Abc Taxa

The Bee Genera and Subgenera of sub-Saharan Africa

Connal Eardley
Michael Kuhlmann
Alain Pauly

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Editors

Yves Samyn - Zoology (non African)

Belgian Focal Point to the Global Taxonomy Initiative
Royal Belgian Institute of Natural Sciences
Rue Vautier 29, B-1000 Brussels, Belgium
yves.samyn@naturalsciences.be

Didier VandenSpiegel - Zoology (African)

Department of African Zoology
Royal Museum for Central Africa
Chaussée de Louvain 13, B-3080 Tervuren, Belgium
dvdspiegel@africamuseum.be

Jérôme Degreef - Botany

Belgian Focal Point for the Global Strategy for Plant Conservation
National Botanic Garden of Belgium
Domaine de Bouchout, B-1860 Meise, Belgium
jerome.degreef@br.fgov.be

Instructions to authors

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by

Connal Eardley

Agricultural Research Council, Private Bag X134, Queenswood, 0121, Pretoria
University of KwaZulu-Natal, P.O. Box X01, Scottsville, Pietermaritzburg, 3209, South Africa
Email: EardleyC@arc.agric.za

Michael Kuhlmann

The Natural History Museum, Cromwell Road, London SW7 5BD, United Kingdom
Email: m.kuhlmann@nhm.ac.uk

Alain Pauly

Royal Belgian Institute of Natural Sciences, Rue Vautier 29, B-1000 Brussels, Belgium
Email: alain.pauly@brutele.be

Cover picture: background: Nimba mountain in Guinea; Honey bee (*Apis mellifera*) on *Tradescantia* (Commelinaceae), Meliponine bee (*Dactylurina staudingeri*) on *Jatropha* (Euphorbiaceae), honey and fruits on market in Kinshasa (R.D. Congo) (Pictures: Didier VandenSpiegel and Nicolas Vereecken)

Picture on this page: Carpenter bee (*Xylocopa combusta*) pollinating a flower of passion fruit (*Passiflora edulis*) (Congo Kinshasa) (Picture: Nicolas Vereecken).

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Preface

I congratulate the distinguished authors and editors of *Abc Taxa* and the Belgian Global Taxonomy Initiative for this important publication as the seventh volume of *Abc Taxa*. This series has positioned itself as an excellent advocate of capacity building in taxonomy and specimen collection management.

This volume on the bees of sub-Saharan Africa will lead to better documentation and understanding of bee biodiversity in Africa. Such comprehensive work on African bees is extremely important considering the formidable challenge of halting the worrisome world-wide loss of pollinators. The issue of loss of pollinators has been recognized by the Conference of the Parties to the Convention on Biological Diversity (CBD) in decision V of its fifth meeting, which established the International Initiative for the Conservation and Sustainable Use of Pollinators.

The Global Taxonomy Initiative calls for several tangible outcome-oriented deliverables one of which is the production of keys to all genera of bees of the world (COP decision IX/22; output 4.12.2). This volume is an important step in that direction and it hoped that other workers will follow the example of Eardley, Kuhlmann and Pauly and that similar taxonomic keys for other regions will emerge.

I also wish to express my praise to each of all authors for delivering this fine piece of work. The clarity, completeness, and high quality illustrations that enrich the book will ensure that it will remain a valuable tool for bee identification and research for a long time to come, and underpin better knowledge and management of this very beneficial group of insect pollinators. Moreover, many bee species are producers of honey, an important component of healthy diets and source of income for local communities.

Loosing bee biodiversity is a severe threat that would seriously jeopardize not only the long-term survival of flowering plants in natural ecosystems but also those used in agriculture, which underpins sustainable development in Africa.

This is a valuable contribution to capacity building, awareness raising and to the scientific literature. I am pleased to welcome it as an outstanding contribution during the International Year of Biodiversity.

Ahmed Djoghlaf
Executive Secretary
Convention on Biological Diversity

1. Introduction

There are few, if any, ecosystems that are not affected by man. Therefore, to a greater or lesser extent, they are all managed, this is especially true for agro-ecosystems. Understanding how our ecosystems function is important for effective management. Although all organisms contribute to ecosystem function, some appear to provide essential ecosystem services. Pollination is such a service. This is because most flowering plant species (Angiosperms) require the inadvertent services of an animal for cross-pollination; that is to move the pollen from the anthers of one plant to a stigma of another plant of the same species.

Pollination precedes fertilization but does not necessarily result in fertilization. When the pollen grains are deposited on a receptive stigma a pollen tube must grow down the style for the male gametes to reach an ovum and only then fertilization occurs. This does not always happen. Mostly, fertilization results in seed and fruit. Therefore, fertilization is not only needed for plant reproduction, but also for fruit and seeds production, making pollinators vital for agriculture. Many flowering plants are self-pollinated or pollinated by wind and water. Cereal crops are wind pollinated, but pollinators are needed for many fruit and seed crops. In natural ecosystems pollination is needed for food for animals and micro-organisms. Therefore pollination is important for the conservation of biological diversity.

Bees are the most important pollinators because they visit plants with the intention of collecting pollen and move from flower to flower before taking the pollen to their nests. Moreover, they often focus on just one plant species. However, they are not the only group of pollinators, and not even the only group that deliberately collects pollen, as the pollen wasps (Masaridae) do the same. Most pollinators visit plants to acquire nectar, pollen and/or plant oils for food for themselves or their larvae, and un-intentionally pollinate plants. Pollinators that do not deliberately collect pollen include moths, beetles, flies, wasps, bats, birds and there are a host of other organisms that have interesting relationships with plants.

Among the different groups of bees there are a variety of different biologies. Most are solitary, many are semi-social and some are eusocial. Whereas most are pollen collectors some are social parasites (they replace the queen and use the host workers to raise their progeny), cleptoparasites (cuckoo bees, who lay their eggs on the host species larval provisions) or robbers (who steal pollen and honey from other bee’s nests). Mostly they nest in cavities, more or less spherical cavities for social species (honey bees and stingless bees), pre-existing tunnels (like wood boring beetle burrows), self-made tunnels in wood (carpenter bees) or in the soil, or make external nests from plant material (carder bees), sand and/or mud (dauber bees) or resin. O’Toole & Raw (1991) describe the different behaviours in more detail. Generally, understanding the taxonomy enables one to predict the behaviour of the bee species.

In first place this book is designed to help novices with the identification of bees to genus and subgenus level. To achieve this, we used as many images as possible to illustrate the bees and their morphological structures. It was not our intention to write a monography of the sub-Saharan bee fauna and therefore the additional information given about genera and subgenera is mostly limited to distribution. To facilitate bee studies, the taxonomy, systematics and morphological terminology used here, even though debatable in some cases, is fully compatible with Michener (2007). To everyone who wishes to learn more about bees or wants to start an advanced study we recommend they consult this essential book on the bees of the world and the references to more detailed publications listed in table 1 at the end of the book.

2. The conservation of bees

Bees contribute to plant reproduction, and plants are the fundamental building blocks of most terrestrial ecosystems. Plants photosynthesise, produce food through foliage, fruit and seed, provide building material, consolidate the soil, maintain water tables, sequestrate carbon and much more. Plant biodiversity enables ecosystems to cope with changing seasons and climate. The maintenance of plant biodiversity therefore depends on pollinator biodiversity, and their conservation goes hand in hand. Bee pollinators can however be disturbed by a number of factors

- Their nests are destroyed for honey (honey bees and stingless bees).
- Wood with tunnels (*e.g.*, wood boring beetle burrows) that could be used as nests, or in which carpenter bees can burrow, is collected for firewood.
- Soils in which they burrow is trampled by stock or tilled for crops.
- Flowers they visit are sprayed with insecticides, poisoning adults directly and resulting in bees feeding their larvae with contaminated pollen and nectar.
- Social species are easily moved, if kept in domestic hives, and hybridize with native varieties/subspecies.
- Water is often kept in reservoirs and/or canalized and may not produce enough mud for daubers.
- Water is polluted by stock and people.
- Food plants are lost when there is selective grazing, cultivation of crops, forestry, removal of bush to open grasslands and by the spread of invasive plants.
- Exotic bee species diminish food (nectar, pollen) for indigenous species.
- Moving bees and the introduction of new species / subspecies by bee-keepers results in the spread of pests and disease (*e.g. Varroa* mites).
- Their sex determination mechanism, which is called haplodiploidy, results in the production of increasing numbers of sterile diploid males in small populations. This "diploid male extinction vortex" results in a very high genetic load and a very high extinction rate in comparison to other organisms with similar population parameters but lacking the sex determining mechanism of bees (Zayed and Packer, 2005). As natural areas provide

many services that reach beyond their boundaries, bee conservation measures should be adopted in both natural and agricultural ecosystems.

Eardley et *al* (2006) gives several case examples of pollinator biodiversity conservation.

Pollination is directly related to agricultural production for crops that require a pollinator. If the ecosystem surrounding farmlands is healthy farmers will usually receive adequate pollination. When agriculture expands to the point where there is insufficient natural areas to function as a healthy ecosystem, pollination must be managed. In Africa pollination management is through managing honey bees. In other continents solitary bees (*Megachile, Osmia, Nomia, Xylocopa* and *Amegilla*), other social bees (Meliponini and *Bombus*), oil palm beetles, bats and many other species are managed. Pollination management must follow certain guidelines, as it involves moving animals to different places and this can have severe consequences.

Before working with bees the taxonomy of the group must be understood. This book is thus best regarded as a precursor to pollination management. Pollination management as such is beyond the scope of this book.

3. How to collect bees

Bees like most insects can rarely be reliably identified in the field. Generally taxonomic training is required and the use of a microscope is inevitable. Thus, it is necessary to collect and adequately prepare bees before they can be studied.

Collectors each have their own unique techniques and equipment. Therefore what is said below is a broad guideline only. Enthusiastic collectors should adapt the equipment to suit themselves and the environment in which they work. Good guidelines can be found in Uys and Urban (2006).

Specimens collected for accurate identification and museum specimens should preferably be kept dry at all times. Wet specimens, like those preserved in alcohol, collected in yellow pans or killed in bottles with condensation on the sides make ugly museum specimens because their pubescence becomes mattered and discoloured. They are difficult to identify. There are techniques to rehabilitate them, but the cleaned bees are never as nice as a specimen that has been kept dry. Also, there are a few groups with little hair that are not seriously harmed by alcohol and moisture. When a series of specimens are collected it is good practice to keep one in a small bottle submerged in 90% ethyl alcohol for genetic barcoding. It should be labelled to indicate that it is part of a series with dry specimens, which are needed for an accurate identification.

Hand nets are the best tools for collecting bees as they allow catching specimens without too much damage, and make field observation possible. Hand nets comprise a handle with a circular frame supporting a gauze bag at one end of the handle. The handle should be about 1 m long; extendible handles are made with two aluminium pipes, one that slides over the other, and a clamp on the end of the outer tube (Fig 1). The outer tube slides up and down the inner tube to alter the length of the net handle, and is secure when clamped. The circular frame should have a 35 cm diameter and be firmly attached to the handle, yet detachable so that the gaze bag can be easily replaced. The gaze bag should be made of a fine, light, yet strong gauze. White material makes it easier to see the bee in the net. It should be about twice as long as the diameter of the net. This allows the net handle to be rotated after catching a bee to prevent it from escaping, *i.e.*, the bee in the apex of the gauze bag lands in the circular frame of the net but with the bag folded over the frame. The gaze bag may have a sleeve around the opening for sliding over the circular frame, or, if the frame is made of a flat material with holes in it, it is sewn to the circular frame.

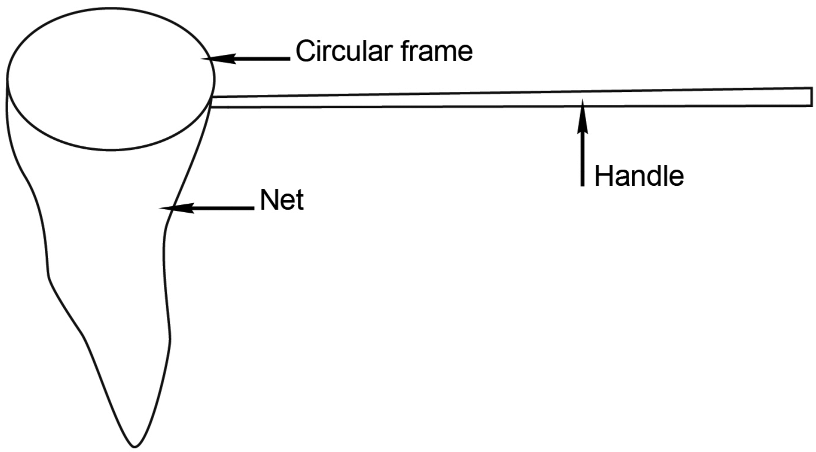

Fig. 1. Hand net.

Malaise traps are useful for collecting bees in certain ecosystems. They are ineffective in catching large bees, like *Xylocopa* and some *Megachile*. They also do not work well in deserts, forests and machia (fynbos). They work best in savannah. If well placed they can collect a large number of small and medium sized bees. A malaise trap looks like a gauze tent (Fig. 2). The short ends are gauze (one is higher than the other), the long sides are open, between the open ends there is a gauze central panel (flight interceptor) and the roof is gauze. The sides and central panel should be black and the roof white. Bees fly into the central panel and then make their way to the highest point of the trap where it opens into a killing bottle. Townes (1972) provides a pattern and they can be purchased from entomological equipment distributors. It is preferable not to place alcohol in the killing bottle, rather an insecticide that will kill the bees and keeps them dry. This results in the absence of preservatives, and therefore the traps should be emptied at least once a day. The killing bottle should not be left on the trap overnight because they collect moths and the bees get covered with moth wing scales. The malaise trap should be placed in a flight path, such as across a narrow foot/game path with dense vegetation on each side.

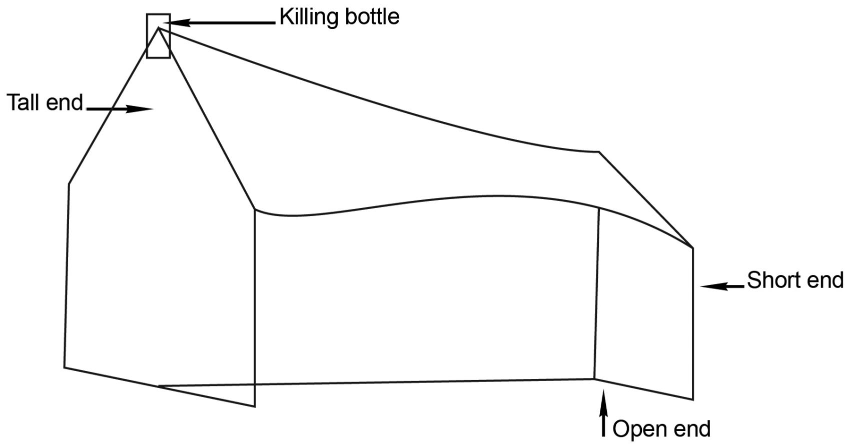

Fig. 2. Malaise trap.

Pan traps are easy to use and transport, but they produce wet bees. A pan trap is a shallow dish of soapy water. The soap reduces the surface tension of the water and prevents the bees from escaping when they drift to the side. Foam on the water surface must be avoided. Yellow pans are the most common, but blue and white ones are used as well and might attract different species. The various colours provide different results in different ecosystems. Bees collected in this way should be temporarily preserved in 70% ethyl alcohol and then dried. To dry bees place them in 96% alcohol and then in a sieve with a gauze top and blow them dry with a hair dryer, but not for too long because this leads to wing damage. Blowdry them until their thoracic hair is dry and fluffy. There are a number of other ways for doing this but they involve expensive equipment, such as a critical point dryer, and hazardous chemicals.

Trap-nests are twigs and blocks of wood (or synthetic material) with holes in them for bees to nest in. Reeds and/or bamboo work well for bees that nest in hollow twigs. They are usually placed horizontally in bundles. They are also easy to split open to observe and extract the specimens inside. Blocks of wood are better when made from planks fastened together to form a block with holes drilled in the joints so that the nests can be opened. Some have a transparent window on one side so that the contents can be observed without disturbing the larvae (see Krombein, 1967). Care should be taken to keep ants away from trap nests. A frame with its feet in water, or car grease on the legs of the frame or wire holding the trap nests tends to keep ants away.

Natural bee nests can be collected. If above ground (in twigs, wood, snail shells, exposed mud nests or exposed plant fibre nests) they can be collected and opened or kept in an emergence box. The latter is simply a box with a funnel in the side of the box and a glass bottle on the end of the funnel (Fig. 3). The bees go through the funnel to the light and don't return to the box. Care must be taken to avoid trapping spiders in the box because they may spin webs and destroy the bees.

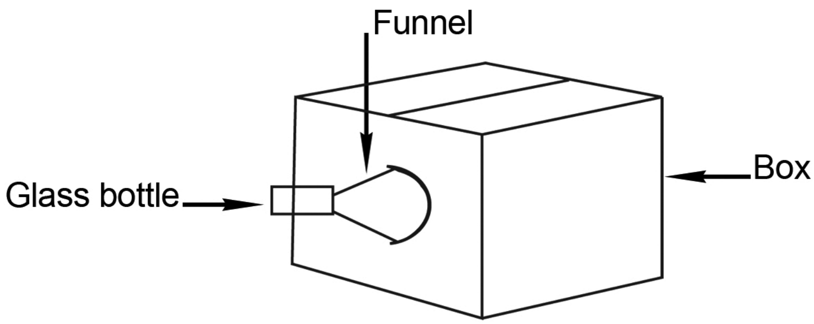

Fig. 3. Emergence box

Bees in natural nests in the ground can also be collected. To collect only the adults a glass jar can be placed over the entrance of the nest whereby the bee will be collected in the jar when it leaves the nest. Ground nests can also be excavated. To follow the nest tunnel in the ground blow white power down the nest and follow the white line created by the powder. It is easier to excavate ground nests by digging a hole next to the nest and slowly shaving away the ground laterally to expose the nest tunnel and cells. Larvae can be raised by putting them with their provision in a glass tube with a tissue paper plug. When the adults emerge they are easily killed in a freezer, which avoids handling.

Once collected the bee must be killed. Killing bottles should be in plastic to avoid breakage. They should contain potassium cyanide crystals with a porous stopper above the crystals in the bottom of the bottle. A drop of water added before use improves the effectiveness of the killing bottle. Potassium cyanide and water produce hydrogen cyanide gas, which is very toxic to insects, and people so it must be used carefully and responsibly. Tissue paper added to the bottle reduces condensation that will make the specimens wet. Ethyl acetate tends to make the bees greasy, but is not as toxic to people as potassium cyanide. It should not be used for specimens collected for molecular research.

4. How to prepare specimens and curate a bee collection

As with collecting, curators have their own specific ways. The best bee collections for scientific study are those with dry specimens that are neatly pinned and labelled. The less bees are handled the better their condition when pinned. For molecular work they are best preserved in 96% ethyl alcohol.

They must be pinned on stainless steel insect pins (about 39 mm long). The pin must be paced vertically through the right hand side of the scutum (Fig. 8A) and