Assessment of Lepidoptera Pollinator Species Diversity Data in East Africa


Editors
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The project is funded by the JRS Biodiversity Foundation
Assessment of Lepidoptera Pollinator Species Diversity Data in East Africa

Dr. Esther Kioko, Project PI & Head Zoology Department, NMK

Project Duration: 36 Months

Start Date: January 2017

End date: December 2019
Regional Partners: Tanzania

• National Museum of Tanzania

➢ Ms. Adelaide Sallema, the curator of biology at the Museum and House of Culture is the project PI

• National partners in Tanzania

➢ TanBIF

➢ University of Dar es salaam
Regional Partners: Uganda

- College of Natural Sciences, Makerere University
  - Prof. Anne Akol, Department of Zoology, Entomology and Fisheries Sciences of Makerere University is the project PI
- National partners in Uganda
  - National Biodiversity Data Bank
  - Curator of the Zoology Museum
Why this Project?

• Many crops in E. Africa require pollination (pollen transfer from male to female part of a flower) mostly by insects to produce seeds and fruits.

• 75% crops & 80% flowering plant dependent on pollinators, reproduction is key for survival!

• AIVs; important sources of fibre, vitamins and minerals, like eg the spider plant (sagaa) are pollinated by hawkmoths.
Why this Project? (Cont.)

• Economic agricultural value for pollination is estimated at US$ 200 billion in global agriculture
• Economic ecological value of pollination is estimated at US$ 120 billion annually
• Decline of pollinators already recorded..result? Decline in plant reproduction!!!
• Causes: land use change, environmental pollution, climate change among others
Gap in data, information, and knowledge access

• NMK houses about 600,000 Lepidoptera collections in drawers in cabinets
• Zoology museum at Makerere University holds about 40,000 specimens of Lepidoptera in insect cases and envelopes, as well as data records
• Museum and House of Culture, NMT has less than 1,000 of the target specimens
• Not easily accessible to users few are digitized
Gap in data, information, and knowledge access (Cont.)

• Improve the situation as the partners learn from each other and assist each to advance in biodiversity informatics

• Undertake a systematic digitization of specimens in the target Lepidoptera families:
  ➢ Sphingidae (Hawkmoths)
  ➢ Hesperiidae (Skipper butterflies)
  ➢ Papilionidae (Swallowtail butterflies)
Hawkmoths in Storage: NMK Reference Collection
Capacity Building

• The project will improve scientific capacity in the region through training of 3 MSc. Student, one in each Country

• Training of scientists and technical staff in the partners Institutions; at least twenty staff in the region will be trained
Digitization, Capacity Building?

- Field Research, The Eastern Arc Mountains (Kenya & Tanzania) and Mabira Forest (Uganda)
- Joint scientific publications
- Sharing of data using the Integrated Publishing Toolkit (IPT) under the GBIF framework
- Policy briefs
- Creating awareness through pollination exhibitions, media outreach among others
Serving end-Users of insect pollinators data

- Scientists, Scholars, Naturalists
- Biodiversity Conservation Organizations
- Centres for Biodiversity: NMK, the Scientific Authority on species & national focal point, MEAs
- Farmers- Crops, Insect-based( Butterfly farming, Apiculture)
Objectives: 2\textsuperscript{nd} NMK JRS Project Workshop

- To share experiences from the project
- Stakeholders to share their experiences in biodiversity data provision/use
- To train on biodiversity data in reference to standards, publishing, access and policy compliance
- Analyze the current situation and map the way forward for strong collaboration on insect pollinator data collection, sharing and usage
ACKNOWLEDGEMENT

• The JRS Biodiversity Foundation
• National Museums of Kenya
• National Museum of Tanzania
• Makerere University
• All other Partners
• All Participants of this Workshop
The End: Thank You
Welcome speech by the Director General Dr. Mzalendo Kibunjia, National Museums of Kenya.

The Director General welcomed the participants to the National Museums of Kenya (NMK) and thanked all the stakeholders for making time to participate in the workshop. He appreciated the work and progress of the Lepidoptera project in the advancement of insect pollinator’s research and emphasized that it is relevant to the current needs of the country and the world at large. The Director General urged the stakeholders to join hands with the NMK to enhance the advancement of collection, management, publishing and access to biodiversity information in the country and the region at large so that policy makers can recognize the importance of insect pollinators in addressing key environmental issues that face the world today.

He informed the participants that the National Museums of Kenya hosts millions of natural history collections that are nationally and internationally used as reference material for research and academic purposes. He thanked the NMK staff for their role in field collection, laboratory processing, identification and curation work that has kept the collections valuable over the years. He noted with appreciation the importance this project has placed on capacity development for biodiversity informatics in the East Africa region and assured the implementers that the NMK management was in full support of the project. He expressed appreciation for the whole exercise of collection digitization and the progress that this project and the institution is making in the exercise at large. He urged all stakeholders to make collection digitization a priority in their work so as to make sharing of biodiversity data easier in the region and world at large. He acknowledged Dr. Siro Masinde, the key note speaker for this workshop for being a pioneer of collection digitization in the NMK.

The National Museums of Kenya is implementing several projects aimed at improving livelihoods in various part of the country and for years, NMK has been a pillar for the butterfly farming project at the Kenyan Coast around Arabuko Sokoke Forest, based at the Gede NMK Station. He noted that with projects like this, butterfly farming can be extended to other regions to improve livelihoods. He said he is happy the project is partnering with butterfly farmers for real-time demonstration on how the target insects are valuable in livelihood support. He thanked Mr. Mwachola (Shigaro butterfly farmer) for the good work he is doing in training others on butterfly farming in Taita Taveta County and proposed him as an ambassador of butterfly farming, who can share his success Taita Taveta with other communities living around forests for fostering forest conservation and improved livelihoods.

Finally, Dr. Mzalendo emphasized on the need for the project stakeholder institutions to have a memorandum of understanding to strengthen their collaboration. This will facilitate scientist to work together and support mandates of their institutions without duplication of activities. It will also create opportunities for undertaking joint fund raising activities for research projects and capacity building.

The Director General wished the participants an enjoyable two day stay at the NMK and wished them a fruitful workshop.
A SURVEY OF END-USER NEEDS FOR BIODIVERSITY INFORMATION

Esther Kioko, NMK
INTRODUCTION

• Biodiversity informatics is the computerized handling of information on biodiversity

• Considerable biodiversity information has been generated over time within the E. African region

• Application of biodiversity information may provide solution to some current environmental and human related challenges
Environmental Issues
Pollinators: hawkmoths at NMK, Nairobi
What have we done?

• A survey was to identify what kinds of biodiversity information would be useful for a variety of users

• Determine the factors that prevent would-be users from making greater use of the available biodiversity information

• Assess if there is a need for more or better quality biodiversity information
Survey: 32 Institutions, 37 Respondents

- Formulation/implementation of government policy
- Formal education/training: University
- Capacity building of groups such as farmer associations
- Agricultural research and development
- Environmental research/education and advocacy
- Donor /development aid
Findings

• All the 37 respondents indicated that they needed biodiversity information for their work

• Thirty three (89%) of the respondents needed biodiversity frequently

• Four (11%) of the respondents required the information sometimes

• As expected, none of the respondents choose to never want biodiversity information
Source of biodiversity information

- Local institutions: 80%
- Own research: 60%
- EA institutions: 40%
- International institutions: 30%
- Other sources: 10%
What format do you get the requested biodiversity data/information?
Usefulness of forms of biodiversity information to respondents’ work
Occurrence/distribution of different organisms

Types of distribution maps

- Invasive species
- Disease-transmitting organisms
- Moths and butterflies as pollinators
- Honey bee/other bees as pollinators
- Birds
- Plants
- Insect species

Frequency of data need:
- Very often
- Fairly often
- Rarely
- Never

% of responses
# Barrier to biodiversity information

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<tr>
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Conclusion & Way forward

• The need for biodiversity information is real

• Data from Museum collections is of great value as a tool for addressing some of the identified gaps

• Ways should be found to inform policy for enhanced access to biodiversity information

• This project will provide Lepidoptera species diversity, abundance and distribution data that can be used to address some of the expressed needs by biodiversity information users
The end: Thank you

*Papilio desmondi teita*
Hawkmoth (Sphingidae:Lepidoptera)
Digitization at the National Museums of Kenya 2017

Augustine Luanga
Introduction:

Hawkmoths, insects of the moth family Sphingidae

Hawkmoths are more commonly known as sphinx, hawk, or hummingbird.
- Adults have a streamlined body, robust forewings and small hind wings that enable them to have a strong and fast flight and ability of hovering on a spot
INTRODUCTION continued

- Adults have long and narrow proboscis
- Are pollinators of crops and wild flora
- The spider plant vegetable (*Cleome gynandra*: Cleomaceae) and papaya (*Carica papaya*: Caricaceae) are pollinated by hawkmoths (FAO, 1995, Martins and Johnson, 2009; Oronje *et al.*, 2012)
-Darwin (1862) argued that the long spurs (300 mm) of a Madagascan orchid (*Angraecum sesquipedale*) represented a floral specialization for pollination by a long-tongued hawkmoth and later this was confirmed by finding the hawkmoth, *Xanthopan morganii praedicta*
What are we doing?

• Looking at what is already available:

• At the NMK and partner institutions, documenting the current status of the hawkmoths focusing on species diversity, distribution based on the reference collections housed at:

  ➢ Invertebrate Zoology Section, Zoology Department
Capturing of specimen data from labels

- Validity check of geography (geo-referencing)
Databasing in progress at the Invertebrate Zoology lab.
Mapping of species distribution
✓ Some of the databased hawkmoths stored in the cabinets below
Preliminary Findings

• NMK hawkmoth collection digitized 3,889 hawkmoths records consisting of 207 species in 58 drawers from all over Africa

• The digitization work is still ongoing with 10 more drawers to go

• The hawkmoth data is being finalized for publishing through the Integrated Publishing Toolkit (IPT) (http://ipt.museums.or.ke/ipt).
• Hawkmoth Species Distribution in Kenya as per NMK data
Conclusion & Way forward

• NMK collection has 1,097 Kenyan records, consisting of 47 species, Carasson (1976) noted Sphingidae had 100 Kenyan species, more needs to be done beyond borders. Collaborators Welcome!

• Data from Museum collections is of great value as a tool for prioritising conservation actions in E. Africa and that methods that allow objective accounting based on species data are needed

• We hope to continue so as to provide hawkmoth species diversity and distribution data that can be used to monitor their population in the face of current threats and feed policy for conservation of pollinators
Thank you
Lepidoptera Pollinator diversity in Ngangao forest, Taita Taveta County, Kenya

Alex Mutinda
National Museums of Kenya
Background

- Most flowering plants depend mostly on insect pollinators for their reproduction

- Pollination is essential for better yields in cash and food crops for basis of balanced human diets
Problem statement

Most insect pollination studies in East Africa:

- Honey bees
- Stingless bees
- Solitary bees

Thus limited information on Lepidopteran pollinator identity, diversity and role in pollination
Study site

At Ngangao forest in Taita hills forest during long rain season in April-May 2017 to assess diversity of:

- Hawkmoths
- Skipper butterflies
- Swallow tail butterflies
Methodology

• Forest edge and farmland
• Six transects -1km with 5 (100m) working stations
• 3 north and 3 south
• Region: 2 forest edge + 1 farmland
• Sweeping -10 minutes
• Light trapping -2 hours
Cont. Methodology

• Collected specimen were identified using existing literature
• DNA material for barcoding confirmation
• Counter confirmation in lab
14 Swallow tails:
- *Papilio ophidicephalus* (50%)
- *Papilio demodocus* (21.4%)
- *Papilio desmondi teita* (21.4%)
- *Papilio nerius* (7.2%)
Results cont
38 skipper butterflies 10 species:
- *Metisella orientalis* (21.1%)
- *Spialia diomus* (18.4%)
- *Zenonia zeno* (18.4%)
- *Coeliades pisistratus* (13.2%)
- *Spialia spio* (10.5%)
- *Sarangesa phidyle* (05.3%)
- *Coeliades sejuncta* (05.3%)
- *Celaenorhinus galenus* (02.6%)
- *Eagris sabadius* (02.6%)
- *Gegenes niso* (02.6%)
89 hawkmoths were identified:

- **Hippotion celerio** (59.6%)
- **Agrius convolvuli** (14.6%)
- **Basiothia medea** (12.4%)
- **Acherontia atropos** (2.3%)
- **Termnora furmosa** (4.5%)
- **Hippotion eson** (2.3%)
- **Coelonia fulvinotata** (1.1%)
- **Nephele rosae** (1.1%)
- **Nephele accentifera** (1.1%)
- **Nephele funebris** (1.1%)
Conclusion

Swallow tails 4 species *P. ophidicephalus*

Skipper butterflies 10 *M. orientalis*

Hawk moths *H. celerio*

Higher abundance of butterflies on the forest edge

71.053% of skipper butterflies

92.857% of swallow tails

The project will continue with the collection of data in the coming seasons
Asanteni sana
What Next after Digitization?

Esther W. Mwangi
National Museums of Kenya
21st November, 2017
Natural History Collections

• **Specimens** – irreplaceable record of past biodiversity

• **Data** from the specimen label

• **Specimen Images**
Uses

• Foundation for biodiversity
• Morphological identification
• Genetic analysis
• Ecological studies
Networked databases

• MaNIS – mammal collections
• ORNIS – ornithology collections
• HerpNET – herpetological collections
• FishNet 2 – Fish collections
• VertNet – All vertebrate collections
GBIF

- Global Biodiversity Information Facility
- Established in 2001 through an MoU between participating governments
- **Open data** research Infrastructure
- Funded by world’s governments
- Secretariat in Copenhagen
- Uses **Darwin Core standards** to bring the species occurrence records together
Darwin Core

- Body of standards
- Glossary of terms (columns, fields, properties etc.) to facilitate sharing of information
- Based on Taxa their occurrence in nature
  - Observations
  - Specimens
  - Samples
  - Related Info
GBIF Tools

• GBIF Excel templates
  – Checklist Data
  – Occurrence Data
  – Sampling Event Data
• Darwin Core Archive Assistant
• Darwin Core Archive Validator
• Name Parser
# Checklist Data Template

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## Sampling Event Data Template

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|         |               |           |                 |                |                |                |              |             |              |              |                |                |             |           |         |                |          |                |                |             |           |                 |
What’s Next?

- Data paper publishing
- Document impacts of climate change on biodiversity
- Research on species response to climate change
- Species Distribution Maps – geographical data
- Ecological Niche models – environmental data
Data Paper

• A searchable metadata document, describing a particular dataset or a group of datasets, published in the form of a peer-reviewed article in a scholarly journal

• Primary purpose of a data paper is to describe data and the circumstances of their collection
What is a Data paper?

• Provide a citable journal publication that brings scholarly credit to the data publishers

• Describe the data in a structured human-readable form

• Bring the existence of the data to the attention of the scholarly community
Conti.

• Increase the **visibility**, usability and **credibility** of the data resources you publish

• **Track** more effectively the usage and citations of the data you publish
Who publishes Data Paper?

- **Pensoft** (main publisher working with GBIF)
- All their papers are peer-reviewed, open access, rapid published, available online and in print
- Some charge for publishing (€200+), but some don’t
- Innovative techniques for writing, reviewing and publishing of articles at Pensoft, including the Pensoft Writing Tool
Who publishes Data Paper?

Biodiversity Data Journal - biodiversity science containing taxonomic, floristic/faunistic, morphological, genomic, phylogenetic, ecological or environmental data on any taxon of any geological age from any part of the world - no lower or upper limit to manuscript manuscript size
http://www.pensoft.net/journals/ bdj/

Nature Conservation: mobilize ideas and data in all aspects of conservation of nature
http://www.pensoft.net/journals/natureconservation/
Who publishes Data Paper?

**BioRisk** - ecology and biodiversity science  
http://www.pensoft.net/journals/biorisk/

**NeoBiota** - journal launched to accelerate research on alien species and biological invasions: aquatic and terrestrial, animals, plants, fungi and micro-organisms.  
http://www.pensoft.net/journals/subtbiol/
Who publishes Data Paper?

**PhytoKeys** - systematic botany
http://www.pensoft.net/journals/phytokeys/

**MycoKeys** - systematics and biology of fungi (including lichens)
http://www.pensoft.net/journals/mycokeys/

**ZooKeys** - systematic zoology, phylogeny and biogeography
http://www.pensoft.net/journals/zookeys/
Ecological Niche Modelling

• Species distribution models, bioclimatic envelope models or habitat suitability models
• Correlate the presence of a species at multiple locations with relevant environmental covariates to estimate habitat preference or predict distribution
• Characterize environmental conditions suitable for a species, then identify where suitable environments are distributed in space
• Presence-absence model
• Systematic surveys of species
  – Museums
    • Locality data from specimens
    • https://www.gbif.org/
• Environmental variables - http://www.worldclim.org/
Conti.

• Software
  – Maxent
  – qGIS
  – Excel or google sheets etc.
Locality Data on Excel spreadsheet

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Maxent software
Geographic Information System

- Create
- Edit
- Visualise
- Analyse
- Publish geospatial information
## Data spreadsheet

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Maps – Sampling Events and Museum collection Data
Resources

• https://www.gbif.org/data-processing
• DarwinCore reference guide: http://rs.tdwg.org/dwc/terms/index.htm
• https://bdj.pensoft.net/articles.php?id=20044
• National Museums of Kenya
PUBLISHING BIODIVERSITY DATA: DATA PUBLISHING, STANDARDS & IPT @ NMK

LAWRENCE MONDA
NMK/JRS PROJECT WORKSHOP,
NATIONAL MUSEUMS OF KENYA, NAIROBI, KENYA, 21ST NOVEMBER 2017

Resource from IDIGBIO and GBIF
WHAT DO WE MEAN BY DATA PUBLISHING?

making biodiversity datasets publicly accessible & discoverable, in a standardized form, via an access point, typically a web address (a URL).
WHY PUBLISH DATA?

Data Use
Data Quality
Attribution

Uses of Specimen Data:
Data Quality
DATA COLLECTION & STANDARDS

- Data quality starts with what you collect & ends with what you publish
Biodiversity Data Standards

- **Darwin Core**
  biodiversity informatics (specimen and observation data)

- **Audubon Core**
  multimedia related to specimens
**DARWIN CORE**

**What:** Darwin Core is a glossary of terms intended to facilitate the sharing of information about biological diversity.

**How:** The Darwin Core is based on taxa, their occurrence in nature as documented by observations, specimens, samples, and related information.

**Where:** [http://rs.tdwg.org/dwc/terms](http://rs.tdwg.org/dwc/terms) provides reference definitions, examples, and commentaries.
DATA STANDARDS & DARWIN CORE

• With data standards like Darwin Core, we have established rules for how we enter certain fields.

• examples:
  • Date
  • Lat/Lon
  • Genus
  • Species
MORE ON DATA STANDARDS FOR DARWIN CORE

• **Dates:** – `dwc:eventDate` is a date and nothing else.
  • Also for `dwc:day`, `dwc:month`, `dwc:year`:
    • this is not a month: Spring
    • this is not a day: 10-18
    • this is not a year: 1989? Or [1989]

• **Taxonomy are reserved fields too:**
  • this is not a species: shrimp

• Get rid of your Tics:
  • * [] {} ?...

Use the verbatim & remarks fields for things that do not fit the definitions.
MORE DATA TIPS…

Your dataset is no longer just for local use, there are other considerations for being digital, and available to the public:

1) Put dates in ISO 8601 format, i.e., YYYY-MM-DD, e.g., 2014-06-22
2) fill in dwc:scientificName with genus and species
3) parse out the dwc:scientificName elements to fill in dwc:genus and dwc:specificEpithet
4) Provide as much higher taxonomy as you feel comfortable with, fill in tribe, sub+super family, kingdom, division, class, order) get out of ‘family’ land.
5) Make sure lat and lon coordinates are in decimal, and not degs, mins, secs,
6) Do not export '0' in fields to represent no value. (This applies to all place holders)
7) put elevation in METERS units in the elevation field without the units (e.g., the fields dwc:minimumElevationInMeters and dwc:maximumElevationInMeters already assume the numeric values are in meters, so there is no need to include the units with the data)
8) Watch out for diacritics, save in UTF-8 (encoding)
Data Sharing
DATA PUBLISHING: WHERE TO BEGIN WITH NMK

• Email lmonda@museums.or.ke / ewmwangi@museums.or.ke
Metadata
METADATA

A set of data that describes and gives information about other data.

• For us, its data that describe a biodiversity dataset.
• Metadata facilitates:
  • Data discovery
  • Search & retrieval
  • Reuse (licensing)
  • Attribution
  • Expressions of fitness-for-use
  • Communication
Data publishing software
Integrated Publishing Toolkit
To publish your data, follow the 7 steps below.

1. Select class of data
2. Transform data
3. Upload data to IPT
4. Map data
5. Fill in metadata
6. Publish dataset
7. Register dataset
http://Ipt.museums.or.ke/ipt

THANK YOU
Biodiversity Information Use in Conservation of Water Towers in Kenya

By Dr. Winnie Musila
Director, Ecosystem Assessment, Planning and Audit
Outline

- What are Water Towers
- Mandate and Functions of KWTA
- Biodiversity hotspots in Conservation planning
- Biodiversity hotspots identification
- Challenges
- Recommendations
What are Water Towers

“Water Tower” means an area that acts as a receptacle for rain water and that stores water in the aquifers underneath it and gradually releases the water to the rivers and springs emanating from it or

- an elevated landscapes of relatively high altitude that forms source of water either permanent or seasonal that flows to the surrounding lowlands.

- Through their watershed function, the Water Towers supply Kenya’s drinking water, its energy, water for irrigation, industry, water for food and other purposes.
Distribution of Water Towers

- 41 Water Towers
  - 18 gazetted
  - 23 non-gazetted
The Mau Complex forms the upper catchments of all (but one) main rivers west of the Rift Valley, including:

- Nzoia River (Lake Victoria)
- Yala River (Lake Victoria)
- Nyando River (Lake Victoria)
- Sondu River (Lake Victoria)
- Mara River (Lake Victoria)
- Kerio River (Lake Turkana)
- Molo River (Lake Baringo)
- Ewaso Nyiro River (Lake Natron)
- Njoro River (Lake Nakuru)
- Nderit River (Lake Nakuru)
- Makalia River (Lake Nakuru)
- Naishi River (Lake Nakuru)

It feeds major lakes, including:

- Lake Victoria
- Lake Turkana
- Lake Baringo
- Lake Nakuru
- Lake Natron

of which three are cross-boundary:

- Lake Victoria (Nile River Basin)
- Lake Turkana (Kenya / Ethiopia)
- Lake Natron (Tanzania / Kenya)
Importance of Water Towers

Mau Complex: key to major conservation areas

1. South Turkana National Reserve
   - Scenic landscape. Wildlife plentiful

2. Kerio Valley National Reserve
   - Kamnarok National Reserve

3. Lake Baringo
   - Important Bird Area (over 470 species)

4. Lake Nakuru National Park
   - Second most visited protected area
   - Ramsar Site (1990)
   - Important Bird Area (over 450 species)

5. Lake Natron
   - Main breeding area for the flamingoes in the Rift Valley

6. Maasai Mara National Reserve
   - World famous for big game and great migration
   - Important Bird Area (over 450 species)

7. Serengeti National Park
   - World Heritage Site
   - World famous for big game and great migration
   - Important Bird Area (over 540 species)

8. Kakamega Forest National Reserve
   - Only remnant in Kenya of the Guineo-Congolian forest ecosystem
   - High biodiversity (birds, butterflies, plants...)

Maasai Mara NR & Lake Nakuru NP
Entry fee (2007): Kshs 1.16 billion / year
Direct and indirect revenues (2007): approx. Kshs 5 billion / year
A large majority of Kenya’s population lives in Lake Victoria basin. This region is crossed by major rivers flowing from the Mau Complex. Millions of people live in the sub-locations crossed by these rivers.

In addition the Mau Complex provides environmental services essential to crop production (continuous river flow, favourable micro-climate conditions) as well as many products (medicinal plants, firewood and grazing).
Importance of Water Towers

Biodiversity Value - species Richness/Concentration in Kenya
Threats facing Water Towers
KWTA MANDATE AND FUNCTIONS

1. **Co-ordinate and oversee** the protection, rehabilitation, conservation, and sustainable management of water towers;

2. **Co-ordinate and oversee** the recovery and restoration of forest lands, wetlands and **biodiversity hot spots**;

3. **Promote** the **implementation** of sustainable livelihood programmes

4. **Mobilize resources** from the Government, development partners and other stakeholders as well as through payment for environmental services

5. In consultation with the relevant stakeholders, **identify water towers** and watersheds for protection;

6. **Assess and monitor** rehabilitation, conservation and management activities in the water towers.
Conservation Planning – hotspots approach including biodiversity hotspots

- Given limited resources – need for conservation planning

This involves;

- Identification and mapping of **hotspots** based on **biodiversity, land use and land cover change**, Critical water catchment areas, slopes and altitude, climatic conditions and human activities.

- Documentation of the **values attached** to the ecosystem

- Identification of **threats** to the ecosystem

- Identification of **priority areas of intervention**
Factors considered in identification of biodiversity hotspots

- Biodiversity hotspots are defined by one or more species-based metrics including species richness, number of species restricted to a particular area and number of rare or threatened species.
- Areas with high species richness
- Habitats of endangered species
- Areas that experience environmental threats
- Wildlife corridors and areas with special association to wildlife e.g. breeding areas
- Centres of endemism
- Areas with high human/wildlife conflicts
Biodiversity hotspots identification and mapping

Desktop Research

1. Consolidate known/ existing biodiversity data on plants, mammals, birds, etc/. these datasets can be easily generated from museum’s collections (zoo/botany)

2. Complement the consolidated data with existing public shared databases such as Jstor, GBIF and any other existing literature

3. Geo-reference the datasets using google earth, FTEA Gazetteer amongst others

4. Expose the data to GIS application programme and have mock GIS
5. Once you visualize your data and ensure points of georeferenced are within the area of interest conduct **spatial analysis and generate the richness maps** which indicate the various **pockets of hotspots**

6. After generating the hotspots based on the desktop research arrange for fieldwork and **also prioritize on areas to visit based on hotspots** generated in no 5.

7. **Field work** to validate and confirm the biodiversity hotspots. This includes assessments of micro-habitats, ecological functions, taxa richness and environmental threats within a 1 km transects distributed throughout the Water Tower.
List of Datasets used in BD hotspots ID

- **Major Biodiversity taxa** for plants, mammals, birds, invertebrates, amphibians and reptiles from the National Museums of Kenya (NMK) databases and the Global Biodiversity Information Facility portal (GBIF) with spatial references for the whole country.

- Species listed by the IUCN in the red list of threatened species.

- Species listed in the CITES

- Background environmental layers like current climatic data acquired from WorldClim, for Temperature, Precipitations and their derivatives.

- Animal Census data from KWS

- Human wildlife conflict data
Process of determining biodiversity hotspots

1. Bird Distribution Point
2. Plant Distribution Point
3. Mammal Distribution Point
4. Invertebrate Distribution Point
5. NDVI

Correlation analysis leads to:

Distribution Points for species of conservation importance:
- Loxodonta africana
- Prunus africana

Species Distribution Modeling

Species distribution model:
- Loxodonta africana
- Prunus africana

Richness layer:
- Birds layer
- Plant layer
- Mammal
- Invertebrate

Biodiversity Hotspot

Revised Biodiversity Hotspot

Ground Truthing and Hotspot validation:
- Microhabitat
- Environmental threats
- Ecological function
- Taxa richness
Case Study of the Chyulu Hills Water Tower

Chyulu Hills is a water tower situated 190 km South-East of Nairobi and 30 km South-West of Kibwezi. It lies between 37.85° to 38.01° East and 2.60° to 2.84°. Its the main source of springs that provide fresh water to the south coast.
The biodiversity hotspots in Chyulu Hills are predominant in the **eastern side of the Chyulu Hills**. These areas serve important role in diverse micro-habitat, generally high species richness and simultaneously experiencing diverse environmental threats. The areas include:

- South of Mang’elele,
- South of Chyulu Game reserve
- Northern area of Muthingiini and
- North west of Olorika
Species Richness Index

- **Birds**
- **Amphibians and reptiles**
- **Invertebrates**
- **Mammals**
- **Plants**
Species of Conservation Importance

- Threatened, rare, endemic species – based on IUCN Red listed and CITES listed

Areas with IUCN Red-Listed Plant Species

Areas with Endemic Plants in Chyulu Hills
Threats affecting Chyulu Hills Water Tower
Priority Areas for Conservation

- Based on the analysis, **priority areas that should be provided high attention for conservation and protection from further deterioration of the existing environmental conditions are identified.**

- They basically consist of hotspots based on **biodiversity hotspots, critical water areas, biodiversity hotspot, critical steep areas, high elevation areas, areas with high population density, riparian areas (200m buffer), and forest loss.**

- Combinations of these hotspots at pair levels or intersection of all hotspots provides a scenario to view intersecting conservation issues in Chyulu. Each intersecting conservation issues are accompanied by the general proposed **interventions that** are meant to provide a general direction for **guided conservation actions.**
Priority Areas for Conservation

- The overall hotspot is classified into **three zones** depending on requirement for intervention:
  
  - **Priority Areas 1** - this requires **immediate intervention** and includes the following areas: Chyulu Game Reserve and Muthingiini areas as highlighted in red
  
  - **Priority Areas 2** - includes Mang’elele and Eastern Olorika areas highlighted in yellow
  
  - **Priority Areas 3** - includes Tsavo Game Reserve highlighted in green
## Priority Areas for Conservation in Chyulu Hills

<table>
<thead>
<tr>
<th>Conservation priorities</th>
<th>Intersecting conservation matrix (priority issues)</th>
<th>Interventions</th>
<th>Colour Code</th>
<th>Sublocation</th>
</tr>
</thead>
</table>
| Priority Areas of Conservation | Critical Water Areas | Biodiversity Hotspot [Species richness, Species of conservation importance, and Conservation threats (observations)] | - Conservation of areas of significant plants and animal occupancy.  
- Participatory conservation of species of conservation importance on areas of occupancies  
- Improving habitat conditions (e.g. cover) for the animals  
- Initiate promulgation of 10% on-farm tree covers | | Chyulu Reserve Muthini |
| | | Endemic Species | - Detailed study on endemic species and their specific distribution  
- Specific species-conservation effort directed on species in areas of concern  
- Encouraging natural adoption of endemic on farms by local residents | | |
| | | Forest Loss | - Replanting, buffering to allow for forest regeneration, enforce the 10% on-farm tree cover | | |
## Priority Areas for Conservation in Chyulu Hills

<table>
<thead>
<tr>
<th>Priority areas of conservation</th>
<th>Biodiversity Hotspot [Species richness, Species of conservation importance, and Conservation threats (observations)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Slope</td>
</tr>
<tr>
<td></td>
<td>- Restriction of settlements in those areas</td>
</tr>
<tr>
<td></td>
<td>- Prevention of cultivation</td>
</tr>
<tr>
<td></td>
<td>- Reservation of forest/bush isolation on steep slope areas</td>
</tr>
<tr>
<td></td>
<td>- Avoid cultivation on steep slopes in critical water areas</td>
</tr>
<tr>
<td></td>
<td>Endemic Species</td>
</tr>
<tr>
<td></td>
<td>- Specific species-conservation effort directed on species in areas of concern</td>
</tr>
<tr>
<td></td>
<td>- Encouraging generation of the endemic plants</td>
</tr>
<tr>
<td></td>
<td>- Encouraging natural adoption of endemic on farms by local residents</td>
</tr>
<tr>
<td></td>
<td>Elevation</td>
</tr>
<tr>
<td></td>
<td>- Restoration of deforested areas</td>
</tr>
<tr>
<td></td>
<td>- Encouraging reforestation and/or afforestation of indigenous trees</td>
</tr>
<tr>
<td></td>
<td>- Restriction of settlements in those areas</td>
</tr>
<tr>
<td></td>
<td>- Prevention of cultivation</td>
</tr>
<tr>
<td></td>
<td>- Encouraging zero-grazing only</td>
</tr>
<tr>
<td></td>
<td>Forest Loss</td>
</tr>
<tr>
<td></td>
<td>- Replanting, buffering to allow for forest regeneration, enforce the 10% on-farm tree cover</td>
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<thead>
<tr>
<th>Priority areas of conservation</th>
<th>2a). Elevation</th>
<th>Endemic Species</th>
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</thead>
<tbody>
<tr>
<td>3</td>
<td></td>
<td>- Detailed study on endemic species and their specific distribution</td>
</tr>
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<td></td>
<td></td>
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</tr>
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<td></td>
<td></td>
<td>- Encouraging natural adoption of endemic on farms by local residents</td>
</tr>
</tbody>
</table>

- Olorika Mang’e
- Olorika Oltiasika
- Tsavo West Game Reserve
Priority Areas for Conservation in Chyulu Hills
Challenges and Recommendations

Challenges
- Limited biodiversity data on some taxa and Water Towers
- Limited spatial data
- Data Access

Recommendations
- More biodiversity assessments – if possible prioritised to the Water Towers
- Need for digitization of existing collections
- Need to incorporate spatial information in biodiversity assessments
- Data agreements to enhance data access
- Build long-term partnerships – MoU
Success and challenges of digitizing unique groups of insect specimens in the zoological collection of National Museums of Kenya

by

James J. Odanga
Invertebrate Zoology Section, National Museums of Kenya
Invertebrate collection, NMK

 Depository of over 2.8m specimens
 Collection curation & management
 Data basing ~ digital imaging

Invertebrate Zoology Section, National Museums of Kenya

http://www.museums.or.ke
Some of unique groups of insect specimens

Butterflies

Beetles

Ants

$Pachycondyla\ tarsata = Paltothyreus\ tarsatus$
Data-basing process; ants (Hymenoptera: Formicidae) in zoological collection, NMK

<table>
<thead>
<tr>
<th>Cat_No</th>
<th>Family</th>
<th>Genus</th>
<th>Species</th>
<th>Author</th>
<th>Locality</th>
<th>Country</th>
<th>Collector</th>
<th>Date_of_collection</th>
<th>Drawer_No</th>
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<td>Gerst</td>
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<td>L. S. B Leakey</td>
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</table>
Citation:
Ownership of digitized insect data

Data description
Metadata language
  English
Data language
  English
GBIF registration
  Registration date
    7 July 2017
  Last modification date
    27 September 2017
  Publication date
    27 September 2017
Host
  National Museums of Kenya
Installation
  National Museums of Kenya IPT
Installation contacts
  • Lawrence Monda
Endpoints
  • http://ipt.museums.or.ke/ipt/archive.do?r=nmk_ants_data (DWC ARCHIVE)
  • http://ipt.museums.or.ke/ipt/eml.do?r=nmk_ants_data (EML)
Identifiers
  • http://ipt.museums.or.ke/ipt/resource?r=nmk_ants_data
Last successful crawl
  31 October 2017 (Not modified)
Last successful crawl with changes
  27 September 2017 (Normal)
Crawling completion reasons
  • 26% Normal
  • 63% Not modified
  • 11% Abort
Crawls in total
  19

Citation
Can deduce information from occurrence data of ants for use by policy makers; national & county

<table>
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Ecosystem type
Collector/ affiliation
Historical / Current data
Spatial data
Challenges of data basing insect collections

- Insect specimens are very brittle hence digitization of museums collection requires high quality personnel
- Taxon names revision requires consultation & networking across taxonomic experts, institutions & nations
- Digitization of museum collections is expensive and time consuming
Way forward/ recommendations

- Need for continued taxonomic trainings within & between institutions/ nations
- Collaborative work programmes where research activities are shouldered by all members of the collaboration
- Need for long-term financial support for digitization efforts
- Enhance passion & consistency for entomology among upcoming data basing personnel
Thank you
Title: Contribution of KEFRI IRC to biodiversity information on pollinators

Presenter: Miriam Gathogo
ARS KEFRI
KEFRI IRC

- Insect reference collection was started in 1950 under East African high Commission EAC

- By then IRC was East Africa Community Services Organization

- Specimens have been collected from East and Central Africa region
Divisions in IRC
Divided into 3 sections:

- Main collection: was for the 3 East African countries
- Duplicate collection – was owned by Kenyan government. All biodiversity here reflects in the main collection
- The two were merged in 1977 after the breakdown of the EA community
- Surplus collection – The excess insects that are donated to museums, schools and Universities. All the orders are represented
What does IRC contain:

• Collection of insects of different orders consisting of many families representing about 6,000 identified insect species. There are 50,000 pinned insect specimen and 10,000 wet collection of insects

• Reprint library – Some project activity findings in form of reprints

• Wood specimen showing different categories of damage by insects

• Records on insects which have been identified by the British Museum(IIE)

• >1000 Unidentified insect specimens
What does IRC contain contd’

- G-books showing insect identification, distribution, host, activities and their localities
- Card index – shows how many species are in the drawers, whether there are immature stages and the drawer number for easier location of the insect
- Posters showing lifecycles of different insects
- A separate termite collection
Lepidoptera in IRC

- 281 families

Species identified:
- Sphingidae - 10
- Hesperidae - 24
- Papillionidae - 4
Uses of IRC

- Some of the information available include: insect taxonomy, species distribution, host species, and their localities
- For identification though cross reference with what we have
- Provide training materials to foresters and students
- Custodian of original/voucher material (holotypes)
- Centre of excellence of collection of insects of order Coleoptera
How IRC contributes to identification of members in Order Lepidoptera

Advisory services to farmers and other stakeholders through:

a) Morphological characterization - Cross reference using morphological features e.g.:
   (i) Antennae; capitate/filiform/segmented
   (ii) Wing venation; Hairy/Smooth

b) Records in the IRC could show previous attack by an insect, its distribution and associated host

Best management strategies of insect-pests and also conservation of beneficial insects
Ways of improving KEFRI IRC

- Complete digitization process
- Georeferencing points of specimens collection
- Mapping of different species
- Publish in GBIF
THANK YOU
DATA SHARING IN THE DIGITAL DIVIDE
DIGITAL DATA LICENSING

GILBERT BUSOLO LUSWETI
ICT OFFICER

22ND NOVEMBER, 2017
Creative Commons is a nonprofit organization that works to increase the amount of creativity (cultural, educational, and scientific content) in “the commons” — the body of work that is available to the public for free and legal sharing, use, repurposing, and remixing.
Creative Commons:

Creative Commons is a global non-profit organization dedicated to supporting an open and accessible internet that is enriched with free knowledge and creative resources for people around the world to use, share, and cultivate.

Easy-to-use licenses provide a simple, standardized way to give the public permission to share and use your creative work — on conditions of your choice.

CC licenses let you change your copyright terms from the default of “all rights reserved” to “some rights reserved.”

Millions of people use CC licenses on some of the world’s most popular platforms for user-generated content.

When you use a CC license to share your photos, videos, or blog, your creation joins a globally accessible pool of resources that includes the work of artists, educators, scientists, and governments.
Kenya is home to a thriving cultural industry. These varied creatives require access to shareable resources that facilitate remixing and creativity. It is, however, important to deepen the understanding of new users in Kenya of CC licenses and their usefulness.

The increasing use of CC licenses in Kenya will help enhancing the visibility and accessibility of Kenyan creativity in the global networked space.
Copyright vs Creative Commons:

Copyright is a legal right created by the law of a country that grants the creator of an original work exclusive rights for its use and distribution. This is usually only for a limited time.

Creative Commons is actually a license that is applied to a work that is protected by copyright. It’s not separate from copyright, but instead is a way of easily sharing copyrighted work.

Creative Commons licenses are not an alternative to copyright. They apply on top of copyright, so you can modify your copyright terms to best suit your needs. We’ve collaborated with copyright experts all around the world to ensure that our licenses work globally.

It makes it easy to share work without giving up total control or spending countless hours granting permissions.
Open access (OA) refers to online research outputs that are free of all restrictions on access (e.g. access tolls) and free of many restrictions on use (e.g. certain copyright and license restrictions).

Open access can be applied to all forms of published research output, including peer-reviewed and non peer-reviewed academic journal articles, conference papers, theses, book chapters, and monographs.
Why Creative Commons?

The internet makes it easy for people to share and build on each other’s creations. But sometimes the law makes it hard.

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#CCAfrica2012 CC Licenses have a common setback: LACK OF ENOUGH AWARENESS AND KNOWLEDGE OF WHAT CC LICENSES ARE.
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Asante.
Application of GIS and data sharing technologies in biodiversity research and conservation

Dickens Odeny

National Museums of Kenya
CONTENT

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  – Definition of data
  – Data sharing
  – Data Taskforce
  – Basic data sharing framework
  – Data Ownership, Copyrights and Intellectual Property Rights
  – Governance framework

• **Biodiversity Informatics and Geographic Information System (GIS)**
  – GIS Spatial Data Types
  – Geographic Variables
  – Data Capture
  – Creating and Building Biodiversity Data Attributes
  – Data storage and retrieval

• **Spatial Data Infrastructure (SDI)**
  – SDI software components
  – Current SDI Initiatives
Introduction

Data/information

• Data: Any recorded information, regardless of the form or medium on which it may be recorded, and includes:
  – writings,
  – films,
  – sound recordings,
  – pictorial reproductions,
  – drawings,
  – Designs or other graphic representations,
  – procedural manuals,
  – forms,
  – diagrams,
  – work flow charts,
  – equipment descriptions,
  – data files,
  – data processing or computer programs (software),
  – statistical records, and
  – other research data.
Data/information Sharing

• The ability to share the same data resource with multiple applications or users.
• This implies data should be stored in one or more servers in the network.
• Data sharing is a primary feature of a database management system.
Data Taskforce

- Taskforce is created to address the overarching challenge of developing privacy-preserving frameworks which support automated data sharing to facilitate smart services creation and deployment.
- Taskforce address technical, regulatory, and authorising frameworks
- The taskforce identify best practice from where it is known to exist. Thus, consider existing models.
Basic Data Sharing Framework

The framework describes increasing access to data with ever fewer restrictions:

• **The data set exists** – no detail may be provided other than the existence of the data set. For example, knowing that a register of species occurrence exists

• **Details about the data set** – such as sharing details of the scope, parameters involved (often referred to as the data dictionary), period over which the data is collected

• **Ability to interrogate aggregated, perturbed, or obfuscated data** – the ability to run a defined set of logical operations over, and receive a result from, data which has been de-identified in some way without accessing the data itself. Access may further be refined through the level of aggregation, perturbation, or obfuscation
• **Ability to access aggregated, perturbed, or obfuscated data** – the ability to run an unlimited set of queries over data which has been de-identified in some way

• **Access to data** – this may still be restricted to certain individuals, for certain approved purposes in secure operating environments, there is no technical limitations to the operations which may be performed

• **Ability to share data** – some systems limit how data is accessed to prevent further sharing.
Data sharing frameworks with quantified access control
Data Ownership, Copyrights and Intellectual Property Rights

• Levels of restriction accorded
  • Citation and acknowledgement
Governance Frameworks

- Existing Standards Driven Frameworks
  - ISO Standard 38505-1
  - European Union – General Data Protection Regulation
  - Evolutionary Governance Models
Biodiversity Informatics and Geographic Information System (GIS)

- **Biodiversity Informatics**
  - Biodiversity
  - Informatics
  - Taxonomic,
  - Biogeography
  - Ecological information

- **Geographic Information System** (GIS) is an integrated computer based system designed to capture, store, manipulate, analyze, manage and present spatial or geographic data.

- Modern computer techniques,
- Predictive models for information
GIS Spatial Data Types:

- **Vector**: comprised of vertices and paths
  - Point data
  - Polyline data
  - Polygon data
- **Raster**: made up of a grid of pixels
Geographic Variables

- **Discrete Variables (Distinct boundaries)**
  - River: Polyline feature
  - Village: Point or Polygon
  - Species occurrence: Point
  - Land Cover Land Use

- **Continuous Variables (Fuzzy boundaries)**
  - Temperature
  - Precipitation
  - Elevation
  - Ecotone
  - Species occurrence
Data Capture

1. Primary GIS Data Capture Techniques
   - Remote sensing and
   - Surveying technologies
   Raster data capture and vector data capture

2. Secondary GIS Data Capture Techniques:
   - scanning,
   - manual digitizing,
   - vectorization,
   - photogrammetry, and
   - COGO feature construction.
Creating and Building Biodiversity Data Attributes

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Back  Biodiversity Informatics
Data storage and retrieval

Storage of geographic datasets in an organizational structures and defining relationships between those datasets

Spatial data files and formats:
- .shp (ESRI Shapefile)
- .kml/z (GoogleEarth)
- .gpx (GPS)
- Grid formats (.img, .tiff, etc)

Spatial database (and DBMS):

Database is optimized to store and query data that represents objects defined in a geometric space

- Open-source spatial databases and APIs
- SpatiaLite extends Sqlite
- Oracle Spatial
- Microsoft SQL Server (2008)
- PostgreSQL DBMS (PostGIS)
- MySQL DBMS (datatype geometry)
Spatial Data Infrastructure (SDI) (Data sharing technology)

- A spatial data infrastructure (SDI) is a data infrastructure implementing a framework of geographic data, metadata, users and tools that are interactively connected in order to use spatial data in an efficient and flexible way.

- SDI should enable the discovery and delivery of spatial data from a data repository, via a **spatial service provider**, to a user.

**SDI software components**

- **Software client** - to display, query, and analyse spatial data (this could be a browser or a desktop GIS)

- **Catalogue service** - for the discovery, browsing, and querying of metadata or spatial services, spatial datasets and other resources

- **Spatial data service** - allowing the delivery of the data via the Internet
• **Processing services** – geoprocessing
• **Spatial data repository** - to store data, e.g., a spatial database
• **GIS software (client or desktop)** - to create and update spatial data
• **Policy and Standards** - allow interaction between the different software components. **Open Geospatial Consortium** (e.g., OGC WMS, WFS, GML, etc.) and **ISO** (e.g., ISO 19115) for the delivery of maps, vector and raster data, data format and internet transfer standards

---

**Spatial database (and DBMS):**

Database is optimized to store and query data that represents objects defined in a geometric space

- Open-source spatial databases and APIs
- **Spatialite** extends **Sqlite**
- **Oracle Spatial**
- **Microsoft SQL Server** (2008)
- PostgreSQL DBMS (PostGIS)
- **MySQL DBMS** (datatype geometry)
Current SDI Initiatives

• National Level
• Regional Level: Asia-Pacific and the European region
• Global Level: GBIF, PROTA
Biodiversity & Taxonomy

- African Plants - A Photo Guide
- African Plant Database
- AmphibiaWeb
- Biodiversity Hotspots
- Catalogue of Life
- Encyclopedia of Life
- Global Biodiversity Information Facility (GBIF)
- IUCN Red List of Threatened Species
- KEW Species Browser
- Global Population Dynamics Database (GPDD)
- InfoTree (information about trees, woods and forests)
- Kenya Reptile Atlas
- Lifemapper
- MammalDIET (diet preferences of mammals)
- Map of Life
- MoveBank
- OneZoom Tree of Life
- PanTHERIA (database of extant & recently extinct mammals)
- The Plant List (working list of all plant species)
- Plant Resources of Tropical Africa (PROTA)
- Species Link
- Tanzania Biodiversity Information Facility (TanBIF)
- Tanzania Mammal Atlas Project
- Tanzania Tree Species Checklist
Sharing information using Google Earth/Map
Acknowledgement

• Dr. Esther Kioko
• JRS Project Team
• Workshop Organizing Committee/Secretariat
• National Museums of Kenya
• Workshop Participants
Advisory services for pest management with a view to conserve beneficial insects

Mwaniki, S.W    KALRO Kabete
• Over the years the entomology subsection has received insect samples and collected others from all over the country

• These samples have been identified by family, genus and species
• The section has over 5000 species from different orders and families
• The identification process has used keys for orders alongside the species collections

• Whenever new species were collected the identification was confirmed by the British Historic museum
The purposes of the collection were either to map the species present in the various parts of the country by researchers or for recommendations for pest management to clients especially farmers.

In the past, KALRO did not carry out research on pollinators although this is a principal area where crop production can be reduced significantly especially in cross pollinated crops.
Introduction

• Recently some work has been carried out by Kasina and others on pollinators especially pollinator bees

• This has opened the pollinator area for research if funding is available

• In the day to day work in entomology section, pollinators have been considered alongside other beneficial insects
Methods of pest control

The methods recommended include:

- Cultural control
- Use of host plant resistant varieties, use of biological control
- Use of botanicals and easily degradable insecticides
Methods of pest control

- Insecticides are used as a last result and especially on non-food crops e.g. cotton and lawns.

- The recommendations for management start in the order of the least harmless to non-targets to the more harmful.
Cultural control methods

• These are the common practices that have been used by farmers for pest management.

• The recommendations to clients always require them to carry out these instructions and only move to the next level if the pests continue to damage crops beyond the economic threshold level. These are the common practices that have been used by farmers for pest management.
Cultural control

• Cultural practices are best practices for crop growing to exclude pest from plots

• These include deep ploughing/digging to expose pests to heat and natural enemies e.g. birds

• Planting and harvesting early to establish the crop before pests arrive and harvesting early to avoid late pests and carrying them to the store
Cultural control

- Weed free plots are recommended because some weeds are sources of pests.
- The burying or burning of debris after harvest is important because this discontinues the life cycles of pests.
- Filling cracks around crops closes the pathways for pest to reach the crops especially for root crops.
- Using ash for some pest deters some pests especially those that hide in the soils like cutworms while.
- Pruning opens the crops to avoid hideouts for pests.
- Strong water jets wash out some pest while crop rotation stops pest built up.
Cultural control

- Some pests can be easily washed by soap and detergents sprays

- The push and pull methods are also recommended where a more susceptible crop is planted surrounding or alternate with the major crop so that the pests leave the crop for the alternative host
Mechanical control

• Mechanical methods include collecting and crashing the pest especially the large insects

• The mass traps both in the ground and within the crop

• Pheromone traps, sticky traps which use colour for attracting specific insects are very safe and can be quite effective
Physical methods

• The other physical methods include Screen nets and greenhouses to keep off insects

• In addition, some plant extracts has been demonstrated as useful

• Such concoctions include garlic, pepper and marigold
Host plant resistance

Plant varieties that are resistant to the pest and the use of genetically modified crop/organisms (GMOs) where genes for resistance to the pests are engineered to the plant like Bt cotton, Bt maize are also safe pest management methods that are recommended.
Biological control

• Use of parasites which infest insects causing mortality, predators that feed on insects

• Parasitoids that feed on the inside of pests causing mortality

• Insect diseases e.g. the granulosis virus against the diamond back moth are some measures presented to farmers as safe pest management options

• The use of various strains of Bt; xentari, thuricide, entomopathogenic fungi and nematodes are other options recommended
Insecticides

• Insecticides are the most effective methods of pest control but they have several negative effects including operator hazards, hitting non targets (pollinators, and natural enemies) and environmental pollution

• This is especially so for the non-degradable insecticides which happen to be instant mortality factors

• There are three classes of pesticides, the lower toxicity and highly degradable pesticides where the products of degradation are safe to the environment
Insecticides

• These include plant based insecticides like pyrethrins and neem

• Others are of medium toxicity and degrades moderately which include synthetic pyrethrins
Insecticides

• The third class is highly toxic and are non-degradable

These include; synthetic organo phosphates, organo cholorines and organo carbons
Insecticides

• When insecticides are recommended against pests that are hard to manage, they must be used judicially beginning with the most friendly ones to the operator, non target organisms and the environment.

• The client uses the lowest effective dose and is advised on proper targeting of pests to reduce runoff and misdirected sprays.
Insecticides

• Most insect pests live on the lower surface of leaves and spray must therefore cover this area.

• The sprayer nozzles have to phase upwards from lower leaf surface for effective contact.

• The third class of pesticides is used as a last resort and only on non-food crops like turfs and crops like cotton.
Conclusion

New pests come without their natural enemies and at their first appearance they are very serious pests. E.g

- Kenya mealy bug from Uganda
- Serpentine leaf minor on chrysanthemums
- The larger grain borer
- Western flower thrip
- Most current problems experienced in Kenya with *Tuta absoluta*
- Fall army worm on maize
Nature preserves a balance in crop fields as demonstrated by the seriousness of these pests at their first appearance. This is also true about pollinators.

Thank you.
Identification of butterfly species and food plants in Taita Taveta County

Clivon Mwachola
Shigaro Butterfly Project
Shigaro butterfly project

• The shigaro butterfly project was started in 2004 as a conservation and economic activity for butterflies

• The project mainly breeds the family Papillionidae for export

• The pupa stage of the butterfly is what is exported

• The species bred are as follows
Cont’

- Papilio ophidicephalus
- Papilio nerius
- Papilio desmondi teita
- Papilio demodocus
- Papilio jacksoni
- Papilio echeriodes
- Papilio dardnus tibullus
**Identification**

- Most of the Papilios exhibit sexual dimorphism
- I.e Male and female of the same species look completely different e.g *Papilio dardnus*, *Papilio jacksoni* and *Papilio echeriodes*

Others are differentiated by the size and brightness of their colours whereby;

- Females look slightly bigger and brighter while males are smaller and not bright
- Females fly with slow, buoyant and sailing motion while males normally patrol an area with fast sailing flight
Food plants

- Papilio butterflies feed on plants during their larval stage (Caterpillars)
- Their food plants are majorly in Rutaceae family, mainly citrus of dicotyledonous group
- Major characteristics of these larval food plants are;
  - Leaves dotted with translucent oil glands
  - Leaves aromatic when crashed
  - Regularly small flowers with four or five sepals
  - Most of their fruits are berry or drupe and are edible
Examples of food plants for Papilio larvae

- Clausena anisata
- Toddalia
- Fagarra
- Teclea
- Catadentria
Methods of breeding

• Cage breeding- Using shed nets
• Bag breeding- using bags- putting adults inside to lay eggs
• Eggs – place them under leaf of the larval leaf plant
• Predators for the larvae are wasps, green spiders among others
• Egg hatch after 1 week depending on weather
Larvae

- The larvae feeds on the egg shell on the first day of hatching
- Changes in size and color every week
- They face predation from wasps, birds, insect eating bats and other predators
- When threatened, they produce pungent smell through osmoterium which emerges from the head as horns
- During the day, they live on the trunk or base of the food plant to avoid predation
- After 4 weeks, the larvae produce sticky white silk and attaches itself firmly on the leaves
- With the aid of the girdle, it attaches itself to the branch and clasp at the back and starts pupating which takes 24
- The pupa takes about 1 month to emerge as adult butterfly depending on species and temperature
Conclusion

• By breeding butterfly, their numbers have increased in my farmland as compared to other areas
• Besides the export business, the butterflies provide other ecosystem services like pollination
• The butterfly farming has been success and I will recommend it to other farmers
Gracious
Section 62 (1) A person may, upon application, access any data or information upon payment of a prescribed fee.
(2) the institute shall avail the data or information under subsection (1) in the format requested unless:

- (a) it is reasonable for it to make the information available in another format; or
- (b) the information is already publicly available and easily accessible to the applicant in another format.
(3) the institute may refuse to grant an application under subsection (1) where the data or information requested is classified and restricted

(4) the institute shall communicate to the applicant, in writing, the reasons for refusal within 21 days from the date of the making the decision
Section 5 subsection (g)

- (i) research priorities
- (ii) the collection and management of the data and information regarding the status of wildlife resources
- (iii) procedures for gathering wildlife data and the analysis and dissemination of wildlife information
Wildlife- Definition

- any wild and indigenous animal, plant or microorganism or parts thereof within its constituent habitat or ecosystem on land or in water, as well as species that have been introduced into or established in Kenya

- (are butterflies, tsetse, bees, wasps, ants etc. wildlife? Pests?)
The sixth schedule of the wildlife Act

- Nationally listed critically endangered, Vulnerable, nearly threatened and protected species
- 7 mammals critically endangered
- 19 mammals as endangered
- 37 mammals as Vulnerable
Birds

- 2 Birds as critically endangered
- 12 Birds listed as Endangered
- 13 Birds listed as Vulnerable
- 30 Birds listed as near threatened
- 37 Bird listed species are protected
Reptiles

- 2 are listed as critically endangered (Hawksbill turtle and Du Toits Torrent Frog)
- 8 listed as Endangered
- 3 listed as threatened
- 2 listed as Vulnerable
- 38 listed as protected
Fish

- 7 listed as critically endangered (4 of them tilapia)
- 4 listed as endangered
- 15 listed as Vulnerable
Trees

- 2 listed as endangered (Voi Cycad and East African Sandalwood)
- 6 listed as Vulnerable
Seventh Schedule – National List of invasive species

- 1 Mammal (Coypu rat)
- 18 Birds
- 7 reptiles and amphibians
- 12 plants
Areas of active jurisdiction

- 24 Terrestrial National Parks
- 6 Marine Parks
- 27 National Reserves
- 102 Community Conservancies
- 26 Private Conservancies
Listed 242 species of bees in four families (Apidae 92, Halictidae 76, Megachilidae 72 and Collectidae 6)

487 species Lepidoptera were listed belonging to three families (Papilionidae, Lycaenidae and Pieridae)

Unknown number of Microlepidoptera exist in the forest

Over 600 species of moths are also listed
- www.biota-africa.org/reg_east_ba.php
- www.biota-africa.org/reg_disciplines_main_ba.php
1. list any endangered species in the sixth schedule (as per section 5 j-criteria for listing and measures for protection and management of endangered and threatened species)