The Pollinator Information Network Newsletter

Editorial

December 18, 2020. Vol. 4, Issue 2

Welcome to the second issue of volume 4 of the Pollinator Information Network Newsletter!

The *Pollinator Information Network Newsletter* is one of the projected outputs of an ongoing project of the JRS Biodiversity Foundation, *i.e.* "The Pollinator Information Network for Two-Winged Insects" or simply PINDIP. The PINDIP project has its own website: https://www.pindip.org/.

In this Newsletter, we give a brief overview of the follow on project of PINDIP, a collaboration between Belgium, Benin and South Africa (pages 2-3). We announce two new training courses in general entomology and collection management which we will organize in 2021. One of these will take place in Tanzania and will focus on young and emerging entomologists from the entire Afrotropical Region (page 4) while the second training course will take place in South Africa and specifically focusses on young and emerging South African entomologists (page 6). Further, you will find a short report on field work in the Zululand forest area (South Africa) to collect pollinating Diptera and conducted by the KwaZulu-Natal Museum and the Albany Museum (page 7).

In this issue, we put three South African MSc students and their work in the spotlight: Luhlumelo Mva of the KwaZulu-Natal Museum (pages 8-9), Gerald Dlamini of the University of KwaZulu-Natal (pages 10-15) and Carly Vlotman of the Stellenbosch University (pages 16-18). We also introduce Terence Bellingan, curator of Diptera at the Albany Museum in Grahamstown (South Africa) (pages 19-20).

Read more on the upcoming 12th International Symposium on Pollination (ISPXII) on page 21 and on the 11th International Symposium on Syrphidae (ISS11) on page 22.

As usual, the issue ends with a list of new, although incomplete, published research related to pollination biology in its broadest sense (pages 23-27). We invite everyone concerned to submit relevant information for the *Newsletter*, including summaries of their own research and projects on pollination biology – or publications that they want to see highlighted, relevant literature, upcoming conferences and symposia, possibilities for cooperation and grant applications related to plant-pollinator networks, *etc.*, before the 15th of April 2021.

Enjoy reading!

Kurt Jordaens
on behalf of the PINDIP team

Table of content

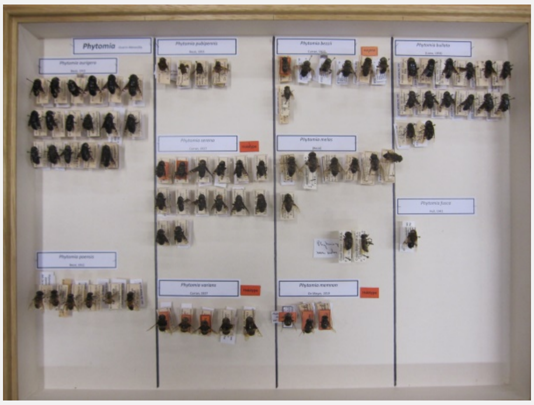
New project

Update: Follow-on project The Pollinator Information Network for two-winged Insects (Diptera) (PINDIP)

The Royal Museum for Central Africa (RMCA), Tervuren, Belgium and the KwaZulu-Natal Museum (KZNM), Pietermaritzburg, South Africa have received a follow-on budget from the JRS Biodiversity Foundation. This is a follow-on project to the 2017-2019 Pollinator Information Network for Sub-Saharan Two-Winged Insects (PINDIP), a JRS-funded project headed by the Royal Museum for Central Africa (RMCA). PINDIP aims to increase knowledge and data accessibility for sub-Saharan Diptera, a group of insect pollinators that includes true flies and mosquitos. This project has already found success in developing a research network on pollinating Diptera in the Afrotropics, digitizing and sharing data records for six Diptera families, publishing research results and sharing identification tools, and training students and researchers. It has also led to three new "spin-off" initiatives in entomological research in the Afrotropics. These new initiatives support the PINDIP network, training, and research activities.

(Left: John Midgley in the Diptera collection at the KZNM)

As a start, we have increased efforts to improve the curation and management of the Diptera collections at the KZNM and RMCA. Then, we increased visibility of, and accessibility to, collection data for sub-Saharan Diptera of various collections. So far, we have published six datasets on GBIF and as such have mobilized almost 41,000 occurrence data. Other data sets will be released in 2021.



(Right: part of the newly curated Syrphidae collection at the RMCA)

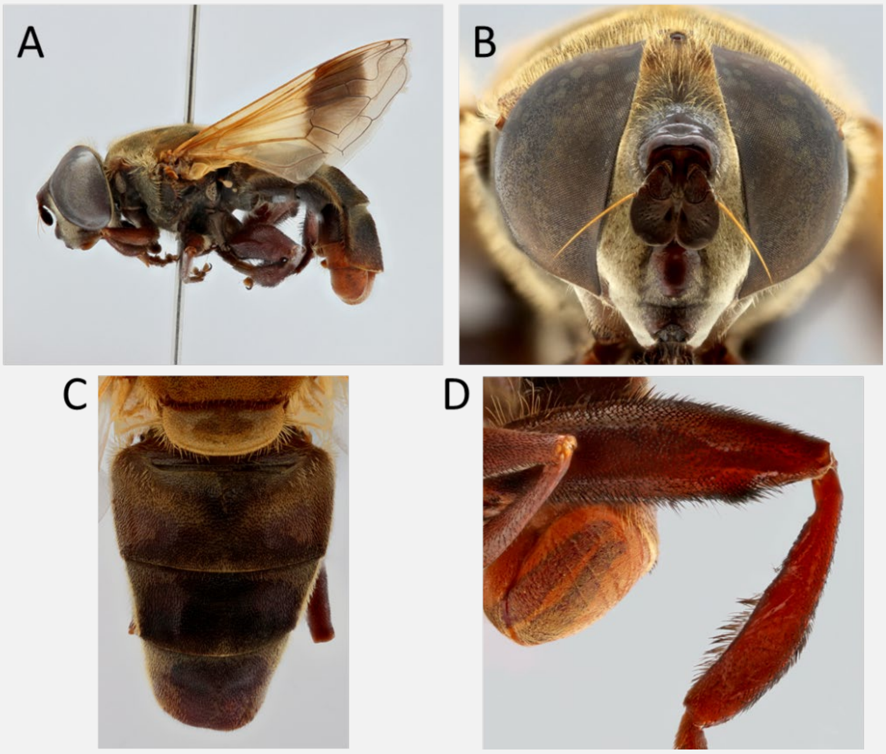
So far, the following datasets have been published:

The Syrphidae in the collections at the National Museums of Kenya (NMK; Kenya): http://www.gbif.org/dataset/0b43443a-2599-42c1-b7c5-f9e2ff93d449 (3,137 occurrences).
The Rhiniidae in the collections at the National Museums of Kenya (NMK; Kenya): https://www.gbif.org/dataset/9d4b213a-4946-46ed-801b-d9f9647a20e8 (102 occurrences).
The Bombyliidae in the collections at the National Museums of Kenya (NMK; Kenya): https://www.gbif.org/dataset/581f48a5-534b-4948-ac09-bde34b23f7e7 (971 occurrences).
The Bombyliidae, Calliphoridae, Mythicomyiidae, Nemestrinidae, Rhiniidae, Syrphidae and Tabanidae (subfamily Pangoniinae) in the collections at the KwaZulu-Natal Museum (KZNM; South Africa): https://www.gbif.org/dataset/d5c0a2dc-a87c-4bcd-8b07-2c1d60f40167 (32,725 occurrences).

The Syrphidae in the collections at the International Center of Insect Physiology and Ecology (*icipe*; Kenya):
https://www.gbif.org/dataset/029ca2ac-d525-4dd0-bfc5-288102358341 (1,470 occurrences).
The Syrphidae in the collections at the International Institute of Tropical Agriculture (IITA; Benin):
https://www.gbif.org/dataset/781747f1-ebab-4eb0-beaf-1f88b3cfd65d (2,293 occurrences).

We have now started with the compilation of species data sheets for 20 of the most common Afrotropical hoverflies to increase awareness of their role as pollinators and as key organisms in biodiversity research. At the same time we are developing a display panel on the role of Diptera in plant-pollinator networks that will be exhibited at the KwaZulu-Natal Museum.

Please visit our website at https://www.pindip.org/ to find out more of on our current projects and to have a look at the pictures of some the Diptera families involved in plant-pollinator networks in the Afrotropical Region (see below for some examples). We are now looking into possibilities to provide easy access to these pictures.



(Left: High-resolution stacking pictures of the Afrotropical hoverfly *Senaspis dentipes* (A: lateral view; B: detail of the head; C: detail of the abdomen; D: detail of the hind leg) as shown on the PINDIP website).

Contact::

Dr. Kurt Jordaens, Royal Museum for Central Africa (RMCA), Tervuren, Belgium; kurt.jordaens[at]africamuseum.be
Dr. John Midgley, KwaZulu-Natal Museum (KZNM), Pietermaritzburg, South Africa; jmidgley[at]nmsa.org.za

Sponsors:

Training

Training course in taxonomy and systematics of African pollinating flies

November 2021, Tanzania

The thirds training course in taxonomy and systematics of African pollinating flies will take place at the Sokoine University of Agriculture (Tanzania) in November 2021.

Group picture of the 2019 training in Morogoro, Tanzania

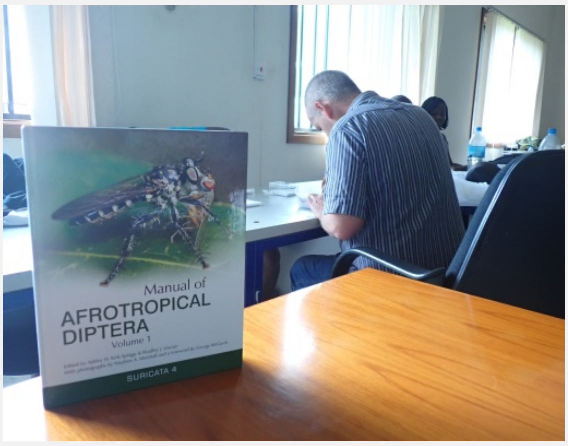
The objective of our group trainings are to ensure, for the sake of the African scientists or the persons confronted with the problem, a basic training on the identification and ecology of African Diptera, with special emphasis on those families (*e.g.*, Bombyliidae, Calliphoridae, Nemestrinidae, Rhiniidae, Syrphidae, and pangonine Tabanidae) that have a significant role in plant-pollinator networks. Participants will be asked to bring their own material which then will be identified up to family or genus level.

The training consists of ex-cathedra courses on morphology, classification, identification, identification methods, collection methods, and conservation methods of Diptera, with a focus on the target families listed above. Practical exercises will be used to comment on, and test, the topics presented in the courses.

Previous page: Practical session in the field: participants will be trained in different trapping techniques such as hand netting (left), the use of yellow pan traps (middle) and the use of Malaise traps (right)

Organisation and more information:

The training course is organized by the Royal Museum for Central Africa (Kurt Jordaens – Marc De Meyer, RMCA, Belgium), the Sokoine University of Agriculture (Christopher Sabuni, SOI, Tanzania), the KwaZulu-Natal Museum (John Midgley, KZNM, South Africa) and the Natural History Museum, London (Ashley Kirk-Spriggs, NHM, UK). A full program and training materials can be found on the PINDIP-website: www.pindip.org. More information on trainings organized by the RMCA can be found at: http://www.africamuseum.be/research/collaborations/training



Top: Practical sessions in the lab: participants receive training in insect conservation methods (left: direct pinning, middle: micro-pinning and staging) and in the morphology, classification and identification of Diptera (right).

Left: The first two volumes of the *Manual of Aftrotropical Diptera* are the main teaching tool during the training. In the background is Ashley Kirk-Spriggs of the NHM London, one of the editors of the *Manual of Aftrotropical Diptera*, getting prepared for one of the practical sessions during an earlier training.

Below: a welcome lunch at the Sokoine University of Agriculture.

More information:

The call for our next training (two weeks in November 2021 will be launched in the first half of 2021 and will be announced in the next issue of the *PINDIP Newsletter*. Keep an eye on the trainings-page on the PINDIP website.

kurt.jordaens[at]africamuseum.be

Sponsors:

AFRICA museum

Belgium partner in development

JRS Biodiversity Foundation

Training

Training course in entomology and collection management for South African entomologists July 2021, South Africa

Organisation:

The training will be organized by the Royal Museum for Central Africa (RMCA, Belgium), the KwaZulu-Natal Museum (KZNM, South Africa) and the University of KwaZulu-Natal (UKZN, South Africa). The training will take place for two weeks in July 2021 (exact dates to be announced). Ten young and emerging South African researchers will be trained in taxonomy, entomology and collection management.

Background:

The aim of this training is to stimulate entomological (taxonomic and ecological) research in South Africa, specifically in students and young researchers and to increase sustainability of taxonomic expertise in Dipterology in South Africa. If you have a South African nationality and want to participate at the training, you can download the application form and find more information on the training on the PINDIP website (https://www.pindip.org/south-africa-2021). The deadline for application is 15 March 2021 CET. Applications received after this date will not be considered. Application have to be submitted to John Midgley of the KZNM (jmidgley[at]nmsa.org.za).



(some pictures of one of our previous training courses, Nairobi, Kenya 2017).

Sponsors:

Belgian Science Policy Office
belspo

NRF National Research Foundation
RISA Research and Innovation Support and Advancement

Report

Fieldwork: Collecting trip in the Zululand forests in KwaZulu-Natal (South Africa)

The arrival of summer is usually a time for increased field work in the Natural Sciences Department and this year was no different, despite COVID regulation making the process a bit more complicated. In November, Dr John Midgley, along with Dr Terence Bellingan from the Albany Museum, undertook a field trip to the Zululand forests in KwaZulu-Natal. While the temperatures were definitely summery, the weather was still dry, meaning that may insects were not at peak activity yet.

The less than ideal weather meant that overall diversity was low, but a few rare specimens were still found. The most exciting was a species of hoverfly, *Meromacroides meromacriformis* (see picture below), last collected in South Africa in about 1858. The exact date is not known, possibly because the collector died of malaria during his expedition. Luckily, modern field collecting is not as dangerous and the team made it back to Pietermaritzburg with a decent number of specimens.

Left: John Midgley collecting in the grasslands at oNgoye Forest (photo Terence Bellingan).
Middle: Terence Bellingan at Entumeni Forest collecting insects next to a small stream (photo John Midgley).
Right: a female of the rare hoverfly species *Meromacroides meromacriformis* hovering above a rot hole (photo Terence Bellingan).

Twitter tags:

@JohnMMidgley @cymatoceps_T @MuseumAlbany

#flies #hoverflies #diptera #syrphidae #entomology #insects #museum

The expedition was funded by JRS Biodiversity Foundation (PINDIP project) and the Belgian Development Cooperation (DIPoDIP project).

ALBANY MUSEUM

Belgium partner in development

JRS Biodiversity Foundation

KwaZulu-Natal MUSEUM an agency of the Department of Arts and Culture

SPOTLIGHT

MSc: Temporal Patterns in Hoverfly (Diptera: Syrphidae) Abundance in KwaZulu-Natal (South Africa).

Luhlumelo Mva

University of KwaZulu-Natal & KwaZulu-Natal Museum, South Africa

I am Luhlumelo Mva, a 23-year-old aspiring scientist that fell in love with the entomology side of science. I was never a science person or science fan simply because I struggled with the other side of science (physics and chemistry) but that changed when the broader aspect of science was introduced to me. My passion for insects and entomology as a whole began the minute it was introduced in my undergraduate program. Their distribution and diversity are what caught my attention as these creatures are very small and many people tend to ignore the importance they bring. All in all, I am a person who is open to learning about all fields of entomology from, medical and veterinary entomology to chemical ecology to insect-plant interaction (just to name a few). I have found each field interesting because when one gets to explore the fascinating world of insects.

As a young scientist, I not only aspire to provide research to upcoming scientists but I aspire to educate people in other fields of study about the importance of insects. I want to change the narrative, where people see insects as annoying and dirty and build a stronger appreciation of the importance they provide to the ecosystem and also recognize them as key components of our ecosystem.

In 2020 I was fortunate and was granted a bursary by the Royal Museum for Central Africa together with the KwaZulu-Natal Museum to further my studies. I am now currently enrolled as a 1st year Master's student at the University of KwaZulu-Natal and my project focuses on hover flies (Diptera: Syrphidae).

Pollination, the process of transfer of pollen from the anther to the stigma, is an important keystone process in an ecosystem and is almost always carried out by wind or insects. Bees are fairly well studied with respect to their pollination efficiency and are generally considered the most important pollinator group in most ecosystems. This is due to their manageability and their degree of domestication. Nevertheless, alarming declines in the number of bees have been reported and in the face of pollinator declines, it is vital that one understands the patterns of solitary pollinator diversity, as these insects are likely to provide the bulk of pollination services going forward.

Hover flies (Diptera: Syrphidae) are one of the most diverse Diptera families with approximately 6000 species worldwide. They are the second most important group in pollinating flowers and are one of the most significant anthophilous Diptera. Adult hover flies are the most abundant group of flower-visiting insects and have been shown to be more effective pollinators than honeybees in a range of crop systems. Syrphids serve as pollinators of different agricultural and horticultural crops and vegetables. Nonetheless, they have an underappreciated role when it comes to plant-pollinator interaction.

Hover flies are diurnal and are normally active in the morning and the afternoon, when the sun is shining. Some hover fly species are migratory and are less active at noon, due to the high temperatures and associated risk of dehydration and heat stress. Most adult hover flies can be observed all year round even though their activity isn't equal throughout the year nor throughout the day. In temperate seasons such as in summer and spring, they are most active and are found in abundance.

The project aims to focus on hover flies as pollinator where their temporal patterns as well as their distribution and abundance in different habitats will be assessed. The project will take place in KwaZulu-Natal.

A study of forest habitat structure between 2009 and 2017 showed reductions in woody vegetation diversity (-14%) and density (-31%), and an increase in the overall height (+11%) of the woody vegetation. These results suggest a rapid simplification of habitat structure and loss of woody vegetation diversity, in these already relatively intensively managed coffee agroforests. I expect that less intensified systems may be prone to even faster degradation rates.

I found negative effects of increasing management on species richness and abundance of coffee flower visiting insects. As smallholder coffee farmers continue to reduce the woody vegetation density and diversity of their production systems, further reductions in habitat quality and associated declines in coffee pollinator communities are expected.

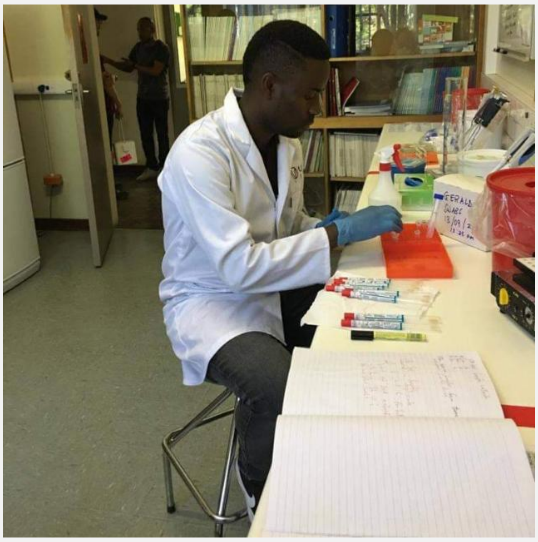
Initial, but not final, coffee fruit set benefitted from insect pollination within the studied coffee agroforests. We found a positive relationship between non-Apis bee diversity within intensively managed coffee production systems and three-year (2016 – 2018) coffee yield stability within the same systems. These results point at the importance of pollination services for long-term yield stability, along with the potential of the surrounding extensively managed landscape matrix to increase pollinator diversity within intensified coffee agroforests.

Contact: Luhlumelo Mva (UKZN-KZNM) or John Midgley (jmidgley[at]nmsa.org.za)

SPOTLIGHT

MSc: Characterisation of Hoverfly-Flower Interactions in the Grassland and Forest Biomes of South Africa.

Gerald Dlamini
University of KwaZulu-Natal, South Africa



Gerald Dlamini started his MSc degree at the University of KwaZulu-Natal in 2020. The aim of his research is to characterize flower-hoverfly interactions in two different vegetation types (grassland and forest) and various levels of anthropogenic disturbances (plantations versus indigenous forest).

Background

The southern Africa flora comprises a large number of unique and specialised plant-pollinator interactions, contributing to the rich biodiversity that characterizes the region. Insect groups that interact most commonly with flowering plants of the region include bees and wasps (Hymenoptera), beetles (Coleoptera), butterflies and moths (Lepidoptera), and flies (Diptera) (Johnson 2010).

The most well-known fly family involved in specialized pollination comprises the Nemestrinidae, including species such as *Moegistrorhynchus longirostris* (with the longest tongue to body ratio of any insect in the world) which interacts mainly with Orchidaceae and Geraniaceae in the Western cape, the forest species *Stenobasipteron wiedmannii* which interacts with Iridaceae, Orchidaceae, Acanthaceae, Balsaminaceae, Gesneriaceae and Lamiaceae in the Eastern region and the grassland species *Prosoeca ganglbaueri* which interacts with plants in families such as Amaryllidaceae, Iridaceae, Orchidaceae and Scrophulariaceae in the Drakensburg mountains. A second well-studied pollinating fly family is the Tabanidae, including species such as *Philoliche rostrata* and *P. gulosa* which visit Iridaceae, Orchidaceae, Geraniaceae in the Southern Cape mountains (Johnson 2010).

Hoverflies (Diptera; Syrphidae) comprise over 125 000 species distributed across 110 families. Hoverflies are as effective pollinators as other well-known groups such as bees, and their plant visiting behaviour suggests they are potential surrogates to replace bees as pollinators, which is relevant in the light of the global decline in bee pollination (Raguso 2020; Willmer 2011).

However, although hoverflies are considered important pollinators in both natural and agricultural systems in the northern hemisphere, almost nothing is known about their importance for pollination in southern African ecosystems, or what type of flowers they visit. This may be due to the fact that they are unimportant as pollinators in Southern Africa, but it may also be due to the fact that most pollination research in Southern Africa has focused on several highly specialized and unusual charismatic fly pollinators (Johnson 2010; Klecka et al. 2018; Ssymank et al. 2008; Rader et al. 2016).

Pollination syndromes

Flowers have evolved traits in response to natural selection imposed by different pollinators. The flower traits are thought to reflect the morphology and preferences of pollinators, and can be categorized into a number of “pollination syndromes”. Pollination syndromes can therefore be defined as suites of floral traits, including rewards, associated with the attraction and utilization of a specific group of animals as pollinators (Fenster et al. 2004). Well known pollination syndromes include the typical red, unscented flowers associated with bird pollination, and the white long-tubed flowers associated with pollination by long-tongued moths.

Is there something like a hoverfly pollination syndrome? Studies have revealed that hoverflies specifically, and many other flies in general, visit flowers more frequently as the number and size of flowers increases. Furthermore, hoverflies have a strong preference for flowers with longer petals with expanded throat rather than short petals (Conner and Rush 1996).

Pollinator observations may reveal interactions that seem at odds with syndrome traits. For instance, *Guihaionthamnus acaulis* has a tubular corolla and vivid colours, suitable for long-tongued pollinators, but a *Pisyrphus* species and *Bassicha maculata*, which are short-tongued hoverflies, were observed to be frequent pollinators of the plant (Xie et al. 2013).

Visual cues for tracing resources

Generally it is thought that pollinator attraction relies on scent for long-distance and colour for short distance attraction, although it is thought that many flies (apart from flies involved in carrion mimicry) only use visual cues for finding flowers. Pollinators usually have preferences for specific colours, which is often a result of their particular colour vision. For instance, many bee-pollinated plant species have flower that reflect ultra-violet light. What is known about flower colour in hoverfly-pollinated plant species? One study revealed that yellow is the most prefered colour by hoverflies and this effect is even more intense in young individuals (Shi et al. 2009; Willmer 2011; Sutherland et al. 1999). When older and young flies are compared, there seems to be an apparent shift from yellow to other colours such as blue and green by adult hoverflies. Perhaps as hoverflies mature, their choice in colour preference shifts towards other colours either due to their physiological changes or due to ecological needs to allow more space for young flies to fully utilize the resources available (Sutherland et al. 1999; Shi et al. 2009).

Cheaters

Hoverflies usually visit flowers to search for pollen and nectar. The availability of pollen is esential for the fly life cycle, especially for females, because pollen contain proteins which are necessary for ovivipostion in female flies, whereas nectar is also essential to both males and females as it provides energy for flying in search for food (Willmer 2011). While foraging on food resources, flies play a role as pollinators by transfering pollen from one flower to another (Willmer 2011; Raguso 2020; Stockl et al. 2011. However, some systems rely on deception. For instance, the Orchid Epipactis veratrifolia provides no nectar in its flowers but instead they attract hoverflies by cheating them (Stokl et al. 20110. Female hoverflies lay their eggs around aphid colonies so that when the eggs hatch the larvae can feed on aphids. Hoverflies find aphids by detecting alarm pheromones produced by aphids that are under attack. The orchid exploits the instinctive behaviour by hoverfly females by mimicking aphid alarm pheromones and get pollinated by duped hoverfly females of the species Episyrphus balteatus (Stokl et al. 2011; Raguso 2020).

Hoverflies as pollinators in agriculture

Hoverflies are not only important pollinators of wildflowers, but also play an important role in crop pollination and therefore have economic value to society (Doyle et al. 2020). Doyle et al (2020) argue that hoverflies are sometimes even more effective pollinators than bumblebees and they play a significant role in fertilisation and protection of natural and agricultural crops. If hoverflies were to disappear, this may have devastating consequences to the world food security. The high mobility of hoverflies potentially makes them effective in fertilising plants as they can carry pollen over long distances (Doyle et al. 2020). In some cases they pollinate flowers under conditions that are unsustainable for other pollinators such as bees (Doyle et al. 2020; Willmer 2011). Pollen which is carried by pollinators can stay viable for up to 2 days, and hoverflies are capable of transporting pollen over a distance of up to 100km (Doyle et al. 2020). This may be critical in pollination because it can facilitate high levels of gene flow between plant populations that would otherwise be isolated. While much evidence shows that bees are suffering colony collapse, there is not much evidence of such process in hoverflies, making them potentially valuable crop pollinators (Ssymank et al. 2008; Doyle et al.2020).

Although we know much about hoverfly-flower interactions from other parts of the world, they are poorly studied in Southern Africa. To bridge the gap in knowledge of the role that hoverflies may play as pollinators in our natural biodiversity, it is therefore important to study this in the Southern hemisphere. This is not only relevant for conservation of biodiversity in the light of the global pollinator crisis, but may also reveal previously unrecognized ecosystem services that may be provided by fly pollinators.

Aim

The aim of this project is to characterise hoverfly-flower interactions in two different vegetation types and different levels of anthropogenic disturbance.

The key objectives are:

1. To determine whether and which plants are visited by which hoverflies in the grassland and forest biomes of South Africa.

2. To determine what flower traits determine hoverflies visitation.

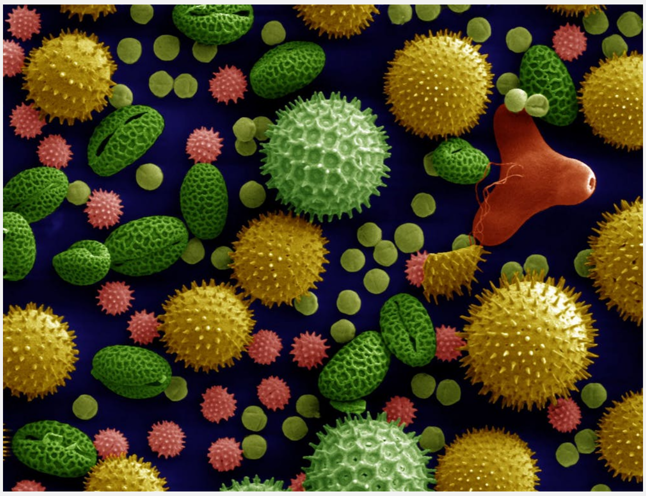
3. To determine the importance of hoverflies as pollinators.

Study Site

The study will be conducted at the Karkloof Nature Reserve which is 22km North of Howick, KwaZulu-Natal, in South Africa (29° 17' 54" S 30° 13' 56"). This area is characterized by a mosaic of grassland and forest, the latter representing commercial plantation and large tracts of indigenous forest. To get a good representation of flies across the three areas and measure variation within sites, three Malaise traps per vegetation type will be set up.

Trap setup

Each trap has the following dimensions; 165 cm in length, 115 cm in with and 190cm in height supported with ropes around to give it shape for proper channelling of the insects to the collection chamber above the trap, and a black mesh covering two sides. The collection bottle at the top will be exchanged timeously during the entire study period.



Pollen collection

Flies caught in the trap will be collected once a week and brought back to the laboratory for pollen sampling. Firstly, in the laboratory, I will be counting and identifying the species of hoverflies to the lowest taxonomic level possible using morphological matching against a reference library (this part of the project will be done in collaboration with another MSc student, who is researching temporal dynamics of hoverfly abundance). Then, plant pollen grains from their bodies will be sampled to identify the plants visited by hoverflies. The collected pollen will be stored at -20°C ready for DNA isolation (extraction), amplification (PCR) and sequencing analysis of the PCR products to compare them to the reference samples in a database (GenBank), which will provide insight into seasonal patterns of flower visitation in different vegetation types.

DNA barcoding

In this research metabarcoding will be the centre stage of the pollen analysis. Meta-barcoding refers to the simultaneous identification of all species in a mixture with the use of high through-put sequencing (HTS) of a standard gene region (Bell et al. 2017).

DNA barcoding is an alternative method for pollen identification compared to visual matching to a reference collection. Both methods have advantages and disadvantages. DNA barcoding is more expensive compared to visual identification, but is faster especially when working with large numbers of pollen samples, due to the possibility of combining samples in so-called “multiplex” reactions of up to 384 samples in a single run. DNA barcoding methods and equipment offers a standardized approach in the molecular biology laboratory where any molecular biologist can follow the steps and repeat previous work. DNA barcoding also offers high taxonomic resolution. The normal traditional method of pollen identification can sometimes be confusing because pollen of closely plant species share the same morphology (i.e. they look the same in terms of their shape), which will result in difficulties in identification (Bell et al. 2017).

Finally, another advantage of DNA barcoding is that it does not require specific knowledge of pollen morphology (paleonology), which means it can be done by a large number of people (Bell et al. 2017).

Challenges

Despite DNA meta-barcoding promising potential for future pollen identification analysis, there are certain challenges. For instance, not much work has been done to test whether markers used in one particular plants species can also be used in other plant species. There is also bias associated with DNA barcoding pollen identification. Such biases include pollen preservation bias where pollen from certain species is better preserved than pollen form other species. A typical example is shown in fossil records where certain species are preserved more in sedimentary layers than others (Bell et al. 2016; Bell et al. 2017). DNA isolation bias may result in an unequal representation of DNA from a mixed pollen sample. Amplification bias, due to primers matching some plant species better than others, or copy number bias where the gene of interest may occur in different copy numbers in different species, may also lead to problems with DNA barcoding. DNA metabarcoding relies entirely on the quality of the reference data for taxonomic assignment. Issues like sequencing errors and intraspecific variation may arise in the library, which could affect the species identification (Bell et al. 2017; Baksay et al. 2020). Challenges associated with DNA metabarcoding can be addressed by combining visual and molecular identification methods (Bell et al. 2016; Bell et al. 2017).

Conclusion

Hoverflies are important pollinators of flowers. Although important, their role in pollination as they visit flowering plants is understudied in the Southern hemisphere. The findings of this project will provide the community with an insight into the interactions that occur between hoverflies and flowering plants and how important those interactions are, not only for natural ecosystems, but also for agricultural systems and possibly assist conservation biologists and ecologists in planning management practices that can encourage the conservation of the species for current and future use.

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SPOTLIGHT

MSc: Fly Pollination of Generalist Daisies in the Greater Cape Floristic Region.

Carly Vlotman

Stellenbosch University, South Africa

Carly Vlotman obtained her undergraduate degree in Conservation Ecology and Entomology at Stellenbosch University. She is currently a Master's student in the Department of Botany and Zoology at the same university.

Background

The Greater Cape Floristic Region (GCFR) has an extremely high plant diversity (Born et al., 2007; Myers et al., 2000). The spring mass flowering displays of western parts of South Africa are an important focus of the ecotourism industry (Turpie et al., 2003). Remarkably our understanding of the basic biology and taxonomy of the dominant daisy species that are the foundation of these displays is very limited.

Generalisation dominates pollination systems around the world. However, generalisation and specialisation occur along a continuum rather than a rigid dichotomy. Similarly, pollinators vary in their effectiveness for different plants. A pollinator that frequently visits daisies and deposits much of the pollen it removes, would be very effective. However, the generalised phenotype of daisies (a radially symmetrical inflorescence with open access to rewards) does not exclude visitation from less effective pollinators, which ultimately results in hierarchies of more and less effective pollinators. Although daisies (Asteraceae) are widely considered to be both ecological and functional generalists (Ollerton et al., 2007), the daisy-fly pollinator interactions of South Africa seem to be unusually specialised.

Recent work in Namaqualand suggests that daisies may be strongly reliant on fly pollinators for reproduction, particularly Bombyliidae: Mariobezzinae, and Tabanidae: Rhigioglossa. However many studies have focussed on specialised plant-fly pollinator interactions, for example, the long-tongued Nemestrinidae that pollinate the long tubular flowers of Iridaceae. Therefore, there remains a large knowledge gap regarding the role these flies play in the maintenance of diversity in the GCFR.

The aims of this project are to determine 1) how widespread fly pollination is in spring mass-flowering daisies in the GCFR and 2) how important flies are, relative to other insect taxa, for daisy pollination.

Left: *Rhigioglossa spp.* (Tabanidae) on *Dimorphotheca sinuata.* **Middle:** *Corsomyza* spp. (Bombyliidae: Mariobezziinae) on *D. sinuata.* **Right:** *Megapalpus capensis* (Bombyliidae: Mariobezziinae) on *Gorteria diffusa. Photos A. G. Ellis*

The study area

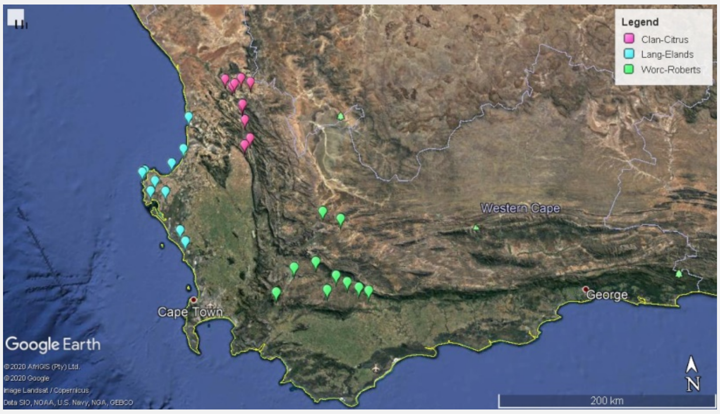

Figure. A Google Earth map showing the three study regions across the Western Cape, each containing ten sites.

This study takes place across the Western Cape Province, South Africa; a winter-rainfall region. Ten sites were sampled in each of the following broad regions, making up a total of 30 sites: 1) the Langebaan-Stellenbosch region, 2) the Ceres-Worcester-Montagu valley and 3) the Clanwilliam-Citrusdal valley. Survey data (collected in the same way as proposed below) is also available from previous years from the Namaqualand and Nieuwoudtville areas which will also be used to broaden our perspective of the daisy-fly pollination interactions across the GCFR.

Pollinator surveys and pollen load

I conducted walked pollinator surveys in multiple populations of each of the dominant annual daisy species encountered (genera: *Gorteria*, *Gazania*, *Arctotis*, *Arctotheca*, *Dimorphotheca*, *Osteospermum*, *Tripteris*). All flower visiting insects associated with each daisy were recorded and I collected two representatives of each insect morphospecies to 1) identify to species level (and to generate barcodes for the flies) and categorise into functional groups, and 2) collect their pollen loads for analysis. Pollinator surveys will be used to investigate the structuring of the pollinator assemblage composition on a wide range of spring-flowering GCFR daisy species, and also determine whether flies are consistently the most abundant visitors to these daisies. Pollen loads will be analysed in the laboratory using a method by MacGillivray (1987). After centrifuging pollen into a drop of glycerol gelatine which will be placed on a preheated microscope slide, the number of pollen grains will be counted using a compound light microscope. I will then be able to rank the importance of different pollinators in terms of their visitation rates and how much pollen they carry.

Literature review

I will conduct a literature review in order to contextualise the GCFR pollination system by querying the Scopus database to identify studies that recorded pollinator diversities and visitation rates to daisy species. I will then create a dataset containing the diversity (abundance and species richness), visitation rate and pollen load data from the relevant papers. I will target annual daisy species from arid or Mediterranean areas around the world. This will allow me to investigate whether the insect visitor communities of GCFR daisies are similar to daisies from other arid/Mediterranean areas globally.

Single visit experiments

I will conduct the single visit experiments on the self-incompatible *Dimorphotheca* daisy. I will expose 50 daisy inflorescences to three different treatments: 1) no pollinator visits, 2) a single pollinator visit and 3) unlimited pollinator visits. I will recreate this setup three times to determine the 1) pollen removal effectiveness, 2) pollen deposition effectiveness and 3) seed set resulting after a single visit for each of the main pollinators. I will then be able to determine if flies are the most effective pollinators when compared to other insect taxa.

Conclusions

The annual daisies of the GCFR rely on a range of insect visitors for reproduction. The results of this study will provide an insight into the effectiveness hierarchies of these GCFR daisy visitor communities. Additionally, this study further investigates the importance of flies in daisy pollination within a South African context and will provide a better understanding of the generalisation continuum within the GCFR.

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Terence Bellingan: Curator of the Department of Entomology and Arachnology, Albany Museum, Makhanda, South Africa

My name is Terence Bellingan, the Curator of the Department of Entomology and Arachnology at the Albany Museum in the small town of Makhanda (formerly Grahamstown), in the Eastern Cape Province of South Africa. I assumed duties as curator in February of 2018, after completing a PhD in Entomology through Rhodes University and the South African Institute for Aquatic Biodiversity (SAIAB). The focus of the PhD research was interactions between stream dwelling fish and aquatic insects.

The shift from working with freshwater insects to terrestrial ones found me assuming responsibility of an entire museum department devoid of any staff members, having stood dormant for nearly a year prior to my appointment. After coming to grips with a mountain of curatorial backlog, which for a significant part remains to be contended with, my research interests have shifted to hoverflies and their pollinating Dipteran allies. To a degree this is not entirely embracing the shift from aquatic to terrestrial insects as some hoverfly larvae are aquatic after all!

The Syrphidae I have taken an interest in and which have captured my attention are the genera *Syritta* and *Eristalinus*, with efforts also being made to track down rarer groups in the form of the wasp mimics *Sphiximorpha* and *Monoceromyia*. These genera are known to visit flowers, and are therefore potentially responsible for pollination, an extremely valuable ecosystem service delivered primarily by insects.

Those who may be familiar with the Albany Museum collection may know that it includes an extremely well curated collection of bees and wasps. These are well presented and accurately identified. However, it also houses the third largest collection of Diptera in South Africa, including approximately 1 000 specimens from the family Syrphidae, and good representation of other pollinating groups like the Pangoninae (Tabanidae), Bombyliidae, Rhiniidae and Nemestrinidae. It is for this reason that attending the Second International Training Course on African Pollinating Diptera held at Sokoine University Pest Management Centre in Morogoro, Tanzania, was so valuable to me.

Learning to correctly identify representatives from these groups has been priceless, resulting in an upgrade of the museum collection in terms of the determinations for these taxa. It has also honed my abilities to notice them around flowers, making finding and collecting them easier. This also adds further value to the collection through fresh material. Meeting people through the course has also given me an opportunity to network across the African continent. The effort undertaken by the organisers to bring specimens of correctly identified voucher material from their respective collections, and then offer world class guidance and advice was truly unparalleled in advancing my understanding of Dipterology! I owe the JRS Biodiversity Foundation and the Belgian Development Cooperation, who through the PINDIP project funded this opportunity to learn an almost unquantifiable debt of gratitude.

On the back of the training I received, my future research interests include taxonomic studies within the hoverfly genera *Syritta* and *Orthonevra* (Diptera: Syrphidae) with collaborative projects underway on these groups already. I am also particularly interested in documenting hoverfly diversity within the arid areas of the Eastern Cape Province. I intend to focus on places that may not have traditionally been sampled for these kinds of flies. It is for this reason that the genus *Eumerus* also holds a particular interest for me. They are easily overlooked and don't occur where a Dipterist might be expected to find hoverflies. A key function for myself as curator of the Department of Entomology and Arachnology at the Albany museum is to support the research of others. Making targeted collaborative collections of important groups of focus alongside my own research collecting is important. These are incorporated into and housed at the Albany Museum insect collection but made available for study loans. This endeavor has produced valuable contributions to the scientific project in Dipterology in South Africa already. As such, researchers are encouraged to reach out to me via email at t.bellingan[at]am.org.za, especially during these trying times, to help facilitate research into our two winged natural history!

Congress

Congress: Twelfth International Symposium on Pollination (ISPXII)

30 August – 3 September 2021, South Africa

The 12th International Symposium on Pollination was intended to take place from 31 August – 4 September 2020, at the Kirstenbosch National Botanical Garden but had to be postponed due to the global pandemic of COVID-19. Whilst the current situation is beyond the organizer's control, the organization has every intention to hold the Symposium and proceed with the same programme (subject to availability of the speakers) from the 30th August to 3rd September 2021.

More information: https://www.turnersconferences.com/conferences/2021/Pollination2021/

Kirstenbosch National Botanical Garden is acclaimed as one of the great botanic gardens of the world. Few gardens can match the sheer grandeur of the setting of Kirstenbosch, against the eastern slopes of Cape Town's Table Mountain. More information can be found on the website of the International Commission for Plant-Pollinator Relationships (ICPPR) (www.icppr.com). ICPPR was founded in 1950 as the International Commission for Bee Botany (ICBB). Its objectives are to promote & coordinate research on relationships between plants and pollinators of all types. That mandate includes studies of insect pollinated plants, pollinator foraging behaviour, effects of pollinator visits on plants, management and protection of insect pollinators, bee collected materials (e.g. nectar and pollen), and of products derived from plants and modified by bees. Further, the ICPPR organises meetings, colloquia or symposia related to the above topics and publishes and distribute the proceedings. The ICPPR collaborates closely with national and international institutions and is one of the 82 scientific commissions of the International Union for Biological Sciences.

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Congress

Congress: 11th International Symposium on Syrphidae

6 – 11 September 2021, France

The 11th International Symposium on Syrphidae will take place in Barcelonette (Alpes de Haute Provence, France) from Monday 6th to Saturday 11th September 2021.You can find more information on the symposium at https://syrphidae11.sciencesconf.org/

The provisional **schedule** is as follows :
Arrival : Monday 6th September 2021
Symposium : Tuesday 7th to Thursday 9th September 2021
Excursion : Friday 10th September 2021
Departure : Saturday 11th September

Access : A bus will be available from and to Marseilles (railway and bus station Saint-Charles) on Monday 6th, departure around 15:00, and on Saturday 11th September, departure around 09:00. The Marseille Saint-Charles railway station is easily accessible by high speed train from neighbouring countries, including London (via Paris), or by bus from Marseille Marignanne International airport.

Accommodation will be available on the congress venue : Seolane center (https://seolane.org/) or at local hotels in Barcelonette, ca. 10 min walk from the venue. During the Symposium a room with binocular microscopes will be available to delegates.
The excursion will be in the nearby Mercantour National Park (http://www.mercantour-parcnational.fr/fr).

At this time, we would like interested entomologists to complete the **registration of interest** (by 29 Feb. 2020) online at https://syrphidae11.sciencesconf.org , to receive further information about the ISS11. Please be assured that the email you will indicate on your account on the sciencesconf.org web site will be used only to keep you informed on the Syrphidae congress !

Further details about accommodation, prices and booking will be announced with the second circular and online. If you have any question or suggestion regarding the Symposium, feel free to contact us at syrphidae11[at]imbe.fr

We are looking forward to welcoming you in beautiful Provence !

The 11ISS local Organizing Committee :

Gabriel Neve - Benoit Geslin - Arne Saatkamp - Jean-Yves Meunier - Marine Berro - Alrick Dias - Vanina Beauchamps-Assali - Delphine Reverbel - Camille Ruel

Literature

Literature: Below you will find a selection of plant-pollinator related publiciations that have been published over the last months.

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