

**Global Pollinator Summit (GPS)
And
Proposal Development Meeting
(PDM)**

*1 – 4 July 2008
Durban, South Africa
And
16-20 Feb, 2010 Nairobi, Kenya*



CONSORTIUM FOR THE BARCODE OF LIFE



FINAL REPORT

April 2010

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**Workshop Host: Plant Protection Research Institute,
Agricultural Research Centre, South Africa and International Centre
Of Insect Physiology and Ecology, Kenya**

**Main Meeting Sponsors: National Science Foundation, Global Biodiversity Information
Facility, Consortium for the Barcode of Life,
The Integrated Taxonomic Information System,
The Smithsonian Institution and BioNet-International**

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Executive Summary

A Global Pollinator Summit was held during 1-4, July 2008 at Tala Game Reserve near Durban, South Africa and was followed with another proposal development meeting in Nairobi, Kenya on during February, 16-20, 2010. The Global Pollinator Summit and the Nairobi proposal development meeting assembled 35 and 26 United States and sub-Saharan African scientists, postdoctoral, graduate students and international bee scientists respectively. The main programs that were represented in both meetings include: the African Pollinator Initiative (API), the Consortium for the Barcode of Life (CBOL), the Global Biodiversity Information Facility (GBIF) Global Pollinator Species Campaign (GPSC), the Integrated Taxonomic Information System (ITIS) and the UVIMA¹ project. These initiatives had different but complementary and overlapping goals, stemming from the central role that taxonomy plays in each of them and their concern for declining bee populations.

The Global Pollinator Summit and the Nairobi Meeting took advantage of the convergent goals of the three principal sponsors: NSF, GPSC and CBOL. The NSF goals were to: (a) facilitate knowledge exchange between US and African-based bee scientists; (b) promote the development of joint research projects; (c) promote the building of communication linkages between US and Africa based bee research scientists; (d) promote the identification of common problems and challenges for which shared solutions and approaches could be useful; (e) provide the forum for developing integrated research strategies and arranging future exchange visits to African and US laboratories by US and Africa-based scientists respectively.

The goals for the GPSC were to: (a) develop a detailed plan for a global campaign to acquire and disseminate taxonomic and collections data and information on pollinators that will be useful for a variety of conservation and scientific applications; and (b) develop specific plans for using data and information to (i) build, maintain a World Bee Checklist that contains all accepted species names, synonyms, and common names, (ii) assist in the identification of pollinator species and (iii) help determine the status and trends of pollinators.

CBOL's goals for the workshop were to: (a) promote global participation in the Bee Barcode of Life Initiative (BeeBOL); (b) expand the participation of African researchers and initiatives in the BeeBOL (c) promote DNA barcoding as a standard practical and reliable approach to pollination-related specimen identification in Africa and elsewhere; (d) identify applications of DNA barcoding in bee pollination research, and initiate planning and implementation of projects in pollination in Africa and elsewhere; and (e) create mutually beneficial partnerships with API, the GPSC and other institutions in Africa.

The workshop brought together basic and applied scientists, taxonomists, ecologists, DNA-based methods and database management specialists. Participants to the Global Pollinator Summit and the proposal development meetings discussed shared goals, challenges and opportunities in bee science and developed project proposal modules respectively. In addition, mechanisms to foster interaction, release taxonomic data, and improve pollinator biodiversity conservation were proposed. Priority research projects were identified during the Global Pollinator Summit as: (a) overcoming bee taxonomic impediment; (b) developing sustainable stingless bee-keeping in Africa (c) providing data on the status of pollinators; (d) assessing the value of pollinator services; (d) barcoding pollinators of cocoa, *Xylocopa* and stingless bees of Africa; (e) developing a bee or pollinator web portal. The Summit also discussed an agenda for improving bee collections in Africa. The follow-on meeting to the 3-day Proposal Development Meeting which developed project modules for taxonomy and for the conservation and management of stingless bees in Africa.

¹ <http://eafrinet.museums.or.ke/uvima.html>

General Introduction

Two meetings were organized in Africa to promote cooperation and joint research in bee research between USA and Africa based scientists. The first meeting, the Global Pollinator Summit was held on 1-4, July 2008 at Tala Game Reserve near Durban, South Africa (see annex 1 for agenda of the summit). A follow-on Proposal Development Meeting was held in Nairobi, Kenya on 16-20 February, 2010.

I. The Global Pollinator Summit (GPS)

Introduction

The Global Pollinator Summit assembled 35 United States and sub-Saharan African scientists, postdoctoral, graduate students and international bee scientists (annex 2 and 3). A variety of research initiatives in bee science were represented at the summit, including, the African Pollinator Initiative (API), the Consortium of the Barcode of Life (CBOL), the Global Biodiversity Information Facility (GBIF)'s Global Pollinator Species Campaign (GPSC) and the Integrated Taxonomic Information System (ITIS). These initiatives had different but complementary and overlapping goals, stemming from the central role that taxonomy plays in each of them and their concern for the global declining bee populations.

The Summit brought together basic and applied scientists, taxonomists, ecologists, specialists involved in DNA-based methods and information technology. The Summit took advantage of the convergent goals of the three principal sponsors: NSF, the GBIF Global Pollinators Species Campaign (GPSC), and CBOL.

NSF sponsored goals for the workshop were to: (a) facilitate knowledge exchange between US and African-based bee scientists; (b) promote the development of joint research projects; (c) to promote the building of communication linkages between US and Africa based bee research scientists and with existing Africa based networks; (d) facilitate the identification of common problems and challenges for which shared solutions and approaches could be useful; (e) promote the process of developing integrated research strategies and arranging the groundwork for future exchange visits to African and US laboratories by US and Africa-based scientists respectively.

The goals for the GPSC were to: (a) develop a detailed plan for a global campaign to acquire and disseminate taxonomic and collections data and information on pollinators that will be useful for a variety of conservation and scientific applications; and (b) develop specific plans for using data and information to: (i) build, maintain a World Bee Checklist that contains all accepted species names, synonyms, and common names, (ii) assist in the identification of pollinator species and (iii) help determine the status and trends of pollinators.

CBOL's goals for the workshop were to: (a) promote global participation in the Bee Barcode of Life Initiative (BeeBOL); (b) expand the participation of African researchers and initiatives in the BeeBOL; (c) promote DNA barcoding as a standard practical and reliable approach to pollination-related specimen identification in Africa and elsewhere; (d) identify applications of DNA barcoding in bee pollination research, and initiate planning and implementation of projects in pollination in Africa and elsewhere; (e) create mutually beneficial partnerships with API, the Pollinator Species Campaign and other initiatives and other institutions in Africa.

Overview of the Summit Structure

The summit began with a half-day devoted to introductory presentations on the objectives and expected products, goals of the sponsors, overview of status of African bee

research infrastructure, pollinator issues in different countries in Africa, (see Annex 4). Another half-day was devoted to presentations on focal themes of the summit including digitization of collections, taxonomic catalogues and checklists, identification of pollinator species, tools and applications for monitoring the status and trends of pollinators and stingless bee cultures. Two half-days were devoted to discussions in break-out groups. The first discussion-group was devoted to the GPSC. The second group was devoted to bee DNA barcoding and the third break-out discussion was devoted to research needs, challenges and priority pollination-related projects in Africa. The final half-day was spent in plenary discussions, sharing and integrating findings of the break-out groups.

Reports from Group Discussions of GPS

Research Group:

1. Needs

The group identified needs, priorities and proposed actions for each identified project including: the need for curated bee collections; bee databases; capacity for bee research; and multi-language bee literature including translations. Permits for collecting and letters of support will be needed from different countries to facilitate collaboration and transfer of specimens for identifications in collaborating laboratories.

2. Shortcomings in the African region

The research break-out discussion group identified the following shortcomings in bee research in Africa: (a) inadequate expertise and infrastructure in taxonomy; (b) insufficient data on the status of pollinators, their services and host plant identification; (c) unavailability of data on stingless bees despite their importance in honey supply and ecosystem services; (d) inadequate outreach programs to school children and policy-makers; (e) scarce data on managed pollination, monitoring and conservation of pollinators; (f) inadequate number of computer scientists; (g) absence of a non-governmental organization to coordinate pollination-related activities; (h) limited information on the causes of bee decline due to agrichemicals and climate change; (i) inadequate Franco/Anglo-Africa integration; (j) few mitigation options; (k) economic evaluation of bee services and products has not been undertaken; (l) lack of a portal for bee information-exchange; (m) lack of information on invasive plants/ bee diseases, visitation/ pollination (bee-plant interactions) and ecology of bees; and (n) non-existence of standardized research methodologies.

DNA Barcoding Group Report:

Participants: E. Frimpong, J. Gibbs, G. Goergen, D. Michez, L. Packer (rapporteur), M. Rightmyer.

The DNA barcoding group used the GPS recommendations as a basis of discussion.

1. Needs:

Properly preserved Specimens: Between 5 and 10 specimens of each species from the species' geographic range will be needed if possible. The precise location of the samples should straddle the type locality (these to be made available through the African bee catalogue), although a single specimen from the actual type locality should be adequate. The Bee-BOL campaign manager will keep track of all the data to ensure that multiple individuals from the same locality are not barcoded unnecessarily. Whenever barcoding suggests that the identity of a "species" is more than a discrete unit, additional sampling will be required. Material should be obtained from museum specimens wherever possible. This requires the contact list of African, and other, institutions with recently collected material. This information should be compiled as soon as possible and the campaign manager will be responsible for soliciting required samples. Pilot projects to barcode small numbers of specimens from each museum with recent collections can be performed with available funds. Field locations will be identified where collecting will be required during the campaign.

2. Funds:

The most likely future source of large scale funding for Bee-BOL will be the International Barcode of Life (iBOL) initiative funded by the Canadian Government (through Genome Canada) with additional sources from Canada and other countries involved in the international effort. Information is being solicited for grants received and applied for since September, 2006, or being planned until 2013, to help bolster co-funding. Additional granting sources can be local, regional or international. CBOL and iBOL will be able to assist with preparation of grant applications.

3. Priorities:

The barcoding priorities identified at the inaugural Bee-BOL meeting that are consistent with the Summit objectives are the Xylocopa of the world, stingless bees of the world, agriculturally important bees of the world, and exotic and invasive species. There were extensive discussions on the first three objectives. Additional topics that were recommended by the bee Summit participants were barcoding of cacao and oil palm pollinators. However, only cacao pollination was discussed at the Summit. It is necessary to increase awareness of barcoding as a tool for identification of specimens. The availability of barcoding as an identification tool was an “eye opener” for many participants and was a potential saviour for cacao pollinator research.

4. Action Items:

1. Michael Ruggiero, Connal Eardley and Georg Georgen to come up with a list of museums and other institutions in Africa that may have recent samples of bees and also provide contact information.
2. Denis Michez and John Ascher will compile similar lists for European and North American institutions that have recent collections of African bees.
3. Jason Gibbs will email the contact people and arrange for small numbers of specimens to be sent to him.
4. Laurence Packer will contact and send additional information to people who may have potential co-funding.
5. Laurence Packer will attempt to add cacao pollinators to the iBOL research plans and email Barbara Herren for contact information for cacao producers outside of West Africa.
6. Eric Frimpong will coordinate samples of cacao pollinators from West Africa.

Campaign Group:

The overall need is to refocus the campaign and develop a fundraising strategy to move the campaign forward. Ideas generated by the working group included:

1. Create a “Bee Portal” as a one-stop-shop. It will include or link to identification keys, species information, and GBIF data. The portal needs guarantees of data security (i.e., data are first accessible in generalized grid cells, but further resolution is available by application to the data provider). Huge data sets exist and should be available with an adequate security plan. Other bee portals, e.g., DiscoverLife, IABIN PTN, NAPPC, etc. should be linked. Portal hosting should be offered to geographic areas that require it. Capacity building in the IT area is greatly needed. Tools (online in a production mode) for collections support should be included to get data into the portal and to improve the quality of collections. The World Bee Checklist should be one of the first data sets in the portal. Action: Thomas Hermann, Jack Hill, and Peter Schalk prepared a proposal outlining requirements and an architecture for the Bee Portal (annex 5).

2. Create a “Strategy and Action Plan” for data acquisition (i.e., who has data where, what is needed to mobilize these data, priorities, funding/donors, etc.). The current Convention on Biological Diversity (CBD)’s International Pollinator Initiative is inadequate in that it is unfunded. The GEF-funded and FAO-led Global Pollinator Project focuses on six countries and about 40 agricultural crops. A much broader-based campaign is needed to report adequately on the 2010 target of the CBD regarding pollinators.
3. A donor conference is needed. Foundations and industry should be visited for sponsorship. ALARM-type economic and food security data should be presented as a compelling story. See book from UK – “A World without Bees.” Look at “Plants of Africa”, funded by Moore Foundation as model. Public involvement (e.g., students, teachers, citizens) is also needed.
4. Develop better strategies and marketing tools to provide support to collections. This should include capacity-building (e.g., training, train-the-trainers, curricula, technical support, IT infrastructure, etc.). At least ask major museums to start digitizing their type collections. Perhaps GBIF, the South African GBIF node, and WDCBE can work together to sponsor digitization training courses for Africa.

Recommended Actions

1. A Global Pollinator Information Portal is needed. It should be a distributed, non-redundant network. A draft design document is presented in Annex 5.
2. A Global Pollinator Assessment is needed. A Project Design Team should be created and given 3-6 months to develop a project proposal. The assessment should learn from previous efforts like the MEA, Global Amphibian Assessment, and the Global Mammal Assessment. It should include useful risk-based world-wide maps similar to those in the ALARM project.

Integration

Five major integrative topics emerged from the plenary discussions of the group results: Global Pollinator Assessment, Global Monitoring of Status and Trends and Pollination Services, Stingless Beekeeping, Outreach, and Taxonomy. Each topic requires broad actions and support from a variety of disciplines and sources.

Global Pollinator Assessment

The assessment should contain summary statistics by country about the relative importance of pollinators to its crops and natural resources. The assessment should also highlight the dependency of plants and ecosystems on pollination and identify critical information gaps. The Millennium Ecosystem Assessment and other regional and global reports (Global Amphibian Assessment and Global Mammal Assessment) should be consulted for format and guidance. While the initial focus should be on bee pollinators, and especially honeybees initially, other pollinator groups such as hummingbirds, bats, and other insect groups should be added as possible. The assessment should proceed through a series of regional writing workshops which review and synthesize existing data and information. An information infrastructure should be developed to manage the data and reporting for the assessment, but it should rely heavily on existing infrastructure and tools. It should support key building, identification and metadata tools as well as allow acquisition, collation, and editing of data and information.

Global Monitoring of Status and Trends and Pollination Services

A system for monitoring the global status and trends of pollinators and their ecosystem services should be created that integrates DNA barcoding and existing collections and uses the global assessment collection infrastructure and bioinformatics tools. Monitoring should include discovery, expeditions, and inventory. The program should link the Millennium Seedbank with African Pollinator information (to maintain bank). National and regional research and synoptic collections, supported by DNA barcoding should be integrated into the program.

Stingless Beekeeping (Africa Focus)

Stingless beekeeping is an important potential economic opportunity for Africa. There is an urgent need to inventory and discover existing and new taxa (and gaps), document existing knowledge, and understand more about bee biology. There are 300 species in Brazil and 30 species in Africa. Exchange of experts, students, practitioners, information, and technology between Africa and Brazil would be very useful and could have very positive effects for bee conservation and poverty alleviation. Basic lessons already learned in Brazil such as splitting hives and increasing honey yield can be shared with Africa. It is also important and a high priority to obtain traditional knowledge about stingless bees and beekeeping in Africa. DNA barcoding can be developed to assist in selecting the best species for meliponiculture. Baseline barcoding for most stingless African bees may already exist. It is also essential to emphasize and support the management and protection of stingless bee colonies and to introduce practices that optimize pollination capacity. Besides honey production it is also important to recognize the adaptability of these bees for sustainable crop pollination (i.e., natural bees for commercial application) and to assess threats such as potential climate change effects. Data and information from the Global Pollinator Assessment should be integrated with African data and issues. There is a need to assess the importance and relative contribution of Apis and non-Apis pollination by crop.

There is a need to learn more about hive products (e.g., medicinal properties), disease and predators, and economic benefits of pollination services as well as honey and hive products.

An extensive training program is required that includes conservation topics as well as beekeeping techniques. A Brazilian-African-US exchange program to support training in would be beneficial.

Outreach

The Campaign should have a significant outreach element. A coordination process or mechanism is needed and it should focus on policy makers. The North American Pollinator Protection Campaign should be looked at as a model. Partnerships are needed. The message should be simple, to the point, and provide real economic case studies and implications. Both social and non-social bees should be emphasized. It should also be a clearinghouse for pollination-focused graduate degree programs.

Taxonomy

Good taxonomic information and knowledge underpins the Campaign. Identification keys are needed, both simple and academic, at regional and national levels. Existing keys should be digitized, web-enabled and allow geographic filtering for species. They should also be available on CD and in print form. They should include pictures of bees and nest structures and be usable by specific local communities. They should also be multi-lingual and free of cost. Exchange programs should be developed to train trainers that build keys.

Research and Funding

The suggested research projects listed below and expanded in Annex 7 were to provide a scientific basis for the recommended research, management and assessment activities. The projects and activities should be closely coordinated to allow rapid transfer of the information generated in the research projects to the management and assessment activities.

NSF can fund basic taxonomic and revisionary studies that involve African scientists, biological studies of stingless bees and staff exchange programs with students. Other potential funding sources including international organizations, development agencies, private foundations, and government should be approached to support the major campaign activities.

The participants suggested the following projects for Africa. Concept notes attached to these projects are described in annex 7

Goal of the projects: Sustainable Development of African Bees.

Priority Project Areas (with suggested African and US leaders *. Names in *italics* did not attend the Summit):

1. Status and Needs of Taxonomy in Sub-Saharan Africa
 - Inventory African collections, literature, locality covered, and curation standards. Examine the collections to inform the state of collections: Coordinators: Simon and Stuart.
 - How to access the state of collections.
 - Funds are needed to capture African material in US collections for access, images can then be repatriated.
 - Who manages the collections? Data standards and questions. Coordinators: Stuart, John A., Terry, Denis, Mary and Millicent.
2. Overcoming the Taxonomic Impediment in Bee research in Sub-Saharan Africa (Coordinators: Connal,* Mary, Terry, John A.*);
3. Assessment and Evaluation of African Pollination Services (Nestor, Mary, John Kasina, Simon, Peter K.*, Georg, *K. Aidoo, W. Kinuthia, Brazilian cooperator, B. Vaissere, T. Ricketts*, C. Kremen **)
4. Towards Conservation and Management of Stingless Bees in Sub-Saharan Africa (Peter K., Mia, Connal, Peter K., Queen, Mary *, Joseph, *D. Roubik*, Brazilian cooperator*)
5. Economically Important Bees of Africa (Georg, Terry, John A., Lawrence, others)
6. Carpenter Bees (Xylocopa: Apidae) of Africa (Connal, Lawrence, *R. Minckley*, others)

A Steering Committee was suggested for the coordination of projects along with some kind of Coordinating Mechanism.

Participants from the Global Summit in partnership with other experts worked online to develop the concept papers (annex 7) related the above topics.

II. Proposal Development Meeting

Introduction

Following the Global Pollinator meeting described above a proposal development meeting was held during February, 16-20, 2010 in Nairobi, Kenya, as a follow-on gathering to the Global Pollinator Summit to further develop the concept notes (annex 7) to full proposals. The proposal development meeting was held in partnership with the UVIMA² project. The objectives of the proposal development meeting was to expand on the work of the Global Pollinator Summit and UVIMA project, to develop joint research project proposals, to further enhance collaboration between USA and Africa-based researchers in pollination science and to build linkages with partners at local, regional and global levels.

The proposal development meeting was sponsored by NSF³, the Consortium of the Barcode of Life⁴, Bionet-International⁵, the Smithsonian Institution, the National Museums of Kenya⁶ and the International Center of Insect Physiology and Ecology⁷. The meeting assembled 26 North American, European and sub-Sahara African scientists, students and three support personnel (annex 8 and 9).

Overview of the Proposal Development Meeting's Structure

An online dialogue was initiated with participants before the Nairobi meeting to discuss the suitability of pre-selected concept notes for development into full proposals during the PDM. Preselected concept notes for PDM included concept notes from the Global Pollinator Summit and from the UVIMA meeting.

The meeting began with introductory presentations on: (a) the objectives and goals of the sponsors; and (b) the expected product of the meeting. A fair amount of time was devoted to continuing the discussing on which concept notes should be developed to full proposals (see agenda of the PDM annex 10). Based on the deliberations, a consensus was reached to develop a proposal on taxonomy of bees and on the conservation and management of stingless bee. Consequently, two break-out groups were formed around the taxonomy and stingless bees' concept notes. Thereby, prioritizing two issues, (a) the taxonomic impediment; and (b) the economic importance of stingless bees in Africa as the most important concerns. The meeting further decided that the two groups should develop modules that can be used to complete proposals for target funding agencies (annex 11).

Reports from Group Discussions at PDM

The taxonomy Group

The taxonomy group identified the goal of the proposal on taxonomy as “*overcoming the taxonomic impediment on bees, enhancing food security and conserving biodiversity and ecosystem services in Africa*”. The group listed different objectives and activities of the proposed taxonomy proposal. The expected outputs, impact of the proposal, beneficiaries of

² <http://eafrinet.museums.or.ke/uvima.html>

³ <http://www.nsf.gov>

⁴ <http://www.barcoding.si.edu>

⁵ <http://www.bionetinternational.org>

⁶ <http://www.museums.or.ke/>

⁷ <http://www.icipe.org>

the actions, as well as relevant partners, timeline for the work, estimated budget and coordinators of activities in each region of Africa were identified (see annex 12 for details).

Stingless bee Group.

The stingless bees' group identified the goal of the proposal as "Increasing food production using Stingless Bees". The group brainstormed on the status of knowledge of stingless bees, on-going activities in the different regions of Africa, problems and required actions to enable the conservation of stingless bees. The benefits of stingless bees to local communities were thrashed out. The group further discussed objectives of the study and the methodology. A log-frame was developed (including the goal, actions, verifiable indicators, outputs and estimated budget for the proposed module) for the research proposal on stingless bees.

The participants agreed that the way forward was to use the developed modules in the future to approach a funding agency

Annex 1. Global Pollinator Summit Agenda

Global Pollinator Summit

Durban, South Africa

1-4 July 2008

Agenda

Tuesday 1 July (Session Chair: Connal Eardley)

13:00	Welcome and introductions	Eardley
13:15	Summit agenda, objectives, and products	Ruggiero
13:30	Workshop Goals: GBIF, NSF, and CBOL	Ruggiero, Rogo
14:00	Overview of Pollinator Initiatives	
	• African Pollinator Initiative(API)	Kwapong
	• GBIF Pollinator Campaign	Ruggiero
	• Bee Barcoding Initiative (BBI),	Packer
15:00	Break	
15:30	African Pollinator Issues (15 minutes each)	
	• Status of African bee research infrastructure	Eardley
	• Pollinator Issues: Ghana	Cobblah/Frimpong
	• Pollinator Issues: Botswana	Turner
	• Pollinator Issues: Kenya	Gikungu
	• Pollinator Issues: South Africa	Sithole
16:45	Break	
17:00	African Pollinator Issues (15 minutes each)	
	• Pollinator Issues: Guinea	Doumbouya
	• Pollinator Issues: Cameroon	Tchuenguem Fohouo
	• Pollinator Issues: Congo	Potts
17:45	Discussion	
18:00	Adjourn	

Wednesday, 2 July (Session Chair: Lucie Rogo)

08:30	Short presentations (15 min) on pollinator issues on major foci of Summit	
	• Digitization of collection and observation data	
	○ GBIF Digitization Program	Chavan
	○ ARS Collections	Griswold
	○ UC/Riverside Collections	Yanega
	○ Belgian Collections	Michez
	• Taxonomic catalogues and checklists	
	○ World Bee Checklist	Ascher
	○ Scratchpad for Bees – Demonstration	Harman
10:00	Break	
10:30	Short presentations (continued)	
	• Identification of pollinator species	
	○ Identification Keys	Schalk
	○ DNA Barcoding	Masiga
	• Tools and applications for monitoring the status and trends of pollinators	
	○ Urban ecosystems	Frankie
	○ European landscapes	Potts/Roberts
	• Other pollinator research needs	All

- 12:30 Lunch
- 14:00 Facilitated discussion of the five main topics addressing the following questions:
- What and where are the principal knowledge and infrastructure gaps?
 - What are the highest priority geographic regions, taxonomic groups, ecosystems, infrastructure needs
- 15:00 Break
- 15:15 Breakout discussion groups (3)
- Campaign Group
 - Barcoding Group
 - Research Group
- (Each group will identify needs, priorities, and proposed actions for each main topic from their unique perspective)
- 18:00 Adjourn

Thursday, 3 July (Session Chair: Michael Ruggiero)

Session 4: Action Planning

- 08:30 Presentation of findings from Breakout Discussion Groups
- 10:00 Break
- 10:30 Integration of GBIF, Bar-coding, and Research priorities, needs, and proposals
- 12:00 Lunch
- 14:00 Summary of Group priorities
- Priority projects identified (including concept notes for proposals, key persons, and commitments)
 - Mode of operation:
 - New small projects?
 - Conduct as part of an existing initiative?
- 15:00 Funding proposals
- Configuration of support needed
 - National support from applied or other government agency
 - Support from US and African counterpart agencies
 - International development aid agencies
 - Private sector industrial funding
- 16:00 Break
- 16:30 Action items
- 17:00 Wrap-up and Conclusion
- 18:00 Adjourn

Friday, 4 July

- 11:00 Departure

Annex 2. Global Summit List of Participants

Name	Country	Funds	Organization	Email Address
Ascher, John	USA	NSF	American Museum of Natural History (AMNH)	ascher@amnh.org
Cardinal, Sophie®	USA	NSF	Cornell University	scc44@cornell.edu
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Cobblah, Millicent ®	Ghana	GBIF	Council for Scientific and Industrial Research (CSIR-Ghana)	macobb@ug.edu.gh
Doumbouya, Saïdou	Guinea	GBIF	Centre National d'Observation et de Suivi Environnemental (CNOSE)	doumbouyasaidou@yahoo.fr
Eardley, Connal	S. Africa	NSF	Plant Protection Research Institute	earleyc@arc.agric.za
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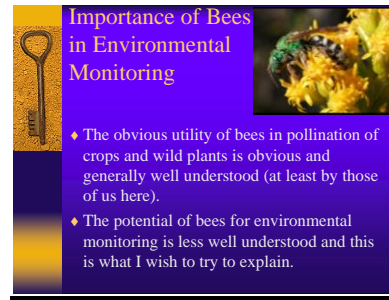
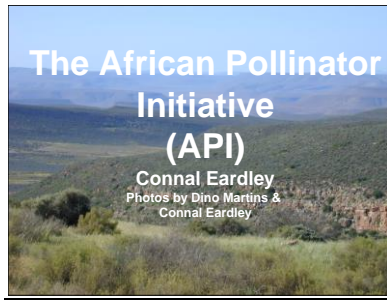
<i>Ruggiero, Michael</i>	<i>USA</i>	<i>GBIF</i>	<i>Integrated Taxonomic Information System (ITIS)</i>	<i>ruggierm@si.edu</i>
<i>Sithole Hendrik</i>	<i>South Africa</i>	<i>NSF</i>	<i>South Africa National Parks</i>	<i>Hendrik S@Sanparks.org</i>
<i>Schalk, Peter</i>	<i>Netherlands</i>	<i>GBIF</i>	<i>ETI</i>	<i>pschalk@eti.uva.nl</i>
<i>Turner, Queen</i>	<i>Botswana</i>	<i>NSF</i>	<i>Botswana Dept. Agriculture.</i>	<i>turnerq@hotmail.com</i>
<i>Yanega, Doug</i>	<i>USA</i>	<i>GBIF</i>	<i>UC-Riverside</i>	<i>dyanega@ucr.edu</i>

® = Students

Annex 3. Group Photo of the Global Pollinator Summit



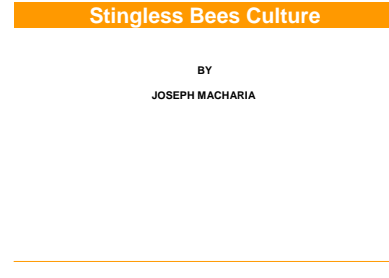
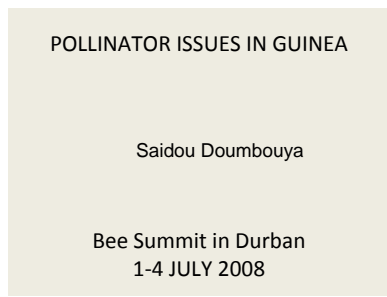
Annex 4. GPS Presentations



Elize Lundall-Magnuson



Agricultural Research Council



Enhancing Collaboration, US- Africa


Lucie Rogo



African Pollinator Initiative (API)


Peter Kwapong
University of Cape Coast,
GHANA

Presented @ BEE SUMMIT, Durban, South Africa.



STATUS OF POLLINATOR STUDIES IN KENYA

Mary Gikungu



NATIONAL MUSEUMS OF KENYA


Insect pollination researches in Cameroon

► **By : Prof. Dr. TCHUENGUEM FOHOUE
Fernand-Nestor**
Entomologist, Beekeeper
Head of the Beekeeping and Flowering insects-
Plants relationships project
Vice-Dean in charge of Student's Affairs
Faculty of Science, University of Ngaoundéré


Pollinator Issues-Ghana

Millicent A. Cobblah

Zoology Department
University of Ghana, Legon



POLLINATOR ISSUES IN BOTSWANA



QUEEN TURNER
GLOBAL POLLINATOR SUMMIT
DURBAN, SOUTH AFRICA
1 - 4 JULY 2008

Annex 5. Draft Design of a Pollinator Web Portal

**Towards a
Bee or Pollinator Webportal:**
a dynamic web resource providing direct access to
global pollinator information and expertise.

Peter Schalk, ETI BioInformatics, Amsterdam
Vishwas Chavan, GBIF Secretariat, Copenhagen
Thomas Herman, USGS, Washington



Rationale

Pollinators are globally threatened in abundance and species diversity caused by factors such as habitat destruction, increasing monoculture farming, and climate change. Pollinators are of particular economic importance since many commercially exploited crops depend on them for fertilization. Worldwide collaboration and sharing of existing information and expertise are instrumental to create a knowledge base that will help to underpin counter measures. Stimulating public awareness and proper education can be an instrument to change attitude.

The Global Pollinator Summit (1-4 July, Durban, South Africa) brought together a broad range of expertise (e.g. specialists on pollinator species, data management, policy making, beekeeping) and addressed issues central to the GBIF Global Pollinators Species Campaign (GPSC), the Consortium for the Barcode of Life (CBOL) and the National Science Foundation (NSF). Principle themes included taxonomic checklists, collections and observations, pollinator/plant interactions, pollinator identification, and status and trends of pollinators.

At the summit particular attention was given to the situation in Africa. Many countries presented their approach to the pollinator issue and mapped their specific needs and risks. Practically all the presenters mentioned a lack of (access to) detailed species information, (traditional) identification tools, and the need for sharing practical solutions (training, beekeeping). Apart from informing the professional community the need to educate the general public on the importance of pollinators was underlined. The summit also demonstrated that globally a considerable amount of information and expertise is available, but that this is spread over numerous sources and formats. Access and communication is a problem.

One of the conclusions of the summit was that setting up a dedicated webportal would provide the community with a single common access point for sharing pollinator information. This could be realized relatively quickly and cost efficient by making use of existing technologies, information sources and agencies. This document sketches the design parameters and roadmap to set up such a portal. The bee or pollinator portal, will not only help in local capacity building, it can also be instrumental as a shared resource underpinning a Global Pollinator Assessment.

Some design parameters for the Bee or Pollinator Portal

The Bee or PollinatorPortal is to provide a low barrier access point to a broad range of shared information. It addresses information needs of the professional community (researchers, beekeepers) by providing a single mechanism for sharing a broad range of information including checklists, collection and observation data, identification tools, species interactions, beekeeping methods, specialists. In addition it should be a quality information source for decision makers, and a useful look-up tool for educators and interested laymen. The portal should have to ability to provide information on both a global, generic scale as well as on a regional basis. The proposed portal should be 'owned' by the pollinator community as their communication platform, directed both internally as well as outside to the world.

The envisioned portal will not store information in a central database but be a true webportal that dynamically communicates with distributed information sources and harvests data throughout the world. The portal host may consider to offer 'hosting services' for databases of data providers who are not capable of setting up or maintaining an internet resource.

The portal should be able to address the following questions:

- What is known about this species? Description, ecology, barcode.
- Who is a specialist on this species? Where to find him/her?
- What is the distribution range of this species?
- What is the (protection) status on this species?
- How to identify this species? Get access to an identification key of a group.

- What species can be encountered in a selected area?
- What pollinators are related to this crop, and vice versa?
- Where can I find image libraries for certain species?
- Where can I find teaching resources (case studies, e-learning apps).
- What are the recent news items on pollinators?
- What is the best method of beekeeping for this species? Expert advice?

The portal should further support:

- A feedback function on provided information; submitted images, observations.
- Forums for different communities (e.g. Africa, South America, etc).

Entries are either by:

- Text: search on scientific name, common name, synonym; specialist, institute)
- geographic search: selecting area on map returns all available data
- browsing: taxonomic hierarchy, directories, images, news items

Information sources to be connected to the portal, e.g.:

- World Bee Checklist / Catalogue of Life
- GBIF network of collection and observation data
- Non-GBIF linked collection and observation data
- Genetic / molecular resources (CBOL, EMBnet)
- Red List data (IUCN)
- FAO crop databases
- Websites with on-line identification data / systems; sources for off-line keys
- Specialists directories: institutes, research centres, projects (NCD toolkit)
- Quality overlay maps with biotic & abiotic data (tools)
- Beekeeper sites, specialists, methods
- News feeds on pollinators

How can we get this done?

Much of the technology needed to set up a Bee or Pollinator Portal is readily available. In GBIF context ETI developed with NLBIF and TANBIF a biodiversity portal toolkit that can be used as a basis for setting up this portal (see annex). This will be a cost efficient and fast approach for developing the Bee or Pollinator Portal. GBIF developed (and maintains) the database wrappers that are used to connect distributed information sources to the Portal. This will warrant sustainability and manageable operational costs of the portal. In addition GBIF can provide, apart from access to its own vast data network, support through various national Nodes. The US National Biological Information Infrastructure (NBII) has similar expertise for setting up webportals and can bring in (links to) analytical tools and instruments for mapping (overlays) and visualisation. NBII also unlocks a wealth of data in the Americas. Setting up the Pollinator Portal should therefore be possible in a relatively short period of time.

Relevance to Pollinator Campaign

The Bee or Pollinator Portal can play a unifying role by bringing the global pollinator community together in a kind of ‘virtual organisation’ and to provide them with a shared information and communication platform. The portal can facilitate generating project proposals, planning of (joint) activities, organizing the regional approaches, and as such may assist in further shaping the pollinator campaign. Maintaining a single shared webpage will send a strong message and facilitate public outreach and enhanced visibility. Catering for the pollinator community itself (sharing info) as well as the world at large (informing, educating) is a cost efficient approach in this stage of the campaign. Later subdivisions can be included (e.g. Africa, North and South America, Asia) addressing issues typical for the region while maintaining a shared (global) knowledge base.

Timeframe and cost items

The Bee or Pollinator Portal will make use of existing tools, organisations and resources. This allows for a speedy and low-cost development. However there will be cost items such as:

- Customizing the portal toolkit to shape this portal
- Linking or Catalogue of Life (with Bee Checklist) and GBIF resources
- Linking to selected RRS biological news feeds
- Sourcing / selecting other quality information sources to be connected to the portal
- Linking these resources to the portal (preferably with GBIF wrappers, or new webservice)
- Linking to existing analytical instruments, mapping tools, identification apps
- Creating the specialist directory (part provided by the World Taxonomist Database).
- Creating a methodological beekeeping directory (or links to relevant sites)
- Creating a NCD database of research institutions / projects (part from GBIF sources)
- Setting up user forums and managing these.
- Setting up a helpdesk a.o. to assist data providers to connect new resources

Version 1 of the portal should be realizable within 4 months.

[activity – time – cost table] follows

Who does what?

This needs a discussion between the ‘founders’. ETI can work on shaping the portal and establishing connections with various database resources. We can also set up the NCD database and specialist directory and populate this partly from WTD and GBIF resources. We can do the helpdesk function (and assist with implementing wrappers or building new webservice)

Who can/will do the inventory of relevant (quality) information sources? Who will do the selection?

Who can provide relevant analytical and visualisation tools, overlay maps and connect these? Who can gather beekeeping information? Manage the discussion forum?

How to involve the host: world data centre in South Africa? Define role.

How can we make this portal work effectively for/with GBIF (e.g. data discovery?)

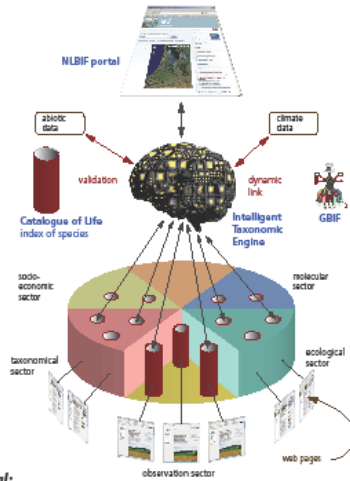
Who can sponsor this development? (NSF, GBIF,)

ETI BioPortals: customizable common access system to distributed heterogeneous data sources

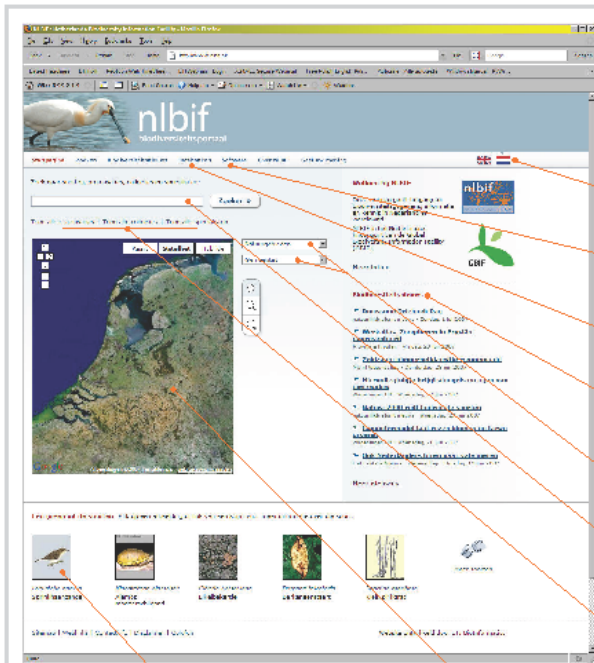
Much knowledge on biological diversity (i.e. on taxonomy, ecology, molecular, conservation, legislation) is nowadays available in digital form. The information is often compiled for a specific purpose and stored in custom made, geographically distributed databases using different formats. Sourcing information can therefore be time consuming, and recombination of data can be cumbersome because of incompatibility. International initiatives such as the Global Biodiversity Information Facility (GBIF), Encyclopedia of Life (EoL), Consortium for the Barcode of Life (CBOL) are paving the way to make data in a specific domain accessible.

However, much of the demand for information is on a national or local level, driven by defined user groups with specific questions or problems. These call for a custom made answer to their information needs. ETI developed a 'google-like' webportal solution that provides a single access point to a large array of heterogeneous information sources. The BioPortal can be customized to specific information needs and user levels: from governments to schools, from scientists to laymen.

The BioPortal tool kit has a modular set up and can therefore be easily tuned to user needs, including the web-interface. It offers access to scientific core data (biological collections, observations, ecological relations, molecular data, image libraries) on a national or local level, and combines these with external ones such as in GBIF, EMBnet. It includes the Linnaeus II Species Bank compiler that allows for creating integrated (national) species information systems that can also be dynamically linked to external sources (e.g. EoL). The BioPortal also includes a module for information on national capacities (experts, museums, research institutes, national parks) and automatically gathers biodiversity news from a range of national and international (RSS feed) sources. The BioPortal deploys standard wrappers (e.g. from GBIF) and custom webservices based on intentional standards. The BioPortal uses the Catalogue of Life as a core validated taxonomic index to match searches to connected data sources.



ETI Bioinformatics
NLBIF BioPortal:
Conceptual design and development by
ETI Bioinformatics

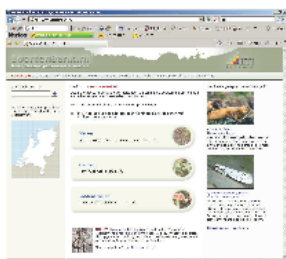
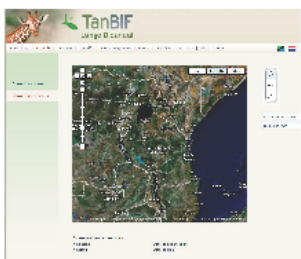


1. Language choice button (currently Dutch and English). The portal can accommodate other languages.
2. Under the item 'software' in the member links to downloadable software applications are provided. Tools are continuously updated and extended.
3. Under the item 'databanken' in the member an overview of all currently connected data sources is provided, including direct links.
4. The column 'biodiversity news' harvests continuously updated news from RSS feeds of more than 36 selected sources in The Netherlands and abroad. News items point to the source websites.
5. With the 'select box' parks, nature reserves and municipalities can be selected and displayed on the map.
6. The search bar gives 'Google-like' access to all connected information sources. Species names, names of experts or collections, institutes, botanic gardens and zoos, parks and nature reserves can be found. The portal provides an overview with web links, and displays location.
7. The 'select' member gives access to NLBIF's metadatabase which holds information on all research institutions, botanic gardens and zoos, biological collections and specialists in The Netherlands. There are links to the websites of the institutes and locations are displayed on the map.

ETI's BioPortal kit was used for the Netherlands' national GBIF portal (NLBIF, illustrated). Currently we are working with Tanzania for a biodiversity portal that is tuned to their national information needs; here emphasis will be given to the use of the information in education and for outreach (tourism). With Colombia and Bulgaria similar BioPortal projects are discussed.

8. The 'species panel' displays thumbnails of random species derived from information sources that are connected to the NLBIF portal. The images are linked to the connected species banks.
9. The interactive map that supports geographic searches uses Google Earth and GoogleMap API. After selecting an area with the mouse, information of that region is displayed.

www.nlbif.nl



Interested?
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Annex 6. Status and Needs of Taxonomy in Sub-Saharan Africa

Status of Bee taxonomy in Sub-Saharan Africa

By Connal Eardley

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Introduction

Africa has always had few resident bee taxonomists. Most of the taxonomic work was done by European and American specialists. Hence, most of the type material is housed outside the continent. Within Africa, all the bee taxonomists, which comprises two-three part time researchers and two dedicated taxonomists, have resided in South Africa. Consequently South African bees are better collected and better studied than those from the rest of Africa.

The Afrotropical Regions includes sub-Saharan Africa, the Yemen area of the Arabian Peninsula and the East Indian Ocean Islands. This report only deals with sub-Saharan Africa, as the bees of Madagascar were revised by Pauly et al (2001), and those from Yemen and the other East Indian Ocean Islands are virtually unrevised.

The North African bee fauna forms part of the Palearctic (European) fauna and is not considered in this report. It should be included in a report on the Palearctic bee fauna.

Current situation

In sub-Saharan Africa there are six bee families, with 108 genera and 2613 valid, described species. Of these 64 genera have been recently revised, 10 are being studied, six have been partly revised in regional studies (Appendix 2) and 28 have not been studied at all. However, several of these unstudied genera are small and for some research projects are currently being planned. The unstudied and partly studied groups need to be studied. Five of the six genera with regional revisions all have only the southern African fauna revised, the other results for an unstudied genus (*Nothylaeus*) being synonymised with a studied genus (*Hylaeus*), and it is receiving attention. The unstudied genera fall into six categories: *Eupetersia* and *Sphcodes* (78 species), *Lasioglossum* (259 species), *Halictus* (93 species), Osmini (7 genera, 138 species), Anthidiini (16 genera, 56 species), *Coelioxys* (102 species) (Appendix 1). This will require about three PhD theses, each followed by a post-doc, and four MSc theses for the partly studied groups. A project to study the anthidine bees is being developed, supported jointly by the USA National Research Foundation (NSF), US Department of Agriculture (USDA) Bee Biology and Systematics Lab., Cornell University and the South African Agricultural Research Council (ARC).

Although there are many vegetation types in sub-Saharan Africa, they should all be able to be serviced by four systematists, one each in the south, east west and central regions.

Taxonomic research in Africa is complicated by the type material being scattered through 58 collections around the world (Appendix 3), and material being in even a greater number of museums. The most important non-African museums are: AMNH, MNHN, MRAC, NHML, SEMC and ZMHB. The most important African museums are: Nairobi Museum, SAMC, SANC, SMWH and TMSA.

One experienced, resident bee taxonomist exists in Africa; another two are in training. A comprehensive catalogue for the entire fauna exists and most of the literature is available as pdf files.

Conclusion

African bee taxonomists are needed in the different regions of Africa, namely east, west, central and southern Africa. They should build up well curated collections that are representative of their areas. Taxonomic revisions of unstudied groups should be undertaken, and periodically these should be updated. Identification tools should be published. This will require training of taxonomists and para-taxonomists, and faunal surveys.

Further, information in overseas museums should be repatriated beginning with type material; specimen data and photographs should be included in repatriation projects. This should all be made readily available on the Internet.

Appendix 1. Bee genera and the publications needed to identify them

Family / Subfamily	Genus	No. species	Reference
Colletidae			
Colletinae	<i>Colletes</i>	056	Being revised, Kuhlmann
	<i>Scrapter</i>	035	Eardley 1996 Davies et al 2005 Davies & Brothers 2006
Hylaeinae	<i>Calloprosopis</i>	001	Michener 2007
	<i>Hylaeus</i>	089	Snelling 1985. Being revised Dathe
Andrenidae			
Andreninae	<i>Andrena</i>	009	Eardley 2007 (part)
Panurginae	<i>Melitturga</i>	004	Eardley 1991c
	<i>Meliturgula</i>	010	Eardley 1991c
	<i>Mermiglossa</i>	001	Eardley 1991c
Halictidae			
Rophitinae	<i>Systropha</i>	009	Patiny ****
Nomiinae	<i>Halictonomia</i>	011	Pauly 1990
	<i>Lipotriches</i>	155	Being revised, Pauly
	<i>Nomia</i>	076	Being revised, Pauly
	<i>Pseudapis</i>	031	Pauly 1990
	<i>Spatunomia</i>	002	Pauly 1990
	<i>Sphegocephala</i>	006	Pauly 1990
	<i>Steganomus</i>	004	Pauly 1990
Nomioidinae	<i>Cellariella</i>	005	Pesenko & Pauly 2005
	<i>Ceylalicthus</i>	011	Pesenko & Pauly 2005
	<i>Nomioides</i>	012	Pesenko & Pauly 2005
Halictinae	<i>Eupetersia</i>	030	Needs revision
	<i>Glossodialictus</i>	001	Michener 2007*
	<i>Halictus</i>	093	Needs revision
	<i>Lasioglossum</i>	259	Needs revision
	<i>Parathrinchostoma</i>	002	Michener 2007*
	<i>Patellapis</i>	139	Being revised, Timmermann
	<i>Sphecodes</i>	048	Needs revision
	<i>Thrinchostoma</i>	037	Being revised, Eardley, Gikungu, Michez
Melittidae			
Dasypodainae	<i>Capicola</i>	012	Michez et al 007
	<i>Haplomelitta</i>	006	Being revised, Eardley, Michez
	<i>Samba</i>	001	Being revised, Eardley, Michez
Meganomiinae	<i>Ceratonomia</i>	001	Michener 1981*
	<i>Meganomia</i>	005	Michener 1981*
	<i>Pseudophilanthus</i>	003	Michener 1981*
	<i>Uromonia</i>	002	Michener 1981*
Melittinae	<i>Melitta</i>	009	Eardley & Kuhlmann 2006; Michez & Eardley 2007
	<i>Rediviva</i>	022	Whitehead & Steiner 2001 Whitehead et al 2008
	<i>Redivivoides</i>	001	Being revised, Eardley
		1198	

Megachilidae			
Fideliinae	<i>Fidelia</i>	011	Whitehead & Eardley 2003
Megachilinae	<i>Lithurgua</i>	004	Eardley 1988
	<i>Afroheriades</i>	006	Needs revision
	<i>Bekilia</i>	001	Michener 2007
	<i>Heriades</i>	097	Needs revision
	<i>Hoplitis</i>	001	Michener 2007
	<i>Noteriades</i>	011	Needs revision
	<i>Ochreriades</i>	001	Michener 2007
	<i>Othinosmia</i>	012	Needs revision
	<i>Pseudoheriades</i>	003	Needs revision
	<i>Stenoheriades</i>	006	Needs revision
	<i>Wainia</i>	003	Needs revision
	<i>Afranthidium</i>	044	Needs revision
	<i>Afrostelis</i>	006	Needs revision
	<i>Anthidiellum</i>	017	Needs revision
	<i>Anthidioma</i>	002	Needs revision
	<i>Anthidium</i>	024	Needs revision
	<i>Aspidosmia</i>	002	Needs revision
	<i>Atropium</i>	001	Michener 2007
	<i>Benanthis</i>	002	Needs revision
	<i>Cyphanthidium</i>	002	To be studies, Eardley and Griswold
	<i>Dianthidium</i>	002	To be studies, Eardley and Griswold
	<i>Eoanthidium</i>	004	To be studies, Eardley and Griswold
	<i>Euaspiis</i>	003	To be studies, Eardley and Griswold
	<i>Gnathanthidium</i>	001	Michener 2007
	<i>Icteranthidium</i>	001	Michener 2007
	<i>Lariostelis</i>	001	Michener 2007
	<i>Pachyanthidium</i>	016	To be studies, Eardley and Griswold
	<i>Pleisianthidium</i>	007	To be studies, Eardley and Griswold
	<i>Pseudoanthidium</i>	008	To be studies, Eardley and Griswold
	<i>Serapista</i>	004	To be studies, Eardley and Griswold
	<i>Stelis</i>	001	Michener 2007
	<i>Trachusa</i>	005	To be studies, Eardley and Griswold
	<i>Agaoapis</i>	001	Michener 2007
	<i>Coelioxys</i>	102	Being studied, Schwarz
	<i>Megachile</i>	322	Being revised, Eardley
Apidae			
Xylocopinae	<i>Xylocopa</i>	126	Eardley 1983 (part).
	<i>Ceratina</i>	095	Eardley & Daly 2007
	<i>Megaceratina</i>	001	Michener 1975
	<i>Allodape</i>	037	Michener 1975
	<i>Allodapula</i>	017	Michener 1975
	<i>Braunsapis</i>	044	Michener 1975

	<i>Compsomelssa</i>	027	Michener 1975
	<i>Effractapis</i>	001	Michener 1975
	<i>Eucondylops</i>	002	Michener 1975
	<i>Macrogalea</i>	010	Michener 1975
	<i>Nasurapis</i>	001	Michener 1975
Nomadinae	<i>Nomada</i>	010	Eardley & Schwarz
	<i>Epeolus</i>	008	Eardley 1991
	<i>Ammobatoides</i>	001	Micheher 2007
	<i>Ammobates</i>	001	Eardley 1997
	<i>Pasites</i>	018	Eardley 1997
	<i>Sphecodopsis</i>	010	Eardley 2007
	<i>Ctenoplectra</i>	007	Eardley 2003
	<i>Ctenoplectrina</i>	003	Eardley 2003
Apinae	<i>Tetralonia</i>	016	Eardley 1989
	<i>Tetraloniella</i>	038	Eardley 1989
	<i>Amegilla</i>	077	Eardley 1994
	<i>Anthophora</i>	055	Eardley & Brooks 1989
	<i>Pachymelus</i>	019	Eardley 1993
	<i>Afrolelecta</i>	003	Eardley 1991
	<i>Melecta</i>	003	Eardley 1991
	<i>Thyreus</i>	042	Eardley 1991
	<i>Cleptotrigona</i>	001	Eardley 2005
	<i>Dactylurina</i>	002	Eardley 2005
	<i>Plebeina</i>	001	Eardley 2005
	<i>Meliponula</i>	012	Eardley 2005
	<i>Hypotrigona</i>	005	Eardley 2005
	<i>Liotrigona</i>	010	Eardley 2005
	<i>Apis</i>	001	Michener 2007
		1415	
		2613	

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Appendix 3. Type depositories and their abbreviations

AMGS - Albany Museum, Grahamstown, South Africa.
AMNH - American Museum of Natural History, New York, USA.
ANSP - Academy of Natural Sciences, Philadelphia, Pennsylvania, USA.
BBSL - Bee Biology and Systematics Laboratory, Utah State University, Logan, USA.
BMSA - National Museum Bloemfontein, Bloemfontein, South Africa.
CASC - California Academy of Sciences, San Francisco, USA.
DEIC - Eberswalde Finow, Institut für Pflanzenschutzforschung, Germany.
DMSA - Durban Natural Science Museum, Durban, South Africa.
FSAG - Zoologie Generale et Faunistique, Gembloux, Belgium.
HNHM - Hungarian Natural History Museum, Budapest, Hungary.
IEGG - Istituto di Entomologia "Guido Grandi", Università di Bologna, Bologna, Italy.
IRSC - Institute de Recherche Scientific, Kinshasa, Congo.
ISNB - Institut Royal des Sciences Naturelles de Belgique, Brussels, Belgium.
LACM - Los Angeles County Museum of Natural History, California, USA.
MCNV - Museo Civico di Storia Naturale, Venice, Italy.
MCSN - Museo Civico di Storia Naturale "Giacoma Doria", Genoa, Italy.
MCZC - Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA
MHNL - Musée Guimet d'Histoire Naturelle de Lyon, Lyon, France.
MIZT - Museo ed Istituto di Zoologica Sistemática della Università di Torino, Italy.
MLUH - Wissenschaftsbereich Zoologie, Martin-Luther-Universität, Halle, Germany.
MMBC - Moravske Muzeum [Moravian Museum], Brno, Czech Republic.
MHNG – Muséum d'Histoire Naturelle, Geneva, Switzerland
MNHN - Muséum National d'Histoire Naturelle, Paris, France
MNMS - Museo Nacional de Ciencias Naturales, Madrid, Spain.
MRAC - Musée Royal de l'Afrique Centrale, Tervuren, Belgium
MSPC - Museo di Storia Naturale "Pietro Calderini", Varallo, Italy.
MT – Museo Insular de Ciencias Naturales de Tenerife, Spain.
MWNH - Museum Wiesbaden, Wiesbaden, Germany.
MZPW - Museum of the Institute of Zoology, The Polish Academy of Sciences, Warsaw, Poland.
MZSF - University of Strasbourg, Strasbourg, France
MZLU - Lund University, Lund, Sweden
NCUS - North Carolina State University, North Carolina, Raleigh, USA
NHMB - Naturhistorisches Museum, Basel, Switzerland
NHML - The Natural History Museum, London, United Kingdom.
NHMV - Naturhistorisches Museum, Vienna, Austria.
NHRS - Naturhistoriska Riksmuseet, Stockholm, Sweden.
NMBZ - National Museum, Bulawayo, Zimbabwe.
OXUM - University Museum, Oxford, United Kingdom
PC - Dr A. Pauly's private collection, Gembloux, Belgium.
PCDC - Private collection, Desmier de Chenon collection, Inra, Versailles, France.
QMBA - Queensland Museum, Brisbane, Australia.
RMNH - Rijksmuseum van Natuurlijke Historie, Leiden, Netherlands.
SAMC - South African Museum, Cape Town, South Africa.
SANC - South African National Collection of Insects, Pretoria, South Africa.
SEMC - Snow Entomological Museum, University of Kansas, Lawrence, Kansas, USA.
SMFD - Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt, BRD, Germany.
SMWH - State Museum of Windhoek, Windhoek, Namibia.
TMSA - Transvaal Museum, Pretoria, South Africa.
UCDC - Bohart Museum of Entomology, University of California, Davis, California, USA.
UMO - Hope Entomological Collections, University Museum, Oxford, United Kingdom.
USNM - United States National Museum, Washington, USA.
UZI - Universitetets Zoologiska Institut, Uppsala, Sweden.
UZMD - Universitetets Zoologiske, Copenhagen, Denmark.

ZISP – Zoological Institute, Russia Academy of Sciences, St. Petersburg, Russia.

ZMAN - Zoologisch Museum, Instituut voor Taxonomische Zoologie, Universiteit van Amsterdam, Amsterdam, Netherlands.

ZMHB - Museum Naturkunde für Humboldt-Universität, Berlin, Germany.

ZMSC - Zoologische Sammlung des Bayerischen Staates, München, Germany.

ZMUK - Zoologisches Museum, Universität Kiel, Kiel, Germany.

Annex 7. Concept Notes

I. Overcoming the taxonomic impediment in bee research in Sub-Saharan Africa

Investigators

1. John Ascher, American Museum of Natural History, New York.
2. Terry Griswold, Bee Biology and Systematics Lab., Logan, USDA.

Partners

1. Connal Eardley, Agricultural Research Council, Private Bag X134, Queenswood, 0121, Pretoria, South Africa. eardleyc@arc.agric.za
2. Mary Gikungu, National Museums of Kenya, Nairobi, Kenya.

Dollar amount for project

Taxonomist training (5 years)	\$ 150 000
Para-taxonomist training (3 years)	50 000
Equipping museums (1 year)	100 000
Field surveys (5 years)	100 000
Collaborative research (5 years)	50 000
Faunal surveys to bee biodiversity hotspots	<u>50 000</u>
Total	\$ 500 000

Introduction and rationale

Different bee species pollinate different plant species. Therefore, the identity of the pollinators is essential for understanding pollination biology. In most ecosystems bees are the most important pollinators. This project will focus on bee taxonomy and its importance in understanding the evolution of bees, and will contribute essential information for understanding pollination ecology and plant/bee co-evolution.

Taxonomy includes the classification of organisms and for the bees this has multiple uses and interests. A robust classification will improve our understanding of inter-species relationships and the creation of hypotheses on: the evolution of bees, the origin of bees, and the co-evolution of bees and their food plants. Within a taxon bees often specialize on related plants, and knowing the classifications of the bees and that of their host plants will enable scientists to predict what plants bees may pollinate. This will enable the development of further hypotheses on pollinator host plant relationships. Bees are most diverse in winter rainfall areas and tropical forests, some (or most) of which are highly threatened by land use practices and climate change, making bee taxonomy a matter of urgency. We could lose species that are vital for understanding the evolution of bee taxa within a few decades in the South Western Cape Province, which is a centre for bee biodiversity and is highly threatened.

Taxonomy is needed to understand bee biogeography. This in turn is required to understand their evolution.

Because of the genetics (haplo-diploidy) of bee's sex determination mechanisms, they are highly susceptible to extinction when population levels decline. This makes them good indicator organisms (Zayed and Packer (2005). Complementary sex determination increases extinction proneness of haplodiploid population. PNAS 102 (30): 10742-10746). Taxonomy is also needed for faunal surveys, including the survey of visitor to flowers.

The overall goal for the activities to be covered in the project concept note is to have a suite of reputable bee taxonomic centres in Africa; one each in southern, East, West and northern Africa. These are not anticipated to be the only centres, as most countries will want their own national centres. It is, however, anticipated that World class regional centres will

foster capacity building each within its region, provide a baseline standard and undertake faunal surveys.

Objectives

Bee taxonomists are needed to:

- Document the bee fauna.
- Document the bee food plants.
- Systematically survey ecosystems.
- Establish and expand well curated, regional specimen reference collections.
- Provide identification services for bees.
- Clarify evolutionary relationships between bees.
- Provide taxonomic revisions.
- Provide biogeographic publications.
- Repatriate data in foreign collections.
- Provide identification tools, both hard copy and electronic.
- Train taxonomists and para-taxonomists.
- Establish research infrastructure, including equipped laboratories and literature collections.

Activities

The purpose of this suite of projects is for:

- Training taxonomists and para-taxonomists for work in African museums. This should be done through student/professional exchange programmes, on site training and distance training.
- Upgrading existing museums for them to meet the basic minimum standard of expert taxonomic centres.
- Participating in faunal surveys for research and to contribute towards growth.
- Collaborative taxonomic research.

Expected outcomes

- Three trained bee taxonomists in Africa.
- Six trained para-taxonomists in Africa.
- Three additional regional, well curated, and equipped bee collections in Africa.
- Taxonomic publications.

Beneficiaries

The primary and immediate beneficiaries will be:

- The scientific community, including academic scientists, biodiversity conservationists and pollination biologists around the World.
- Institutions that house the collections.

The secondary beneficiaries will be:

- Agriculturists, as a result of better pollination of crops.
- School pupils and university students, as the taxonomists will be expected to teach and produce awareness campaigns.

II. Assessment and evaluation of African pollination services

Investigators:

Claire Kremen (University California, Berkley, USA), , Simon G. Potts (University of Reading, UK), Taylor Ricketts (WWF, USA), Bernard Vaissière (INRA, France)

Co investigators:

Fernand-Nestor Tchuengem Fohouo (University of Ngaoundéré, Cameroon), Mary Gikungu and Wanja Kanuthia (National Museums of Kenya), John Kasina (Kenya Agricultural Research Institute), Peter Kwamong and Kwame Aidoo (University of Cape Coast, Ghana) Georg Gorgen (IITA-Benin)

Budget:

\$1,500,000

1. Carry out assessment surveys in natural and agro-ecosystems to identify key pollinators (bees other insects, birds and bats. \$300,000
2. Set up pan-African monitoring schemes in several participating countries. \$100,000
3. Investigate trends in managed pollinators (honey bees) and monitor trends in stingless bees and their assessments and use. \$100,000
4. Assess the economic value of pollinators and pollination services (e.g. those developed by the ALARM project in Europe) and model scenarios depicting expected changed in pollination provision in the future. \$200,000
5. Carry out assessments of key crops to know if they are limited in their production by pollination. \$300,000
6. Investigate the drivers of changes in pollination services provision within key geographic and climatic regions such as landscape structure, pesticide use, protected areas, hedgerows, and climate change on key crops. \$100,000
7. Build taxonomic capacity (including knowledge enhancement on farmers about pollinators and pollination service) of key pollinator groups in the participating African countries. \$100,000
8. Project coordination. \$ 300,000

The project is a five-year research to assess and evaluate pollination services in selected areas of Africa. Experts from America and Europe will be the lead investigators and will partner with experts from selected African countries as co investigators.

Timeline:

Introduction:

Pollination as a factor in food production and security is little understood and appreciated, in part because it is often provided by nature at no explicit cost to human activities. As farm lands have become larger, and the use of agricultural chemicals that impact beneficial insects such as pollinators along with plant pests has increased, pollination services are showing declining trends. The process of securing effective pollinators to service large agricultural fields and natural landscapes is proving difficult to engineer, and there is a

renewed interest in managing nature to provide pollination services. To do this effectively a number of issues are important must be considered seriously:

- Catalogue key flowering plants, agricultural crops and non-timber forest products that are pollinator dependent
- Identify and determine efficiency of main pollinators to these flowering plants
- Assess these crops and flowering plants for pollination limitation (i.e. where yield is limited by the provision of pollination services)
- Quantify the main drivers impacting on the communities of pollinators delivering pollination services
- Monitor the trends and status of important agricultural pollinators

Most of these have been carried out and/or are on-going in Europe, USA, and other places more than in Africa (in fact data is very scanty and probably only widely known for South Africa). It is on this basis that the American government is to bring champions from the USA, UK and Africa together to formulate projects that will lead to collection and documentation of data in order to mitigate problems of the globally declining pollination services

Objectives:

We need to assess and evaluate the status of pollination services in African for:

- Consolidate existing data on pollination dependent crops
- Collect complementary data on crop pollination
- Consolidate and publish lists of pollination dependent crops
- Identify pollinators of pollination dependent crops
- Assess pollination limitation in crops
- Assess economic value of pollination to crops
- Train experts, students and technicians on assessment and evaluation methods for pollination services.

Activities:

- Carry out assessment surveys in natural and agro-ecosystems to identify key pollinators (bees other insects, birds and bats. **By partners in various countries January 2010 and December 2014**)
- Set up pan-African monitoring schemes in several participating countries. **By Monitoring team in selected Africa countries yearly for 4 years (2010-2014)**
- Investigate trends in managed pollinators (honey bees) and monitor trends in stingless bees and their assessments and use. **By investigators in selected African countries 4 years (2010-2014)**

- Use various methods to assess the economic value of pollination services (e.g. those developed by the ALARM project in Europe). **By UK, American and African investigators of selected countries 4 years (2010 and 2015)**
- Carry out assessments of key crops to know if they are limited in their production by pollination. **By partners in selected African countries 3 years (2010-2012)**
- Investigate the drivers of pollination services within key geographic and climatic regions such as effects of landscape, pesticides, protected areas and climate change on key crops. **By investigators in selected African countries 4 years (2010-2014)**

Outcomes:

- Trends and status of pollination services of key crops in Africa will be known
- Lists of pollinators (mainly bees) within Africa would have been identified and barcoded
- The socio-economic value of crop pollination/ pollinators including managed bees (honey bees and stingless bees) would have been known on key pollination dependent crops in Africa.
- Various drivers of pollination services would have been identified to enable prediction of possible future changes and to develop mitigation scenarios
- Many experts, students and technicians would have been trained and pollination services improved.
- Communities empowered to manage pollination in their agricultural landscapes
- Contribution to the CBD and other international initiatives

III. Towards Conservation and Management of Stingless Bees in Sub-Saharan Africa

Investigators

1. David Roubik, Smithsonian Tropical Research Institute.
2. Mia Park, Cornell University, Ithaca.

Partners

1. Connal Eardley, Agricultural Research Council, Private Bag X134, Queenswood, 0121, Pretoria, South Africa. eardleyc@arc.agric.za
2. Mary Gikungu, National Museums of Kenya, P. O. Box 40658-00100, Nairobi, Kenya. mgikungu@museums.or.ke.
3. Joseph Macharia, Jomo Kenyatta University of Agriculture and Technology, P. O. Box 62000, Nairobi, Kenya. jmacharia86@gmail.com.
4. Peter Kwapong, University of Cape Coast, Ghana. pkwapong@yahoo.com
5. Queen Turner, Botswana Department of Agriculture, Gaborone, Botswana. turnerq@hotmail.com.

Request summary:

Funding is sought for a four-year project that will develop strategies for the conservation and sustainable utilization of stingless bee community in Africa south of Sahara, and the use of these bees for improving local small and broad-scale horticulture. The project will involve the training of African and American Msc, PhD and post-doc students as well as building capacity of researchers in collaborating research institutions in Africa via a partnership with bee specialists and pollination ecologists at American and European Universities.

Estimated budget: \$ 650,000

Introduction and rationale

Stingless bees are closely related to honey bees. They are social and store honey, but are largely confined to the equatorial, tropical/sub-tropical regions of the World, except in southern Africa where they are found in very dry climates. Recent reports show that there are over 600 species represented in 56 genera in both tropical and subtropical areas of the world but there are more than 100 species awaiting taxonomic description (e.g. Cortopassi-Laurino, 2006). South America has the greatest stingless bee biodiversity and their fauna has been extensively studied. In Africa little is known about the biology of stingless bees. Those who keep them (keeping stingless bees is called Meliponiculture) mostly do not study their biology, and use the honey for food and medicine. They are not kept for pollination of wild or cultivated plants, as is done with the honey bee.

Deforestation and poor management are the main problems faced meliponiculture. In Africa, stingless bee honey is mostly obtained by harvesting from feral colonies, an activity which kills or destroys the colonies. Replacing destructive harvesting of stingless bees with well designed management practices would provide honey for food, income, medicine, and enhance pollination of both commercial and indigenous plants.

There are several important academic reasons for studying stingless bee biology in Africa; namely to understand:

- The evolutionary radiations of the group, as some South American species possibly have their closest relatives in Africa.
- The classification of the group, as they are hard to identify using morphology and clues to separate species appear to exist in their nesting biology.
- The mechanisms they evolved to cope with different parasites and environmental conditions.
- The co-evolution of the bees with their food plants and social parasites.
- Differences in biology between humid forest species and dry savannah species, the latter being the exception and possibly a derived condition.
- Their adaptation to changing environment due to climate change.
- Their biology and pollination ecology.

As pollinators, stingless bees contribute to plant reproduction and the production of food (seed and fruit) for other animals. They therefore help in maintenance biological diversity. But this has not been studied. Unlike most other parts of the World, the honey bee, *Apis Mellifera* Linnaeus, is indigenous to Africa and is also an important pollinator of wild plants. As new honey bee diseases ravage the continent, other pollinators will become increasingly important as pollinators. Stingless bee honey is used more for medicine than food. Mostly, it is harvested destructively, which leads to a loss of these bees in the wild. This research will contribute to the sustainable use of these bees for honey and crop pollination, reducing the need to import exotic pollinators. Apart from the academic interest in these bees, some practical application that will emerge from this research are:

- Pollination of wild plants in the wake of the diminishing honey bee populations.
- Pollination of crops, especially in areas where honey bees cannot be kept (some stingless bees inhabit very hot, dry areas where honey bees do not occur).
- Honey production for food and medicine.

Objectives

Stingless bee research is needed for:

- Understanding and documenting stingless bee biology.
- Comparative research in the biology of all stingless bees.
- Documenting stingless bee host plants and understanding their pollination ecology.
- Developing meliponiculture for economic development, increased food security and biodiversity conservation.
- Improved human health and food production, and an offshoot of this will be documenting traditional knowledge, i.e., which plants produce medicinal honey and for what purpose it is used.
-

Activities

The purpose of this suite of projects is for:

- Training scientists in stingless bee biology, pollination ecology and importance of stingless bees in maintaining of pollination service and other biodiversity, such as wild birds and primates.
- Developing Meliponaries (equivalent for apiary) and techniques for keeping stingless bees, for research, honey production and pollination management.
- Biotic surveys.

Expected outcomes

- Six trained scientists in Africa and the USA.
- Meliponaries in different climatic regions for ongoing research.
- Guidelines for raising stingless bee numbers in game reserves, like Kruger National Park, to replace diminishing honey bee populations.
- Guidelines for pollination management.
- Scientific publications.

Beneficiaries

The primary and immediate beneficiaries will be:

- The scientific community, including academic scientists, biodiversity conservationists and pollination biologists around the World.
- Stingless bee farmers (Meliponiculturists).

The secondary beneficiaries will be:

- Agriculturists, as a result of better pollination of crops.
- School pupils and university students, as the taxonomists will be expected to teach and produce awareness campaigns.

Supporting literature

There is a broad range of very recent literature in high quality journals highlighting the problems that loss of native bee pollinators poses for agriculture and conservation biology. Below we give references to some of these publications. However, there are very few publications on stingless bees in Africa yet they are taxonomically different from other tropical and neotropical meliponines. We note that any attached copies of these publications may be subject to copyright restrictions.

Biesmeijer, J. C. et al (2006) Parallel declines in pollinators and insect-pollinated plants in Britain and the Netherlands. *Science* 313:351-354

Cortopassi-Laurino, V.L. Imperatriz-Fonseca, D. W. Roubik, A. Dollin, T. Heard, I. Aguilar, G. C. Venturieri, C. Eardley, P. Nogueira-Neto (Brazil, Australia, Costa Rica, South Africa). (2006). Global meliponiculture: challenges and opportunities. *Apidologie* **37** (2) 121-316.

Eardley, C. D. 2004. Taxonomic revision of the African stingless bees (Apoidea: Apinae: Meliponini). *African Plant Protection* **10** (2): 63-96

Gikungu, M. W. & Grace Njoroge (2007). Species Diversity, Plant Resources and Conservation Status of Stingless Bees in Mwingi District, Eastern Kenya: *Discovery and Innovation* (RPSUD Special Edition). Vol.19 (No.3).

Kremen, C & Ricketts, T. (2000) Global perspectives on pollination disruptions. *Conservation Biology* 14:1226-1228.

Macharia, J. K. (2008). **Macharia J. K** (2008). Status and thesis Potential of Stingless Bees (*Apidae:Meliponinae*) for Forest Conservation and Income Generation; Case Study of Kakamega Forest. Msc Thesis Jomo Kenyatta University of Agriculture and Technology

Macharia J. K., Raina S. K, Muli E.M. (2007) Stingless bees in Kenya. *Bees for Development Journal* issue 83.

Njoroge G. N. & Gikungu M. W (2007). Traditional knowledge of Stingless Bees in Mwingi District, Eastern Province, Kenya. *Discovery and Innovation* (RPSUD Special Edition). Vol.19 (No.4).

Roubik, D. W. (2006). Stingless bee nesting biology. *Apidologie* 37 (2) 121-316.

Steffan-Dewenter, I., Potts, S. G. and Packer, L. (2006) Pollinator diversity and crop pollination services are at risk. *Trends in Ecology & Evolution*. 20: 651-652

Vamosi, J. C. et al. (2006) Pollination decays in biodiversity hotspots. *PNAS* 103:956-961

IV. Economically important bees of Africa

Investigators:

Georg Goergen, or designate, and others to organize sampling. Numerous taxonomists for identification (Griswold, Ascher, etc.). Packer's lab to coordinate actual barcoding.

Partners:

Just about everyone associated with the global bee barcoding campaign with an interest in the bees of Africa. FAO, ICIPE.

Dollar amount: Total – ?

\$50 per crop/locality to obtain samples.
\$7 (per barcode) X 10 (individuals) X ? species of crop visitors
\$X for student stipends – I have no idea what NSF expects for this. Ditto for overhead etc.

Timeline:

Sampling to begin in 2010, samples to be sent to York at end of field season, samples will be processed within three months and data made available immediately. Project completion date will depend upon how quickly samples are obtained and sent to York. Annual samples to be obtained and sent for barcoding/identification. Student research projects can be completed within two year MSc timelines for particular crops and/or regions. Timeline for completion of the database will depend upon the law of diminishing returns for new species discovery resulting from sampling.

Introduction and Rationale

In addition to *Apis mellifera*, *Xylocopa* and stingless bees which are to be treated as part of other barcoding projects, there are numerous economically important bee species for African crops (agricultural, silvicultural, pharmacological and cover crops), but the species level identification and status of these are often entirely unknown. Research on pigeon peas in Kenya and passion fruit in Cameroon indicate that there is often a great diversity of bees visiting crops within single localities.

Our taxonomic understanding of these other agriculturally important bees is poor. Numerous samples will have to be obtained over several years at a wide range of localities for each agricultural crop that is pollinated by bees. Given the variability in rainfall within localities across years, it will be necessary to assess pollinator visitors over multiple years per site. This will be particularly essential in dry years because only the most drought tolerant species might be active in these years and it will be important to know which pollinators will be active in the worst of years.

Objectives

To obtain DNA barcode data for all of the important pollinators of African crops other than those being dealt with through other projects (stingless bees, *Xylocopa*, domesticated honey bee, cacao midges).

To provide rapid identification tools for all of these pollinators.

To provide rapid identification tools for pollinators of each individual crop.

Activities

Sampling of bees from crops throughout the continent should form the initial basis of this work. These will be made for each flowering period for each crop over multiple years

such that at least one drought year per locality is included. Sampling in areas adjacent to crops outside of periods of flowering should be made to test whether “companion” floral resources are needed by economically important bees. This is often essential in situations where the bee requires floral resources for a longer period of time than the crop is in bloom in order to maintain sustainable populations. The samples would have to be identified to genus using tools that are almost complete (Eardley, in preparation) and then identified to species by experts and barcoded.

Multiple samples from the same crop throughout the range where the crop is grown should be obtained. There is organizational infrastructure in place to permit this sampling, through IITA, but funds are required to actually obtain the samples. The methods to be used to obtain bee samples would also result in other economically important pests and other organisms being obtained.

Data analysis can be performed by crop and/or geographic region. Student research projects can be focused in either one of these ways.

Outputs

- 1) DNA barcode database of the bees that pollinate the crops of Africa, searchable by crop and region.
- 2) Compendium/catalogue of the bee pollinators of the crops of Africa.
- 3) Identification guides for the bee pollinators of the crops of Africa organized by a)crop and b) region.

Benefits: Without knowledge of the pollinators of local crops, it is not possible to manage agricultural ecosystems for the increase of crop productivity through increased pollination. It is expected that solving the taxonomic impediment to Africa’s pollinators will be an essential step towards improving agricultural productivity in the continent.

V. Carpenter Bees (*Xylocopa*: Apidae) of Africa

Investigators: R. Minckley (Univ. of Rochester) for species identification and phylogenetic study. Connal Eardley (Pretoria) to coordinate sampling, species identification, and identification keys. L. Packer lab (York Univ.) to coordinate barcoding.

Partners:

Those associated with the global bee barcoding campaign focused on Africa, particularly the associated project on “Economically important bees of Africa”. FAO. ICIPE.

Costs: ~\$196,000

\$7 X 10 specimens X <200 species = \$14,000 for chemical supplies.

Sequencing costs for nuclear genes - \$20,000

2 years of pdf funding = \$84,000

One MSc student to work with Connal Eardley on Southern African species.
\$20,000?

One PhD student from the University of Rochester to be involved in all facets of the project (collection of specimens, DNA extraction, sequence analysis and, phylogenetic study) for 3 years = \$36,984

Funds for four researchers and African associates to go on three 21-day collecting trips to Africa = \$21,000

Timeline:

Sampling to begin in 2010, samples to be sent to Univ. of Rochester at end of field season for photographic records to be made and DNA extraction, then transferred to York within one month for barcoding. Photo voucher, locality data and species determination will be made available immediately. Smaller subgenera can be revised as part of masters thesis research that can be completed in 2 years from initiation. The larger genera can be revised as PhD research – either simultaneously, or following on from the MSc research (so 5 or 7 years from initiation). Synthetic work on the entire genus can be completed towards the end of the PhD (perhaps as a postdoctoral research fellowship).

Introduction and rationale:

Carpenter bees are large, comparatively easily recognized bees that are found throughout the tropics and warm temperate regions of the world. Their biology is reasonably well understood and some species are important pollinators of crops such as cucurbits, passion fruit, and other fruit and vegetable crops.

They are often collected because of their large size. Collections of these bees are distributed throughout the world such that material for morphological and barcoding study should be reasonably available.

There are approximately 460 described species in 30 subgenera. Keys to species are available that will permit the identification of less than one quarter of the species worldwide, although there are a few keys to regional faunas. Seven subgenera are found in sub-Saharan Africa with perhaps 200 species. Among these are many species of two of the largest subgenera in the eastern hemisphere; *Koptortosoma*, a group that exhibits extreme sexual dimorphism and has a chaotic taxonomic history as a result, and *Xylomelissa*, a species rich group that has a poorly understood distribution and has never received systematic attention. One African subgenus (*Gnathoxylocopa*) is monotypic; an identification key is available for the 6 species of the subgenus *Ctenoxylocopa* (although this subgenus is not restricted to

Africa; Maa, 1970); and a key is available for all the southern African species of the whole genus (Eardley, 1983).

Objectives:

- To obtain DNA barcode data for all *Xylocopa* in Africa and reliably associate sexes of these important pollinators of African crops
- To rigorously test the extent to which DNA barcode data correspond with other DNA markers as indicators of species level differentiation
- To provide well illustrated identification keys for the species
- To document those *Xylocopa* species that are crop pollinators and better define their distributions

Activities:

Because many of these species are commonly collected a first step will be to contact and accumulate data on specimens presently in museums worldwide that are suitable for barcoding. Once these specimens/ species are databased, gaps in taxa and distributional areas can be identified for targeted collecting by principal investigators and associates. Samples from these trips will be curated, identified to species and processed for the barcoding and other molecular plus phylogenetic analyses.

The smaller subgenera that remain unrevised (e.g. *Prosopoxylocopa*, *Rhysoxylocopa* and *Xenoxycopa*) could be revised as perhaps one or two masters research projects. Revisions of the two larger subgenera (*Xylomelissa* and *Koptortosoma*) could form a PhD research project. A complete species-level revision of the genus could be completed upon finalization of these projects.

Outputs

- 1) A barcode database for all the *Xylocopa* of Africa.
- 2) User-friendly identification keys to the species of Africa.
- 3) A phylogenetic analysis of all large carpenter bees in Africa with associated stability in subgeneric nomenclature.
- 4) Complete GBIF-style distribution maps, DIGIT records.

Benefits: Without knowledge of the pollinators of local crops, it is not possible to manage agricultural ecosystems for the increase of crop productivity through increased pollination. The genus *Xylocopa* is commonly found to be important in pollination of crops. As such, reliable identification of the species will permit their roles in agricultural production to become better understood and will enable management strategies to be developed to increase their abundance and augment crop yields.

Annex 8. Participants: Proposal Development Meeting

	NAME	AFFILIATION	COUNTRY	E-MAIL CONTACT
1	Agwanda Bernard	Mammal Department National Museums of Kenya	Kenya	bagwanda@museums.or.ke
2	Asiko Grace®	PhD Student @ Nairobi University Ministry of Livestock Dev- APiculture Dision Current Acting Head of Bee Station @ Lenana	Kenya	gasiko2002@yahoo.com
3	Bokoto De Semboli Bruno	National Coordinator GCP /RAF/441/GER Project, FAO Agency- Bangui PO-Box: 2157 Avenue Joseph Degrain Bangui	Central African Republic	bbdesemboli@yahoo.fr
4	Buchmann, Stephen	NAPPC International Coordinator 2849 W. Placita Paciente, Tucson, Arizona	USA	stephenbuchmann@comcast.net and sb@pollinator.org
5	Gikungu Mary	Bee Taxonomy Department: Zoology - Invertebrate Section National Museums of Kenya P. O. Box 40658 - 00100, Nairobi, Kenya.	Kenya	mgikungu@yahoo.com
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10	Kinuthia Wanja	Department: Zoology - Invertebrate Section National Museums of Kenya P. O. Box 40658 - 00100, Nairobi	Kenya	eafrinet@africaonline.co.ke
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12	Lusini Juma	Principal Entomologist Head: National Insect Reference Collection (NIRC) Tropical Pesticides Research Institute	Tanzania	jalossini@yahoo.com

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13	<i>Macharia Joseph</i>	<i>Bee Taxonomy Zoology Dept. P.O. Box 62000 Jomo Kenyatta University of Agriculture and Technology</i>	<i>Kenya</i>	jmacharia86@gmail.com
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18	<i>Munyuli Theodore®</i>	<i>(Pollination biologist/ economist and bee systematist) Researcher, UVIMA projet-NTL-Pollinators Makerere University Institute of Environment and Natural Resources P.O.Box:7062 Kampala</i>	<i>Uganda</i>	tmunyuli@muienr.mak.ac.ug , tmunyuli@gmail.com , tmunyuli@yahoo.com
19	<i>Ndugu Nelly®</i>	<i>ICIPE DNA- Barcoding- Bee MSc- student- International Centre of Insect Physiology and Ecology (ICIPE) P. O. Box 30772-00100</i>	<i>Kenya</i>	nellymucugu@gmail.com
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® = Students

Annex 9: Group Photo from the Nairobi Meeting



Annex 10: Agenda of the Proposal Development Meeting

Tuesday, 16 February

- Arrivals of non-residents
- Lodging and meals at ICIPE Duduville Guest Centre

Wednesday, 17 February

Morning

- Welcome
- Dr. Dr Christian Borgmeister- ICIPE Director General
- Dr. Wanja Kinuthia- NMK/BIONET-EAFRINET
- Introductions
- Dr. Lucie Rogo and Dr Mike Ruggiero as Co-Chairs and acknowledging donors goals and requirements (Lucie Rogo for NSF and CBOL, Mike Ruggiero/ for BioNet contribution)
- Round-robin of participants
- Review of Process and Goals of this meeting (Mike Ruggiero)
- Global Pollinator Summit summary and action items for this meeting (Lucie Rogo)
- UVIMA workshop summary and relevant action items for this meeting (Wanja Kinuthia)
- Morning break
- Review of Proposal Briefs (Coordinators)
- Review and discussion of potential funding sources/targets (Mike/Lucie/All)
- Required Proposal Formats
- Writing Team Assignments
- Other Discussion
- Lunch

Afternoon

- Writing in breakout groups
- Afternoon break
- Writing in breakout groups
- Reassemble in plenary (Lucie/Mike)
- Adjourn
- Dinner

Thursday, 18 February

Morning

- Writing in breakout groups
- Morning break
- Reassemble for group picture
- Lunch

Afternoon

- Brief presentations on progress by groups and review/critique (Lucie/Mike)
- Discussion of institutional commitments and requirements
- Writing in breakout groups
- Afternoon break
- Reassemble in plenary (Lucie/Mike)
- Adjourn
- Dinner

Friday, 19 February

Morning

- Finish writing in groups
- Morning break
- Group presentations and review/critique in plenary (Lucie/Mike)
- Plans and assignment of lead/teams for submission of proposals (Lucie/Mike)
- Adjourn formal part of meeting
- Lunch

Afternoon

- Training workshop on bee taxonomy and DNA barcoding (Laurence Packer/others)
- Other optional activities
- Group dinner at Carnivore Restaurant

Saturday, 20 February

- Non-residents departure

Annex 11: Potential Funding Agencies for the Proposed Modules

NSF-PIRE;

CS Fund (small grants 20-30, 000)

Fulbright (For African and American students)

National Geographic

ESPA (Ecosystem services for poverty alleviation)

National Research Council (NRC) - Kenya based

Development Agencies (IDRC- needs Canadian leader), ADB

ASERECA

BREAD (NSF-GATES)

Foundations

LEVERHULME TRUST for science and Development

IFAD but need community participation

Earth Watch (Volunteer labor) for ecological and biological research

USAID- Very targeted

AGRA (Alliance for Grain Revolution in Africa)

ASARECA

GBIF (JRS) Foundation for Digitization projects and collection infrastructure)

Horticulture CRP (US and shovel ready projects) and geared towards capacity building and research.

FAO

Annex 12: Proposed Modules.

Module 1: The Taxonomy Group Module

The Goal:

- 1) Overcome the taxonomic impediment about bees in Africa to enhance food security and biodiversity conservation and ecosystem services.

Or

- 2) To enhance conservation of bees as pollinators for food security and biodiversity conservation

Justification:

The increased knowledge on pollinators and pollination will increase food production and improve livelihoods through higher pollination efficiency as ecosystem service.

Apis proved to be less efficient as compared to the non-*Apis* species found naturally in the region/country. Therefore, we want to document the natural bee fauna, which seems according to new research, pollinate a greater variety of crops and fruits in a given area, thus increasing yield and improving food security.

High spatial variability of species pollinating the same crop

DNA barcoding proved to be a powerful tool in detecting cryptic and sibling species within a morphological defined species. This issue is essential to understand the adaptation to local habitats, thus increasing success of establishment in conservation and restoration of disturbed habitats.

Bee diversity follows different patterns than most other insects do, showing greatest diversity in semi-arid and arid areas, instead of wet-hot regions.

Additional arguments to be mentioned in a proposal:

- Taxonomy as predictive tool for management of pollination ecosystem service
- Honey bees is not the most important pollinator in the African agricultural system, the actual high pollinators are stingless bees and other insects;
- Actual pollinators vary widely with locality, ecosystem, and agricultural system so localized studies are needed;
- Specific taxa and groups can be targeted with similar Objectives and Activities, such as *Xylocopa*, *Megachilidae*, stingless bees....

See publication by Heard Annual Review of Entomology.

Objectives and activities:

- 1) Document the bee fauna and their food plants and other ecological requirements.
 - Conduct comprehensive survey of bee fauna and associated plants (Invasive Alien Species, crops) in different ecological zones and habitats in sub-Saharan Africa;
 - Develop simple to use identification keys for different target user groups;
 - Develop a database of ecological and behavioral traits and threats (climate change, bee diseases, land use changes, vegetation changes, plant phenology shifts, pollutants);
 - Study interactions between invasive alien plant species and pollinators; and
 - Study and identify drivers of bee diversity within and among agro-ecosystems.
- 2) Establish and expand authoritatively verified, well-curated, regional specimen reference collections.
 - Contribute to a comprehensive checklist of sub-Saharan African bees (has been done by Connal Eardley but new species through new collection and unblitzed areas);

- Provide bio-geographic, geo-referenced databases and publications;
 - Repatriate (digitally) data and information in foreign collections; and
 - Improve quality of African bee type collections outside of Africa.
- 3) Create and maintain DNA barcode database for all African bee species.
 - Obtain additional specimens specifically preserved for barcoding technique when necessary; and
 - Sequencing of COI.
 - 4) Documenting indigenous knowledge (IK) and cultural uses
 - Compile list of names in local languages for bees and associated plants; and
 - Compile IK on bee-plant-interaction and ecology
 - 5) Capacity building: training in bee taxonomy and establish research infrastructure
 - Provide identification training and services at various end-user levels;
 - Provide training on conducting taxonomic revisions; and
 - Obtain research capacities to perform DNA barcoding regionally.

Outputs:

- 1) Document the bee fauna and their food plants and other ecological requirements
 - a. Checklist of afrotropical bee fauna and associated flora and habitats available (but Connell list);
 - b. Identification guides and keys for different user groups produced and disseminate;
 - c. Threat classification developed (along the line of IUCN Threats Classification);
 - d. Database established and accessible online;
 - e. Publications, Policy Briefs, public sensitization and awareness campaigns etc; and
 - f. Major drivers of diversity identified
- 2) Establish and expand authoritatively verified, well-curated, national and regional specimen reference collections
 - a. Sets of authoritatively verified and synoptic specimen collections for different end-users produced;
 - b. Specimens amongst partner institutions (locally, nationally, regionally and globally) exchanged;
 - c. Mechanism of specimen exchange established;
 - d. All specimens georeferenced and data available online through GBIF portal and an ATLAS of AFRICAN POLLINATORS, guide of effective pollinators for different crops/varieties produced; and
 - e. African bee type collections outside Africa curated and data accessible
- 3) Create and maintain DNA barcode database for all African bee species.
 - a. Freely available online access through the BOLD and GenBank portal; and
 - b. Detection of “species” that require additional taxonomic evaluation
- 4) Documenting indigenous knowledge and cultural uses
 - a. Dictionary of local language names for bees compiled and available online

- 5) Capacity building: training in bee taxonomy and establish research infrastructure
 - a. At least three more bee taxonomists in Africa trained and locally based;
 - b. At least 100 more para-taxonomists in Africa trained and locally based (existing Bee Course at NMK-BIOTA and beyond);
 - c. Community level outreach (to small holder farmers, policy makers, planers and other users) established; and
 - d. National and Regional Centers of Excellence on Bee established (identified, upgraded and enhanced existing institutions)

Impacts:

- 1) Document the bee fauna and their food plants and other ecological requirements
 - a. Increased public awareness of pollinator and bee contribution to agriculture;
 - b. Education model for conservation and biology;
 - c. Restoration of habitats and landscapes;
 - d. Increased germplasm conservation to maintain local varieties and wild relatives of crop plants;
 - e. Enhanced food security and improved nutrition;
 - f. Improved ecosystem services conservation and biodiversity;
 - g. Protection of endangered species and associated plants; and
 - h. Guaranteed food security for endangered wildlife (eg gorillas) and livestock
- 2) Establish and expand authoritatively verified, well-curated, regional specimen reference collections.
 - a. Increased taxonomic knowledge and identification efficiency;
 - b. Improved local and national decision making; and
 - c. Improved integration of pollination issue in IPM development and implementation
- 3) Create and maintain DNA barcode database for all African bee species.
 - a. Corroboration of species level identifications;
 - b. Enabled rapid automated identification;
 - c. Resolving difficult taxonomic issues and identification of cryptic species;
 - d. Inform and complement morphological revisions and analyses; and
 - e. Providing phylogenetic insight for biological studies and conservation
- 4) Documenting indigenous knowledge and cultural uses
 - a. Conservation and recording of traditional knowledge;
 - b. Incorporation of IK into conservation strategies;
 - c. Community level exchange of IK; and
 - d. Development of cottage industry (eg pollinator gardens) related to IK
- 5) Capacity building: training in bee taxonomy and establish research infrastructure
 - a. Increased local, national and regional taxonomic expertise;
 - b. Lowered expenses by reducing taxonomic impediment;
 - c. Increased independence in solving pollination issues;
 - d. Increased innovation through synergistic collaboration and breakthroughs; and

- e. Improved pollinator conservation at local and national level

Beneficiaries

Smallholder farmers; policy and decision makers; wildlife, conservationists and natural resource managers; local and national agricultural suppliers and businesses; industry; media and extension workers (NARES); NGOs and development agencies; educational institutions at primary and secondary schools; local, national and regional academic and research institutions.

Key and Contact Personnel:

Regional Coordinator for Eastern Africa: Muo Kasina

Kenya: Mary Gikungu

Tanzania: Juma Lossini

Uganda: Robert Kajobe

Central Region: Theodore Munyuli

Western Africa: Peter Kwapong

Southern Africa: Connal Eardley

Eastern Africa

Kenya

National Museums of Kenya: Mary Gikungu (Collection, Survey, Identification)

Icipe: Dan Masiga, Fabian Haas, Eliud Muli (Collection, DNA barcoding, GBIF Node, ARPPIS?)

KARI: Muo Kasina (Collection, DNA barcoding, Survey)

Tanzania

TPRI: Juma Lossini (Collection, Surveying)

Uganda

Makerere University: Theodore Munyuli (Collection, Survey, Experiments, Supervision)

NARO: Robert Kajobe (Collection, Survey)

Southern Africa

South Africa: Connal Eardley (Collection, Identification, Supervision) and Greg Davies (Identifications)

Western Africa

Ghana: Peter Kwapong and Rofella (Collection, Survey, Identifications)

Nigeria and Benin: Georg Goergen (Collection, Survey)

Central Africa

Cameroon: Fernand-Nestor Tchuenguem Fohouo (Collection, Survey)

Central African Republic: Bruno Bokoto (Collection, Survey)

Democratic Republic of Congo: National Center for Research in Natural Sciences: Theodore Munyuli (Collection, Survey, Experiments, And Supervision)

International:

Belgium: University of Mons: Dennis Michez, Alan Pauly (Collection, Identification, Teaching)

Canada: Laurence Packer (DNA Barcoding, Coordination, Voucher Collection)

Denmark: University of Aarhus: Claus Rasmussen (DNA Barcoding, Identification)

Germany: University of Bielefeld Manfred Kraemer (Collection, Survey, Databasing)

University of Bayreuth: Ingolf Steffen Dewenter (Survey)

University of Goettingen: Alexandra Klein and Teja Tscharnke (Survey, Supervision)

Netherlands: Peter Schalk (ETI) (Databasing, IT)

Switzerland: Andreas Mueller (Supervision, Collection, Identification) and Christoph Praz (Identification)

UK: University of Reading: Simon Potts, Stewart Roberts (Identification, Collection, Survey, And Supervision)

USA: Mike Ruggiero (SI/VTU), David Roubik (STRI), Lucie Rogo (SI), John Ascher (AMNH), Terry Griswold (USDA), Robert Minckley (Rochester University), Steve Buchmann (NAPPC/UAZ), David Inouye (Maryland University/NSF). (Collection, Survey, Coordination, Identification). Jack Hill (World Data Centre for Ecosystems and Biodiversity)

Partners:

Canadian Centre for DNA Barcoding

Canadian Pollinator (Canpolin) Initiative: Peter Kevan

CBD GTI PO- Junko Shimura

BioNET-International (Richard Smith)

BIOTA succession BIOTAs on (TREES): Manfred Kraemer (University of Bielefeld)

FAO: Barbara Herren

GBIF (Nick King)

Horticulture-CRSP

Natural History Museum: Michael Kuhlman (Identification, Collection, Survey)

Donors:

NSF, IDRC, JRS, National Geographic, BREAD, NSF-PIRE

DANIDA

Syngenta (Mike Ruggiero)

Clinton Global Fund

Government of Sweden, SIDA

McArthur Foundation

NORAD

Sloan Foundation

Swiss Development Cooperation

Turner Foundation

Wallace Genetics

Duration: 3-5 years

Estimated Budget:

- 1) Document the bee fauna and their food plants and other ecological requirements
 - Conduct comprehensive survey of bee fauna and associated plants in different ecological zones and habitats in sub-Saharan Africa
 - Student
 - KE: 1700USD tuition, 4200USD stipend per year, 12.000USD/y in total
 - UG: 3000USD tuition, stipend 500USD per person per month, 20.000USD/year in total
 - GH: Master student 30.000USD (living and research)
 - PhD
 - 20.000USD/y
 - Supervisor of PhD and Student group
 - 30.000 – 60.000USD/y
 - Develop simple to use identification keys for different target user groups
 - 100.000USD

- Develop and document a database of ecological and behavioral traits and threats (invasive plant, climate change, bee diseases, land use changes, vegetation changes, plant phenology shifts, pollutants) (Literature Review database)
 - 25-50.000USD Postdoc time for input
- Study and identify drivers of bee diversity within and among agro-ecosystems
 - 1.400.000USD total (200.000USD per region)
 -
- 2) Establish and expand authoritatively verified, well-curated, regional specimen reference collections.
 - Contribute to a comprehensive checklist of sub-Saharan African bees (done by Connell but new species through new collection and unblitzed areas)
 - Next to nothing
 - Provide biogeography, georeferenced databases and publications.
 - 10.000USD
 - Repatriate (digitally) data and information in foreign collections.
 - 50.000USD
 - Improve quality of African bee type collections outside of Africa
 - 100.000USD
- 3) Create and maintain DNA barcode database for all African bee species.
 - Obtain additional specimens specifically preserved for barcoding technique when necessary
 - 10.000USD
 - Sequencing of COI
 - 30.000 specimens @ 7USD*1.3 = 280.000USD max
- 4) Documenting indigenous knowledge and cultural uses
 - Compile list of name in local languages for bees and associated plants
 - 30.000USD/y (Master) * 7 regions = 210.000USD/y
 - Compile IK on bee-plant-interaction and ecology
 - Included above
- 5) Capacity building: training in bee taxonomy and establish research infrastructure
 - Provide identification training and services at various end-user levels.
 - Train the Trainers: 2 courses per year per region (French and English)
 - 30.000USD for 60 people per course (travel etc)
 - 100.000USD for 30 Stereomicroscopes, Lab Equipment
 - Policy makers, Journalists: 1 information day per region
 - 5.000USD* 7 regions = 35.000USD
 - School: 10.000USD per country (whole project period)
 - Scientist & taxonomists: 1 workshop per year for all regions
 - 60 people 75.000USD per workshop
 - Provide training on conducting taxonomic revisions.
 - Students
 - 30.000USD/y per student*2 Master years*20Students+4*PhD years*10Student = 3.200.000USD
 - 1 staff person per region receives sabbatical to supervise revisions
 - 50.000USD*7 regions = 350.000USD in total

- Obtain research capacities to perform DNA barcoding regionally
 - 900.000USD for equipment and technician of sequencer
 - 1.000.000USD Upgrading museums for DNA vouchering
 -

Coordination of taxonomic activities: 80.000USD/y

References

Connell Eardley 2009 Apidologie

Heard 1999 Stingless Bee Pollination Annual Review of Entomology

Group 2. Increasing food production and Stingless Bees.

1. Peter Kwapong provided an overview of work being done on Stingless bees in Ghana
2. Crops: beans, pumpkins, watermelon, Cucurbits,
 - a. In Kenya, African indigenous vegetables are re-emerging eg. Solanacea
 - b. In West Africa, Shea, solanacea, mango, papaya
 - c. Tanzania – Ethnobotany projects are going on with database on various trees eg. Baobab tree
 - d. CAR- Central African Republic; No knowledge about biodiversity, pollination and ethnobotany. Livelihood comes from the forest and lack of knowledge. Database of pollinators is lacking, production of NTFPs. Fear about if the project is for East Africa according to the title?
 - e. Sunflower is also very important. This is becoming very important in Kenya.
3. We need to develop a concept for crop and then various countries can choose the type of plant (medicinal).
4. Records on food crops in countries can be found in Ministries of Agriculture and also FAO.
5. It will be important to distinguish from indigenous and exotic crops.eg. Citrullus. We need to refer to David Roubik's book on Pollination Cultivated Plants in the Tropics. Pub 1995 FAO.
6. One way of approaching Funding agencies is to talk about food security and also wild plants for food security:
 - a. What plants are pollinated what wild plants are harvested? Which of these plants require pollination? Is production limited by pollinations? What are the pollinators, can the pollinators be increased, -- etc in any productions or organic.
7. **Objectives:**
 - a. A first draft of a table of the crops
 - b. Stingless bees that Peter Kwapong of Ghana and Mary Gikungu of Kenya has worked on –
 - i. List of crop plants that it forages on
 - ii. Products and their uses
 - iii. Wild non destructive harvesting of stingless bees by pygmies
 - iv. Source of pollen and nectar (whether indigenous or what). Sampling pollenology from cubacula and pollen pots as well as bee feces. Stingless bees may not be major pollinators of crops but can be managed for pollination.
8. Climate change – What will the modifications be with time in harsh environment for pollination and food production. Using trees like Shea for keeping back desertification.
 - a. Leguminous plants for livestock.
 - b. Greenhouse farming? in Kenya.
9. At this point we need to come up with modules and then go into smaller groups to handle the groups.
10. Modules:
 - a. Document native and introduced crops including NTFPs and finding out who pollinates them. Best practices of farmers (indigenous knowledge) and wild plants (applied modules??)
 - b. Stingless bee biology and management for pollination including other non Apis bees eg. Carpenter bees, leafcutter bees, etc
 - c. Management of pollinators with interventions of best practices

11. In terms of numbers of SB species we have about 25 but in South America there are many

Module A. Document native and introduced crops including NTFPs and finding out who pollinates them. Best practices of farmers (indigenous knowledge) and wild plants (applied modules)

1. Literature search on major and minor crops
 - a. What published records on native exist
2. Production data from Min of agric and FAO
3. Document best practices on farm and nesting sites including bad practices
4. Pollinator surveys on flowers
5. Phenology of both plants and pollinators
6. Economic valuation of pollination
7. The role of pollinator on IPM

Module B. Stingless bee biology and management for pollination including other non Apis bees eg. Carpenter bees, leafcutter bees, etc

1. Indigenous knowledge of stingless bees in Africa including indigenous para taxonomy
2. Stingless bees management methods such as
 - a. colony duplication
 - b. protection from natural enemies,
 - c. supplemental feeding,
 - d. documenting floral resources

Proposal writing

1. fact finding
2. contact people who can help
3. references
4. Expand the outline

Module B. Stingless bee biology and management for pollination including other non Apis bees eg. Carpenter bees, leafcutter bees, etc

1. Indigenous knowledge of stingless bees in Africa including indigenous para taxonomy mainly for stingless bees
2. Indigenous knowledge in Kenya, Uganda, Ghana, Tanzania, CAR, South Africa and DRC
 - a. Name
 - b. Nest site
 - c. Floral resource where they find them
 - d. Use for hive products
 - e. Conservation
 - f. Honey harvesting methods
 - g. Further product processing of honey
3. Peter Kwapong to provide publication on IK on stingless bees. (KariKari & Kwapong, 2007)

Methodology through interviews and questionnaires

OUTLINE OF METHODS

- Stingless bees management methods such as
 - a. Collection from the wild
 - b. Building artificial hives based existing technology
 - c. Management of pests eg ants, spider, lizards, robber bees, cleptotrigona, florid flies, small hive beetles
 - d. colony duplication (mother to daughter)
 - e. supplemental feeding during times of drought and nectar dearth

- f. training component for farmers in keeping,
- g. documenting floral resources
- Indigenous knowledge in Kenya, Uganda, Ghana, Tanzania, CAR, South Africa and DRC
 - Name
 - Nest site
 - Floral resource where they find them
 - Use for hive products
 - Conservation
 - Honey harvesting methods
 - Further product processing of honey
- Peter to provide publication on IK on sb.

DAY 2 --18-02-10

The benefit of project to local communities??

- Pollination for crops conservation
- Medicinal hive products??? Market development /survey??

Module b. Stingless bees

Introduction

(HEARD, T. A. 1999. The role of stingless bees in crop pollination. Annual Review of Entomology 44: 183-206.) Judith SlaaSLAA, E. J., L. A. S. CHAVES, K. S. MALAGODI-BRAGA, and F. E. HOFSTEDDE 2006. Stingless bees in applied pollination: practice and perspectives. Apidologie 37: 293-315.)

BOSCH, J., and W. P. KEMP 2002. Developing and establishing bee species as crop pollinators: the example of *Osmia* spp. (Hymenoptera: Megachilidae) and fruit trees. Bulletin of Entomological Research 92: 3-16.—for solitary bee management

Objectives

1. Improving crop/plant pollination through Stingless beekeeping and non Apis management / conservation
2. Develop and implement methods for non Apis (*Xylocopa*, ceratina, leafcutter bees, *Allodapines* , and stingless beekeeping

With the aim of providing food security

Methodology:

- Field surveys for locating nests and interview with communities
 - a. Visiting communities for acquiring local knowledge and for assistance in locating stingless bees' nests/colonies.
 - b. This will be done through structured interviews and/ or questionnaires in the village and in the field.
 - c. Contact people will be very experience farmers and loggers through the community structures.
 - d. Project will be community-based with reasonable accessibility.
- Using previously designed nesting boxes and trap nesting materials to test suitability for management. Based on literature and trials bees will be managed.
- Management methods: (Torchio, Phillip F. – leafcutter bee and *Osmia* management)
 - a. Transferring into artificial nests
 - b. Colony division and queen rearing (mother to daughter)
 - c. Supplemental feeding
 - d. Pests/predators/ disease control
- Follow up on management for pollination efficiency for crops eg. Macadamia, cucumber, coconut, mango, strawberry, avocado, coffee, tomatoes, sweet pepper,

mint, and Osmium sp. (HEARD, T. A. 1999. The role of stingless bees in crop pollination. Annual Review of Entomology 44: 183-206.) Judith SlaaSLAA, E. J., L. A. S. CHAVES, K. S. MALAGODI-BRAGA, and F. E. HOFSTEDE 2006. Stingless bees in applied pollination: practice and perspectives. Apidologie 37: 293-315.)

- Development of training materials (see Stingless be training materials from Ghana)
- Trainer of trainers workshops for bee management in each of the following countries : Kenya, Uganda, Ghana, Tanzania, CAR, South Africa and DRC

Log frame

Intervention logic	Objectively verifiable indicators	Verification	Assumption
GOAL <ul style="list-style-type: none"> • Increase crop production for food security in Africa 	GOAL MEASURES <ul style="list-style-type: none"> • Increased crop production in fields with managed pollinators • Increased number of managed colonies • More pollinator friendly activities 	HOW TO VERIFY <ul style="list-style-type: none"> • Number of communities involved and their amount of managed pollinators • Yield measurements and amount of managed pollinators 	To reach goal and beyond <ul style="list-style-type: none"> • Communities not receptive to project • Farmers commitment • Government support • Political stability
PURPOSE <ul style="list-style-type: none"> • More pollinator friendly activities • For improved livelihood through increased crop production 	PURPOSE MEASUREMENTS <ul style="list-style-type: none"> • More crops for commercialization • Raised environmental awareness 	HOW TO VERIFY <ul style="list-style-type: none"> • Increased yield per area • 	TO ACHIEVE PURPOSE <ul style="list-style-type: none"> • Support from communities • Farmers reduce use of pesticides • Farmers abandon practice of burning fields
OUTPUTS <ul style="list-style-type: none"> • Collecting bee nests and information • Develop management protocols • Organize workshops 	OUTPUT <ul style="list-style-type: none"> • Install 100 colonies pr country • Viable colony effectively pollinating the field • 2 years [depending on donor] • Local community as customer • Cost >> see appendix 	HOW TO VERIFY <ul style="list-style-type: none"> • Increased community participation in the management of bees • Number of colonies actively kept by local communities 	TO PRODUCT OUTPUTS <ul style="list-style-type: none"> • Support from Government, extension agents, and NGOs • Influence governmental and community leaders • Socio stability
INPUTS <ul style="list-style-type: none"> • Field work and 	SCHEDULE <ul style="list-style-type: none"> • Available 	HOW TO VERIFY <ul style="list-style-type: none"> • Monitoring 	TO OBTAIN RESOURCES

community preparation (researcher + community) <ul style="list-style-type: none"> • Optimizing management protocols through experimentation (researcher) • Preparation of training materials for workshop (researcher) • Organization of workshops (researcher + community) 	transportation , carpenter work, local interpreter	through visitation	<ul style="list-style-type: none"> • Arrange logistics and network
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Budget

Item	Activity	Cost \$\$\$ USD	Justification
1. Transport	<ul style="list-style-type: none"> • Field visits 5000km/country • Expert visit (1) Flight 1500 Bord & log 200/day for 14 days =2,800	30,000 4.300	
2. Community entry	<ul style="list-style-type: none"> • Organising community (5x7) 1000/35 	35,000	
3. Nest/hive construction	<ul style="list-style-type: none"> • Carpentry and construction of infrastructure • 25/hive 		
4. Hive management	<ul style="list-style-type: none"> • Hive management tools 		
5. Preparation of field material	<ul style="list-style-type: none"> • Questionnaire • Nets (30), pan traps, pins(20), alcohol, storage boxes (30	
6. Equipment	<ul style="list-style-type: none"> • Computer (1000), printer, high resolution camera(2000), insect cabinet (2500) • Software (1000) 	2500	
7. training	<ul style="list-style-type: none"> • Training manual preparation (5000) • International training(TOT) (20,000) • Community training (5x7) x2days (2000) 		
8. Research permit	Local permits		
9. Personnel	<ul style="list-style-type: none"> • 1 international expert (for 14 days) • 2 local experts <ul style="list-style-type: none"> ○ Student <ul style="list-style-type: none"> ▪ KE: 1700USD tuition, 4200USD stipend per year, 		

	<ul style="list-style-type: none"> ▪ 12.000USD/y in total ▪ UG: 3000USD tuition, stipend 500USD per person per month, 20.000USD/year in total ▪ GH: Master student 30.000USD (living and research) ○ PhD <ul style="list-style-type: none"> ▪ 20.000USD/y ○ Supervisor of PhD and Student group <ul style="list-style-type: none"> ▪ 30.000 – 60.000USD/y • • 2 students (60,000) • 1 technician • 10 x 5 communities x 7 countries 		
10. Communication	<ul style="list-style-type: none"> • Air time • Email • Postage of specimens 		
11. International meetings	<ul style="list-style-type: none"> • Evaluation meeting and reporting 		
12. Contingency (10%)			

Comments during plenary

The title must include Poverty alleviation and gender (women –friendly)

1. Taxonomic component
 - a. Barcoding
 - b. Taxonomic experts
 - c. International cooperation – bringing S American (Georgio)
2. Pollinator management
 - a. Hive building
 - b. Placing trap nests for Xylocopa to increase pollinator visitation
3. Danger of moving colonies from original habitats to new which may have
 - a. effects on Gene pool
 - b. danger of creating imbalance
 - c. effects on environment and wild colonies
 - d. The fact it takes 3 year for colony to be sturdy.
 - e. Need to use existing colonies for augmentation
 - f. In colony multiplication of stingless bees, need to ensure presence of wild populations for availability of male maintaining the gene pool.
4. Using stingless bees for pollination
 - a. continental transfers of plants or pollinators may lead to disease transfer and cross breeding with local species
5. Need to increase the number of students in the project to look at anthropological issues including economics of pollination.
6. Home gardens /orphaned crops (indigenous vegetables and food crops that have been ignored that are being introduced into home garden eg. African egg plant

7. Laurence Parker will lead the group (Mary, Peter, Refela, Nelly Ndugu, Dan Masiga, Joseph Macharia, Claus) that will do DNA barcoding including pollinator.

