



The Role of National Museums in Promoting Animal Welfare

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6TH AFRICA ANIMAL WELFARE CONFERENCE, 31 October- 02 November 2022



PRESENTATION OUTLINE

i. Introduction

- Museums in reference to National Museums of Kenya

ii. The relevance of Museums in animal welfare with focus on:

- Museum Collections

- Research

- Education

iii. Challenges facing Museums

iv. Concluding remarks and recommendations



INTRODUCTION: THE NATIONAL MUSEUMS KENYA (NMK)



- Started in 1910, a State Corporation under Museums/Heritage Act 2006
- **Vision:** To be a global leader in Heritage Research and Management
- **Mission:** To promote conservation and sustainable utilization of national heritage through generation, documentation and dissemination of research and collection management knowledge, information and innovations
- Regional Museums in various parts of the country, Kenya



WHAT IS DONE AT NMK: ZOOLOGY DEPT

1.0 COLLECTION MANAGEMENT: Core activity of zoology Dept-collection management, documentation, preservation of specimens (>3M) from Kenya and other African countries



Study skin preserved in cabinets



2.0 ECOLOGICAL RESEARCH:

Specialized research, in taxonomy and systematics, ecology and zoogeography (distribution), of animal species (Birds, mammals, Amphibians/reptiles, Fish, Invertebrates) in Kenya/beyond.

3.0 EDUCATION & CAPACITY BUILDING

Sensitize /educate on conservation and build capacity to the public & all academic levels Certificate, Diploma, Undergraduates, M.Sc. & PhD



MAMMALOLOGY SECTION: DIVERSE COLLECTIONS

Stuffed skins >10,000



Wet collection > 15,000



Flat skins > 3,000



Trophies-Mounted specimens >50

INVERTEBRATE COLLECTION: Over 3 M

- Wet Collection (for fleshy specimens)



- Dry pinned collections-Flies, bees..



ICHTHYOLOGY COLLECTION

48,000 Fish
specimens curated in
Ethanol

➤ 35,000 Freshwater

➤ 15,000 Marine

Approx 1000 Tissue
specimens for genetic
studies

Bone and Scale material
Bones: 41 specimen
Scales: 60 specimens



COLLECTION BASED RESEARCH IS DIVERSE!

- Museum specimens fill critical gaps in taxonomic, geographic, and temporal understanding of biodiversity
- Description of species based on diagnostic characters, habitat information, geographical distribution, phenology, and other biological features, as well as reliable economic uses and conservation information
- Host range associations: including the geographic ranges of pathogens and hosts, host and pathogen phylogeny, and life history traits (Malpica et al. 2006)



TAXONOMY: SPECIES IDENTIFICATION

- Can we take care of what we do not know and understand?
- Diverse ways of identification
- paw (foot) of an animal
- Identification keys, an important tool in species identification
- Focus on diagnostic characters – like wing morphology in insects
- Molecular tools



Taxonomy: Animal Classification

Donkey

Kingdom: Animalia

Phylum: Chordata

Class: Mammalia

Order: Perissodactyla
(donkeys, horses, rhinos)

Family: Equidae (horses, donkeys, zebras, among others)

Genus: *Equus*

Species: *Equus asinus*



African Queen Butterfly

Kingdom: Animalia

Phylum: Arthropoda

Class: Insecta

Order: Lepidoptera -
Butterfly/Moth

Family: Nymphalidae

Genus: *Danaus*



Why Identification is Vital: Look – Alike Species

- Rhombic Egg-eater Snake (non-venomous)
- Note difference in body markings
- Puff-Adder (venomous)
- Note head shape markings



Look- Alike Species: Caecilians Vs Earthworms



- An order of limbless amphibians the vast majority of caecilians live underground, in moist soil and sand or leaf litter frequently near water sources; they sometimes shelter in decomposing logs
- Earthworm is a terrestrial invertebrate that belongs to the phylum Annelida, lives in the soil



Earthworm (Source: Wikipedia)



Caecilian in Kibale forest,

Look – Alike Species: Mimicry in Butterflies

Batesian mimicry-A palatable butterfly protected by its resemblance to one avoided by predators (unpalatable)

- *Amauris niavius* (Friar) model vs *Hypolimnastis anthedon* (Variable Eggfly) mimic



Look – Alike Species: Frogs in Stores

- African clawed frog (*Xenopus laevis*) is a large frog species native to sub-Saharan Africa that has become established in the Americas, Europe, and Asia
 - Unlike most frogs, the African Clawed Frog can also survive in water with high salinity (Trueb 2003)
 - Used globally as a laboratory research specimen and is also found in the pet trade
 - African clawed frog mislabelled African Dwarf Frog in pet stores
- African clawed frog **webbing between their claws on the hind legs**
African Dwarf Frogs which **have webbed front feet**

African clawed frog (*Xenopus laevis*) (Source: CABI)



Not so Look-Alike: Sexual Dimorphism in Animals

Xylocopa nigrita carpenter bee, orange male & black female



Impacts of Collection Use in Research: Museum Eagle Egg Collections

- The banning of Dichlorodiphenyltrichloroethane (DDT), an pesticide persisting for a long time in the environment and in animal tissues was banned in USA in 1972, based on research conducted on several museum egg collections
- Scientists compared Museum eagle eggs to modern ones, established link between the pesticide and the brittle, prematurely cracked eggshells
- The birds of prey were poisoned with DDT from contaminated fish interfering with the ability of the birds to produce strong eggshells
- The eggs thin shells often broke during incubation
- How are the birds of prey doing today?



Museum Specimens Support the IUCN Red List Database

- Threatened and Endangered Species- Museum specimens used in **taxon assessments** in support of the IUCN Red List database
- The African savanna elephant (*Loxodonta africana*) is now listed as endangered on the IUCN Red List
- The golden-rumped elephant shrew (*Rhynchocyon chrysopygus*), the largest species of the elephant shrew family is classified as endangered



Golden-rumped Shrew from Sokoke

Museum Collections, Infectious Diseases & Species Extinction (i)



- Chytridiomycosis is an infectious disease of amphibians caused by the fungus *Batrachochytrium dendrobatidis* (Doherty-Bone et al., 2019)
- An emerging disease that is significantly impacting amphibian populations across the globe, populations declined, some species become extinct
- This pandemic serves as a first example for the threat of infectious diseases impact on animals & biodiversity
- It primarily affects the skin of amphibians, through which they breathe and take up water thus interfering with these essential processes
- In Africa, the Kihansi Spray Toad (*Nectophrynoides asperginis*) was driven to extinction in the wild in the Kihansi gorge, Tanzania during a rapid Bd epidemic wave (Weldon et al., 2019)
- The investigations indicated human induced habitat modification, predators, pesticides and disease as possible causes of the rapid population decline (Weldon et al., 2020)
- The amphibian chytrid was previously thought to originate from the African continent based on **infected museum specimens** from early 20th century in South Africa, Cameroon and Uganda (Weldon et al., 2004); Soto-Azat et al., 2010; Vredenburg et al., 2013; Seimon et al., 2015)
- Further research on archived specimens from other continents eventually revealed early 20th century records also in Brazil and Japan
- Recent analysis of genomic diversity and phylogeny of Bd has shown origin from Asia to be more probable (O'Hanlon et al., 2018)

Museum Collections, Infectious Diseases and Species Extinction (ii)



- Decline in amphibians could impact their predators like snakes, long-term data from a particular sites is needed, which is very rare and difficult to attain, but **Museum specimens** can support
- Extinction of amphibians will have other ecological impacts besides those on snakes, removal of frog tadpoles has been shown to lead to more algae growth in streams, depriving them of oxygen (Osborne et al. 2006)
- Surveys have listed infectious disease among the top five causes of species extinctions in the United States (Wilcove et al. 1998)

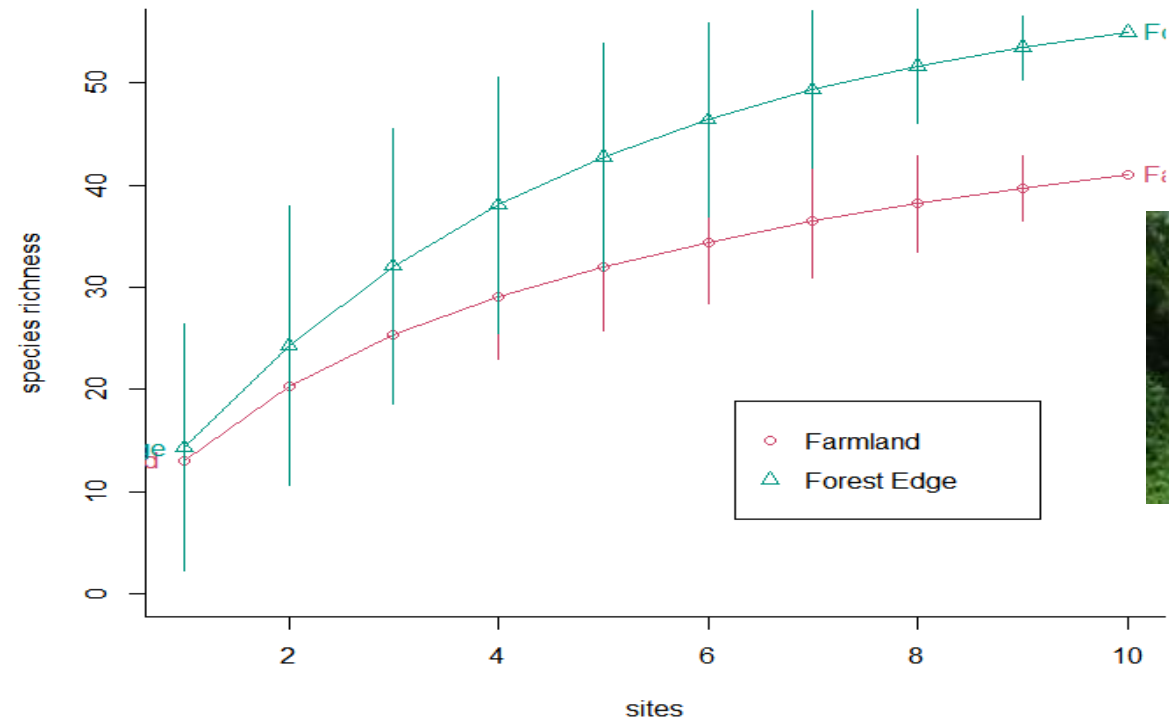
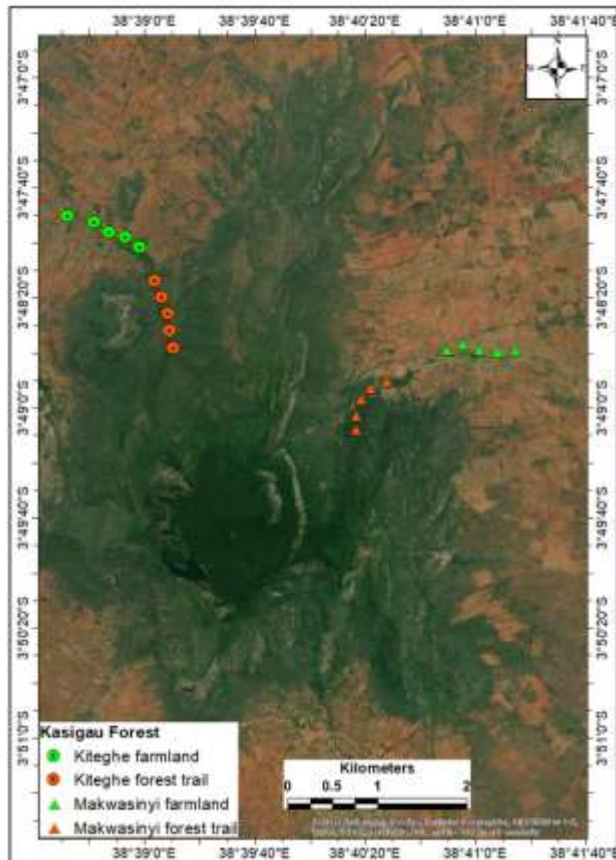
Museum Collections and Animal Diseases: Fish & Birds

- Museum samples used in pathogen surveillance, Go & Waltzek et al 2016, detected infectious spleen and kidney necrosis virus (ISKNV) and turbot reddish body iridovirus (TRBIV) from **archival ornamental fish samples** from 1986 and 1988
- Fecchio & Collins et al 2019, unveiled that **bird tissues from Museum collections** are reliable for assessing avian haemosporidian diversity, critical to the study of avian host-parasite ecology and evolution and for understanding and preventing epidemics in wild bird populations
- Haemosporidian parasites that reproduce and develop in the host blood cells, muscle tissue, and various organs, cause negative effects on the survival and reproduction of their bird hosts
- Thus, identifying wild animal reservoirs can be challenging when museum collections are lacking
- Taxonomy as undertaken by museums is key in understanding the evolution of pathogens and that of their animal hosts
- Emerging infectious disease surveillance requires sampling depth **across space, time, and taxonomy enabled by Museum collections**

Museums, Ecology & Zoogeography Research



- ❖ Field surveys are undertaken to determine the distribution of species, relations to one another and to their physical surroundings
- ❖ Example here: Butterfly/Plant richness along Forest edge & Farmland in Kasigau, Taita Hills



Museums, Ecology & Zoogeography

Research: Species Distribution Maps

- Species distribution maps are done from field survey data
- Example of 2 amphibians, Changamwe caecilians & Bullfrogs (Source: Spawls et al)

East African Caecilians: Genus *Boulengerula*. A genus of relatively large caecilians, with a transverse vent. Usually pink or purplish in colour, with no visible eyes; living in soil, decomposing logs, root tangles etc. Five species are formally described from Kenya, but there are likely more to be discovered, an unidentified form has been recently reported from Ngulia Hill in Tsavo West National Park, a hill range from which no caecilian records exist.

Changamwe Caecilian *Boulengerula changamwensis*

Remarks: A small caecilian, reaching 23 cm in length. Usually pink or purple-pink. Known only from the moist coastal strip, in forest and farmland, from Kilifi southwards to the Shimba Hills.



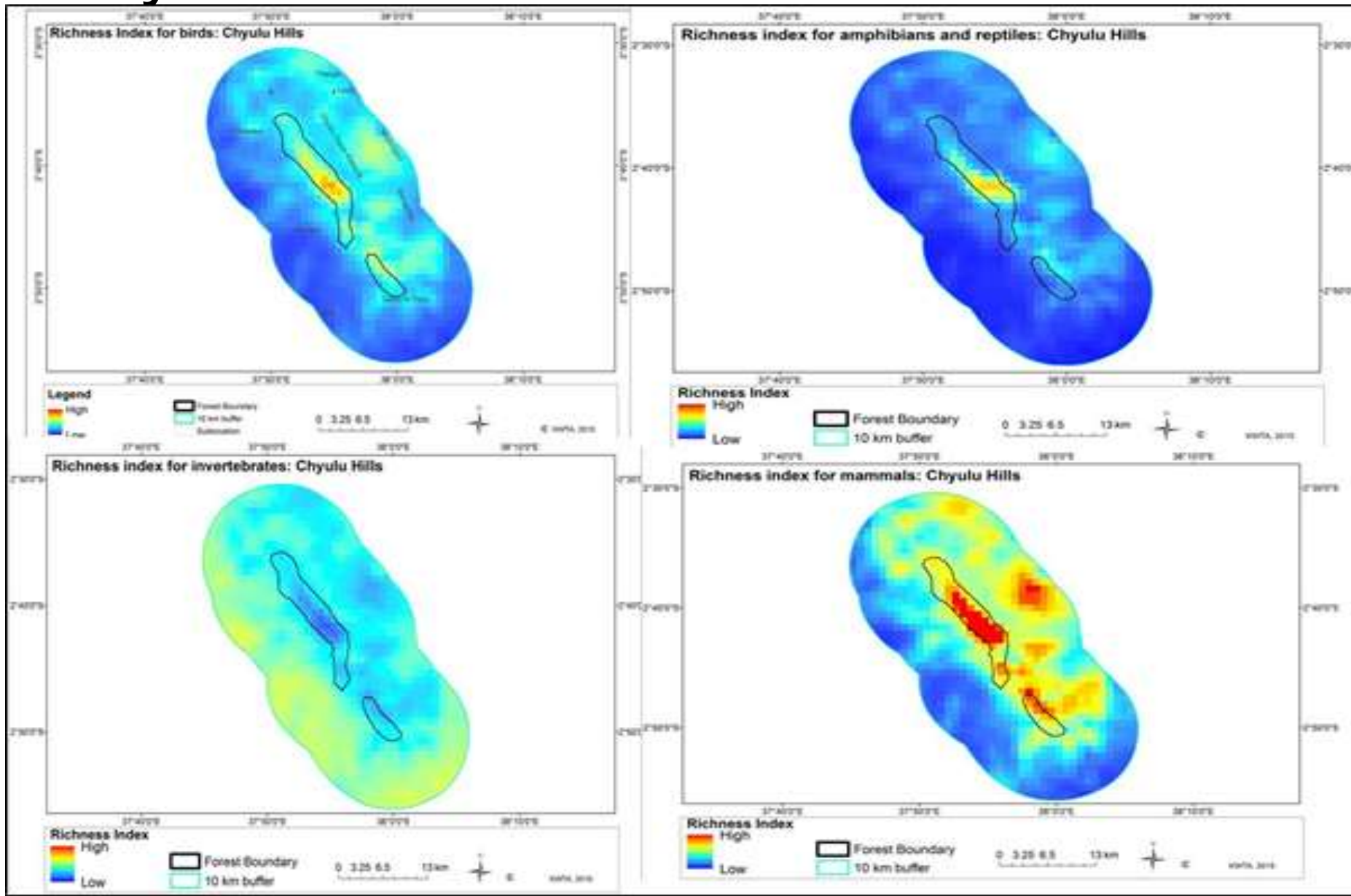
African Bullfrogs: Genus *Pyxicephalus*. Huge squat frogs, the largest in Kenya, up to 12 or 13 cm, in eastern Kenya. They show a remarkable colour change as they grow larger. The taxonomy is confused; the two species recorded from Kenya might not actually be genetically distinct

Edible Bullfrog *Pyxicephalus edulis*



Richness index Maps for different Species in Chyulu Hills

(Source: D.Odeny, NMK)



Museums, Ecology & Zoogeography + IK

- The Local Communities are living adjacent to biodiversity
- They have their knowledge that is key in animal welfare
- Control measures used depending on livestock type, numbers, level of infestation, type of target parasites, available financial resources ...
- Cattle egret (*Bubulcus ibis*) association with cattle – removes ticks and flies & consumes them



***Milletia oblata ssp teitensis* (Mwavwa).**
Used as acaricide in Taita Hills



Museums and Education (i)

- Museum audiences number in the hundreds of millions
- Museum collections and exhibits play a major role in educating and inspiring the broad public
- Museums seed the science education by stimulating curiosity and care for the natural world including animals wild/domestic
- The connection between Museum audiences, collections and expertise forms the foundation of a critical science infrastructure requiring useful, accessible, and visible data and the transfer of expert knowledge to current and future generations



Museums and Education (ii)

- Museums establish education programmes aimed at providing education services for the public
- Scientific Expos
- Cultural Expos
- Clubs such as younger researchers
- Short Courses



Education Support Materials

- Diverse publications by Museum Researchers & Collaborators

An annotated checklist of mammals of Kenya

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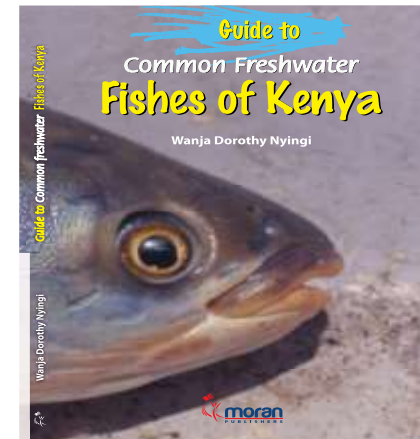
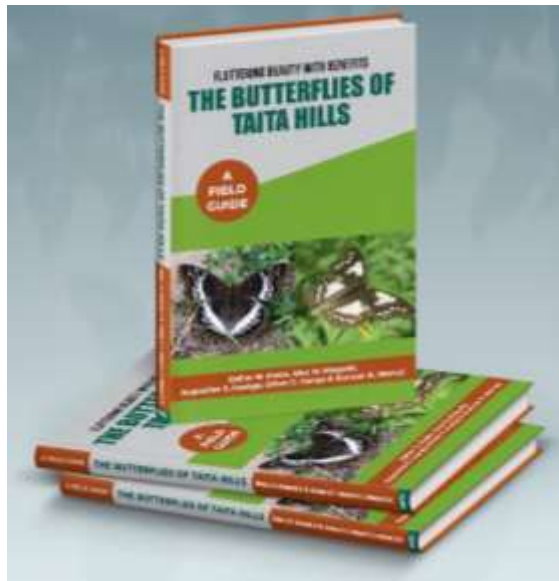
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Abstract

Kenya has a rich mammalian fauna. We reviewed recently published books and papers including the six volumes of Mammals of Africa to develop an up-to-date annotated checklist of all mammals recorded from Kenya. A total of 390 species have been identified in the country, including 106 species of rodents, 104 species of bats, 63 species of even-toed ungulates (including whales and dolphins), 36 species of insectivores and carnivores, 19 species of primates, five species of elephant shrews, four species of hyraxes and odd-toed ungulates, three species of afrosericids, pangolins, and hares, and one species of armadillo, elephant, sirenian and hedgehog. The number of species in this checklist is expected to increase with additional surveys and as the taxonomic status of small mammals (e.g., bats, shrews and rodents) becomes better understood.



CHALLENGES FACING MUSEUMS

- ✓ Museums remain poorly supported and largely disconnected from other animal/ human health initiatives
- ✓ Standards/best practices for many Museums as primary biological infrastructure still not sufficient
- ✓ Most of Museum specimen data is still locked up in paper labels but for effective and efficient access, it needs to be freely available
- ✓ Most museums have focused on voucher specimens with limited tissue sample collections
- ✓ Scientists, policy makers and many others – are not generally aware of the immense resources of Museum collections & how they can be of benefit to animal welfare & biodiversity in general..
- ✓ Little use of the education opportunities at Museums by agencies

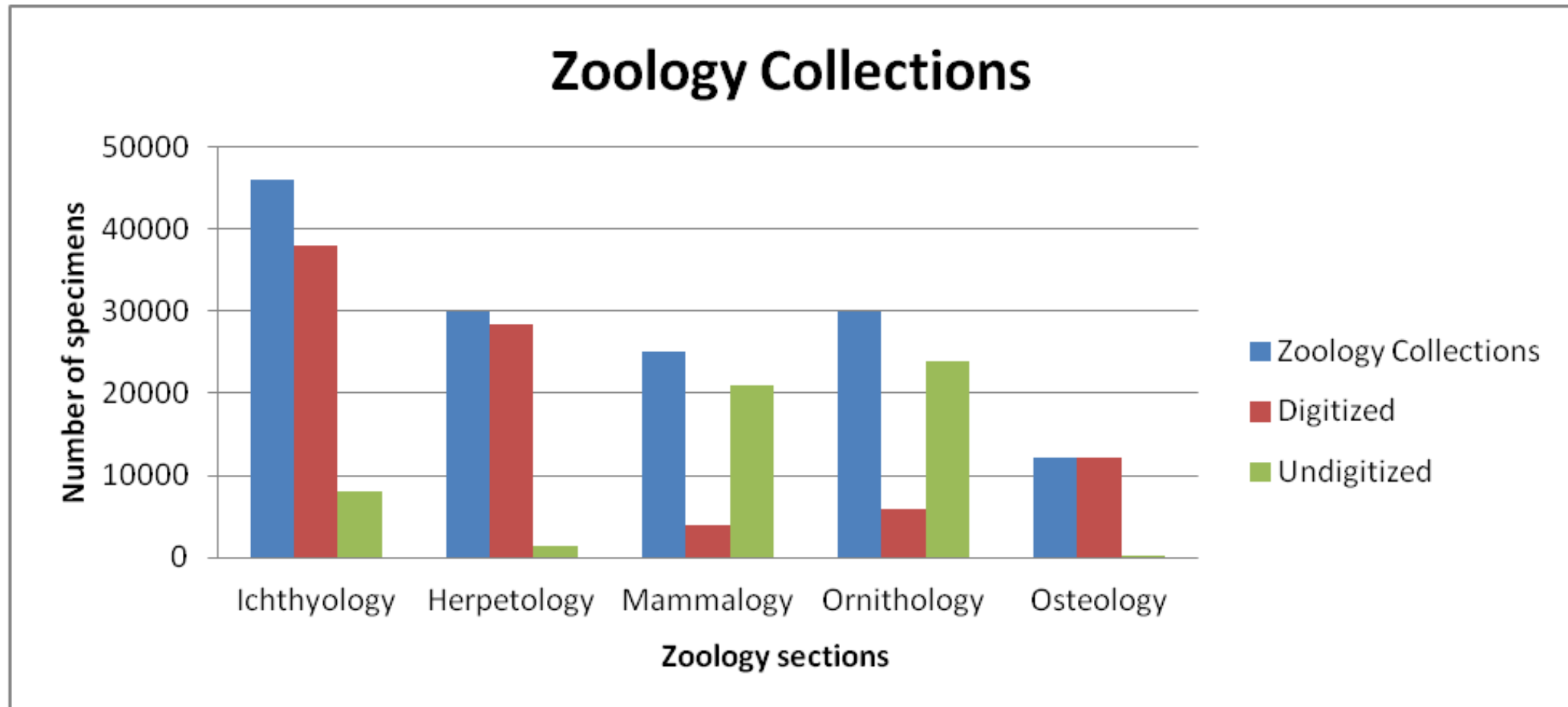
Concluding Remarks

- ❖ Museum collections were acquired from places and time periods that cannot be resampled, making them an exceptional resource for understanding this rapidly changing world
- ❖ Museum collections provide baselines and forecasts for the state of the natural world, through taxonomic and cultural expertise alongside new collections and information systems
- ❖ The disasters of climate change and biodiversity loss makes a strong case for continued collecting – with new collections using the older collections as baselines – to understand the rate /scale of global environmental change
- ❖ Museums hold collections uniquely positioned to respond to today's interconnecting crises in animal welfare, both wild/domestic
- ❖ Need for integrated research on biodiversity and environmental infrastructure in matters of animal welfare
- ❖ Museums present an avenue for promoting awareness and education on animal welfare

Recommendations (i)

- **Search for more specimens:** Report on biological collections by the committee convened by the US National Academy of Science (NASEM 2020) recommendations to GenBank to **require voucher** information for pathogen (and other) genetic information (Cook et al. 2020, Thompson et al. 2021) but we need the right balance between appropriate policy oversight and access/benefit sharing
- **More field surveys:** Changes in climate are altering certain animal behaviors, like the timing of migration, which has the potential to alter multi-host pathogen transmission by changing when and where pathogens and parasites encounter their hosts, affecting both the time and size of disease outbreaks (Altizer et al. 2011)
- **Targeted Population dynamics studies:** Multi-host pathogens may regulate not only populations and communities of host species, but also predator, prey, or competitor populations (Hatcher et al. 2006), the ecology and evolution of multi-host pathogens may also be important for species conservation and biodiversity preservation (McCallum & Dobson 1995, Smith et al. 2006)
- **Vector surveillance:** Arthropods like biting flies (mosquitoes, tsetse flies) ticks and fleas that transmit a pathogen between host species
- **Museum Collection Digitization:** The Atlas of Living Australia is a model for the value of digitization and the ways in which digitized specimen data can be used to solve societal problems, with direct implementation of data tools by governmental agencies – for us mass digitization is possible before it is too late to use the data- ALA the Australian government has invested and is reaping very positive returns
- Huge investment in digitization and databasing by the US National Science Foundation resulting iDigBio, too has positive returns

Digitization Process: NMK Zoology Collections



Recommendations (ii)

- **Museum Collection Digitization:** Leading to virtual Museums accessible through the internet
- **Museum Collection Digitization:** Will minimize handling of the specimens in the collections some of which date back more than a hundred years ago and need preservation in the same state for the current & future generations



Among the oldest specimens in the NMK collection is this blister beetle (*Coryna Kersteni*) from Bagamoyo, Tanganyika Territory, sampled on 15th August 1888

Acknowledgements

- ❖ The 6th Africa Animal Welfare Conference Secretariat for this opportunity
- ❖ National Museums of Kenya and all Museums safeguarding collections
- ❖ My colleagues at NMK for sharing photos and ideas (Ogeto, Malombe, Njoroge, Malonza, Musila, Njagi, Odenyi,)
- ❖ All of you for your audience

African Trident Bat/Triple Nose-leaf Bat (*Triaenops afer*)

Photo credit: S. Musila, NMK



THE END: THANK YOU



The bull elephant “King of Marsabit” a permanent exhibit at the National Museums of Kenya