SURICATA 4

Manual of

Afrotropical Diptera

Volume 1

Introductory chapters and keys to Diptera families

Edited by
Ashley H. Kirk-Spriggs & Bradley J. Sinclair

Editorial Assistance
Burgert S. Muller

SANBI
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SURICATA

Suricata is the generic name of the suricate (*meerkat*), which is near-endemic to the arid western parts of southern Africa (occurring in Namibia, South Africa and Botswana; and just entering into a very small area in the extreme south of Angola). Behaviourally, suricates are socially inclusive and innately inquisitive, symbolising the commitment of South African National Biodiversity Institute (SANBI) to include all biodiversity and serve all of Africa and the scientific curiosity that precedes and drives research and publication of research results. Sister journal to SANBI's *Strelitzia*, *Suricata* is a peer-reviewed journal and publishes original and applied research, such as monographs, revisions, checklists, red lists, atlases and faunas of any taxa belonging to Regnum Animalia (the Animal Kingdom).

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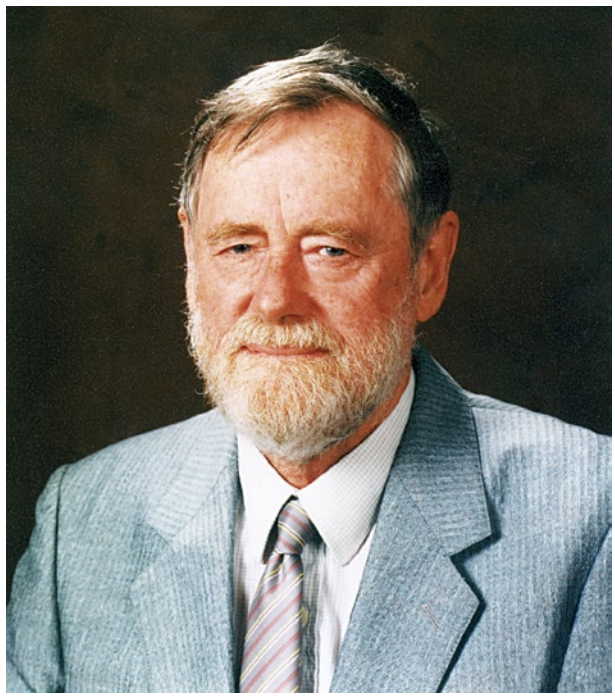
DEDICATION TO BRIAN ROY STUCKENBERG (1930–2009)



The *Manual of Afrotropical Diptera* is dedicated to the memory of the late Brian Roy Stuckenberg, regarded by many as "the father of modern African dipterology". Brian was a formidable scholar with an encyclopaedic knowledge of the dipterological literature. He was in many ways unusual among South African entomologists, in that he took a strong interest in more theoretical and philosophical aspects of biological enquiry, especially phylogenetic systematics and biogeography. Always progressive in his thinking, in 1958 Brian published his revision of Malagasy Blephariceridae, which was the first publication in English to apply Hennig's theory of cladistics. In a distinguished career that spanned 56 years, Brian published over 100 publications, including studies of at least 23 families of Diptera. As a mark of the respect in which he was held by his peers, over 100 species and five genera of Diptera were named in his honour, together with taxa in at least 11 other insect orders.

The reader is referred to the following publication, for additional information on Brian's life and career: Kirk-Spriggs, A.H. 2012. Dedication – the life, career and major achievements of Brian Roy Stuckenberg (1930–2009). *In*: Gedenkschrift in honour of Brian Roy Stuckenberg (1930–2009). *African Invertebrates* **53**: 1–34.

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FOREWORD

George McGavin

George McGavin was born in Glasgow and educated at Daniel Stewart's College in Edinburgh. He studied Zoology at Edinburgh University, followed by a PhD in entomology at Imperial College and the Natural History Museum in London. After 25 years as an academic at Oxford University, looking after the world famous Hope Entomological Collections, he became a television presenter, working mainly for productions from the BBC Natural History Unit in Bristol. George is an Honorary Research Associate of the Oxford University Museum of Natural History and a Research Associate of the Department of Zoology at Oxford University, as well as a Fellow of the Linnean Society and the Royal Geographical Society, an Honorary Fellow of the Royal Society of Biology and an Honorary Life Fellow of the Royal Entomological Society. As well as his many TV appearances George has written numerous books on insects and other animals.

What is it about the natural world that is so endlessly absorbing? Perhaps it is because, to paraphrase the British scientist John Burdon Sanderson Haldane (1892–1964), it is not only stranger than we can imagine, it is stranger than we could possibly imagine. My first serious study of insects concerned plant bugs (Hemiptera) and although they are interesting animals – what insects are not – I now feel rather short changed. If only I had found the wonderful world of flies at that formative stage in my career. The Diptera are without doubt the most ubiquitous and extraordinary of all insects. The impact they have had on human beings has been and continues to be truly immense. In popular consciousness, the word "fly" usually conjures up images of dirt, disease and death, more so perhaps in Africa than elsewhere, but it is the activities of relatively few species that have had a negative impact. It is an inescapable fact that flies cause tremendous losses of crops and other important plants and enormous numbers of wild and domestic animals and perhaps as many as one person in six are affected by fly-borne diseases. But the feeding habits and abilities of the vector species have been hijacked by pathogens and it would be totally illogical to tar all flies with the same brush. Flies are one of the dominant and most ecologically diverse insect orders and most fly species are crucial to the functioning of global ecosystems. The sheer variety of fly lifestyles is astounding. As pollinators, herbivores, parasites, parasitoids and predators and as vital part of the processes of decomposition and nutrient recycling they are a completely indispensable group of animals.

Halteres, or balancing organs as they are sometimes known, are unique to flies and even most wingless species such as louse flies and bat flies have a pair. The genetic tweaking that converted the hind wings of their antecedents into these gyroscopic stabilisers opened up a whole world of possibilities and for the past 245 million years or so flies have taken full advantage of their unparalleled aerial supremacy. No one can watch a hover fly darting and hovering and not be mesmerised by the utter beauty and brilliance of their flight and it is not surprising that their flight mechanics and control systems are being studied.

I spent twenty-five years looking after the insect collections in the Oxford University Museum of Natural History and some of the specimens I would take great pleasure in showing visitors included the holotype of *Glossina morsitans* – collected in Africa by Dr. David Livingstone (1813–1873) and sent back to John Obadiah Westwood (1805–1893) in Oxford for description. The life cycle of *tsetse* shows just how flexible and versatile dipterans can be. There is no need for a risky, free-living, larval stage when the female *tsetse* can nurture her single larva *in utero*. I have since had close encounters with *tsetse* in Africa. Another favourite show-and-tell was a box of strange, mud cylinders with perforated margins like three-dimensional postage stamps. These intriguing artefacts are made by the larvae of certain species of horse fly that live in ephemeral pools. As the larvae mature the pools often dry up, so to avoid being ripped apart and desiccated, the larvae burrow up and down in the stiffening mud. Their path isolates a neat cylinder inside which they pupate. As the ground dries as hard as concrete the cracks that form bypass the cylinders and the flies survive.

I was lucky enough to have had the opportunity to study the insect fauna of savanna tree canopies in Tanzania for a few years and the masses of specimens I collected by pesticide mist blowing was both staggering and overwhelming in equal measure. In the end it was necessary, as with many mass collection studies, to simply assign individuals to RTU's (recognisable taxonomic units) – a technical-sounding phrase that actually means – "I don't really know what this species is, but it's not like the other species in the sample". I knew in my heart it was not good enough, but I had to make some headway with the mounds of material under my microscope. I shudder to think what amazing species are still languishing in tubes of alcohol. If only I had had this book to hand I could have done and learned so much more. The *Manual of Afrotropical Diptera* will be an indispensable guide and reference, both for those just starting on the path to entomological enlightenment and those who have made it their life's work to study the most successful and enduring multi-cellular organisms to have ever lived on Earth. Just as important, the *Manual* will be an inspiration to

anyone wanting to contribute something to science, but not yet sure how to do it. A multitude of fly species awaits collection and description and the biology of many named species is unknown and the larvae of many others have not yet been found or described.

I am delighted that this major work will bring the diverse and astonishing Afrotropical fly fauna to a much wider audience. The four volumes of the *Manual* are the result of a collaboration of over ninety international experts, truly "Lords of the Flies" and is the first ever synopsis of the 108 families of flies that occur in the Afrotropical Region. It is quite simply a superb achievement and will be an essential research tool and teaching aid for as long as people pick up a collecting net or empty a Malaise trap.

The natural world and its innumerable six-legged inhabitants, is the only thing that has ever really interested me and it will continue to enthral me until I die. If I have a choice in the matter, when I die I would like to be laid out in a tropical forest where I would be rapidly consumed and then recycled. A large number of the atoms that I have had on loan would surely end up in the bodies of flies. I can think of no better end.

Dr. George McGavin

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Ashley H. Kirk-Spriggs

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The **National Museum, Bloemfontein** (South Africa) now has the largest collection of Diptera on the African continent, with over 209,374 accessioned specimens. The collection is a unique research tool, as it comprises recent, high quality material from numerous poorly sampled Afrotropical countries, including Benin, Burundi, Cameroon, Democratic Republic of Congo, Kenya, Réunion Is., Madagascar, Malawi, Mauritius, Namibia, South Africa (Eastern and Western Cape, Free State, Mpumalanga, KwaZulu-Natal Provinces), Togo and Zambia. The collection is widely used by local and international researchers, with over 25,000 dry-pinned specimens currently on loan to specialists. The National Museum is, therefore, a centre of excellence for the study of dipterology on the continent and the collection represents an extremely important national asset and research tool. Two full-time dipterists are employed by the Museum, which actively encourages the study of the Diptera collection by specialist researchers and offers collection access and bench space at no cost to *bona fide* researchers. R. Nuttall (Director) and the Council of the National Museum is thanked for supporting the project.

NATIONAL MUSEUM
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The **KwaZulu-Natal Museum** (South Africa) is a leading centre for dipterological research in the Afrotropical Region. The Museum has a proud history of over 50 years of research on Diptera and has accrued a collection of Diptera from over 98 countries, comprising approximately 205,000 specimens, representing over 7,000 species. It further holds an extensive type collection of over 2,000 species of Diptera. It houses the collections of B.R. Stuckenberg and J.G.H. Londt (both previous Directors of the institution), as well as part of the Diptera collection of the former South African Institute for Medical Research (including the collection of F. Zumpt and associated types). Currently it also houses one of the most comprehensive collections of Asilidae in the world. It offers *bona fide* researchers access to the extensive collection of Diptera and bench space at no cost. The Director and the Council of the KwaZulu-Natal Museum are thanked for supporting the project.

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South African National Biodiversity Institute (South Africa). SANBI is responsible for exploring, revealing, celebrating and championing biodiversity for the benefit and enjoyment of all of South Africa's people. As well as being the custodian of the National Botanical Gardens' system, SANBI is a respected authority in research and has an unmatched research record in the indigenous, naturalised and alien flora of South and southern Africa and beyond. SANBI's research management covers systematics and collections expansion, conservation and applied biodiversity science and climate change. The Institute's knowledge management and planning branch, strives to make biodiversity science more available and accessible through various "mainstreaming" projects and initiatives. M. Hamer is thanked for supporting the project.

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E Oppenheimer & Son and the Diamond Route (South Africa). The Diamond Route is a massive South African national project which focuses on linking the conservation properties of the Oppenheimer family and De Beers. These properties conserve vast areas and provide a safe haven for a wide variety of unique, rare and ecologically important plants and animals. E. Oppenheimer & Son sponsored a wine reception and banner for the official launch of the project in 2010 and also provided funding for illustrations to be prepared for the *Manual*. D. MacFadyen is thanked for securing funding in support of the project.

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The Samuel Wendell Williston Diptera Research Fund (USA). A Smithsonian administered endowment fund, established for the increase and diffusion of knowledge about Diptera. Williston was a great biologist, who made significant contributions to palaeontology, entomology, medicine and education. He was the first native dipterist, the first to produce generic monographs of Nearctic Diptera, the first to curate and study the Diptera of the US National Museum and the first to make a contribution to that collection. This man and his achievements, thus epitomise what this fund was established to support. The Samuel Wendell Williston Diptera Research Fund is a major sponsor for the project and has provided funding to cover production costs. F.C. Thompson and T. Dikow are thanked for securing funding in support of the project.

S.W. Williston Diptera Research Fund

Natural History Museum, London (UK). The international collection holds important type material of Diptera, some dating back to the 18th century, most notably of taxa described by F. Walker, J.M.F. Bigot, E.A. Brunetti, F.W. Edwards and E.E. Austen. The collection holds extensive material from the Afrotropical Region, much of which was generated during Africa's colonial period. The *Manual* project was in receipt of funding from the Dr. E.C. Zimmerman Bursary (administered through the Museum), specifically to cover the cost of illustrations to be prepared for the *Manual*. A. Polaszek is thanked for securing funding in support of the project.

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The Schlinger Foundation, a not-for-profit organisation, promotes and supports research and education in systematics, natural resources and environmental sciences, and within those, particularly projects that involve flies (order Diptera) and spiders (order Araneae). The Schlinger Foundation does not accept unsolicited applications for project support. The Schlinger Foundation is a major sponsor for the project and has provided funding to cover production costs. M.E. Irwin is thanked for securing funding in support of the project.

General acknowledgements

This *Manual* represents the first regional initiative for any insect order on the African continent. Production of any regional manual of this kind is a monumental task that involves a multitude of people throughout the international dipterological community. Without the dedication of time, energy and commitment of this community as a whole, such projects would be impossible and it is an accolade to the spirit of cooperation that abounds in this community that this *Manual* is now published (the fourth regional Diptera manual of its kind!). As Editor-in-chief I express my very sincere thanks to the over 90 chapter authors who have submitted such professional and comprehensive chapters and made this *Manual* possible. The Afrotropical Diptera faunas of numerous families has never been properly reviewed in the past and no identification keys were available, so for many authors this has entailed the examination of extensive material from the region, dealing with complex issues of defining the limits of genera (and nomenclature) and the construction of entirely new identification keys and synopses of the fauna.

As with many great ideas, the seed concept of a *Manual of Afrotropical Diptera* was sown in the pub! The idea was first raised over drinks when Thomas Pape visited Namibia way back in 1999. Thomas' idea grew from this initial suggestion and over the intervening years various informal discussions were held with dipterists based in South Africa and elsewhere, including D.A. Barraclough, J.G.H. Londt, M.B. Mostovski and the late B.R. Stuckenberg, to assess the feasibility and practicalities of embarking on such a project. One concern that was expressed by many, was our ability (or otherwise), of securing willing authors, prepared to contribute chapters on each and every family that occurs in the region. The project became more formalised in 2009 and the first list of potential chapter contributors was compiled, with the assistance of various dipterists from around the world. The Editorial Panel was established at the same time and invitations to contribute chapters were distributed to potential authors. With the assistance of M.B. Mostovski, the official website was launched in 2009, which provided extensive information for contributing authors. The project was officially launched at the 7th International Congress of Dipterology, San José, Costa Rica, in 2010 (ICD7), with a wine reception sponsored by E. Oppenheimer & Son. M.B. Mostovski was initially Assistant Editor, but dropped out of the project shortly before leaving South Africa in January 2014, after which the task was very ably taken on by B.J. Sinclair. The original plan was to publish the *Manual* in two volumes in 2015, but it soon became apparent after the closing date for chapter submissions (November 2014), that this would not be possible, as numerous chapter authors had not then submitted and the processing of chapters was taking far longer than anticipated. It was also decided around this time that due to the length of the very large Tachinidae chapter (with over 400 key couplets), we would need to publish the *Manual* in three rather than two volumes. It was, therefore, announced at the 8th International Congress of Dipterology, Potsdam, Germany (ICD8), that Volume 1 would be published in 2016 (later extended to 2017), with the aim to publish Volumes 2 and 3 in 2018, to coincide with ICD9, which will be held in Africa for the first time. Near to the completion of Volume 1 it became apparent, however, that this had become unmanageably large and could not be published as a single volume. It was therefore decided to split this into two volumes with the final *Manual* eventually appearing as four separate volumes.

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My aim with this *Manual* was to have a fresh approach to the use of illustrations and take advantage of the digital techniques that are now available to us. This is the first regional manual to use colour extensively and it is largely due to the contribution of S.A. Marshall's amazing photographs of living flies that this could be achieved. He has shown unrivalled dedication in capturing images specifically for this *Manual* and has undertaken fieldtrips to Madagascar, Mauritius, Namibia, South Africa (twice) and Tanzania. I accompanied him on five of these trips and I thank him sincerely for his good humour and company in the field and for his insights into fly behaviour. The vast majority of chapter authors acknowledged him for inclusion of frontispiece images (which are not repeated below).

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