry savanna, arid and semi-arid lands

Distribution: A single species was collected in riverrine vegetation at S03°37.517′ and E039°44.292′.

***Philothamnus hoplogaster* (Günther, 1863) South Eastern Green snake**

Habitat: Moist savannah

Distribution: One specimen was recorded basking on a tree at the forest edge (S03°37.339′ and E039°43.971′).

Viperidae

***Causus resimus* (Peters 1862) Velvety-Green Night Adder**

Habitat: Coastal Savannah and thicket, savannah and woodland.

Distribution: Not collected but identified by farmers in Mhoni village.

Herpetofauna and sustainable utilization of the Kaya Kauma forest

Most amphibians and reptiles being relatively small in size and also less conspicuous unlike other higher vertebrates are rarely targeted for conservation purposes. Apart from their small size these animals are also feared by many and considered dangerous. While many people fear direct contact with amphibians and reptiles, they remain curious about them and would not mind spending money to see these animals in a snake/reptile Park. The community should be encouraged to consider non consumptive initiatives that can contribute to conservation of amphibians and reptiles in the area.

Kaya Kauma like most of the coastal forests is home to diverse amphibians and reptiles that can be displayed in a snake/reptile park to attract both local and foreign visitors. For example, a

reptile/snake park can be constructed at appropriate area within Kaya Kauma where visitors can pay to visit the park and the money from the establishment can be used to improve the livelihood of the community. This way the community can learn to appreciate these animals and help in their conservation.

Establishing a snake Park in the area can also help curb cases of snakebite and related deaths in the area. Kilifi County together with other hot and wet areas in Kenya are known for relatively high numbers of snakebite and related deaths incidences. A snake Park within the areas will serve as a resource centre that can provide important information on snake bite management such as; the dangerous snakes in the area, how to avoid snakebite and on snake bite related first aid. Such information when made available in the local language can go a long way in reducing cases of snakebite and related deaths in the area.

5.5 Recommendation and conclusion

Just like in most Kayas, information on herpetofauna of Kaya Kauma is still incomplete and needs to be documented. Given that the Kaya is surrounded with various income generation activities such as agriculture, sand harvesting, etc. Kaya Kauma therefore is the only refuge for herptofauna of the surrounding area. Efforts should therefore be made to ensure that its conservation is maintained if the biodiversity it currently holds is to survive.

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