BATS

OF SOUTHERN AND CENTRAL AFRICA

A Biogeographic and Taxonomic Synthesis

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The following organisations and individuals gave financial support for the publication of this book:
South African National Biodiversity Institute (SANBI)
Bat Interest Group of KwaZulu-Natal (Bats KZN)
The Dorothea Behr Fund of the Durban Natural Science Museum Trust Fund
All Out Africa Foundation
Dr Andy Moore

[TO BE COMPLETED BY WITS PRESS]

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FOREWORD

Field and laboratory research on bats over the past decades has revealed numerous aspects about these nocturnal and generally secretive animals that include some rather extraordinary details. This new information, combined with public education, helps to dispel some of the incorrect notions about bats found within different cultural folklores and cinema myths. Ongoing research and new works on regional bat faunas further advance knowledge on these fascinating creatures and their conservation. A few of the many possible examples are presented here.

In certain portions of the world where fruit bats have been locally extirpated – generally associated with human hunting pressures – a reduction can be measured in the ability of forests to redevelop naturally after some form of disturbance, such as cyclones or forest clearing. These animals play a major role in the dissemination of forest tree seeds and habitat regeneration and restoration. Detailed analyses of the faeces of insectivorous bat have revealed that some species consume a large number of mosquitoes and flies, the most important vectors in the transmission of different diseases that afflict humans, such as malaria and dengue. Certain bats can consume up to 500 insects per night and, hence, a colony of 1,000 individuals devours 500,000 insects per night or approaching 200 million per year! In 2006, over 247 million people across the world were afflicted with malaria – a significant proportion on the African continent. The contribution bats make to reduce the number of insects that transmit diseases should not be underestimated, and aid in increasing the number of day roost sites, often a limiting factor in population size, through devices such as artificial bat boxes should be encouraged. Finally, research in the past few years has found that bats play an even greater role in ecosystem functioning than previously realised, reducing levels of herbivorous insects in both temperate and tropical areas, including agricultural settings. Hence, in short, bats are unsung heroes for the different ecological services they provide to our planet and humanity. Declining bat populations may compromise these benefits, and improved information on aspects of their distribution and natural history are critical for advancing their conservation.

Bats of Southern and Central Africa: A Biogeographic and Taxonomic Synthesis contains an extraordinary wealth of information on these animals. It is a synthesis of over a century of research in the southern portion of the continent. The authors, some of the foremost scientists in the study of African bats, have done an exceptional job in making this information available to natural historians, bat enthusiasts and scientists alike. There is vitality and precision to the text that clearly reflects their intimate knowledge of these animals in the field and their detailed studies of specimens in museums around the world. One aspect I found to be exceptional is that the research interests of the different authors are complementary to one another, ranging from animal-specific and inventory field studies, classical and molecular systematics, biogeography, echolocation, and conservation, further enhancing the contents and importance of this book. The introductory sections provide the needed background on geology and biotic systems in southern Africa to place aspects of bat distribution, ecology, and conservation into context, and the subsequent detailed species accounts provide considerable precise information.

The authors have found several commendable ways of bridging the needs of bat enthusiasts and scientists in the presentation of information. For example, I consider the utilisation of character matrices for identifying bats in the hand as an improvement from the classically used and often complicated system of dichotomous keys. In most cases, external characters are included in these matrices, allowing most species to be identified in the hand. Significantly, the authors are clear about the importance of voucher specimens for advancing knowledge. The range maps provide updated and precise information on the distribution of the different species, and at the same time details on modelling habitat preferences are also given without complicating the presentation. The spectrograms of echolocation calls are an extraordinary addition, which will help to advance studies and knowledge of bat vocalisations.

This is an important book for the region, as well as the world scientific literature, and will certainly be a critical reference for years to come. Knowledge and disseminated information on bats is a critical step in advancing conservation of these animals. The authors, with many decades of combined efforts in unravelling information and details on southern African bats, have produced a very useful book to meet this end and they should be praised for this effort.

Steven M. Goodman
Senior Field Biologist, Field Museum of Natural History (USA) and *Conseil scientifique*, Association Vahatra (Madagascar)

ACKNOWLEDGEMENTS

For a book of this nature to be valuable and original, it depends on two critical factors: the efforts of past researchers who collected, described and mapped distributions of bats in our region; and the goodwill of current bat biologists to share their knowledge and resources, such as pictures, with us. The scientific data underpinning this book are almost entirely based on the collections of bats from southern Africa that have been deposited in museums around the world. These collections are a priceless resource without which our efforts to understand the species limits and distributions of African bats would be futile. The more than 14,000 museum specimens that form the foundation of this book have been collected over the past two centuries by scores of people, the most important of whom are mentioned in the section 'Museum collections'. We would like to pay special tribute to all these collectors, and hope that this book goes some way to acknowledging their efforts.

We are grateful to the following people who provided critical assistance: Dr Teresa Kearney, Ernest Seamark, Kate Richardson and Wendy White.

Tina Smith, always attentive to minute detail, generously and on a tight time schedule, read the entire draft manuscript, picking up what seemed like a never-ending number of errors and omissions. Thank you. Any remaining errors are, of course, our own.

All the photographs in this book have been acknowledged in the captions. However, we would like to single out Dr Merlin Tuttle (Bat Conservation International), Dr Brock Fenton and Ernest Seamark for freely providing numerous photographs without which this book would have been far more incomplete than it presently is. We thank Petra Muller, Zoology Department, UCT for her cheerful help with scanning batches of 35 mm slides. Paula Jenkins, Malcolm Perch, Ariya Dejtaradol and John Hanks have aided and abetted searches to depict bat researchers. We are grateful to the many libraries and librarians for kind help with sourcing often obscure literature.

We have relied heavily on museum curators who have given us permission to examine their collections or have loaned us specimens; these include: Dr Nancy Simmons and the late Dr Karl Koopman (American Museum of Natural History, New York), Dr Nico Avenant (National Museum, Bloemfontein), Seth Eiseb (National Museum of Namibia, Windhoek), Dr Teresa Kearney (Transvaal Museum, Pretoria), Dr Robert Kityo (Makerere University Museum of Zoology, Kampala), the late Lloyd Wingate (Amathole Museum, King William's Town), Beryl Wilson (McGregor Museum, Kimberley), Denise Hammerton (South African Museum, Cape Town), Dr Julian Kerbis, Bill Stanley and John Phelps (Field Museum, Chicago), Dr Michael Carleton, Linda Gordon and Dr Don E. Wilson (Smithsonian Museum of Natural History, Washington D.C.), Dr Judith Eger (Royal Ontario Museum), Wim Wendelen and Dr Wim van Neer (Musée Royale d'Afrique Centrale, Tervuren, Belgium), Jim Dines, Ken Stager and Dr Inez Horowitz (Los Angeles County Museum, Los Angeles), Paula Jenkins, Daphne Hills and Julie Ingles (Natural History Museum, London), Dr Christiane Denys and Jacques Cousin (Muséum national d'Histoire naturelle, Paris), Dr David Harrison and Dr Paul Bates (Harrison Zoological Museum, Sevenoaks). A large proportion of the specimens, however, were housed in institutions where (either in the past or at present) two of us were curators: Dr Peter Taylor (Durban Natural Science Museum, Durban) and Dr Woody Cotterill (Natural History Museum of Zimbabwe, Bulawayo, 1992–2004).

Dr Steven Goodman and Dr Teresa Kearney critically reviewed an earlier version of this book, and made numerous suggestions that greatly improved the content.

The South African National Biodiversity Institute (SANBI) granted substantial financial support without which the quality of the book would have been severely compromised. Dr Phoebe Barnard, in particular, did her utmost to ensure that the funds were secured. We thank Phoebe and her team at SANBI for their invaluable support. We also sincerely thank the following organisations and individuals for making funds available for the publication of this book: Bat Interest Group of KwaZulu-Natal (Bats KZN), the Dorothea Behr Fund of the Durban Natural Science Museum Trust Fund, All Out Africa Foundation, and Dr Andy Moore, who also kindly commented on the biogeography section.

We thank the University of the Witwatersrand Press for guiding this book through the publication process, particularly Marthina Mössmer, Julie Miller and Salomé Smit. Marthina's professionalism, innovative ideas and attention to detail immeasurably improved the manuscript, for which we are eternally grateful.

AM: I would like to thank my erstwhile boss, Dr I. S. Kunene, Head of Department of Biological Sciences (University of Swaziland), for never losing her sense of humour with my erratic schedule, which has often revolved around bats and bat expeditions. These expeditions have been supported by many colleagues, assistants, volunteers and students. In particular, I would like to thank Julien Cornut, Niall Higgins, Dr Lindy Lumsden, Mduduzi Ngwenya, Dorothea Pio, Maria Rasmussen, April Reside and Tina Smith. Kim Roques, through All Out Africa (www.alloutAfrica.org), provided financial and logistical support for many of these trips. Finally, I would like to thank Tina Smith for her support, passion for and dedication to the final stages of this project. I dedicate this book to my boys: Keyan, Damian and Liam. Thank you for loving me, despite my spatial isolation.

PJT: My contribution to this book was wholeheartedly supported by Guy Redman, Director of the Durban Natural Science Museum, as well as the management of the eThekwini Municipality's Parks, Recreation and Culture Unit. I am indebted to them and all my museum colleagues for much moral and logistic support. Kate Richardson, Wendy White, Juan Wood, Fiona Mackenzie, Tammie van Zyl, Helen Bruigom, Carol and Graham Allan and other members of Bats KZN provided many spirited discussions about various aspects of bats and bat conservation. They also enthusiastically assisted with fieldwork and generally shared their knowledge, observations and experience, in particular concerning behaviour and rehabilitation of captive bats. My wife, Frances, and children, Ashleigh, Robyn, Lauren and Ben, either stoically tolerated my frequent periods of absence or joined in the fun! I dedicate this book to my family and other animals (bats).

MCS: To my wife Tania, I am grateful beyond words for your unswerving support and love.

FWC: I dedicate this book to Frank Ansell (1923–1996) and Reay Smithers (1907–1987), who each supported my bat research in so many ways, both directly and indirectly. Without their pioneering commitment, there would be a lot less data to report. Moreover, the opportunity to curate the wealth of specimens (many collected by Frank) in the Bulawayo Museum (inaugurated by Reay) remains an immense privilege. I also single out the kind help and encouragement of Dr David L. Harrison, who aided and encouraged my efforts over two decades, after his pioneering work on the bat collection in the then Museums of Rhodesia. In complementary ways, all three of these scientists laid the foundations of this world-class mammal collection. The late Karl Koopman (AMNH) and the late John Edwards Hill (BM) selflessly provided expert advice and information. My bat research began whilst I was still a high school pupil at Falcon College, where biology teacher, E. J. 'Ted' Marais, and Richard Peek, then the Curator of Mammals in Bulawayo, encouraged an aspiring interest in bats. Dave Cumming, Colin Craig, Debbie Gibson, Liz Herzholdt and Jon Hutton provided continuing help and encouragement. At the University of Zimbabwe, John Loveridge, Peter Frost, Brian Marshall, the late Steve Telford and 'Basher' Attwell supported my undivided commitment to bat biology, despite the costs exacted in other arenas of academia. I also benefited from the mentorship and expertise of Andy McWilliam during his tenure in Zimbabwe (1987–1990) assessing pesticide impacts on bats in tsetse control areas. National Parks personnel at the former Sengwa Wildlife Research Area (SWRA) helped tirelessly with bat research through 1989; I am especially indebted to the late Ian Coulson, Resident Ecologist, who taught me so much. The Coulson family in Esigodini, and the Douie, Searle and Teede families in Harare

all provided key support. J. Bingham, R. N. Cunliffe, G. Eick, R. A. Fergusson, A. J. Gardiner, M. C. M. Griffiths, G. R. Griffiths, the late Ron Hartley, K. Mkwananzi, A. Ndlovu, D. Parry, E. M. B. Parry, N. Sango-Moyo, T. Volpers and S. Wilson helped with fieldwork. Members of Operation Raleigh, and the Exploration Societies of Falcon College and Girls College, Bulawayo, provided help and vital logistical support, which aided the collection of so many of the specimens mapped through these pages. For over three decades, John Stakesby Lewis assumed a leading role in organising museum expeditions almost annually and often into remote regions. These biodiversity surveys collected a wealth of data, in addition to Chiroptera. I thank the many landowners for considerable support for inventories, including the Bingham, Bruce-Miller, Fisher and Middleton families in Zambia and the Bristows in Zimbabwe. Almin Metal Industries and Saltrama Plastics in Harare are thanked for their generous donations of materials, vital for the construction of a variety of bat collecting devices. Colleagues in Bulawayo, notably Don Broadley, Moira FitzPatrick, Kit Hustler, John Minshull, and Rudo Sithole, provided encouragement for my science, especially during some bleaker periods. Without the deep commitment of A. Ndlovu, K. Mkwananzi, N. Sango-Moyo, the late F. M. Masiyandima and the late A. N. Sango, there would be very few specimens to study in NMZB. This research has benefited immensely from a Biodiversity Leadership Award from the Bay Foundation, and the Josephine Bay Paul and C. Michael Paul Foundations, New York City, funding critical to work directly on the immense wealth of specimens preserved in the museums outside Africa, and to database many thousands of specimen records. I am especially grateful to all the curators, collection managers and research associates in so many museums in Europe and North America for boundless hospitality, helpful assistance and permissions to examine specimens. I thank Margaret Sandwith (Percy FitzPatrick Institute, University of Cape Town), who has cheerfully located some of the most obscure publications. Jacqueline Bishop, Moctar Doucouré, Andy Duncan, and Maarten de Wit have provided critical encouragement in Cape Town, which aided inputs into this book amongst a spectrum of research demands. The completion of the final, protracted episodes in this project has been dependent on support provided under the auspices of AEON (University of Cape Town). Andy Moore and Glynis Humphrey provided sanctity in Maun, enabling me to devote undivided attention to penultimate tasks. Lastly, I thank my family for continual support and encouragement in studying bats across Africa.

INTRODUCTION

Bats show a remarkable variety of adaptations to their environment and consequently vary considerably in size, appearance, and morphology. For example, the world's smallest bat, the 2-gram *Craseonycteris thonglongyai* (Figure 1) from Thailand, is 600 times smaller than *Pteropus vampyrus*, which weighs up to 1.2 kilograms and has a wingspan of 1.8 metres (Jones 1996).

The oldest known bat fossil, *Onychonycteris finneyi*, was discovered recently in fossil beds in Wyoming, USA, and dates to 52 million years ago. Its diagnostic characters are intermediate between bats and non-flying mammals (Simmons *et al*. 2008). The fossil bat species had claws on each finger and relatively long hind legs in relation to its forelimbs, similar in ratio to sloths and lemurs. Its short, broad wings indicate that it probably alternated between flapping flight and gliding, and that it was also capable of clambering in trees. The small cochlea (ear) bones show that it could not echolocate, suggesting that flight evolved before echolocation in bats. By 50 million years ago, during the Eocene, there were already at least 3 families and 13 species of bats. Eocene fossil bats are known from North America, Europe and Australia. All these ancestors were already fully developed as bats, although they did not closely resemble extant species. Recent discoveries in Egypt of extinct bats from the late Eocene and early Oligocene (37–27 million years ago), which appear more closely related to modern species, suggest that bats may have diversified in Africa following migration of primitive ancestors from Europe (Gunnell *et al.* 2008). A recent molecular study also suggested Africa to be the centre of divergence of modern bat families (Eick *et al.* 2005).

Taxonomic classifications are essential to the universal communication of verifiable scientific knowledge (Cotterill 1995a, Ghiselin 2005), in which descriptions of species, and any other taxon, should adhere to scientific conventions of nomenclature

Figure 1. The skull of the world's smallest living bat, the tiny Bumblebee bat, *Craseonycteris thonglongyai* (right), next to those of two of Africa's largest insectivorous bats (microbats), *Hipposideros gigas* (bottom) and *Scotophilus nigrita* (top). Scale bar = 10 mm (© F. P. D. Cotterill).

(Winston 1999, Gardner and Hayssen 2004). In this respect, the prevailing confusion over the real species diversity of African house bats (genus *Scotophilus*) testifies to why precise and accurate taxonomy is so critical to all of biology and conservation. This example especially highlights the relevance of type material, preserved in museums, if we are to apply scientific evidence to clarify the distinctiveness of a population in a taxonomic revision. Thus, where our own research on collections or published evidence allows, we have detailed respective type material (the holotype, syntype or lectotype) for each of the 116 species in the species accounts section, which also discusses related taxa of biogeographical relevance, where the status of synonyms and purported subspecies is currently unresolved in relation to the nominate taxon. Nevertheless, this book does not provide an exhaustive synonymy, for which full taxonomies are available (Meester *et al.* 1986, Ansell 1989, Simmons 2005).

Selected from amongst several competing alternatives, the concept of the species category has radical impacts on how biodiversity is classified. With respect to the diversity of living bats, the microtaxonomic treatment of Simmons (2005) is based primarily on a Phylogenetic Species Concept (PSC), as an operational criterion of the Evolutionary Species Concept (ESC) – see Cotterill (2002a) for discussion. Different choices of species concept have significant consequences on a taxonomy, and thus any facet of knowledge of a group of organisms. Although the authors of this book are not in total agreement on microtaxonomic practice (notably the scientific relevance of the subspecies concept), we have recognised phylogenetically distinct populational lineages as specifically distinct; we have highlighted existing microtaxonomic problems in this context.

Today, there are at least 1,115 recognised species of bats in the world, or one-fifth of the total 5,416 mammalian species listed by Wilson and Reeder (2005). Bats occur worldwide, except in extreme polar and desert habitats. The species diversity of bats is highest in equatorial regions, notably in tropical forests, with progressively fewer species encountered with increasing latitudes in temperate climates. Southern Africa boasts well over 100 species.

This book presents the most comprehensive account, to date, of the bats of southern Africa. This synthesis of knowledge is underpinned by extensive specimen collections housed in southern Africa, as well as in overseas museums. We have compiled species accounts for the 116 species of bats known to occur in the southern African region. This synthesis of knowledge is accompanied by identification matrices, distribution maps, sonograms, photographs of bats and their skulls, and tables of measurements.

GEOGRAPHICAL SCOPE

In this book, we define southern Africa in its broadest, biogeographical context to cover the southern third of the continent, which covers a large portion of Central Africa, as it is loosely termed. Inclusive of the southern African subregion, it includes all of Angola, Malawi, Zambia, Mozambique, and also the southern portion of the Democratic Republic of Congo (DRC). The northern boundary is set at 4°S; this line of latitude extends east to the western shore of Lake Tanganyika (Figure 2). This definition – pertinently the northern boundary at 4°S – extends the region recognised by previous workers, notably Ellerman *et al*. (1953) and Werger (1978), who placed a northern limit of 10°S on their studies of southern Africa. The syntheses of Smithers (1983) and Meester *et al*. (1986) were even more tightly restricted to the southern African subregion south of the Kunene and Zambezi rivers. Nevertheless, these treatments, including that of this book, all exclude the political region of East Africa, the main forest belt of the Congo basin, and the principal portion of the Albertine Rift.

Within practical limits, the geographical scope of this synthesis of southern and Central African Chiroptera includes all known literature and museum records. So in addition to all the taxa known to occur throughout the southern African subregion, our biogeographical coverage incorporates important records for Central Africa. This includes the wealth of data compiled by Hayman *et al*. (1966), additional to Crawford-Cabral (1989) and Ansell (1978) for Angola and Zambia, respectively.

It is important to justify such a vast coverage, extending north of the southern African subregion to include all of Angola, Malawi, Mozambique and Zambia, and much of the southern DRC. Beyond incorporating bat faunas of the southwestern arid and southern savanna biomes, this coverage adds many bats that augment the region's chiropteran

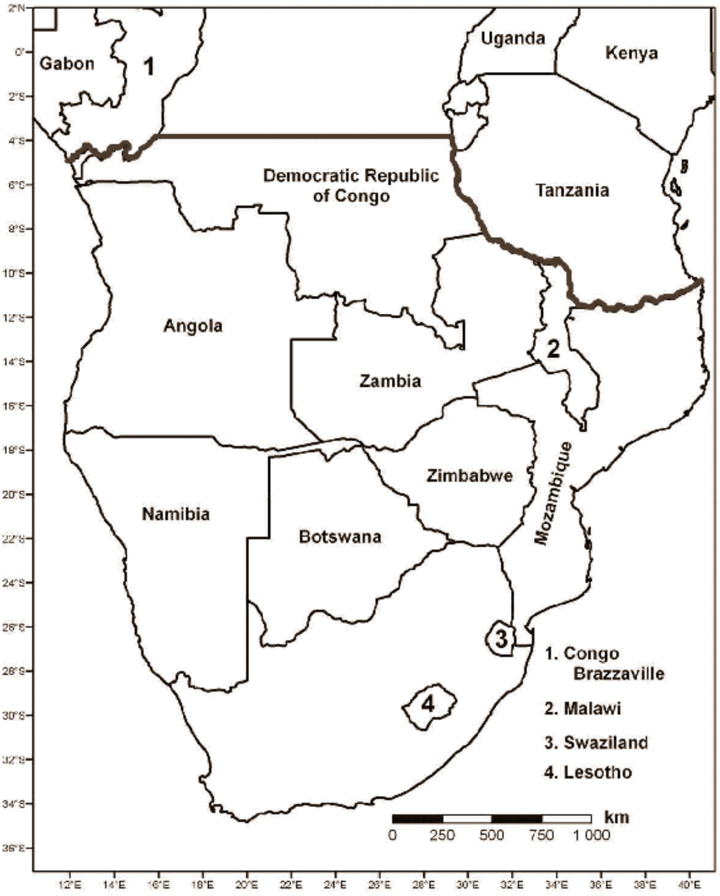


Figure 2. Outline of the study area covered in this book: southern and central Africa south of the bold line. It includes all of Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe.

diversity significantly. The occurrence of these interesting species reflects a key determinant of habitat, represented in the mesic savannas of the Zambesian phytochorion, and the Guinea-Congolia/Zambesia Transition Zone. These habitats dominate the vegetation of northern Angola and the southern Congo basin (White 1983). The biodiversity of the evergreen gallery forests is of special biogeographical significance, because of their high complement of Guinea-Congolian species (additional to local elements of Afromontane affinities); these forest-associated bats increase the overall diversity (see 'Biogeography' for more detail and maps).

The pattern of occurrence of these Guinea-Congolian elements (including notable Chiroptera) exhibit a clustering in the landscape, because they are restricted to forest patches that form a mosaic in the encompassing savanna. This forest-savanna mosaic is structured along a latitudinal gradient. Its extent and composition reflects closely on the sub-continental trend in rainfall, which increases northwards; thus, the vegetation of south-central Africa grades from savanna in the south, through a savanna-forest mosaic, into the closed, high forests closer to the equator. Influences of this association between climate, landscape and vegetation on the biodiversity extend far beyond the main forest belt of the equatorial Congo, for even landscapes south of the Great Equatorial Divide (the Congo-Zambezi watershed, Dixey 1943) reveal its signatures; these are represented in the forested headwaters of the Upper Zambezi river and its main tributaries. Accordingly, the geographical scope of this book incorporates this forest-savanna mosaic, which dominates landscapes across so much of northern and central Angola, the southern Congo, and also a large portion of northern Zambia.

CLASSIFICATION AND TAXONOMY

Until recently, two suborders of bats were recognised – the larger Old World fruit-eating Megachiroptera (commonly called megabats), and the smaller, predominantly insect-eating Microchiroptera (commonly called microbats). However, recent molecular findings, reviewed by Hutcheon and Kirsch (2006), provide compelling evidence for a close alliance between Old World fruit bats (Pteropodidae) and certain families traditionally placed in the Microchiroptera (Figure 3). They suggested the names Pteropodiformes for this newly defined suborder and Vespertilioniformes to accommodate the remaining microbat families. We follow this classification here and list four southern African bat families within Pteropodiformes: Pteropodidae, Hipposideridae, Rhinolophidae and Megadermatidae. We place all other southern African families in the suborder Vespertilioniformes, and hence have done away with the micro- and megabat distinction. Nevertheless, in this book we often refer to the terms 'microbats' and 'megabats' to refer to the older classification with which so many readers are still most familiar. We follow Eick *et al*. (2005) and Miller-Butterworth *et al*. (2007) in recognising Miniopteridae to be a distinct family and not a subfamily of Vespertilionidae as accepted until recently.

A total of 117 bat species have been recorded within the southern African region (Table 1) and, with one exception, all are treated in separate species accounts. The exception, *Mormopterus acetabulosus*, is known from the region by a single specimen collected in the 1830s or 1840s in Port Natal (Durban), South Africa. This species occurs in Réunion and its presence in southern Africa is doubtful. The Durban specimen was possibly translocated on a ship, or may have been a vagrant individual. No other material evidence supports its occurrence in the region. Consequently, we have omitted *M. acetabulosus* from the species accounts.

The total number of known species is likely to increase as new species are discovered. Moreover, pending further investigation, several species groups are likely to be split in the future. Examples include distinct populations currently all treated as *Hipposideros vittatus*, and *Scotoecus albigula* and *S. hindei*. We have removed *Nycteris vinsoni* from the southern African list, as we do not consider it a valid species (see the species account for *Nycteris macrotis*).

The recognition of many new species has augmented the bat fauna of southern Africa in recent decades. Some, previously recognised as synonyms or subspecies, are now given full species status, for example *Hipposideros vittatus*, *Miniopterus natalensis* and *Pipistrellus hesperidus*. Other additions reflect the description of entirely new taxa; five such new species have been described since 1980: *Myonycteris relicta*, *Lissonycteris goliath*, *Rhinolophus maendeleo*, *R. sakejiensis* and *Epomophorus anselli*. At least one species awaits formal description (*Neoromicia cf. melckorum*). In addition, *Scotophilus viridis* may represent two species, while several new taxa of *Rhinolophus* are currently under investigation. No doubt many new species still await discovery in southern Africa.

A recent paper by Riccucci and Lanza (2008) pointed out that as the genus name *Neoromicia* is feminine, the species name *'nanus'* (which is masculine) should be corrected to the feminine form, *'nana'*; all species names in this genus are affected similarly.

Unless otherwise stated, we follow the nomenclature of scientific and common names of Simmons (2005). Annual updates on the classification of African bats are given in the African Chiroptera Report (*www.africanbats.org/ACR.htm*), a valuable resource for anyone interested in the biology and diversity of African bats.

CONSERVATION STATUS

Of the 116 southern African bat species, 5 have a Global Redlist status of Vulnerable, 17 Near-threatened, 77 Least Concern, 14 Data Deficient and 3 Not Evaluated by the IUCN (Figure 4). Table 1 gives the South African and Global conservation status of all southern African bat species. Table 2 lists the species that have been identified as globally threatened by the World Conservation Union (IUCN).

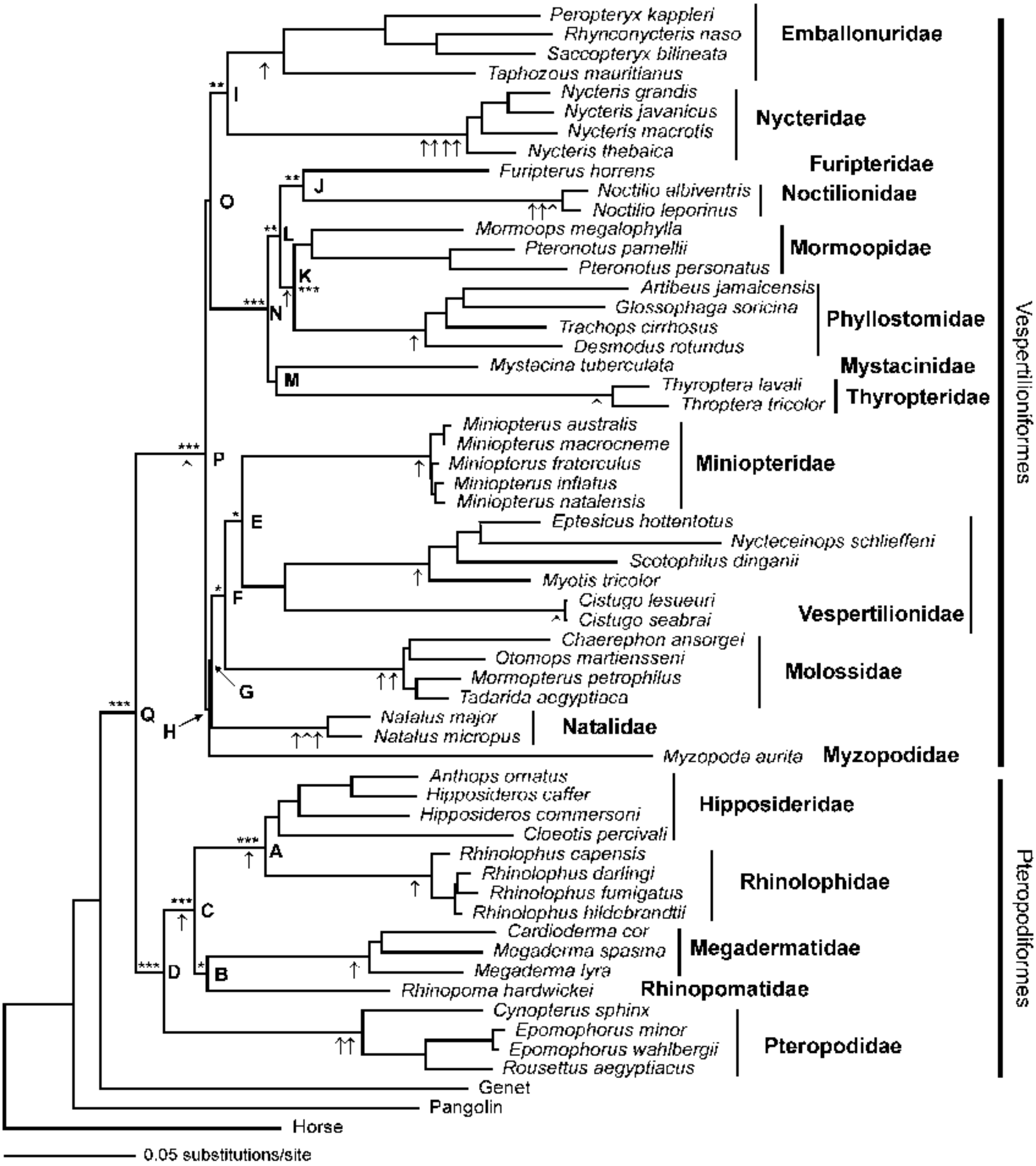


Figure 3. A phylogenetic tree depicting the evolutionary relationships among the principal clades of living bats. It presents the combined evidence of four DNA markers (selected gene sequences). This phylogeny structures the systematic layout of this book (after Eick *et al*. 2005). The number of asterisks indicates the level of 'statistical confidence' placed in particular nodes. Arrows indicate the number of insertions or deletions of nucleotides unique to particular nodes.

TABLE 1. Checklist of species, endemism, and conservation status of southern African bats. This checklist catalogues the 117 species included in this book. Endemic species (●) are restricted to southern Africa; the distribution of near-endemic species (◆) is virtually restricted to southern Africa, occurring only marginally beyond it. South African (Friedmann and Daly 2004) and global (IUCN Redlist category: www.iucnredlist.org) conservation (Red Data) status: CR = Critically Endangered, EN = Endangered, V = Vulnerable, NT = Near-threatened, LC = Least Concern, DD = Data Deficient, NE = Not Evaluated, * = no species account.

SPECIES	RED DATA STATUS	
	SA	GLOBAL
PTEROPODIDAE		
Casinycteris argynnis		NT
Eidolon helvum	NE	LC
Epomophorus angolensis		NT
Epomophorus anselli ●		NE
Epomophorus crypturus ●	DD	LC
Epomophorus grandis ●		DD
Epomophorus labiatus/minor		LC
Epomophorus wahlbergi	LC	LC
Epomops dobsonii		LC
Epomops franqueti		LC
Hypsignathus monstrosus		LC
Lissonycteris angolensis		LC
Lissonycteris goliath ●		V
Megaloglossus woermanni		LC
Micropteropus intermedius ●		DD
Micropteropus pusillus		LC
Myonycteris relicta		V
Myonycteris torquata		LC
Plerotes anchietae ●		DD
Rousettus aegyptiacus	LC	LC
Rousettus lanosus		LC
HIPPOSIDERIDAE		
Cloeotis percivali	CR	V
Hipposideros caffer	DD	LC
Hipposideros fuliginosus		NT
Hipposideros gigas		NT
Hipposideros ruber		LC
Hipposideros vittatus	NE	LC
Triaenops persicus		LC
RHINOLOPHIDAE		
Rhinolophus alcyone		LC
Rhinolophus blasii	V	NT
Rhinolophus capensis ●	NT	NT
Rhinolophus clivosus	NT	LC
Rhinolophus darlingi	NT	LC
Rhinolophus deckenii		DD
Rhinolophus eloquens		DD
Rhinolophus fumigatus	NT	LC
Rhinolophus hildebrandtii	NT	LC
Rhinolophus landeri	NT	LC
Rhinolophus maendeleo		DD
Rhinolophus sakejiensis ●		DD
Rhinolophus simulator	LC	LC
Rhinolophus swinnyi	EN	NT
MEGADERMATIDAE		
Lavia frons		LC
EMBALLONURIDAE		
Coleura afra		LC
Saccolaimus peli		NT
Taphozous mauritianus	LC	LC
Taphozous perforatus		LC
NYCTERIDAE		
Nycteris arge		LC
Nycteris grandis		LC
Nycteris hispida	NT	LC
Nycteris intermedia		LC
Nycteris macrotis		LC
Nycteris major		V
Nycteris nana		LC
Nycteris thebaica	LC	LC
Nycteris woodi	NT	NT
MOLOSSIDAE		
Chaerephon ansorgei	LC	LC
Chaerephon bivittatus		LC
Chaerephon chapini		DD
Chaerephon major		DD
Chaerephon nigeriae ◆	NE	LC
Chaerephon pumilus	LC	LC
Mops brachypterus		LC
Mops condylurus	LC	LC
Mops midas	LC	LC
Mops nanulus		LC
Mops niveiventer		LC

SPECIES	RED DATA STATUS	
	SA	GLOBAL
*Mormopterus acetabulosus**		
Myopterus whitleyi		LC
Otomops martiensseni	V	NT
Sauromys petrophilus ●	LC	LC
Tadarida aegyptiaca	LC	LC
Tadarida fulminans	NE	LC
Tadarida lobata		DD
Tadarida ventralis	NE	NT

MINIOPTERIDAE

SPECIES	RED DATA STATUS	
	SA	GLOBAL
Miniopterus fraterculus ●	NT	LC
Miniopterus inflatus	NE	LC
Miniopterus minor		NT
Miniopterus natalensis	NT	NT

VESPERTILIONIDAE

SPECIES	RED DATA STATUS	
	SA	GLOBAL
Cistugo lesueuri ●	NT	V
Cistugo seabrae ●	V	NT
Eptesicus hottentotus ●	LC	LC
Glauconycteris argentata		LC
Glauconycteris beatrix		NT
Glauconycteris variegata	NT	LC
Hypsugo anchietae	NT	LC
Kerivoula argentata	EN	LC
Kerivoula lanosa	NT	LC
Laephotis angolensis ●		NT
Laephotis botswanae ◆	V	LC
Laephotis namibensis ●	NE	LC
Laephotis wintoni	V	LC
Mimetillus moloneyi		LC
Mimetillus thomasi ●		LC
Myotis bocagii	DD	LC
Myotis tricolor	NT	LC
Myotis welwitschii	NT	LC
Neoromicia capensis	LC	LC
Neoromicia cf. melckorum ● ◆	NE	DD
Neoromicia nana	LC	LC
Neoromicia rendalli	CR	LC
Neoromicia tenuipinnis		LC
Neoromicia zuluensis	LC	LC
Pipistrellus grandidieri		NE
Pipistrellus hesperidus	LC	LC
Pipistrellus nanulus		LC
Pipistrellus rueppellii	NE	LC
Pipistrellus rusticus	NT	LC
Scotoecus albofuscus	V	DD
Scotoecus hindei/albigula		DD
Scotophilus dinganii	LC	LC
Scotophilus leucogaster	LC	LC
Scotophilus nigrita	NE	NT
Scotophilus viridis	LC	NE

Note that for *Chaerephon nigeriae*, *Rhinolophus denti* and *Eptesicus hottentotus* only the southern African subspecies are endemic or near-endemic.

SPECIES	GLOBAL RED DATA STATUS	SOUTH AFRICAN RED DATA STATUS
Casinycteris argynnis	NT	
Cistugo lesueuri	V	NT
Cistugo seabrae	NT	V
Cloeotis percivali	V	CR
Epomophorus angolensis	NT	
Glauconycteris beatrix	NT	
Hipposideros fuliginosus	NT	
Hipposideros gigas	NT	
Laephotis angolensis	NT	
Lissonycteris goliath	V	
Miniopterus minor	NT	
Miniopterus natalensis	NT	NT
Myonycteris relicta	V	
Nycteris major	V	
Nycteris woodi	NT	NT
Otomops martiensseni	NT	V
Rhinolophus blasii	NT	V
Rhinolophus capensis	NT	NT
Rhinolophus swinnyi	NT	EN
Saccolaimus peli	NT	
Scotophilus nigrita	NT	NE
Tadarida ventralis	NT	NE

TABLE 2. Southern African bat species listed as globally threatened by the IUCN.

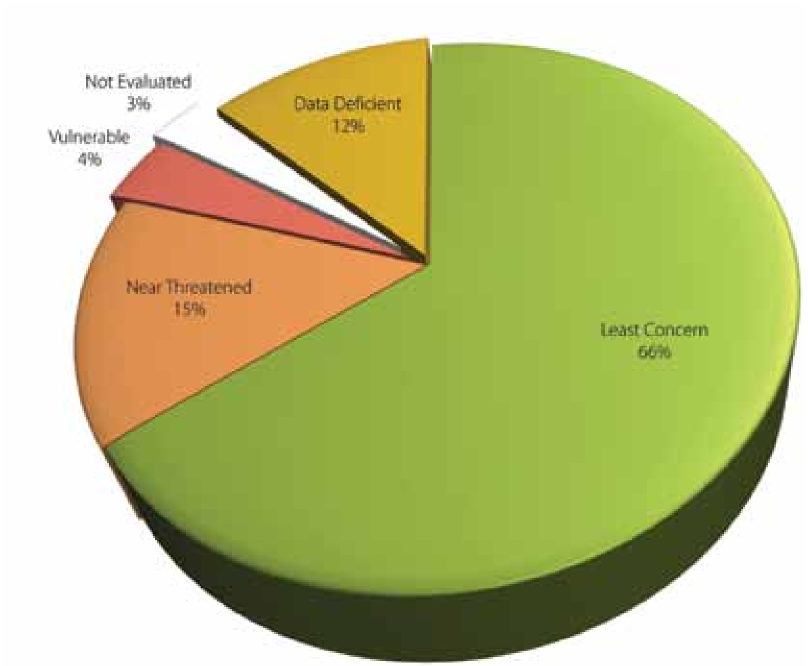


Figure 4. Global conservation status of southern African bat species.

MUSEUM COLLECTIONS AND PIONEERING RESEARCHERS

During the eighteenth and nineteenth centuries, early explorers and hunters such as Temminck and Wahlberg collected biological specimens in southern Africa, which were then sent back to the major museums of Europe, such as the Natural History Museum in London (previously known as the British Museum of Natural History). Within the past few decades, mammalogists including Knud Andersen, Wim Bergmans, J. L. Eger, D. L. Harrison, R. W. Hayman, J. Eric Hill, J. Edwards Hill, J. Kingdon, D. Kock, K. F. Koopman, R. L. Peterson, D. R. Rosevear and O. Thomas, have done an excellent job of making much sense out of these invaluable historical collections, and have published taxonomic and biogeographical treatises in books, checklists and journals.

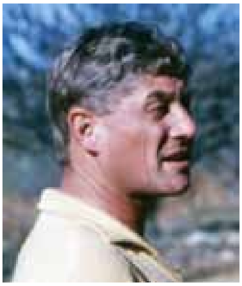
In the early twentieth century, local mammalogists, notably G. C. Shortridge, W. L. Sclater, and A. Roberts, worked prodigiously to build up collections of southern African bats and other mammals (Smithers 1984). Their researches were part of broader faunal surveys and research, especially of the mammals of the region. Many benefited directly and in kind from the devotion of Sir John Ellerman, a most studious researcher of the world's rodents. A significant milestone was the publication of *Southern African Mammals 1758–1951: A Reclassification* (Ellerman *et al*. 1953), which remains a valuable reference for the mammalian taxonomist. This tradition was continued in the latter part of the twentieth century by several biologists – notably Reay H. N. Smithers, J.A.J. 'Waldo' Meester, R. C. Wood and W. Frank H. Ansell made invaluable collections of bats and many other mammals. In the 1960s and 1970s, the Smithsonian Institution initiated ground-breaking surveys of African mammals in at least 13 African countries; the vast collections obtained are a testimony to many dedicated field collectors, including Tim N. Liversedge and John Herbert in southern Africa (Schmidt *et al*. 2008). This led to the compilation of the authoritative *Mammals of Africa: An Identification Manual*, under the editorship of Waldo Meester and H. W. Setzer between 1971 and 1977 – the chapter on Chiroptera by Robert W. Hayman and J. Edwards Hill still includes the most up-to-date identification keys available for much of Africa. It was superseded to some extent in southern Africa by *Classification of Southern African Mammals* (1986; updated by Bronner *et al*. 2003), in which Meester and co-authors derived the keys for Chiroptera largely from Karl L. Koopman's authoritative *Bats of the Sudan* (1975).

The significance of three publications on African Chiroptera can be singled out, because they greatly improved the state of knowledge: *Bats of West Africa* (Rosevear 1965), *Bats of the Congo and of Burundi and Rwanda* (Hayman *et al.* 1966) and the reappraisal of Lang and Chapin's Congo Collection (AMNH) by Koopman (1965). These resolved major taxonomic problems in African bats that had persisted for decades, many since the 19th century. In addition to their taxonomic resolution, these publications presented a wealth of new biogeographical data. Together, this refined knowledge created the foundations for the continental synthesis of Hayman and Hill (1971). All four of these works continue to underpin bat research across Africa today.

Behavioural and ecological studies of African bats began with the extensive field observations published by Lang and Chapin (1917). Verschuren (1957b) published a detailed monograph of the roosting and foraging ecology and behaviour of the bats of Garamba National Park, northeast Congo; his pioneering observations on roost selection have yet to be matched. Brosset (1966a, b) obtained equally detailed data on the biology of the bats of Gabon and Congo (Brazzaville). Through the 1970s and 1980s, M. B. Fenton and colleagues studied the foraging ecology and behaviour of southern African bats intensively in Zimbabwe and northeastern South Africa. As a result, the bat assemblages of the then

Sengwa Wildlife Research Area (SWRA) in Zimbabwe (Fenton 1985) and the Pafuri region of the northern Kruger National Park became amongst the best known worldwide. This research also resulted in many new distributional records and collections of museum specimens, which continue to be used in taxonomic revisions. Not least, these studies brought a welcome focus on research into the echolocation of the region's bats. Detailed studies of the reproduction of selected species of African bats (including McWilliam 1982 and Cotterill 1989) provided valuable data (reviewed by Cumming and Bernard 1997), which were associated with significant additions to museum collections.

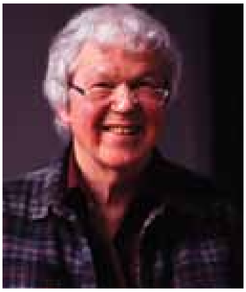
RESEARCHER GALLERY



© Peter Moss

William Frank Harding Ansell (1923–1996), here photographed at Chilanga, Zambia, in 1971, contributed enormously to scientific knowledge of African mammals. Amongst his many publications, one can single out his faunal syntheses of the mammals of west Africa, Malawi and Zambia, the exhaustive taxonomy of African mammals (Ansell 1989) and his classification of the Artiodactyla. Each publication attests to the meticulous attention paid to the most arcane detail, expunging any mystery that had attached to a specimen. Frank's boundless energy culminated in an encyclopaedic knowledge of African mammals. His devoted work in the Game Department of Northern Rhodesia (later Zambia) from 1947 to 1974 created a significant legacy for conservation as well. Thanks to his thorough collections and lasting publications, our knowledge of the Zambian bat fauna ranks amongst the best known on the African continent – a monument to Frank's boundless enthusiasm and commitment to conservation and mammalogy.

Wim Bergmans (b. 1940) is the world's leading expert on the diversity of the Pteropodidae. Over the past three decades, his exhaustive studies of all available museum material culminated in a series of detailed publications, revising the taxonomy and biogeography of Afrotropical fruit bats. These brought welcome order to considerable chaos, and immeasurably eased the challenges of writing all the species treatments of fruit bats in this book.



© Hans van Brandwijk

Courtesy of the Royal Ontario Museum, photo: Brian Boyle © 2010 Royal Ontario Museum

Judith Eger is Senior Curator of Mammals at the Royal Ontario Museum. Her research has been instrumental in expanding the vast collection of the ROM, including significant additions from Asia. Her notable contributions to knowledge of Afrotropical bats, have concentrated on relationships between the Malagasy and African bat faunas; valuable publications include descriptions of new species, amongst important papers on molossids and Butterfly Bats, *Glauconycteris*.

© Ariya Dejtaradol

David L. Harrison (b. 1926) is a zoologist and retired medical doctor. His studies of bats began early, under the auspices of the family museum in Sevenoaks, England. His collaborations with Phillip Clancey and Reay Smithers, among several expert naturalists across Africa, resulted in a series of important papers on African bats, alongside the creation of one of the world's significant scientific collections of small mammals. Amongst his publications on the mammals, including the Chiroptera of the Middle East and India, he holds a profound knowledge of Old World bats, notably of the Vespertilionidae and Molossidae.

Robert William Hayman was a scientific officer in the Mammal Section of the British Museum (Natural History) from 1921 to 1968. He published benchmark papers on African bats. His two major contributions remain Hayman *et al.* (1966) and Hayman and Hill (1971). These resolved many taxonomic problems and remain invaluable syntheses of knowledge for ongoing research.

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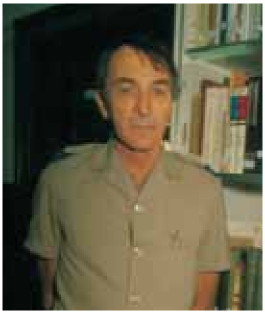
John Edwards Hill (1928–1997) researched mammals in the British Museum as a Scientific Officer from 1948 until 1997, continuing after his official retirement in 1988. A research focus on bats cultivated his encyclopaedic knowledge of the diversity of the world's Chiroptera, reflected in the legacy of his numerous publications. These included descriptions of 55 new mammalian taxa, which include 37 new species and subspecies of Chiroptera, alongside describing the hitherto unknown Asian family Craseonycteridae, which is represented by a monotypic species, the minute *Craseonycteris thonglongyai* (Figure 1).

Karl L. Koopman (1920–1997) was a mammalogist in the American Museum of Natural History, New York, where he worked studiously until the weekend of his death. His career began in 1948, developing into a focus on taxonomy and biogeography, especially bats. He joined the AMNH in 1961. His encyclopaedic knowledge of the diversity of the world's Chiroptera rivalled that of John Edwards Hill. Karl's contributions to knowledge of African Chiroptera include revisions of the taxonomy of the bats of Sudan (1975), Liberia and West Africa; these exemplify both a meticulous attention to the details, and sweeping geographical perspective. A skilled debater on the subjects he held dear, Karl Koopman remains fondly acknowledged as the mentor of an impressive alumni of postgraduate students (Griffiths 1998).

© American Society of Mammalogists

J. A. J. 'Waldo' Meester (1931–1994) devoted his life to the study of African small mammals, specialising in the taxonomy of shrews and golden moles. He is best known for his two definitive works: *The Mammals of Africa: An Identification Manual* (Meester and Setzer 1971–1977) and *Classification of Southern African Mammals* (Meester *et al*. 1986). He served as Curator of Mammals at the Transvaal Museum (1952–1963), Director of the Kaffrarian Museum in King William's Town (1964) and Founder and Director of the Mammal Research Institute at the University of Pretoria (UP) (1966–1971). As Board Member of the Durban Natural Science Museum, he campaigned for the creation of a Mammalogy position there and donated his entire library to the museum.



© Durban Natural Science Museum

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Randolph L. Peterson (1920–1998) curated the Mammal Section at the ROM from 1946 until retirement in 1985, continuing his research until his death; he assembled one of the world's significant collections of African bats. His work on bats was the joy of his professional life, and under his curation the collection of bats at the Royal Ontario Museum grew into one of the world's finest, both in size (over 35,000 specimens) and global representation (Eger and Mitchell 1990). His thorough studies of African free-tailed bats deserve to be singled out in providing an invaluable contribution to our knowledge of this poorly known group.

Austin Roberts (1883–1948) worked at the Transvaal Museum, Pretoria from 1910 to 1946. He was a superb field naturalist and perceptive vertebrate taxonomist. Alongside his well known pioneering research on the southern African avifauna, Roberts described a total of 406 taxa of mammals as new to science; these included 15 subspecies and 8 species amongst a total of 29 Chiropteran taxa (Brain 1998).

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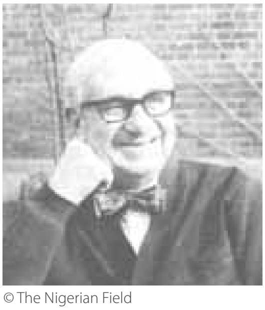
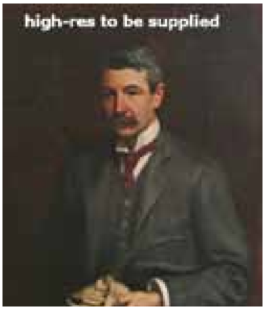


© The Nigerian Field

Donovan Reginald Rosevear (1900–1986) pioneered the development of the forestry industry in Nigeria from 1924 to 1954. His enthusiastic studies of the west African fauna included significant collections of mammals. After his formal retirement, he completed three monographs on West African mammals over the subsequent twenty years in research at the British Museum (Kyle 1986). These included a significant, lasting contribution in the *Bats of West Africa* (Rosevear 1965).

Reay Henry Noble Smithers (1907–1987), naturalist, falconer, editor, conservationist and mammalogist (among many professions), began his career as a chemist until joining the South African Museum in 1933; he transferred to the fledgling organisation of then Museums of Southern Rhodesia in 1947. Besides his founding of four major museums in Zimbabwe, Reay Smithers both undertook and facilitated comprehensive natural history surveys across south-central Africa, notably of the mammals of Botswana (Smithers 1971). Amongst many selfless contributions were lasting inputs into conservation, notably to pioneering legislation of the National Parks and Wildlife Act of Zimbabwe. Perhaps the greatest monument to his legendary excellence in museology and commitment to science resides in the largest collection of mammals in the southern hemisphere at Bulawayo's Natural History Museum. His *magnum opus*, the *Mammals of the Southern African Subregion* (Smithers 1983) collated a wealth of his original data on the region's mammal fauna, including bats (Raath 1988).


© Transvaal Museum



© The Natural History Museum, London

Michael Robert Oldfield Thomas (1858–1929) devoted virtually all his life's attentions to the mammal collection at the British Museum (Natural History) – from 1878 until long after his official retirement in 1924. In this period the collection grew exponentially through at least 1 million specimen accessions. His life's total of 1,090 scientific publications included the scientific descriptions of some 2,090 new taxa of mammals from across the world; Thomas named many Afrotropical bats (Hill 1990). This immense taxonomic legacy endures, alongside the mammal collection in the British Museum, as a significant foundation of scientific knowledge in the 21st century.

THE VALUE OF SPECIMENS

Many of the known bat records – vouched for by preserved specimens of bats – have been published. For example, the first article devoted exclusively to the bats of Zimbabwe (Harrison 1959) summarised new material added to the museum collections of the country. In the main, these older articles were published in museum journals that are relatively hard to obtain, or the data reside in monographs long out of print (e.g. Ansell 1978, Smithers and Wilson 1979). Existing taxonomic uncertainties often undermine the credibility of these historical data, but fortunately, nearly all the originally reported specimens still exist – in museum collections. In this way, each of these specimens maintains the veracity of scientific knowledge. This is an excellent example of how the value of these natural history collections preserved in museums increases with time, but they are regrettably too often neglected, even within the biological community (Cotterill 1995a, 1999, 2002, 2009, Cotterill and Foissner 2010).

The loss of any one of these specimens, let alone an entire collection, has severe consequences. A pertinent example is the fire that destroyed a wealth of unique zoological specimens at the Museu Bocage, Lisbon, in March 1978. Its depredations on scientific knowledge included the destruction of all the type material of the Chiroptera described by J. V. Barboza du Bocage and A. F. de Seabra from Angola (see Palmeirim *et al.* 1979, Bergmans 1990). In this book we repeatedly refer to the problems these losses will continue to cause in bat taxonomy for many taxa.

These specimens are the fundamental sources of scientific data to support efforts to conserve biodiversity, as explicitly recognised by the 1992 Convention on Biological Diversity (CBD). The distribution maps in this book are based entirely on museum specimens

fig. 5a

fig. 5b

Figure 5. (a) A small part of the wet collection of mammals, Natural History Museum of Zimbabwe, Bulawayo. (b) The study skins and skull collection of small mammals in Bulawayo is estimated at over 50,000 specimens, including invaluable series of bats. A series of *Mops midas* is arrayed in the foreground (© F. P. D. Cotterill).

representing 6,000 unique locality-species records (Figure 11), 73% of which have been personally checked by at least one of the coauthors (marked as red dots on the species distribution maps in the species accounts). These collections provide unique references for the scientific identification of new specimens, as they include those type specimens that vouch for the formal description of species (Cotterill, 1995a, b, 1999, 2002, Cotterill and Dangerfield 1997, Cotterill and Foissner 2010).

Discovery of new species of bats continues today in many biodiversity hotspots, including parts of Africa. This is in part due to new collections from remote areas, as well as sophisticated new taxonomic tools, which include echolocation studies and systematic revisions that incorporate molecular evidence (DNA sequences). As with any serious biogeographical or taxonomic work, the direct study of specimens is essential to the scientific credibility of all such research.

CHIROPTERA COLLECTIONS

The devotion of bat collectors in southern Africa has led to the establishment of several major Chiroptera collections, housed in the following southern African museums: the Amathole Museum (previously the Kaffrarian Museum; King William's Town), the Durban Natural Science Museum, the National Museum (Bloemfontein), the South African Museum (Cape Town), the Northern Flagship Institute's Transvaal Museum (Pretoria), the Natural History Museum of Zimbabwe (Bulawayo), and the Namibian National Museum (Windhoek).There are smaller mammal collections in Angola (Lubango and Dundo), Zambia (Livingstone), Malawi (Blantyre) and Mozambique (Maputo). These important resources, located within Africa, complement the major natural history museums in Europe and North America.

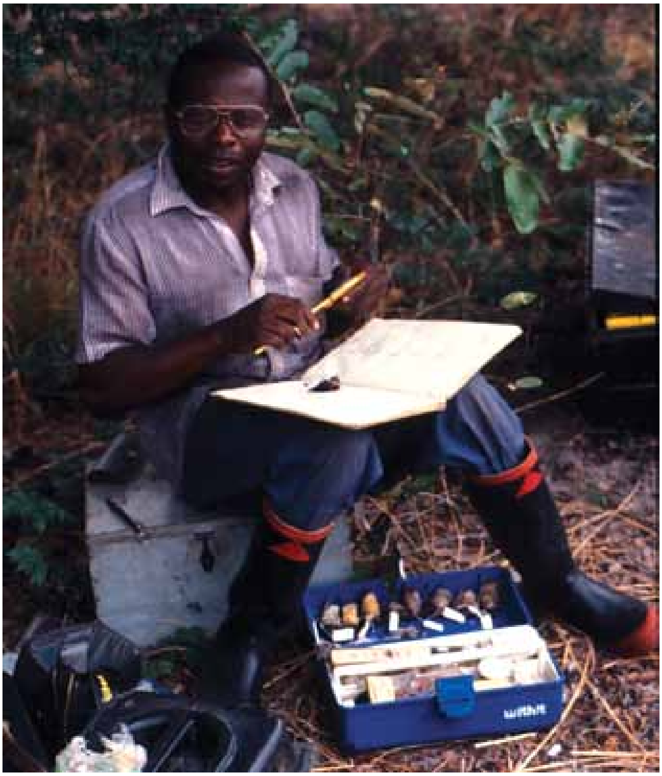


fig. 6

◂ ***Figure 6.*** Senior Technical Officer Alick Ndlovu, Natural History Museum of Zimbabwe, collating field data on bat specimens in western Zambia in November 1998. Alick Ndlovu deserves special credit for his sterling efforts in re-cataloguing the entire Mammal Collection (NMZB), which includes nearly 9,000 specimens of Chiroptera (© F. P. D. Cotterill).

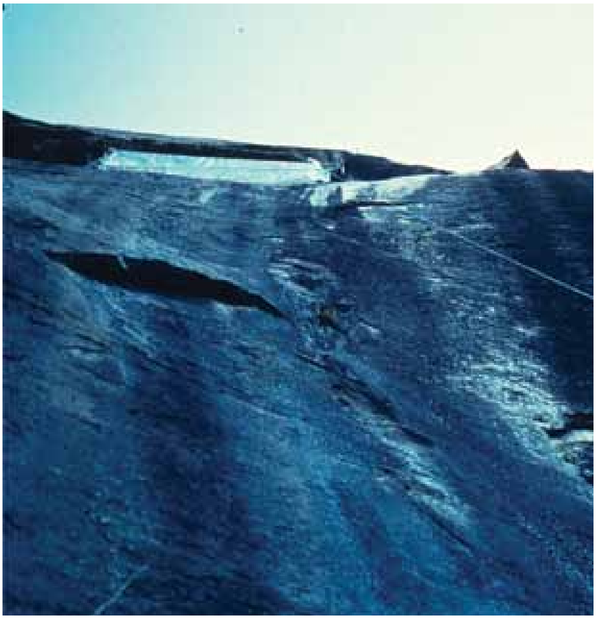


fig. 7a

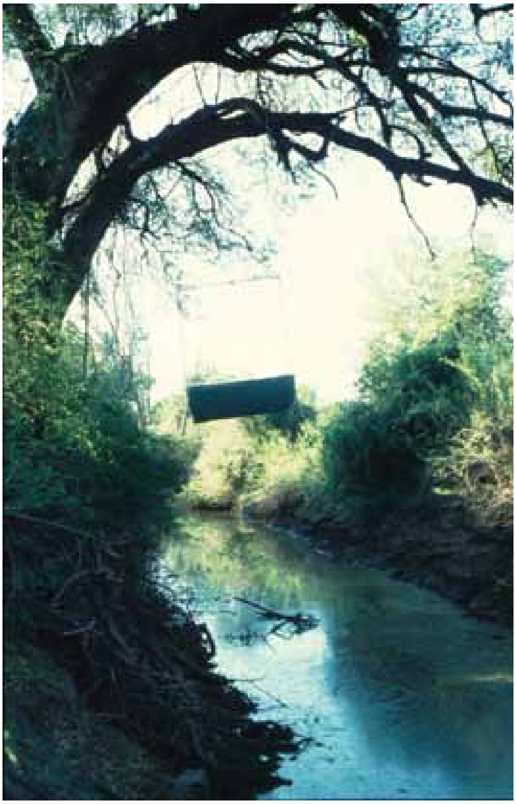
fig. 7b

▴ ***Figure 7***. (a) Prototype of a bicycle trap placed under a crevice roost, ~100 m up a granite precipice; the trap is suspended from pulleys secured on the inselberg summit (Cotterill and Fergusson 1993). (b) Three species of free-tailed bats captured from their crevice roost using a bicycle trap near Chikupu Caves, including *Chaerephon ansorgei* and *C. bivittatus*, with a *Tadarida fulminans* in the foreground (Murigabveni, northeast Zimbabwe; © F.P.D. Cotterill).

fig. 8a

fig. 8b

▲ ***Figure 8.*** (a) A harp trap set in a path through forest understory, near Sakeji School, northwest Zambia. (b) Detail of the three banks of nylon lines that intercept flying bats. This design was modified from that of Tidemann and Woodside (1978) (© F.P.D. Cotterill).



◀ ***Figure 9.*** Harp trap set over a side channel of the Limpopo River (© F.P.D. Cotterill).

fig. 10a

fig. 10b

Figure 10. (a) Macronet (30×6 m) awaiting nocturnal fieldwork (Chivi District, southern Zimbabwe). The modified 8 m yacht masts are held erect by guy ropes. (b) Detail of the net links and pulley system that facilitates rapid access to netted bats (© F.P.D. Cotterill).

The following European and North American museums hold significant collections from Africa (including its southern and central regions): the American Museum of Natural History (New York), the California Academy of Sciences Natural History Museum (San Francisco), the Carnegie Museum of Natural History, (Pittsburgh), the Field Museum of Natural History (Chicago), the Harrison Zoological Museum (Sevenoaks), the Los Angeles Country Museum, the Museum Alexander Koenig (Bonn), the Museum of Comparative Zoology (Harvard), the Museum of Natural History (Berlin), the Muséum national d'Histoire naturelle (Paris), the Royal Ontario Museum, the Royal Museum of Central Africa (Tervuren), the Smithsonian's National Museum of Natural History (Washington D.C.), the Natural History Museum of the University of Kansas (Lawrence), the State Museum of Natural History (Stuttgart), and the Natural History Museum (London).

Despite this heritage of information gathered over two centuries of collecting, our knowledge of the basic aspects of biology of the majority of bat species, not least their distributions, remains very poor. The magnitude of this deficiency is quantified across the pages of this book. There are just too few collectors and scientists relative to the high diversity of bats occurring in our region. This makes contributions by enlightened and observant amateur bat workers all the more valuable. Significantly, four out of the five southern African records of two rare species, *Tadarida lobata* and *T. ventralis*, constitute specimens found dead by the public and submitted to the museum in Harare, Zimbabwe. *Scotoecus albofuscus* was recorded for the first time in South Africa when two amateur bat workers responded to distress calls by a pregnant female bat (the bat later gave birth to twins and died in their care). Additional specimens of this rare bat have been located in the Durban region by bat rehabilitators. The first South African records of the rare *Scotophilus nigrita* were discovered in bat houses manufactured by a local bat enthusiast, Nigel Fernsby.

The rapid rate of habitat change across large regions of southern Africa, under burgeoning human demands for natural resources, magnifies the significance of the deficiencies in our knowledge. It underpins arguments to improve our knowledge of bats and indeed all biodiversity.

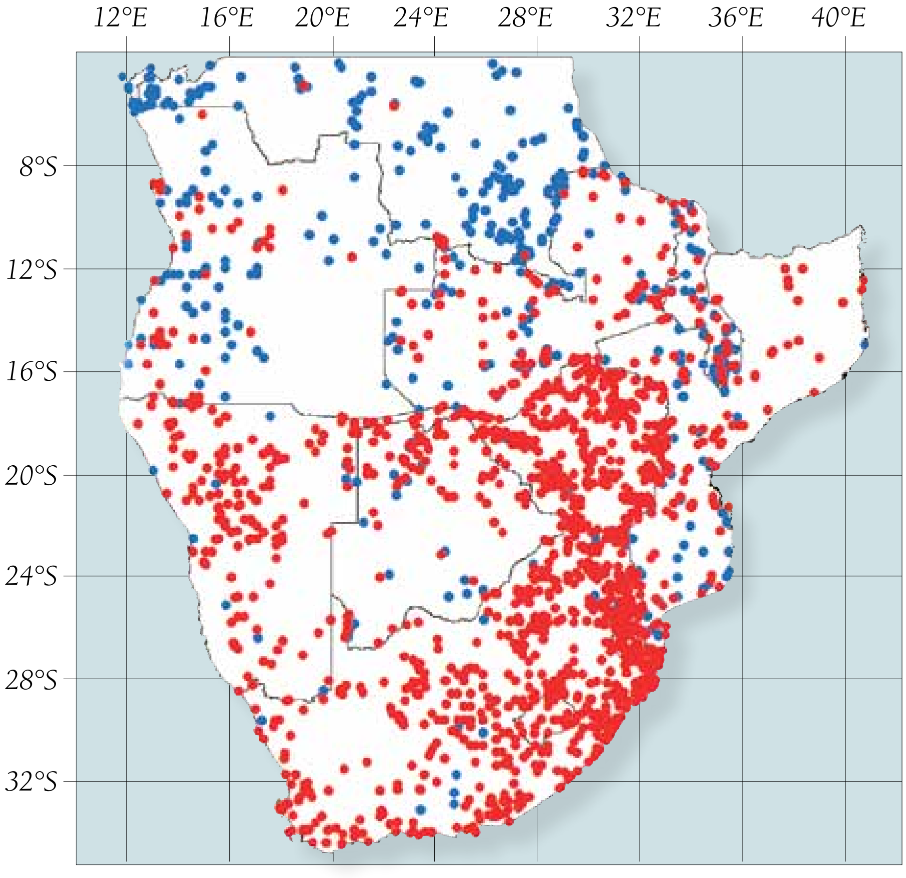


Figure 11. This map shows the distribution of the 6,000 museum specimen records used to create the maps in this book. Red dots mark specimens that have been personally checked by at least one of the authors.

BAT BIOLOGY

This section gives an introduction to the biology of bats. The behaviour of individual species is discussed in the species accounts section. More detailed information, beyond this overview, can be obtained in the specialised and comprehensive literature, including Adams and Pedersen (2000), Kunz (1982, 1988), Kunz and Racey (1998) and Kunz and Fenton (2003). Hill and Smith (1984), Richarz and Limbrunner (1993), Altringham (1996) and Neuweiler (2000) are readable syntheses that contain valuable information about the natural history of the Chiroptera.

MIGRATION

In temperate (and some subtropical) regions, cold winters force bats to migrate or hibernate. A few species migrate over longer distances (> 500 km), while many make short, local (< 50 km) or medium distance (< 500 km) movements between winter and summer roosts (Fleming and Eby 2003). In southern Africa, the seasonal appearances and disappearances of *Eidolon helvum* likely reflect responses of these bats to changing food supplies (Richter and Cumming 2008).

In Gauteng, Limpopo and the Western Cape (South Africa), *Miniopterus natalensis* migrates up to 260 km (van der Merwe 1973a, 1975) between warmer maternity caves where females give birth in summer (e.g. the De Hoop Guano Cave in the Western Cape, and several caves in the lowveld of Limpopo), and colder caves in winter, where mating and hibernation occurs (e.g. several caves in the interior of the Western Cape, and on the highveld of Gauteng). *Myotis tricolor* undertakes similar seasonal migrations, although the details are not yet known.

Rousettus aegyptiacus may also make migrations of hundreds of kilometres. An individual tattooed at caves in the Tzaneen area of Mpumalanga was subsequently recovered at Mtunzini on the northern coast of KwaZulu-Natal (Jacobsen and du Plessis 1976). Population numbers of the Mpumalanga colonies decrease during winter and increase again in summer, while, conversely, a known colony at Mission Rocks Bat Cave (Greater St Lucia Wetland Park) on the northern coast of KwaZulu-Natal decreases in size dramatically (from > 5,000 to < 300) at the beginning of spring, and increases again during winter. It seems highly likely that the same bats migrate from winter roosts on the warm KwaZulu-Natal coast to summer roosts in the Mpumalanga lowveld.

TORPOR AND HIBERNATION

Although bats are warm-blooded mammals, and can maintain a constant body temperature, some show a remarkable degree of thermolability, which occurs on a daily or seasonal basis. The body temperature of torpid bats is colder than that of homeothermic mammals and fluctuates in concordance with the ambient temperature. Daily torpor and hibernation are common in the Vespertilionidae, Rhinolophidae and Hipposideridae, and in some Molossidae (Ransome 1990). Other southern African bats are more conventional thermoregulators and cannot enter torpor.

Recent research by Bronner *et al*. (1999) in the South African lowveld has shown that the Angolan free-tailed bat, *Mops condylurus*, routinely selects the hottest roosts under tin roofs, and by allowing its body temperature to rise is able to save energy that would otherwise have been required for cooling (i.e. the reverse of torpor). These same bats readily undergo torpor to conserve energy during day-time roosting in both summer and winter (Vivier and van der Merwe 2007).

Although a few bats migrate to warmer climates for winter, as do some birds, many bats paradoxically move to colder climates for winter (Fleming and

Figure 12. Several species of bat carry their young while foraging. This female *Eidolon helvum* carrying her young pup was photographed at a large maternity roost on Bat Island, Lake Kivu, Rwanda (© Ian Little).

Eby 2003). Here, facultative torpor enables these small mammals to shut down their metabolism to a basic level in response to winter cooling, thus allowing their body temperature to fall to that of their environment, or to just above freezing in subzero temperatures. The colder the ambient temperature, the greater the energy saving through the lowering of their internal body temperature. By switching off their energy-expensive heating system during hibernation, bats can survive cold winters when insects (i.e. fuel reserves) are very scarce. Prior to hibernating, in late summer, bats will eat voraciously to build up their fat reserves, which may comprise up to 26% of their total body weight just before hibernation. These reserves may have to tide them over for up to six months during hibernation (Fleming and Eby 2003). Bats budget their fat reserves very precisely and forced arousal from hibernation consumes huge amounts of energy reserves, and can result in bats starving before the end of winter. Studies from the northern hemisphere show that one arousal costs the energy that could cover ~60 days of hibernation (Kunz 1982, Kunz and Fenton 2003).

REPRODUCTION

The demands of hibernation also lead to interruptions of the reproductive process, and the reproductive patterns of bats show some unique features compared with mammals generally (Crichton and Krutzsch 2000, Adams and Pederson 2000).

Worldwide, the average length of bat gestation varies from 44 days in *Pipistrellus pipistrellus* to 7 months in *Desmodus rotundus*, but typically it is around 2 months (Barclay and Harder 2004). Gestation in southern African bats varies from 60 days in *Chaerephon pumilus* to an effective 7 or 8 months in species with delayed reproduction.

Bats exhibit three patterns of delayed reproduction (for reviews see Racey 1982, Bernard 1989, Bernard and Cumming 1997): sperm storage, delayed implantation, and retarded embryonic development. These have evolved in species in tropical as well as temperate biomes, which reveals that these adaptations have a tropical origin (Racey 1982).

Sperm storage: After mating occurs in autumn, viable spermatozoa are stored and nourished in the female's uterus or oviducts throughout the hibernation period. Eggs are only fertilised once the females have ovulated after arousal from hibernation in spring. Most temperate-climate bats use this phenomenon, as do many southern African Vespertilionidae and Rhinolophidae. The burden of sperm storage might be shared or is confined to one of the sexes. In *Neoromicia nana* (Bernard *et al*. 1997), *Neoromicia rusticus* (Van der Merwe and Rautenbach 1990b), *Myotis tricolor* (Bernard 1982b), and most Rhinolophidae (Bernard 1983, 1989), viable sperm is stored predominantly in the female reproductive tract, while in *Neoromicia capensis* (Van der Merwe 1994a) and *Nycticeinops schlieffeni* (Van der Merwe and Rautenbach 1990a), sperm is stored in both the male and female tracts. At the other extreme, only *Rhinolophus capensis* males store sperm (Bernard 1985), and mating, ovulation and fertilisation all occur after winter.

Delayed implantation: Mating, ovulation and fertilisation occur in autumn, but the implantation and subsequent development of the resulting blastocyst (fertilised ovum) is delayed until after hibernation is completed. In southern Africa, *Miniopterus natalensis* and *M. fraterculus* exhibit this phenomenon (Bernard 1980, 1994, Bernard *et al*. 1996), as does *Scotophilus dinganii* (van der Merwe *et al.* 2006).

Retarded embryonic development: Normal mammalian fertilisation and implantation occur, but the embryo's growth is retarded during hibernation and only resumes after hibernation is over. In southern Africa, *Hipposideros caffer* exhibits this phenomenon (Bernard and Meester 1982), as does *Rhinolophus simulator* (Cotterill 1998). In *Scotophilus cf. viridis*, delayed implantation occurs in combination with retarded development (van der Merwe *et al*. 1988).

In addition to these patterns of delayed reproduction in hibernating bats, two basic types of 'normal' mammalian reproduction – seasonal polyoestry and seasonal monoestry – are common in non-hibernating southern African bats (Happold and Happold 1990a, Bernard and Cumming 1997). An interesting life history has evolved in the polyoestrous molossid *Tadarida fulminans*, which breeds over the cool, dry season in southern Africa; this is interpreted as a response to predation on insect prey (aerial plankton) at high altitudes (Cotterill and Fergusson 1993, Cotterill 2001b).

Seasonal polyoestry: More than one pregnancy and birth season occurs during the restricted breeding season, e.g. *Epomophorus wahlbergi*, *Mops condylurus* and *Chaerephon pumilus*. The high-flying molossid *Tadarida fulminans* is unique amongst known bats, as females lactate over the cool, dry season (Cotterill and Fergusson 1993).

Seasonal monoestry: Only a single pregnancy and birth season occurs during the restricted summer breeding season (e.g. the majority of bats, including most Vespertilionidae).

Most bats give birth to a single young per litter (Barclay and Harder 2004), while some Vespertilionidae such as *Neoromicia nana*, *N. rusticus*, *N. capensis*, *Scotophilus* spp. and *Nycticeinops schlieffeni* commonly give birth to twins or triplets, and sometimes even quadruplets in the case of *Neoromicia capensis* (see species accounts for details).

Species with widespread distributions may have multiple births in equatorial parts of their range in Africa, but only one or two birth periods in more temperate regions; this seems to be the case in *Taphozous mauritianus* (Happold and Happold 1990a).

In gregarious species, pregnant females typically form nursery (maternity) colonies in summer. Here, the babies are born, often with the mother clinging upside down to the substrate with her toe claws and one wing claw to maintain a semi-horizontal position. The wing and tail membranes are used to catch the newborn baby. Depending on the species, newborn bats weigh 7–43% of their mother's weight (compared with 8% in other mammals) (Neuweiler 2000). They have adult-sized hind feet and deciduous teeth to assist with clinging onto the fur, or pelvic nipples, on the mother's belly. Babies may be carried for one or two weeks while the mothers forage, but thereafter they are left in nursery clusters. *Tadarida brasiliensis* mothers at Bracken Caves (Texas, USA) recognise their own young, even though there may be some 4,000 young per square metre (Neuweiler 2000).

In Europe, *Pipistrellus* species engage in melodious ultrasonic courtship songs to attract females (Park *et al.* 1996). Male *Epomophorus* species sing from well-situated calling stations and flash their large fluffs of white shoulder fur to attract mates (Kingdon 1974); they probably also use pheromonal secretions from glands contained in their shoulder pouches.

In some species, it seems that favoured mating territories guarded by certain males are more attractive to females than to the males themselves. In Britain, individual *Rhinolophus ferrumequinum* guard the same spot at cave entrances over many years (Ransome 1991). The male leks of *Hypsignathus monstrosus* may represent another example of this (Bradbury 1977).

Bat mating systems exhibit considerable variability. A common pattern is polygyny, in which one dominant male mates with multiple females. This pattern is known in the South American *Desmodus rotundus*, but may also be common in southern Africa. It appears to be the case in *Otomops martiensseni*, where a dominant larger-sized male usually challenges approaching intruders with a piercing squeak (P. J. Taylor, personal observation). Other members of the colony are typically females with juvenile or subadult males and females. In a large cave colony of *Coleura afra* in Kenya, which exceeded 50,000 individuals, the bats roosted in clusters, the majority of which were harems attended by a single adult male, sometimes with a second 'satellite male' on the periphery (McWilliam 1987a). Social monogamy, which is the norm in birds, is rare in bats and has not been shown to occur in any southern African species (McCracken and Wilkinson 2000).

For their size, bats are the slowest-reproducing mammals on Earth (Barclay and Harder 2004). On average, a mother rears only one young per year (Barclay and Harder 2004), and some females are two or three years old before they have their first young (Corbet and Harris 1991). Bats are also incredibly long-lived for their size. Life spans of 38 years have been recorded (Kritankov and Ovodov 2001), although average longevity is lower at 14.6 years (Tuttle and Stevenson 1982). Mortality is highest in the first year, when some 70% of juveniles may die (Monadjem 2006a). The longevity record for a southern African bat is 13 years for *Miniopterus natalensis* (van der Merwe 1989). In Swaziland, a banded *Nycteris thebaica* has lived for at least 10 years (A. Monadjem, unpublished data).

PREDATION

Although the natural mortality of bats is high in their first year, it is remarkably low in subsequent years of life (Ransome 1995, Cummings and Bernard 1997). In *Nycteris thebaica*, about 40% of female and 30% of male juveniles survive through the first year (Monadjem 2006a), after which survival increases to about 60% per year. The survival rates of other southern African bat species are poorly known. Numerous animals hunt bats, including snakes, owls (Cotterill 1992), other birds of prey (Kemp and Rautenbach 1987, Thomsett 1987, Fenton *et al.* 1994, Fenton 1995), certain passerine birds, small carnivores such as genets and domestic cats, and humans. Some bats, for example *Nycteris grandis* of central and southern Africa (Fenton *et al.* 1993), also eat other bats, while the Bat hawk (*Macheiramphus alcinus*) is a specialised avian predator of bats (Hustler and Dean 2005).

FORAGING ECOLOGY

In southern Africa, all fruit bats have plant-based diets, while all other bats feed on a wide range of insect prey or, exceptionally in the case of *Nycteris grandis*, vertebrate prey as well (Fenton *et al.* 1990, 1993).

Frugivory and nectivory: The pteropids feed on the fruits, leaves, flowers and nectar of a wide range of indigenous trees, often showing preference for the fruits of Ficus (F. J. Bonaccorso, personal communication) and *Podocarpus*. Soft-fleshed cultivated fruits are also favoured, including mangos, guavas, papayas, avocados, litchis, bananas, dates, and even *Syringa* berries. Bats prefer ripe fruits, and since most commercial fruits are picked under-ripe for shipping, fruit bats generally should pose no significant risk to fruit orchards (Smithers 1983, Fleming *et al.* 2009). However, there are apparently exceptions to this generalisation – *Rousettus aegyptiacus* has been shown to cause damage to litchi orchards in South Africa (Jacobsen and du Plessis 1976).

Carnivory: A few bats, including *Nycteris grandis*, are carnivorous. This species feeds on smaller vertebrates such as fish, frogs, mice, birds, and even other bats

(Fenton *et al*. 1990, 1993). Elsewhere, notably in central America, frog-eating bats exploit the mating calls of frogs, while fish-eating bats have a specialised echolocation system to detect fine ripples on the water surface caused by fish, and sharp, hooked hind claws with which they can gaff their prey.

Insectivory: Some 70% of bat species worldwide eat insects (Jones and Rydell 2004). Depending to varying extents on their body size, jaw construction, wing shape, foraging behaviour, habitat use, and the nature of their echolocation calls, different insectivorous species feed on different groups of insects. Although studying the diet of insectivorous bats requires detailed microscopic or molecular examination of faecal remains, skull and mandible morphology are good predictors of diet (Jacobs 2000, Schoeman and Jacobs 2003). Strong robust jaws and long canines are indicative of hard-shelled prey, while a weak jaw with poorly developed coronoid processes, is indicative of soft-bodied prey such as moths (Freeman 1979, 1981). In general, smaller bats are limited to smaller prey, while larger bats can take a wide size range of prey (Aldridge and Rautenbach 1987).

Aerial feeders, such as most Vespertilionidae, Emballonuridae and Molossidae, hunt flying insects exclusively on the wing; they are typically fast fliers and lack manoeuvrability (Aldridge and Rautenbach 1987). Gleaners, such as Hipposideridae and Rhinolophidae, capture stationary prey from branches or the ground and are typically capable of slow, manoeuvrable flight in confined spaces (Aldridge and Rautenbach 1987). Some species, such as *Nycteris thebaica*, *Hipposideros caffer* and certain *Rhinolophus* species, appear capable of both aerial feeding and gleaning. Some of these species are also perch hunters: they hang on a perch and make quick attacks when prey is detected moving past.

To a large extent, the design of the wing and the structure of the echolocation call together determine the prey that can be taken by a bat (Norberg and Rayner 1987). This relationship is discussed in detail in 'Echolocation'.

There is growing evidence that bats play vitally important ecological roles that may also have significant economic benefits, as bats are the major predators of night-flying insects.

Every year, billions of corn earworm moths (*Helicoverpa zea*), fall armyworms (*Spodoptera frugiperda*) and other insects migrate in swarms from northern Mexico into Texas at altitudes of up to 3 km above ground. These insect swarms cause massive crop losses across the southern and central United States, costing the United States billions of dollars annually (McCracken 1996). Recent research using radar, weather balloons and bat detectors has estimated that the 100 million *Tadarida brasiliensis* bats occupying Bracken Cave and other major caves in central Texas can eat approximately 1,000 tons of insects each night. Even if only 10% of the bats' diet were corn earworm moths (at 250 mg per moth), these bats would eat 340 million pest species moths each night, saving farmers millions of dollars (McCracken 1996, McCracken and Westbrook 2002, Kalko *et al.* 2008). Studies using bat detectors suspended on helium balloons in the Sengwa Wildlife Research Area, Zimbabwe, also demonstrated feeding by high-flying free-tailed bats (including *Otomops martiensseni* and *Tadarida* species) and *Taphozous mauritianus* at over 500 m above ground (Fenton and Griffin 1997).

Agricultural pests also featured prominently in the diet of bats occupying the fertile Sacramento Valley (Long *et al*. 1998). In another study reported in *New Scientist* magazine (Anonymous 1999), California pear farmers suffered crop losses of less than 5% to the corn earworm when a bat colony was situated within 2 km; when the bat colony was situated over 4 km away, crop losses of 60% were reported.

Closer to home, South Africa's largest colony of 300,000 bats at the De Hoop Guano Cave assists farmers in the Bredasdorp area by consuming approximately 100 tons of insects annually, including many crop pests (McDonald *et al*. 1990b). With a growing emphasis on biological control and integrated pest management to reduce environmental impacts, more and more farmers are taking bats seriously, especially given the evidence that a single colony of bats may consume millions of insects, including crop pests, each growing season. For this reason, farmers throughout southern Africa are now exploring ways of attracting bat colonies to their fields; these include erecting bat houses.

Bats may also be important in mosquito control. In a laboratory experiment, bats of the genus *Myotis* were recorded capturing up to 600 mosquitoes in an hour (Griffin *et al.* 1960). Mosquitoes have been found in the diet of certain species of bats worldwide, but a priority for research is to establish their importance in the diet of southern African bats.

Fruit bats also bring important ecological and economic benefits. Research sponsored by Bat Conservation International has shown that the seed dispersal and pollination activities of fruit-eating bats are vital to the survival of equatorial and tropical rain forests. Some 300 plant species in the Old World tropics alone depend on bats for pollination or seed dispersal or both, providing more than 450 economically important products valued at hundreds of millions of US dollars annually (Fujita and Tuttle 1991). Seeds dropped by tropical bats are estimated to contribute towards some 95% of forest regrowth on cleared land in the African tropics (www.batcon.org). Certain bat-dependent trees, such as the baobab, *Adansonia digitata* (whose white flowers may help attract bats at night), are ecologically crucial, supporting dozens of other species themselves. Extinction of baobabs resulting from the extinction of the *Epomophorus* species that pollinate them would trigger a cascade of linked extinctions.

ROOSTING HABITS

Different species of bats roost in various places during the day, such as amongst foliage, in hollows or crevices, and in specialised roosts, notably caves (Figures 13, 14, 18).

Foliage-roosting bats

Most Pteropodidae, as well as *Taphozous mauritianus*, *Neoromicia nana*, *Glauconycteris variegata* and *Myotis welwitschii*, hang up or cling onto surfaces in trees or shrubs. Pteropodidae, *G. variegata* and *M. welwitschii* hang by their hind claws from the undersurface of leaves or branches, the last two hanging in a disguised manner among clumps of leaves. *T. mauritianus* roosts face-down, anchored by its hind claws, but with its belly, thumb claws and hind claws in contact with the surface of a tree or wall. *N. nana* clings with its ventral surface in contact with the smooth surface of unfurling banana leaves (Figure 13; Taylor 2000).

Hollow-roosting bats

Hollow-roosting bats occupy underground caves, hollows in trees, and anthropogenic hollows such as roofs and basements of houses, tunnels or cavities in dam walls, and abandoned mine shafts (Kunz and Lumsden 2003). Some members of Vespertilionidae, Emballonuridae and Molossidae roost in tree hollows. Radio-tracked *Scotophilus cf. viridis* were found to occupy hollow *Colophospermum mopane* trees in the Kruger National Park (Fenton *et al*. 1985). The presence of mature trees in woodlands is essential for the persistence of tree-roosting bats, which are adversely affected by the removal of such trees (Fenton *et al*. 1998). While a large amount of research has been carried out on tree-roosting microbats living in American forests, very little is known about such species in southern Africa.

▸ *Figure 13.* Schematic comparison of the diversity of different daylight domiciles selected by representative species of African Chiroptera that roost in trees: **A** free-hanging from main boughs, *Eidolon helvum*; **B** clinging under exfoliating bark, *Laephotis* spp., *Nycticeinops schlieffeni*, and *Pipistrellus* spp.; **C** clinging within foliage, reliant on crypsis, *Glauconycteris variegata*; **D** clinging within cracks within an elephant-damaged branch, *Chaerephon chapini*; **E** Clinging in hollow branches, *Chaerephon pumilus*; **F** free-hanging in large cavity of tree trunk, *Nycteris grandis*; **G** clinging on tree trunk, *Taphozous mauritianus*; **H** free-hanging under exposed roots, *Nycteris* spp.; **I** sheltering under elephant-stripped bark, *Taphozous mauritianus*; **J** deep in dense foliage, *Scotoecus* spp.; **K** free-hanging in shrubs, *Lavia frons*; **L** inside disused bird nests or spider nests, *Kerivoula* spp.; **M** in hollow boles high up in tree, *Mops condylurus* and *M. niveiventer*; **N** under exfoliating bark, *Chaerephon nigeriae*; **O** in narrow holes, small-bodied Molossidae (modified after Verschuren (1957a) and Brosset (1966a) with addition of unpublished data, F. P. D. Cotterill).

Scotophilus dinganii and *S. viridis* are frequently found roosting in hollow spaces in the attics of houses, as opposed to the crevice-like roosts used by many Molossidae. Occasionally, so-called 'cave bats', such as Nycteridae, Rhinolophidae and Hipposideridae, may be found in larger attics or basements (Figure 14).

Cave-dwelling bats form the largest aggregations known of any mammal. In southern Africa, cave-dwelling bats include *Rousettus aegyptiacus*, *Myotis tricolor*, and species of the Rhinolophidae, Hipposideridae, Nycteridae, and Miniopteridae. As many as twenty million bats may occupy Bracken Caves in Texas (Tuttle 1997). South Africa's largest known cave colony of bats, at De Hoop Guano Cave, near Bredasdorp in the Western Cape, comprises some 300,000 bats (McDonald *et al*. 1990a). Apart from De Hoop Guano Cave, other well-known cave

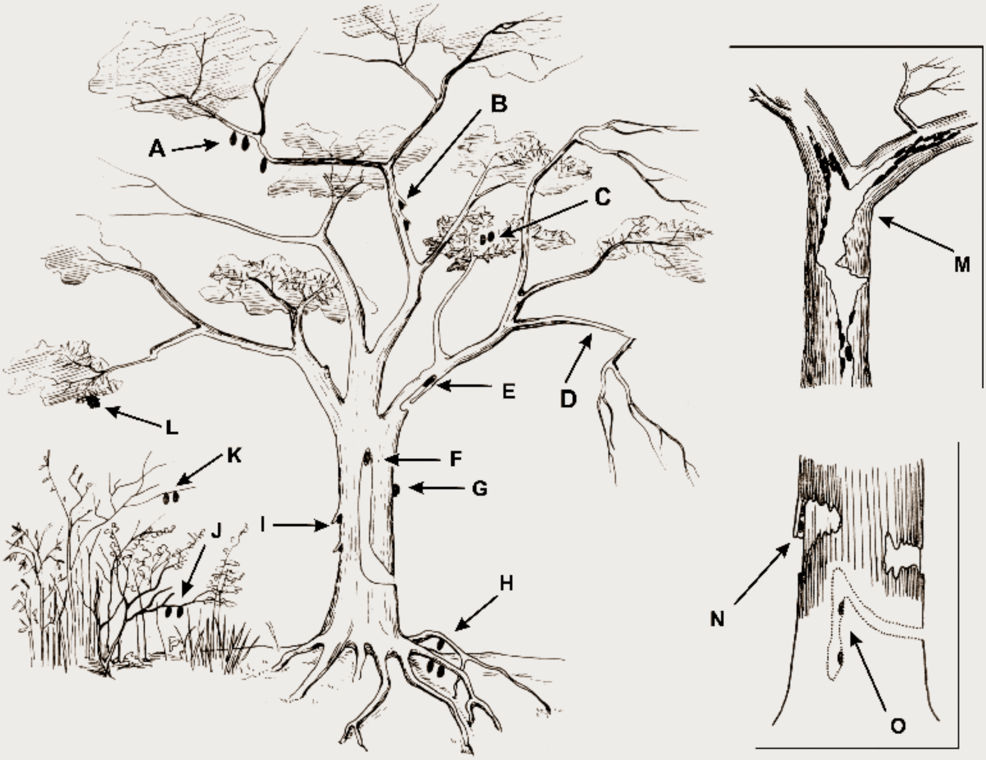


fig. 13

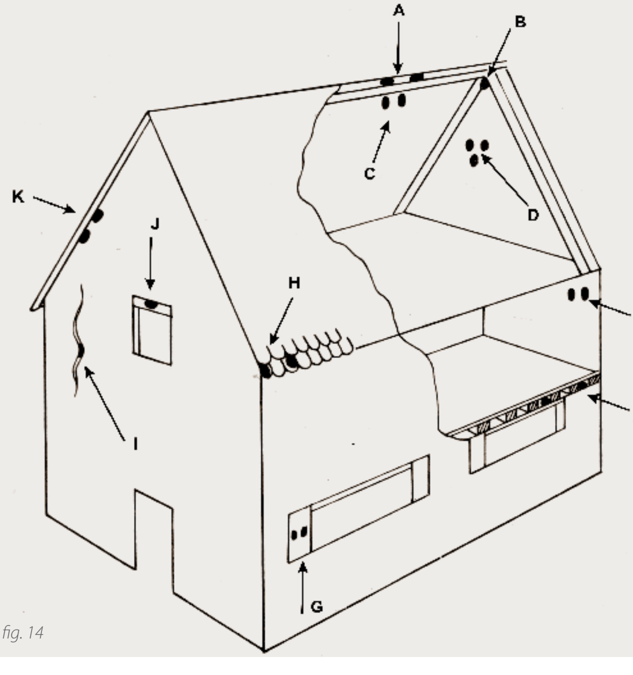


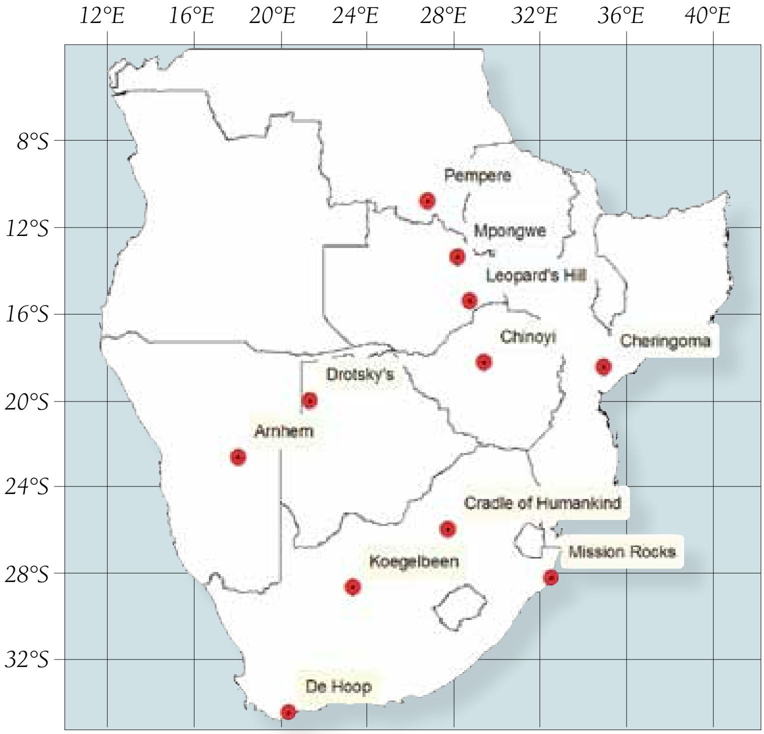
fig. 14

Figure 14. Schematic comparison of the diversity of different daylight domiciles selected by representative Chiroptera that roost in buildings: **A** spaces within roof timbers, *Mops condylurus*; **B** crevices in roof materials, *Neoromicia capensis*; **C** attic spaces, *Rhinolophus blasii*; **D** attic surfaces, *Scotophilus dinganii*; **E** dark, abandoned rooms, *Rhinolophus clivosus*; **F** gaps under suspended floors, *Nycteris thebaica*; **G** cellars *Coleura afra, Rhinolophus hildebrandtii*; **H** under crannies in roofs, *Chaerephon pumilus*; **I** hollow cement bricks, crevices and cracks in masonry, Molossidae species and *Neoromicia*; **J** sheltered window ledges, *Kerivoula argentata*; **K** under eaves, *Taphozous mauritianus* (modified after Brosset 1966a with additions).

bat roosts include Kogelbeen Cave in the Northern Cape (Monadjem *et al.* 2008), various caves within the Cradle of Humankind World Heritage Site in Gauteng and Mission Rocks in the Greater St Lucia Wetlands Park in KwaZulu-Natal in South Africa, Arnhem Cave and several others in Namibia (Churchill *et al.* 1997), a cave system harbouring eight bat species on the Cheringoma Plateau, Mozambique (A. Monadjem, personal observation), Drotsky's Caves in Botswana (Smithers 1971), a series of caves in the northern and central Zimbabwe (Cotterill and Fergusson 1999, Truluck 1992), and Leopard's Hill Cave and other caves in Zambia (Whitaker and Black 1976, Ansell 1978, Kaiser *et al.* 1998). Where not already protected under national legislation, all these landforms hold high rank as sites of critical conservation status (Figures 15–17).

Bats use caves and other cavities for protection from predators and to take advantage of the stable microclimate (temperature and humidity). The microclimate preferences of bats change during the year. In summer, bats select warm and humid roosts to help their young to maintain their body temperature. In winter, hibernating bats select cooler roosts, which allow them to decrease their body temperature (and consequently, their metabolic needs) through torpor to conserve energy while insect availability is low. On the other hand, non-hibernating bats (e.g. *Nycteris thebaica)* will select warmer roosts during winter to reduce energy expenses needed to maintain a constant body temperature.

The changing microclimate needs of different species of cave bats are well demonstrated by the colony of five bat species occupying De Hoop Guano Cave in the Western Cape (McDonald *et al.* 1990a) (Figure 17). The different species, and even sexes of one species, use this cave at different times of the year and for different reasons. For example, during summer, a colony comprising up to 290,000 *Miniopterus natalensis* lives there. Males occupy cooler roosting sites near the cave entrance, while females and their young inhabit a domed 'maternity chamber' within the cave complex, where temperature and humidity are extremely high (31°C and 91% relative humidity), as a result of the combined body temperature of the bats, During winter, all the pregnant females migrate 100–200 km from De Hoop to caves in the interior of the Western Cape, where the lower



◀ *Figure 15.* The locations of some of the caves that are important bat roosts in southern Africa.

ambient temperatures are necessary for hibernation. Males and non-pregnant females remain at De Hoop during winter, without entering deep hibernation.

De Hoop is also an important maternity cave for *Myotis tricolor*, but the maternity roost of this species is somewhat cooler and drier (21°C and 85% relative humidity) than for *Miniopterus natalensis*. Like *M. natalensis*, the females and young migrate to colder caves during winter in order to hibernate.

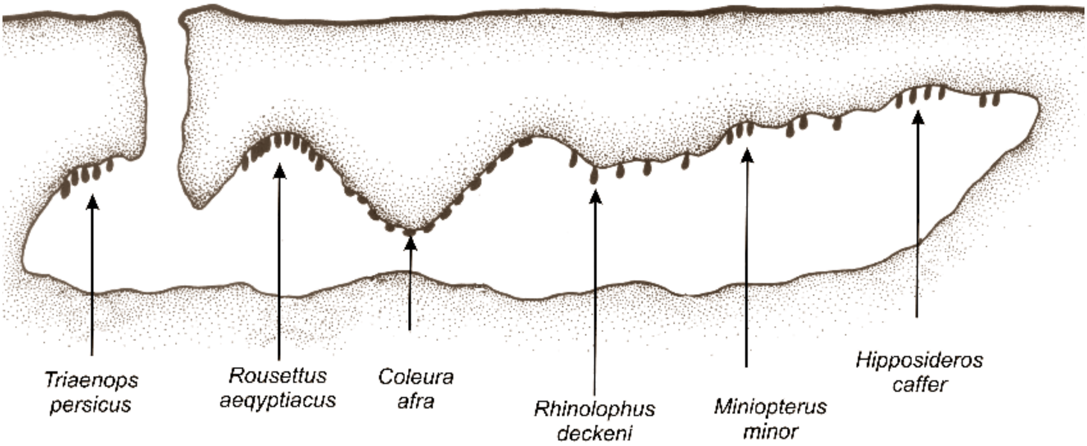
On the other hand, the non-hibernating *Nycteris thebaica* is present at De Hoop Guano Cave in autumn and winter, but not in summer. Since it cannot hibernate or enter torpor, this species overwinters in a warm (30°C) roosting position, just beyond the 'maternity dome' of *M. natalensis*.

Two horseshoe bats species, *Rhinolophus clivosus* and *R. capensis*, roost at De Hoop Guano Cave throughout the year, giving birth in December, but occur in much higher numbers during winter when *Miniopterus natalensis* and *Myotis tricolor* are absent. They particularly favour a cold (19°C) roosting site just beyond the first bend in the cave, which results in most individuals being in a torpid state for much of winter. Although they are frequently torpid during the day in winter, *R. capensis* and *R. clivosus* do not enter a deep prolonged hibernation and actively forage throughout the year. This is because the winter rainfall climate of the Western Cape ensures a good supply of insects during that season. During summer, the entrance site of the cave is also occupied by males and non-breeding females of *Miniopterus natalensis* and *Myotis tricolor* (McDonald *et al.* 1990a).

Crevice-roosting bats

Whilst also roosting in natural situations under the bark of trees, in fissures of hollow trees or in rocky crevices, crevice-roosting bats (including the many species of Vespertilionidae and Molossidae) typically exploit crevices in built structures such as buildings and bridges (Skinner and Chimimba 2005, Jacobs and Barclay 2009).

Buildings resemble caves in many ways and suitable buildings, usually the roof spaces, are readily exploited by bats (Figure 14). Although colonies of up to 2,000 *Chaerephon pumilus* have been estimated to occur in the roof of a sugar mill in KwaZulu-Natal, colonies of most house-dwelling bats are generally much smaller, from a few individuals to a few dozen.



▲ *Figure 16.* Schematic cross-section through a cave in coastal Tanzania illustrating differences in roost selection. These six species of cavernicolous bats select local microclimates contingent on aspect, temperature, humidity, ambient light, and height above the cave floor (after Hill and Smith 1984).

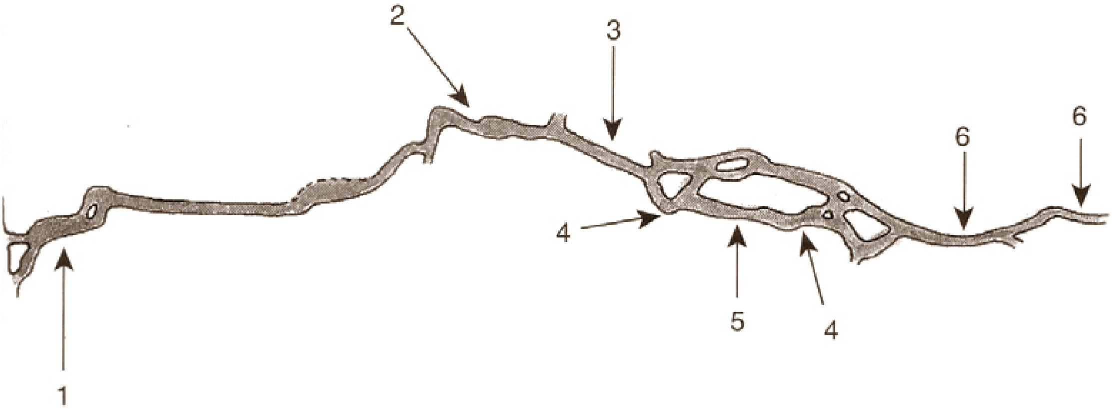


Figure 17. Cross section of De Hoop Guano Cave (after McDonald *et al*. 1990a): 1 summer roosting site for non-breeding bats and winter roost for *Miniopterus natalensis*, *Rhinolophus clivosus* and *R. capensis* (19°C); 2 maternity chamber for *Miniopterus natalensis* (31°C); 3 winter roost for *Nycteris thebaica* (30°C); 4 maternity roosts for *Myotis tricolor* (21°C); 5 roost for *Rhinolophus clivosus* and *R. capensis* (21°C); 6 incidental roost sites for all five species (21°C).

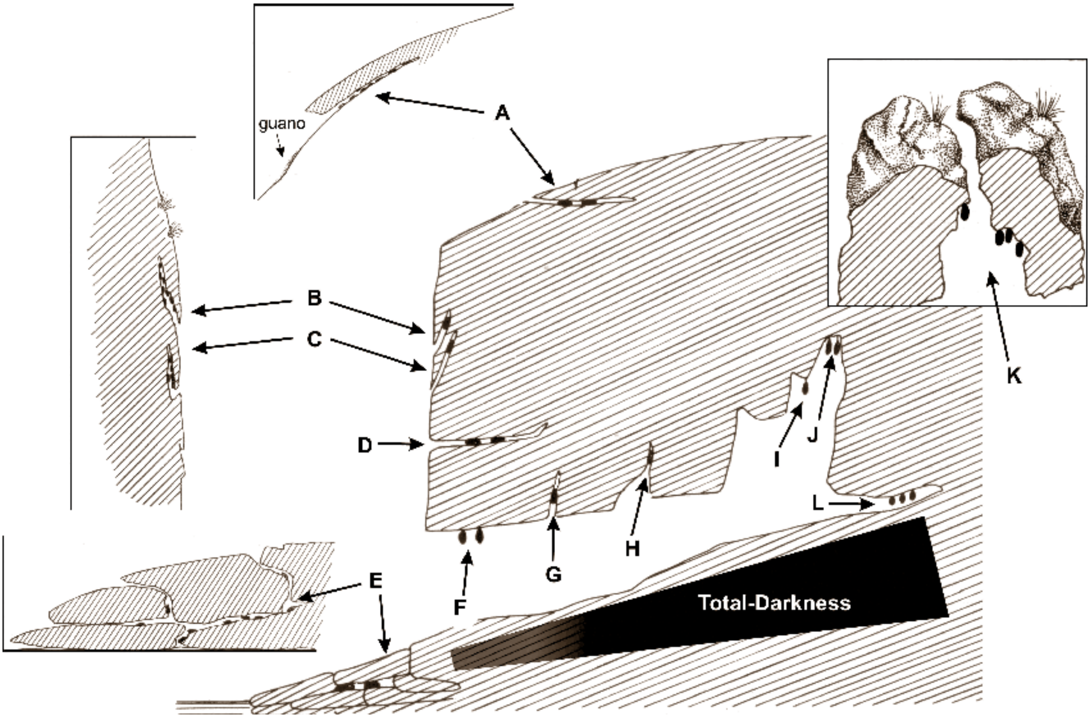


Figure 18. Schematic comparison of the diversity of different daylight domiciles selected by representative cavernicolous and rupicolous species of Chiroptera that roost in caves and rock crevices, respectively: **A** crevices in sloping inselbergs, *Chaerephon ansorgei*; **B** and **C** crevices in vertical precipices, *Chaerephon major* and *Tadarida fulminans*; **D** horizontal crevices, *Tadarida aegyptiaca*; **E** crevices in boulders at ground level, *Chaerephon major* and *Sauromys petrophilus*; **F** free-hanging in dimly illuminated caverns, often near entrance, *Rousettus aegyptiacus*; **G** cavities in roof, *Myotis tricolor*; **H** in contact, cavities high in ceiling, *Miniopterus natalensis*; **I** free-hanging from ceiling in pitch darkness, *Rhinolophus* spp.; **J** high roofs and walls, in contact *Hipposideros vittatus*; **K** partially-lit and well ventilated boulder caves and overhangs, *Rhinolophus fumigatus* and *Taphozous perforatus*; **L** free-hanging from low ceiling, hot and humid, *Hipposideros caffer*. The scale at bottom-centre presents an index of the trend of ambient lighting within a cave, which underlies important differences between the roosts selected by cavernicolous bats. (Modified after Verschuren (1957a) and Brosset (1966a) with additions)

Information on dealing with unwanted roof-dwelling bats, as well as further details on where and how to locate bat roosting sites and exit holes within the roof space, are provided by Taylor (2000).

Specialised roost sites

Open structures, such as garages and outhouses, thatched game hides, culverts under roads and the eaves of buildings, are frequently used as night roosts (Monadjem *et al.* 2009). Many cave-dwelling bats carry their insect prey to such night roosts or feeding stations, which provide temporary shelter. These activities of night-roosting bats can often be located by the piles of discarded insect parts below their feeding spots.

Bats may also be found roosting in a variety of other situations. A most interesting example are the use of sunbird and weaver nests as the favoured diurnal roost sites for woolly bats of the genus *Kerivoula* (Roberts 1951).

Some bats use artificial roosts such as bat houses (Tuttle 1997). These may be most effective when used to relocate nuisance bat colonies from human dwellings, or to attract bats as potential biocontrol agents in agricultural monocultures and in ecotourism developments. Establishing such bat populations offers the opportunity to reduce the use of pesticides in controlling insect pests. However, the possible negative consequences of bat houses in natural ecosystems, where common species may be favoured over rare species, remain to be investigated.

Figure 19. Sandstone hills in the western Limpopo Valley provide daylight roosts for many crevice-roosting bats, such as *Sauromys petrophilus* (© F. P. D. Cotterill).

BIOGEOGRAPHY

Biogeography is the study of the spatial patterns in the distribution of biodiversity and the causes of those patterns, especially differences in species' distributions. At this level, species distribution patterns are explained through a combination of historical factors that have governed events of dispersal, speciation and extinction. Such factors include the influence of geological and climatic changes, notably continental drift, glaciation, variations in sea level, and drainage evolution, in combination with macro-ecological factors that determine the availability of ecological resources to species in an assemblage (Morrone 2009).

GEOLOGY

The geology of a continent has a profound influence on the living organisms that have evolved across its landscapes. Local and regional geological controls on the composition of Africa's bat faunas provide many textbook examples of this relationship. For example, the distributions of rupicolous and cavernicolous species are associated closely with particular formations of granites, sandstones and limestones that have crevices and caves eroded and weathered into these rocks (Figure 18). The geomorphology of the landscape plays an equally significant role, as such caves and crevices tend to be clustered along cliffs and scarps. In recent times, mining activity has influenced bat roost availability, especially in the gold-rich contact zones of the granite-greenstone belts. These artificial cavities are of great significance to many cavernicolous bat species. Numerous mining shafts and adits have been sunk over the past few centuries at many sites in Namibia, central Zimbabwe, South Africa, Zambia and the southern DRC.

This overview of the formative events that forged the southern portion of the African continent singles out formations and events that bear directly on the composition of the regional bat fauna, especially rock formations that provide daylight roosts for cavernicolous and rupicolous species. Unless specifically referenced, the remainder of this section draws on syntheses of knowledge of the geology of South Africa, Lesotho and Swaziland (McCarthy and Rubidge 2005, Johnson *et al.* 2006), Namibia (Miller 2008) and Zimbabwe (Stagman 1978). The geology of Angola, the Congo basin, Botswana, Malawi, Mozambique and Zambia await deserving synthesis, with relevant knowledge scattered widely through the primary literature and in the less accessible in-house reports of mining companies.

Ancient basement rocks

The very earliest of events that would come to control bat biogeography occurred as long as 3.8 billion years ago when the first continents – known as cratons – started to form on what was then a young planet. Ultimately, two of these, known as the Kaapvaal and Zimbabwe cratons, came to make up a large part of southern Africa. The granite-greenstone terrain that makes up these cratons contains some of the oldest rocks on earth, as can be seen in the Barberton Mountain Land of South Africa.

The granites that characterise so much of Zimbabwe, and also dominate much of the topography and soils of southern Africa, exhibit a spectrum of ages of formation. The majority of the intrusions that ultimately weathered into Zimbabwe's extensive granitic shield were formed 2,650 million years ago (hereafter Ma). By contrast, the Cape granites are much younger (~550 Ma). Prolonged weathering and erosion (Twidale and Vidal Romani 2005) has led to the diversity of landforms characteristic of such exposed granites (for example in the Matobo Hills of Zimbabwe). The rich variety of these granitic landforms has a strong influence on the soils, hydrology, and vegetation of these landscapes (Whitlow 1980, 1982) (Figure 21).

Figure 20. Aerial view over the granitic shield near its southwest edge in the Matobo Hills, Zimbabwe. Its crevices, caves, and woodlands provide a rich variety of daylight domiciles for roosting bats (© F. P. D. Cotterill).

The ecological importance of granites is demonstrated in roost selection by the large molossid bats *Tadarida fulminans*, *T. lobata*, and *T. ventralis*. The distributions of these species are closely associated with crevice roosts in granite precipices, and to a lesser extent in Karoo sandstones and basalts (Cotterill 2001b, Cotterill and Fergusson 1993).

Sedimentary rocks

Many formations of sedimentary rocks exercise significant controls over bats in southern Africa today. The oldest formed as long ago as 3.8 billion years. The oldest of these – the rocks of the Dominion Group (over 3 billion years old) – represent the earliest accumulation of sediments on the basement provided by the Kaapvaal Craton, and are preserved in the North West province of South Africa. In northern KwaZulu-Natal and Swaziland similar formations developed and include the Nsuze group (3,000 Ma). The slightly younger sedimentary formations of the Transvaal Supergroup (2,600–2,100 Ma) and the extensive Waterberg and Soutpansberg groups (1,800 Ma) formed after renewed rifting and the eventual subsidence of extensive areas to below sea level. Cyanobacteria thrived in this shallow sea and caused the precipitation of a deep layer (up to 1 km thick) of calcium carbonate across most of the Kaapvaal Craton; this calcium carbonate was later converted to dolomite (calcium magnesium carbonate). Today the dolomites form karstic outcrops in the Northern Cape, North West, Gauteng and Mpumalanga in South Africa and in southern Botswana (the Ghaap and Chuniespoort groups). The Transvaal Supergroup also contains thick quartzites, which represent highly recrystallised sandstones.

Later, the hard sandstones in these sediments were weathered and eroded into ridges and mountain ranges, and their regular horizontal bedding led to the formation of crevices. Many species of molossid and vespertilionid bats now exploit these crevices for shelters.

Although deep caves are the exception in these sandstones, caves and sinkholes characterise the surface weathering of the slightly soluble dolomites. The large cave systems that formed in these rocks, for example at the Cradle of Humankind in Gauteng and the Drotsky Caves in northwestern Botswana, are significant to several species of bats. The extensive caves in Gauteng, which many of us more readily associate with the our hominin ancestors, provide critically important roosting resources for the breeding and seasonal roosts of several species, notably the Natal long-fingered bat, *Miniopterus natalensis*. It is remarkable to realise that ancient marine bacteria formed these Gauteng dolomites between 2,600 and 2,400 Ma.

Precambrian dolomites in central Zimbabwe (the Lomagundi Formation) and in central Zambia and southern Katanga in the DRC are equally important and a high density of cave systems characterises these regions, for example, the Mpongwe and Chipongwe caves in Zambia (Kaiser *et al.* 1998), and the Chinoyi and Mabura caves in central Zimbabwe. These calcareous formations scattered across the southern Congo basin and northern Zambia are associated with metamorphosed sediments of the Lufilian Arc (~700 Ma), represented in the heavily mineralised Copperbelt of northern Zambia and neighbouring Katanga (Kaiser *et al.* 1998, Porada and Berhorst 2000, Wendorff 2005). The caves formed in these calcareous formations across Katanga support a diverse bat fauna (Hayman *et al.* 1966, Anciaux de Faveaux 1978). In addition, some localised deposits of limestones in banded ironstones, and also the ancient greenstones, have weathered into cave systems, and also constitute important bat roosts; examples that have escaped mining occur in the vicinity of Redcliff in Zimbabwe (F. P. D. Cotterill, unpublished data).

Two important sandstone formations had their origins during Gondwana times. The first is the Cape Supergroup (~500–460 Ma), which ultimately formed the Cape Fold Belt mountains that fringe Africa's southern margin. The second important formation was forged during the Mesozoic, in Karoo times, when vast sediments built up across the interior of Gondwana and formed the Karoo Supergroup (~350–200 Ma). Ultimately, the more recent of these sediments, the Molteno and Ecca formations, came to form extensive sandstone formations in southern Africa, while wind-borne sand deposition resulted in the Cave Sandstones (Clarens Formation), characteristic of parts of the Drakensberg Mountains. These Karoo sandstones, especially where exposed along valley margins, provide important roosts to bat assemblages, notably in the Limpopo, Luangwa and Zambezi drainage basins.

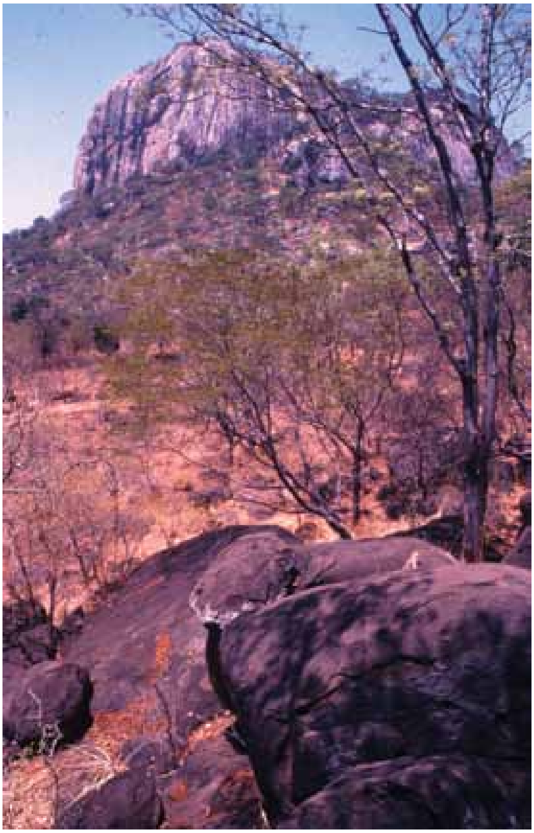


Figure 21. The rugged landscape of the extensive granitic shield extends from the Tete Province of Mozambique south across eastern and southern Zimbabwe to the Matobo Hills into southeastern Botswana. The most spectacular examples of inselbergs dominate the catchments of the Ruenya and Mazowe rivers in northeast Zimbabwe (here in the Mudzi district). The vegetation is diverse across the rocky slopes, especially where it is protected from fires. Miombo woodland dominates, although it has been largely destroyed by agriculture and settlement on arable lands. These large trees and granite kopjes and inselbergs (*dwalas*) provide abundant roosts for many species of bats. Here in northeastern Zimbabwe (70 km north of Mutoko), the rarely encountered molossids *Tadarida fulminans* and *T. lobata* are locally common (Cotterill 2001b) (© F. P. D. Cotterill).

Rift valleys

Major zones of uplift and faulting across southern Africa created the Luangwa, Gwembe and Kamalondo rift valleys. Precursors of these graben first formed during Karoo times (350–180 Ma). This tectonic activity is associated with the rifting that continues across Africa today in the East African Rift System, which started to propagate into southern Africa about 20 Ma. The East African Rift is a narrow zone in which the African Plate is in the process of splitting into two new tectonic plates. The dramatic scarps and graben that characterise the East African Rift System are very young when considered against the deep antiquity of the continent's geological history; nevertheless, they are of key importance in controlling biotic evolution (see 'Geomorphology' below). The chain of rift valleys propagates south across East Africa from Afar, Ethiopia, diverging into two discrete forks across southern Africa. One is expressed southward, through Malawi into the Urema Trough of Mozambique; the second extends southwest into the Okavango graben in northeastern Botswana from Katanga (DRC) and Zambia.

GEOMORPHOLOGY

The greater portion of southern Africa lies at an average elevation of 1,000 m above sea level. Aptly termed the Kalahari Plateau, this hinterland extends north far across the Congo basin, with its northeastern boundaries abutting the East African Rift System along Lake Tanganyika. This anomalous topography is geologically ancient, dating from before the final breakup of Gondwana in the Mesozoic (~127 Ma) and is likely even older. The characteristically subtle changes in drainage and landforms across the Kalahari plateau (de Wit 2007), has exercised marked control over biogeographical processes over the past 30 million years (Cotterill 2003, 2005).

Escarpments

The margins of the Kalahari Plateau are edged with steep escarpments, comprising a single horseshoe arc. In the south, the high relief of the Cape Fold Belt forms a partial arc against these greater escarpments flanking southern Africa that extend west and east. The eastern escarpment is dominated by the rim of the Drakensberg Massif, continuing north in the Lebombo and Mpumalanga mountains, and farther northeast into East Africa. In Zimbabwe, the Eastern Highlands dominate the topography, especially in contrast to the Mozambique coastal plain. The Livingstone Mountains, bounding the eastern edge of the Nyasa (Malawi) graben (Smithers and Lobão Tello 1976), form the northern margin of the plateau (albeit recently modified by the Malawi rift). On the Atlantic coast, the western margin of the Kalahari Plateau is formed by the mountainous flanks of the Bokkeveld and Namaqua plateaux, and extends northwest through Namibia. It reappears north of the Kunene River's incision in the high mountain land of western Angola.

The topography of southern Africa has been influenced by past tectonic events, which have expressed both subtle and dramatic effects across the subcontinent. The most dramatic evidence lies in the East African Rift System, exemplified in the deep graben occupied by Lakes Tanganyika and Malawi. A southwestern extension of the East African Rift accounts for the remarkably varied topography of Katanga in the DRC, especially the Kundulungu and Kibara plateaux, which at over 1,800 m above sea level dominate the adjacent Kamalondo and Lufira depressions (whose lowest elevations lie below 600 m above sea level) (Broadley and Cotterill 2004, Cotterill 2005). There are steep escarpments in this region, most notably Zambia's Muchinga Escarpment, which bounds the western edge of the Luangwa valley. The significance of the Muchinga Escarpment as a biogeographical boundary was originally emphasised by Neave (1907, 1910a, b) and Ansell (1978). The enhancement of the Muchinga Escarpment by the East African Rift created a prominent eastern bound to the Kalahari Plateau; this rugged scarp extends south, bordering the Gwembe trough, markedly eroded by the Middle Zambezi (today artificially impounded in Lake Kariba at Kariba Gorge).

Equally impressive escarpments form the steep flanks of the Middle Zambezi valley in Zambia and Zimbabwe (Figure 27; Cotterill 2003, Moore *et al.* 2009). These escarpments bound formerly extensive landscapes, and have witnessed a prolonged history of uplift and erosion that has persistently lifted and warped the Kalahari Plateau, faulting its margins in parts (de Wit 2007).

Figure 22. View north along the western escarpment of the Tanganyika graben, northeastern Zambia, illustrates the dramatic topography expressed along the East African Rift System (EARS). The vegetation is dominated by miombo woodland, with gallery and scarp forest, and also includes Itigi thicket on the valley floor (© F. P. D. Cotterill).

Drainage systems

The modern hydrology of southern Africa is dominated by several major drainage basins, with the Congo and Cuanza basins in the extreme north, the Zambezi and Limpopo rivers, which drain eastwards into the Indian Ocean, and the Kunene and Orange-Vaal systems that drain west into the Atlantic (Figure 23). This river topology strongly influences the distributions of bat species that depend on riparian habitats for food and daylight roosts. This can be seen very clearly in the Namib Desert, where the Kuiseb River supports populations of tree-roosting bats.

The drainage systems that characterise southern Africa today are very different from their precursors. Repeated uplift and erosion of the Kalahari Plateau and the propagation of the East African Rift System into southern Africa caused radical rearrangements of the region's drainage systems.

Following the final stages in the break up of Gondwana (~127 Ma), the Palaeo-Limpopo River drained a large part of the interior of central southern Africa, with most of the rivers of today's lower DRC, Angola, Botswana and Zimbabwe flowing into it. About 80 Ma, epeirogenic uplift created vast depressions across the Kalahari Plateau Basin in the interior of southern Africa. What are today the headwaters of the Kunene, Orange, Limpopo and Zambezi rivers originally flowed into the Kalahari Basin (Moore *et al*. 2009). These endorheic rivers maintained vast lakes in the interior, notably in the Etosha basin and northeastern Botswana; one of the largest of these lakes was Palaeo-Lake Makgadikgadi, which had an area of ~67,000 km^2 (Cotterill 2006).

The southwest propagation of the East African Rift System into southern Africa had a marked influence on the development of the Zambezi River System. Concomitant with this rifting, the Zambezi and its tributaries incised deeply westwards across the eastern rim of the Kalahari Plateau, capturing several of the rivers that were feeding the palaeo-lakes. This prolonged episode began with the Zambezi's piracy of the Palaeo-Luangwa, and its most recent piracies of the Upper Zambezi and Upper Kafue rivers (Moore *et al*. 2007, 2009). The Proto-Congo

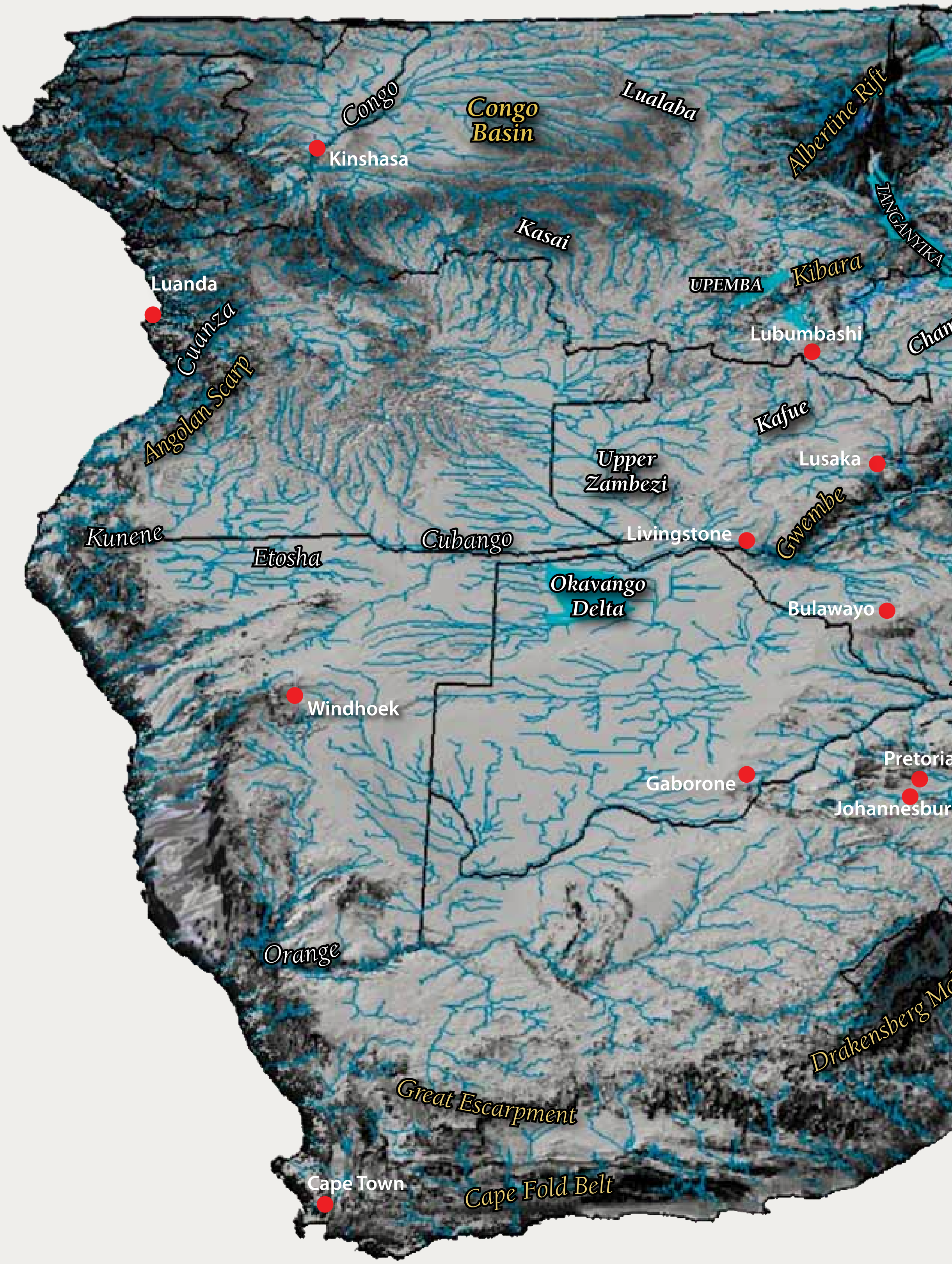

Congo
Congo Basin
Lualaba
Albertine Rift
Kinshasa
TANGANYIKA
Kasai
Luanda
UPEMBA
Kibara
Cuanza
Lubumbashi
Cham
Angolan Scarp
Kafue
Upper Zambezi
Lusaka
Gwembe
Kunene
Cubango
Livingstone
Etosha
Okavango Delta
Bulawayo
Windhoek
Pretoria
Gaborone
Johannesbur
Orange
Drakensberg Mo
Great Escarpment
Cape Town
Cape Fold Belt

Figure 23. The extent of the elevated expanse of the Kalahari Plateau is depicted in this computer generated Digital Elevation Model (DEM). Situated south of the Congo basin, the Kalahari Plateau is bounded by flanking coastal escarpments, and has been greatly altered by the East African Rift System (notably the Gwembe-Luangwa valleys). (Generated from the SRTM-3 (Shuttle Radar Topographic Mapping 3) dataset compiled by NASA, with annotations, including locations of principal cities © F. P. D. Cotterill, AEON.)

and Middle Zambezi rivers expanded their catchments significantly through the piracy of most of the large endorheic rivers. Continued tectonism on the Kalahari Plateau, associated with tectonism along the East African Rift System, also led to the diversion of the Kwando (= Chobe) River into the Zambezi River. Today, the only large endorheic rivers still draining into the Kalahari Basin are the Cubango and Quito, which form the Okavango Delta in northern Botswana (Figure 23) (Goudie 2005, Cotterill 2006, Moore *et al*. 2009).

These dynamic drainage systems are landforms of central significance to palaeobiological and geological research, because their history provides invaluable keys to decipher the complexities of landscape evolution. Although comparatively subtle, these changes have profoundly influenced the distribution and evolution of Africa's fauna, including bats (Cotterill 2003, 2004, 2005, Moore *et al*. 2007, 2009).

CLIMATES PAST AND PRESENT

The climate of southern Africa is dominated by a characteristic seasonality, with a cool-dry season interfacing with a hot-dry season, and then a hot-wet season, through the annual cycle. The southwestern Cape region experiences a winter-rainfall regime with hot, windy summers. A gradient of increasing rainfall trends from west to east; precipitation is both erratic and lowest in the deserts of the Namib, Namaqua, and the southwestern Kalahari. Adiabatic rainfall is not infrequent along the windward margins of the coastal escarpments and mountains. Prevailing mean annual temperatures and mean annual rainfall also exhibit an overall increase from south to north; with precipitation under increasing influence of the Inter-Tropical Convergence Zone (ITCZ) and the Congo Air Boundary. The Monsoon rainfall system also influences the climate of northeastern Mozambique (Tyson and Preston-Whyte 2000).

The evolution of southern Africa's landscapes and, especially, its vegetation has been influenced strongly by palaeo-climatic dynamics. Empirical evidence for past conditions across the hinterland is very poor, especially for the time before the Late Pleistocene (120,000 years ago). Nevertheless, the widespread fossil dune systems across the central and northern Kalahari plateau testify to widespread arid conditions that prevailed across a vast portion of the subregion, presumably during the Late Cenozoic (de Menocal 2004, Goudie 2005). Such extreme periods of aridity were interspersed with equally humid phases, when mesic vegetation expanded south and west of the Congo basin (Benson and Irwin 1965).

Several lines of evidence suggest these expansions were focused along drainage lines in the Upper Congo and Zambezi systems. The significance of this interplay of both geomorphological evolution and palaeo-climatic dynamics in exercising dominant controls over palaeo-environments, is illustrated by the modern habitat mosaic characterising the Great Equatorial Divide. Here, Late Cenozoic drainage evolution has seen the overall migration of the Congo's headwaters southward, by their repeated captures of Zambezi tributaries. These piracy events have culminated in the Great Equatorial Divide shifting south by ~400 km through the late Cenozoic (F. P. D. Cotterill and M. J. de Wit, unpublished data). This has contributed, significantly, to a 'shuffling' juxtaposition of forest species and savanna species across these landscapes. It explains interesting biogeographical patterns in mammals, birds (Cotterill 2002a, b, 2006) and snakes (Broadley *et al*. 2003), and is congruent with the high endemism and species richness of plants documented across this region (Linder 2001). This history is invoked to explain vicariant speciation of forest-adapted vertebrate species with their ranges centred on *mushitu* (gallery forest) and fringes of mesic miombo savannas in Katanga and northern Zambia. Alongside vegetation shifts that accompanied major changes in the palaeo-climate through the Plio-Pleistocene, this geomorphological evolution plausibly explains why the Ikelenge Pedicle (northwestern Zambia) and Katanga in the DRC are zones of high endemism. At least one horseshoe bat species, *Rhinolophus sakejiensis*, is known only from the Ikelenge Pedicle (Cotterill 2002a, b, 2006, Broadley *et al*. 2003). It is this forest–savanna mosaic that dominates the vegetation of the southern Congo basin and northern Angola, and justifies inclusion of such a vast portion of south-central Africa into this book (see 'Geographical Scope').

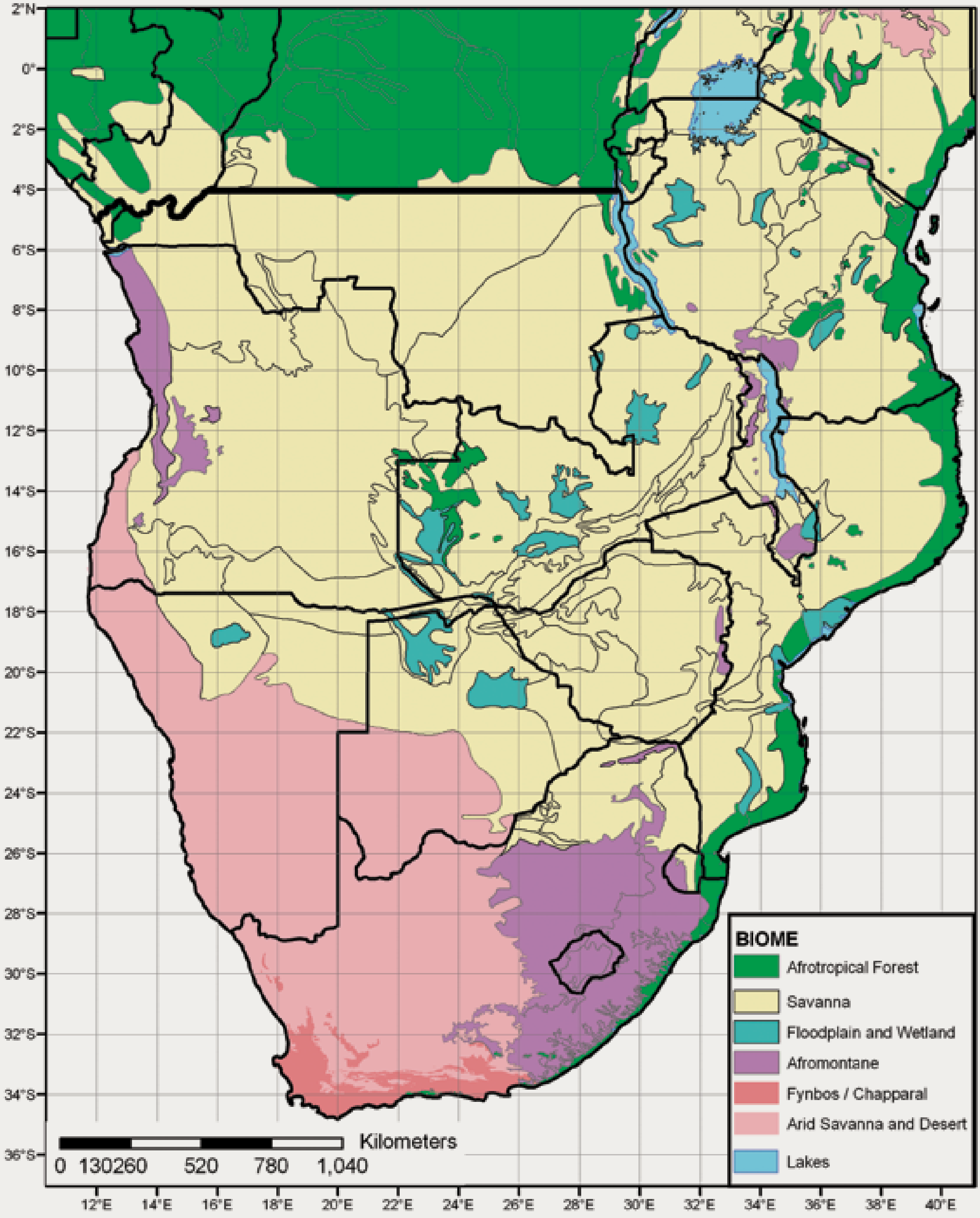


Figure 24. Biomes of southern and Central Africa, based on climate and plant architecture (modified after White 1983). The bold line at 4°S depicts the northern limit to the biogeographical region that underpins this synthesis of chiropteran diversity.

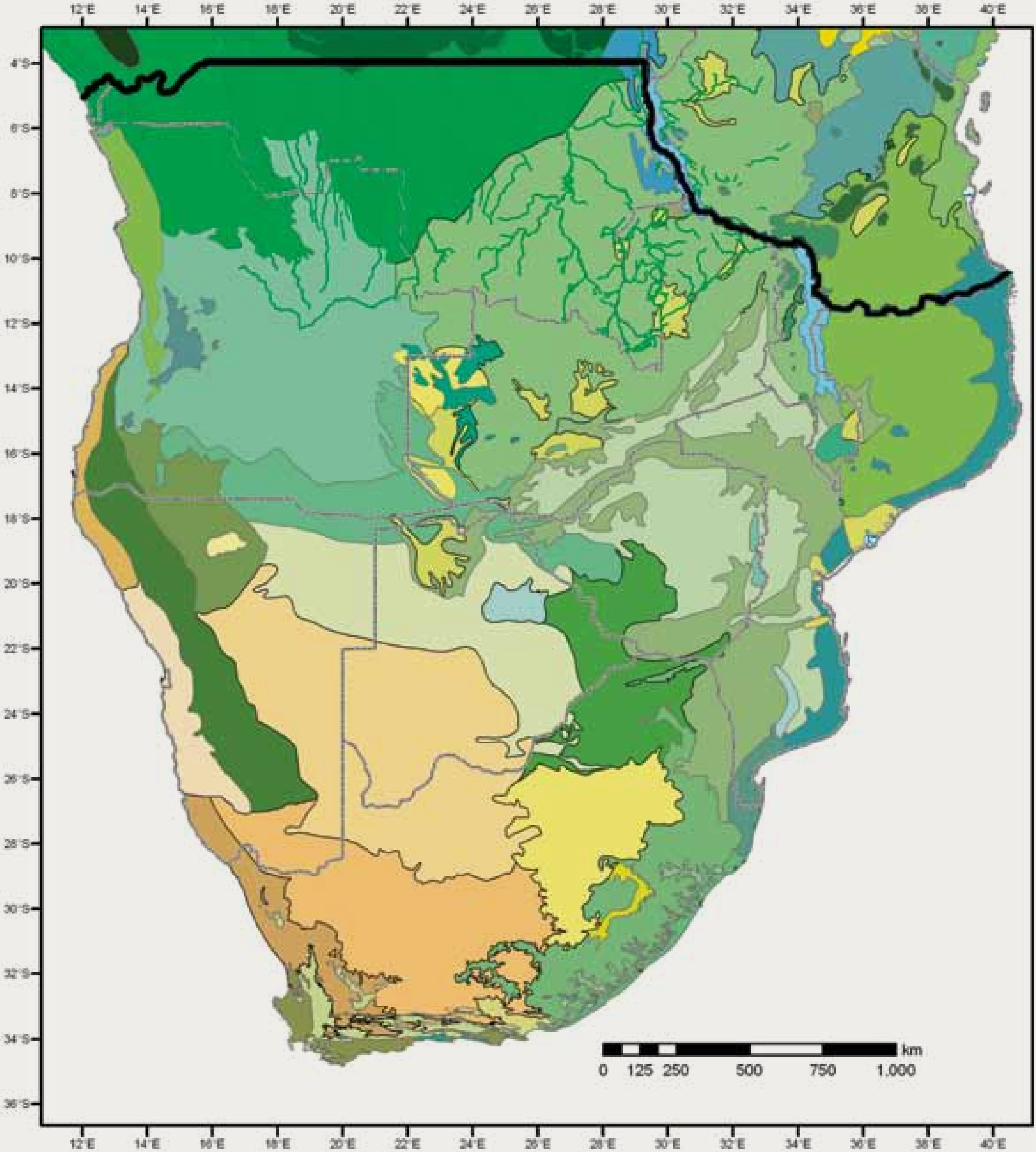


Figure 25. Ecoregions of southern and Central Africa (after Olson *et al*. 2001) are derived from the phytochoriological classification of White (1983). The bold line depicts the northern limit to the study area, which at 4°S approximates the southern limit of the belt of Congo closed forest, and the northern extent of the Guinea-Congolia/Zambesia Transition Zone.

- 🟨 Albany thickets
- 🟦 Albertine Rift montane forests
- 🟩 Angolan Miombo woodlands
- 🟩 Angolan Mopane woodlands
- 🟩 Angolan montane forest-grassland mosaic
- 🟩 Angolan scarp savanna and woodlands
- 🟩 Atlantic Equatorial coastal forests
- ⬜ Atlantic coastal desert
- 🟩 Central African mangroves
- 🟩 Central Congolian lowland forests
- 🟩 Central Zambezian Miombo woodlands
- 🟨 Drakensberg alti-montane grasslands and woodlands
- 🟩 Drakensberg montane grasslands, woodlands and fore
- 🟩 East African halophytics
- 🟩 East African montane forests
- 🟩 East African montane moorlands
- 🟩 Eastern Arc forests
- 🟩 Eastern Miombo woodlands
- 🟩 Eastern Zimbabwe montane forest-grassland mosaic

- 🟨 Etosha Pan halophytics
- 🟨 Highveld grasslands
- 🟩 Itigi-Sumbu thicket
- 🟨 Kalahari Acacia-Baikiaea woodlands
- 🟧 Kalahari xeric savanna
- 🟧 Kaokoveld desert
- 🟩 Knysna-Amatole montane forests
- 🟩 KwaZulu-Cape coastal forest mosaic
- 🟦 Lake
- 🟩 Lowland fynbos and renosterveld
- 🟩 Mandara Plateau mosaic
- 🟩 Maputaland coastal forest mosaic
- 🟩 Maputaland-Pondoland bushland and thickets
- 🟨 Montane fynbos and renosterveld
- 🟧 Nama Karoo
- ⬜ Namib desert
- 🟩 Namibian savanna woodlands
- 🟩 Northeastern Congolian lowland forests
- 🟩 Northern Acacia-Commiphora bushlands and thickets
- 🟩 Northern Zanzibar-Inhambane coastal forest mosaic

- 🟩 Northwestern Congolian lowland forests
- 🟨 Serengeti volcanic grasslands
- 🟩 South Malawi montane forest-grassland mosaic
- 🟦 South Saharan steppe and woodlands
- 🟩 Southern Acacia-Commiphora bushlands and thickets
- 🟩 Southern Africa bushveld
- 🟩 Southern Africa mangroves
- 🟩 Southern Congolian forest-savanna mosaic
- 🟩 Southern Miombo woodlands
- 🟩 Southern Rift montane forest-grassland mosaic
- 🟦 Southern Zanzibar-Inhambane coastal forest mosaic
- 🟫 Succulent Karoo
- 🟩 Western Congolian forest-savanna mosaic
- 🟨 Western Zambezian grasslands
- 🟩 Zambezian Baikiaea woodlands
- 🟩 Zambezian Cryptosepalum dry forests
- 🟩 Zambezian and Mopane woodlands
- 🟨 Zambezian coastal flooded savanna
- 🟨 Zambezian flooded grasslands
- 🟩 Zambezian halophytics

VEGETATION

Vegetation can be classified in markedly different ways. Prominent classifications include the phytochoria (regions of floristic endemism) of White (1983), which were subdivided into habitats (e.g. grasslands and forests). More recently, Olson *et al.* (2001) reclassified the phytochoria in White's *Vegetation of Africa* into ecoregions. This book relies mainly on biomes, whereby the vegetation of southern Africa is classified into several principal vegetation types based on the growth form or architecture of plants (grasses, shrubs, trees) and habitat structure (such as forest compared to woodland) that has evolved across the landscapes of the region. Examples of these vegetation types are forest, savanna, grassland, semidesert, desert and sclerophyllous shrubland (known as fynbos in South Africa). The distribution of these vegetation types is controlled to a large extent by the interplay of abiotic and biotic determinants (annual rainfall and its seasonality, soils, ambient temperature, and disturbance regimes, notably the incidence of fire and herbivory). It is the interplay of these ecological determinants that control whether a landscape is dominated, for example, by grasslands and not savanna woodlands. At a global scale, these determinants also largely explain the convergence in vegetation structure in different parts of the world with similar climatic conditions, despite their extreme isolation. An example is the occurrence of similar sclerophyllous vegetation in areas with a Mediterranean climate: known as *fynbos* in South Africa, *chaparral* in California, *matorral* in Chile, *kwongan* in Australia and *maquis* or *macchia* in southern Europe. Similarly, forest occurs in areas with a high-rainfall tropical climate (van Wyk and Smith 2001).

To a large extent, the structural features of a vegetation type also determine its associated fauna. The preference shown by birds and mammals for a specific vegetation type, for example forest or savanna, is determined mainly by the structural features of the dominant plants, not by their taxonomic identity. In the case of bats, vegetation structure has two very important controls on the bat assemblages associated with a biome: these govern the nature of foraging habitat (see 'Echolocation' for more detail) and the characteristics of roosts and food. An area that is more or less uniformly covered by one of these

fig. 26a

fig. 26b

fig. 26c

▲ *Figure 26.* The intricate spatial associations between patches of gallery forest within the savanna matrix that comprises the Guinea-Congolia/Zambesia Transition Zone of White (1983). The spatial structure of this habitat mosaic across the landscape is closely associated with the drainage topology across the southern Congo basin, central and northern Angola, and northern Zambia. Edaphic control and protection from fires are equally important determinants of where evergreen forest patches persist in the landscape. (a) View south at 10.5°S from mesic miombo woodland on a Kalahari sand ridge reveals floodplains and fringing gallery forest along the Upper Kwango River, on the Angola–Congo border; (b) dense fringing gallery forest along the Kwango River; (c) a forested tributary within savanna grassland with scattered trees on Kalahari sediments (© F. P. D. Cotterill).

▲ *Figure 27.* Riparian fringe along the Angwa River below the Zambezi escarpment, northern Zimbabwe, looking north towards the Chewore Hills. The flora of this region is diverse. The vegetation at intermediate altitudes is mainly mixed woodlands (including *Diplorhynchus condylocarpon* and *Combretum* spp.), with the valley basin dominated by mopane (*Colophospermum mopane*) and jesse thickets (mixed *Commiphora–Combretum*). Baobabs (*Adansonia digitata*) are abundant. Hollows in these trees – especially in cathedral mopane – provide daylight domiciles for many chiropteran species, as do riparian emergents (e.g. *Diospyros mespiliformis* and *Berchemia discolor*) (© F. P. D. Cotterill).

▲ *Figure 28.* Open woodland on the floodplain of Mana Pools National Park, northern Zimbabwe, is dominated by *Faidherbia albida*. The bat fauna has been well studied (Rautenbach and Fenton 1986). The animal-eating bat *Nycteris grandis* is one of several species that roosts in the hollow boles of these large trees (© F. P. D. Cotterill).

◀ *Figure 29.* Mesic miombo woodland covers large portions of Katanga (DRC) and the northern regions of Angola and Zambia. Hollows in large trees provide daylight roosts for several species of bats, including *Scotophilus dinganii* and *Mops niveiventer*. This photograph was taken near the type locality of *Rhinolophus sakejiensis*, which was in the dense understorey of thick gallery forest along a stream (© F. P. D. Cotterill).

Figure 30. Southern miombo woodland dominated by *Brachystegia glaucescens* on rugged granitic terrain in the Matobo Hills supports a rich bat fauna. Species include the vesper bats, *Eptesicus hottentotus, Myotis tricolor* and *Laephotis botswanae*, and the horseshoe bats, *Rhinolophus darlingi* and *R. hildebrandtii* (© F. P. D. Cotterill).

Figure 31. Moremi Game Reserve, Botswana. Cathedral mopane woodland, *Colophospermum mopane*, illustrating incidence of elephant impacts on habitat structure, with fallen, damaged and standing dead trees. Gaps under bark, hollows, and crevices in mature mopane trees provide daylight roosts for many species of bats, including *Chaerephon chapini*, *Scotophilus leucogaster* and several other small vespertilionids, notably *Nycticeinops schlieffeni* (© F. P. D. Cotterill).

Figure 32. A stark contrast between agroecolandscapes and relatively intact southern miombo woodland on Kalahari sand in the Sebungwe Region, Zimbabwe. The conservation implications of widespread loss of arboreal habitat for biodiversity is exemplified in this aerial view comparing Gokwe Communal Land (left) and the Mafungabusi State Forest (right). (© A. J. Loveridge)

vegetation types usually represents a major biotic zone and is often called a biome (van Wyk and Smith 2001). The major biomes of southern Africa are fynbos, desert, succulent karoo, Nama karoo, savanna, forest, and grassland. In contrast, the classification of vegetation into phytochoria describes the biogeographical affinities of constituent plant species (principally endemics) across Africa as a whole. Congruent patterns in animals (including vertebrates, such as birds (Dowsett *et al*. 2008) are also explained by an association with phytochoria. Examples include the association of *Rhinolophus sakejiensis* with relictual Guineo-Congolian forest, and *Plerotes anchietae* with moist miombo woodlands of the Zambesian phytochorion.

The fynbos biome, also known as the Cape Floristic Region, is situated at the southern tip of Africa on the Cape Fold Belt mountains and is recognised as one of the main centres of plant diversity and endemism in Africa (van Wyk and Smith 2001). While this biome supports a remarkably high endemism of plants and some animals, its bat fauna is distinctly depauperate, and only one species, *Rhinolophus capensis*, can be considered a partial endemic to this region.

To the west of the subcontinent, arid and semi-arid biotas characterise the Namib Desert, succulent karoo and the Nama karoo (often referred to as semi-arid scrub vegetation).

Grassland

The high-lying central plateau ('Highveld') of South Africa and the Drakensberg mountains are dominated by grasslands and (in the Drakensberg and its foothills) small patches of Afromontane Forest. Montane

fig. 33a

▲ ▶ ***Figure 33.*** (a) Interior of dense gallery forest that includes Guinean-Congolian plant species, at the source of the Zambezi river, Ikelenge Pedicle, Mwinilunga District, northwestern Zambia; (b) dense riparian forest (East African Coastal Mosaic) with emergent palms, Zambezi Delta, Mozambique.

grassland–forest mosaics also characterise the Eastern Highlands of Zimbabwe and the central Angolan Highlands. Grasslands also constitute the most widespread vegetation unit mapped across south-central Africa, where they represent a 'wetland archipelago' of seasonally inundated floodplains: its islands extend from the Okavango Swamps in Botswana, to Lakes Bangweulu and Mweru in Zambia, and the Kamalondo Depression in the Katanga Province of the DRC. These valley grasslands are widespread in the catchments of the Chambeshi, Cubango, Upper Kafue, Kasai, Upper Lualaba, Upper Kunene and Upper Zambezi rivers across the Kalahari Plateau (White 1983).

Savanna

The savanna biome is characterised by widely spaced trees that form an open canopy, allowing sufficient light to reach the ground to support an unbroken herbaceous layer consisting primarily of grasses. Much of the southern African region is covered by such savanna woodlands, which support the greatest species richness of bats (Gelderblom *et al*. 1995). Second only to rodents, bats are also one of the most species-rich group of mammals occurring in the southern savanna biome (Grubb 1999).

Miombo woodlands – the world's most extensive dry forests – cover a large portion of southern Africa north and east of the 600-m annual rainfall isohyet.

fig. 33b

Miombo occurs from Angola in the west across Katanga (DRC), Zambia and Malawi to Tanzania, most of Mozambique, and much of Zimbabwe (Frost 1996, Rodgers 1996). The southern limit of miombo just reaches South Africa near the Luvuvhu River and on the Soutpansberg massif. Bat species encountered in mesic miombo include the molossid *Mops niveiventer* and the vespers *Mimetillus thomasi* and *Scotoecus hindei/albigula*. The southernmost limits of many Congo basin vertebrate species are associated with gallery forests that penetrate mesic miombo woodlands (Cotterill 2002 a, b). These include the fruit bats *Lissonycteris angolensis* and *Myonycteris torquata*.

There are also extensive miombo woodlands on deep Kalahari sands in the western regions of Zambia, eastern Angola and the southern DRC. Although much of the southern portion of this belt receives rainfall characteristic of semi-arid savannas, these tall woodlands depend on groundwater in deep Kalahari sediments. This edaphic control on the vegetation is exemplified in the *Cryptosepalum* evergreen forests (Mavunda) on Kalahari sediments in western Zambia and eastern Angola (White 1983); and equally in the hardwood Zambezi teak forests dominated by *Baikiaea plurijuga*, with their distribution centred on the Four Corners Region (Frost 1996, Huckaby 1986).

Mopane woodlands are associated with particular soil formations, largely on alluvium at lower altitudes throughout the middle and lowveld of Zimbabwe, and also in large parts of southern Zambia, central and southern Mozambique, northern South Africa, northern and eastern Botswana, as well as northern Namibia and southwestern Angola (Cole 1986). Mopane woodlands are of singular significance to bat biogeography, because the hollows in mature trees, the aptly named cathedral mopane, offer plentiful roosting sites for bats. Woodland degradation, whether by elephants or humans (e.g. wholesale clearing for cotton plantations in northwestern Zimbabwe) destroys the larger trees and has highly negative effects on the abundance and species richness of bat assemblages (Fenton *et al*. 1998) (Figure 31).

Thorny *Acacia* savannas dominate large parts of southern Zimbabwe, northern South Africa, Botswana and Namibia, extending into the Kalahari. Cavities in these large trees, and cavities under bark, support tree-roosting bats.

Forest

The northernmost reaches of the region covered in this book interface, in complex, historically-derived patterns, with the southern margin of the main belt of moist tropical forests, which extend from the Congo basin into West Africa. This transition zone comprises a forest–savanna mosaic, whose southern limits are represented by the gallery forests that fringe drainage lines in northern Angola, Katanga and northern Zambia (Figures 22, 26, 27, 32, 33). Locally termed *mushitu* in Zambia or *mihulu* in Katanga, these gallery forests constitute important habitats for forest-adapted species, including bats. Alongside several species of fruit bats, at least one endemic bat, *Rhinolophus sakejiensis*, occurs here (Cotterill 2002a, b, 2005, 2006).

Coastal forest mosaic associations extend along the eastern seaboard from Tanzania into the Eastern Cape and KwaZulu-Natal provinces of South Africa.

High-altitude Afromontane forest occurs as 'islands' in the Eastern Cape and Drakensberg mountains, the Chimanimani-Nyanga in Zimbabwe, and Gorongosa in Mozambique, and the highlands of Malawi. Relatively few endemic mammals are associated with these forests in southern Africa: an undescribed crocidurine shrew (Willows-Munro and Matthee 2009) and a golden mole (*Carpitalpa arendsi*) are endemic to Zimbabwe's eastern highlands. An undescribed *Rhinolophus* species is confined to the Chimanimani-Nyanga and Gorongosa massifs (P. J. Taylor and F. P. D. Cotterill, unpublished data).

In addition, riparian forest plays an important role in bat distribution. Riparian fringes along the Limpopo and Zambezi rivers and their major tributaries extend the ranges of several species deep into the semi-arid savanna of southern and northern Zimbabwe. This factor can be invoked to explain outlying records of several species, including *Epomops dobsonii* and *Myotis bocagii*, and especially *Pipistrellus rueppellii*.

ECHOLOCATION

The majority of vertebrates rely on vision to perceive their environment. Even nocturnal predators such as owls and lions principally use their eyes to navigate and hunt. In contrast, most bats find food and avoid obstacles at night with great ease using an alternative sensory mechanism, called echolocation. Although usually associated with bats, other animals such as toothed whales, porpoises, some species of shrews and tenrecs, oilbirds, and several species of swiftlets also use echolocation.

Echolocating bats emit sound pulses and analyse the returning echoes to detect, characterise, and localise objects that reflect the impinging pulse as an echo (Fenton 1990, Schnitzler and Kalko 2001) (Figure 34). Sound pulses are generated in the larynx (except in *Rousettus* species, which produce echolocation pulses by repeatedly clicking their tongue against the palate), and emitted through the mouth (e.g. Vespertilionidae, Emballonuridae, and Molossidae) or nose (e.g. Rhinolophidae, Hipposideridae, and Nycteridae). The ears, or pinnae, receive returning echoes, which are then funnelled and processed into the rest of the bat's hearing system.

Not all vocalisations produced by bats are echolocation calls. For example, the audible squeaks bats make in their roosts, the calls that mother and young make to one another, or the calls flying bats make to defend their foraging territories, are not echolocation calls.

The echolocation frequencies of most bat species are ultrasonic (i.e. above the range of human hearing), and peak echolocation frequencies (i.e. the frequencies with the highest intensity) usually fall within 20–60 kHz (Fenton 1990). This may be due to the frequency-dependent effects of atmospheric attenuation and target strength (Jones and Rydell 2004).

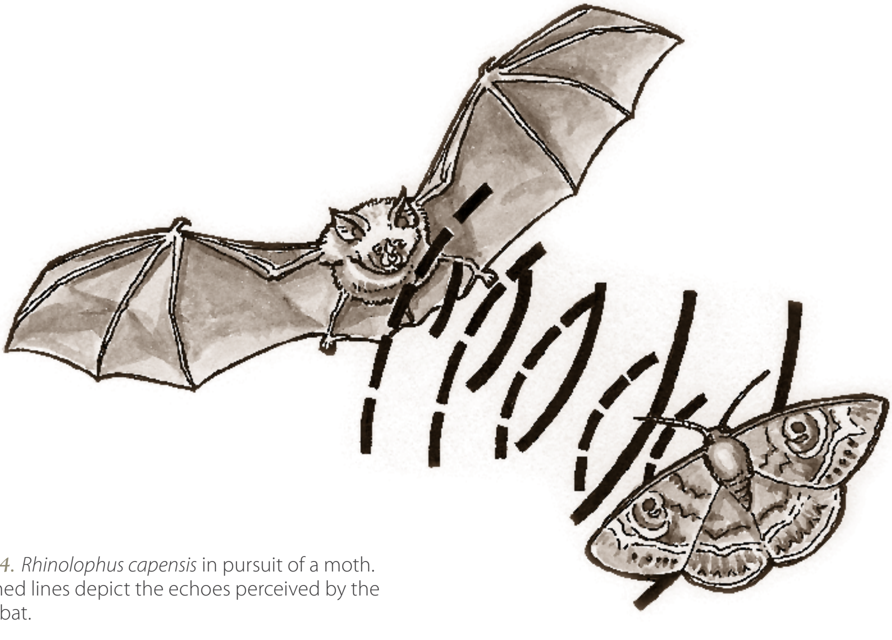


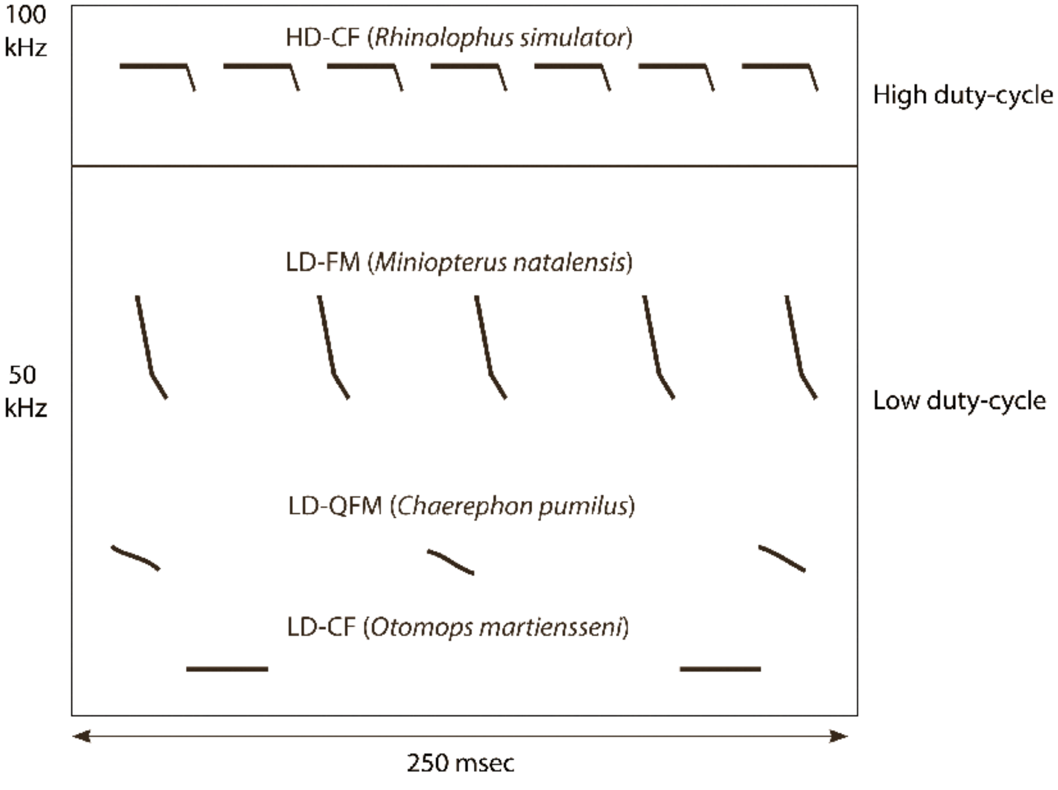
Figure 34. *Rhinolophus capensis* in pursuit of a moth. The dashed lines depict the echoes perceived by the hunting bat.

Echolocation coupled with flight enables bats to capture nocturnal flying insects in a variety of habitats. This ability probably explains how the radiation of bat species has manifested into the highest trophic diversity amongst mammals (Patterson *et al*. 2004). Nevertheless, not all bats echolocate (e.g. fruit bats from the family Pteropodidae, except *Rousettus* species), nor do all echolocating bats use the same type of echolocation.

ECHOLOCATION SYSTEMS

Two different echolocation systems – high and low duty-cycle echolocation – evolved independently in the Chiroptera (Eick *et al*. 2005). Low duty-cycle echolocation bats emit narrowband or broadband sound pulses separated by inter-pulse intervals that are much longer than the duration of the emitted pulses. Such species therefore separate the emitted pulse from the returning echo in time (Fenton 1990).

High duty-cycle bats emit long, narrowband pulses that are separated by much shorter inter-pulse intervals. Consequently, the emitted signals often overlap with the returning echo. However, the overlap does not produce masking effects (Schnitzler and Kalko 2001), because Doppler-shift compensation keeps the target echo in the range of the neurons of the acoustic fovea – a group of neurons sharply tuned to a very narrow frequency band, a few kHz higher than the peak frequency of the emitted signal (Neuweiler 1990). The Doppler effect is the change in frequency of a sound wave as perceived by a listener moving relative to the source of the sound. For example, the frequency of the siren of a passing emergency vehicle will start out high, slide down as it passes by the listener, and continue lower as it recedes into the distance. In other words, high duty-cycle bats separate the emitted pulse from the returning echo in frequency rather than time (Fenton 1990).



TYPES OF BAT ECHOLOCATION PULSES

Broadband, low duty-cycle, frequency-modulated (LD-FM) echolocation pulses typically sweep downward through as much as an octave for a short duration of time (Fenton 1990, Schnitzler and Kalko 2001) (Figure 35). At the same time, the bat senses with increasing precision the range and position of the object in space – its localisation (Simmons and Stein 1980). This is because LD-FM signals sweep rapidly through the corresponding neural filters, and are therefore reliable time markers to determine the range of the target from the foraging bat (Moss and Schnitzler 1995). In addition, the neuronal filters are activated across a broad frequency range, which increases the reliability of the monaural and binaural cues the bat uses to localise the target in space (Schnitzler and Kalko 2001). Nevertheless, LD-FM signals are less suited for the detection of distant and/or weak echoes, because the neuronal filters are activated for only a short time (Schnitzler and Kalko 2001).

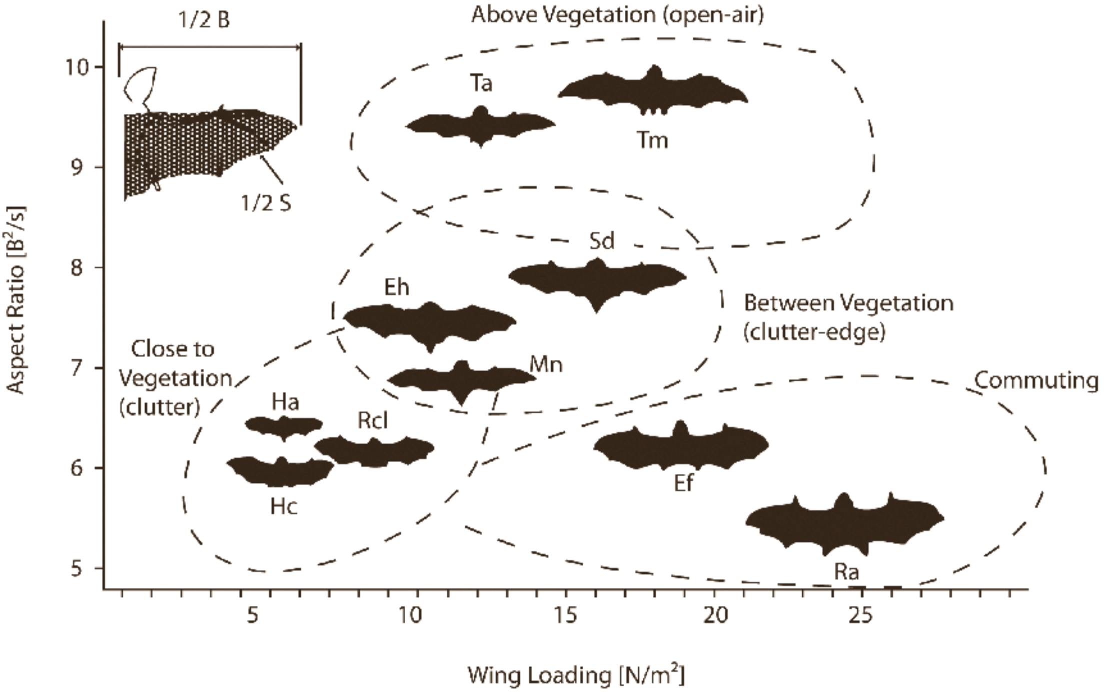
Narrowband, low duty-cycle pulses composed of constant frequency (LD-CF) or shallow frequency-modulated (LD-QCF) components (Figure 35) are not suitable for localisation of a hunted target, but are well suited to detection, because they activate the neuronal filters of the corresponding narrow frequency band during the entire echo (Schnitzler and Kalko 2001). In addition, acoustic 'glints' (short prominent amplitude peaks in the echo that are created when a fluttering insect's wing is perpendicular to the incoming sound wave) can be 20–30 dB stronger than the echo from the body of the insect; it is these glints off the flying insect's wings that further increase the likelihood of its detection by the bat (Kober and Schnitzler 1980, Moss and Zagaeski 1994).

In contrast to low duty-cycle bats, Doppler-shift compensation combined with a specialised auditory system enables **constant frequency high duty-cycle (HD-CF)** echolocating bats to localise and classify fluttering insects in dense (clutter) habitats (Schnitzler and Kalko 2001). HD-CF bats can classify insects by listening to the unique acoustic glints imprinted by the fluttering wings of different insects onto the echoes of their CF calls (Schnitzler 1987, von der Emde and Menne 1989, von der Emde and Schnitzler 1990) (Figure 35).

◂ *Figure 35.* Diagram showing sonograms of southern African bats that use high duty-cycle and low duty-cycle echolocation calls.

ECOLOGY OF BAT ECHOLOCATION AND FLIGHT

Bat species exhibit great diversity in how and where they fly. The most important ecological constraint on foraging insectivorous bats is clutter, i.e. the number of obstacles a bat has to detect and avoid (Fenton 1990). Vegetation structure (see 'Vegetation' above) has an overriding control over the relative clutter of the habitats exploited by foraging bats. Perceptually, bats are constrained by the capabilities of their sensory mechanisms (e.g. echolocation, vision, olfaction, hearing) to detect, classify, and localise potential prey near clutter. Echolocation is ineffective over long ranges, and therefore sets spatial limits on where bats can forage. Geometric and atmospheric attenuation severely reduce the intensity of echolocation echoes with increasing target distance (Pye 1980, Lawrence and Simmons 1982). Furthermore, the intensity of the target echo depends on the size and shape of the target (Barclay and Brigham 1991, Waters *et al*. 1995). Mechanically, bats are constrained by the capabilities of their flying ability (Figure 38). These factors explain why the flight morphology and echolocation systems of bats are adapted specifically to the habitat structure in which they forage (Aldridge and Rautenbach 1987, Norberg and Rayner 1987). For example, a wing shape that allows fast flight would be useless if coupled with echolocation calls that are effective only at short range. Such a bat would not be able to detect prey soon enough to capture them. Similarly, wing morphology adapted for slow, manoeuvrable flight in clutter needs to be coupled with echolocation signals that can distinguish prey from clutter echoes. Wing morphology and echolocation signals are therefore part of the same adaptive complex (Arita and Fenton 1997). Based on these adaptations, sympatric bats can be classified into



▲ *Figure 36*. Adaptations of wing shape and the resulting flight style to different foraging habitats. Fast fliers (e.g. *Tadarida*) hunt above the vegetation (open-air functional foraging group). These bats have narrow, long wings, wide wingspans, and high wing loading. Species that are highly manoeuvrable (e.g. *Hipposideros*) forage in and near vegetation (clutter functional foraging group). These bats have short, broad wings and low wing loading. Bats that hunt insects between vegetation (clutter-edge functional foraging group) have intermediate-sized wings, wingspans, and wing loading (e.g. *Scotophilus*). Fruit-eating bats (e.g. *Rousettus*) have large wings and high wing loading. **Ef** *Epomops franqueti*; **Eh** *Eptesicus hottentotus*; **Ha** *Hypsugo anchietae*; **Hc** *Hipposideros caffer*; **Mn** *Miniopterus natalensis*; **Ra** *Rousettus aegyptiacus*; **Rcl** *Rhinolophus clivosus*; **Sd** *Scotophilus dinganii*; **Ta** *Tadarida aegyptiaca*; **Tm** *Taphozous mauritianus* (modified after Neuweiler 1990).

three broad functional foraging groups: open, clutter-edge, and clutter foragers (Crome and Richards 1988, Fullard *et al*. 1991, Schnitzler and Kalko 2001).

Open air foragers that feed on flying prey high above the ground and far from vegetation have no problems with clutter echoes and obstacles. Masking problems are not likely to affect echolocation signals, as long as the emitted signal does not overlap with the returning echo. Nevertheless, bats that forage in open habitats must find relatively small prey in a big space. Hence, their echolocation signals are optimised for detection, and their wing morphology is geared for speed and agility (Norberg and Rayner 1987, Schnitzler and Kalko 1998, 2001). Some of the species in this functional group fly at considerable heights above ground; in Zimbabwe, Fenton and Griffin (1997) revealed that six species of molossids and *Taphozous mauritianus* feed at over 500 m above ground.

Clutter-edge foragers are bats that hunt for insects near the edges of clutter such as forest edges and gaps. Clutter-edge bats therefore experience perceptual and mechanical constraints at the same time. They must distinguish insect echoes from clutter-edge echoes, and navigate along these edges avoiding collision. Clutter-edge bats solve these problems by using mixed signals (Schnitzler and Kalko 1998, 2001). Typically, search phase echolocation consists of low duty-cycle QCF signals alternated with FM signals. QCF signals increase detection distance, while FM signals allow the bats to localise and distinguish between clutter echoes and insect echoes. Wing morphology is variable, but most species have average wingspans and wing areas. Consequently, some bats are very flexible in their foraging and echolocation behaviour and often switch between open and clutter-edge habitat space (Fenton 1990).

Clutter foragers are bats that search and capture insects in highly cluttered space close to the ground or vegetation, and therefore experience more perceptual and mechanical constraints than clutter-edge foragers. Clutter foragers must distinguish insect echoes buried in clutter echoes, and at the same time know their exact spatial position to navigate and avoid collision with the clutter. Bats have evolved two different echolocation sensory strategies to solve this problem (Schnitzler and Kalko 2001). On the one hand, HD-CF bats use overlap-insensitive CF signals of long duration to hunt fluttering insects. On the other hand, LD-FM bats, which glean prey from surfaces use overlap-sensitive uni- or multi-harmonic FM signals of short duration at low intensities (< 100 dB). Short-duration and low-intensity calls don't overload the sensory system with clutter echoes (Schnitzler and Kalko 2001). In addition, many of these bats have long ears that listen for prey-generated acoustic cues, such as the calls of crickets and frogs (Tuttle and Ryan 1981, Bell 1982, Fenton *et al*. 1983). All clutter-foraging bats have similar short and broad wings associated with the slow, manoeuvrable flight necessary to hunt in clutter habitats (Norberg and Rayner 1987).

In this book, **open air foragers** include insectivorous bat species from the families Molossidae and Emballonuridae. These LD-CF and LD-QCF bat species are characterised by long and narrow wings with high wing loading and aspect ratio (> 10.9), coupled with narrowband echolocation calls at low frequencies (< 30 kHz) and of long duration (> 8 ms).

Clutter-edge foragers include insectivorous bat species from the families Vespertilionidae and Miniopteridae. In general, these bat species are characterised by average wingspans, and wing areas with low to intermediate wing loading and aspect ratio between 7 and 10.9, coupled with echolocation calls at intermediate frequencies (30–70 kHz), ranging from broadband (> 20 kHz) to narrowband signals (< 20 kHz) of intermediate duration (3–8 ms).

Clutter foragers are divided into two groups: HD-CF bats of the families Hipposideridae and Rhinolophidae, which emit CF signals of long duration (10–100 ms), and medium to high peak frequency (> 30 kHz); and LD-FM bats of the families Nycteridae and Megadermatidae, which use FM signals of short duration (1–3 ms) at low intensities (< 100 dB). Despite having very different echolocation systems, the wings of all clutter feeders are relatively short and broad with low wing loading and aspect ratio (< 7).

RECORDING ECHOLOCATION CALLS

Sound originates when matter vibrates in a medium such as air or water, and is perceived by the sense of hearing. Physically, sound is the compression and rarefaction of particles as a wave in the medium through which the sound is travelling. A microphone converts the wave motion of the particles into an electric signal. Special ultrasound microphones are required to record ultrasonic bat frequencies.

Before a complex sound such as a bat's echolocation call can be manipulated or analysed with a digital computer, the signal must be *acquired* or *digitised* by an analog-to-digital (A/D) converter. The A/D converter repeatedly samples the voltage amplitude of the electric input signal at a particular sampling rate, typically tens or hundreds of thousands of times per second. The quality of the resultant digitised signal depends on the rate at which amplitude measurements are made (the sampling rate), and the number of bits used to represent each amplitude measurement (the sample size).

The sampling rate must be more than twice as high as the highest frequency contained in the original signal. Otherwise, the digitised signal will have (phantom) frequencies that were not present in the original signal. This is called *aliasing*. For example, an accurate recording of an echolocation pulse with a peak frequency of 100 kHz requires a sampling rate of at least 200 kHz.

The precision with which the digitised amplitude represents the actual amplitude at the instant the sample is taken depends on the sample size or number of bits used. Some recording models have an 8-bit sampling limit, while others allow a choice between 8-bit and 16-bit samples. An 8-bit sample can resolve 256 (= 2^8) different amplitude values; a 16-bit converter can resolve 65,536 (= 2^{16}) values.

For the echolocation recordings in this book, the sampling rate (250 or 500 kHz) was always more than twice the highest frequency contained in the original bat signal, and the sample size was 16-bit.

SPECTRUM ANALYSIS

Any acoustic signal can be graphically or mathematically represented in two ways: time-domain and frequency-domain. A time-domain graph shows how a signal changes over time, while a frequency-domain graph shows how much of the signal lies within each given frequency band over a range of frequencies. A pure tone is called a sinusoid because its amplitude is a sine function in the time domain. In the frequency domain, it is a vertical line. Any continuous sound, no matter how complex, can be represented as the sum of sinusoidal components, because each pure tone has a particular amplitude and time relationship relative to the other pure tone components.

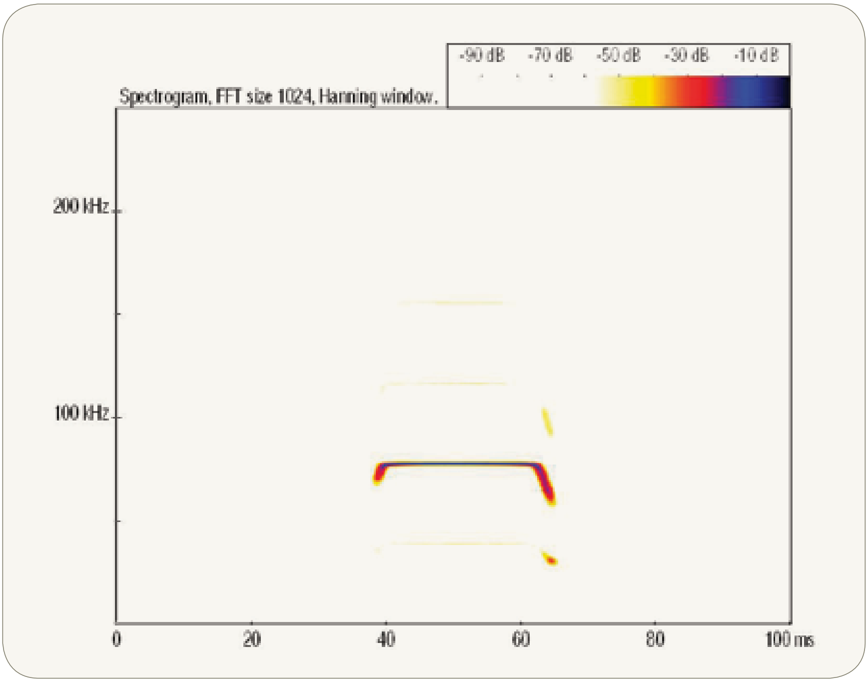
Spectrum analysis is the process of converting the time-domain signal to a frequency-domain signal, showing how different frequency components contribute to the sound. Fourier transformation is the mathematical function that is often used to convert the time-domain form to a frequency-domain representation or spectrum. An individual spectrum contains no information about temporal changes in frequency composition of the spectrum. A spectrogram shows how the frequency composition of a signal changes over time. The spectrograms in this book are based on a Fast Fourier Transform (FFT) algorithm. A Hanning window was used to eliminate the effects of background noise (Figure 37).

BAT DETECTORS

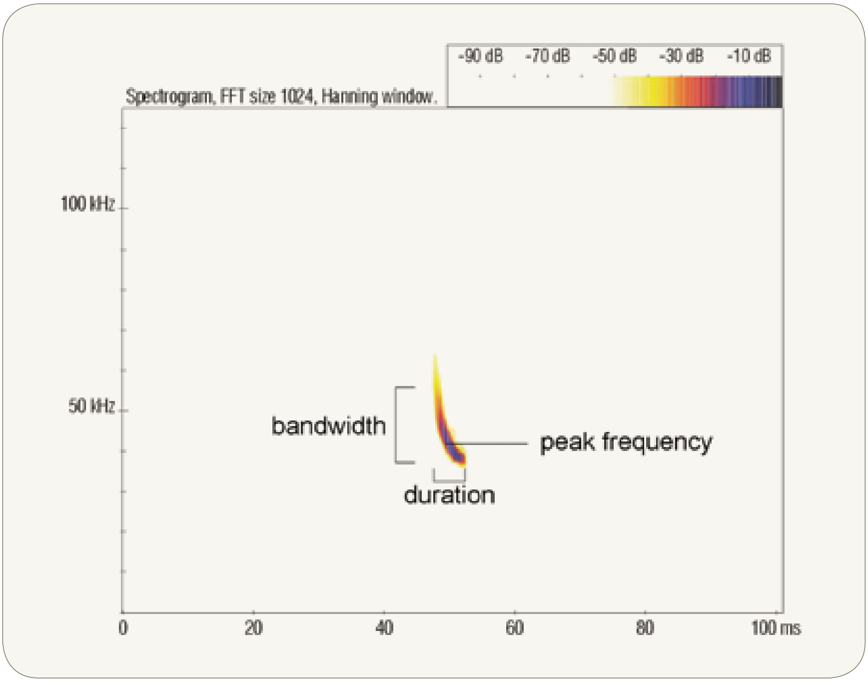
The transformation of ultrasound into a signal audible to human ears requires the use of specialised bat detectors, of which there are three main types.

Heterodyne detectors convert bat calls into electronic signals, which are then compared to an internal signal of a particular frequency. The internal frequencies of detectors are ‘tunable’ so that the bat’s actual peak frequency can be estimated within a limited band of frequencies, usually 10 kHz. Two disadvantages of this system are that bat passes can be missed because the full range of possible echolocation frequencies used by bats (e.g. between 10 and 214 kHz in southern Africa) has to be scanned ~10 kHz at a time, and bandwidth information is lost. Advantages of heterodyne detectors are that they work in real time, are easy to use, and are the least expensive. In fact, in Europe, heterodyne detectors such as the Magenta, Maplin, and Batbox III are very popular among the public and scientists for basic field identification of species and the monitoring of bat activity, because calls of local species are increasingly well known.

Frequency division detectors digitally scale down the entire ultrasonic frequency range of a bat call into the human hearing range. This is done by converting the call into a square wave, called a zero crossing signal. The square wave is divided by a constant factor, usually 10, meaning that a frequency of 50 kHz will be converted to 5 kHz. In other words, frequency division detectors count the number of cycles of the ultrasonic signal (N), and effectively divide the frequency by N, where N is usually 10. Frequency division detectors are only capable of tracking one frequency (harmonic) at a time. Usually this is the fundamental frequency. Consequently, it is difficult to perform a harmonic analysis from a frequency division signal. Advantages of frequency division detectors are that they are reasonably priced, work in real time, and cover a broad bandwidth, i.e. all of the ultrasonic frequencies of coexisting bats are recorded, without missing frequencies of species because of tuning choices. Because some scientists use the ANABAT frequency division bat detector



▲ *Figure 37*. A spectrogram depicting a HD-CF call: the frequency in kilohertz (kHz) is shown on the vertical axis and the time in milliseconds (ms) on the horizontal. Colours represent amplitude ('loudness') in decibels; darker colours depict the louder components of the call.



▲ *Figure 38*. A graphical representation of echolocation parameters. Note that these parameters were not measured from the spectrogram: peak frequency and bandwidth were measured from the power spectrum, while duration was measured from the oscillogram.

(Titley Electronics, Australia) to identify bat species and monitor bat activity (but see Fenton *et al*. 2001), echolocation data of southern Africa bat species that were recorded by the authors with the ANABAT system are presented in Table 3.

Time expansion detectors digitise bat calls at a high sampling rate and record them in real time or replay them at a lower sampling rate afterwards. Typically the sampling rate ratios vary from 1:10 to 1:32. This is the equivalent of recording sound on a high-speed tape recorder and then playing it back at a slower speed, i.e. time is effectively 'expanded' (slowed down) by a set factor (e.g. 10). The main disadvantage of time expansion bat detectors is that they are usually expensive. The main advantage of time expansion is that all information of bat calls – including amplitude, frequency and harmonic structure – is preserved, making it ideal for detailed analyses of call characteristics. Echolocation data used to generate the spectrograms in this book were recorded with three time-expansion bat detectors: the Pettersson D980 detector (Pettersson Elektronik AB, Uppsala, Sweden), and the Avisoft Ultrasoundgate 416 and 116 detectors fitted with Ultrasoundgate CM16 microphones (Avisoft Bioacoustics, Berlin, Germany).

SPECTROGRAMS AND ECHOLOCATION

In this book, three criteria were applied to graphically represent the echolocation call of bat species on spectrograms using BatSound Pro software (version 3.20; Pettersson Elektronik AB, Uppsala, Sweden). First, only signals with a high signal-to-noise ratio were considered, i.e. the signal from the bat was at least three times stronger than the background noise as displayed on the time-amplitude window. Second, only signals that were not saturated were analysed (Fenton *et al*. 2001). Finally, for most low duty-cycle bats only search phase signals that were recorded at least three seconds after releasing the bat were considered (O'Farrell *et al*. 1999). Echolocation calls of high duty-cycle bats were recorded with the bat in the hand to eliminate any possible Doppler-shift or compensation for it by the bat when in flight (Heller and von Helversen 1989).

Duration, bandwidth and peak echolocation frequency are reported as indicators of sensory ability of low duty-cycle echolocating bats (Figure 38). Only duration and peak echolocation frequency are reported as indicators of sensory ability of high duty-cycle echolocating bats because the bandwidths of their CF calls are similarly narrow.

Where possible, genetic analyses confirmed species identification of the bats that were recorded for this book (e.g. Eick *et al*. 2005, Schoeman 2006, Stoffberg 2007).

TABLE 3. ANABAT call data, listing the mean (± standard deviation) echolocation parameters of 29 bat species caught in southern Africa. Recordings were made with ANABAT bat detectors and analysed with ANALOOK software. **N** = number of bats in sample; **Fc** = Characteristic frequency, the frequency at the end or flattest portion of the call; **Fk** = Frequency at the 'knee' or the point at which the slope of the call abruptly changes from a downward slope to a more level slope; **Fmin** = Minimum call frequency; **Fmax** = Maximum frequency; **DUR** = Total duration of the call; **Tc** = Time from the start of the call to Fc; **Tk** = Time from the start of the call to Fk.

SPECIES	N	FMAX	FMIN	FC	FK	DUR	TC	TK
MOLOSSIDAE								
Chaerephon ansorgei	3	26.3±2.1	20.9±0.6	21.6±0.5	23.7±0.7	7.4±4	4.7±2.8	2.3±0.8
Chaerephon pumilus	11	29.2±4.7	24.6±2.8	25.1±3	27.7±3.4	6.2±2.8	7.0±4.5	1.3±1.3
Mops condylurus	6	37.3±2.9	19.1±6.4	26.5±1	30.1±0.9	7.0±1.6	4.7±0.6	2.0±1
EMBALLONURIDAE								
Taphozous mauritianus	2	28.0±0.7	25.3±0.4	25.7±0.5	27.9±0.7	2.3±0.2	2.1±0.2	0.1±0
RHINOLOPHIDAE								
Rhinolophus blasii	3	86.6±0.2	77.3±0.9	86.0±0.3	86.3±0.4	20.6±0.1	19.3±1.8	2.2±0.4
Rhinolophus clivosus	7	90.8±1.2	76.4±6.1	89.6±2.2	89.9±1.78	29.7±7.9	25.7±7.7	2.9±2.3
Rhinolophus darlingi	4	85.6±0.2	72.2±3.9	85.4±0.3	85.0±0.4	21.5±6.3	21.6±5.6	3.0±1.4
Rhinolophus hildebrandtii	5	35.9±1.2	24.4±10.5	35.3±0.2	34.8±1.1	29.9±2.7	27.3±3.1	2.2±0.6
Rhinolophus deckenii	3	72.0±0.02	56.6±5.1	71.9±0.1	71.9±0.02	27.6±5	23.4±5	2.2±1.2
Rhinolophus simulator	6	84.1±0.3	41.7±22.2	83.9±0.7	83.8±0.6	22.5±3.6	17.2±5.5	1.2±0.5
HIPPOSIDERIDAE								
Cloeotis percivali	4	103.2±0.7	99.4±4.3	102.4±0.7	103.1±0.8	1.9±0.6	1.6±0.3	0
Hipposideros caffer	6	143.8±1.1	125.5±13.2	142.6±1.2	142.3±1.5	4.5±0.5	3.2±0.3	0.9±0.5
Hipposideros ruber	4	136.6±2.7	106.9±21.2	136.3±2.9	135.8±2.9	4.8±0.5	3.9±0.8	1.1±1.5
Hipposideros vittatus	2	65.3±1.9	57.9±0.4	64.5±1.7	64.9±2.1	9.5±1.3	7.6±1.8	0.4±0.07
Triaenops persicus	15	77.5±5.5	67.4±5.3	77.1±5.6	77.0±5.5	8.8±3.2	7.2±2.5	0.4±0.6
MINIOPTERIDAE								
Miniopterus fraterculus	2	62.3±0.5	55.5±0.1	55.8±0.03	58.4±1	2.3±0.1	2.5±0.3	0.6±0.07
Miniopterus inflatus	7	58.1±6.4	47.2±0.9	47.4±0.8	50.0±1	3.2±0.8	3.0±0.6	1.0±0.3
Miniopterus natalensis	7	61.6±3.6	53.1±0.8	53.3±0.7	55.6±0.5	2.3±0.5	1.9±0.5	0.4±0.2
NYCTERIDAE								
Nycteris thebaica	3	75.4±7.5	63.1±2.8	68.2±5.2	71.0±4.6	0.8±0.2	0.7±0.2	0.2±0.1
VESPERTILIONIDAE								
Kerivoula lanosa	7	148.7±16.9	81.9±6.6	131.3±17.3	141.2±15.4	0.8±0.2	0.3±0.1	0.1±0.05
Myotis bocagii	2	56.8±0.7	37.7±6.7	44.0±4.2	49.1±3.4	1.4±0.4	0.8±0.07	0.3±0
Myotis tricolor	3	58.1±5.3	38.1±3.8	50.7±1.1	54.3±1.8	1.7±1.3	0.5±0.2	0.2±0.3
Neoromicia capensis	2	52.7±11.9	39.3±0.7	41.7±0.1	44.9±4.4	1.3±0.1	0.8±0.4	0.2±0
Neoromicia nana	3	86.0±10.4	67.9±4.3	75.3±7.8	81.4±14.6	1.3±1.2	0.9±0.8	0.2±0.2
Neoromicia zuluensis	4	62.8±5.4	48.8±3.7	50.4±3.7	54.8±5.9	2.7±1.2	2.4±1.5	1.0±0.6
Nycticeinops schlieffeni	8	50.6±4.7	39.4±3.1	41.1±1.9	43.8±2.2	2.2±0.9	2.0±0.9	0.8±0.4
Pipistrellus hesperidus	10	65.4±5.7	46.9±2	50.4±1.9	54.8±2.9	2.0±0.7	2.5±1.4	1.0±0.5
Scotophilus dinganii	11	44.2±6.6	33.6±2.5	34.0±2.8	36.6±2.9	3.0±1.1	2.8±1.1	1.2±0.6
Scotophilus viridis	4	57.5±5.6	41.1±4.2	42.9±4.8	46.3±4.6	3.7±2.7	2.3±1.8	0.7±0.4

SPECIES ACCOUNTS

This section contains species accounts for 116 species of bats known to occur in the southern African region, accompanied by identification matrices, distribution maps, sonograms, photographs of bats and their skulls, and tables of measurements.

Rather than using dichotomous keys, which can be misleading, especially when characters are missing, we provide identification matrices throughout, providing important characters for all species. Table 1 presents an identification matrix for distinguishing between the nine families of bats.

The families are arranged phylogenetically within the two orders Pteropodiformes and Vespertilioniformes. Each family account starts with a general description of the family and genera, followed by one or more identification matrices to the genera and species. Within each identification matrix, taxa are arranged according to ascending size (FA length). Species accounts are arranged alphabetically within each family. Each species account covers the following aspects.

Name: Scientific and common names are given (following Simmons 2005, except as stated), together with the author and date of description of each genus and species.

Conservation status: Global Redlist categories appear after the name in each account. These are sourced from the *2007 IUCN Red List of Threatened Species (www.iucnredlist.org)*; individual species ratings were based on mutual consensus among bat biologists at the January 2004 'Global Mammal Assessment' meeting in London.

Description: External, cranial and dental characters are described. Where known, the dental formula of each species is presented as follows: 2132/2133 = 34, where the numbers before the slash refer to the teeth in half of the upper jaw and the ones after it to half the teeth in the lower jaw. In this example, the species has four upper incisors, two canines, six premolars and four molars in the upper jaw and a total of 34 teeth. Figure 39 illustrates the dental and osteological features referred to in this book.

Key identification features: Main species characteristics useful for identification are provided, as well as comparisons between closely related species that may be easily confused. These features are also summarised in the relevant Identification Matrices provided for each family and genus. In some cases, diagnostic traits are visible from the species photographs and skull photographs (dorsal, ventral and lateral views of the cranium and lateral view of the mandible).

Echolocation call: We provide sonograms and call parameters of time expanded calls for 56 species for which we have data, because these have been shown to be superior to those obtained using the ANABAT system (Fenton *et al.* 2001). Nevertheless, given the large user base of bat workers still using the ANABAT system, we provide relevant species call parameters for 29 species in Table 3. N = number of individual bats, unless otherwise indicated. For more information, see 'Echolocation'.

Distribution, habitat and roosting: We plotted the provenance of all known museum specimens as locality records. Red dots represent the specimens personally checked by one or more of the coauthors, while unchecked specimens are shown with blue dots. We also included photographic distribution records for two species – *Taphozous mauritianus* and *Eidolon helvum*. Where possible, we have given the museum accession number for the type specimen of each species, and have stated in which museum the specimen is deposited.

The distribution maps also include the predicted potential distribution of each species throughout southern Africa, calculated from the georeferenced distribution records. We employed the recently developed MaxEnt algorithm (version 2.3; Phillips *et al*. 2006) that has been shown to perform particularly

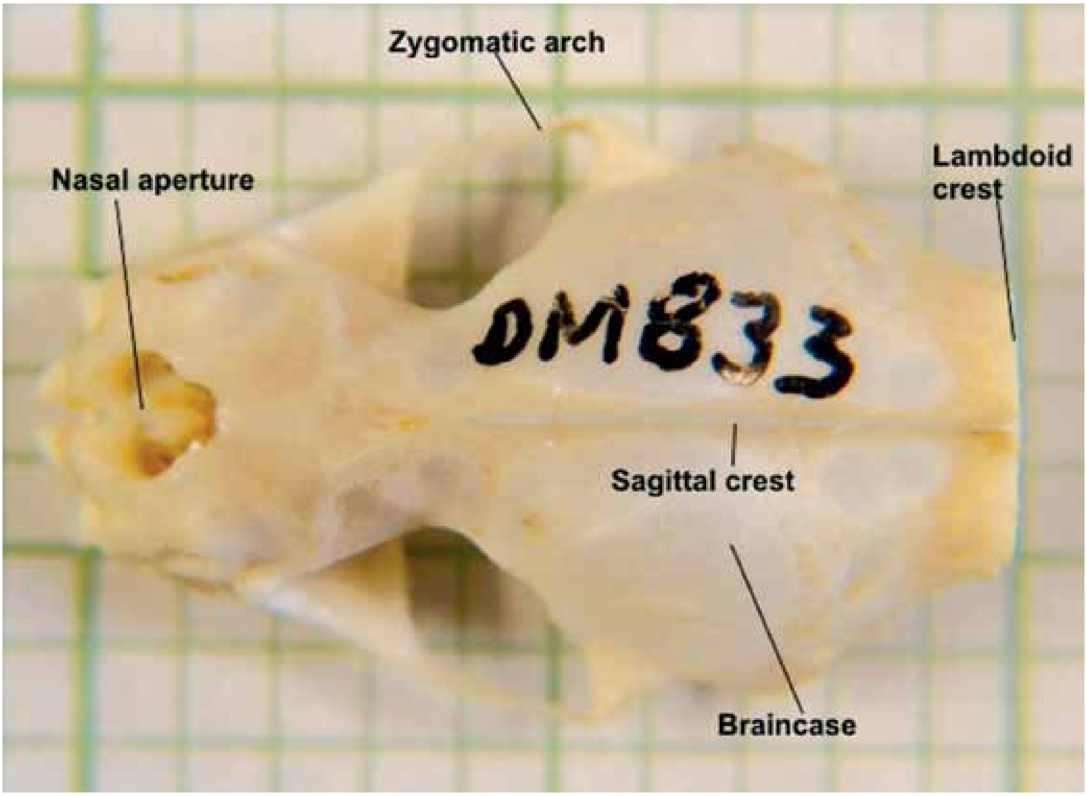


fig. 39a

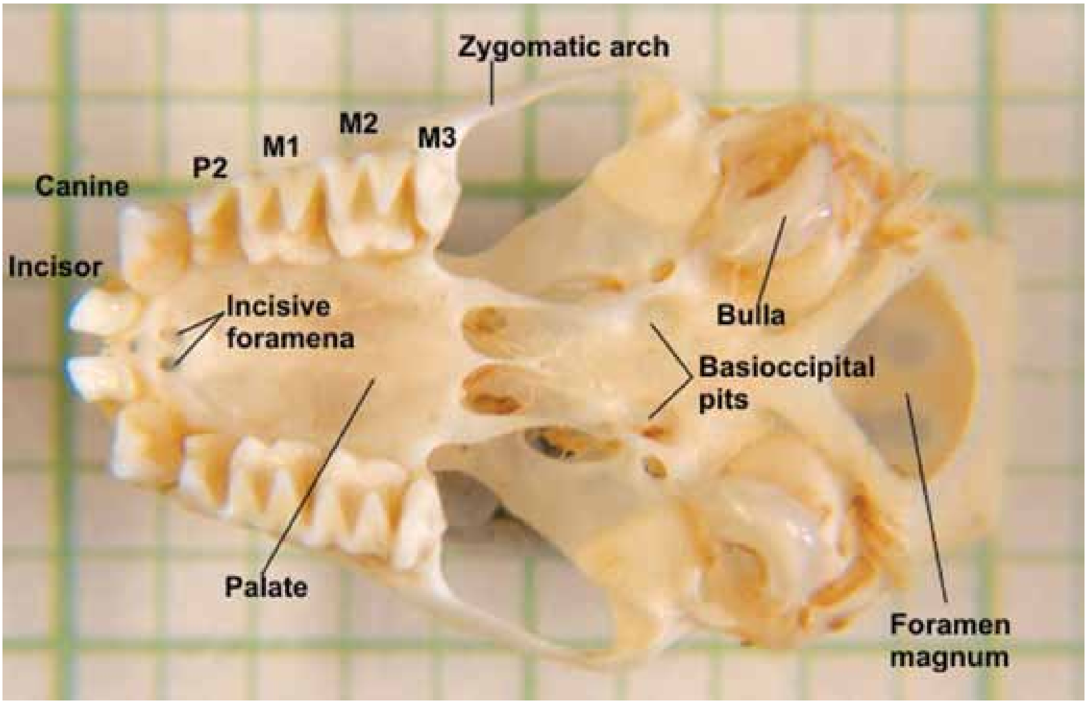


fig. 39b

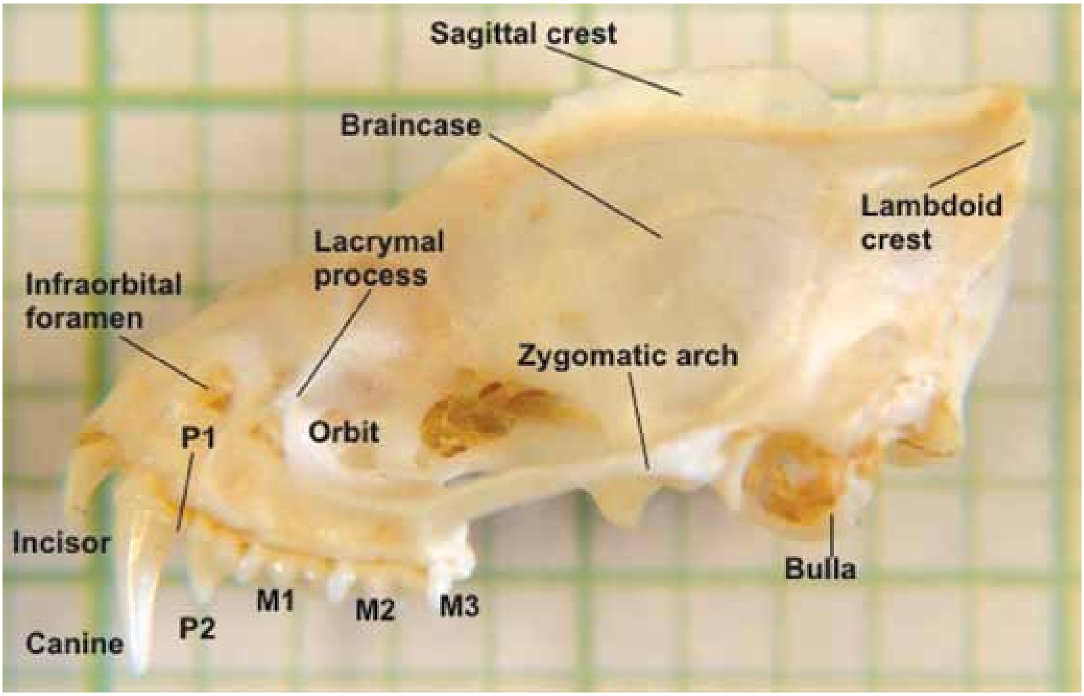


fig. 39c

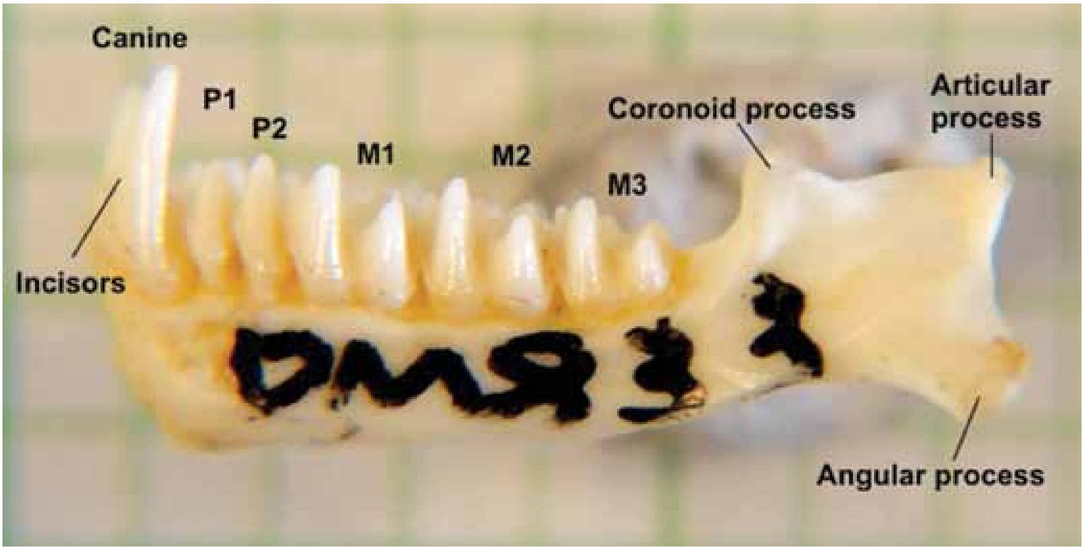


fig. 39d

Figure 39. (a) Dorsal, (b) ventral, and (c) lateral views of the skull, and (d) lateral view of the mandible of a typical bat showing the osteological features that are referred to in this book. Grid squares represent 2 mm × 2 mm in all skull and mandible photographs, except where a note in the caption states otherwise.

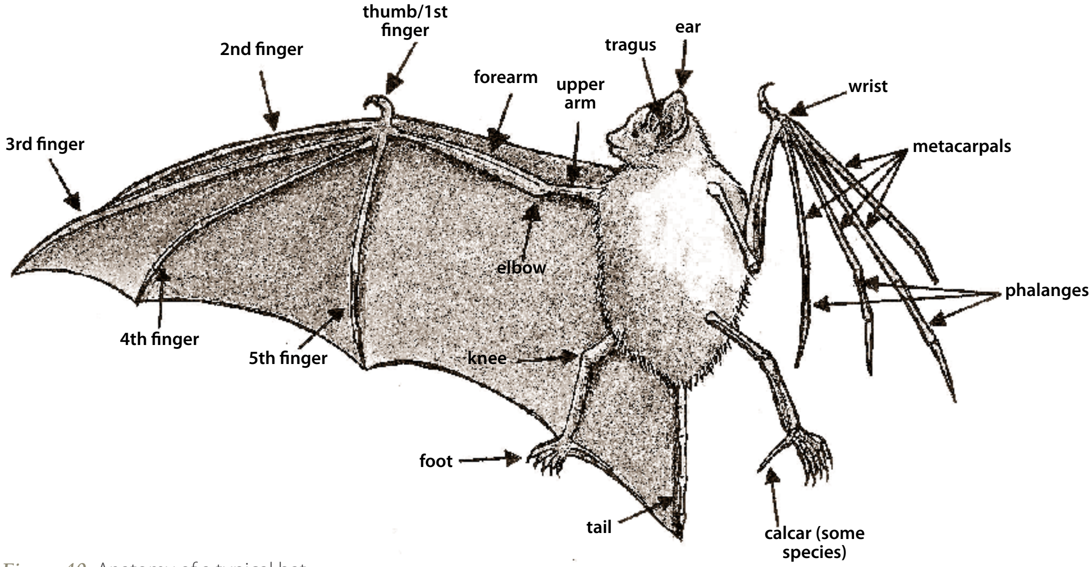


Figure 40. Anatomy of a typical bat.

TABLE 4. IDENTIFICATION MATRIX FOR SOUTHERN AFRICAN CHIROPTERAN FAMILIES

FAMILY	FACE	EYES	NOSELEAF	EAR
Pteropodidae	dog-like	large	absent	simple, edge forming an unbroken ring
Rhinolophidae	not dog-like	tiny	complex – pointed tip	large, triangular
Hipposideridae	not dog-like	tiny	complex – half-moon shape; sella and connecting process absent	large, triangular
Megadermatidae	not dog-like	large	enveloped by pointed spike	very long, rabbit-like
Nycteridae	not dog-like	tiny	vertical slit in face, covering noseleaf beneath	very long, rabbit-like
Emballonuridae	not dog-like	large	absent	intermediate length
Molossidae	not dog-like	small	absent	intermediate to large, co-joined
Vespertilionidae	not dog-like	small	absent	simple, usually separate
Miniopteridae	not dog-like	small	absent	simple, separate

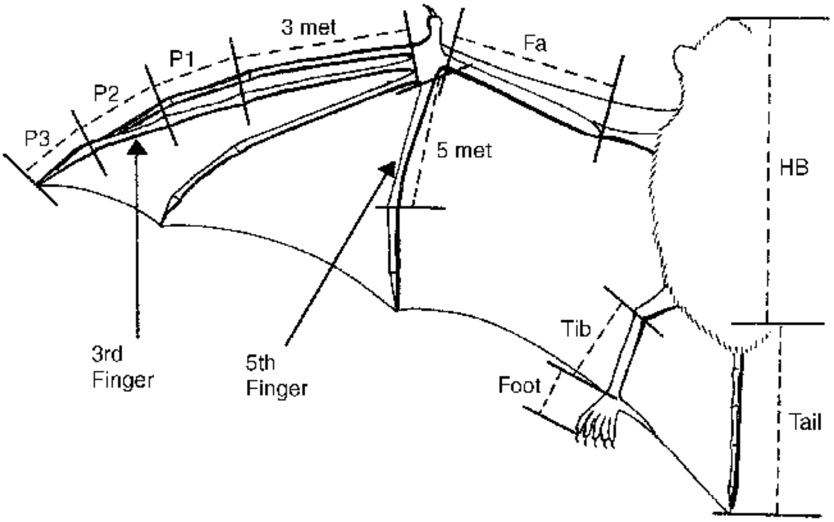


Figure 41. Measurements used in bat identification: **Fa** forearm length; **Tib** tibia length; **Ear** length of ear from notch to tip; **Trag** length of tragus in the ear; **3** met length of metacarpal in the third finger of the wing; **5** met length of metacarpal in the fifth finger of the wing; **Tail** tail length from tip to anus; **HB** head and body length from nose tip to anus; **Foot** hind foot length, heel to toe tips, excluding claws; **P1** length of first phalanx of the third finger of the wing; **P2** length of second phalanx of the third finger of the wing; **P3** length of third phalanx of the third finger of the wing.

TRAGUS	TAIL	CLAWS ON WING	OTHER
absent	small or absent, not contained in tail-membrane	1st + 2nd finger	cheek-teeth without w-pattern of cusps
absent, well-developed anti-tragal lobe	moderate length tail enclosed within membrane	1st finger	
absent	moderate length tail enclosed within membrane	1st finger	
well-developed; divided	tail absent	1st finger	2nd finger has one phalanx, the 3rd has two phalanges
well-developed	moderate length tail enclosed within membrane ending in a T-shape	1st finger	
well-developed	tail protrudes from upper half of membrane near mid-point	1st finger	pocket-like skin pouch between base of 5th finger and forearm (except *Coleura afra* and *Saccolaimus peli*)
absent or small; well-developed anti-tragus	terminal portion of tail protrudes beyond hind margin of tail-membrane	1st finger	
well-developed	long tail fully enclosed within membrane	1st finger	
well-developed	long tail fully enclosed within membrane	1st finger	2nd phalanx of 3rd digit three times longer than 1st phalanx

well with presence-only data (Elith *et al*. 2006). Nine continuous environmental variables were used as predictors in the final model, including: altitude, mean annual temperature, maximum temperature of the hottest month, minimum temperature of the coldest month, temperature seasonality, annual precipitation, precipitation of the wettest month, precipitation of the driest month and precipitation seasonality. These environmental variables were downloaded from the **worldclim** website *(www.worldclim.org/bioclim.htm)*. The environmental data were set to a spatial grid resolution of 2.5 arc-minutes (≈5 km). The MaxEnt model was run with all distribution records (100% training); the regularisation multiplier was set to 1 and maximum number of iterations was set to 500; other MaxEnt settings were kept unchanged. Since MaxEnt produces a continuous logistic probability (ranging from 0 to 1), we transformed the continuous model output to a map representing probabilities above two predefined thresholds to give two different shades. The darker shading represents higher probability (i.e. more suitable conditions for finding the species) and the lighter shading lower probability. Generally, only species with ten or more distribution localities were modelled. These models may prove to be useful in predicting the distributions of species in areas that have not been previously surveyed; however, that is not our intention here. We do not claim that a species occurs continuously across the shaded areas. Instead, we suggest that shaded areas without museum records may indicate sites worth surveying in the future.

Foraging ecology: Prey items, foraging behaviour and other relevant data (e.g. wing loading and aspect ratio) are included when available for southern Africa, or when data from elsewhere in Africa are likely to be true for southern Africa. Wing loading and aspect ratio are described as low if they are < 7, intermediate if they lie between 7 and 10.9, and high if they are > 10.9. Information on prey items and feeding behaviour is based on a number of studies of southern African species. These studies have generally described prey contents from the droppings of different species of bats, and related the findings to comparative observations of echolocation, wing morphology and feeding behaviour (e.g. Aldridge and Rautenbach 1987, Bowie *et al*. 1999, Jacobs 1999, Schoeman and Jacobs 2003, and numerous papers by M. B. Fenton).

Reproduction: Gestation, litter size, birth season and any other relevant details are given when data are available for southern Africa, or when available only for other parts of Africa and likely to be true for the subregion.

Systematic notes: Recent taxonomic studies and points of taxonomic debate are discussed at the end of each species account.

Measurements: Means, standard deviations and ranges of each species are given for males and females separately (but have been combined where small sample sizes do not allow for this), for mass (in grams) and for the following linear measurements (in millimetres): forearm length, total body length, tail length, tibia length and condylo-incisive skull length. Other measurements are occasionally presented for certain species (e.g. greatest skull length) where these measurements are important in identifying the species. To reduce variability, most of the measurements presented in this book were taken by two authors (P. J. Taylor and A. Monadjem). As far as possible, only measurements of adults have been used. FA = forearm length; Total = total length (including tail); Tail = length of tail; Tibia = length of tibia; Ear = length of ear; CI = condylo-incisive length; GSL = greatest skull length.

SUBORDER PTEROPODIFORMES

FAMILY PTEROPODIDAE
FRUIT BATS

The Pteropodidae encompass a diverse assemblage of fruit-eating bats, represented by about 28 species in mainland Africa, of which 21 species in 11 genera occur in southern Africa (Simmons 2005). The only mainland genera not recorded in southern Africa are *Nanonycteris* and *Scotonycteris*, which are restricted within the rainforest zone. Nevertheless, museum records of *Scotonycteris zenkeri* Matschie 1894 mapped by Bergmans (1990) extend nearly to 4°S in the Congo basin. So it is likely that *S. zenkeri* occurs in our area; if not resident, then possibly as a migrant.

Furthermore, several species of *Pteropus* breed on islands in the Indian Ocean, some very close to the mainland (at Pemba and Zanzibar).

The Pteropodidae are a distinctive group, readily distinguished from other bats by the possession of two claws on the wing (all other bats have only one wing-claw, which is the homologue of our thumb) (Figure 42b). Traditionally, they are also viewed as being larger than 'microbats', but this is not always so. For example, at 13 g, the diminutive pteropodid *Megaloglossus woermanni* is smaller than many 'microbat' species. However, it is true that the largest bats belong to this family. In Africa, *Hypsignathus* and *Eidolon* may have forearm lengths of over 120 mm, and a large male of the former can exceed 400 g. By comparison, the largest 'microbats' weigh less than 200 g. The other typical features of the Pteropodidae are their dog-like faces with elongated muzzles and large eyes (Figure 42a), and their diet of fruit. In contrast to the 'microbats', eyesight is important in the Pteropodidae – they rely on this sensory organ for perception of their environment. A primitive form of echolocation has developed in only one genus, *Rousettus* (Neuweiler 1990).

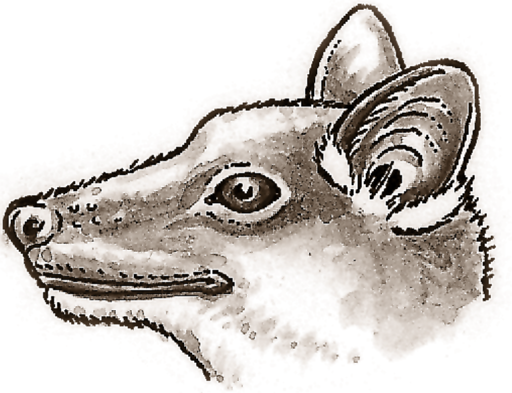


fig. 42a

fig. 42b

Figure 42. A typical Pteropodidae species: (a) head showing the large eyes and absence of noseleafs, and (b) wing showing the presence of claws on the first and second digits.

fig. 43a

fig. 43b

Figure 43. (a) The absence of a tail (e.g. *Epomophorus* species), and (b) the presence of a short tail (e.g. *Rousettus* species).

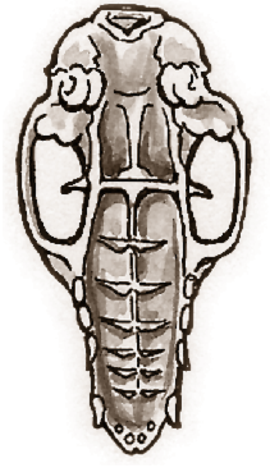


fig. 44a

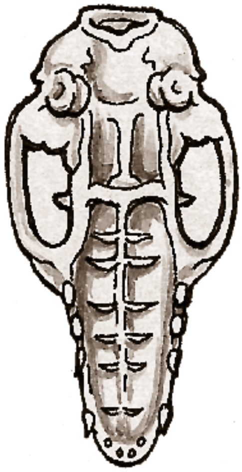


fig. 44b

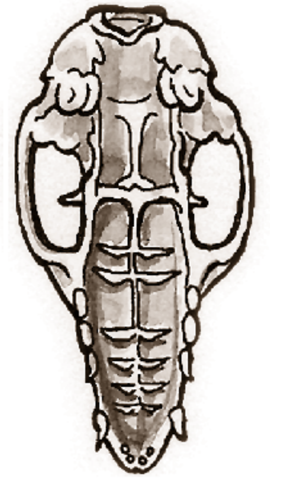


fig. 44c

Figure 44. The configuration of palatal ridges in three Pteropodidae species (a) *Epomophorus wahlbergi*, (b) *E. crypturus*, and (c) *E. angolensis*

Fruit bats, worldwide, are known to pollinate at least 528 species of flowering plants (Fleming *et al.* 2009). In Africa, the pollination of selected plants by fruit bats has been studied in West African fruit bats only (Rosevear 1965); an inaugural study revealed that fruits bats pollinate the Baobab, *Adansonia digitata* (Jaeger 1945), and subsequent studies focused on pollination of the Sausage Tree, *Kigelia africana*, and other west African trees by pteropids (Baker and Harris 1957, Harris and Baker 1958, 1959). These interesting subjects of the ecology and coevolution of Afrotropical plants and pteropids await deserving study – improving our understanding of bat –plant interactions in pollination and seed dispersal in tropical landscapes has important significance for biodiversity conservation (Bermingham *et al.* 2005, Fleming *et al.* 2009). Such exigency and the dearth of knowledge on these subjects challenges evolutionary biologists – in southern Africa especially – with interesting opportunities.

The genus *Megaloglossus* is sufficiently derived, with its unique, extensible tongue and nectivorous diet, to warrant its own subfamily Macroglossinae, while the remaining southern African genera are placed in the Pteropodinae (Bergmans 1997). Southern African representatives of the latter subfamily fall

TABLE 5. IDENTIFICATION MATRIX FOR GENERA WITHIN THE FAMILY PTEROPODIDAE

GENUS	FA (MM)	TAIL	WHITE EAR PATCHES	GLANDULAR PATCH/HAIRS (MALES)	PALATAL RIDGES[1]	WING	OTHER
Megaloglossus	39–49	very short	no	throat – ruff of longer whitish hairs	7 ridges, 4+2+1	inserts on 2nd or 3rd toe or between	Africa's smallest fruit bat; pointed snout and elongated tongue
Casinycteris	50–64	absent	yes	unknown	2 series: 3–4 thick + 1 thin, then 13–16 thin, irregular, serrated	unknown	shortened palate and upturned rostrum
Plerotes	50–53	absent	yes	unknown	8 simple ridges, 4+0+4	unknown	narrow interfemoral membrane, calcar absent
Micropteropus	49–64	very short	yes	shoulders – long white hair	6 prominent ridges (1st undivided, remainder divided by prominent medial gap), followed by variable number of narrow serrated ridges, 1+5+2–4	unknown	-
Myonycteris	66–75	short tail	no	throat – ruff of long sticky hair	usually 9 ridges, 3+4+2	inserts on 2nd toe	metacarpal and first phalanx of 5th digit = forearm length
Epomophorus	60–95	absent	yes	shoulders – long white hair	6 ridges, typically 4+2+0 (see genus matrix below)	inserts on 2nd toe	face as long as brain case
Lissonycteris	85–86	short tail	no	throat – ruff of long sticky hair	8 or usually 9 ridges, usually 3+4+2	inserts on 2nd toe	metacarpal and first phalanx of 5th digit longer than forearm length
Epomops	80–104	absent	yes	shoulders – long white hair	5 thick undivided and 3–4 thin ridges in *E. dobsoni*, 5+0+3–4, and 3 thick undivided and 5–8 thin ridges in *E. franqueti*, 3+0+5–8	inserts on 2nd toe	face much shorter than braincase
Rousettus	86–106	short tail	no	two restricted glandular areas with stiffened hairs on sides of neck	typically 8 ridges, 4+3+1	inserts on 1st toe or between 1st and 2nd	metacarpal and first phalanx of 5th digit much shorter than forearm length
Eidolon	110–130	short tail (~15 mm)	no	glandular hairs on neck	8–11 ridges, 4+3+1–4 or 3+4+1–4	inserts on 1st toe; naked wing	dorsal fur restricted to narrow band
Hypsignathus	114–134	absent	yes	absent	10–11 ridges, the first 5 are thick while the remainder are thin	unknown	large, swollen muzzle, especially pronounced in males

[1] Palatal formula indicates, from front to back, three groups: undivided ridges, divided ridges and thin serrated ridges near the posterior end of the palate

TABLE 6. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE GENUS *EPOMOPHORUS* (PTEROPODIDAE)

SPECIES	FA (MM)	DISTINGUISHING COLOUR AND MARKS	PALATAL RIDGE	ROOST	RANGE IN SOUTHERN AFRICA
E. labiatus	58–66	-	2nd to 4th ridges not divided	banana trees, palm roofs of huts	widespread in Malawi and Zambia
E. grandis	62–66	-	2nd to 6th ridges divided by narrow groove	not known	restricted to Angola and DRC
E. anselli	64–77	-	2nd to 4th ridges not divided	not known	restricted to northeast Malawi
E. wahlbergi	69–93	broad muzzle	only 1 post-dental palatal ridge	dense foliage of tall trees	widespread and abundant in eastern parts
E. crypturus	75–88	narrow muzzle	2 post-dental palatal ridges; 4th ridge is midway between 3rd and 5th ridges	dense foliage of tall trees	widespread and abundant in eastern parts
E. angolensis	76–94	narrow muzzle	two post-dental palatal ridges; 4th ridge closer to 3rd than 5th ridge	not known	restricted to southwestern Angola and northwestern Namibia

TABLE 7. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE GENERA *EPOMOPS*, *MYONYCTERIS* AND *LISSONYCTERIS* (PTEROPODIDAE)

	FA (MM)	PALATAL RIDGES	ROOST	RANGE IN SOUTHERN AFRICA
***EPOMOPS* SPP.**				
E. dobsonii	80–92	2–4 post-dental palatal ridges, 5+0+3–4	-	widespread in northern parts
E. franqueti	88–104	5–8 post-dental palatal ridges, 3+0+5–8	-	marginal into the region: DRC, northwestern Angola and northeastern Zambia
***MYONYCTERIS* SPP.**				
M. torquata	< 65	typically 9 ridges, 3+4+2	probably trees	marginal into region: restricted to rainforests of Central and West Africa
M. relicta	69–71	typically 8 ridges, 3+3+2	not known	widespread along eastern coastal parts
***LISSONYCTERIS* SPP.**				
L. angolensis	72–83	typically 9 ridges,3+4+2	hollow trees, entrance to caves	marginal southern African endemic: restricted to rainforests of Central and West Africa
L. goliath	75–90	typically 9 ridges, 3+4+2	probably as above	southern African endemic: highlands of eastern Zimbabwe and central Mozambique

TABLE 8. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE GENERA *ROUSETTUS* AND *MICROPTEROPUS* (PTEROPODIDAE)

SPECIES	FA (MM)	DISTINGUISING COLOUR AND MARKS	PALATAL RIDGES	ROOST	RANGE IN SOUTHERN AFRICA
***ROUSETTUS* SPP.**					
R. aegyptiacus	82–101	short-furred	typically 4+3+1 in R. a. leachii from southern Africa	caves	widespread in the eastern parts of the region and northwestern Angola
R. lanosa	91–93	long-furred	typically 4+3+1	caves	associated with montane regions
***MICROPTEROPUS* SPP.**					
M. pusillus	49–56	white ear base	1+5+2–4, 2nd and 3rd ridges fused	trees	marginal, northern Angola
M. intermedius	57–64	white ear base	1+5+2–4, no ridges fused	not known	marginal, northern Angola

into two groups: an epomophorine group and rousettine group. The epomophorine group encompasses the following genera: *Epomophorus, Hypsignathus, Casinycteris, Micropteropus, Epomops* and *Plerotes*; while the rousettine group contains *Rousettus, Eidolon, Lissonycteris* and *Myonycteris*. The epomophorine group typically possesses white ear patches and the males possess shoulder epaulettes. In contrast, the rousettine group lacks both these features, rendering these bats far drabber in appearance; they have a short tail (Figure 43). Surprisingly, the taxonomic position of *Lissonycteris* and the closely related *Myonycteris* is disputed, with some authorities placing them in the epomophorine group. *Lissonycteris* was once considered a subgenus within *Rousettus*. Relationships within the Pteropodidae have traditionally been based on a number of characters; one of the most important of these is the configuration of palatal ridges (Figure 44).

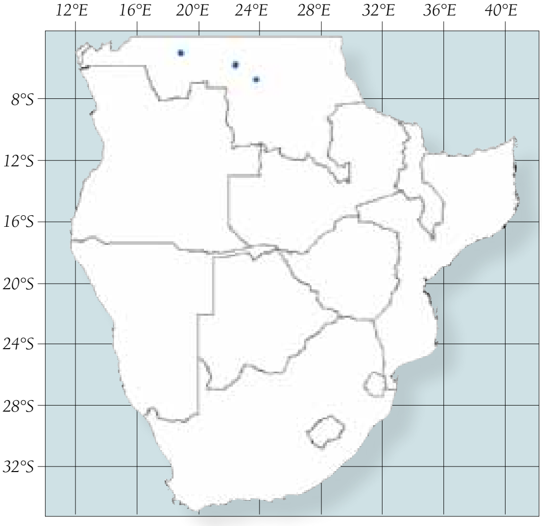
Hypsignathus and *Nanonycteris* are monotypic genera, and their taxonomic status is not currently disputed. *Micropteropus*, *Epomophorus* and *Epomops*, however, are not as clearly distinct and there is still debate on the position of species within them. *Epomophorus grandis* was originally described as *Micropteropus grandis* (hence the species epithet), and may still be a member of the latter genus. The palatal ridges in this species appear to be intermediate between that of the two genera. Similarly, *Epomops dobsonii* may in fact be an *Epomophorus*, judging by its biogeography and its intermediate palatal ridges. Externally, *Micropteropus* and *Nanonycteris* are almost identical (to the point that they cannot be identified with certainty on external features alone), but their palatal ridges are completely different, justifying generic separation (note that *Nanonycteris* does not occur in southern Africa).

Within the rousettine group, *Lissonycteris* and *Myonycteris* are closely related. *Rousettus* and *Eidolon* are also closely allied. However, the former pair may actually be more appropriately placed within the epomophorine group.

Casinycteris argynnis Thomas 1910

Golden short-palate fruit bat

Near Threatened



Description: *Casinycteris argynnis* is a small fruit bat with a mass of around 30 g. The broad muzzle is dog-like and distinctly shortened; the very thick, extensible lips resemble cheek pouches and emphasise the short-snoutedness of this species. The eyes are relatively large, their prominence accentuated by the yellow skin of the eyelids. The overall colour of the longish fur is russet-brown, with conspicuous greyish-white fur on the neck and belly and prominent white fur around the anterior bases of the ears. The skin of the large, rounded, vertical ears is similarly brightly coloured yellow or yellowish-brown. There are patches of white fur on the rostrum, above the eyes and anterior bases of the ears, with fur on the cheeks and lips paler, tending to white; this paler fur contrasts against the yellow skin of the nostrils, chin and lips; these brighter patches varying amongst individuals from orange to yellow; the brightly coloured reticulations on the wing membranes are a similar yellow or orange, and are most distinct on the skin around the finger joints. The bright skin pigment fades in museum specimens. The thumb is relatively long. No visible tail.

The skull has a domed braincase; zygomatic arches relatively strong and prominent in dorsal view of the skull. The premaxillae are relatively well developed; the canines are relatively long, with short, broad, sub-circular molars; post-dental palate markedly reduced. There are two series of palatal ridges; one of three to four interdental ridges, in front of a ladder of crowded, thin post-dental ridges (13–16) (Andersen 1912, Bergmans 1990).

Key identification features: *Scotonycteris zenkeri* is a smaller bat (FA < 56 mm), and lacks the white fur around the ears; the ears of C. argynnis are larger, and the eyelids, muzzle and reticulated wing membranes are often a bright orange or yellow, but this pigment fades in museum specimens. The wing membranes of *S. zenkeri* are brown. Scotonycteris opidion is a larger bat (FA > 75 mm). The palate of *C. argynnis* ends at the level of the upper molar teeth, and the upturned rostrum is correspondingly shorter. The orbital cavities are larger; the zygoma, postorbital processes and cranial ridges of the skull are more strongly developed compared to *Scotonycteris* (Bergmans 1990).

Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Casinycteris argynnis* is restricted to the main forest belt, with scattered records that extend its equatorial range across the Congo basin to the western edge of the Albertine Rift. Records are associated with Guinean-Congolian lowland rainforest, Swamp forest, and rainforest–grassland mosaic. Three specimens from the southern Congo basin extend its range as far south as Kananga (= Luluabourg) at ~6°S in the DRC. The type specimen is from Bitye, Cameroon (BM 11.5.5.1).

Little is known about its roosting behaviour. Lang *et al.* (1917) described a solitary individual roosting in a tree.

External and cranial measurements (mm) and mass (g) for *Casinycteris argynnis*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	26	-	-	-	1	**Mass**[1]	-	28.5	33.0	-	3
FA[1]	-	49.8	54.9	-	10	**FA**[1]	-	54.4	63.5	-	13
Total	-	-	-	-	-	**Total**[2]	95.0	-	-	-	1
Tail	-	-	-	-	-	**Tail**	-	-	-	-	-
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear	-	-	-	-	-	**Ear**	-	-	-	-	-
CI[1]	-	21.8	23.9	-	3	**CI**	-	24.0	26.7	-	11

[1] Bergmans (1990)
[2] Thomas (1910)

Extralimital: Known from four localities in eastern Cameroon, in addition to the total of eight localities in the DRC (Bergmans 1990).

Foraging ecology: There is no information on the diet or foraging behaviour of this species, although it is frugivorous.

Reproduction: No reproductive information is available.

SYSTEMATIC NOTES

1910. *Casinycteris argynnis* O. Thomas 1910 Ann. Mag. Nat. Hist. (Ser. 8) 6: 111. Bitye, Cameroon.

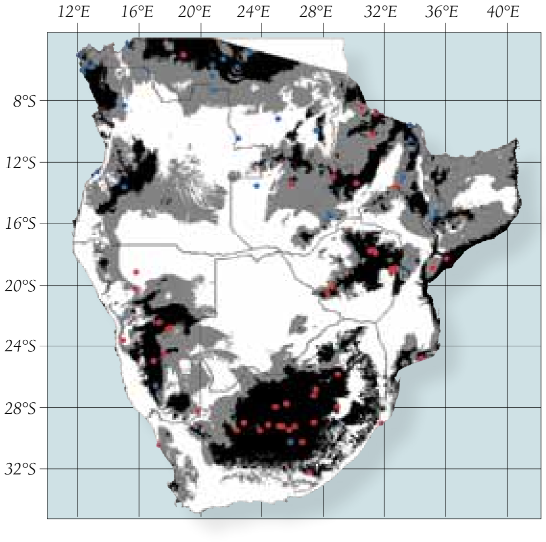
This rarely collected species represents a monotypic genus with distinct morphological characters, which distinguish it from all other Pteropodidae (Bergmans 1990).

Figure 45. A specimen of *Casinycteris argynnis* from the eastern Congo (© W. Bergmans).

Eidolon helvum (Kerr 1792)

African straw-coloured fruit bat

Least Concern



Description: *Eidolon helvum* is a very large fruit bat with a mass of around 170 g, making it the second-largest fruit bat on mainland Africa after *Hypsignathus monstrosus*. The pelage is typically pale yellow-brown to orange-brown with paler underparts. A distinct orange collar is present in most individuals that extends from the sides of the neck to the throat. The wings are dark brown and contrast strikingly with the pale underparts. There are no shoulder epaulettes and the ears do not have a patch of white fur at their base. The muzzle is dog-like and rather short and broad. A short tail is present.

The skull is massive with moderate zygomatic arches. The cranium is distinctly arched with the rostrum tapering rapidly anteriorly from orbit and posterior braincase strongly deflected downwards. The auditory meatus opens into a long neck (Rosevear 1965). The sagittal crest is low, but usually clearly visible. The lambdoid crest is fairly well developed. The palatal ridges have been illustrated in Happold (1987). The dental formula is 2132/2133 = 34 with the first upper premolar reduced in size, but larger than the incisors.

Key identification features: The combination of large size (FA > 105 mm) and lack of white ear patches separates *Eidolon* from all other African fruit bats. Its pale colouring with contrasting dark wings distinguishes it from very large specimens of *Rousettus* (which can marginally overlap in size with juvenile *E. helvum*). *Hypsignathus monstrosus* is similar in size, but has white patches of fur at the base of the ears and a cylindrical muzzle.

Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Eidolon helvum* occurs widely in the region as a non-breeding migrant. There are numerous individual records from the central plateaus of South Africa and Namibia. The species has also been widely recorded in Zimbabwe, Zambia, southern DRC and Malawi. There are scattered records from western Angola. The type specimen is from Senegal.

This species is relatively well represented in museums, with more than 100 specimens examined for this book.

Little is known about its roosting behaviour in the region. Two large colonies have been described from southern Africa: a probable breeding colony at Marromeu, Mozambique, that supports hundreds of bats (Cotterill 2001c), and a massive colony at Kasanka National Park, Zambia, that sees an influx of 1.5 million non-breeding bats between November and January (Sorensen and Halberg 2001). Based on four bats from the Kasanka colony radio-tracked using satellite telemetry, large-scale feeding and migratory movements were documented (Richter and Cumming 2008). Bats foraged at distances of up to 59 km from their roost. One migrating bat moved 370 km in one night, and one individual travelled a cumulative 2,518

External and cranial measurements (mm) and mass (g) for *Eidolon helvum*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	196.4	140.5	252.5	-	2	**Mass[1]**	158.2	117.0	196.0	-	3
FA[1]	112.5	103.6	130.0	8.75	9	**FA[1]**	119.3	110.7	135.0	10.28	5
Total[1]	197.0	140	240	40.80	6	**Total[1]**	215.0	160	270	43.1	5
Tail[1]	17.0	9	20	4.20	6	**Tail[1]**	18.0	12	22	4.40	5
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	22.0	10	29	8.50	4	**Ear[1]**	26.0	23	28	2.20	5
CI[1]	50.8	45.8	55.1	3.91	8	**CI[1]**	50.2	46.0	53.0	3.08	8

[1] Specimens measured by the authors

fig. 46a

fig. 46b

fig. 46c

Figure 46. Skull and teeth of *Eidolon helvum*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (SMM 6848).

fig. 46d

km in 149 days. This Kasanka population depends critically on a functional network of roosting and foraging sites, and intact fruit-producing woodlands, throughout Zambia and the DRC.

Extralimital: *Eidolon helvum* is widespread in sub-Saharan Africa occurring from Senegal in the west to Kenya in the east, south into southern Africa and north to the Sahel (DeFrees and Wilson 1988, Bergmans 1990).

Foraging ecology: *Eidolon helvum* has broad wings with high wing loading (30.6 Nm 2) and low aspect ratio (6.9) (Norberg and Rayner 1987). There is no information on the diet or foraging behaviour of this species in southern Africa, but elsewhere it feeds on the following fruits (both wild and cultivated) and on some flowers (Fujita and Tuttle 1991): *Anacardium occidentale, Mangifera indica, Pseudospondias spp., Spondias mombin, Annona spp., Kigelia aethiopica, K. pinnata, Adansonia digitata, Bombax buonopozense, Ceiba pentandra, Ochroma pyramidale, Carica papaya, Musanga cecropioides, Parinari excelsa, Terminalia spp., Bridelia ferruginea, Sapium ellipticum, Persea americana, Albizia spp., Erythrina spp., Parkia clappertoniana, P. filicoidea, P. roxburghii, Antiaris africana, Artocarpus spp., Chlorophora spp., C. excelsa, Ficus exasperata, F. leprieurii, F. mucosa, F. natalensis, F. thonningii, F. umbellata, F. vogelii, Musa sapientum, M. paradisiaca, Pycnanthus angolensis, Eucalyptus spp., Psidium guajava, Syzygium spp., Borassus aethiopum, Elaeis spp., Phoenix dactylifera, Adenia cissampeloides, Passiflora spp., Maesopsis spp., Eriobotrya spp., Vitellaria paradoxum, Solanum anomalum, Cola spp., Theobroma cacao,* and *Celtis spp*. Richter and Cummings (2006, 2008) suggest that the annual migration to Kasanka is driven by seasonal variations in food supply.

Reproduction: At present, only a single probable breeding colony is known from southern Africa at Marromeu, central Mozambique. However, the collection of females, both full-term and carrying neonates from Chiniziwa, central, and Mutare, eastern Zimbabwe, confirm that this species breeds in southern Africa (Cotterill 2001c). Several hundred bats are present at the Marromeu colony throughout the year, including sexually active adults and subadults, suggesting that breeding is taking place. Breeding in Uganda occurs in April–June; the bats then migrate away until August and September when they start returning; births are recorded in December–February (Kingdon 1974).

SYSTEMATIC NOTES

1792. *Vespertilio vampyrum helvus* Kerr, Linnaeus's Animal Kingdom 1(1): xvii, 91. Senegal.

Only the nominate subspecies occurs in Africa; *E. h. sabaeum* K. Andersen 1912 occurs in Arabia.

The diploid number in *E. helvum* is 2n = 34 (Matthey 1962).

fig. 47a

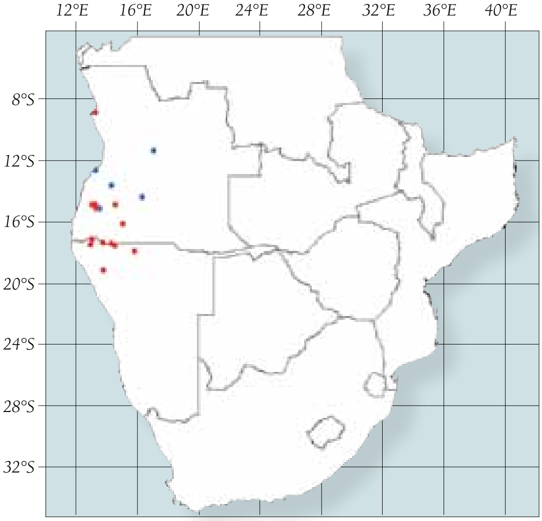
fig. 47b

Figure 47. *Eidolon helvum*: (a) portrait showing orange collar, and (b) roosting individuals showing contrasting dark wings with orange-brown bodies (a: © Merlin D. Tuttle, Bat Conservation International, www.batcon.org; b: Marromeu, Zambezi Delta © F. P. D. Cotterill).

Epomophorus angolensis Gray 1870

Angolan epauletted fruit bat

Near Threatened



Description: *Epomophorus angolensis* is a large bat with a mass of around 90 g. Its external appearance is very similar to *E. crypturus*. The pelage is light sandy-brown. The underparts are paler than the upper parts. The wings are light brown and sparsely covered in hair. Adult males are much larger than females, and may be distinguished by a broader muzzle with a folded upper lip and the presence of shoulder epaulettes. These epaulettes are pockets containing long, white fur that can be erected to display prominent white shoulder patches. At rest, these patches disappear as the fur is retracted into the pocket. The ears have a patch of white fur at their base. The muzzle is dog-like and similar to that of *E. crypturus*.

The skull is relatively robust with sturdy zygomatic arches. In lateral profile, the entire cranium is dorsoventrally flattened and only very slightly bowed; the rostrum gradually slopes downwards anteriorly and the braincase is very slightly deflected downward posteriorly. The sagittal crest is weak, while the lambdoid crest is fairly well developed. There are six narrow palatal ridges present, two beyond the last molar. The fourth palatal ridge is nearer the third than the fifth ridge. The dental formula is 2121/2132 = 28.

External and cranial measurements (mm) and mass (g) for *Epomophorus angolensis*, sexes combined

	Mean	Min	Max	SD	n
Mass[1]	86	80	92	-	2
FA[1]	81.7	76	90	-	3
Total[1]	147.3	140	154	5.89	6
Tail	-	-	-	-	-
Tibia	-	-	-	-	-
Ear[1]	24.5	24	26	0.89	6
CI[1]	50.7	45.4	59.6	5.24	9

[1] Specimens measured by the authors

Key identification features: The combination of white patches at the base of the ears and shoulder epaulettes (males) separates *Epomophorus* and *Epomops* from other fruit bats. Palatal ridges of *Epomops* are very different from those of *Epomophorus*; in the latter there are six narrow ridges. Adult *E. angolensis* can be distinguished from sympatric *E. wahlbergi* by the former's broader muzzle and the presence of two post-dental palatal ridges. *E. crypturus* does not co-occur with *E. angolensis*, and differs in the position of palatal ridges, whereby the fourth palatal ridge is closer to the third than the fifth ridge in *E. angolensis*, but is midway in *E. crypturus*.
Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Epomophorus angolensis* is restricted to southwestern Angola and extreme northwestern Namibia. Most Namibian records are from the Kunene River, but it has been collected to the south from Sesfontein. In Angola, it has been collected as far as Luanda in the north and Chitau in the east. The type specimen is from Benguela, Angola (BM 1864.1.9.4, Holotype).

This species is poorly represented in museums, with just 24 records included in this book. Very little is known about its biology.

Extralimital: *Epomophorus angolensis* is endemic to southern Africa.

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: Juveniles, attached to their mothers, have been recorded in September and October in Namibia (Shortridge 1934).

SYSTEMATIC NOTES

1870. *Epomophorus macrocephalus* var. *angolensis* Gray, Catalogue of the Monkeys, Lemurs and Fruit-eating Bats in the British Museum: 125. Angola.

Epomophorus angolensis appears to be closely related to *E. crypturus*, with which it is allopatric and may form a species complex. No subspecies are recognised.

fig. 48a

fig. 48b

fig. 48c

fig. 48d

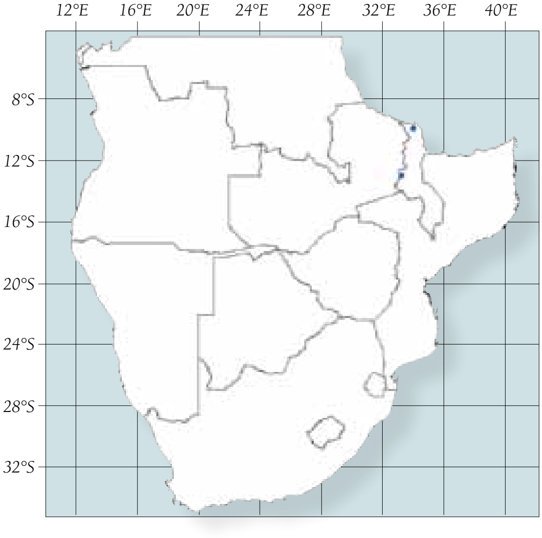
Figure 48. Skull and teeth of *Epomophorus angolensis*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (SMM 8212).

Figure 49. *Epomophorus angolensis*, portrait showing white ear tufts (© A. Monadjem).

Epomophorus anselli Bergmans & van Strien 2004 ○

Ansell's epauletted fruit bat

Not Evaluated



Description: *Epomophorus anselli* is a medium-sized bat with an estimated mass of about 70 g, and is midway in size between the smallest and the largest representatives of its genus. The pelage is light sandy-brown. Adult males are larger than females, and may be distinguished by a broader muzzle with a folded upper lip and the presence of shoulder epaulettes. These epaulettes are pockets containing long, white fur that can be erected to display prominent white shoulder patches. At rest, these patches disappear as the fur is retracted into the pocket. The ears have a patch of white fur at their base. The muzzle is dog-like.

For a fruit bat, the skull is relatively delicate with fairly weak zygomatic arches. In lateral profile, the rostrum and interorbital region are flat, while the parietal region is deflected downwards. The sagittal crest is absent, while the lambdoid crest is weak. There are six narrow palatal ridges present, two beyond the last molar. Only the fifth and sixth ridges are divided by a narrow groove (Bergmans and van Strien 2004). The dental formula is 2121/2132 = 28.

Key identification features: The combination of white patches at the base of the ears and shoulder epaulettes (males) separates *Epomophorus, Epomops* and *Micropteropus* from other fruit bats. Palatal ridges of *Epomops* and *Micropteropus* are very different from those of *Epomophorus*; in the latter there are six narrow ridges (five thick ridges in *Micropteropus* and *Epomops*). Adult male *E. anselli* can be distinguished from the larger male *E. wahlbergi* and *E. crypturus* by size (FA < 80 mm, in adult *E. wahlbergi* and *E. crypturus* FA > 80 mm). *Epomophorus labiatus minor* and *E. grandis* are smaller (FA < 70 mm) and in *E. grandis* the second to sixth palatal ridges are divided (second to fourth ridges not divided in *E. anselli*).

Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Epomophorus anselli* is known from just two specimens collected in Kasungu National Park, Malawi; a further two specimens collected from Karonga, Malawi, are suspected to belong to *E. anselli* (Bergmans and van Strien 2004). *Epomophorus anselli* is probably more widespread than currently known, and should be searched for in eastern Zambia and neighbouring DRC, northern Mozambique and southern Tanzania. The type specimen for *E. anselli* is from Kasungu, Malawi (ZMA 21.693b, Holotype).

Nothing is known about the habitat and roosting habits of this species. Both specimens at Kasungu National Park were captured in miombo woodland at an elevation of approximately 1,000 m.

Extralimital: *Epomophorus anselli* is endemic to southern Africa, thus far only recorded from Malawi.

External measurements (mm) for *Epomophorus anselli*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass	-	-	-	-	-	**Mass**	-	-	-	-	-
FA[1]	77.4	-	-	-	1	**FA**[1]	66.5	64.0	68.0	-	3
Total	-	-	-	-	-	**Total**	-	-	-	-	-
Tail	-	-	-	-	-	**Tail**	-	-	-	-	-
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear	-	-	-	-	-	**Ear**	-	-	-	-	-
CI	-	-	-	-	-	**CI**	-	-	-	-	-

[1] Bergmans and van Strien (2004)

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: No reproductive information is available.

SYSTEMATIC NOTES

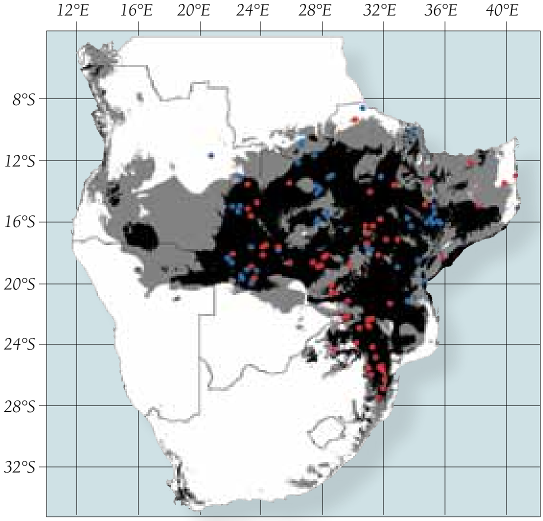
2004. *Epomophorus anselli* Bergmans and van Strien, Acta Chiropterologica 6: 249–268.

There is confusion regarding the taxonomic relationships within the small-sized bats of the genus *Epomophorus* (see the *E. labiatus* account for further details). The specimens now referred to as *E. anselli* were originally identified as an isolated Malawian population of *E. anurus* (see Bergmans and van Strien 2004), which has since been synonymised with *E. labiatus* (Bergmans 1988).

Epomophorus crypturus Peters 1852

Peters's epauletted fruit bat

Least Concern



Description: *Epomophorus crypturus* is a large bat with a mass of about 100 g. The pelage is light sandy-brown. The underparts are slightly paler than the upper parts. The wings are light brown and sparsely covered in hair. Adult males are much larger than females, and may be distinguished by a broader muzzle with a folded upper lip and the presence of shoulder epaulettes. These epaulettes are pockets containing long (9 mm in length), white fur that can be erected to display prominent white shoulder patches. At rest, these patches disappear as the fur is retracted into the pocket. The ears have a patch of white fur at their base. The muzzle is dog-like and narrower than that of the similar *E. wahlbergi* (Taylor and Monadjem 2008).

The skull is robust with sturdy zygomatic arches. Mature males have larger skulls (greatest length > 52 mm) than females (< 52 mm). In lateral profile, the entire cranium is dorsoventrally flattened and only very slightly bowed; the rostrum slopes gradually downwards anteriorly and the braincase is very slightly deflected downward posteriorly. The maxilla is distinctly narrower than in *E. wahlbergi* (Taylor and Monadjem 2008). The sagittal crest is low, but usually clearly visible. The lambdoid crest is fairly well developed. There are six narrow palatal ridges present, two beyond the last molar. The fourth palatal ridge is midway between the third and the fifth ridges. The dental formula is 2121/2132 = 28.

Key identification features: The combination of white patches at the base of the ears and shoulder epaulettes (males) separates *Epomophorus* and *Epomops* from other fruit bats. Palatal ridges of *Epomops* are very different from those of *Epomophorus*; in the latter there are six narrow ridges. Adult *E. crypturus* can be distinguished from sympatric *E. wahlbergi* by the presence of two post-dental palatal ridges (only one in *E. wahlbergi)* and narrower muzzle (in *E. crypturus*, width of maxilla at labial posterior edges of the upper M3 < 13 mm, <14 mm in adult females and males, respectively; in *E. wahlbergi* > 13 mm, > 14 mm in females and males, respectively) (Taylor and Monadjem 2008). *E. crypturus* and *E. angolensis* can be separated by the pattern of palatal ridges whereby the fourth palatal ridge is midway between the third and fifth ridges in *E. crypturus*.

Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Epomophorus crypturus* is widespread and abundant in the eastern parts of the region, where it has been recorded from northern KwaZulu-Natal and Swaziland, through the Kruger National Park to

External and cranial measurements (mm) and mass (g) for *Epomophorus crypturus*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	104.5	80.0	140.0		12	**Mass[1]**	75.5	64.0	88.0		12
FA[2]	84.5	80.0	88.4		51	**FA[2]**	79.0	75.0	83.2		40
Total[3]	147.0	126	168	14.30	14	**Total[3]**	129.0	106	148	12.20	16
Tail[3]	0				8	**Tail[3]**	0				12
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[3]	24.8	19	28	2.50	14	**Ear[3]**	24	21	27	1.77	16
CI[3]	51.5	44.7	55.1	2.70	18	**CI[3]**	42.3	37.7	46.0	2.49	18

[1] From Skinner and Chimimba (2005)
[2] Bergmans (1988)
[3] Specimens measured by the authors

fig. 50a

fig. 50b

fig. 50c

fig. 50d

Figure 50. Skull and teeth of *Epomophorus crypturus*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8035).

fig. 51a

fig. 51b

Zimbabwe, northern Botswana, Zambia, Malawi, extreme southern DRC and northern Mozambique. It appears to be absent from coastal forest in southern Mozambique, and there are only two records for eastern Angola. It is possibly widespread in eastern Angola, where it may have been overlooked. The type specimen is from Tete, Mozambique (ZMB 10080, Lectotype).

This species is well represented in museums, with over 160 records examined for this book.

Epomophorus crypturus roosts singly or in small groups in dense foliage of a large, leafy tree and may travel several kilometres each night to reach fruiting trees. It is associated with forest and forest-edge habitats, particularly riparian forest which extensively incises savannas in the eastern part of the region. However, it appears to prefer drier conditions than *E. wahlbergi*, hence its absence from coastal forests in Mozambique and South Africa. It may occur sympatrically with *E. wahlbergi*, but usually one or the other species is numerically dominant.

Extralimital: *Epomophorus crypturus* is a near-endemic to southern Africa, occurring marginally outside of it in the extreme south of Tanzania.

Foraging ecology: *Epomophorus crypturus* feeds on a wide variety of fruit and flowers, with figs apparently being favoured (Smithers 1983). Fruits eaten include *Ficus* spp., *Sclerocarya birrea, Parinari curatellifolia, Pseudolachnostylis maprouneifolia, Uapaca kirkiana, Berchemia discolor, Mimusops zeyheri* and *Rauvolfia caffra* (Smithers 1983). Fruits are typically carried to feeding sites close to where they were plucked from; these feeding roosts are often on a large branch from which the bats can hang. They are wasteful feeders, discarding hard skins, seeds, pips and mouthfuls of chewed pulp onto the ground below (Smithers 1983). In Zimbabwe, telemetry studies showed that they began foraging less than 45 minutes after dark, visiting the same fruiting tree on two subsequent nights (Thomas and Fenton 1978).

Reproduction: In Zimbabwe, pregnant females were recorded throughout most of the year, with a peak in the presence of juveniles in September, suggesting that births predominantly occur at the beginning of the wet season (Smithers and Wilson 1979). One or rarely two young are born.

SYSTEMATIC NOTES

1852. *Epomophorus crypturus* Peters, Reise nach Mossambique, Zoologie 1, Säugethiere: 26. Tete, Zambezi, western Mozambique.

Epomophorus crypturus has traditionally been treated as a subspecies of *E. gambianus*. Bergmans (1988) recognised three subspecies *gambianus* (Olgiby 1835), *pousarguesi* Trouessart 1904 and *crypturus*; and showed that *parvus* Ansell 1960 from Zambia did not differ cranially from *crypturus*. However, *crypturus* is widely separated from the other two subspecies, occurs in a different habitat and may have some cranial differences (Bergmans 1988). For this reason we prefer to treat *crypturus* (incorporating *parvus*) as a full species.

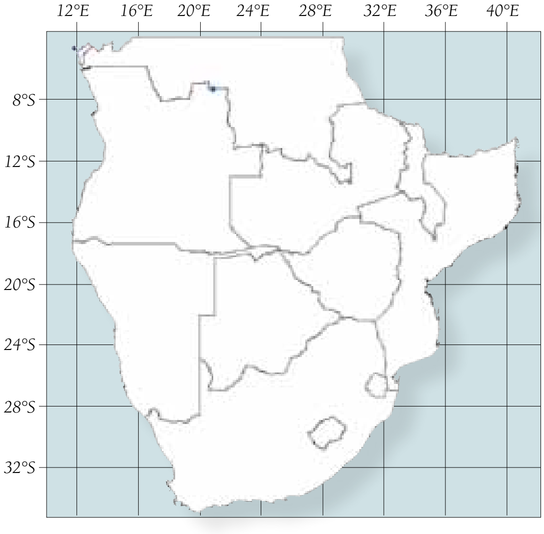
The diploid number in *E. crypturus* is 2n = 35 (male), 36 (female) and FN = 68 (Peterson and Nagorsen 1975).

Figure 51. *Epomophorus crypturus*: (a) portrait showing white ear tufts, and (b) individual in flight carrying fruit in its mouth (a: © P. J. Taylor; b: © Merlin D. Tuttle, Bat Conservation International, www.batcon.org).

Epomophorus grandis (Sanborn 1950)

Sanborn's epauletted fruit bat

Data Deficient



Description: Despite its name, *Epomophorus grandis* is a medium-sized bat (and small for a fruit bat) with an estimated mass of 50–60 g. The pelage is light brown; the individual hairs are uniformly coloured (Hayman 1963). It is assumed that, as a member of the genus *Epomophorus*, adult male *E. grandis* will display white shoulder epaulettes; however, two date only two young males have been collected, neither of which had these patches (Bergmans 1988). The ears have a patch of white fur at their base. The muzzle is dog-shaped.

The dental formula is 2121/2132 = 28.There are six narrow palatal ridges present with the second to the sixth divided by a narrow groove (Sanborn 1950). One ridge is present beyond the last molar.

Key identification features: The combination of white patches at the base of the ears and shoulder epaulettes (males) separates *Epomophorus* and *Epomops* and *Micropteropus* from other fruit bats. Palatal ridges of *Epomops* and *Micropteropus* are very different from those of *Epomophorus*; in the latter there are six narrow ridges (five thick ridges in *Micropteropus* and *Epomops*). *Epomophorus grandis* can be distinguished from sympatric *E. wahlbergi* by its much smaller size (FA < 70 mm; in E. wahlbergi FA > 75 mm). *Epomophorus grandis* is the same size as *E. labiatus* and *E. anselli*, but in the last two species, the second to the fourth palatal ridges are undivided (second to sixth palatal ridges divided in *E. grandis*).

External measurements (mm) for *Epomophorus grandis*, sexes combined

	Mean	Min	Max	SD	N
Mass	-	-	-	-	-
FA[1]	63.6	62.3	65.8	-	3
Total[1]	99.0	-	-	-	1
Tail[1]	5.7	3.8	7.5	-	2
Tibia[1]	28.1	27.3	28.7	-	3
Ear[1]	16.9	16.0	17.5	-	3
CI	-	-	-	-	-

[1] Bergmans (1988)

Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Epomophorus grandis* is known from just four specimens collected at two localities in Angola and Congo (Bergmans 1988). It is probably more widespread than suggested by these two localities. It may occur throughout northern Angola and possibly the western DRC and Congo. The type specimen is from Dundo, northeastern Angola (FMNH 66433, Holotype).

This species appears to be associated with a mosaic of lowland rainforest and secondary grassland (Bergmans 1988), suggesting that it will not be found to occur in primary rainforest to the north of its known range, but may occur in the Guinea-Congolia/Zambesian Transition Zone between forest and savanna to the south.

Extralimital: *Epomophorus grandis* is a near-endemic to southern Africa, occurring marginally outside of it in the extreme southwest of Congo.

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: No reproductive information is available.

SYSTEMATIC NOTES

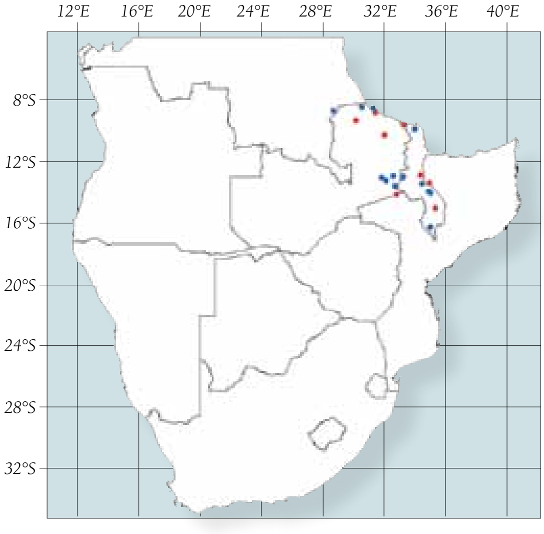
1950. *Micropteropus grandis* Sanborn, Chiroptera from Dundo, Lunda, northeastern Angola. Publções cult. Co. Diam. Angola 10: 53–62.

Epomophorus grandis was originally described as *Micropteropus grandis*; the other two members of that genus are much smaller, hence the epithet '*grandis*'. Ironically, it is one of the smallest members of the genus *Epomophorus*. *Micropteropus* is maintained as a distinct genus by Bergmans (1988), based on the configuration of palatal ridges: five in *Micropteropus* and six in *Epomophorus*. Furthermore, in *Micropteropus*, the palatal ridges are thick with the second to the fifth deeply divided by a groove. In *Epomophorus*, the palatal ridges are narrow with only the fifth and sixth marginally divided. However, in *E. grandis*, the palatal ridges are narrow (as is typical of *Epomophorus*), but the second to the sixth are divided (as in *Micropteropus*).

Epomophorus labiatus (Temminck 1837)

Little epauletted fruit bat

Least Concern



Description: *Epomophorus labiatus minor* is a medium-sized bat with a mass of around 45–55 g; it is the smallest representative of its genus. The pelage is light sandy-brown. The underparts are slightly paler than the upper parts. The wings are light brown and sparsely covered in hair. Adult males are larger than females, and may be distinguished by a broader muzzle with a folded upper lip and the presence of shoulder epaulettes. These epaulettes are pockets containing long, white fur that can be erected to display prominent white shoulder patches. At rest, these patches disappear as the fur is retracted into the pocket. The ears have a patch of white fur at their base. The muzzle is dog-like.

For a fruit bat, the skull is small and relatively delicate with weak zygomatic arches. In lateral profile, the rostrum and interorbital region are flat, while the parietal region is rounded and deflected downwards. The sagittal crest is absent, while the lambdoid crest is weak. There are six narrow palatal ridges present, two beyond the last molar. Only the fifth and sixth ridges are divided by a narrow groove. The dental formula is 2121/2132 = 28.

Key identification features: The combination of white patches at the base of the ears and shoulder epaulettes (males) separates *Epomophorus*, *Epomops* and *Micropteropus* from other fruit bats. The palatal ridges of *Epomops* and *Micropteropus* are very different from those of *Epomophorus*; in the latter there are six narrow ridges (five thick ridges in *Micropteropus* and *Epomops*). Adult *E. labiatus* can be distinguished from the much larger sympatric *E. wahlbergi* and *E. crypturus* by size (FA < 70 mm, in *E. wahlbergi* and *E. crypturus* FA > 75 mm). *Epomophorus labiatus minor* overlaps in size with *E. grandis*, but in the latter the second to sixth palatal ridges are divided (second to fourth ridges not divided *E. labiatus*). *Epomophorus anselli* is larger (male *E. anselli* FA > 70 mm; male *E. labiatus minor* FA < 70 mm).

Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Epomophorus labiatus* is widespread in Malawi and northeast Zambia. It has also been collected from northwestern Mozambique along the shores of Lake Malawi. It may have been overlooked in northern and central Mozambique where it might be more widespread than the current map suggests. The type specimen for *labiatus* is from the Nile Province of Sudan, while that for *minor* is Zanzibar, Tanzania (BM 79.9.12.4, Lectotype).

Considering the restricted distribution of this taxon, it is relatively well represented in museums, with over 30 records examined for this book.

In southern Africa, it has been recorded roosting in a banana tree (Lawrence and Loveridge in Happold *et al.* 1987) and a disused tourist hut (Ansell 1967). In Mozambique, it was netted in a small banana plantation (A. Monadjem, personal observation), suggesting that it was roosting in the

External and cranial measurements (mm) and mass (g) for *Epomophorus labiatus minor*, males and females presented separately

	Mean	**Min**	**Max**	**SD**	**N**		**Mean**	**Min**	**Max**	**SD**	**N**
Males						**Females**					
Mass¹	53.5	48.0	63.5	6.30	5	**Mass¹**	40.5	32.5	51.0	5.80	9
FA¹	63.7	61.0	68.0	2.80	5	**FA¹**	60.5	58.0	63.5	1.70	9
Total¹	110.7	105	115	-	4	**Total¹**	97.2	90	103	5.40	5
Tail¹	2.0	0	5	-	4	**Tail¹**	2.4	0	5	2.50	5
Tibia¹	27.2	26.0	29.0	1.10	5	**Tibia¹**	25.7	24.0	27.5	1.30	7
Ear¹	19.6	18	21	1.10	5	**Ear¹**	17.8	17	19	0.90	7
CI²	34.3	30.0	36.0	2.57	5	**CI²**	31.5	29.1	33.7	2.17	5

[1] Happold *et al.* (1987)
[2] Specimens measured by the authors

fig. 52a

fig. 52b

fig. 52c

fig. 52d

Figure 52. Skull and teeth of *Epomophorus labiatus minor*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8644).

Figure 53. Adult *Epomophorus labiatus minor,* showing the small size of the bat (DM 8644, © A. Monadjem).

banana trees. This taxon is associated with fruiting trees in woodland savanna (Happold *et al*. 1987).

Extralimital: *Epomophorus labiatus minor* occurs widely in East Africa west to Nigeria including: Tanzania, Burundi, Rwanda, Uganda, Kenya, Somalia, Sudan, Ethiopia, Chad, Congo, DRC and Nigeria. The taxon *minor*, however, is restricted to East Africa, occurring in Kenya, Tanzania, Ethiopia, Sudan and DRC.

Foraging ecology: There is no information on the diet or foraging behaviour of *Epomophorus labiatus minor* in southern Africa, but elsewhere it feeds on the following plants: *Mangifera indica*, *Kigelia aethiopica*, *K. pinnata*, *Ficus natalensis*, *F. vallis-choudae*, and *Irvingia smithii* (Fujita and Tuttle 1991).

Reproduction: In Zambia, a pregnant female with foetus was collected on 16 November (Ansell 1967); in Malawi, juveniles have been taken in January, March, April, May, October and November (Bergmans and van Strien 2004), suggesting that *Epomophorus labiatus minor* may breed throughout the year.

SYSTEMATIC NOTES

1837. *Pteropus labiatus* Temminck, Monographies de mammalogie, ou description de quelques genres de mammifères, dont les espèces ont été observées dans les differens musées de l'Europe. II (2): 49–140. Van de Hoek, Leiden and Dufour and d'Ocagne, Paris.

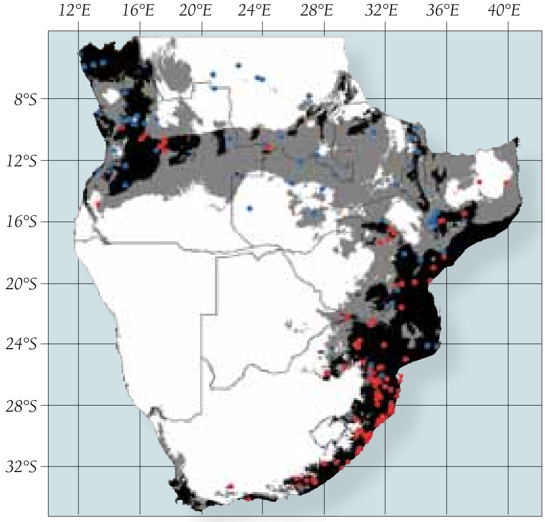
1880. *Epomophorus minor* Dobson, Dobson, Proc. Zool. Soc. Lond., 1879, IV: 715. Zanzibar, Tanzania.

The names *reii* Aellen 1950 and *doriae* Matschie 1899 are synonyms. There is confusion regarding the taxonomic relationships within the small-sized *Epomophorus* bats – the *labiatus/minor/minimus* group. Here, we retain *minor* within *labiatus*. Bergmans (1988) recognised *E. minor* as a valid species with a predominantly East African distribution ranging from Malawi and Zambia north to Tanzania, Kenya and Ethiopia. *Epomophorus labiatus*, in contrast, has the core of its distribution centred around Lake Victoria, extending north into Ethiopia and Sudan and south into northwestern Tanzania. The isolated population from Malawi (Bergmans 1988), which was identified as *anurus* (Heuglin 1864), is now recognised as a synonym of *labiatus*; this Malawi population was recently elevated to specific rank as *E. anselli* (Bergmans and Van Strien 2004). Currently, *labiatus* and *minor* can only be distinguished based on slight differences in size alone. Molecular studies, not yet conducted on this group, are long overdue and may finally resolve the relationship between these two taxa.

Epomophorus wahlbergi (Sundevall 1846)

Wahlberg's epauletted fruit bat

Least Concern



Description: *Epomophorus wahlbergi* is a large bat with a mass of around 100 g. The pelage is light sandy-brown. The underparts are slightly paler than the upper parts. The wings are light brown and sparsely covered in hair. Adult males are much larger than females, and may be distinguished by a broader muzzle with a folded upper lip and the presence of shoulder epaulettes. These epaulettes are pockets containing long (9 mm in length), white fur that can be erected to display prominent white shoulder patches. At rest, these patches disappear as the fur is retracted into the pocket. The ears have a patch of white fur at their base. The muzzle is dog-like and broader than that of the similar *E. crypturus* (Taylor and Monadjem 2008).

The skull is robust with sturdy zygomatic arches. Mature males have larger skulls (greatest length > 52 mm) than females (< 52 mm). In lateral profile, the entire skull is conspicuously dorsoventrally flattened; the braincase is without posterior downward deflection. The maxilla is distinctly broader than in *E. crypturus* (Taylor and Monadjem 2008). The sagittal crest is low, but usually clearly visible. The lambdoid crest is fairly well developed. There are six narrow palatal ridges present, but just one beyond the last molar. The dental formula is 2121/2132 = 28.

Key identification features: The combination of white patches at the base of the ears and shoulder epaulettes (males) separates *Epomophorus* and *Epomops* from other fruit bats. The palatal ridges of *Epomops* are very different from those of *Epomophorus*; in the latter there are six narrow ridges. Adult *E. wahlbergi* can be distinguished from sympatric *E. crypturus* by the presence of one post-dental palatal ridge (two in *E. crypturus*) and broader muzzle (in *E. wahlbergi*, width of maxilla at labial posterior edges of the upper M3 > 13 mm, > 14 mm in females and males, respectively; in *E. crypturus* < 13 mm, < 14 mm in adult females and males, respectively) (Taylor and Monadjem 2008).

Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Epomophorus wahlbergi* is widespread and abundant in the eastern parts of the region, where it has been recorded from the Eastern Cape, through KwaZulu-Natal and Swaziland to Mozambique, eastern Zimbabwe, Zambia and the southern DRC. It is widespread in Malawi and western Angola, but is absent from Namibia, Botswana, Lesotho and the western two-thirds of South Africa. The type specimen is from near 'Port Natal' (= Durban), KwaZulu-Natal, South Africa.

This species is well represented in museums, with over 280 records examined for this book.

Epomophorus wahlbergi roosts singly or in small groups in dense foliage of a large, leafy tree and may travel several kilometres each night to reach fruiting trees (Fenton *et al.* 1985). It is associated with forest and forest-edge habitats,

External and cranial measurements (mm) and mass (g) for *Epomophorus wahlbergi*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	111.1	68.0	165.0	25.30	5	**Mass[1]**	91.6	64.0	124.7	14.15	33
FA[1]	85.1	75.0	93.0	4.07	5	**FA[1]**	81.2	68.7	91.0	3.71	64
Total[1]	145.3	105	211	23.20	4	**Total[1]**	129.9	85	165	16.75	53
Tail[1]	0				4	**Tail[1]**	0				18
Tibia[1]	-	-	-	-	5	**Tibia[1]**	-	-	-	-	-
Ear[1]	24.4	20	31	2.55	5	**Ear[1]**	23.3	11	30	3.51	60
CI[1]	51.9	44.2	54.7	2.95	5	**CI[1]**	46.3	41.6	52.4	2.53	25

[1] Specimens measured by the authors

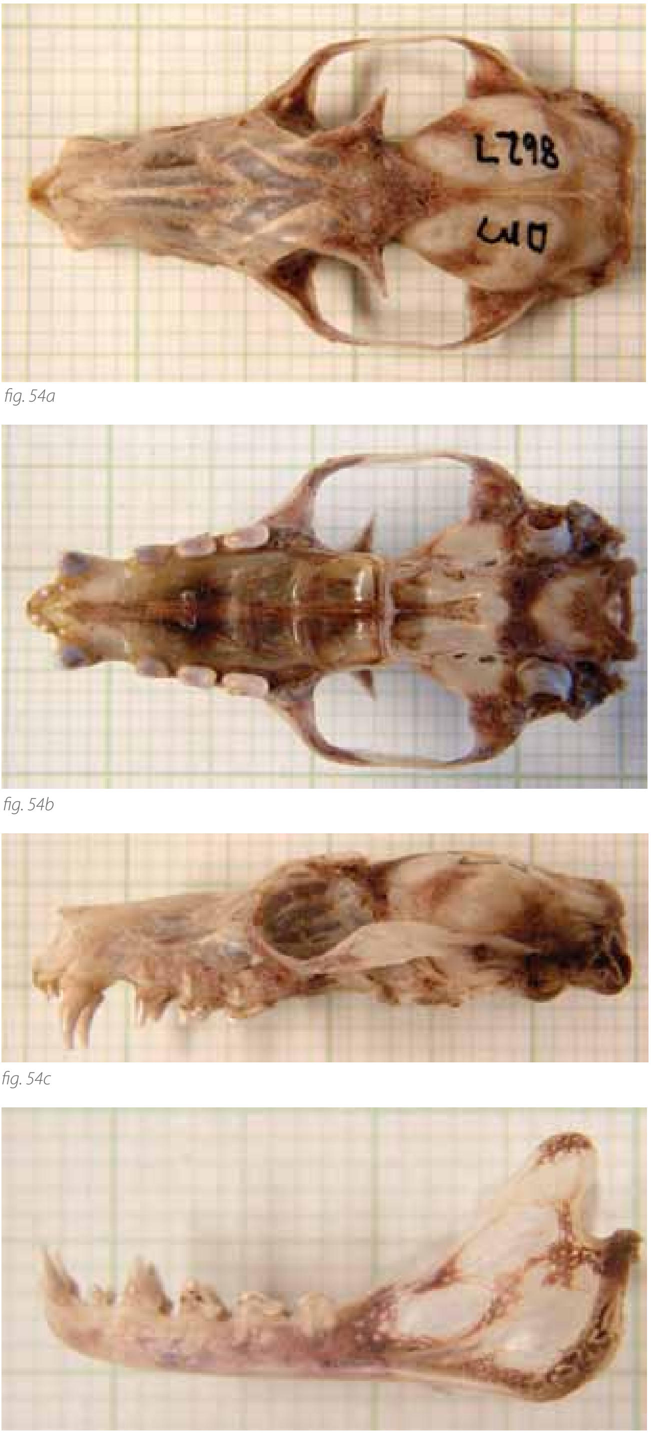


fig. 54a

fig. 54b

fig. 54c

fig. 54d

Figure 54. Skull and teeth of *Epomophorus wahlbergi:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8627).

including riparian forest which extensively incises savannas in the eastern part of the region. It may also penetrate peri-urban areas with extensive wooded gardens. It occurs sympatrically with *E. crypturus* in Mozambique, Malawi and eastern Zimbabwe. However, *E. crypturus* appears to prefer drier situations. For example, in Mozambique, *E. wahlbergi* is captured at higher rates in the south, while the capture rate of *E. crypturus* increases in the north.

Extralimital: *Epomophorus wahlbergi* has also been recorded from Burundi, Cameroon, Congo, Equatorial Guinea, Ethiopia, Gabon, Kenya and Tanzania.

Foraging ecology: *Epomophorus wahlbergi*feeds on fruit, nectar, pollen and flowers. Fruits include a variety of cultivated and indigenous tree species, but figs appear to be favoured. At Mtunzini, KwaZulu-Natal, the following trees were recorded from 'spit-outs' collected from under feeding stations (C. Sapsford, personal communication): *Ficus sur*, *F. trichopoda*, *F. natalensis*, *Voacanga thouarsii*, *Tabernaemontana ventricosa*, *Syzygium cordatum*, *Bridelia micrantha*, *Euclea natalensis*, *Eugenia capensis*, *Ekebergia capensis*, *Annona senegalensis*, *Podocarpus latifolius*, *P. falcatus*, *Sideroxylon inerme*, *Rauvolfia caffra*, *Halleria lucida*, *Sclerocarya birrea*, *Trichilia emetica*, *Harpephyllum caffrum* and *Mimusops caffra*. In the Kruger National Park, this species appears to specialise on the fruits of *Ficus sycomorus* (F. J. Bonaccorso, personal communication).

They are also known to pollinate *Adansonia digitata* flowers. They feed while hovering in front of the fruit or flower, or after landing on a suitable branch alongside it (Fenton *et al*. 1985).

Recent telemetry work in the Kruger National Park, South Africa, has shown that *Epomophorus wahlbergi* individuals may travel over 13 km between roosting and feeding sites in a single night and that the same fruiting tree may be visited on subsequent nights (F. J. Bonaccorso, J. R. Winkelmann, C. Todd and A. C. Miles, unpublished data). However, most flight activity was within 400 m of a fig tree (*Ficus sycomorus*) with ripe fruits. The home ranges of females appear to vary with fig abundance and season.

Reproduction: Births occur throughout the year, but with peaks in July (winter) and the summer months. Breeding males have particularly long epaulette hairs, as well as a brown discoloration of the skin in the vicinity of the testes and in the neck region. These males will sing from traditional sites to attract females. One (or rarely two) young are born at a time, after a gestation period of five to six months.

SYSTEMATIC NOTES

1846. *Pteropus wahlbergi* Sundevall, Öfversigt af Kungliga Svenska Vetenskapsakademiens Förhand-lingar, Stockholm 3(4): 118.

The names *unicolor* (Gray 1870), *neumanni* Matschie 1899, *stuhlmanni* Matschie 1988 and *zenkeri* Matschie 1899 are synonyms. The putative subspecies *haldemani* (Halowell 1846) is cranially similar to *wahlbergi*, with which it is sympatric in Angola and Zambia (Bergmans 1988), and is therefore not recognised as a valid taxon.

The diploid number in *E. wahlbergi* is 2n = 36 and aFN = 68 (Peterson and Nagorsen 1975).

fig. 55a

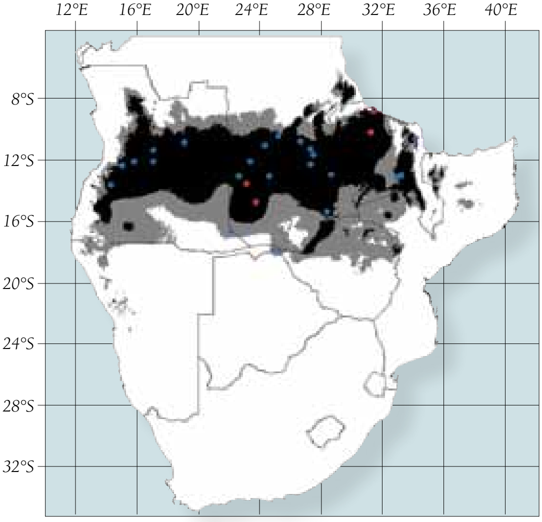
fig. 55b

Figure 55. Epomophorus wahlbergi: (a) female roosting showing white ear tufts and (b) male, showing covered epaulettes (a: © P. J. Taylor; b: © L. Lumsden).

Epomops dobsonii (Bocage 1889) ●

Dobson's epauletted fruit bat

Least Concern



Description: *Epomops dobsonii* is a large bat with a mass over 100 g in adult males. The pelage is greyish-brown. The wings are dark brown. Adult males are larger than females, and may be distinguished by a broader muzzle with a folded upper lip and the presence of shoulder epaulettes. These epaulettes are pockets containing long (18 mm in length), white fur that can be erected to display prominent white shoulder patches. At rest, these patches disappear as the fur is retracted into the pocket. Adult males also have dark grey-brown throats, while females have greyish throats. The ears have a patch of white fur at their base. The muzzle is dog-like and broader than that of similar-sized *Epomophorus* species.

The skull is robust with sturdy zygomatic arches. In lateral profile, the rostrum and interorbital region are rather flat, while the parietal region is deflected downwards. From above, the rostrum is broad. There are five thick palatal ridges present, two beyond the last molar. The first three ridges are continuous, while the last two are divided giving the impression of four triangles behind the last molar. The dental formula is 2121/2132 = 28.

Key identification features: The combination of white patches at the base of the ears and shoulder epaulettes (males) separates *Epomops* and *Epomophorus* from other large fruit bats. Palatal ridges immediately separate these two genera with *Epomophorus* exhibiting six narrow ridges (five thick ridges in *E. dobsonii*). *Epomops dobsonii* is easily distinguished from *E. franqueti* by the number of post-dental palatal ridges (two in *E. dobsonii*, five in *E. franqueti*).

Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Epomops dobsonii* is widespread in the northern parts of the region, where it has been recorded from central Angola and northern Botswana (Smithers 1971), west through Zambia, southern DRC and northern Malawi. It may have been overlooked over much of eastern Angola, the Caprivi Strip of Namibia, and the extreme northwest of Mozambique. The type specimen is from Quindumbo, Angola. This specimen (housed in the Museu Bocage) was destroyed in the tragic fire of 1978. Bergmans (1989) selected a new type specimen from Chitau approximately 250 km to the southwest of Quindumbo (AMNH 88068, Neotype).

This species is poorly represented in museums, with just 27 records examined for this book.

A single specimen was collected amidst a colony of *Epomophorus crypturus* hanging in a riparian tree (Smithers 1971). *Epomops dobsonii* is associated with miombo woodland throughout Angola and Zambia, although the single specimen from Botswana was collected in riverine woodland (Smithers 1971).

External and cranial measurements (mm) and mass (g) for *Epomops dobsonii*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1,4]	124.5	120.0	129.0	-	2	**Mass[1,4]**	-	-	-	-	-
FA[2]	86.9	84.0	89.9	-	11	**FA[2]**	83.7	80.4	88.3	-	11
Total[3]	160.0	146	168	-	4	**Total[3]**	142.0	137	145	-	3
Tail	-	-	-	-	-	**Tail**	-	-	-	-	-
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	30	-	-	-	1	**Ear[1]**	26	25	27	-	3
CI[4]	51.8	-	-	-	1	**CI[4]**	47.5	-	-	-	1

[1] Smithers (1971)
[2] Extracted from Bergmans (1989) using data from Angola, Malawi and Zambia
[3] Skinner and Chimimba (2005)
[4] Specimens measured by the authors

Extralimital: The core of this species' distributional range is in southern Africa, beyond which it occurs in a narrow band through Tanzania to Rwanda (Bergmans 1989).

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: In Zambia, immature individuals have been collected in September and November (Bergmans 1989).

SYSTEMATIC NOTES

1889. *Epomophorus dobsonii* Bocage, Jornal de sciencias mathematicas, physicas e naturaes, Lisboa (2)1: 1. Quindumbo, Benguela district, western Angola.

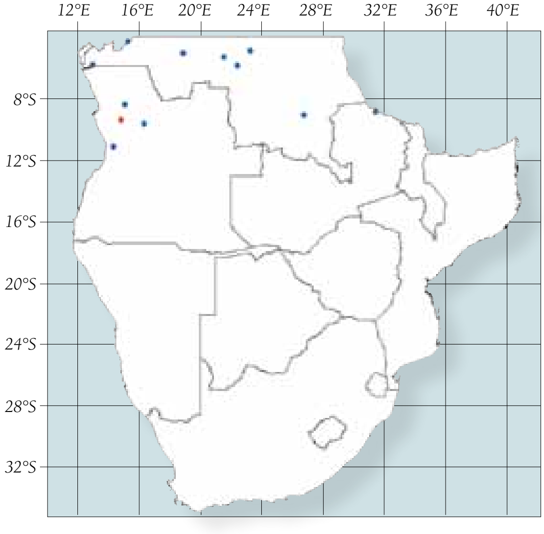
Epomops dobsonii is atypical of the genus (Bergmans 1989), as it has only two post-dental palatal ridges, and may be best placed in its own genus; the other two congeneric species, *E. franqueti* and *E. buettikoferi,* both have five such ridges. It may possibly be more closely allied to *Epomophorus* than *Epomops*. Molecular studies are needed to resolve these relationships.

Figure 56. Epomops dobsonii, portrait showing white ear tufts (© F. P. D. Cotterill).

Epomops franqueti (Tomes 1860)

Franquet's epauletted fruit bat

Least Concern



Description: *Epomops franqueti* is a large bat with a mass over 150 g in adult males and around 120 g in adult females. The pelage is greyish-brown. The wings are dark brown. Adult males are much larger than females, and may be distinguished by a broader muzzle with a folded upper lip and the presence of shoulder epaulettes. These epaulettes are pockets containing long, white fur that can be erected to display prominent white shoulder patches. At rest, these patches disappear as the fur is retracted into the pocket. The ears have a patch of white fur at their base. The muzzle is dog-like and broader than that of similar-sized *Epomophorus* species.

The skull is robust with sturdy zygomatic arches. In lateral profile, the rostrum and interorbital region are rather flat, while the parietal region is deflected downwards. From above, the rostrum is broad. There are eight palatal ridges present: three thick undivided ridges within the last molar and five divided ridges beyond it. The dental formula was 1121/2132 = 26 in two skulls from the Makerere University Collection (Figure 57) and not 2121/2132 = 28 as stated by Rosevear (1965).

External measurements (mm) and mass (g) for *Epomops franqueti*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	114.7	72.0	178.0	35.86	7
FA[1]	93.5	87.6	103.4	5.25	7
Total[2]	126.0	110	150	-	-
Tail[2]	0	-	-	-	-
Tibia[3]	-	32.0	37.5	-	-
Ear[2]	22.0	19	25	-	-
CI	-	-	-	-	-

[1] Measured by A. Monadjem (unpublished data) in Uganda
[2] Happold (1987)
[3] Rosevear (1965)

Key identification features: The combination of white patches at the base of the ears and shoulder epaulettes (males) separates *Epomops* and *Epomophorus* from other large fruit bats. Palatal ridges immediately separate these two genera with *Epomophorus* exhibiting six narrow ridges (eight thick ridges in *E. franqueti*). *Epomops franqueti* is easily distinguished from *E. dobsonii* by the number of post-dental palatal ridges (five in *E. franqueti*, two in *E. dobsonii*).

Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Epomops franqueti* is a common rainforest inhabitant of Central and West Africa, but is marginal to southern African. So far, it has only been recorded from the southern DRC and northwestern Angola, with a single specimen from extreme northeastern Zambia (Ansell 1978). However, it may be more widely distributed in the far northern parts of Angola and the southwestern DRC. The type specimen is from Gabon (MNHN A 107, Holotype).

The southern African population of this species is poorly represented in museums, with just seven records examined for this book.

Nothing is known about its roosting habits in southern Africa, but in West Africa it hangs in trees. It is associated with closed forest, but may venture into open habitats (e.g. villages) to feed on fruiting trees that are situated close to forest.

Extralimital: *Epomops franqueti* is widespread in tropical African forests occurring in: Uganda, Sudan, DRC, Congo, Central African Republic, Gabon, Cameroon, Equatorial Guinea, Nigeria, Benin, Togo, Ghana and Côte d'Ivoire.

Foraging ecology: *Epomops franqueti* has broad wings with high wing loading (19.4 Nm^{-2}) and low aspect ratio (6.5) (Norberg and Rayner 1987). There is no information on the diet or foraging behaviour of this species in southern Africa, but elsewhere it is known to feed on the following plants: *Mangifera* spp., *Annona* spp, *Terminalia catappa*, *Persea americana*, *Artocarpus* spp., *Ficus* spp., *Psidium guajava*, and *Solanum torvum* (Kingdon 1974, Fujita and Tuttle 1991).

Reproduction: In Angola, two immature bats were collected in September (Bergmans 1989).

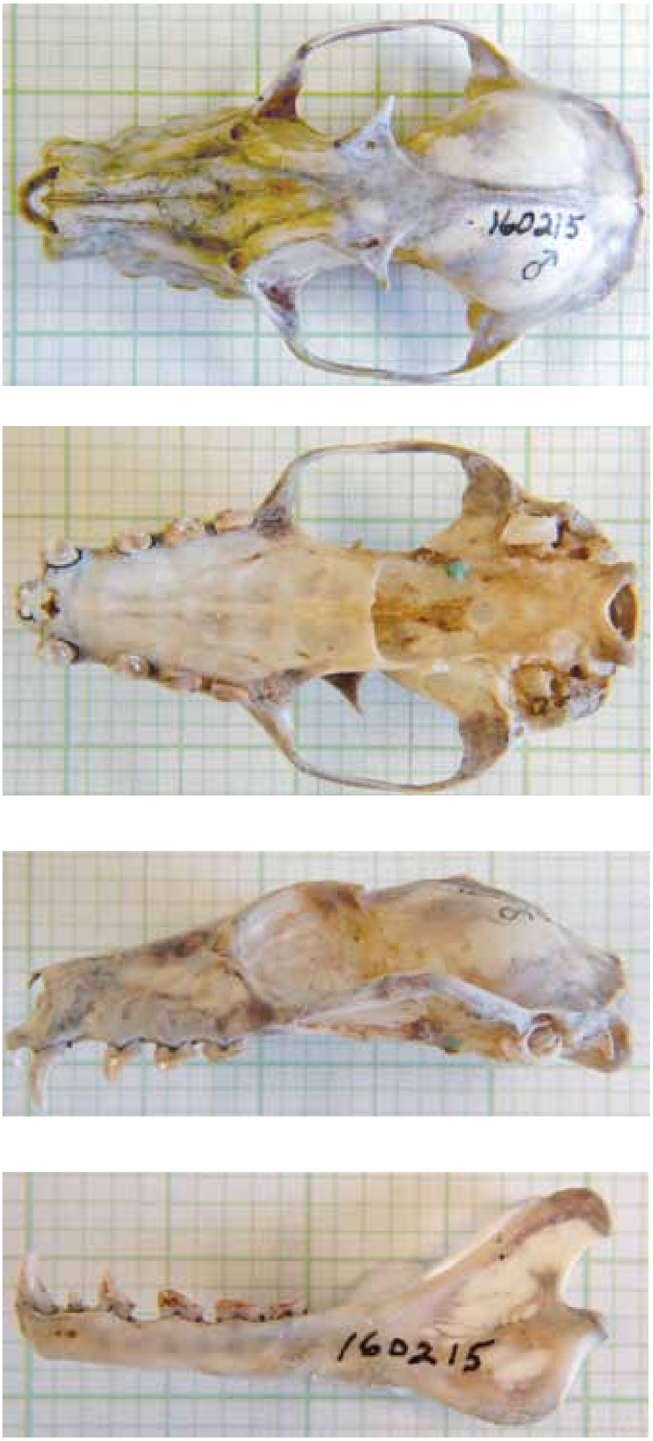


fig. 57a

fig. 57b

fig. 57c

fig. 57d

Figure 57. Skull and teeth of *Epomops franqueti*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral mandible view (FMNH 160215).

SYSTEMATIC NOTES

1860. *Epomops franqueti* Tomes, Proc. Zool. Soc. Lond., 1: 54, pl. 75. Gabon.

The names *comptus* H. Allen 1862 and *strepitans* K. Andersen 1910 are synonyms. *Epomops franqueti* is closely related to the West African *E. buettikoferi*, but the latter species does not occur further east than Liberia (Monadjem and Fahr 2007).

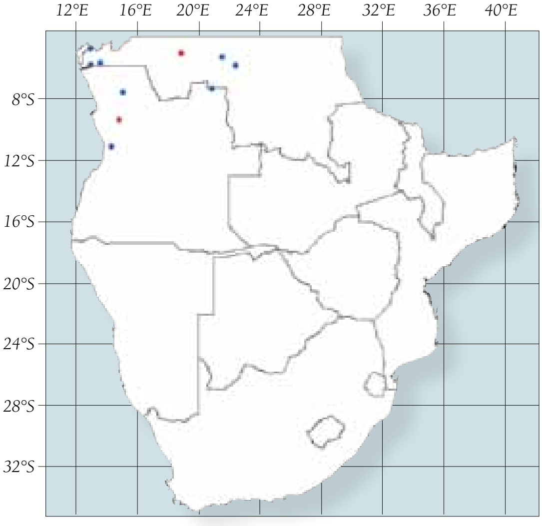
The diploid number in *E. franqueti* is 2n = 36 and FN = 68 (Haiduk *et al*. 1980).

Figure 58. Roosting *Epomops franqueti,* showing white ear tufts (Uganda, © A. Monadjem).

Hypsignathus monstrosus H. Allen 1862 ●

Hammer-headed fruit bat

Least Concern



Description: *Hypsignathus monstrosus* is the largest bat in mainland Africa with a mass of well over 300 g in adult males and over 200 g in adult females. The wingspan can exceed 91 cm. The pelage is sepia-brown to reddish-brown with white speckling on the belly. The wings are dark brown. Adult males are much larger than females, and may be distinguished by an enormous cylindrical muzzle with a blunt end. The muzzle of the female is not as exaggerated as that of the male. The face, head and shoulders are greyish with an indistinct dark line running along the midline of the top of the muzzle, which is partially devoid of hair or covered by very short hair. There is a small dark patch at the base of each long hair on the pale muzzle, giving a spotted appearance. Shoulder epaulettes are absent in both sexes. The ears have a patch of white fur at their base.

The skull is massive with moderate zygomatic arches. In lateral profile, the rostrum is deep, slightly rounded, and greatly elevated above the dental line. Sexual dimorphism in this feature is pronounced, with males having a much deeper rostrum than females. The sagittal crest is moderately to well developed, while the lambdoid crest is well developed. There are ten or eleven palatal ridges present; the first five are thick, and the remainder are thinner and somewhat irregular. The dental formula is 2121/2132 = 28. The first lower premolar is minute (Rosevear 1965).

Key identification features: The combination of large size (FA > 110 mm) and shape of muzzle immediately distinguishes *Hypsignathus monstrosus* from all other African bats.

Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Hypsignathus monstrosus* is a common rainforest inhabitant of Central and West Africa, but is marginal to southern Africa. So far, it has only been recorded from the southwestern DRC and northern Angola. However, it may be more widely distributed in the far northern parts of Angola and southwestern DRC than shown in the map. The type locality is not known for certain, but may be in Gabon.

The southern African population of this species is poorly represented in museums, with just eight records examined for this book.

Nothing is known about its roosting habits in southern Africa, but in West Africa it roosts singly or in small groups in trees (Rosevear 1965). It is associated with closed forest and riverine habitats, but may venture into orchards to feed on fruiting trees that are situated close to forest.

Extralimital: *Hypsignathus monstrosus* is widespread in tropical African forests in Kenya, Uganda, southern Sudan, DRC,

External and cranial measurements (mm) and mass (g) for *Hypsignathus monstrosus*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	393.0	374.0	412.0	-	2	**Mass[1]**	232.0	208.0	256.0	-	3
FA[1]	131.0	128.0	134.0	-	2	**FA[1]**	114.0	108.5	118.5	-	3
Total[2]	-	220	275	-	-	**Total[2]**	-	195	220	-	-
Tail[2]	0	-	-	-	-	**Tail[2]**	0	-	-	-	-
Tibia[2]	-	54	60	-	-	**Tibia[2]**	-	52	55	-	-
Ear	-	-	-	-	-	**Ear**	-	-	-	-	-
CI[3]	59.1	57.3	60.8	-	2	**CI[3]**	68.7	-	-	-	1

[1] Wolton *et al.* (1982) based on specimens from Liberia
[2] Rosevear (1965)
[3] Specimens measured by the authors; males were juveniles, while female was adult

fig. 59a

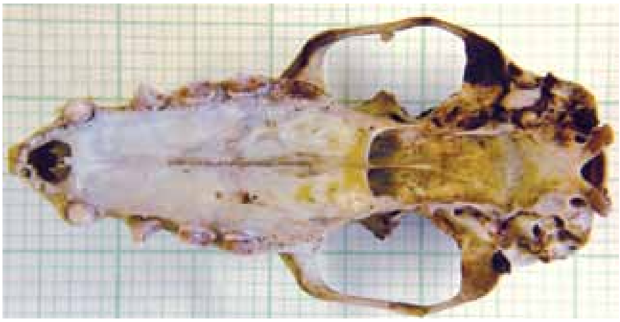


fig. 59b

fig. 59c

fig. 59d

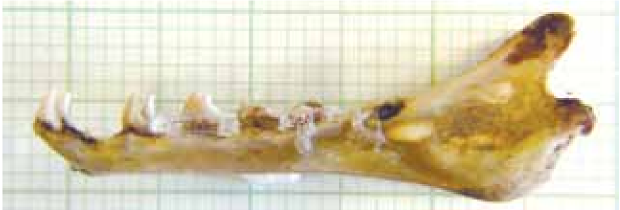


fig. 59e

Figure 59. Skull and teeth of *Hypsignathus monstrosus:* (a) dorsal view, (b) ventral view, (c) lateral view, and (e) lateral mandible view of male (P 3079, Makerere University, Kampala), and (d) lateral view of female specimen (unnumbered, Makerere University, Kampala).

Congo, Central African Republic, Gabon, Cameroon, Equatorial Guinea, Nigeria, Benin, Togo, Ghana, Côte d'Ivoire, Liberia, Burkina Faso and Sierra Leone (Bergmans 1989).

Foraging ecology: *Hypsignathus monstrosus* has broad wings with high wing loading (36.3 Nm^{-2}) and low aspect ratio (6.7) (Norberg and Rayner 1987). There is no information on the diet of this species for southern Africa, but elsewhere it feeds on the following plants: *Mangifera indica, Annona* spp., *Ceiba* spp., *Musanga cecropioides*, *Anthocleista* spp., *Chlorophora* spp., *Ficus lyrata*, *F. ovata*, *F. scott-elliotii, Musa* spp., *Psidium guajava*, *Adenia cissampeloides*, and *Solanum* spp. (Fujita and Tuttle 1991). Soft fruit is plucked while hovering and taken to a nearby perch where the juice is squeezed out and the rest discarded (Rosevear 1965, Kingdon 1974).

Reproduction: No reproductive information is available for southern Africa. In East Africa, males form leks in which several individuals will call within the same tree (Bradbury 1977). One, or rarely two, young may be born throughout the year (Kingdon 1974).

SYSTEMATIC NOTES

1862. *Hypsignathus monstrosus* H. Allen, Proc. Acad. Nat. Sci. Philadelphia 13(11): 157. 'West Africa' (= Gabon).

The diploid number in *H. monstrosus* is 2n = 36 and FN = 68 (Haiduk *et al.* 1980).

fig. 60a

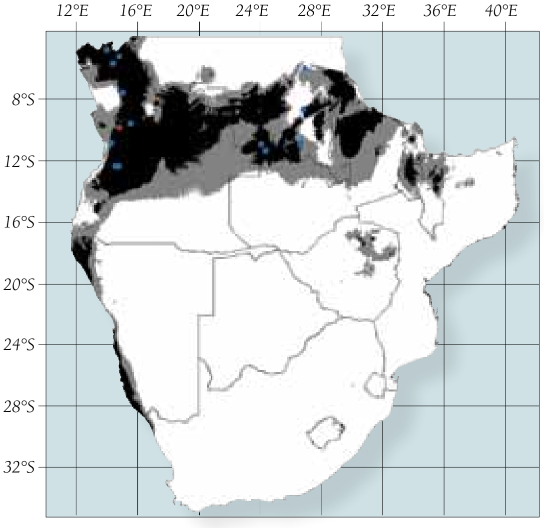
fig. 60b

Figure 60. Hypsignathus monstrosus: (a) roosting female showing dark line along midline of muzzle and (b) close-up of female about to feed on *Eugenia jambos* (a: © A. Monadjem; b: © Merlin D. Tuttle, Bat Conservation International, www.batcon.org).

Lissonycteris angolensis (Bocage 1898)

Angolan soft-furred fruit bat

Least Concern



Description: *Lissonycteris angolensis* is a medium-sized fruit bat with a mass of around 75 g. In appearance, it is very similar to its congeners *L. goliath* and *L. ruwenzorii*. The pelage is variable, ranging from reddish-brown to grey-brown; the fur on the underparts is paler and shorter. The hairs on the neck and head are generally longer. The wings are dark brown and inserted on the second toe. Adult males are similar in size to females, but have a broad frontal ruff extending from the sides of the neck across the throat and the upper chest. These hairs are long and arise from glands, giving the hairs a sticky feel. The colour of the ruff is typically buffy or tawny. There are no shoulder epaulettes and the ears do not have a patch of white fur at their base. The muzzle is dog-like and rather short and broad. A short tail is present.

The skull is fairly robust with moderate zygomatic arches. In lateral profile, the rostrum and interorbital region are relatively flat, while the parietal region is deflected downwards. There are three undivided palatal ridges followed by four divided ridges. This pattern is similar to that of *Myonycteris* and has been illustrated in Happold (1987). The dental formula is 2132/2133 = 34. The first lower premolar is small or minute.

External measurements (mm) for *Lissonycteris angolensis*, sexes combined

	Mean	Min	Max	SD	N
Mass	-	-	-	-	-
FA[1]	-	72.0	83.0	-	44
Total[2]	-	116	137	-	-
Tail[2]	-	11	12	-	-
Tibia[2]	-	29	34	-	-
Ear[2]	-	19	25	-	-
CI	-	-	-	-	-

[1] Bergmans (1997)
[2] Rosevear (1965)

Key identification features: The combination of medium size (FA 70–85 mm) and lack of white ear patches separates *Lissonycteris* from most African fruit bats, except *Myonycteris* and *Rousettus*. *Myonycteris* is typically much smaller (in the largest species *M. relicta* FA < 75 mm, in adult *Lissonycteris* FA > 80 mm). *Rousettus* (FA > 80 mm and generally > 90 mm) also lacks white ear patches, but the wing typically inserts on the first toe or between the first and second toe (in *Lissonycteris* the wing inserts on the second toe). However, in *Rousettus lanosus*, the wing may occasionally insert on the second toe, but this species has long, shaggy fur, distinguishing it from the short, sleek fur of *Lissonycteris*.

Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Lissonycteris angolensis* is a common rainforest inhabitant of Central Africa, but is marginal in southern Africa. It occurs only in western Angola, southern DRC and the extreme northwest of Zambia. However, it may be more widely distributed in the far northern parts of Angola and the southern DRC. The type specimen from northern Angola was housed in the Museu Bocage, but was destroyed in the fire of 1978. A type specimen survives in the British Museum (Natural History) London (BM 97.8.6.1, Syntype).

The southern African population of this species is poorly represented in museums, with just four records examined for this book.

Nothing is known about its roosting habits in southern Africa, but in Central Africa it roosts in small colonies in hollow trees and entrances to caves (Rosevear 1965, Happold 1987). It is associated with forest and forest edge habitats, but its distribution is influenced to a larger extent by the availability of suitable roosting sites rather than vegetation associations.

Extralimital: *Lissonycteris angolensis* is widespread in Central African forests in Congo, Cameroon, Nigeria and the Central African Republic (Bergmans 1997).

Foraging ecology: There is no information on the diet or foraging behaviour of this species in southern Africa.

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1898. *Cynonycteris angolensis* Bocage, J. Sci. mat. Phys. nat., Lisboa, ser. 2, 5: 133, 138. North of Quanza River, Angola.

Three taxa of *Lissonycteris* occur in southern Africa and were previously treated as subspecies of *L. angolensis* (Bergmans 1997). However, as they in most likelihood represent three distinct phylogenetic lineages, they may be best viewed as three different species (Cotterill 2001c). Here we recognise *L. goliath* as a separate species, but treat *angolensis* and *ruwenzorii* as subspecies of *L. angolensis* (Bergmans 1997). The subspecies *L. a. angolensis* occurs in western Angola and the extreme western DRC, and includes *crypticola* (Cabrera 1920) as a synonym. *L. a. ruwenzorii* occurs in the extreme northwest of Zambia and the southern DRC.

Lissonycteris angolensis angolensis (Bocage 1898)

Lissonycteris angolensis ruwenzorii (Eisentraut 1965)

1965. *Rousettus angolensis ruwenzorii*, Eisentraut, Bonn. Zool. Beitr., 16 (1/2): 3. Ruwenzorii East, Uganda.

The diploid number in *L. angolensis* is 2n = 36 and FN = 66 (Haiduk *et al*. 1980).

fig. 61a

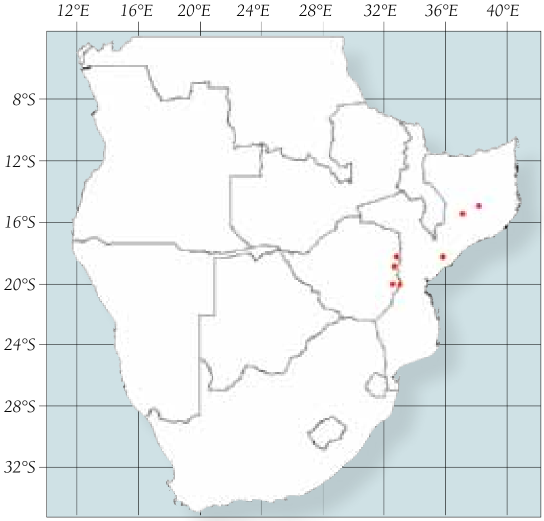
fig. 61b

Figure 61. *Lissonycteris angolensis*: (a) portrait showing the absence of white ear tufts, and (b) ventral view of male *L. a. ruwenzori*, showing throat collar of sticky hairs (a: © Merlin D. Tuttle, Bat Conservation International, www.batcon.org; b: Uganda, © A. Monadjem).

Lissonycteris goliath Bergmans 1997

Harrison's soft-furred fruit bat

Vulnerable



Description: *Lissonycteris goliath* is a medium-sized fruit bat with a mass of around 80 g. The pelage is variable, ranging from reddish-brown to grey-brown; the fur on the underparts is paler and shorter. The hairs on the neck and head are generally longer. The wings are dark brown and inserted on the second toe. Adult males are similar in size to females, but have a broad frontal ruff extending from the sides of the neck across the throat and the upper chest. These hairs are long and arise from glands, giving the hairs a sticky feel. The colour of the ruff is typically buffy or tawny. There are no shoulder epaulettes and the ears do not have a patch of white fur at their base. The muzzle is dog-like and rather short and broad. A short tail is present.

The skull is fairly robust with moderate zygomatic arches. Proportionately, the rostrum is distinctly shorter than in *Epomophorus*. In lateral profile, the rostrum and interorbital region are relatively flat, and slope downwards anteriorly from the orbit, while the parietal region is deflected downwards. There are nine palatal ridges in total: three undivided ridges followed by four divided ridges, behind which are two narrow, serrated ridges (formula 3+4+2). The dental formula is 2132/2133 = 34. The first lower premolar is small or minute.

External measurements (mm) and mass (g) for *Lissonycteris goliath*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	89.4	68.0	101.0	9.44	10
FA[1,2]	82.4	75.2	88.0	3.23	21
Total	-	-	-	-	-
Tail	-	-	-	-	-
Tibia	-	-	-	-	-
Ear	-	-	-	-	-
CI	42.1	41.9	42.2	-	2

[1] A. Monadjem and A. Reside (unpublished data)
[2] Cotterill (2001c)

Key identification features: The combination of medium size (FA 70–88 mm) and lack of white ear patches separates *Lissonycteris* from most African fruit bats, except *Myonycteris* and *Rousettus*. *Myonycteris* is typically much smaller (in the largest species *M. relicta* FA < 75 mm, in adult *Lissonycteris* FA > 80 mm). *Rousettus* (FA > 80 mm and generally > 90 mm) also lacks white ear patches, but the wing inserts on the first toe or between the first and second toe (in *Lissonycteris* the wing inserts on the second toe). However, in *Rousettus lanosus*, the wing may occasionally insert on the second toe, but this species has long, shaggy fur, distinguishing it from the short, sleek fur of *Lissonycteris*.

Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Lissonycteris goliath* is endemic to southern Africa, occurring only in the highlands of eastern Zimbabwe and central Mozambique (Cotterill 2001c, A. Monadjem and A. Reside, unpublished data). The type specimen is from Nyanga, Zimbabwe (NMZB 59831, Holotype).

This species is poorly represented in museums, with just 14 specimens examined for this book.

Nothing is known about its roosting habits in southern Africa, as all the specimens collected to date have been netted. The closely related *L. angolensis* roosts in hollow trees or at the entrance to caves (Bergmans 1997). *L. goliath* is associated with forest edge habitats and has been netted in riparian locations.

Extralimital: *Lissonycteris goliath* is endemic to southern Africa.

Foraging ecology: In Zimbabwe, *Lissonycteris goliath* has been observed to feed on *Ficus* spp. (Smithers 1983).

Reproduction: No reproductive information is available.

SYSTEMATIC NOTES

1997. *Lissonycteris goliath* Bergmans, W. Beaufortia 47(2): 11–90. Zimbabwe and Mozambique.

Three taxa of *Lissonycteris* occur in southern Africa and were previously treated as subspecies of *L. angolensis* (Bergmans 1997). Later, Cotterill (2001c) recognised *L. goliath* as a separate species, based on its larger size. New material and the broader distribution in Mozambique reported here, however, suggest that the range may be continuous with Tanzanian populations along the Southern Zanzibar–Inhambane Coastal Forest Mosaic. A critical analysis is required to test the hypothesis that *goliath* may represent the extreme of a geographical cline in body size.

The diploid number in *L. goliath* is not known.

fig. 62a

fig. 62b

fig. 62c

fig. 62d

Figure 62. Skull and teeth of *Lissonycteris goliath*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8655).

fig. 63

fig. 64a

fig. 64b

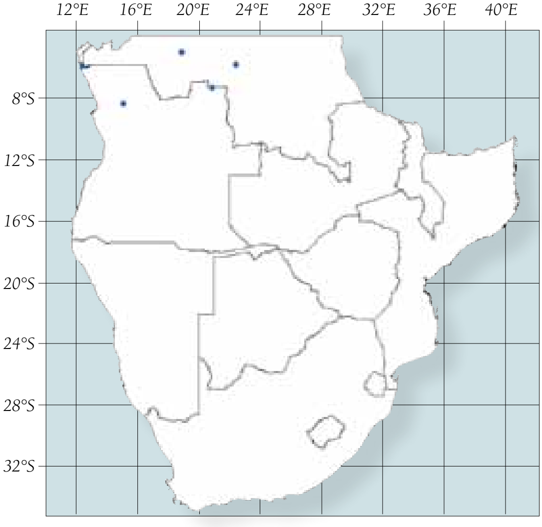
Figure 63. Lissonycteris goliath holotype skin (© F. P. D. Cotterill).

Figure 64. Lissonycteris goliath: (a) portrait showing absence of white ear tufts, and (b) a large roosting male from Rusitu Forest (a: DM 8655, © A. Monadjem; b: NMZB 30055 © F. P. D. Cotterill).

Megaloglossus woermanni Pagenstecher 1885

Woermann's long-tongued fruit bat

Least Concern



Description: *Megaloglossus woermanni* is the smallest fruit bat in Africa, with a mass of about 14 g. The pelage is uniformly brown and is slightly paler on the underparts. The wings are also dark brown. The sexes are similar in size, but adult males have a collar of long, cream-coloured hairs running from the sides of the neck across the throat. There are no markings on the face in either sex. The muzzle is narrow and the tongue is long with papillae at its tip; both are adaptations for feeding on nectar.

For a fruit bat, the skull is delicate and the zygomatic arches poorly developed. In lateral profile, the braincase is rounded and deflected markedly downwards posteriorly. The rostrum is obviously narrow and long. The sagittal crest is completely absent. There are six narrow palatal ridges present; the last two are divided. The dental formula was 2132/2133 = 34 and 2133/2134 = 38 (i.e. with additional posterior molars in both jaws) in two individuals examined in the collection of the Makerere University, Kampala. The canines of both jaws are large and hooked.

External measurements (mm) and mass (g) for *Megaloglossus woermanni*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	13.3	12.0	15.0	1.03	6
FA[1]	41.0	40.3	43.34	1.30	6
Total[2]	66.0	60	75	-	-
Tail[2]	0	-	-	-	-
Tibia[3]	-	15	18	-	-
Ear	-	-	-	-	-
CI	-	-	-	-	-

[1] J. Fahr and A. Monadjem, unpublished data, based on specimens from Liberia

Key identification features: The combination of small size, lack of facial markings and narrow muzzle distinguishes *Megaloglossus woermanni* from all other African fruit bats.

Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Megaloglossus woermanni* is a widespread inhabitant of tropical African forests, but is marginal to southern Africa. So far, it has been recorded from the southern DRC and the extreme north of Angola., It may, however, be more widely distributed in the far northern parts of Angola and the southern DRC. The type specimen is from Gabon (ZMB 54589, Holotype) (Bergmans 1989).

The southern African population of this species is poorly represented in museums, with just five records examined for this book.

Nothing is known about its roosting habits in southern Africa, but in West Africa, it roosts in shrubs (Rosevear 1965). It is associated with closed forest, but may enter cultivated areas adjacent to forest to feed.

Extralimital: *Megaloglossus woermanni* is widespread in tropical Africa and has been recorded from the DRC, Uganda, Congo, Central African Republic, Gabon, Cameroon, Nigeria, Togo, Ghana, Côte d'Ivoire and Liberia (Bergmans 1997).

Foraging ecology: *Megaloglossus woermanni* is a specialist nectar feeder. It visits *Kigelia africana* flowers (Eisentraut 1963) and presumably those of other species as well, and uses its specialised tongue to extract pollen and nectar.

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1885. *Megaloglossus woermanni* Pagenstecher, Zool. Anz., 8: 245. Gabon.

Hayman (1966) described *prigoginei* (RMCA 32577, Holotype) on specimens from the eastern Congo basin, tentatively including a series from Kananga (= Luluabourg); this taxon was described as distinctly larger, notably in the longer forearm (Hayman *et al.* 1966). In contrast, Bergmans (1997) concluded that a west-to-east cline of increasing body size characterises intraspecific variation in *M. woermanni*. No subspecies are recognised. *Megaloglossus woermanni* is the sole African representative of the long-tongued bats in the subfamily Macroglossinae.

The diploid number in *M. woermanni* is 2n = 34 and FN = 62 (Haiduk *et al.* 1980).

fig. 65a

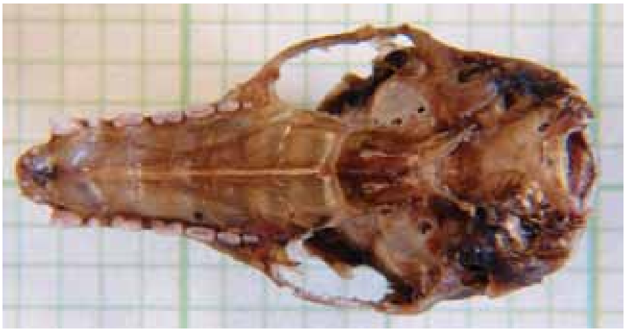


fig. 65b

fig. 65c

fig. 65d

Figure 65. Skull and teeth of *Megaloglossus woermanni:* (a) dorsal view, (b) ventral view, (d) lateral view, and (e) lateral mandible view, and (c) ventral view showing additional posterior molars (a, b, d, e: MHH 349, Makerere University, Kampala; c: unnumbered individual, Makerere University, Kampala).

fig. 66a

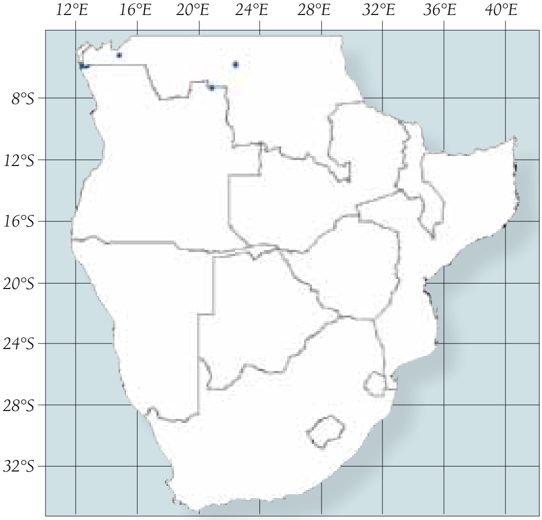
Figure 66. Adult *Megaloglossus woermanni*:, (a) whole body showing diminutive size, and (b) stiffened throat hairs on mature male (Liberia, © A. Monadjem).

fig. 66b

Micropteropus intermedius Hayman 1963

Hayman's lesser epauletted fruit bat

Data Deficient



Description: *Micropteropus intermedius* is a small fruit bat, with an estimated mass of 35–40 g. The pelage is medium brown and is slightly paler on the underparts (Rosevear 1965). The wings are dull brown. The sexes are similar in size, but adult males have shoulder epaulettes containing long, white fur that can be erected to display prominent white shoulder patches. At rest, these patches disappear as the fur is retracted into the pocket. The ears have a patch of white fur at their base. The muzzle is dog-like and rather short and broad compared with that of the larger *Epomophorus* species.

For a fruit bat, the skull is small and relatively delicate with weak zygomatic arches. The skull is similar to that of *Epomophorus*, but the rostrum is markedly shorter and broader. Furthermore, in lateral profile, the braincase is not as flat. There are six palatal ridges present; the first is undivided and arrow-shaped, while the remaining five are deeply divided and separated by a wide gap. The second and third palatal ridges are weakly developed but not fused. The dental formula is 2121/2132 = 28.

External measurements (mm) for *Micropteropus intermedius,* sexes combined

	Mean	Min	Max	SD	N
Mass	-	-	-	-	-
FA¹	59.3	57.2	63.6	-	4
Total	-	-	-	-	-
Tail¹	4.0	3	5	-	2
Tibia¹	24.9	23.7	26.0	-	3
Ear¹	15.5	14.3	17.4	-	3
CI	-	-	-	-	-

¹ Bergmans (1989)

Key identification features: The combination of white patches at the base of the ears and shoulder epaulettes (males) separates *Micropteropus* and *Epomophorus* from other small fruit bats in the region. Palatal ridges immediately separate these genera, with *Micropteropus* exhibiting six thick ridges, the second to the sixth deeply divided and separated by a wide gap. *Micropteropus intermedius* can be distinguished from the similar *M. pusillus* by its larger size (FA > 57 mm, in *M. pusillus* FA < 56 mm) and a slight difference in palatal ridges (the second and third ridges may be partially or completely fused in *M. pusillus*). *Epomophorus grandis* (FA > 62 mm) is slightly larger than *M. intermedius* (FA < 63 mm), and there are slight differences in palatal ridge structure.

Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Micropteropus intermedius* is known from just four specimens collected at four localities in the extreme northwest of Angola and the southern DRC, all within the boundaries of southern Africa. However, it may be more widely distributed in the far northern parts of Angola and the southern DRC, possibly extending into southern Congo. The type specimen is from Dundo, Angola (BM 1962.2073, Holotype).

The four specimens were all collected in a mosaic of forest and open grassland, suggesting that this species does not occur in closed forest. Practically nothing is known about the roosting habits of this species, except that one specimen was collected at the entrance to a cave (Bergmans 1989).

Extralimital: *Micropteropus intermedius* is endemic to southern Africa.

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: The type specimen was pregnant when collected during June or July (Bergmans 1989).

SYSTEMATIC NOTES

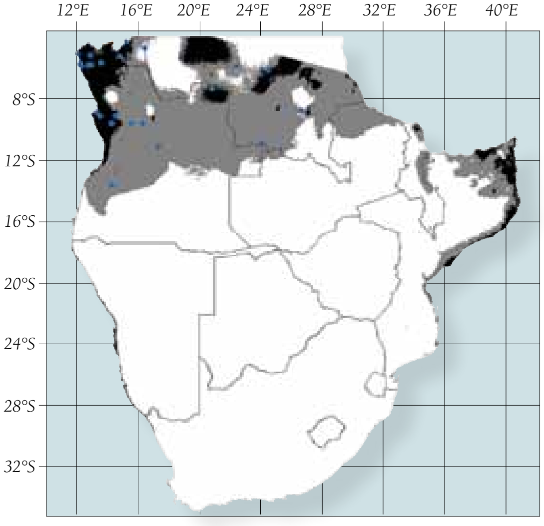
1963. *Micropteropus intermedius* Hayman, Publ. Cult. Comp. Diamantes Angola. Dundo, Angola.

Micropteropus intermedius is closely related to *M. pusillus*, from which it is distinguishable only by its larger size and slight differences in palatal ridges (Bergmans 1989).

Micropteropus pusillus (Peters 1867)

Peters's lesser epauletted fruit bat

Least Concern



Description: *Micropteropus pusillus* is a small fruit bat, with a mass of around 30 g (Marshall and McWilliam 1982). The pelage is medium brown and is slightly paler on the underparts (Rosevear 1965). The wings are dull brown. The sexes are similar in size, but adult males have shoulder epaulettes containing long, white fur that can be erected to display prominent white shoulder patches. At rest, these patches disappear as the fur is retracted into the pocket. The ears have a patch of white fur at their base. The muzzle is dog-like and rather short and broad compared with that of the larger *Epomophorus* species.

For a fruit bat, the skull is small and relatively delicate with weak zygomatic arches. The skull is similar to that of *Epomophorus*, but the rostrum is markedly shorter and broader. Furthermore, in lateral profile, the braincase is not as flat. There are six thick palatal ridges present; the first is undivided and arrow-shaped, while the remaining five are deeply divided and separated by a wide gap; the second and third ridges are thick and often fused. There are a variable number (up to four) of additional narrow, serrated ridges at the back of the palate. The dental formula is 2121/2132 = 28 (Rosevear 1965).

Key identification features: The combination of white patches at the base of the ears and shoulder epaulettes (males) separates *Micropteropus* and *Epomophorus* from other small southern African fruit bats. Palatal ridges immediately separate these genera, with *Micropteropus* exhibiting six thick ridges, the second to the sixth deeply divided and separated by a wide gap. *Micropteropus pusillus* can be distinguished from the similar *M. intermedius* by its smaller size (FA < 56 mm, in *M. intermedius* FA > 57 mm) and a slight difference in palatal ridges (the second and third ridges not fused in *E. intermedius*).
Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Micropteropus pusillus* is a widespread inhabitant of Central and West African savannas and woodlands, but occurs marginally in southern Africa. So far, it has been recorded only from the southern DRC and northwestern Angola, with a single specimen collected in the extreme northwest of Zambia (Ansell 1974). However, it may be more widely distributed in the far northern parts of Angola and the southern DRC. The type specimen is from Yoruba, Nigeria, but the description is based on a specimen from the Gambia (Bergmans 1989), which was subsequently lost.

The southern African population of this species is poorly represented in museums, with just 20 records examined for this book.

Nothing is known about its roosting habits in southern Africa, but in West Africa *Micropteropus pusillus* roosts solitarily or occasionally in pairs in low bushes, often near

External and cranial measurements (mm) and mass (g) for *Micropteropus pusillus*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	29.2	24.0	34.0	2.80	43	**Mass[1]**	27.6	24.0	34.0	3.20	10
FA[1]	51.2	49.0	53.0	1.10	43	**FA[1]**	52.1	50.0	56.0	1.50	10
Total	-	-	-	-	-	**Total**	-	-	-	-	-
Tail	-	-	-	-	-	**Tail**	-	-	-	-	-
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear	-	-	-	-	-	**Ear**	-	-	-	-	-
CI	-	-	-	-	-	**CI**	-	-	-	-	-

[1] Marshall and McWilliam (1982) based on specimens from Ghana

water. Although it occurs throughout tropical Africa, it is associated with open woodlands and forest edges, avoiding mature, closed forest.

Extralimital: *Micropteropus pusillus* is widespread in tropical Africa from the Gambia in the west through West and Central Africa and east to Uganda and Ethiopia.

Foraging ecology: *Micropteropus pusillus* has broad wings with high wing loading (12.6 Nm^{-2}) and aspect ratio (8.7) (Norberg and Rayner 1987). There is no information on the diet or foraging behaviour of this species in southern Africa, but elsewhere it feeds on the following wild and cultivated plants: *Kigelia pinnata*, *K. africana*, *Spathodea campanulata*, *Adansonia digitata*, *Ceiba pentandra*, *Maranthes polyandra*, *Parinari polyandra*, *Parkia clappertoniana*, *P. roxburghii*, *Ficus capensis*, *Psidium guajava*, and *Vitellaria parkii* (Rosevear 1965, Fujita and Tuttle 1991).

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1867. *Epomophorus pusillus* Peters, Monatsb. K. preuss. Akad. Wiss. Berlin. Yoruba, Nigeria.

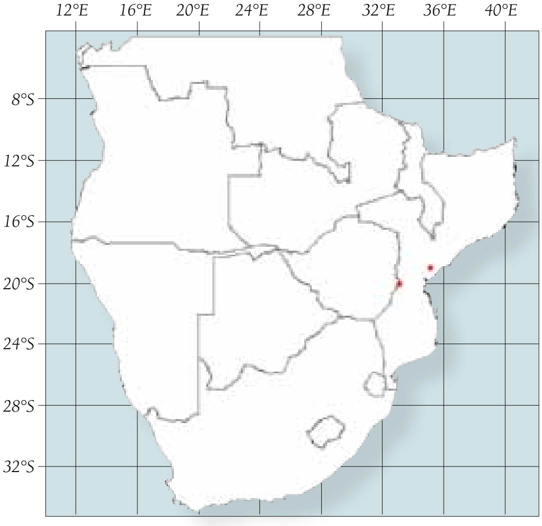
Micropteropus pusillus is closely related to *M. intermedius*, from which it is distinguishable only by its smaller size and slight differences in palatal ridges (Bergmans 1989). The diploid number in *M. pusillus* is 2n = 35 (males) and aFN = 64 (Haiduk *et al.* 1980, 1981). The odd number of chromosomes is due to a chromosomal rearrangement involving the Y-chromosome so that two Y elements are present.

Figure 66. *Micropteropus pusillus* feeding on a fig, showing white ear patches (© Merlin D. Tuttle, Bat Conservation International, www.batcon.org).

Myonycteris relicta Bergmans 1980 ●

Bergmans's collared fruit bat

Vulnerable



Description: *Myonycteris relicta* is a small to medium bat with a mass of around 55 g. The pelage is greyish-brown, and is paler and shorter on the underparts. The wings are dark brown and inserted on the second toe. Adult males have a broad reddish-brown frontal ruff extending from the sides of the neck across the throat and the upper chest, although no males have been collected from southern Africa. These hairs are long and arise from glands, giving the hairs a sticky feel. There are no shoulder epaulettes and the ears do not have a patch of white fur at their base. The muzzle is dog-like and rather short and broad. A short tail is present (Bergmans 1980).

The skull is moderately robust with moderate zygomatic arches. The rostrum is moderately long (about one-third of greatest skull length). The braincase is smooth, deep and rounded. In lateral profile, the skull is arched; the rostrum tapers gradually anteriorly, while the parietal region is strongly deflected downwards posteriorly. The sagittal crest is absent, while the lambdoid crest is weakly developed, but clearly defined. The dental formula is 2132/2132 = 32. The first upper premolar is small or minute. The third lower molar is absent (but is present in *M. torquata*).

External measurements (mm) and mass (g) for *Myonycteris relicta*, sexes combined

	Mean	Min	Max	SD	N
Mass^{1,2}	54.0	52.0	56.0	-	2
FA^{1,2}	70.3	69.4	71.1	-	2
Total^{3}	105	-	-	-	1
Tail^{1}	9	-	-	-	1
Tibia^{1}	30.0	-	-	-	1
Ear^{1}	19	-	-	-	1
CI^{1}	33.2	-	-	-	1

[1] A. Monadjem and A. Reside (unpublished data)
[2] Bergmans (1997)
[3] Measured from an alcohol specimen with skull removed

Key identification features: The combination of average size (FA 50–80 mm) and lack of white ear patches separates *Myonycteris* and *Lissonycteris* from all other African fruit bats. *Megaloglossus* (FA < 45 mm) and *Rousettus* (FA > 80 mm) also lack white ear patches, but *Megaloglossus* is significantly smaller, while *Rousettus* is much larger. *Lissonycteris* is very similar in appearance, but is larger (FA > 68 mm, but generally > 77 mm, in *M. relicta* FA < 75 mm) and without any overlap in forearm length of adults. *Myonycteris torquata* is very similar in appearance, but slightly smaller in size (FA < 65 mm); it has six (as opposed to five) lower cheek teeth, the interfemoral membrane is fully haired (not in *relicta*), and their geographical distributions do not overlap.

Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Myonycteris relicta* appears to be restricted to the east coast of Africa, with a marginal intrusion into southern Africa. So far, only two specimens have been recorded from two sites within the region – the confluence of the Haroni and Rusitu rivers in eastern Zimbabwe (Cotterill 1995, Bergmans 1997), and Chinizuia Forest in central Mozambique (A. Monadjem and A. Reside, unpublished data). The type specimen is from Shimba Hills, Kenya (RMNH 27909, Holotype).

This species is known from just seven museum specimens (Bergmans 1997, A. Monadjem, unpublished data).

Nothing is known about its roosting habits anywhere in its range, but presumably it hangs in trees. It appears to be associated with riparian and coastal forest.

Extralimital: *Myonycteris relicta* is confined to coastal East Africa and has been recorded from southeastern Kenya and northeastern Tanzania (Bergmans 1997).

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: No reproductive information is available.

SYSTEMATIC NOTES

1980. *Myonycteris relicta* Bergmans, Zool. Meded. Rijksmus. Nat. Hist. Leiden, 55(14): 126. Shimba Hills, Kenya.

Bergmans (1980) discovered this species while examining a specimen labelled as *Myonycteris torquata* from East Africa (Bergmans 1997).

The diploid number in *M. relicta* is not known.

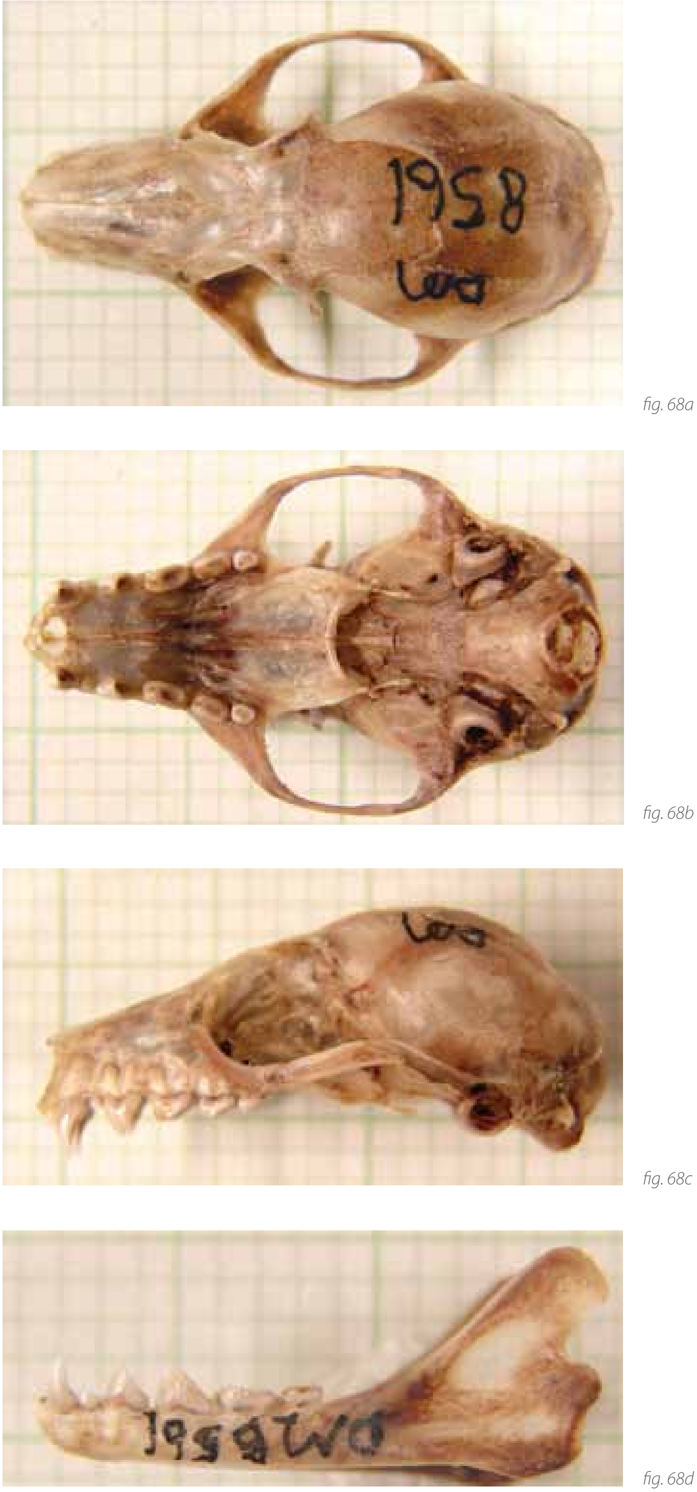


Figure 68. Skull and teeth of *Myonycteris relicta*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8561).

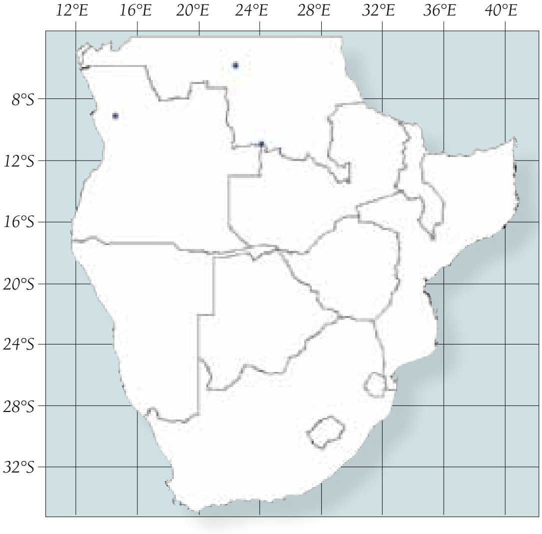
Figure 69. *Myonycteris relicta*, showing absence of white ear tufts (DM 8561, © A. Monadjem).

Figure 71. Myonycteris torquata, showing absence of white ear tufts (Liberia, © A. Monadjem).

Myonycteris torquata (Dobson 1878)

Little collared fruit bat

Least Concern



Description: *Myonycteris torquata* is a small fruit bat with a mass of around 45 g. The pelage is variable, ranging from greyish-brown to chestnut-brown; the fur on the underparts is paler and shorter. The wings are dark brown and inserted on the second toe. Adult males are slighter larger than females, and have a broad yellow to reddish-brown frontal ruff extending from the sides of the neck across the throat and the upper chest. These hairs are long and arise from glands, giving the hairs a sticky feel. There are no shoulder epaulettes and the ears do not have a patch of white fur at their base. The muzzle is dog-like and rather short and broad. A short tail is present.

The skull is moderately robust with moderate zygomatic arches. In lateral profile, the skull is arched, the rostrum tapers gradually anteriorly, while the parietal region is strongly deflected downwards posteriorly. The sagittal crest is absent, while the lambdoid crest is weakly developed, but clearly defined. The palatal ridges have been illustrated in Happold (1987). The dental formula is 2132/2133 = 34. The third lower molar is present (absent in *M. relicta*).

External measurements (mm) and mass (g) for *Myonycteris torquata*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	45.7	30.0	54.0	5.90	18
FA[1]	62.9	59.6	65.2	1.90	18
Total[2]	102	94	111	-	-
Tail[2]	10	9	11	-	-
Tibia[3]	-	20	23	-	-
Ear	-	-	-	-	-
CI	-	-	-	-	-

[1] Monadjem and Fahr (2007)
[2] Happold (1987)
[3] Rosevear (1965)

Key identification features: The combination of average size (FA 50–80 mm) and lack of white ear patches separates *Myonycteris* and *Lissonycteris* from all other African fruit bats. *Megaloglossus* (FA < 45 mm) and *Rousettus* (FA > 80 mm) also lack white ear patches, but *Megaloglossus* is significantly smaller, while *Rousettus* is much larger. *Lissonycteris* is very similar in appearance, but is larger (FA > 68 mm and generally > 77 mm, in *M. torquata* FA < 68 mm) without any overlap in forearm length. *Myonycteris relicta* is very similar in appearance, but slightly larger (FA > 65 mm) and their geographical distributions do not overlap.

Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Myonycteris torquata* is a common rainforest inhabitant of Central and West Africa, but is marginal to southern Africa. So far, it has been recorded from single sites in the southern DRC, northwestern Angola, and the extreme northwest of Zambia (Ansell 1978). However, it may be more widely distributed in the far northern parts of Angola and the southwestern DRC. The type specimen is from northern Angola (BM 66.1.20.4, Lectotype).

The southern African population of this species is poorly represented in museums, with just four records examined for this book.

Nothing is known about its roosting habits in southern Africa, but in West Africa *Myonycteris torquata* is thought to hang in trees (Happold 1987). It is associated with closed forest, but like many other tropical African fruit bats, it may venture into open habitats (e.g. villages) to feed on fruiting trees situated close to forest (Monadjem and Fahr 2007).

Extralimital: *Myonycteris torquata* is widespread in tropical African forests in Uganda, Sudan, DRC, Congo, Central African Republic, Gabon, Cameroon, Equatorial Guinea, Nigeria, Togo, Ghana, Côte d'Ivoire, Liberia and Guinea (Bergmans 1997).

Foraging ecology: There is no information on the diet of this species in southern Africa.

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1878. *Cynonycteris torquata* Dobson, Cat. Chiroptera Brit. Mus.: 71, 76. Lower Cuanza region (= Golungo Alto), Angola.

The diploid number in *M. torquata* is 2n = 36 and FN = 66 (Haiduk *et al*. 1980).

fig. 70a

fig. 70b

fig. 70c

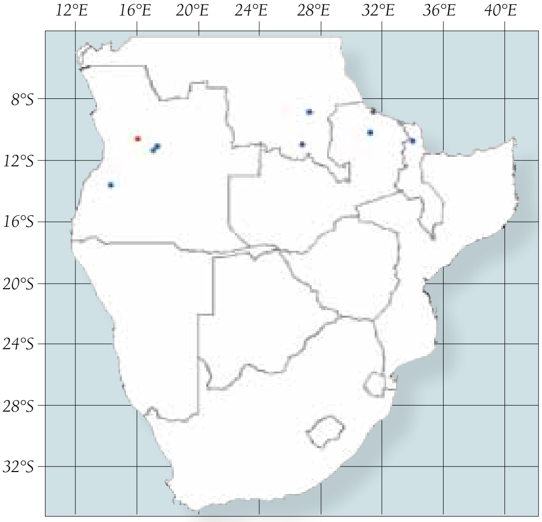
fig. 70d

Figure 70. Skull and teeth of *Myonycteris torquata*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (2985, Makerere University, Kampala).

Plerotes anchietae (de Seabra 1900)

Anchieta's broad-faced fruit bat

Data Deficient



Description: *Plerotes anchietae* is a small fruit bat, with an estimated mass of 30 g. The pelage is yellowish, with paler underparts (Bergmans 1989). When Bergmans (1989) reviewed the genus, it was unknown whether adult males developed the shoulder epaulettes typical of other epomophorine fruit bats, as no males had been collected at the time. Subsequently, a single adult male has been collected; it had neither epaulettes nor incipient invaginations in the shoulder region (Kock *et al.* 1998), strongly suggesting that epaulettes are not present in this species. The ears have a patch of white fur at their base in both sexes. The muzzle is dog-like and similar to that of the smaller *Epomophorus* species. The interfemoral membrane is very narrow and the calcar is absent.

For a fruit bat, the skull is relatively delicate with weak zygomatic arches. In lateral profile, the braincase is rounded and the rostrum tapers to the front. The dental formula is 2121/2132 = 28. The first upper premolar is greatly reduced. The second upper molar appears to be absent, but may possibly be present in adults (Bergmans 1989).

External and cranial measurements (mm) for *Plerotes anchietae*, sexes combined

	Mean	Min	Max	SD	N
Mass	-	-	-	-	-
FA[1]	48.9	45.3	52.5	1.96	11
Total[1]	82.4	70	96	10.9	7
Tail[1]	0	-	-	-	5
Tibia[1]	20.6	19.0	24.0	1.94	7
Ear[1]	16.9	15	18	0.98	7
CI	-	-	-	-	-
GSL[1]	27.4	25.1	29.5	-	5

[1] Based on measurements in Bergmans (1989)

Key identification features: *Plerotes anchietae* could be confused with *Micropteropus* or the small *Epomophorus* species. However, the interfemoral membrane is very narrow and the calcar is absent. In contrast, in *Micropteropus* and *Epomophorus*, the interfemoral membrane is well developed and a calcar is present.

Echolocation call: This bat does not echolocate.

Distribution, habitat and roosting: *Plerotes anchietae* is endemic to southern Africa with just eleven specimens collected from northern Angola, the southern DRC (although the specimen from Likasi, Katanga, could not be traced), north-eastern Zambia (Bergmans 1989) and northern Malawi (Kock *et al*. 1998). The type specimen is from Galanga, Angola (MLZA 481a). This specimen (housed in the Museu Bocage) was destroyed in the tragic fire of 1978. Bergmans (1989) selected a new type specimen from Dande, approximately 250 km to the northeast of Galanga (IICT 31–59026, Neotype).

Nothing is known about the roosting habits of this species. It appears to be associated with miombo woodlands at elevations above 1,000 m.

Extralimital: *Plerotes anchietae* is endemic to southern Africa.

Foraging ecology: The Kasama specimen was netted next to a flowering *Parinari curatellifolia* (Harrison 1960). The morphology of the palate and dentition suggests that *Plerotes* might be a specialised feeder on nectar and pollen. The stiff 'moustache' along the upper lip and the 'beard' on the chin of *P. anchietae* are formed of short, stiff hairs; whilst their function is unknown, it is hypothesised that they facilitate transfer of pollen between flowers (Bergmans 1989).

Reproduction: No reproductive information is available.

SYSTEMATIC NOTES

1900. *Epomophorus anchietae* de Seabra, J. Sci. mat. phys. nat., Lisboa, ser. 2, 6: 116. Galanga, Benguela, Angola.

The genus *Plerotes* is closely allied to *Epomophorus*, from which it differs by 11 characters; these are outlined by Bergmans (1989).

The diploid number in *P. anchietae* is not known.

fig. 72a

fig. 72b

fig. 72c

fig. 72d

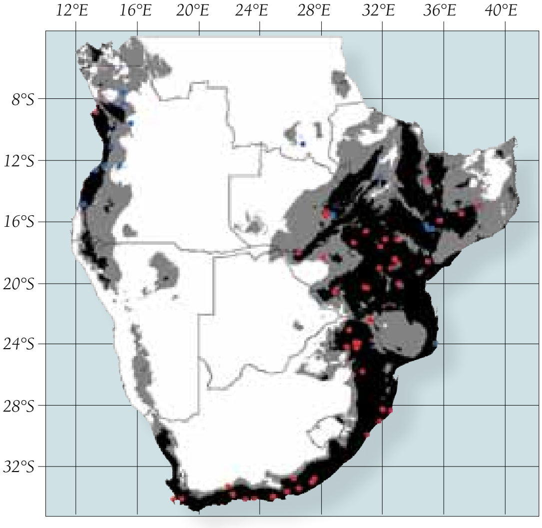
Figure 72. Skull and teeth of *Plerotes anchietae:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (IICA 6734). Scale bar = 10 mm (© A. Monadjem).

Figure 73. Plerotes anchietae: museum specimen showing narrow interfemoral membrane (IICA 6734, © A. Monadjem).

Rousettus aegyptiacus (E. Geoffroy Saint-Hilaire 1810)

Egyptian rousette

Least Concern



Description: *Rousettus aegyptiacus* is a large fruit bat with a mass of around 120 g. The pelage colour is variable, ranging from slate-brown to dark brown on the upper parts; the underparts are paler. The fur is short and sleek. On the head and neck, the fur is generally sparser than on the back. The wings are dark brown and inserted on the first toe, or between the first and second toe. Adult males are similar in size to females and both sexes have a buffy or yellowish collar around the throat, which contrasts with the general dark colour of the fur. These hairs do not arise from glands and are therefore not sticky as in *Lissonycteris* and *Myonycteris*. There are, however, two small glandular areas of specialised stiffer hairs at the sides of the neck (Bergmans 1994). There are no shoulder epaulettes and the ears do not have a patch of white fur at their base. The muzzle is dog-like and rather short and broad. A short tail is present.

The skull is robust with moderate zygomatic arches. Proportionately, the rostrum is distinctly shorter than in *Epomophorus*. In lateral profile, the braincase is high and rounded with the parietal region strongly deflected downwards. The sagittal crest is weak or absent, while the lambdoid crest is fairly well developed. The southern African subspecies (*R. a. leachii)* has eight palatal ridges; four undivided ridges are followed by three divided ridges and one narrow, serrated posterior ridge (i.e. 4+3+1). The dental formula is 2132/2133 = 34. The first upper premolar is very small and may occasionally be absent.

Key identification features: The combination of large size (FA > 80 mm) and lack of white ear patches separates *Rousettus* from most African fruit bats, except *Lissonycteris*. *Myonycteris* is typically much smaller (in the largest species *M. relicta* FA < 75 mm, in adult *Rousettus* FA > 90 mm). In *Rousettus aegyptiacus*, the wing inserts on the first toe or between the first and second toe. In *Lissonycteris* (which is also smaller, FA < 88 mm), the wing inserts on the second toe. *Rousettus aegyptiacus* has short sleek fur, while *R. lanosus* has characteristically long fur, giving it a shaggy appearance.

Echolocation call: Species of this genus do echolocate, making *Rousettus* an exception among fruit bats. *Rousettus aegyptiacus* uses a primitive form of echolocation: it produces the sound by repetitive tongue clicks. The lower part of its frequency range of 10–60 kHz is audible to humans.

Distribution, habitat and roosting: The subspecies *leachii* is widespread in the eastern parts of the region, occurring from Cape Town in the extreme southwest of South Africa, east and north along the coast to KwaZulu-Natal. There is a gap in its distribution in Swaziland and southern Mozambique, with

External and cranial measurements (mm) and mass (g) for *Rousettus aegyptiacus leachii, males and females presented separately**

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	126.8	79.0	165.0	25.29	17	**Mass**[1]	113.8	78.0	144.0	21.9	13
FA[1]	92.0	82.0	100.0	5.46	20	**FA**[1]	92.6	85.0	101.0	4.54	19
Total[1]	141.5	107	171	20.93	15	**Total**[1]	149.3	108	169	14.94	16
Tail[1]	13.3	7	18	2.95	13	**Tail**[1]	16.8	9	26	4.57	16
Tibia[1]	42.3	-	-	-	1	**Tibia**[1]	-	-	-	-	-
Ear[1]	22.7	19	27	2.19	15	**Ear**[1]	22.4	22	25	1.34	16
CI[1]	40.1	35.4	42.7	2.64	8	**CI**[1]	40.2	38.7	42.5	1.15	12

* Mean FA of three R. a. unicolor males from Angola is 97.5 mm, range: 93.7–102.0 mm (Bergmans 1994)

[1] Specimens measured by the authors

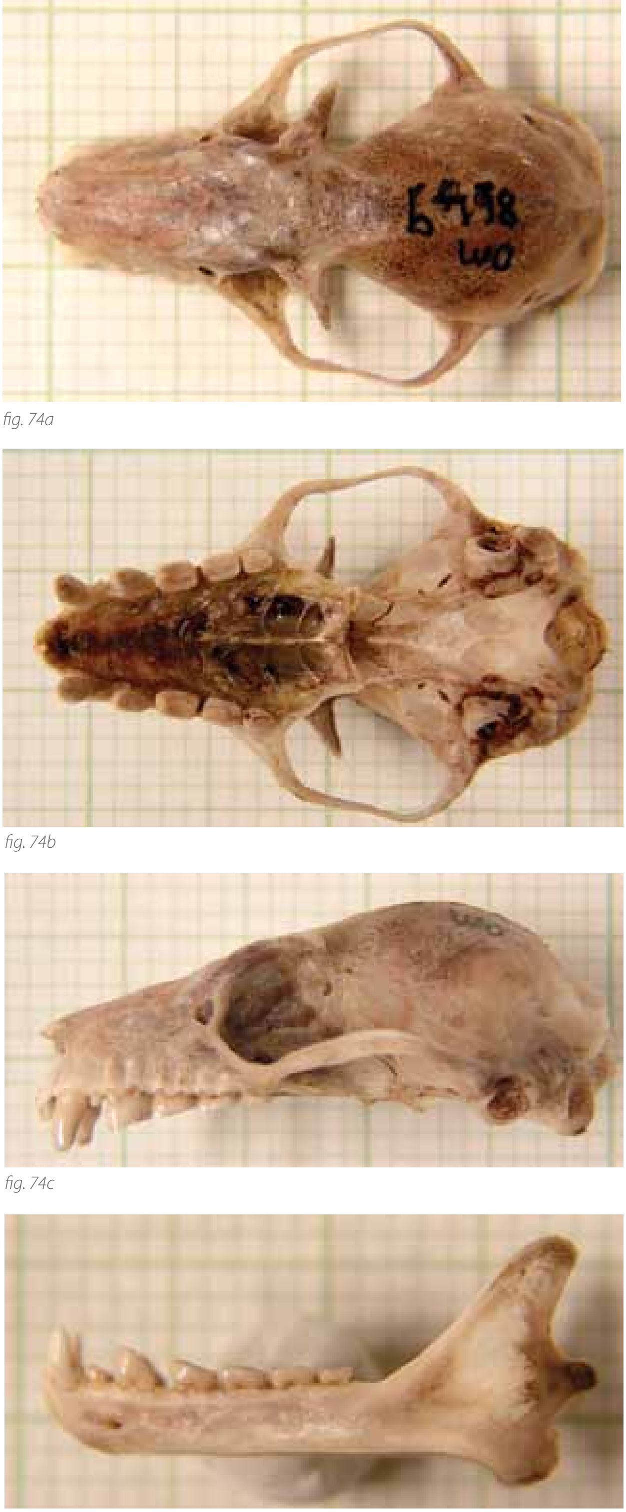


fig. 74a

fig. 74b

fig. 74c

fig. 74d

Figure 74. Skull and teeth of *Rousettus aegyptiacus*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8649).

fig. 75a

Figure 75. *Rousettus aegyptiacus*: (a) feeding on mango fruit, and (b) portrait showing absence of white ear tufts and uniformly short fur on head and back (a: © Merlin D. Tuttle, Bat Conservation International, www.batcon.org; b: DM 8649, © A. Monadjem).

records re-appearing in northern South Africa, through Zimbabwe, northern Mozambique, southern Zambia, Malawi and the southern DRC. The subspecies *unicolor* occurs in western Angola. The type specimen for the species is from Egypt (MNHN A70, MNHN A69-762A, Paratype); the type locality for *leachii* is the Company Gardens, Cape Town, South Africa.

This species is well represented in museums, with more than 200 specimens examined for this book.

Rousettus aegyptiacus roosts gregariously in caves. The bats are totally dependent on the presence of caves and their distribution is influenced more by the availability of suitable roosting sites than vegetation associations. The species occurs in the moist, well-watered eastern parts of the region, but is absent from the dry west; this is possibly an indication of its reliance on fruiting trees. Roosting colonies may number over 5,000 individuals, e.g. in the Mission Rocks caves in the Greater St Lucia Wetland Park. Numbers may also vary seasonally; at the Mission Rocks caves there may be fewer than 300 individuals in summer. Jacobsen and du Plessis (1976) observed the opposite pattern in caves in the Tzaneen area of Limpopo, South Africa, where numbers reached over 9,000 individuals at the Matlapitsi cave in March–April (late wet season) and declined to just over 3,000 individuals in June–August (winter). This suggests that some movement occurs between these two populations. Indeed, a bat tattooed in the Tzaneen area was subsequently recovered 500 km away at Cape Vidal in northern KwaZulu-Natal (Jacobsen and du Plessis 1976).

Extralimital: *Rousettus aegyptiacus* is widespread in sub-Saharan Africa and Arabia, but there is a wide gap (through much of the DRC, Central African Republic, Chad and Sudan) between the distributions of the eastern *leachii* and western *unicolor* (Bergmans 1994).

Foraging ecology: *Rousettus aegyptiacus* has broad wings with high wing loading (24.6 Nm^{-2}) and low aspect ratio (5.9) (Norberg and Rayner 1987). A study in Limpopo, South Africa, showed that *Ficus* spp. comprised the bulk of this species' diet, but that the bats also regularly raided fruit orchards such as *Litchi chinensis* (Jacobsen and du Plessis 1976). Other fruits recorded in its diet include *Syzygium* spp., *Harpephyllum caffrum, Ekebergia capensis, Prunus africana* and *Diospyros senensis* (Jacobsen and du Plessis 1976, Herzig-Straschil and Robinson 1978, Thomas and Fenton 1978).

Radio-tracked individuals flew about 24 km from their roosting cave to a feeding site, a journey that took 90 minutes (Jacobsen *et al.* 1986).

Reproduction: In southern Africa, parturition generally occurs in the wet summer months. In Limpopo, South Africa (a summer rainfall region), mating and fertilisation take place in June–August and births occur in October–December (Jacobsen and du Plessis 1976, Penzhorn and Rautenbach 1988). In contrast, births are less seasonally restricted in the Western Cape (a winter rainfall region) and occur in October–February and June (Herzig-Straschil and Robinson 1978). In parts of East Africa, births occur twice per year (Kingdon 1974).

One or, occasionally, two young are born after a 105–107-day gestation period, followed by a 6-week lactation period. The young start flying at 9–10 weeks (Kingdon 1974, Jacobsen and du Plessis 1976).

fig. 75b

SYSTEMATIC NOTES

1810. *Pteropus egyptiacus* E. Geoffroy Saint-Hilaire, Ann. Mus. Hist. Nat. Paris 15: 96. Giza, Egypt.

Two geographically isolated subspecies of *Rousettus aegyptiacus* occur in sub-Saharan Africa, both entering the southern African region: *unicolor* in Angola and *leachii* in the rest of the region; *unicolor* is slightly larger than *leachii*.

Rousettus aegyptiacus leachii (A. Smith 1829)

1829. *Pteropus leachii*, A. Smith, Zool. Journ., 4: 433. Cape Town, South Africa.

Rousettus aegyptiacus unicolor (Gray 1870)

1870. *Eleutherura unicolor*, Gray, Cat., Monkeys, Lemurs, Fruit-eating Bats Brit. Mus.: 117. Gabon.

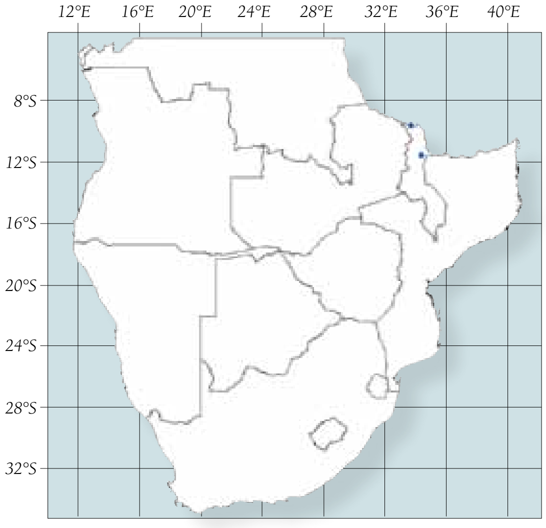
The original name of this species was *egyptiacus*. The author, Geoffroy Saint-Hilaire, changed it to *aegyptiacus*, which has been widely followed. Corbet and Hill (1992) argued that there was no reason to use *ae* instead of *e*, and reverted to *egyptiacus* again, which was followed by Koopman (1993) and Bergmans (1994). However, Kock (2001a) defended the use of the original spelling, as endorsed by Simmons (2005).

The diploid number in *R. aegyptiacus* is 2n = 36 and aFN = 66 (Dulic and Mutere 1973, 1977).

Rousettus lanosus (O. Thomas 1906)

Long-haired rousette

Least Concern



Description: *Rousettus lanosus* is a large fruit bat with a mass of around 145 g. The pelage is rich rufous dark brown on the upper parts, and paler on the underparts. The fur is long and shaggy, also on the head, giving it an unkempt appearance. It does not have a neck ruff of stiff hairs like *Myonycteris* and *Lissonycteris*, but there are two small areas of specialised stiffer hairs at the sides of the neck (Bergmans 1994). The wings are dark brown and inserted on the second toe, or between the first and second toe. Adult males are similar in size to females. There are no shoulder epaulettes and the ears do not have a patch of white fur at their base. The muzzle is dog-like and rather short and broad. A short tail is present.

For a large fruit bat, the skull is fairly delicate with weak zygomatic arches. In lateral profile, the braincase is rounded, with the parietal region strongly deflected downwards posteriorly. The dental formula is 2132/2133 = 34 (Bergmans 1994).

External and cranial measurements (mm) and mass (g) for *Rousettus lanosus*, sexes combined

	Mean	Min	Max	SD	N
Mass[2]	145	120	165	-	-
FA[1]	91.9	91.3	92.9	-	4
Total	-	-	-	-	-
Tail[2]	-	15	25	-	-
Tibia[2]	40	-	-	-	-
Ear	-	-	-	-	-
CI	-	-	-	-	-
GSL[1]	44.0	-	-	-	1

[1] Based on Malawi specimens, extracted from Bergmans (1994)
[2] Kingdon (1974)

Key identification features: The combination of large size (FA > 80 mm) and lack of white ear patches separates *Rousettus* from most African fruit bats, except *Lissonycteris*. *Myonycteris* is typically much smaller (in the largest species, *M. relicta*, FA < 75 mm, in adult *Rousettus* FA > 90 mm). *Rousettus lanosus* is very similar to *R. aegyptiacus* in overall size and appearance, but it has long, shaggy fur that contrasts strongly with the short, sleek fur of *R. aegyptiacus*. The shaggy fur of *R. lanosus* also distinguishes it from the sleek *Lissonycteris*, which is also smaller (FA < 88 mm).

Echolocation call: Like *R. aegyptiacus*, this species is able to fly in total darkness by echolocation. It produces a clinking sound by clicking its tongue.

Distribution, habitat and roosting: *Rousettus lanosus* is marginal to southern Africa. The first southern African specimens were discovered in Malawi in 1989, where it is now known from seven specimens at two sites (Bergmans 1994). The type specimen is from Uganda (BM 1906.7.1.2, Holotype).

Nothing is known about its roosting requirements in southern Africa, but it uses caves in East Africa. It is gregarious, occurring in colonies of hundreds of bats, occasionally sharing a roost with *R. aegyptiacus* and *Lissonycteris angolensis* (Kingdon 1974). It is a montane species that typically occurs at higher altitudes than *R. aegyptiacus*. Of 44 known specimens, just two were collected below 1,000 m above sea level, whereas 37 specimens were obtained at elevations between 1,500 and 4,000 m (Bergmans 1994).

Extralimital: *Rousettus lanosus* is sparsely distributed in East Africa, occurring in Tanzania, Kenya, Uganda, Rwanda, DRC, Sudan and Ethiopia (Bergmans 1994).

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1906. *Rousettus lanosus* O. Thomas, Ann. Mag. Nat. Hist., ser.7, 18 (104): 137. Uganda.

The name *kempi* Thomas 1909 is a synonym. *Rousettus lanosus* was previously placed in the genus/subgenus *Stenonycteris* Andersen 1912 (e.g. Kingdon 1974); however, Bergmans (1994) has argued that *Stenonycteris* is not clearly defined and retained *lanosus* in *Rousettus*.

The diploid number in *R. lanosus* is not known.

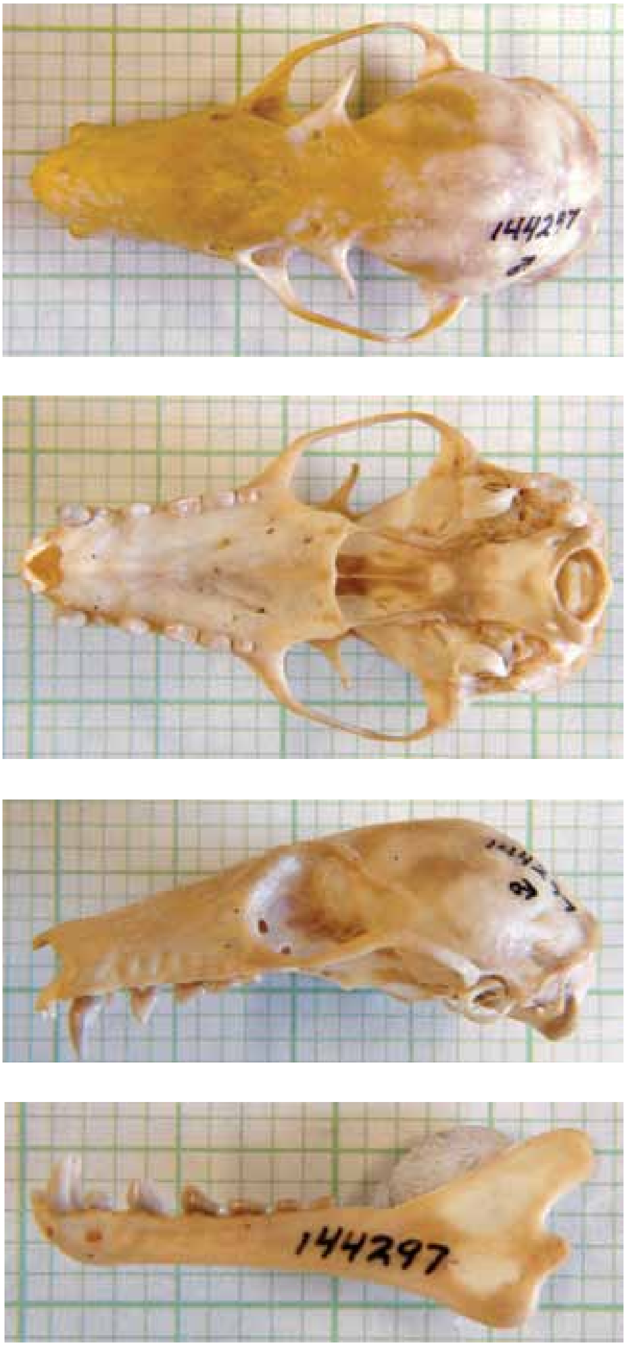


fig. 76a

fig. 76b

fig. 76c

fig. 76d

Figure 76. Skull and teeth of *Rousettus lanosus*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral mandible view (FMNH 144297).

Figure 77. *Rousettus lanosus*, showing individual long hairs on head and back (Uganda, © A. Monadjem).

SUBORDER PTEROPODIFORMES

FAMILY HIPPOSIDERIDAE
TRIDENT AND LEAF-NOSED BATS

Within Africa, this family contains some 19 species in four genera, of which seven species in three genera occur in southern Africa (Simmons 2005). The genus *Asellia*, which is widespread in the northern parts of the continent, does not extend south into our region. Members of this family typically have a prominent noseleaf that is simple and elliptical or three-pronged in shape (Figure 81), but lacks the single, triangular erect process of the Rhinolophidae (Figure 94).

Hipposideros is a large genus found throughout the Old World. It is well represented in tropical Africa with species richness declining away from the equator. In our region, not more than three species co-occur at any one site (and usually just one or two species). The noseleaf of this genus (half-moon-shaped; Figure 78) is widely used in identification of its species. *Hipposideros cyclops* (Temminck 1853), a forest species, occurs marginally in the extreme northwest of the region. This is based on two records; one from Lovanium, Republic of Congo (Congo–Brazzaville) (04.25 S 15.03E, RMCA 31201), and a second mapped south of the Bas Congo in the DRC (Decher and Fahr 2005).

Cloeotis and *Triaenops* are represented by single species in this region. Both these genera are immediately recognisable by their unique noseleaf, which is characteristically three-pronged (Figure 78).

Echolocation calls in this family typically show a high duty-cycle, constant frequency (HD-CF) component. The CF component differs between species and may be used as a guide to their identification (Monadjem *et al*. 2007). The noseleaf plays an important role in the emission of the echolocation signal. All members of this family have broad wings, allowing them to manoeuvre through cluttered environments such as dense vegetation (Neuweiler 1990).

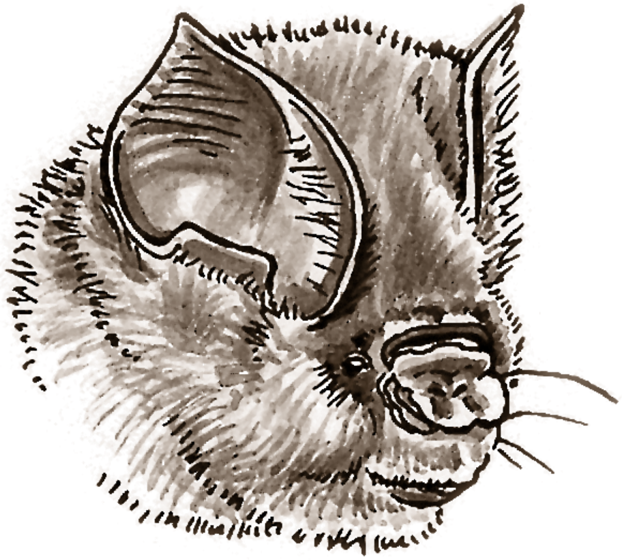


fig. 78a

fig. 78b

Figure 78. (a) *Hipposideros caffer*, and (b) *Triaenops persicus*, showing the differing structure of their noseleafs.

TABLE 9. IDENTIFICATION MATRIX FOR GENERA WITHIN THE FAMILY HIPPOSIDERIDAE

GENUS	FA (MM)	PF (KHZ)	NOSELEAF
Cloeotis	31–35	208	tridentate (three-pronged) shape
Hipposideros	40–53 and 100–108	~56–140	leaflet of noseleaf with elliptical upper edge
Triaenops	46–49	~80	tridentate (three-pronged) shape

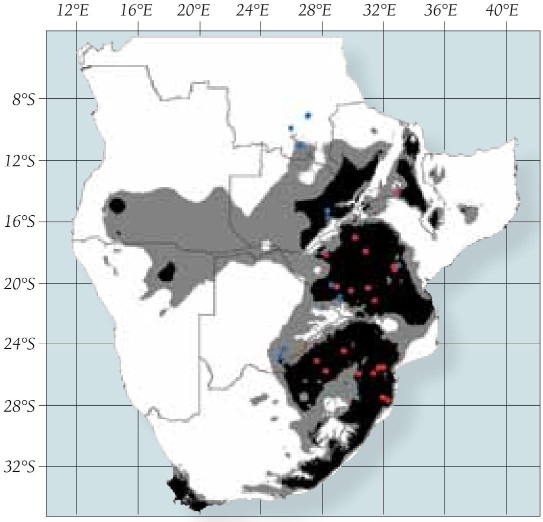
TABLE 10. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE GENUS *HIPPOSIDEROS* (HIPPOSIDERIDAE)

SPECIES	FA (MM)	DISTINGUISHING COLOUR AND MARKS	PF (KHZ)	ROOST	RANGE IN SOUTHERN AFRICA	OTHER
H. caffer	40–50	fur is long and shaggy grey-brown to brown	~144	caves, mines, sink holes, road culverts	widely distributed throughout region, but absent from south to south western parts	skull of *H. caffer* visibly less robust than that of *H. ruber* (CI < 16.0 mm)
H. ruber	50–53	fur is long and shaggy; usually darker brown than that of H. caffer	~137	caves, sink holes, tree cavities	restricted to northern parts	skull of *H. ruber* visibly more robust than that of *H. caffer* (CI > 16.5 mm)
H. fuliginosus	52–54	fur is long and dark brown	~120–123	caves and tree cavities	forested habitats in Congo basin	thumb pad and claw well developed
H. vittatus	100–109	short fur	~61–66	caves	widely but sparsely distributed in northern parts	-
H. gigas	109–124	short fur	~56	caves and tree cavities	forested habitats in Congo basin	-

Cloeotis percivali Thomas 1901

Percival's short-eared trident bat

Vulnerable



Description: *Cloeotis percivali* is a very small bat with a mass of 4–5 g. The pelage is normally sandy-brown on the back and head, while the underparts are lighter. Dark markings surround the eyes. The wings are dark grey. It is distinguished by its noseleaf, a feature shared with the far larger *Triaenops persicus*. The posterior part of the noseleaf is characteristically three-pronged. The ears are small, almost circular and forward-facing. The sexes are alike.

The skull is delicate with weak zygomatic arches. The rostral swellings are well developed, resulting in a rounded rostral profile. The frontal depression is shallow without defined supra-orbital ridges. The sagittal crest is weak or absent and the palatal bridge is long. The dental formula is 1123/2123 = 30.

Key identification features: The three-pronged noseleaf distinguishes *Triaenops persicus* and *Cloeotis percivali* from all other bats in the region. However, *T. persicus* (FA > 48 mm) is significantly larger than *C. percivali* (FA < 37 mm).

Echolocation call: *Cloeotis percivali* produces HD-CF calls with a high peak frequency (207.8±3 kHz, n = 6) and intermediate duration (4.6±1.2 ms, n = 6) (Schoeman and Jacobs 2008; also see Fenton and Bell 1981, Taylor 1999a, Jacobs 2000, Monadjem *et al*. 2007). Besides the second harmonic, the fundamental harmonic is often present on the spectrogram at around 104 kHz.

Distribution, habitat and roosting: *Cloeotis percivali* is sparsely distributed in the northeast of southern Africa (Cotterill 2001a). It occurs from northern KwaZulu-Natal, through Swaziland and northern South Africa to Zimbabwe, Zambia and the southern DRC. The model suggests that suitable climatic conditions exist through much of KwaZulu-Natal and the northern parts of the Eastern Cape; however, this species has not been recorded south of northern KwaZulu-Natal. The type specimen is from Mombasa, Kenya (BM 1901.5.1.11, Holotype).

This species is relatively well represented in museums, with over 120 specimens examined for this book.

Cloeotis percivali is not abundant and the entire southern African population may well be restricted to less than 20 caves, with numbers ranging from 20–200 individuals per roost. However, Seamark (2005) suggests that it may be more common than indicated by museum specimens, as it is not easy to capture by conventional mist nets and may roost in narrow crevices, possibly leading it to be overlooked at a number of roosts. Its habitat preferences are not well known, but it appears to be associated with woodland.

Extralimital: *Cloeotis percivali* has also been recorded from Kenya.

External and cranial measurements (mm) and mass (g) for *Cloeotis percivali*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	4.4	4.0	6.0	0.62	14	**Mass**[1]	4.5	3.6	5.5	0.65	16
FA[1]	34.0	32.6	36.0	0.88	27	**FA**[1]	34.4	32.2	36.0	0.99	22
Total[1]	66.2	60.0	72.0	2.70	26	**Total**[1]	66.7	56.0	73.0	3.79	18
Tail[1]	26.0	18.0	32.0	3.80	26	**Tail**[1]	28.0	22.0	36.0	3.30	18
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	8.2	7.0	10.0	0.80	26	**Ear**[1]	8.8	8.0	9.0	0.40	18
CI[1]	11.3	11.1	11.6	0.23	9	**CI**[1]	11.6	11.2	12.0	0.22	10

[1] Specimens measured by the authors

fig. 79a

fig. 79b

fig. 79c

fig. 79d

Figure 79. Skull and teeth of *Cloeotis percivali:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8026).

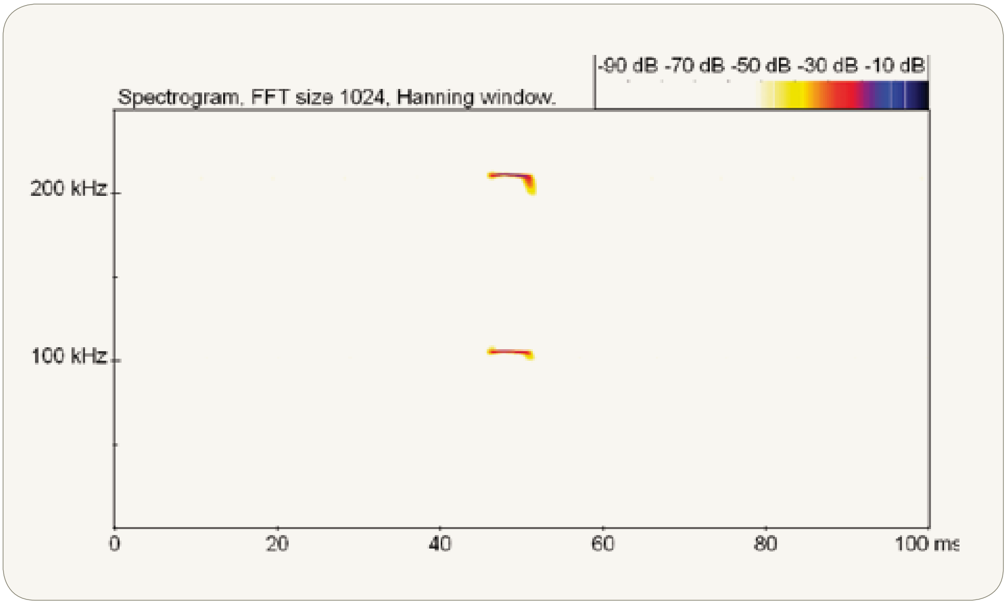


Figure 80. Echolocation call of *Cloeotis percivali*.

fig. 81a

Foraging ecology: *Cloeotis percivali* has short, rounded wings with low wing loading (6.7 N.m^{-2}) and low aspect ratio (5.8) (Jacobs 2000, Schoeman and Jacobs 2008). It is a clutter forager. It appears to prey exclusively on Lepidoptera, and its extremely high echolocation call (well over 200 kHz) may be an adaptation to avoid being detected by tympanate moths (Jacobs 2000; also see Findley and Black 1983, Schoeman 2006).

Reproduction: In Zimbabwe, pregnant females were collected in October (Smithers and Wilson 1979), while pregnant females and females with attached young were recorded at Jozini Dam on 28 November in KwaZulu-Natal (Taylor 1998).

SYSTEMATIC NOTES

1901. *Cloeotis percivali* Thomas, Annals and Magazine of Natural History (7)8: 28. Takaungu, north of Mombasa, Kenya.

Meester *et al.* (1986) recognised two subspecies: the nominate subspecies from Kenya and *C. percivali australis* (TM 1690, Holotype) from southern Africa.

Cloeotis percivali australis Roberts 1917

1917. *Cloeotis percivali australis* Roberts, Annals of the Transvaal Museum 5: 264. Mooimeisiesfontein, Rustenburg district, western Transvaal (= North West Province), South Africa.

The validity of these two subspecies remains to be tested. However, considering the patchy distribution of this species and the geographic isolation of the Kenyan population, there may well be significant genetic differentiation between these two populations.

The diploid number in *Cloeotis percivali* is 2n = 40 (Rautenbach *et al.* 1993).

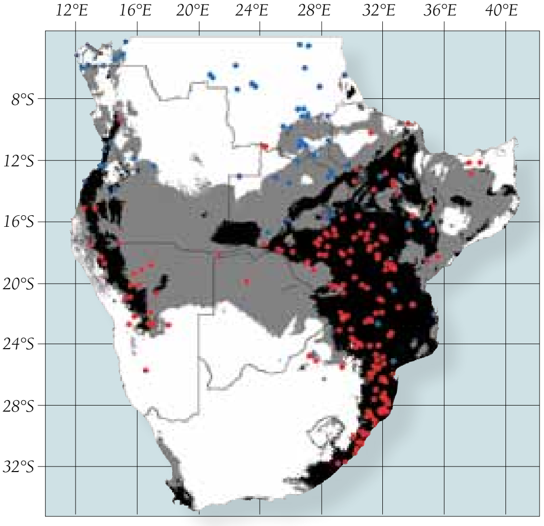
fig. 81b

Figure 81. *Cloeotis percivali* showing three-pronged noseleaf (a: © A. Monadjem; b: © Merlin D. Tuttle, Bat Conservation International, www.batcon.org).

Hipposideros caffer (Sundevall 1846)

Sundevall's leaf-nosed bat

Least Concern



Description: *Hipposideros caffer* is a small bat with a mass around 8 g. It is distinguished by its noseleaf, a feature shared with other members of the genus. The pelage is variable in colour, but is normally brown on the back and head, while the underparts are slightly lighter. The wings are dark grey. There is a rufous form with a rich chestnut-orange pelage, which is otherwise similar to the brown form. The pelage of the western population is a much paler sandy-brown or cream. The ears are small and rounded with pointed tips. The sexes are alike.

The skull is delicate with weak zygomatic arches. The rostral swellings are well developed, resulting in a rounded rostral profile. The frontal depression is shallow without defined supra-orbital ridges. The sagittal crest is weak or absent and the palatal bridge is of medium length. The dental formula is 1123/2123 = 30.

Key identification features: The simple, elliptical noseleaf distinguishes the genus *Hipposideros* from all other southern African bats. *Hipposideros vittatus* is much larger (FA > 90 mm). Separating *H. caffer* and *H. ruber* in the field is more tricky; *H. ruber* is larger (FA > 50 mm and usually > 51 mm; in *H. caffer* FA < 51 mm and usually < 50 mm) and generally darker. However, lighter forms of *H. ruber* do occur, and occasionally dark forms of *H. caffer* may co-exist with *H. ruber*, especially on the edge between woodland and rainforest. The skull of *H. ruber* is visibly more robust with little overlap in condylo-incisive length (in *H. ruber* mean CI > 16.5 mm; in *H. caffer* mean CI < 16.0 mm).

Echolocation call: *Hipposideros caffer* produces HD-CF calls with a high peak frequency (142.3±0.6 kHz, n = 10) and intermediate duration (8.4±0.7 ms, n = 10) (Schoeman and Jacobs 2008; also see Fenton and Bell 1981, Fenton 1986, Taylor 1999a, Jacobs 2000, Taylor *et al.* 2005, Monadjem *et al.* 2007). Besides the second harmonic, the fundamental harmonic may be present on the spectrogram at ~71 kHz.

Distribution, habitat and roosting: *Hipposideros caffer* is widely distributed throughout southern Africa, but is absent from much of the southern and central parts of the region. It occurs from the Eastern Cape and KwaZulu-Natal through Swaziland and northern South Africa, to Zimbabwe, Zambia, Malawi, Mozambique, DRC and marginally in northern Botswana. The western population is widespread in western Namibia and western Angola. The type specimen is from Durban, South Africa (BM 1848.6.2.16, Syntype).

This species is well represented in museums, with over 900 specimens examined for this book.

External and cranial measurements (mm) and mass (g) for *Hipposideros caffer*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	7.9	5.0	11.0	1.41	33	**Mass[1]**	8.4	5.0	11.0	1.65	39
FA[1]	47.1	40.0	49.3	1.58	64	**FA[1]**	47.9	42.0	51.0	1.53	61
Total[1]	81.0	66	91	5.86	48	**Total[1]**	82.6	72	94	4.24	47
Tail[1]	30.0	21	38	4.10	49	**Tail[1]**	30.6	25	38	2.71	47
Tibia[1]	20.5	19.5	21.7	0.85	5	**Tibia[1]**	17.7	15.6	19.8	-	2
Ear[1]	13.5	10	17	1.89	52	**Ear[1]**	14.3	11	18	1.71	43
CI[1]	15.6	14.6	16.4	0.42	34	**CI[1]**	15.4	14.6	16.5	0.45	33

[1] Specimens measured by the authors

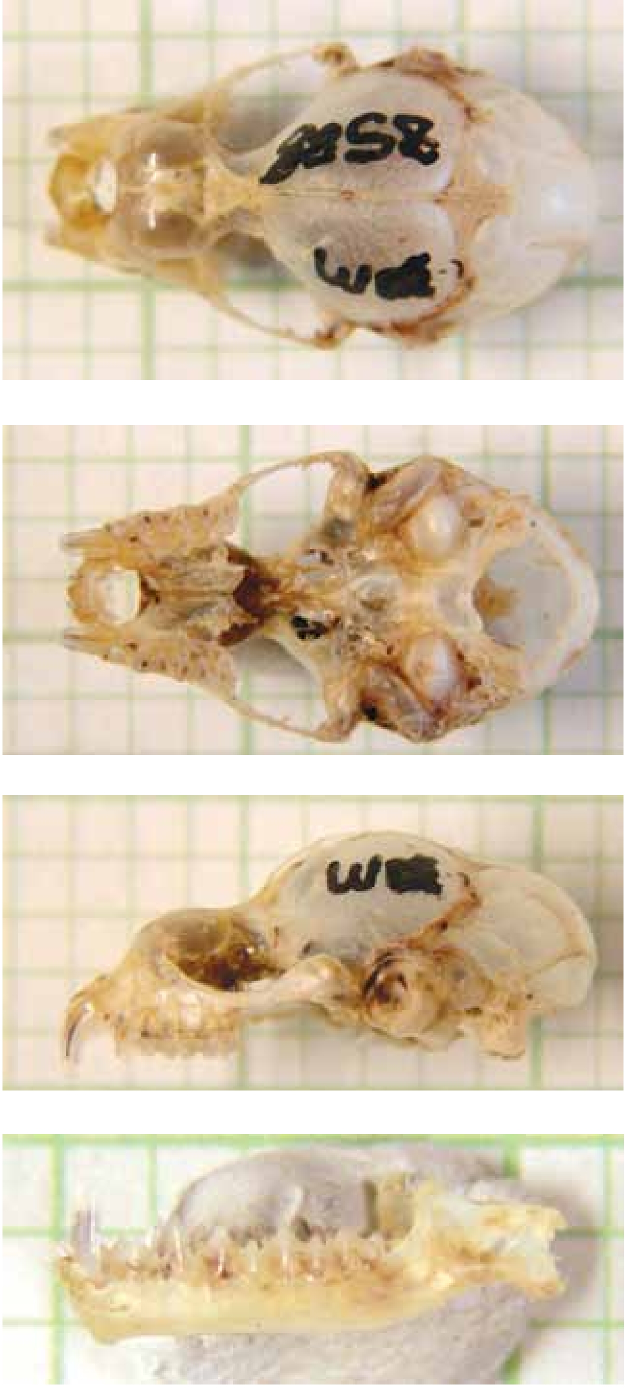


Figure 82. Skull and teeth of *Hipposideros caffer*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8588).

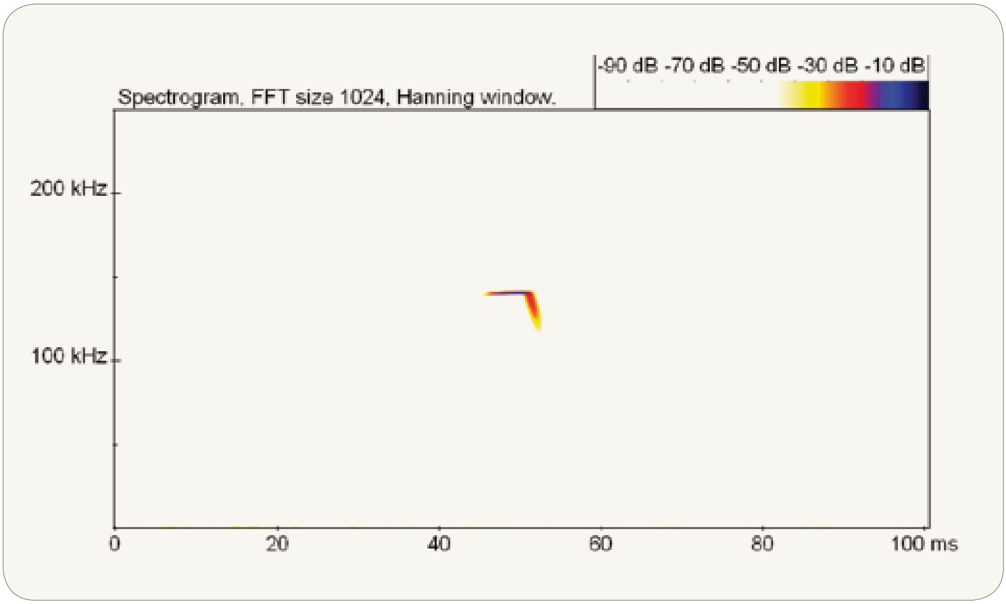


Figure 83. Echolocation call of *Hipposideros caffer.*

Hipposideros caffer roosts in a wide range of caves, sinkholes and cavities, including anthropogenic ones such as mines and culverts (Cotterill 2001a). Colonies vary in size from less than a dozen to hundreds of individuals. Males may roost solitarily. Roosts are commonly shared with other species (e.g. *Nycteris thebaica* in Swaziland). It is closely tied to savanna woodland, where it is closely associated with riparian locations (Monadjem and Reside 2008). It appears to forage in and around thickets and well-developed undergrowth vegetation, avoiding open areas. Its low wing loading and aspect ratio allow it to fly slowly and nimbly through cluttered environments (Aldridge and Rautenbach 1987).

Extralimital: *Hipposideros caffer* has been recorded widely throughout sub-Saharan Africa.

Foraging ecology: *Hipposideros caffer* has short, rounded wings with low wing loading (6.6 N.m^{-2}) and low aspect ratio (6.3) (Norberg and Rayner 1987; also see Jacobs 2000, Schoeman and Jacobs 2008). It is a clutter forager. Its diet consists predominantly of Lepidoptera, with smaller quantities of Trichoptera and Coleoptera (Dunning and Kruger 1996, Bowie *et al.* 1999, Jacobs 2000, Schoeman 2006; also see Whitaker and Black 1976, Fenton *et al.* 1977, Fenton and Thomas 1980, Findley and Black 1983, Aldridge and Rautenbach 1987).

Reproduction: In KwaZulu-Natal, copulation and fertilisation occurred in April, followed by retarded development during the cool winter months until September, after which normal development was resumed. Births occurred in early December and the young were lactated for 60 days (Bernard and Meester 1982).

SYSTEMATIC NOTES

1846. *Rhinolophus caffer* Sundevall, Öfversigt af Kungliga Svenska Vetenskapsakademiens Förhandlingar, Stockholm 3(4): 118. Near Port Natal (= Durban), South Africa.

Meester *et al.* (1986) recognised two subspecies from southern Africa: the nominate subspecies from the eastern part of its range and *H. caffer angolensis* from Namibia and Angola.

Hipposideros caffer angolensis Seabra 1898

1898. *Hipposideros caffer angolensis* Seabra, Jornal de sciencias mathematicas, physicas e naturaes, Lisboa (2)5: 256. Benguela, Angola.

The validity of these two subspecies remains to be tested. The eastern and western populations do not appear to be geographically isolated, as there may be corridors through the Caprivi (Namibia) and the DRC. Furthermore, a recent specimen from Maun (Botswana) suggests that the species has been overlooked in the northern parts of that country. Molecular research across the entire range of this species is long overdue.

The diploid number in *Hipposideros caffer* is 2n = 32 and aFN = 60 (Rautenbach *et al.* 1993).

fig. 84a

fig. 84b

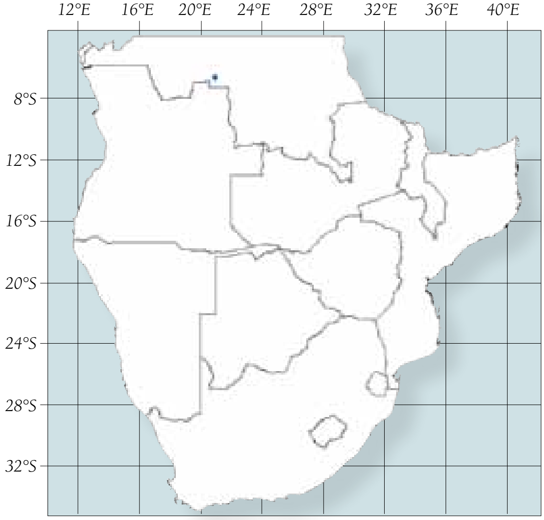
Figure 84. *Hipposideros caffer*: (a) portrait showing characteristic noseleaf, and whole body views of (b) grey and (c) rufous colour phases (a: © A. Monadjem; b, c: © E. C. J. Seamark).

fig. 84c

Hipposideros fuliginosus (Temminck 1853)

Sooty leaf-nosed bat

Near Threatened



Description: *Hipposideros fuliginosus* is a medium-sized leaf-nosed bat with a mass of around 15 g. The pelage colour is variable, typically dark brown above and slightly paler below. An orange phase is also not uncommon. The wings are pale brown, and the ears are small and rounded with pointed tips. The frontal sac, which is present behind the posterior noseleaf in some *Hipposideros* species, is absent in both sexes. The sexes are alike (Rosevear 1965).

The skull is fairly robust with weak to moderate zygomatic arches. The sagittal crest well is developed. The dental formula is: 1123/2123 = 30.

Key identification features: The simple, elliptical noseleaf distinguishes the genus *Hipposideros* from all other southern African bats. *Hipposideros caffer* is similar but smaller with no overlap in size (FA < 51 mm; > 52 mm in *H. fuliginosus*). *Hipposideros ruber* is, on average, slightly smaller, but there is considerable overlap in all external measurements. A frontal sac is usually present behind the posterior noseleaf in male *H. ruber* (but absent in females). The thumb pad and claw are both well developed in *H. fuliginosus*, less so in *H. ruber*.

External measurements (mm) and mass (g) for *Hipposideros fuliginosus*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	15.0	13.0	17.0	2.00	3
FA[1]	53.6	52.9	54.4	0.80	3
Total[2]	-	88	94	-	-
Tail[2]	-	26	31	-	-
Tibia[2]	-	21	26	-	-
Ear[2]	-	14	18	-	-
CI	-	-	-	-	-

[1] Based on species from Liberia (Monadjem and Fahr 2007)
[2] Rosevear (1965)

Echolocation call: *Hipposideros fuliginosus* produces HD-CF calls with a high peak frequency of 120–123 kHz (Fahr and Ebigbo 2003).

Distribution, habitat and roosting: Reliable museum records are scarce; all are associated with rainforest in West Africa and the central Congo basin (Monadjem and Fahr 2007). The inclusion of this species in this book is based on a specimen from southwest Congo (Hayman *et al.* 1966). The ecology of this species is poorly known. It is sympatric with *H. ruber* throughout most of its range; in West Africa, the two species may occupy the same roosts in hollow trees, where small colonies have been recorded (Rosevear 1965, Monadjem and Fahr 2007).

Extralimital: This species has a disjunct African distribution, which ranges from Uganda and the DRC west through Cameroon and Gabon to Nigeria, Ghana, Côte d'Ivoire, Liberia, Guinea and Sierra Leone (Rosevear 1965, Hayman *et al.* 1966, Monadjem and Fahr 2007).

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: No reproductive information available for southern Africa or indeed from elsewhere in Africa.

SYSTEMATIC NOTES

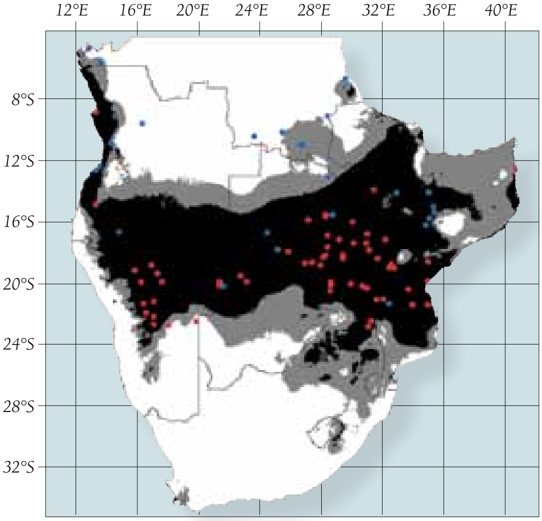
1853. *Phyllorrhina fuliginosa* Temminck, Esq. zool. Côte de Guiné, 77.

The diploid number in *H. fuliginosus* is not known.

Hipposideros gigas (Wagner 1845)

Giant leaf-nosed bat

Near Threatened



This map shows the combined distribution of *H. gigas* and *H. vittatus* (see text)

Description: *Hipposideros gigas* is a very large leaf-nosed bat; forearm length can reach 124 mm. This species is second in size and mass to the emballonurid, *Saccolaimus peli*. Averaging 148 g in the wet season, the mass of an adult male can exceed 200 g, but females weigh significantly less, and are smaller (FA females 100–111, n = 19; males 104–124, N = 56). The pronounced sexual dimorphism is evident in overall body size and cranial dimensions. The colour and thickness of the pelage also differs markedly between sexes and among individuals. The fur is longest in females, in which it varies from cream to a rich fulvous colour on the back, venter, neck and head. The wings in both sexes are pale brown. The ears are small and rounded with pointed tips. A well-developed frontal gland further distinguishes mature males from females (Brosset 1966a, 1969, Brosset and St. Girons 1980).

External and cranial measurements (mm) for *Hipposideros gigas*, sexes combined

	Mean	Min	Max	SD	N
Mass	-	-	-	-	-
FA[1]	112.0	98.0	124.0	-	43
Total[2]	-	135	171	-	-
Tail[2]	-	30	45	-	-
Tibia[1]	42.0	43.0	46.0	-	43
Ear[2]	-	28	32	-	-
CI[2]	-	34.0	37.0	-	-

[1] Brosset (1966a)
[2] Rosevear (1965)

The massive skull is characterised by robust zygomatic arches, and a very highly developed sagittal crest, which extends posteriorly to meet the well-developed lambdoid crest. This development of the lambdoid and sagittal crests reaches its extreme in reproductively active males. The rostral swellings are moderate, resulting in a fairly rounded rostral profile. The frontal depression is shallow without defined supra-orbital ridges. The palatal bridge is of medium length. The dental formula is 1123/2123 = 30. Sexual dimorphism is also evident in the thicker dentary of males and their thicker, longer canines (Rosevear 1965, Brosset 1966a, McWilliam 1982).

Key identification features: The simple, elliptical noseleaf distinguishes the genus *Hipposideros* from all other southern African bats. *Hipposideros gigas* differs from *H. vittatus* on the criterion of its larger size (Rosevear 1965), and these differences reflect the marked sexual dimorphism in both species; as *H. vittatus* is distinctly smaller (FA < 100 mm in females and FA < 109 mm in males)

Echolocation call: *Hipposideros gigas* produces HD-CF calls with an intermediate peak frequency of 56 kHz (n = 5) based on recordings in Kenya (Pye 1972).

Distribution, habitat and roosting: Reliable museum records of *H. gigas* are associated with mesic savanna and forest in Equatorial Africa in West Africa and the central Congo basin. The inclusion of this species in this book reflects the recent reappraisal of the identity of the type specimen (Bavarian State Collection of Zoology, Munich) from Benguela, southwest Angola; its forearm length of 113.8 mm is diagnostic (J. Fahr, personal communication). This locality in semi-arid savanna is over 100 km from the nearest forest on the west Angolan Escarpment. Although some published records from northern Angola, and southern Congo include authentic records of *H. gigas*, these are impossible to separate from those of the sympatric *H. vittatus*. Owing to the confusion over the identity of *H. gigas* and *H. vittatus.*, the map shown here combines the distributions of both species. Colonies in caves in Gabon varied between 300 and 400 individuals, and one colony numbered in the thousands (Brosset 1966a).

Extralimital: This species ranges from The Gambia east to Uganda, south across the Congo basin into Angola, and east to Tanzania and coastal Kenya (Rosevear 1965, McWilliam 1982).

Foraging ecology: Not studied directly, but it is likely similar to *H. vittatus*, which forages in a 'flycatcher style', around the edges of clutter, often intercepting large flying insects from a foraging perch (Vaughan 1977); Lang *et al.* (1917) described the capture of an individual, which had gorged on flying termites.

Reproduction: The reproductive biology of *H. gigas* was studied in Gabon by Brosset (1969, Brosset and Saint-Girons 1980) and in coastal Kenya by McWilliam (1982). The seasonal events of copulations and parturition are confined within large caves, on which these large bats are entirely dependent to raise the single young.

SYSTEMATIC NOTES

1845. *Rhinolophus gigas* Wagner 1845. Arch. Naturgesch 11: 148. Benguela, Angola.

No subspecies are recognised, so the following taxa are treated as synonyms of *H. gigas*:

1906. *Hipposideros gigas gambiensis* K. Andersen 1906 Ann. Mag. Nat. Hist. (Ser. 7) 17: 42. Gambia (BM 42.9.27.36, Holotype).

1917. *Hipposideros gigas niangarae* J. A. Allen 1917, Bull. Amer. Mus. Nat. Hist. 37: 438-439. Niangara, Uele, northeast Democratic Republic of Congo (AMNH 49103, Holotype).

H. gigas was previously treated as the West and Central African subspecies of *H. commersoni* (Ellerman *et al.* 1953, Hayman and Hill 1971), even though Andersen (1906) had concluded that *H. gigas* was clearly distinct from *H. commersoni* (= *vittatus*), and that both species occurred in Angola. A reliable understanding of the larger *H. gigas*, with respect to the smaller *H. vittatus*, requires thorough checking of all museum material. Although *H. cf. gigas* occurs in East Africa (Tanzania, Loveridge 1942) and coastal Kenya (McWilliam 1982), the relationship of these East African populations to those in the main forest belt west of the Albertine rift is equally unclear.

The taxonomy and biogeography of these large *Hipposideros* currently classified as either *H. gigas* or *H. vittatus* is under long-overdue revision, which entails through comparison of all museum material, together with studies of the molecular genetics and sonar calls of all populations.

Figure 85. Dorsal view of the skull of *Hipposideros gigas*. Scale bar = 10 mm (BM 75.890; © F. P. D. Cotterill).

fig. 86a

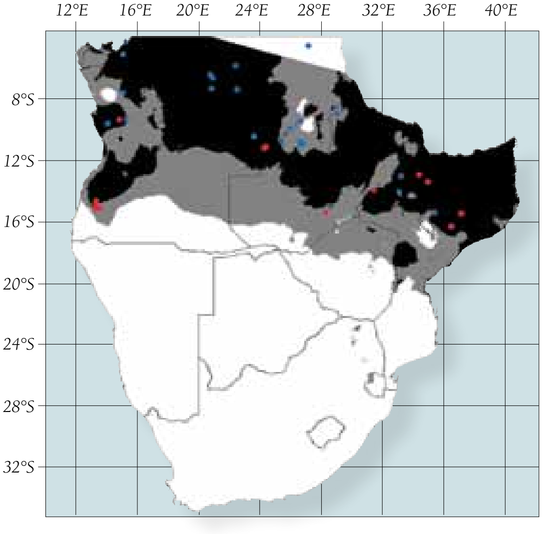
fig. 86b

Figure 86. Male *Hipposideros gigas* from the Republic of the Congo (Congo–Brazzaville): (a) whole body, and (b) portrait showing the prominent noseleaf and robust rostrum; the frontal gland has yet to develop fully in this young male (© Sandi Sowler).

Hipposideros ruber (Noack 1893)

Noack's leaf-nosed bat

Least Concern



Description: *Hipposideros ruber* is a small bat with a mass of around 10 g. It is distinguished by its noseleaf, a feature shared with other members of the genus. The pelage is variable in colour, but is normally dark brown on the back and head, while the underparts are slightly lighter. The wings are dark grey. The ears are small and rounded with pointed tips. The sexes are alike.

The skull is fairly robust with weak to moderate zygomatic arches. The rostral swellings are well developed, resulting in a rounded rostral profile. The frontal depression is shallow without defined supra-orbital ridges. The sagittal crest is low, but clearly visible anteriorly and the palatal bridge is of medium length. The dental formula is 1123/2123 = 30.

Key identification features: The simple, elliptical noseleaf distinguishes the genus *Hipposideros* from all other southern African bats. *Hipposideros vittatus* is very much larger (FA > 90 mm). Separating *H. caffer* and *H. ruber* in the field is more tricky; *H. ruber* is larger (FA > 50 mm and usually > 51 mm; in *H. caffer* FA < 51 mm and usually < 50 mm) and generally darker. However, lighter forms of *H. ruber* do occur, and occasionally dark forms of *H. caffer* may co-exist with *H. ruber*, especially on the edge between woodland and rainforest. The skull of *H. ruber* is visibly more robust with little overlap in condylo-incisive length (in *H. ruber* mean CI > 16.5 mm; in *H. caffer* mean CI < 16.0 mm). The most reliable diagnostic character is the difference in shape of the nasal compartments, in dorsal view of the cleaned skull (Fenton 1986)

Echolocation call: *Hipposideros ruber* produces HD-CF calls. ANABAT recordings show a CF frequency of 137 kHz and duration of 5.8 ms (A. Monadjem, unpublished data; Table 3).

Distribution, habitat and roosting: *Hipposideros ruber* occurs only in the northern parts of the region. It has been collected from sites in Zambia, Malawi, northern Mozambique, DRC and western Angola. The climatic model suggests that suitable habitat occurs extensively in northern Mozambique and northern Zambia. The type specimen is from Tanzania (ZMB 89571, Holotype).

This species is poorly represented in museums, with just 40 specimens examined for this book. This poor representation is likely not due to its rarity, but reflects that the species reaches the southern periphery of its range in southern Africa; it is widespread and abundant further north across the Congo

External and cranial measurements (mm) and mass (g) for *Hipposideros ruber*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	10.2	10.0	11.0	0.50	4	**Mass[1]**	9.0	-	-	-	1
FA[1]	51.5	49.6	52.7	1.27	5	**FA[1]**	51.4	50.0	52.5	1.12	4
Total[1]	92.0	-	-	-	1	**Total[1]**	92.3	90	94	1.53	3
Tail	-	-	-	-	-	**Tail[1]**	36.0	35	37	1.00	3
Tibia[1]	23.4	20.4	24.5	2.06	3	**Tibia[1]**	22.3	-	-	-	1
Ear[1]	18.0	-	-	-	-	**Ear1**	16.0	16	16	0	3
CI[1]	16.7	16.7	16.7	-	2	**CI1**	16.5	16.2	16.7	0.29	4

[1] Specimens measured by the authors

fig. 87a

fig. 87b

fig. 87c

fig. 87d

Figure 87. Skull and teeth of *Hipposideros ruber:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8549).

basin. It is likely that literature records plotted for this species and *H. caffer* require reappraisal to ascertain which of these two similar species these specimens represent.

It roosts in a wide range of situations including caves and sinkholes, and favours tree cavities in tropical forests. Colonies vary in size from less than a dozen to hundreds of individuals. In contrast to *H. caffer, H. ruber* is closely tied to forest habitats, rarely occurring outside of these, although in Malawi it is also known from woodland (Happold *et al.* 1987).

Extralimital: *Hipposideros ruber* has been recorded widely throughout sub-Saharan Africa, but mostly in the equatorial zone.

Foraging ecology: *Hipposideros ruber* feeds predominantly on Lepidoptera (Bell and Fenton 1984).

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1893. *Phyllorhina rubra* Noack, Zool. Jahrb., Syst. 7: 586.
'Lugerrunjere Fluss' (= Ngerengere River?), Tanzania.

The specific status of *H. ruber* was questioned by Koopman (1975) but endorsed by Ansell (1969). Both *H. caffer* and *H. ruber* occur sympatrically in northwestern Zambia and the Tete Province of Mozambique (Fenton 1986, Cotterill 2001a, 2002b). Owing to the striking morphological similarity of *H. ruber* and *H. caffer*, they are easily confused, which has affected their published distributions in southern Africa. In particular, *H. ruber* may have been overlooked in parts of its range (Fenton 1986, Cotterill 2002b).

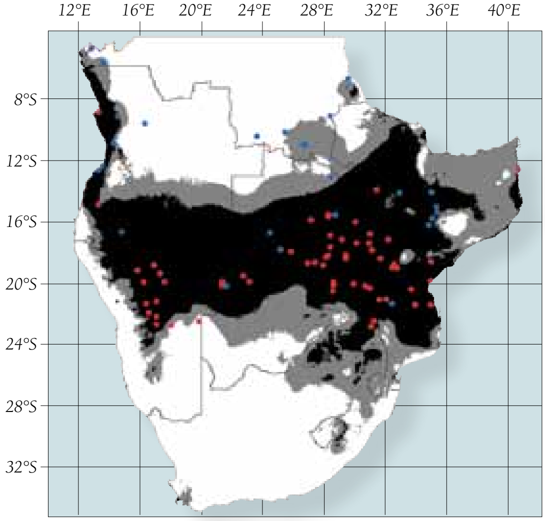
The diploid number in *H. ruber* is not known.

Figure 88. *Hipposideros ruber,* showing characteristic noseleaf (DM 8549, © A. Monadjem).

Hipposideros vittatus (Peters 1852)

Striped leaf-nosed bat

Least Concern



This map shows the combined distribution of *H. vittatus* and *H. gigas* (see text)

Description: *Hipposideros vittatus* is a very large bat, second in size and mass only to the congeneric *H. gigas* and *Saccolaimus peli*. Masses in adult females and males average 85 and 136 g, respectively. An adult territorial male can exceed 200 g in peak condition. This pronounced sexual dimorphism is evident in overall body size and cranial dimensions. The pelage also differs markedly between sexes. The fur is longest in females, in which it varies from rich fawn to fulvous on the back and head, while the underparts are paler. The fur of subadult males is similar to that of females, while the pelage of mature males is thinner and paler. There are distinctive patches of white fur on the shoulders in both sexes, especially in mature males. The wings in both sexes are pale brown. The ears are small and rounded with pointed tips. A well-developed frontal gland further distinguishes mature males from females (Cotterill and Fergusson 1999).

The skull is massive with robust zygomatic arches, with the sagittal crest very highly developed, extending posteriorly to meet the well-developed lambdoid crest. This development of the lambdoid and sagittal crests reaches its extreme in reproductively active adult males. The rostral swellings are moderate resulting in a fairly rounded rostral profile. The frontal depression is shallow without defined supra-orbital ridges. The palatal bridge is of medium length. The dental formula is 1123/2123 = 30. Sexual dimorphism is also evident in the thicker dentary of males and their thicker, longer canines.

Key identification features: The simple, elliptical noseleaf distinguishes the genus *Hipposideros* from all other southern African bats. *Hipposideros vittatus* is very much larger (FA > 90 mm) than all other African *Hipposideros* species except for *H. gigas* (adult males FA > 105 mm, adult females FA > 100 mm).

Echolocation call: *Hipposideros vittatus* produces HD-CF calls with an intermediate peak frequency of 61 kHz and long duration of 12 ms (Fenton and Bell 1981, Aldridge and Rautenbach 1987; also see Pye 1972).

Distribution: *Hipposideros vittatus* is distributed sparsely, but widely, in the northern parts of southern Africa. It occurs from the Pafuri (northern Kruger National Park), through Zimbabwe, central Mozambique, southern Malawi, Zambia, DRC, northern Botswana, north-central Namibia and south-western Angola. The type series from Ibo Island, northern Mozambique, includes four type specimens (ZMB 6312, ZMB 86257-89, Syntypes) (Turni and Kock 2008). However, there has been confusion over the identity of *H. gigas* and *H. vitta-*

External and cranial measurements for *Hipposideros vittatus*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	136.0	105	175	20	20	**Mass[1]**	85	52	118	18	28
FA[1]	102.5	99.5	107.9	2.50	20	**FA[1]**	95.9	90.4	100.9	2.30	20
Total[1]	155.0	147	162	-	2	**Total[1]**	132.0	108	141	15.80	4
Tail	33.0	30	36	-	2	**Tail**	34.0	27	38	5.00	4
Tibia[1]	39.2	-	-	-	1	**Tibia[1]**	-	-	-	-	-
Ear[1]	27.0	24	30	-	2	**Ear[1]**	31.0	29	32	1.40	4
GSL[2]	36.0	34.3	37.8	0.9	20	**GSL[2]**	32.0	31.1	33.4	0.6	20
CI[1]	31.0	28.8	32.7	1.50	7	**CI[1]**	29.7	27.8	31.9	1.26	10

[1] Specimens measured by the authors
[2] Cotterill and Fergusson (1999)

fig. 89a

fig. 89b

fig. 89c

fig. 89d

Figure 89. Skull and teeth of adult male *Hipposideros vittatus*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8645).

fig. 90a

Figure 90. Adult *Hipposideros vittatus*: portraits of (a) a fulvous female and (b) male, showing the difference in their frontal glands; (c) neonate; (d) roosting males (Mabura Cave 1, Zimbabwe, © F. P. D. Cotterill).

fig. 90b

fig. 90c

tus, hence the map shown here combines the distributions of both species.

This species is relatively well represented in museums, with over 220 specimens examined for this book.

This species is entirely dependent on large caves for breeding, where large colonies numbering hundreds of thousands of individuals may aggregate. Numbers of bats fluctuate markedly through the annual cycle (Cotterill and Fergusson 1999). The majority of localities vouched for by museum specimens mainly represent transient individuals. In contrast to the forest-dwelling *H. gigas*, *H. vittatus* occupies a variety of savanna and woodland habitats, ranging from arid scrubby savanna in Namibia to moist miombo woodland in Zimbabwe and Mozambique (Cotterill 2001a). In parts of its range, this large insectivorous species (and equally *H. gigas*) is sensitive to disturbance of its cavernicolous roosts (especially by guano mining). It is also a popular target of bushmeat hunters.

Extralimital: *Hipposideros vittatus* has been recorded widely throughout sub-Saharan Africa, but due to confusion with *H. gigas*, the boundaries of its African distribution are not clear, especially in coastal Kenya (McWilliam 1982).

Foraging ecology: *Hipposideros vittatus* has rounded wings with high wing loading (15.7 N.m^{-2}) and intermediate aspect ratio (7.7) (Norberg and Rayner 1987). It is a clutter-edge forager. Its diet consists mainly of large Coleoptera (Whitaker and Black 1976, Aldridge and Rautenbach 1987, Cotterill and Fergusson 1999; also see Vaughan 1977), but also includes Isoptera (Cotterill and Fergusson 1999).

Reproduction: Reproduction in *Hipposideros vittatus* in Zimbabwe has been described in detail by Cotterill and Fergusson (1999). Males are highly territorial in February–July, but may roost together at other times of the year. Mating and fertilisation take place in June–July and young are born in late October. Pregnant females leave the breeding roost for approximately two months at the end of the cool-dry season (August); when they return in late October to give birth, they have gained major fat deposits (Cotterill and Fergusson 1999). Lactation continues for at least 13 weeks.

SYSTEMATIC NOTES

1852. *Phyllorhina vittata* Peters, Naturw. Reise Mossamb., Säugethiere: 32, pl. 6. Ibo Island, Mozambique.

Phyllorhina commersoni var. *marungensis* Noack 1887 (ZMB 6312, Syntype, from Qua Mpala, Marungu Plateau, DRC) appears to be a synonym (Turni and Kock 2008). The systematic and taxonomic relationships of *H. vittatus* and *H. gigas* are not entirely clear, although *H. gigas* is distinctly larger. These two African mainland species are both now treated as two species distinct from *H. commersoni*, a Malagasy endemic (Simmons 2005). They are generally viewed as ecological equivalents occupying different habitats – savanna woodland and tropical rainforest. Both taxa occur in southern Africa, since the type specimens of both taxa are from within this region. A comparative phylogeographic study of these species, in concert with studies of variation in sonar calls, should resolve this issue.

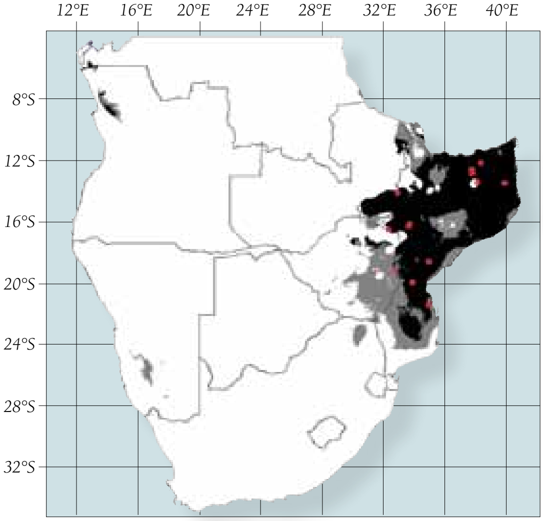
The diploid number in *H. vittatus* is 2n = 52 (Rautenbach *et al.* 1993).

fig. 90d

Triaenops persicus Dobson 1871

Persian trident bat

Least Concern



Description: *Triaenops persicus* is a small bat with a mass of around 12 g. It is distinguished by its noseleaf, a feature shared with the far smaller *Cloeotis percivali*. The pelage is variable, ranging from pale sandy-brown to deep chestnut. In paler individuals, the upper parts are darker than the underparts, while in chestnut individuals, upper and underparts are the same shade. The wings are dark grey-brown. The ears are small and rounded. The sexes are alike.

The skull is fairly robust with moderate zygomatic arches that have pronounced dorso-ventral swelling of their posterior half. The well-developed rostral swellings result in a rounded rostral profile. The frontal depression is shallow without defined supra-orbital ridges. The sagittal crest is well developed and the palatal bridge is of medium length. The dental formula is 1123/2123 = 30.

Key identification features: The three-pronged noseleaf readily distinguishes *T. persicus* and *C. percivali* from all other microbats in the region. However, *T. persicus* (FA > 48 mm) is significantly larger than *C. percivali* (FA < 37 mm).

Echolocation call: *Triaenops persicus* produces HD-CF calls with a high peak frequency (83±0 kHz, n = 11 pulses) and intermediate duration (8.5±1.7 ms, n = 11 pulses) (data for a single female, Taylor *et al.* 2005). Besides the second harmonic, the fundamental and third harmonics are often present. Peak frequencies of males are lower than those of females (A. Monadjem and A. Reside, unpublished data, M. C. Schoeman and S. Stoffberg, unpublished data). In Malawi, males called at 72–75 kHz and females at 80–85 kHz (D. C. D. Happold and M. Happold, unpublished, cited in Taylor *et al.* 2005).

Distribution, habitat and roosting: *Triaenops persicus* is widely distributed along the east African coast from Arabia. It is widespread in central and northern Mozambique, extending very marginally into Zimbabwe and Zambia. It appears to be absent from southern Mozambique south of the Save River. The model suggests that it may possibly occur in southern Malawi. The record from the western Congo represents the subspecies *T. p. majusculus* (see 'Systematic notes'). The type specimen of nominate *T. persicus* is from Iran, while that of *T. p. afer* is from Mombasa, Kenya (ZMB 5074, Holotype).

Records of this species for the region are not well represented in museums, with just 31 records examined for this book. Nevertheless, it is locally abundant and was captured at most sites in central and northern Mozambique during a recent collecting trip (A. Monadjem, unpublished data). The dearth of museum specimens, therefore, may be due to undersampling in the core of its distribution in southern Africa.

Its habitat preferences are not known. It has predominantly been collected from riparian locations and may in fact be

External and cranial measurements (mm) and mass (g) for *Triaenops persicus,* males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	12.2	10.0	13.0	1.00	9	**Mass**[1]	12.0	11.0	13.0	1.00	3
FA[1]	53.3	48.2	55.8	2.19	11	**FA**[1]	51.2	50.5	53.1	1.06	5
Total[1]	96.8	92	103	4.44	5	**Total**[1]	92.8	88	95	3.2	4
Tail[1]	33.0	27	37	3.90	5	**Tail**[1]	34.0	30	36	2.7	4
Tibia[1]	19.5	19.0	20.0	0.48	5	**Tibia**[1]	18.3	-	-	-	1
Ear[1]	14.0	13	16	1.10	5	**Ear**[1]	15.0	14	16	1.00	4
CI[1]	18.0	17.6	18.3	0.29	6	**CI**[1]	17.2	16.6	18.3	0.75	4

[1] Specimens measured by the authors

fig. 91a

fig. 91b

fig. 91c

fig. 91d

Figure 91. Skull and teeth of *Triaenops persicus:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8638).

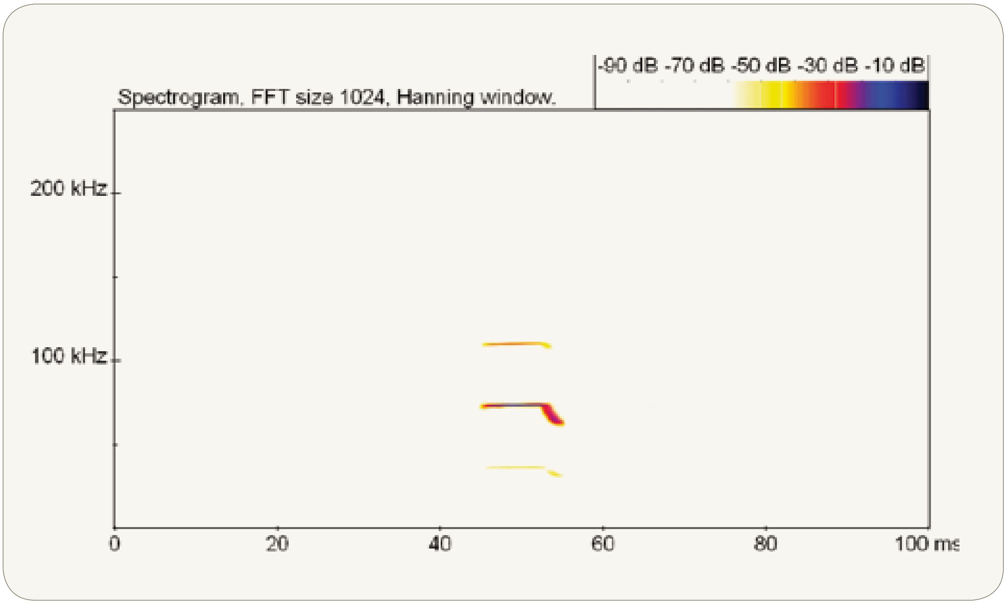


Figure 92. Echolocation call of *Triaenops persicus*.

associated with well-wooded vegetation. Little is known about its roosting requirements, although a series of specimens from Tete, central Mozambique, were collected from an underground cellar (data from label of Transvaal Museum specimen). Presumably, it roosts in a variety of shelters, including caves and hollow tree trunks.

Extralimital: Within Africa, *Triaenops persicus* has also been recorded from Somalia, Kenya and Tanzania.

Foraging ecology: *Triaenops persicus* has rounded wings with intermediate wing loading (9.2 N.m^{-2}) and aspect ratio (7.4) (Norberg and Rayner 1987). It is a clutter forager. In Mozambique, its diet consists predominantly of Lepidoptera (M. C. Schoeman and S. Stoffberg, unpublished data).

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1871. *Triaenops persicus* Dobson, Journal of the Asiatic Society, Bengal 40(2): 455. Shiraz, Iran.

Meester *et al.* (1986) recognise three subspecies: the nominate subspecies from Iran and Arabia, *T. persicus afer* from eastern Africa and western Arabia, and *T. p. majusculus* from the Congo basin.

Triaenops persicus afer Peters 1877

1877. *Triaenops afer*, Peters, Monatsberichte der Königlichen Preussischen Akademie der Wissenschaften zu Berlin (1876): 913. Mombasa, Kenya.

Triaenops persicus majusculus

1968. *Triaenops persicus majusculus* Aellen and Brosset, Rev. suisse Zool., 75 (14): 450. Type locality: Loudima, Congo.

Recent morphologic and molecular work suggests that *afer* may be a distinct species (Benda and Vallo 2007). The status of *majusculus* (MNHN 1968-412, Holotype) remains unclear and it may represent a distinct species (Cotterill 2001a).

The diploid number in *T. persicus* is not known.

Figure 93. *Triaenops persicus*, showing three-pronged noseleaf (a: NMZB 84335 © F. P. D. Cotterill; b: © Merlin D. Tuttle, Bat Conservation International, www.batcon.org).

fig. 93a

fig. 93b

SUBORDER PTEROPODIFORMES

FAMILY RHINOLOPHIDAE
HORSESHOE BATS

This Old World family is represented by just one genus, Rhinolophus, which is immediately recognisable by its intricate noseleaf. This complicated organ consists of several parts, including the sella, connecting process and lancet (Figure 94), all of which are useful in identifying the species. All members of this family have broad wings, allowing them to manoeuvre through cluttered habitats such as dense vegetation (Hill and Smith 1984). Echolocation is highly evolved with calls typically exhibiting a high duty-cycle, constant frequency (HD-CF) component. The CF component differs between species and may be used as a guide to their identification (Monadjem *et al*. 2007). Morphological differences between species, especially those of similar size, are subtle. The principal diagnostic characters include skull and noseleaf characters. The noseleaf is important in the emission of the echolocation signal. Some 26 species are known from Africa, of which 15 occur in southern Africa. Furthermore, several taxa (e.g. *R. darlingi*, *R. fumigatus* and *R. hildebrandtii*) comprise sibling species that are being split. Hence, the true species richness of this genus is far higher in southern Africa than the 15 reported here. Csorba *et al.* (2003) have recently reviewed this family and list 71 species in the world.

fig. 94a

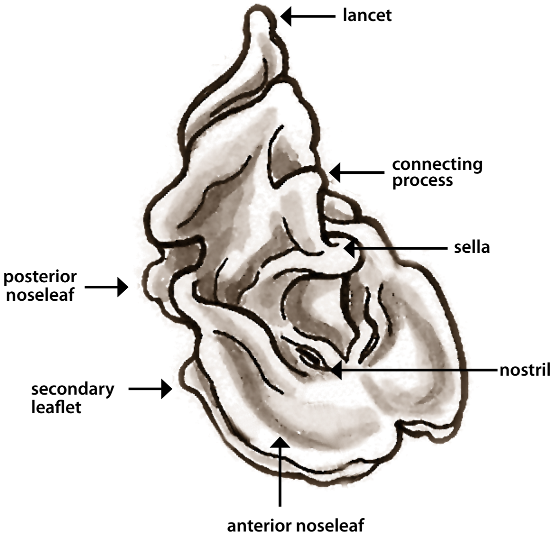


fig. 94b

Figure 94. A typical Rhinolophidae species, showing (a) the location of the horseshoe on the face, and (b) the structure of the horseshoe.

TABLE 11. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE SOLE GENUS *RHINOLOPHUS* WITHIN THE FAMILY RHINOLOPHIDAE

SPECIES	FA (MM)	CONNECTING PROCESS	OTHER FEATURES	PF (KHZ)
R. swinnyi	37–44	high and rounded	ears < 20 mm	~107
R. denti	41–44	high and rounded	ears < 20 mm	~111
R. blasii	41–47	rises to high sharp point	1st phalanx of 4th finger not shortened; no axillary tufts of stiff hairs in armpit of male	~87
R. simulator	42–47	high and rounded	horseshoe width < 9 mm	~82
R. landeri	42–48	rises to high sharp point	1st phalanx of 4th finger shortened; axillary tufts of stiff hairs in armpit of adult male	~107
R. darlingi	43–49	high and rounded	horseshoe width < 9 mm	~86
R. maendeleo	48–50	high and rounded	horseshoe width < 9 mm	NA
R. capensis	48–52	high and rounded	horseshoe width < 9 mm	~84
R. clivosus	48–57	high and rounded	horseshoe width < 9 mm, nasal inflations inconspicious	~92
R. alcyone	49–58	prominent rises to a blunt point	rounded nasal inflations prominent, rise above the rostrum	~87
R. eloquens	53–59	low and rounded	ears > 22 mm; horseshoe width > 9 mm	NA
R. fumigatus	48–59	low and rounded	ears > 22 mm; horseshoe width > 9 mm, nasal inflations prominent	~54
R. deckenii	48–56	rounded	rounded nasal inflations rise above the rostrum; ears < 20mm; horseshoe width < 9mm	~72
R. sakejiensis	52–55	high and rounded	ears < 22 mm; horseshoe width < 9 mm, nasal inflations inconspicious	NA
R. hildebrandtii	61–67	low and rounded	ears > 22 mm; horseshoe width > 9 mm	~33, 38, 40 or 46

ROOST	RANGE IN SOUTHERN AFRICA	DENTITION
caves, mines	widely distributed throughout eastern parts	1st upper premolar is present in toothrow
caves, mines, road culverts	widely but sparsely distributed throughout arid western parts	1st upper premolar is present in toothrow
caves, mines	widely but sparsely distributed throughout eastern and northern parts	1st upper premolar is present in toothrow
caves, mines, road culverts	widely distributed throughout eastern parts	1st upper premolar is present in toothrow
caves, mines, hollow trees	widely distributed throughout northern and northeastern parts	1st upper premolar is present in toothrow
caves, mines, road culverts	widely distributed throughout region, absent from fynbos	1st upper premolar is outside toothrow
not known	isolated populations in coastal Mozambique and Tanzania	1st upper premolar is present in toothrow
caves, mines	endemic to western parts	1st upper premolar is present in toothrow
caves, mines, road culverts	widely distributed throughout region, absent from Namibia	1st upper premolar is outside toothrow
caves (and possibly hollow trees)	main Congo forest belt	1st upper premolar is present in toothrow
not known	extreme northeast	1st upper premolar is usually absent; if present it is outside toothrow
caves, mines, road culverts	2 isolated populations in east and west	1st upper premolar is usually absent; if present it is outside toothrow
caves	coastal margins of Mozambique and Tanzania	1st upper premolar outside toothrow
hollow trees	only known from extreme northwestern Zambia	1st upper premolar is absent
caves, mines, buildings, trees	widely distributed throughout northern and eastern parts	1st upper premolar is usually absent; if present it is outside toothrow

Rhinolophus alcyone Temminck 1852

Halcyon horseshoe bat

Least Concern

Description: *Rhinolophus alcyone* is a medium-sized horseshoe bat with a mass of around 16 g. The pelage is dark brown on the upper parts, with the under parts almost as dark. Two distinct colour phases occur; some individuals are fulvous. Adult males have axillary tufts. The ears are medium-sized (23 mm), rounded with a pointed tip. The wings are dark brown; the third metacarpal is distinctly shortened. The connecting process is low and rounded. The lower lip commonly has one mental groove. The sexes are alike. The broad horseshoe (8.5–10.5 mm) covers the whole muzzle; prominent connecting process rises to a blunt point.

The skull is robust with sturdy zygomatic arches, which greatly exceed the mastoid width. The rostral swellings are well developed; so the rounded rostral profile rises high above the rostrum. The frontal depression is moderately deep with strongly defined supra-orbital ridges. The sagittal crest moderately developed, and the palatal bridge is of medium length, 29–35% of the upper toothrow. Canines long and well developed; the first upper premolar is distinct, situated inside the toothrow; it distinctly separates the canine from the second premolar. The dental formula is 1123/2133 = 32.

Key identification features: *Rhinolophus alcyone* is larger than *R. landeri*. It differs from *R. sakejiensis* in noseleaf and cranial characters: *R. sakejiensis* lacks the anterior upper premolar, and this character also distinguishes *R. alcyone* from *R. fumigatus*, which in addition has a larger, hairier noseleaf. The shorter, more massive canines of *R. silvestris* are diagnostic, and the anterior upper premolar in *silvestris* is also minute and displaced from the toothrow (Cotterill 2002a, Csorba *et al*. 2003).

Echolocation call: *Rhinolophus alcyone* produces HD-CF echolocation calls with a high peak frequency (87 kHz) based on recordings in Uganda (Pye and Roberts 1970).

Distribution, habitat and roosting: *Rhinolophus alcyone* is restricted to tropical forest habitats in west Africa and the Congo basin. Scattered records extend from Guinea and Liberia across Côte d'Ivoire and Ghana to the coastal margins of Nigeria and Cameroon, and across the equatorial Africa to western Uganda (Kingdon 1974, Csorba *et al*. 2003). The most southerly record is from Scerie Forest, south of Kindu near the Lualaba River (Gallagher and Harrison 1977), within 80 km of our region, so its occurrence further south in suitable forest habitat is possible in the southern DRC and northern Angola. The type specimen is from Boutry River, Ghana and is in the Leiden Museum.

Little is known about its roosting behaviour, but it has been recorded in caves on Mount Cameroon (Rosevear 1965).

Extralimital: This species has a wide geographical range from western Uganda and southwest Sudan, across the Congo basin as far west as Guinea and Senegal.

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: Births occur in June and September in Uganda (Csorba *et al*. 2003).

SYSTEMATIC NOTES

1852. *Rhinolophus alcyone* Temminck 1852. Esquisses zoologiques sur la côte de Guiné: 80. Boutry River, Ghana.

The diploid number in *R. alcyone* is not known.

External and cranial measurements (mm) and mass (g) for *Rhinolophus alcyone*, males and females separate

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	15.6	9.5	22	2.9	32	**Mass**[1]	14.4	6	19	2.8	31
FA[1]	53.0	49.4	58	1.8	39	**FA**[1]	52.9	49.5	56	1.8	39
Total[1]	89.7	70	105	7.3	38	**Total**[1]	89.9	74	103	7.2	35
Tail[1]	27.0	18	33	3.7	41	**Tail**[1]	27.775	22	35	3.6	40
Tibia[1]	23.1	19	32	2.0	42	**Tibia**[1]	22.07	12.5	25	2.1	40
CI[1]	20.9	20.3	21.7	0.6	11	**CI**[1]	20.3	18.6	20.9	0.8	8

[1] Specimens measured by the authors

fig. 95a

fig. 95b

fig. 95c

Figure 95. Skull and teeth of *Rhinolophus alcyone*: (a) dorsal view, (b) ventral view and (c) lateral view. Scale bar = 5 mm (© F. P. D. Cotterill).

fig. 96a

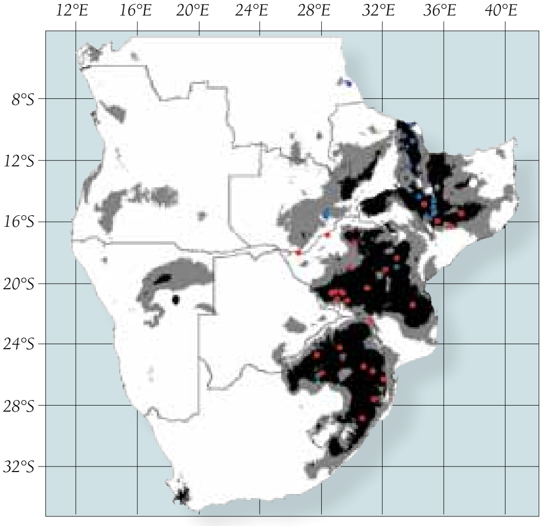
Figure 96. *Rhinolophus alcyone*: showing (a) fulvous flanks, and (b) ears and noseleaf (© A. Monadjem).

fig. 96b

Rhinolophus blasii Peters 1867

Blasius's horseshoe bat

Near Threatened



Description: *Rhinolophus blasii* is a small bat with a mass of around 8 g. The pelage is light brown on the back and head, while the underparts are cream. The wings are pale brown. The ears are medium-sized, rounded with a pointed tip. The connecting process characteristically rises to a high, sharp point. The lower lip has three mental grooves. The sexes are alike.

The skull is fairly delicate with moderate zygomatic arches. The moderately inflated rostral swellings result in a rounded rostral profile. The braincase is high and domed. The frontal depression is shallow with poorly defined supra-orbital ridges. The sagittal crest is medium and the palatal bridge is of medium length, 32–35% of the upper toothrow (Csorba *et al.* 2003). The dental formula is 1123/2133 = 32. The first upper premolar is small and in the toothrow, separating the canine and second premolar.

Key identification features: The complicated noseleaf with the vertical connecting process distinguishes the genus *Rhinolophus* from all other southern African bats. *Rhinolophus blasii* is similar in size and appearance to several species (*R. simulator, R. landeri* and *R. darlingi*) but can be separated from these and all other southern African *Rhinolophus* by the high-rising, sharply pointed connecting process. Confusion is most likely with *R. landeri*, but its connecting process is not as sharply pointed as that of *R. blasii*. Also, male *R. landeri* have obvious axillary tufts of hair in the armpit, which are absent in *R. blasii*. Another useful character is the ratio of the metacarpal of the fourth finger to the first phalanx: it is 3.53 (range 3.09–3.81) in R. *blasii* and 4.87 (range 4.41–5.56) in *R. landeri* (Happold *et al*. 1987).

Echolocation call: *Rhinolophus blasii* produces HD-CF echolocation calls with a high peak frequency (86.5±0.6 kHz, n = 2) and long duration (27.7±12.6 ms, n = 2) (Schoeman and Jacobs 2008; also see Monadjem 2005, Monadjem *et al.* 2007). Besides the second harmonic, the fundamental and third harmonics may be present on the spectrogram.

Distribution, habitat and roosting: The subspecies *R. blasii empusa* is mostly restricted to southern Africa, occurring marginally beyond in the eastern DRC (Csorba *et al.* 2003) and Tanzania (Kock and Howell 1988). It is widely but sparsely distributed in the eastern parts of the region. It occurs from KwaZulu-Natal and Swaziland through northern South Africa to Zimbabwe, southern Zambia, Malawi and southeastern DRC. There are isolated records from central and north-

External and cranial measurements (mm) and mass (g) for *Rhinolophus blasii*, males and females presented separately*

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	8.0	7.0	9.0	0.71	6	**Mass**[1]	10.0	9.0	12.0	1.73	3
FA[1]	46.2	45.2	47.7	0.75	8	**FA**[1]	46.2	44.0	47.4	1.22	6
Total[1]	76.0	62	90	12.00	6	**Total**[1]	81.8	70	90	9.18	4
Tail[1]	28.0	21	35	5.50	6	**Tail**[1]	27.0	19	32	5.60	4
Tibia[1]	-	-	-	-	-	**Tibia**[1]	-	-	-	-	-
Ear[1]	20.0	18	21	1.50	6	**Ear**[1]	19.0	17	21	1.70	4
CI[1]	17.3	16.6	17.7	0.45	6	**CI**[1]	16.8	16.3	17.2	0.42	4

* In a large series from Malawi, FA = 45.6±1.0 (SD) (range 43.0– 47.0 mm), n = 127; mass = 8.8±0.8 (range 7.0–13.0), n = 165; tibia = 19.3±0.6 (18.0–21.0 mm), n = 41 (Happold *et al.* 1987)

[1] Specimens measured by the authors

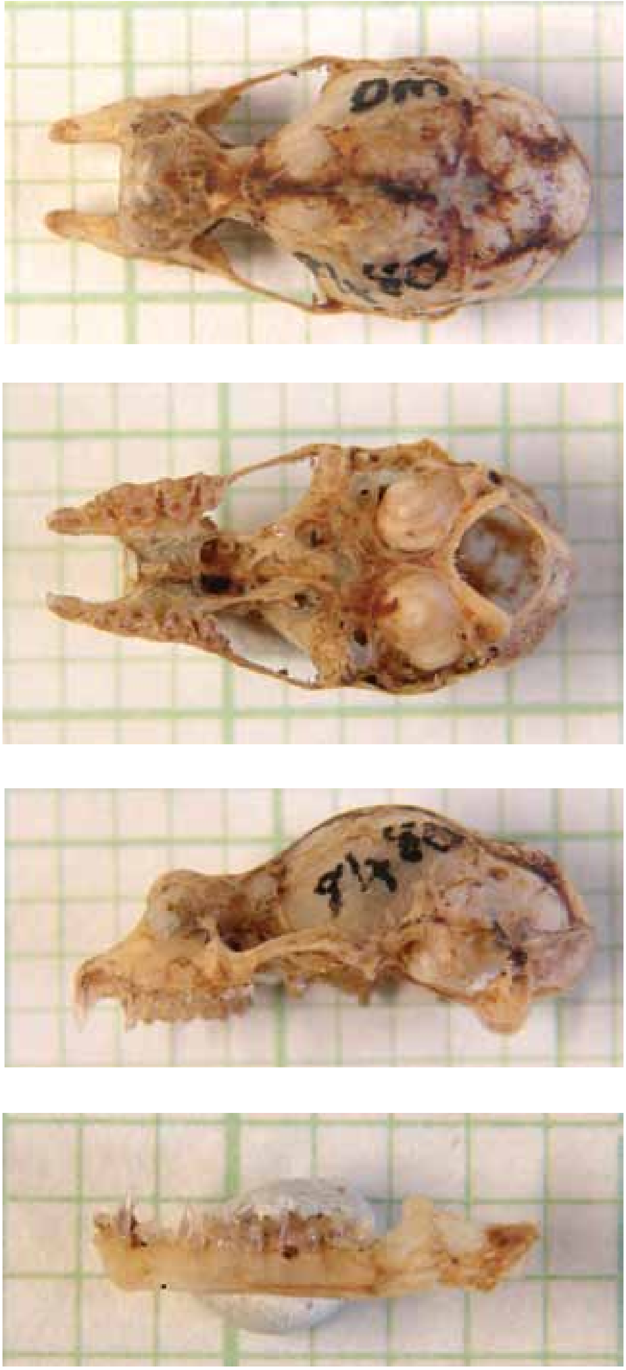


fig. 97a

fig. 97b

fig. 97c

fig. 97d

Figure 97. Skull and teeth of *Rhinolophus blasii*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8480; note that premaxilla is missing).

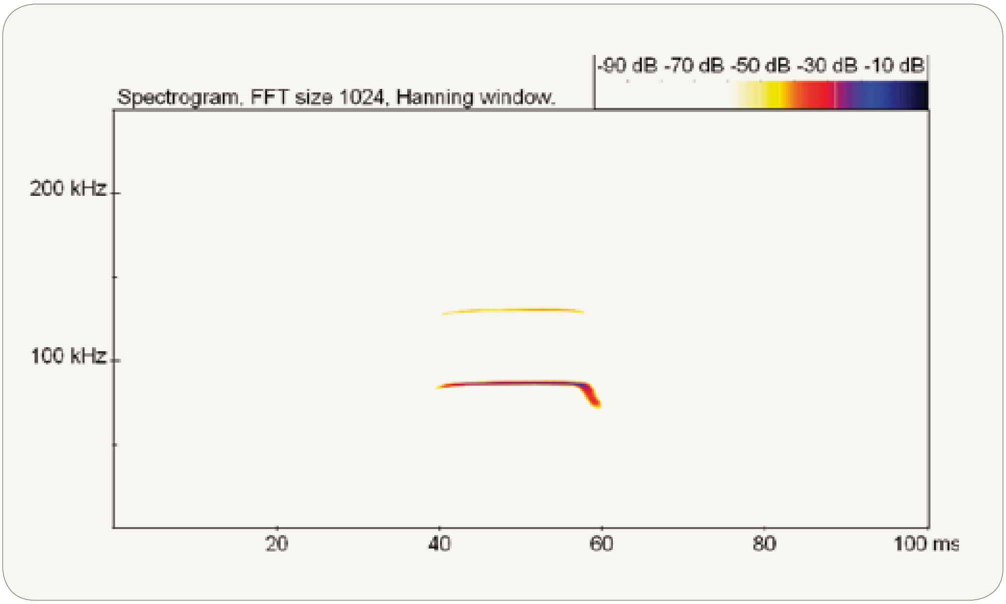


Figure 98. Echolocation call of *Rhinolophus blasii.*

ern Mozambique, where the model suggests suitable conditions occur. The type specimen for the species is from Italy (ZMB 557, Syntype); the type locality of the southern African empusa is Zomba, Malawi (BM 93.7.9.33, Holotype).

The southern African subspecies is not well represented in museums, with just over 60 specimens examined for this book.

It roosts in caves and mine adits where it forms small groups of up to four individuals (Rautenbach 1982, Smithers 1983, Monadjem 2005). In Swaziland, *Rhinolophus blasii* shared the roost (an abandoned gold mine) with several other bat species, including the numerically dominant *R. clivosus* (Monadjem 2005). In southern Africa, this species is associated with savanna woodland (Skinner and Chimimba 2005), but is only known from montane habitats in Zambia (Ansell 1978) and both montane and savanna habitats in Malawi (Happold *et al.* 1987).

Extralimital: The subspecies *R. blasii andreinii* occurs in Ethiopia and Somalia and the nominate subspecies in northwestern Africa and Europe. The species also occurs in the Middle East to Pakistan (Csorba *et al.* 2003).

Foraging ecology: *Rhinolophus blasii* has short and broad wings with intermediate wing loading (7.6 N.m^{-2}) and low aspect ratio (5.6) (Schoeman and Jacobs 2008). It is a clutter forager and aerially hawks and gleans prey (Siemers and Ivanova 2004). Its diet consists mainly of Lepidoptera (Findley and Black 1983, Schoeman 2006).

Reproduction: A female collected in Swaziland on 27 October was lactating and had a small offspring (weighing 2.7 g) (Monadjem 2005). In Malawi, parturition occurs early in the wet season, from November to January, followed by a one-month lactation period (Happold and Happold 1990a).

SYSTEMATIC NOTES

1867. *Rhinolophus blasii* Peters, Monatsberichte der Königlichen Preussischen Akademie der Wissenschaften zu Berlin (1866): 17. Italy.

The subspecies *R. blasii empusa* is known from southern Africa (Meester *et al.* 1986, Csorba *et al.* 2003):

Rhinolophus blasii empusa K. Anderson 1904

1904. *Rhinolophus blasii empusa* K. Anderson, Annals and Magazine of Natural History (7)14: 378. Zomba, Malawi.

Its taxonomic status awaits deserving phylogeographic investigation.

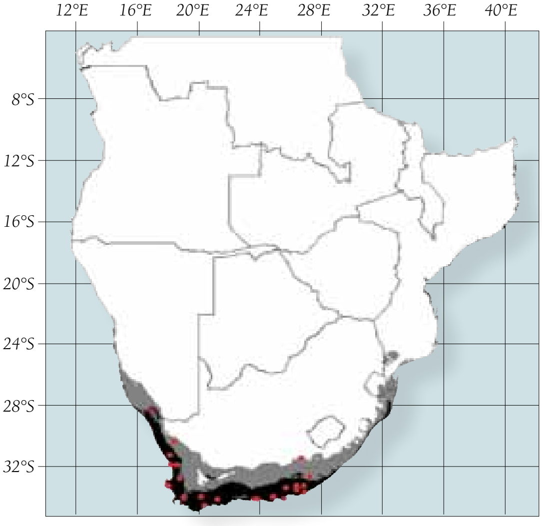
The diploid number in *R. blasii* is 2n = 58 and aFN = 60 (Rautenbach 1986).

Figure 99. *Rhinolophus blasii*, showing pointed connecting process (DM 7897, © A. Monadjem).

Rhinolophus capensis Lichtenstein 1823

Cape horseshoe bat

Near Threatened



Description: *Rhinolophus capensis* is a medium-small bat with a mass of around 12 g. The pelage is dark brown on the upper parts and lighter on the underparts. The wings are dark brown. The ears are medium-sized, rounded with a pointed tip. The connecting process is characteristically high and rounded. No mental grooves are discernable on the lower lip. The sexes are alike.

The skull is robust with sturdy zygomatic arches. The well-developed rostral swellings result in a rounded rostral profile. The frontal depression is shallow with poorly defined supraorbital ridges. The sagittal crest is moderate and the palatal bridge is of medium length, 33–39% of the upper toothrow. The dental formula is 1123/2133 = 32. The first upper premolar is small and in the toothrow or slightly displaced, separating the canine and second premolar (Csorba *et al.* 2003).

Key identification features: The complicated noseleaf with the vertical connecting process distinguishes the genus *Rhinolophus* from all other southern African bats. Confusion is most likely with the slightly larger *R. clivosus* (which also has a rounded connecting process) with which it shares most of its range. They can only be separated reliably by the presence and position of the minute first upper premolar, which is always present, and in the toothrow in R. capensis manifesting in a gap between the canine and second premolar (this premolar lies outside the toothrow in R. clivosus). It can also be confused with R. darlingi in the north of its range, but in R. darlingi the first premolar also lies outside the toothrow. Rhinolophus denti is much smaller (FA < 44; in R. capensis FA > 48 mm).

Echolocation call: *Rhinolophus capensis* produces HD-CF echolocation calls with a high peak frequency (83.9±0.6 kHz, n = 10) and long duration (41.2±3.2, n = 10) (Jacobs *et al.* 2007a; also see Jacobs *et al.* 2008, Schoeman and Jacobs 2008).

Distribution, habitat and roosting: *Rhinolophus capensis* is endemic to the extreme southwest of the region, occurring from the Eastern Cape west to Cape Town and then north to just south of the Namibian border. It may occur in southern Namibia. The type specimen is from the Western Cape, South Africa (ZMB 377, Lectotype).

This species is relatively well represented in museums, with 70 specimens examined for this book.

Rhinolophus capensis roosts in caves and mine adits where it forms colonies of a thousand or more individuals (Herselman and Norton 1985); McDonald *et al.* (1990a) estimated 19,000 individuals at De Hoop Guano Cave. It is closely tied to the fynbos and succulent karoo biomes, but forages predominantly in the canopy of trees (McDonald *et al.* 1990b).

Non-torpid bats have a higher body temperature (35–37°C) compared to torpid bats (19–22°C) and select warmer

External and cranial measurements (mm) and mass (g) for *Rhinolophus capensis*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	10.5	9.0	12.0	1.06	7	**Mass**[1]	12.9	10.0	15.0	2.32	4
FA[1]	49.3	48.0	52.0	1.43	11	**FA**[1]	50.2	48.7	52.0	1.70	5
Total[1]	87.2	72	98	5.93	15	**Total**[1]	86.1	78	97	5.84	9
Tail[1]	28.0	24	32	2.60	15	**Tail**[1]	25.0	22	29	3.10	9
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	23.6	21	26	1.63	15	**Ear**[1]	23.2	21	26	1.48	9
CI[1]	19.1	18.5	20.3	0.53	16	**CI**[1]	19.0	18.5	19.9	0.50	8

[1] Specimens measured by the authors

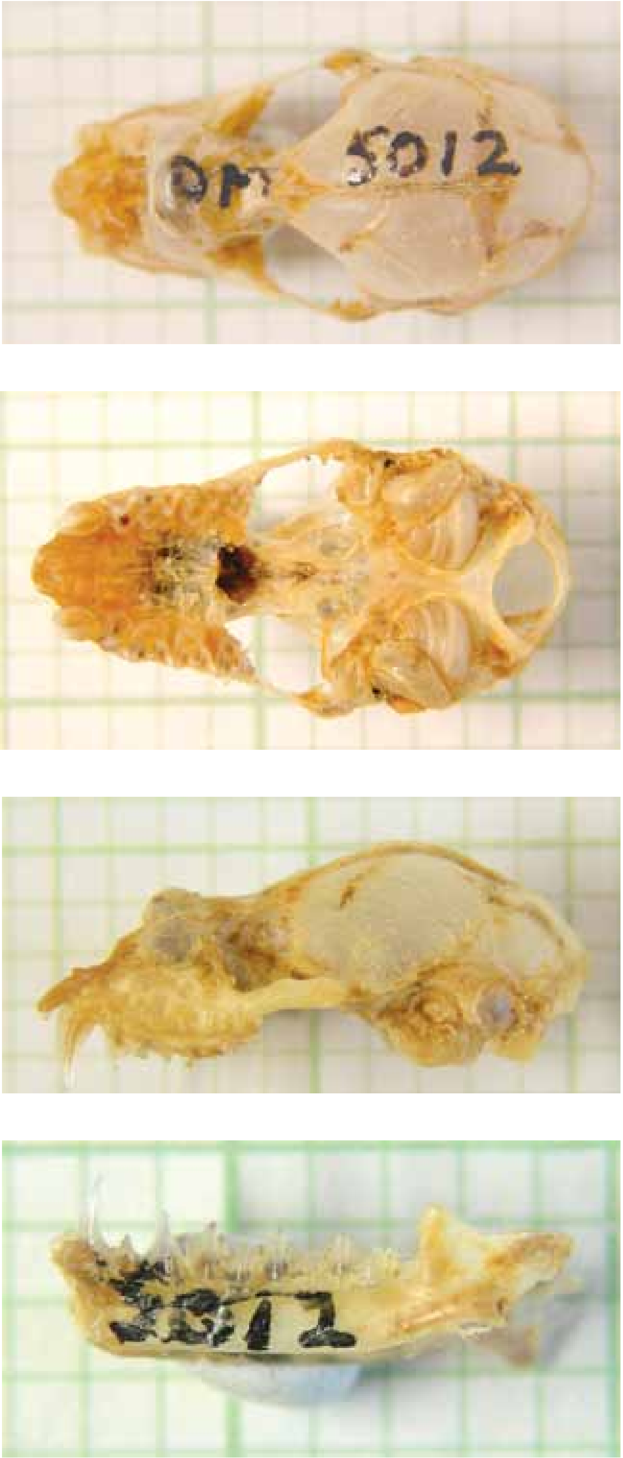


fig. 100a

fig. 100b

fig. 100c

fig. 100d

Figure 100. Skull and teeth of *Rhinolophus capensis:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 5012).

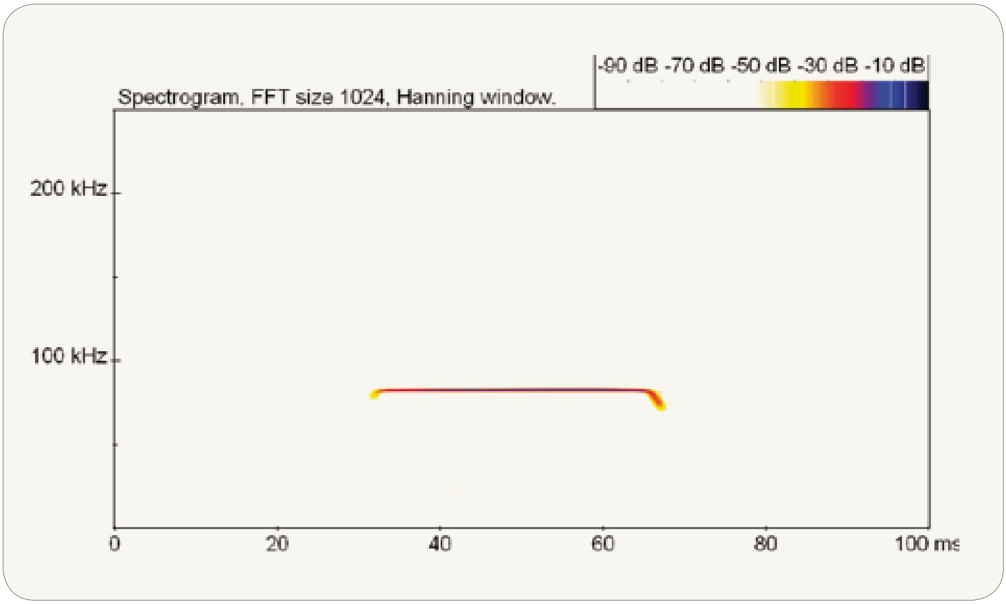


Figure 101. Echolocation call of *Rhinolophus capensis*.

roost temperatures (22–30°C compared with 17–22°C) at De Hoop Guano Cave in the Western Cape (Brown and Bernard 1994). They do not undergo a deep hibernation during winter and feed throughout the year. Nevertheless, there is a large influx of bats into De Hoop Guano Cave during the winter period (MacDonald *et al.* 1990a).

Extralimital: *Rhinolophus capensis* is endemic to South Africa.

Foraging ecology: *Rhinolophus capensis* has short and broad wings with intermediate wing loading (7.2 N.m-2) and low aspect ratio (6.0) (Jacobs *et al.* 2007a; also see Schoeman and Jacobs 2008). It is a clutter forager. The diet varies during the year, with Coleoptera and Lepidoptera predominating throughout (Schoeman 2006, Jacobs *et al.* 2007a).

Reproduction: Sperm storage occurs in the male reproductive tract. Sperm production begins in December, with sperm being released into the cauda epididymis in April and May and stored thereafter until August, when copulation and ovulation take place. Parturition occurs in November and December after a gestation period of around 110 days (Bernard 1985, 1986).

SYSTEMATIC NOTES

1823. *Rhinolophus capensis* Lichtenstein, Verzeichnis der Doubletten des Zoologischen Museums der Königlichen Friedrich-Wilhelm-Universität, Berlin: 4. Cape of Good Hope, South Africa.

Ansell (1978) reported two records from Zambia, but re-examination of these specimens confirmed that they had been misidentified (Ansell 1986). Considering the biogeography of this species (i.e. its distribution is confined to the fynbos and succulent karoo biomes of South Africa), it is unlikely that it occurs elsewhere on the continent.

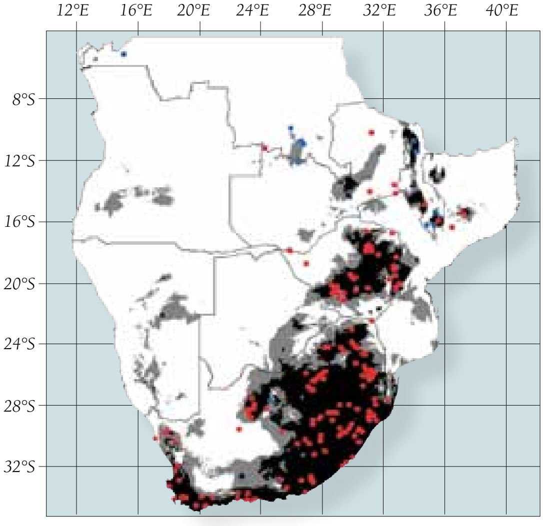
The diploid number in *R. capensis* is 2n = 58 and aFN = 60 (Rautenbach 1986).

Figure 102. Rhinolophus capensis showing complex horseshoe (© B. Fenton).

Rhinolophus clivosus Cretzschmar 1828

Geoffroy's horseshoe bat

Least Concern



Description: *Rhinolophus clivosus* is a medium-sized bat with a mass of around 17 g. The pelage is buffy-brown to greyish-brown on the upper parts and lighter on the underparts. The wings are pale brown. The ears are medium-sized, rounded with a pointed tip. The connecting process is characteristically high and rounded. The lower lip has one distinct mental groove. The sexes are alike.

The skull is robust with sturdy zygomatic arches. The poorly inflated rostral swellings result in a nearly horizontal upper rostral profile. The frontal depression is shallow with low, but well-defined supra-orbital ridges. The sagittal crest is relatively well developed and the palatal bridge is short, 25–31% of the upper toothrow length. The first upper premolar is outside the toothrow, bringing the canine and second premolar in contact (Csorba *et al.* 2003). The dental formula is variable; when all teeth are present it is 1123/2133 = 32. However, the first upper and third lower premolars are often absent.

Key identification features: The complicated noseleaf with the vertical connecting process readily distinguishes the genus *Rhinolophus* from all other southern African bats. *Rhinolophus clivosus* is a large member of the genus and is thus readily distinguished from the smaller species. A useful character for separating *R. clivosus* and *R. darlingi* from all other southern African *Rhinolophus* species is the absence of the minute first upper premolar in the toothrow. These two species, however, can easily be confused, but *R. clivosus* is larger (FA > 48 mm, CI > 18.4 mm; in *R. darlingi* FA < 49 mm, CI < 19.0 mm). Rhinolophus sakejiensis is larger (GSL > 24.6 mm; in R. clivosus GSL < 23.8 mm) and has a pointed connecting process (rounded in R. clivosus).

Echolocation call: *Rhinolophus clivosus* produces HD-CF echolocation calls with a high peak frequency (91.7±1 kHz, n = 10) and long duration (37.4±6.2 ms, n = 10) (Jacobs *et al.* 2007a; also see Taylor 1999a, Schoeman and Jacobs 2003, 2008, Monadjem *et al.* 2007). Besides the second harmonic, the fundamental and third harmonics may be present on the spectrogram.

Distribution, habitat and roosting: *Rhinolophus clivosus* is distributed widely in the eastern parts of southern Africa, but is absent from Namibia, Botswana and Angola. Previous reports of this species from Namibia refer to *R. darlingi* (see account for that species). It occurs widely in South Africa, but appears to be absent from the arid interior, through Zimbabwe, eastern Zambia and Malawi. The specimens previously cited as *R. clivosus* from Namibia (Skinner and Chimimba 2005) are in fact probably a new species with closer affinities to *R. darlingi* (Stoffberg 2007; P. J. Taylor and A. Monadjem, unpublished data). The type specimen is from Mohila, Arabia (SMF 12296). The type specimen of *augur* is from Kuruman,

External and cranial measurements (mm) and mass (g) for *Rhinolophus clivosus*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	16.2	12.0	21.7	2.88	40	**Mass**[1]	18.8	12.0	26.1	3.52	32
FA[1]	53.1	48.0	60.0	2.07	86	**FA**[1]	54.1	49.8	59.0	2.15	59
Total[1]	92.6	74	111	8.48	74	**Total**[1]	96.0	78	113	6.81	49
Tail[1]	31.2	23	39	3.56	77	**Tail**[1]	32.3	20	39	3.15	53
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	20.2	16	23	1.92	76	**Ear**[1]	20.9	15	24	1.91	49
CI[1]	20.2	18.4	21.2	0.60	61	**CI**[1]	20.1	18.7	21.4	0.53	52

[1] Specimens measured by the authors

fig. 103a

fig. 103b

fig. 103c

fig. 103d

Figure 103. Skull and teeth of *Rhinolophus clivosus:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8047).

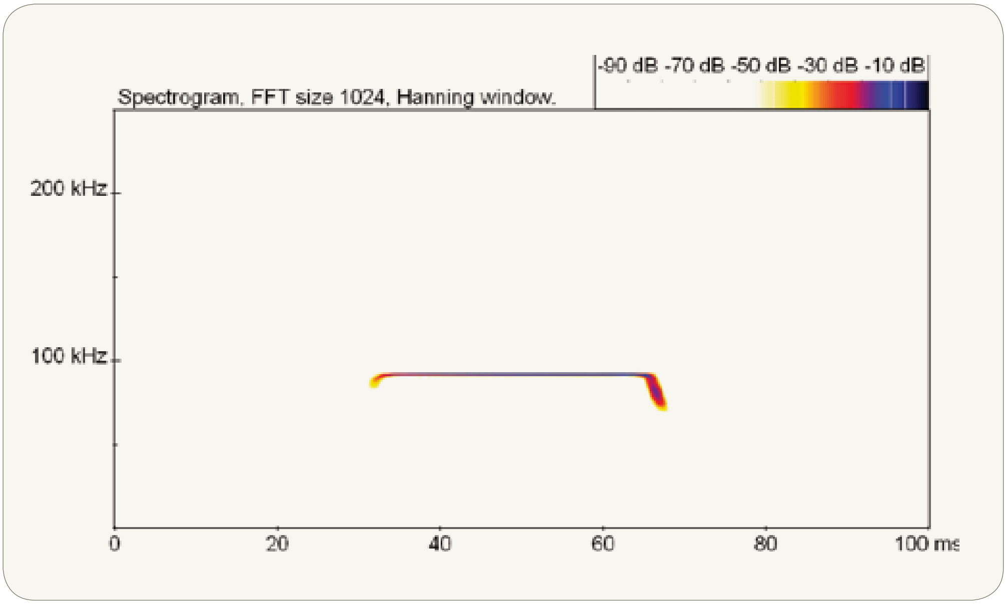


Figure 104. Echolocation call of *Rhinolophus clivosus*.

Northern Cape (BM 4.10.1.1, Holotype); that of *zuluensis* is from the Insuzi valley, northwest of Eshowe, KwaZulu-Natal, South Africa (BM 4.5.1.8, Holotype).

This species is well represented in museums, with just over 380 specimens examined for this book.

It roosts in caves and mine adits (Smithers 1983) where it may form large colonies of up to several thousand individuals (McDonald *et al.* 1990a, Monadjem 1998a). The bats leave their roosts about half an hour after sunset to forage and return to them before first light. During the night, they establish feeding stations, hanging from branches of trees or even entering the verandas of houses to hang up and eat their prey, discarding the harder parts in a pile underneath the night roost. In southern Africa, *Rhinolophus clivosus* is associated with a variety of habitats including arid savanna, woodland and riparian forest. Records indicate that this is primarily a temperate species, absent from hot low-lying areas and associated with mountainous areas in more northerly regions.

Extralimital: *Rhinolophus clivosus* occurs widely in sub-Saharan Africa including: Tanzania, Kenya, DRC, Ethiopia, Sudan, Cameroon, Gabon, Nigeria, Togo, Ghana, Côte d'Ivoire, Burkina Faso, Guinea, Sierra Leone, Senegal, Gambia and Mali (Csorba *et al*. 2003).

Foraging ecology: *Rhinolophus clivosus* has short and broad wings with intermediate wing loading (9.1 N.m^{-2}) and low aspect ratio (5.5) (Jacobs *et al.* 2007a; also see Schoeman and Jacobs 2003, 2008). It is a clutter forager. Its diet comprises mainly Lepidoptera and Coleoptera (Fenton *et al.* 1977, Rautenbach 1982, Schoeman and Jacobs 2003, Schoeman 2006, Jacobs *et al.* 2007a).

Reproduction: In KwaZulu-Natal, sperm production occurs from December to April, copulation in May, with sperm being stored in the oviducts and uterine horns of the females until the end of July. Ovulation and fertilisation occur in August, with parturition in December. Females became sexually mature during their first year, whereas males reach sexual maturity in their second year (Bernard 1983). In Gauteng, females did not uniformly store spermatozoa for prolonged periods, suggesting that sperm storage occurs in males (Wessels and van der Merwe 1997).

SYSTEMATIC NOTES

1838. *Rhinolophus clivosus* Cretzschmar, in Rüppell's Atlas zu der Reise im nördlichen Afrika, Säugethiere: 47. Mohila, Red Sea Coast, Arabia.

Meester *et al.* (1986) recognised two subspecies in southern Africa. The summarised distributions of these two populations by Meester *et al.* (1986) differ markedly from those presented by Csorba *et al.* (2003); Meester *et al.* (1986) appears to be the most accurate summary (F. P. D. Cotterill, unpublished data). These are based on the following original descriptions, and these two taxa are tentatively treated as subspecies:

Rhinolophus augur K. Andersen 1904. Ann. Mag. nat. Hist. (Ser 7) 14: 380. Kuruman, Cape Province.

Rhinolophus augur zuluensis K. Andersen 1904. Ann. Mag. nat. Hist. (Ser 7) 14: 383. Insuzi Valley, 32 km NW Eshowe, KwaZulu-Natal.

Their distribution appears to be parapatric, and awaits further study, especially on the larger Namibian specimens currently identified as *R. clivosus*. The type of *zambesiensis* K. Andersen 1904 (BM 1897.10.1.18, Holotype) appears to be a synonym of *zuluensis*.

The diploid number in *R. clivosus* is 2n = 58 and aFN = 60 (Rautenbach 1986).

fig. 105a

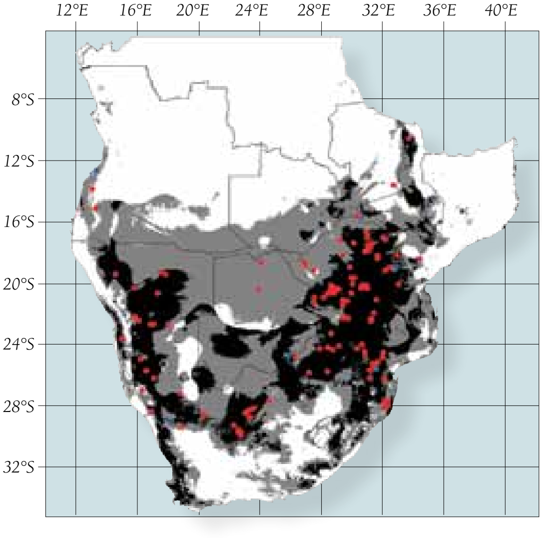
fig. 105b

Figure 105. Rhinolophus clivosus, showing high and rounded connecting process (a: DM 7893, © A. Monadjem; b: © L. Lumsden).

Rhinolophus darlingi K. Anderson 1905

Darling's horseshoe bat

Least Concern



Description: *Rhinolophus darlingi* is a small bat with a mass of around 8 g in the east and 13 g in the west. In the east, the pelage is grey or greyish-brown on the upper parts and lighter grey on the underparts. In the west, the upper parts are light brown and the underparts off-white. The wings are pale grey-brown. The ears are medium-sized, rounded with a pointed tip. The connecting process is characteristically high and rounded. The lower lip has one mental groove. The sexes are alike.

The skull is robust with sturdy zygomatic arches. The rostral swellings are moderately inflated. The frontal depression is shallow to moderately deep with well-defined supra-orbital ridges. The sagittal crest is relatively well developed and the palatal bridge is of medium length, 30–35% of the upper toothrow length. The dental formula is variable; when all teeth are present it is 1123/2133 = 32; however, the first upper and third lower premolars are often absent. The first upper premolar is outside the toothrow, bringing the canine and second premolar in contact (Csorba *et al*. 2003).

Key identification features: The complicated noseleaf with the vertical connecting process readily distinguishes the genus *Rhinolophus* from all other southern African bats. The rounded connecting process prevents confusion with similar-sized *R. landeri* and *R. blasii* (both have pointed connecting processes). Confusion is most likely with the similar-sized *R. simulator* (which also has a rounded connecting process), and they can only be reliably separated by the presence and position of the first upper premolar. It is always present and in the toothrow in *R. simulator*, and manifests as a gap between the canine and second premolar. If present, it is outside the toothrow in *R. darlingi*, hence no gap between the canine and second premolar (although the minute first premolar is not always visible in live specimens, the gap between the canine and second premolar is usually obvious in live *R. simulator*). Where they both occur, *Rhinolophus darlingi* can be distinguished from *R. clivosus* (which has rounded connecting process and first premolar outside of toothrow) by its smaller size (FA < 49 mm, CI < 19.0 mm; in *R. clivosus* FA > 48 mm, CI > 18.4 mm). The two also have different echolocation calls (see below).

Echolocation call: *Rhinolophus darlingi* produces HD-CF echolocation calls with a high peak frequency (87.1±2.1 kHz, n = 10) and long duration (39.5±10.6 ms, n = 10 ms) (Schoeman and Jacobs 2008; also see Taylor 1999a, Monadjem *et al*. 2007). Besides the second harmonic, the fundamental and third harmonics may be present on the spectrogram.

Distribution, habitat and roosting: *Rhinolophus darlingi* is distributed widely in the region, but is mostly absent from the northern parts. The western population occurs from the North-

External and cranial measurements (mm) and mass (g) for Rhinolophus darlingi*

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Eastern						**Western**					
Mass[1]	8.8	6.0	14.0	1.69	25	**Mass[1]**	12.2	8.0	14.0	1.70	10
FA[1]	46.3	43.0	50.1	1.55	40	**FA[1]**	49.1	44.0	52.9	2.30	19
Total[1]	81.9	69	95	6.87	28	**Total[1]**	88.9	83	99	4.72	15
Tail[1]	28.4	24	35	2.79	26	**Tail[1]**	31.1	28	35	2.02	10
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	20.0	15	22	1.80	26	**Ear[1]**	20.0	17	22	1.40	15
CI[1]	17.8	17.0	19.0	0.54	28	**CI[1]**	18.4	17.6	19.1	0.45	16

* Measurements are presented separately for the eastern (KwaZulu-Natal, Mpumalanga, Limpopo, Swaziland and Zimbabwe) and western (Namibia and Angola) populations

[1] Specimens measured by the authors

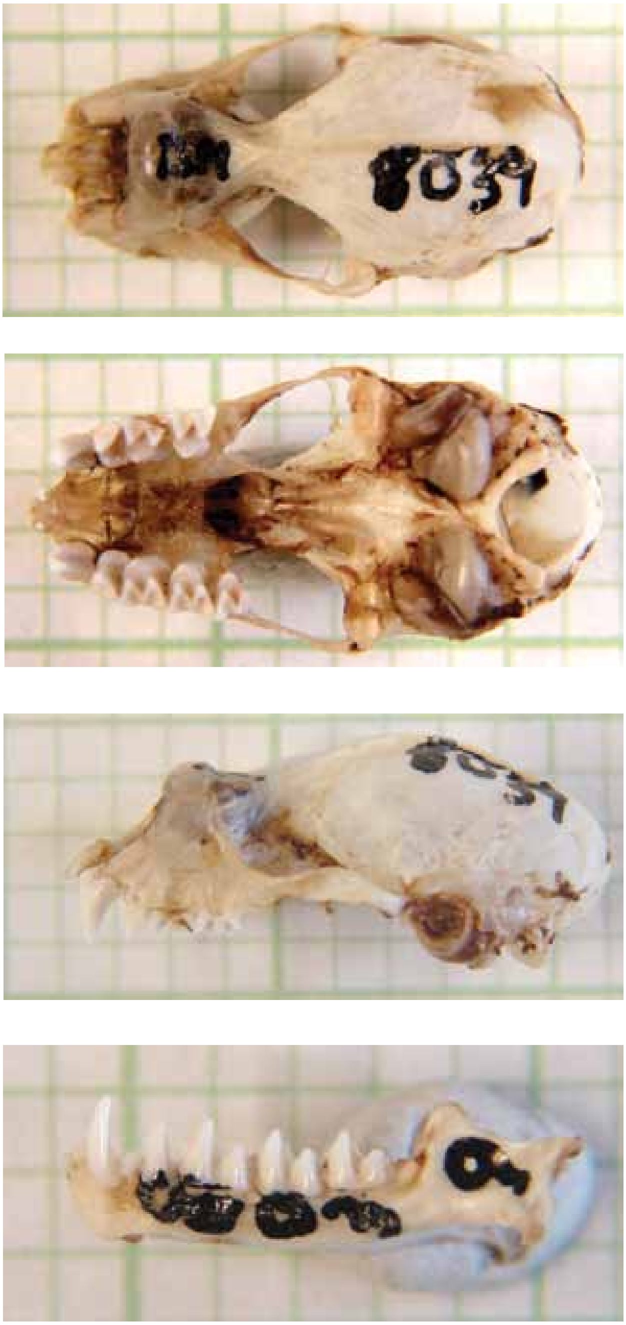


fig. 106a

fig. 106b

fig. 106c

fig. 106d

Figure 106. Skull and teeth of *Rhinolophus darlingi*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8039).

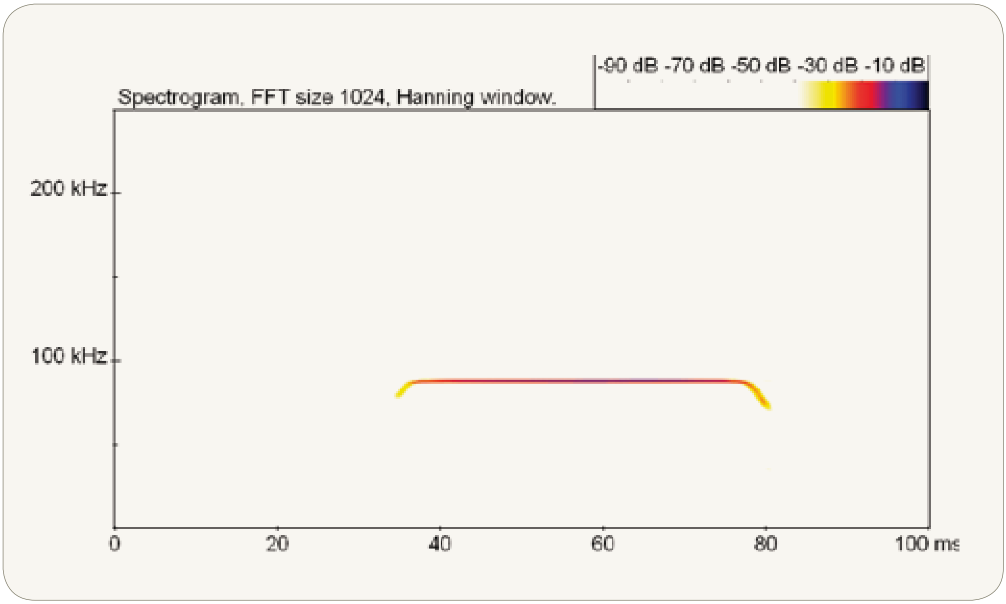


Figure 107. Echolocation call of *Rhinolophus darlingi*.

ern Cape, westwards to Namibia and north through to southwestern Angola. The eastern population occurs from northern KwaZulu-Natal through Swaziland and northern South Africa to Zimbabwe, northern Botswana, the extreme southeast of Zambia and southern Malawi. The species has probably been overlooked in central Mozambique. The eastern and western populations are geographically isolated. The type specimen is from Zimbabwe. The type material of *darlingi* is from the Upper Mazoe valley, north of Harare, Zimbabwe (BM 95.8.27.1, Holotype).

This species is well represented in museums, with 320 specimens examined from both populations for this book.

Rhinolophus darlingi roosts in caves and mine adits, where it may form medium-sized colonies of 160 individuals (Churchill *et al*. 1997). It also roosts in smaller groups or singly in culverts (Monadjem 1998a), or in cavities in piles of boulders (Skinner and Chimimba 2005). In southern Africa, the species is associated with a variety of habitats, including arid savanna in the west and woodland in the east. In Zimbabwe, it is closely associated with broken and hilly terrain (Skinner and Chimimba 2005). In Namibia, in three cave roosts, *R. darlingi* selected roost sites that varied greatly in humidity, but occupied a narrow temperature range of 24–24.5°C (Churchill *et al.* 1997). In Zimbabwe, they enter torpor daily during the cool-dry season (Cotterill and Happold in press d).

Extralimital: *Rhinolophus darlingi* is predominantly a southern African species with isolated records from Nigeria (Hill *et al.* 1988) and Tanzania (Csorba *et al.* 2003).

Foraging ecology: *Rhinolophus darlingi* has short and broad wings with intermediate wing loading (7.8 N.m^{-2}) and low aspect ratio (6.3) (Norberg and Rayner 1987, Aldridge and Rautenbach 1987, Schoeman and Jacobs 2008, Cotterill and Happold in press d). It is is a clutter forager. Lepidoptera and Coleoptera dominate in its diet (Schoeman 2006).

Reproduction: *Rhinolophus* darlingi females typically give birth to a single young. Twinned foetuses near full term, one in each uterine horn, were observed once in Zimbabwe. In Zimbabwe, females with young were recorded in October, and one pregnant female in December (Smithers and Wilson 1979). No pregnant or lactating females were recorded during the cool-dry season (Cotterill and Happold in press d). In the former Transvaal, one pregnant female was recorded in October (Rautenbach 1982).

SYSTEMATIC NOTES

1905. *Rhinolophus darlingi* K. Andersen, Annals and Magazine of Natural History (7)15: 70. Mazoe, Mashonaland, Rhodesia (= Zimbabwe).

Two subspecies are recognised in southern Africa, *R. d. darlingi* and *R. d. damarensis* Roberts 1946, the latter known from Namibia and possibly the Northern Cape (Meester *et al.* 1986). An individual from Arnhem Cave in Namibia, identified provisionally as *R. cf. darlingi*, had a CF frequency of 83 kHz and duration of 30–60 ms. This individual varied genetically by > 10% sequence divergence of the cytochrome-b gene, compared with *R. darlingi* from Swaziland, suggesting that this is a distinct species, for which the name *R. damarensis* would probably be available. Hence, the Namibian populations of *R. cf. darlingi* are genetically distinct from eastern populations and appear to have a distinct echolocation call. In addition, they are significantly larger and usually possess a minute upper first premolar, which is usually lacking in the eastern populations; this suggests that *R. damarensis* (TM 9474, Holotype) may be a good species (P. J. Taylor and A. Monadjem, unpublished data; also see Stoffberg 2007).

The diploid number in *R. darlingi* is 2n = 58 and aFN = 60 (Rautenbach 1986).

fig. 108a

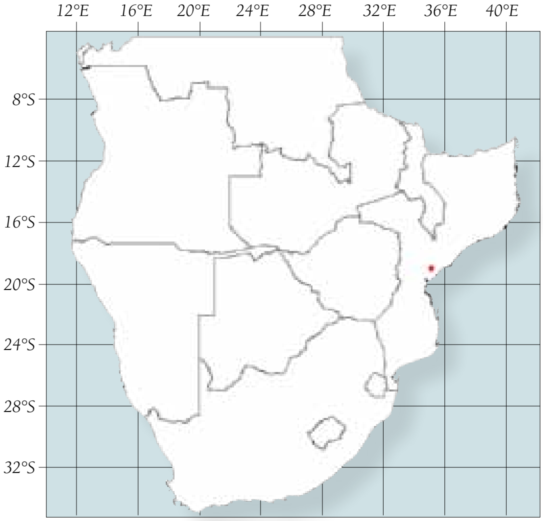
fig. 108b

Figure 108. *Rhinolophus darlingi,* showing high and rounded connecting process (a: Taung, Northwest, South Africa, TM 48040, © E. C. J. Seamark; b: Matobo, Zimbabwe, © F. P. D. Cotterill).

Rhinolophus deckenii Peters 1868

Decken's horseshoe bat

Data Deficient



Description: *Rhinolophus deckenii* is a medium-small bat with a mass of around 15 g. The pelage is dark brown on the upper parts and lighter on the under parts. The wings are dark brown. The ears are medium-sized (23 mm), rounded with a pointed tip. The connecting process is rounded. The lower lip has a deep, central mental groove, between two superficial grooves. The sexes are alike. The horseshoe is wide (9.0–11.0 mm), covering the whole muzzle.

The skull is robust with sturdy zygomatic arches. The rostral swellings are well developed resulting in a rounded rostral profile, which rises above the rostrum. The frontal depression is moderately deep with strongly defined supra-orbital ridges. The sagittal crest is weak and the palatal bridge is of medium length, 37–39% of the upper toothrow. The first upper premolar is small and partially inside the toothrow narrowly separating the canine and second premolar. The dental formula is: 1123/2133 = 32.

External and cranial measurements (mm) and mass (g) for *Rhinolophus deckenii*, males only

	Mean	Min	Max	SD	N
Males					
Mass[1]	15.0	-	-	-	1
FA[1]	52.9	51.8	54.0	0.96	4
Total[1]	89.3	84.0	94.0	4.6	4
Tail[1]	29.0	29.3	26.0	32.0	4
Tibia	-	-	-	-	4
Ear[1]	22.3	20.0	25.0	2.22	?
CI[1]	19.6				1

Key identification features: The complicated nose-leaf with the vertical connecting process readily distinguishes the genus *Rhinolophus* from all other southern African bats. On external characters, this species is very difficult to distinguish from *R. silvestris*; in addition to their marked geographic separation, they are separable on subtle differences in cranial, bacular and noseleaf characters. The anterior surface of sella is straight (besides a curved tip) in *deckenii*, but is bent and convoluted in *silvestris*. The broader rostrum of *silvestris* presents in more pronounced nasal inflations (greatest width over 6.0 mm) compared to *deckenii*. These two species are also separable on differences in the baculum; although both species exhibit a buccinate (trumpet-shaped) baculum, that of *silvestris* has a long, cylindrical, parallel sided shaft compared to the flattened spatulate, blade-shaped shaft of *deckenii*. Confusion is likely with large individuals of the smaller *R. clivosus* but the connecting process is low and rounded in *deckenii*, as opposed to high and rounded in *clivosus*; the nasal swellings are conspicuously more inflated in *deckenii* (less so in *clivosus*); above all, the noseleaf width is wider (9.0 mm or greater in *deckenii* and < 9.0 mm in *clivosus*). The position of the minute first upper premolar is variable, being external to the toothrow, or partly within it, manifesting in a slight gap between the canine and second premolar (Csorba *et al.* 2003). *R. darlingi* is smaller in the eastern part of its range (FA < 49 mm; FA > 48 mm in *R. deckenii*). The skull of *deckenii* is similar to that of *fumigatus*, but there is no gap between the upper canine and posterior premolar in *fumigatus*, and the noseleaf tends to be wider with a hairy sella (naked in *deckenii*). The baculum is 3.8 mm long and distinctive in shape, with its wide, dorsoventrally flattened shaft; the basal portion is notched slightly in ventral and dorsal views (Cotterill 2002a).

Echolocation call: This species produces HD-CF echolocation calls with a peak frequency of 72 kHz (Monadjem unpublished data).

Distribution, habitat and roosting: In southern Africa, *Rhinolophus deckenii* is known from a single specimen collected in the Chinizuia forest of central Mozambique. The species is relatively common in coastal Kenya and Tanzania, where the majority of museum specimens have been collected in caves. The type specimen is from 'Zanzibar Coast' (mainland Tanzania opposite Zanzibar) (ZMB 3269, Holotype: adult female, alcoholic specimen with skull missing).

Extralimital: The species is known from Uganda, Kenya, Zanzibar and Pemba.

[1] Specimens measured by the authors


fig. 109a


fig. 109b


fig. 109c


fig. 109d

Figure 109. Skull and teeth of *Rhinolophus deckenii*: (a) dorsal view; (b) ventral view; (c) lateral view and (d) lateral view of mandible (DM 8560).

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: No reproductive information is available.

SYSTEMATIC NOTES

1868. *Rhinolophus deckenii* Peters, Monatsb. k. preuss. Akad. Wiss. Berlin, 705 (for 1867). Zanzibar coast (mainland opposite Zanzibar).

Rhinolophus deckenii was treated as synonym of *R. clivosus* by Hayman and Hill (1971) but recognised as specifically distinct by Aellen and Brosset (1968), Koopman (1975) and Bogdanowicz and Owen (1992). Distinct bacula and morphological characters distinguish *deckenii* from the *clivosus* complex, and its closest relative, *silvestris* Aellen 1959, restricted within the western Congo basin (Cotterill 2002a). Known only from two localities, *R. silvestris* possibly occurs south of the Congo River.

Figure 110. *Rhinolophus deckenii*, profile showing rounded connecting process (DM 8560, © A. Monadjem).

fig. 111a

fig. 111b

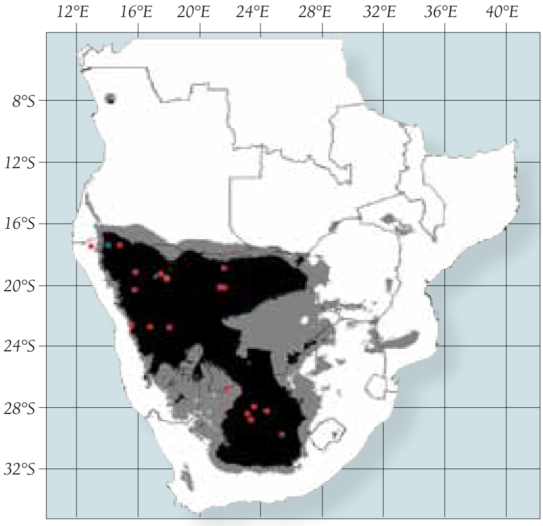
fig. 111c

Figure 111. Ventral (a), dorsal (b) and lateral (c) views of the baculum of *Rhinolophus deckenii* (DM 8560, © P. J. Taylor).

Rhinolophus denti Thomas 1904

Dent's horseshoe bat

Data Deficient



Description: *Rhinolophus denti* is a small bat with a mass of around 7 g. The pelage is pale grey to cream on the upper parts and off-white on the underparts. The long dorsal hairs have white bases. The wings are pale. The ears are rounded with a sharply pointed tip. The connecting process is characteristically high and rounded. The lower lip has three mental grooves. The sexes are alike.

The skull is delicate with thin zygomatic arches. The well-developed rostral swellings result in a rounded rostral profile. The braincase is high and domed. The frontal depression is shallow with poorly defined supra-orbital ridges. The bullae are distinctly inflated in proportion to the skull. The sagittal crest is usually weak and the palatal bridge is of medium length, 30–34% of the upper toothrow. The first upper premolar is small and in the toothrow, separating the canine and second premolar (Csorba *et al*. 2003). The dental formula is 1123/2133 = 32 (Cotterill in press a).

Key identification features: The complicated noseleaf with the vertical connecting process readily distinguishes the genus *Rhinolophus* from all other southern African bats. *Rhinolophus denti* should not be confused with any other *Rhinolophus* in southern Africa. *Rhinolophus swinnyi* is similar in size and morphology, but is grey or pale brown (pale cream in *R. denti)* and their distributions do not overlap. *Rhinolophus darlingi* is much larger (FA > 48 mm in the west; in *R. denti* FA < 45 mm).

Echolocation call: *Rhinolophus denti* produces HD-CF echolocation calls with a high peak frequency (111.2±1.8 kHz, n = 10) and long duration (23.4±4 ms, n = 10) (Schoeman and Jacobs 2008).

Distribution, habitat and roosting: *Rhinolophus denti* is widely but sparsely distributed in western parts of the region. It occurs from the Northern Cape north through western Botswana and central and northern Namibia. It has probably been overlooked in southern Angola. Records from Zimbabwe and Mozambique are misidentified *R. swinnyi* (Smithers 1983); records of *R. denti* for eastern Zimbabwe and western Mozambique, mapped by Csorba *et al.* (2003), therefore appear to represent *R. swinnyi*. The type specimen is from Kuruman, Northern Cape, South Africa (BM 4.4.8.2, Holotype).

This species is relatively well represented in museums, with over 80 specimens examined for this book.

Rhinolophus denti roosts in caves, semi-dark caverns and crevices in rocky outcrops, where it may be encountered in small colonies of a few dozen individuals, e.g. at Drotsky Caves in Botswana (Smithers 1971). In Namibian caves, individuals selected humid (mean relative humidity 90.4%) and comparatively cool (mean 24.4°C) microclimates (Churchill

External and cranial measurements (mm) and mass (g) for *Rhinolophus denti*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	6.5	5.0	8.0	0.86	13	**Mass[1]**	7.4	6.0	9.0	0.86	13
FA[1]	42.7	42.0	44.0	0.65	13	**FA[1]**	43.5	42.0	45.0	0.84	14
Total[1]	72.6	65	84	4.43	13	**Total[1]**	73.4	69	81	3.78	12
Tail[1]	22.0	20	25	1.90	13	**Tail[1]**	21.0	20	24	1.10	13
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	19.0	16	22	1.40	13	**Ear[1]**	19.0	18	20	0.80	13
CI[1]	15.1	14.8	15.6	0.22	12	**CI[1]**	15.1	14.0	15.5	0.35	17

[1] Specimens measured by the authors

fig. 112a

fig. 112b

fig. 112c

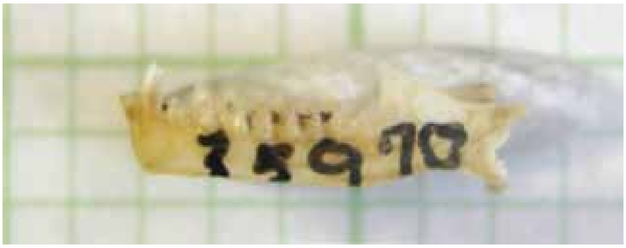


fig. 112d

Figure 112. Skull and teeth of *Rhinolophus denti*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (TM 35970).

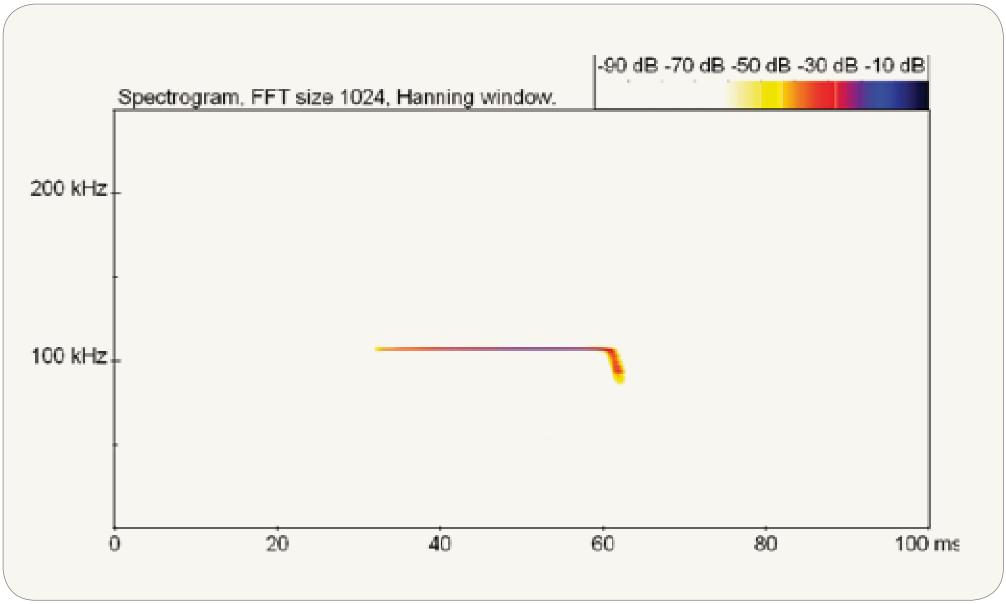


Figure 113. Echolocation call of *Rhinolophus denti.*

et al. 1997). Apart from caves, they have been found roosting under the thatched roof of a house and in a road culvert (Shortridge 1934). The species is associated with arid habitats where suitable roosting sites occur, typically restricting it to broken country with rocky outcrops or suitable caves.

Extralimital: *Rhinolophus denti denti* is endemic to southern Africa, while *R. denti knorri* is known from Ghana, Côte d'Ivoire and Guinea (Csorba *et al.* 2003).

Foraging ecology: *Rhinolophus denti* has short and broad wings with low wing loading (4.7 N.m^{-2}) and low aspect ratio (6.0) (Schoeman and Jacobs 2008). It is a clutter forager. Its diet consists mainly of Lepidoptera (M. C. Schoeman, unpublished data).

Reproduction: No reproductive information is available.

SYSTEMATIC NOTES

1904. *Rhinolophus denti* Thomas, Annals and Magazine of Natural History (7)13: 386. Kuruman, Northern Cape, South Africa.

Only the nominate subspecies is recognised in the region. The subspecies *R. denti knorri* Eisentraut 1960, which occurs in West Africa, is separated from the nominate subspecies by at least 4,000 km and may eventually be shown to be a separate species.

The diploid number in *R. denti* is 2n = 58 and aFN = 62 (Rautenbach 1986).

fig. 114a

fig. 114b

Figure 114. *Rhinolophus denti:* (a) portrait showing high and rounded connecting process, and (b) whole body showing pale underparts (a: TM 48035, © E. C. J. Seamark; b: DM 10132, © A. Monadjem).

Rhinolophus eloquens Andersen 1905

Eloquent horseshoe bat

Data Deficient

Description: *Rhinolophus eloquens* is a medium-sized bat with a mass of around 15 g. The fluffy pelage is brown on the upper parts and grey below. The wings are greyish-brown. The ears are medium-sized, rounded with a pointed tip. The horseshoe is wide (> 9 mm, and typically > 10 mm) with a triangular lancet, and the connecting process is characteristically low and rounded. The noseleaf is wide and the sella is covered in long hairs. The lower lip has one mental groove. The sexes are alike.

The skull is massive with robust zygomatic arches. The prominent rostral swellings result in a rounded rostral profile. The frontal depression is moderately deep or shallow with low supra-orbital ridges. The sagittal crest is well developed and the palatal bridge is of variable length, 32–37% of the upper toothrow (Csorba *et al.* 2003). The dental formula is usually: 1123/2133 = 32. However, the first upper premolar is invariably absent; when present it is small and external to the toothrow, bringing the canine and second premolar in contact.

Key identification features: The complicated nose-leaf with the vertical connecting process readily distinguishes the genus *Rhinolophus* from all other southern African bats. On morphometric criteria, *R. eloquens* is of intermediate size: between the larger *R. hildebrandtii* and the less robust *R. fumigatus*. The wide horseshoe and low and rounded connecting process separate it from all other *Rhinolophus* species except the similar-sized *R. fumigatus* and the much larger *R. hildebrandtii* (FA > 60 mm; in *R. eloquens* FA < 60 mm). *Rhinolophus eloquens* can be separated from *R. fumigatus* by greatest skull length (*R. eloquens* > 24.5 mm; *R. fumigatus* < 24.5 mm). All three species can be distinguished from the morphology of the baculum, which is species-specific (Cotterill, unpublished data).

Echolocation call: The echolocation call of this species has not been recorded.

Distribution, habitat and roosting: *Rhinolophus eloquens* is a poorly known bat in southern Africa, with just a single verified specimen collected from Katanga in the DRC (the exact locality is not specified). The type specimen is from Entebbe, Uganda (BM 1899.8.4.4, Holotype). Localities are associated with mesic savanna and open forest habitats.

Extralimital: This species has also been recorded in Uganda, Kenya, Sudan, Somalia and Rwanda.

Foraging ecology: There is no information on the diet or foraging behaviour of this species in southern Africa.

Reproduction: No reproductive information available for southern Africa or indeed from elsewhere in Africa.

SYSTEMATIC NOTES

1905. *Rhinolophus eloquens* K. Andersen, Ann. Mag. nat. Hist., ser. 7, 15 (85): 74.

Koopman (1975) treated the synonym *perauritus* De Beaux 1922 as the Somalian subspecies of *R. eloquens*. A thorough, Pan-African study of the phylogeography and morphometrics of this entire species complex is required to clarify the species boundaries between these populations, and especially to refine the southern limit to what has traditionally been treated as an equatorial species.

The diploid number in *R. eloquens* is not known.

External and cranial measurements (mm) and mass (g) for *Rhinolophus eloquens*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	21.0	-	40.0	4.00	104	**Mass**[1]	21.5	-	30.0	4.00	102
FA[1]	58.1	53.1	63.0	2.00	122	**FA**[1]	58.7	53.0	62.7	2.00	108
Total[1]	100.3	88.0	116.0	6.00	127	**Total**[1]	106.1	90.0	117.0	5.00	115
Tail[1]	30.6	23.0	45.0	3.00	127	**Tail**[1]	31.4	20.0	39.0	3.00	116
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	27.6	14.0	38.0	2.00	126	**Ear**[1]	26.5	21.0	32.0	3.00	115
GSL[1]	26.0	23.1	28.7	0.90	34	**GSL**[1]	25.7	22.5	27.0	1.00	26

[1] Specimens measured by the authors

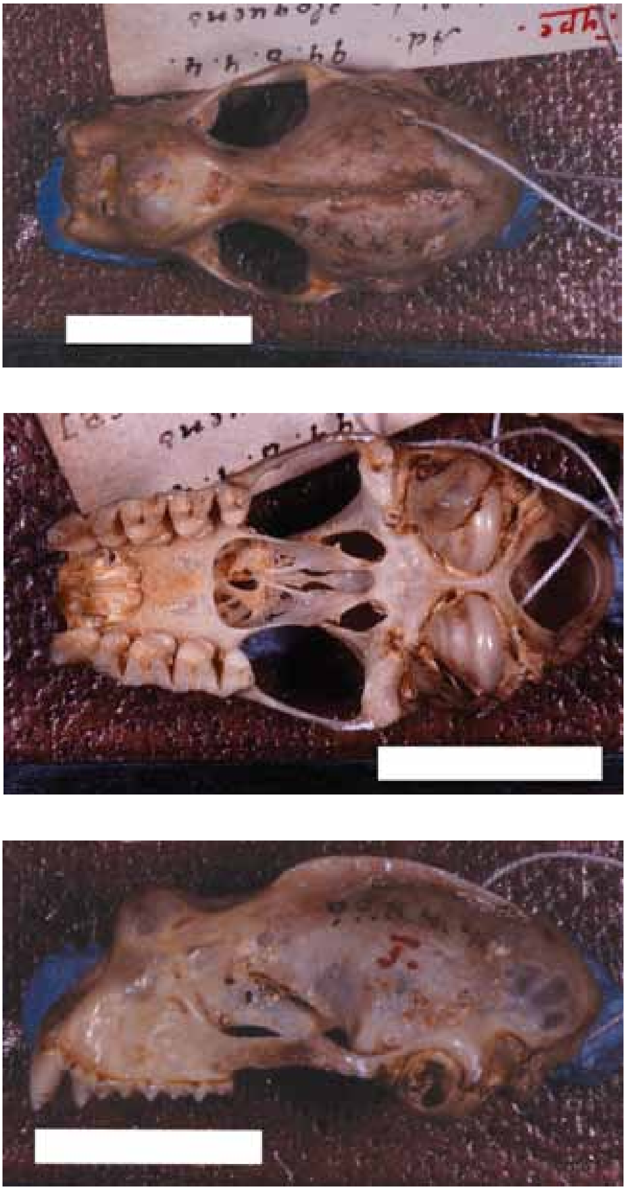


fig. 115a

fig. 115b

fig. 115c

Figure 115. Skull and teeth of *Rhinolophus eloquens:* (a) dorsal view, (b) ventral view and (c) lateral view. Scale bar = 10 mm (BM 1899.8.4.4, Holotype; © F. P. D. Cotterill).

Figure 116. The study skin of *Rhinolophus eloquens*
(BM 99.8.4.4, Holotype; © F. P. D. Cotterill)..

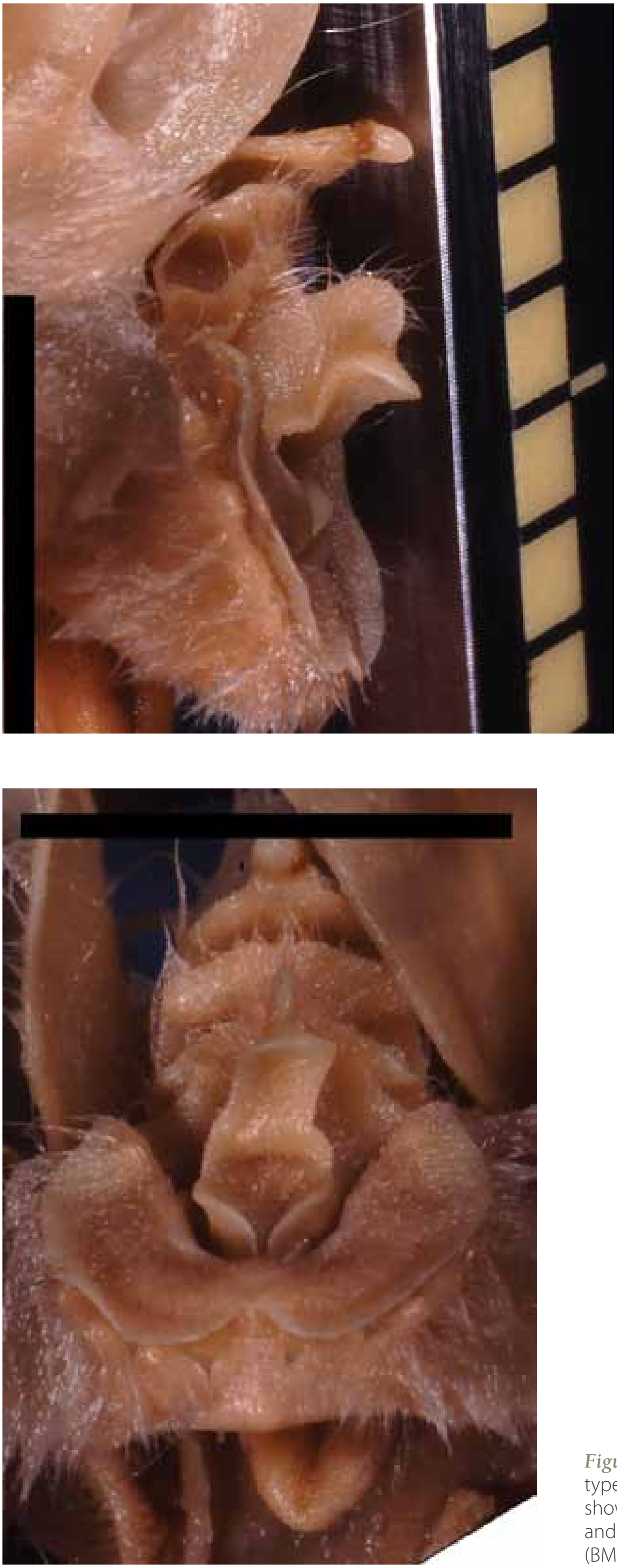
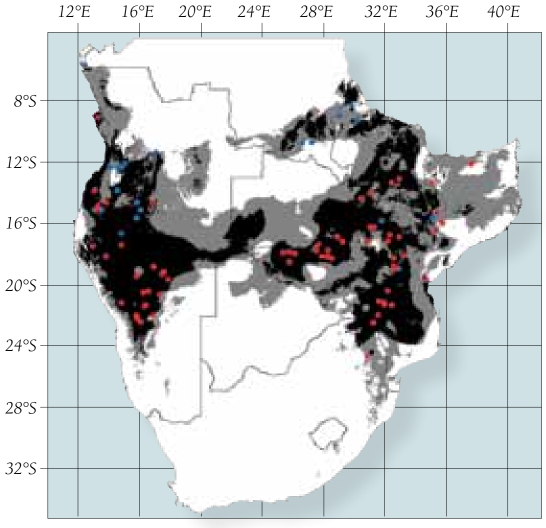


Figure 117. *Rhinolophus eloquens* type specimen from Entebbe, Uganda, showing the noseleaf in (a) lateral view, and (b) frontal view. Scale bar = 10 mm (BM 64.2078, Topotype; © F. P. D. Cotterill).

Rhinolophus fumigatus Rüppell 1842 ●

Rüppell's horseshoe bat

Least Concern



Description: *Rhinolophus fumigatus* is a medium-sized bat with a mass of around 14 g. The pelage is grey-brown on the upper parts and light grey on the underparts. The wings are greyish-brown. The ears are medium-sized, rounded with a pointed tip. The horseshoe is wide (> 9 mm, and typically > 10 mm) and the connecting process is characteristically low and rounded. The lower lip has one mental groove. The sexes are alike.

The skull is massive with robust zygomatic arches. The rostral swellings are prominent, resulting in a rounded rostral profile. The frontal depression is shallow with pronounced supra-orbital ridges. The sagittal crest is well developed and the palatal bridge is of variable length, 28–37% of the upper toothrow (Csorba *et al.* 2003). The dental formula is usually 1123/2133 = 32. However, the first upper premolar is frequently absent; when present it is small and external to the toothrow, bringing the canine and second premolar in contact.

Key identification features: The complicated noseleaf with the vertical connecting process distinguishes the genus *Rhinolophus* from all other southern African bats. This species should not be confused with other members of this genus. The wide horseshoe and low and rounded connecting process separate it from all other species, except *R. eloquens* and the much larger *R. hildebrandtii* (FA > 60 mm; in *R. fumigatus* FA < 58 mm). These two species also differ in the shape of the lancet, which is triangular, rising to a sharp point in *R. fumigatus*, but is rounded in *R. hildebrandtii*. (For differences between *R. fumigatus* and *R. eloquens*, see the *Rhinolophus eloquens* species account.)

Echolocation call: *Rhinolophus fumigatus* produces HD-CF echolocation calls with an intermediate peak frequency (53.7±1 kHz, n = 2) and long duration (40.3±6.2 ms, n = 2) (Schoeman and Jacobs 2008; also see Aldridge and Rautenbach 1987).

Distribution, habitat and roosting: Two geographically isolated populations of *Rhinolophus fumigatus* occur in the east and west of southern Africa. In the east, the species occurs from northern South Africa through Zimbabwe, southern and eastern Zambia, southern Malawi, southern DRC and central and northern Mozambique. The western population occurs widely in central and northern Namibia and southwestern Angola. There is confusion over whether this species occurs in the Northern Cape. We have been unable to locate any museum specimens to validate this record. Apparently, there are two specimens collected by C. H. B. Grant in 1903 at Klipfontein, Namaqualand, in the British Museum of Natural History (Herselman and Norton 1985). However, until these specimens are located and their identifications verified, we suggest that the Northern Cape record be treated as unsub-

External and cranial measurements (mm) and mass (g) for *Rhinolophus fumigatus*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass¹	13.7	11.0	20.0	2.93	7	**Mass¹**	14.2	-	-	-	1
FA¹	53.5	48.1	58.6	3.97	15	**FA¹**	52.7	46.5	57.2	3.60	6
Total¹	98.4	90	106	6.80	7	**Total¹**	92.0	89	95	-	2
Tail¹	33.0	29	40	3.50	7	**Tail¹**	31.0	27	35	-	2
Tibia¹	22.4	21.6	23.3	0.86	3	**Tibia**	-	-	-	-	-
Ear¹	26.1	23	29	1.95	7	**Ear¹**	24.0	23	25	-	2
CI¹	21.3	19.4	23.0	1.29	14	**CI¹**	21.2	19.8	22.4	0.88	10

¹ Specimens measured by the authors

fig. 118a

fig. 118b

fig. 118c

fig. 118d

Figure 118. Skull and teeth of *Rhinolophus fumigatus*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8569).

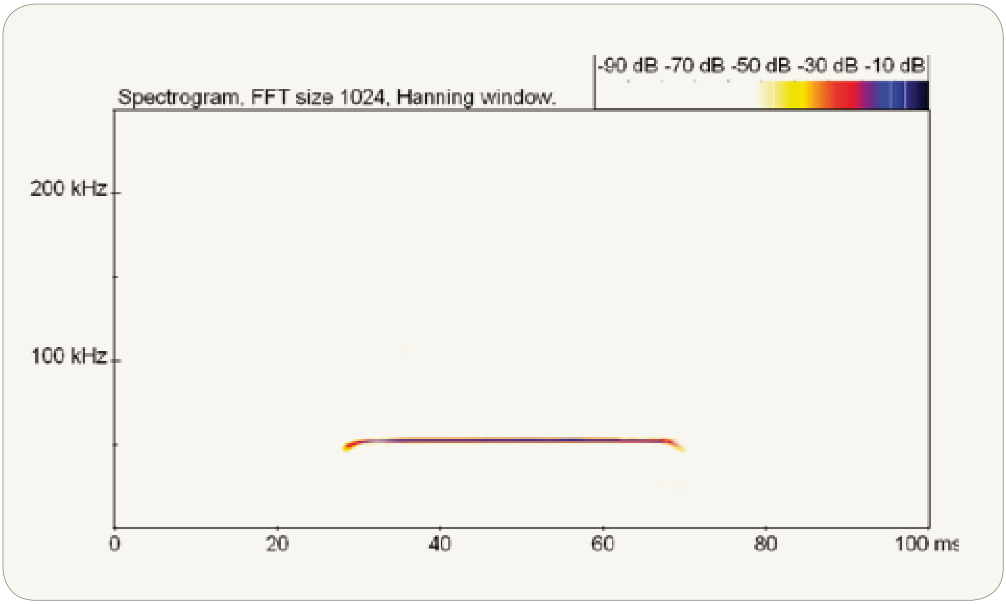


Figure 119. Echolocation call of *Rhinolophus fumigatus*.

stantiated, especially considering the range expansion of over 750 km. The type specimen for *R. fumigatus* is from Ethiopia (SMF 4372, Lectotype), while the type specimen for the southern African subspecies is from Namibia (ZMB 3295, Lectotype) (see 'Systematic notes' below).

This species is relatively well represented in museums, with over 90 specimens examined for this book.

Rhinolophus fumigatus roosts in caves, mine adits and culverts under the road (Skinner and Chimimba 2005). The western population may form large colonies of up to 500 individuals (Churchill *et al.* 1997) while the eastern population is generally encountered singly (Rautenbach 1982, A. Monadjem, personal observation). This species is associated with arid savanna in the west and savanna woodland in the east.

Extralimital: *Rhinolophus fumigatus* is widely distributed in sub-Saharan Africa, but absent from the Congo basin and the West African tropical forest zone (Csorba *et al.* 2003).

Foraging ecology: *Rhinolophus fumigatus* has short and broad wings with intermediate wing loading (7.7 $N.m^{-2}$) and low aspect ratio (6.7) (Norberg and Rayner 1987, Aldridge and Rautenbach 1987; also see Schoeman and Jacobs 2008). It is a clutter forager. Its diet consists mainly of Coleoptera and a smaller proportion of Lepidoptera (Aldridge and Rautenbach 1987, M. C. Schoeman, unpublished data).

Reproduction: Pregnant females (with single foetuses) have been collected in September and October in southern Africa (Smithers 1983).

SYSTEMATIC NOTES

1842. *Rhinolophus fumigatus* Rüppell, Museum Senckenbergianum 3: 132, 155. Shoa, Ethiopia.

Several subspecies are described for Africa, but only *R. fumigatus aethiops* (ZMB 3295, Lectotype) is known from the region.

Rhinolophus fumigatus aethiops Peters 1869

1869. *Rhinolophus aethiops* Peters, Monatsberichte der Königlichen Preussischen Akademie der Wissenschaften zu Berlin (1868): 637. Otjimbingue, Damaraland, Namibia.

This subspecies is thought to range over the entire region (Meester *et al.* 1986). However, the eastern and western populations are geographically isolated (separated by at least 750 km), and differ in size and pelage colour. These two populations may well represent different species.

The diploid number in *R. fumigatus* from the eastern population is 2n = 58 and aFN = 60 (Rautenbach 1986).

Figure 120. Rhinolophus fumigatus: (a) profile showing low connecting process, and (b) frontal view showing wide horseshoe (DM 8568, © A. Monadjem).

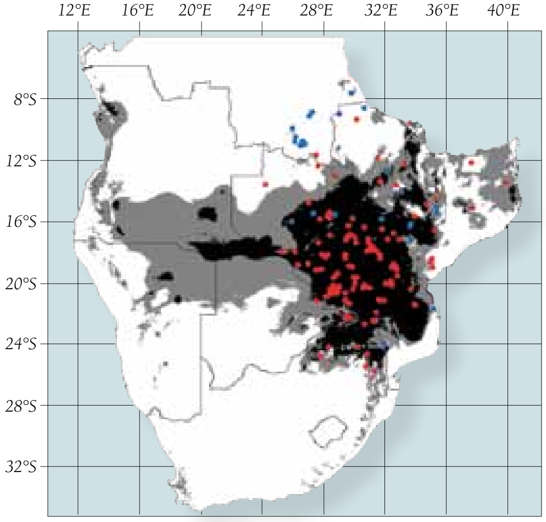
fig. 120a

fig. 120b

Rhinolophus hildebrandtii Peters 1878

Hildebrandt's horseshoe bat

Least Concern



Description: *Rhinolophus hildebrandtii* is a large bat with a mass of around 22 g. The pelage is pale grey-brown on the upper parts and light grey or cream on the underparts. The wings are greyish-brown. The ears are medium-sized, rounded with a pointed tip. The lower lip has a single mental groove. The horseshoe is wide (> 13 mm) and the connecting process is characteristically low and rounded. The sexes are alike.

The skull is massive with robust zygomatic arches. The rostral swellings are prominent, resulting in a rounded rostral profile. The braincase is low and flattish in profile, not domed, no higher than the rostral swelling, but with a pronounced sagittal crest. The frontal depression is shallow with pronounced supra-orbital ridges. The coronoid processes of the mandible are pronounced. The palatal bridge is relatively long, 32–38% of the upper toothrow (Csorba *et al.* 2003).

The dental formula is usually 1113/2133 = 30. The first upper premolar is usually absent; when present it is typically (but not always) minute and external to the toothrow, bringing the canine and second premolar in contact (exceptions where a gap was present were noted among specimens from Mpumalanga, South Africa and Mt Mabu, Mozambique, which may represent an undescribed species).

Key identification features: The complicated noseleaf with the vertical connecting process readily distinguishes the genus *Rhinolophus* from all other southern African bats. This is the largest *Rhinolophus* species in southern Africa and should not be confused with other members of this genus. The wide horseshoe and low, rounded connecting process separate it from all other species except the much smaller *R. fumigatus* (FA < 58 mm; in *R. hildebrandtii* FA > 60 mm). These two species also differ in the shape of the lancet, which has a rounded tip in *R. hildebrandtii*, but is triangular, rising to a sharp point, in *R. fumigatus*. The forest-dwelling *R. eloquens* is similar in appearance but smaller (FA < 60 mm).

Echolocation call: *Rhinolophus hildebrandtii* has an HD-CF echolocation call. Peak frequency is variable among southern African populations. Calls recorded in South Africa have intermediate peak frequencies of 33±0.8 kHz (duration: 44.8±5.7 ms, n = 10) at Sudwala caves and 44 kHz (duration: 41 ms, n = 2) at Pafuri (Schoeman and Jacobs 2008, unpublished data; also see Aldridge and Rautenbach 1987). Similar differences in peak frequencies among different populations were recorded in Mozambique (35 kHz, Monadjem *et al.* 2007, versus 40 kHz, M. C. Schoeman and S. Stoffberg, unpublished data). At Lutope Gorge, just south of Sengwa in Zimbabwe, 17 individuals with peak frequencies of ~37 kHz and one with 46 kHz were captured and recorded (Taylor *et al.* 2004). This may be evidence for more than one species of *R. hildebrandtii* in southern Africa (see 'Systematic notes' below).

External and cranial measurements (mm) and mass (g) for *Rhinolophus hildebrandtii,* males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	23.4	20.0	33.0	4.35	7	**Mass[1]**	27.2	22.0	38.5	5.32	11
FA[1]	63.4	60.9	65.6	1.21	17	**FA[1]**	63.5	58.4	67.0	2.64	18
Total[1]	111.0	101.0	117.0	5.87	7	**Total[1]**	113.0	102.0	126.0	7.35	10
Tail[1]	39.3	31.0	47.0	5.97	8	**Tail[1]**	37.9	30.0	45.0	3.84	10
Tibia[1]	28.1	27.6	28.5	-	2	**Tibia**	25.7	-	-	-	1
Ear[1]	30.2	26.0	33.0	2.45	8	**Ear[1]**	32.2	28.0	35.0	2.56	11
CI[1]	24.8	23.8	25.9	0.70	10	**CI[1]**	24.4	22.5	25.7	0.91	12

[1] Specimens measured by the authors

fig. 121a

fig. 121b

fig. 121c

fig. 121d

Figure 121. Skull and teeth of *Rhinolophus hildebrandtii:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 7886).

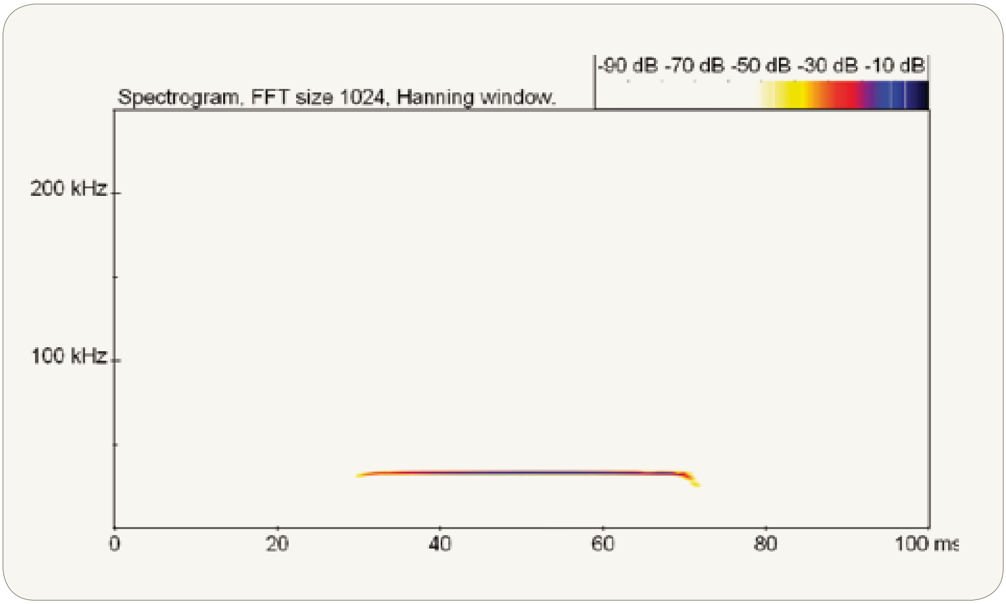


Figure 122. Echolocation call of *Rhinolophus hildebrandtii* (33 kHz type).

Distribution, habitat and roosting: *Rhinolophus hildebrandtii* is widely distributed in the northeast of the region. It occurs from northern South Africa through Zimbabwe, extreme eastern Botswana, central and northern Mozambique, Zambia, Malawi and the southeastern DRC. The type material is from Kenya (ZMB 5378, BM 1879.1.21.1, Syntypes).

This species is well represented in museums, with over 530 specimens examined for this book.

It roosts in caves, mines, disused buildings, and hollow trees (Pearl 1994), where it may form small to medium-sized colonies numbering over 100 individuals (Smithers 1971). It is associated with savanna woodland.

Extralimital: *Rhinolophus hildebrandtii* occurs widely in East Africa including Tanzania, Kenya, Uganda, Sudan, Ethiopia, Somalia, Rwanda, Burundi and DRC (Csorba *et al*. 2003).

Foraging ecology: *Rhinolophus hildebrandtii* has short and broad wings with intermediate wing loading (9.8 N.m^{-2}) and low aspect ratio (6.8) (Norberg and Rayner 1987, Aldridge and Rautenbach 1987; also see Schoeman and Jacobs 2008). It is a clutter-edge and clutter forager. Its diet comprises predominantly Lepidoptera and Coleoptera (Fenton *et al*. 1977, Fenton and Rautenbach 1986, Aldridge and Rautenbach 1987, Schoeman 2006).

Reproduction: In Zimbabwe, copulation occurs in July (cool-dry season) followed by a three-month gestation, with parturition in late October (early wet season), and a further three-month lactation period. Females give birth to a single naked young (Cotterill 1998).

SYSTEMATIC NOTES

1878. *Rhinolophus hildebrandtii* Peters, Monatsberichte der Königlichen Preussischen Akademie der Wissenschaften zu Berlin 195. Ndi, Taita district, Kenya.

Only the nominate subspecies is currently recognised (Meester *et al.* 1986). However, within this species, individuals in Zimbabwe differed in their echolocation calls with the CF component at 37 and 46 kHz, respectively (Taylor *et al.* 2005). These different call types (which were unrelated to sexual differences) may eventually prove to represent sympatric sibling species.

The diploid number in *R. hildebrandtii* is 2n = 58 and aFN = 60 (Rautenbach 1986).

Figure 123. Rhinolophus hildebrandtii: (a) and (b) portraits showing low connecting process, and (c) comparison of two individuals from Lutope Gorge, Zimbabwe representing narrower (left) and wider horseshoe widths which corresponded with CF frequencies of 38 and 46 kHz, respectively (a: © P. J. Taylor; b: © E. C. J. Seamark; c: © P. J. Taylor).

fig. 123a

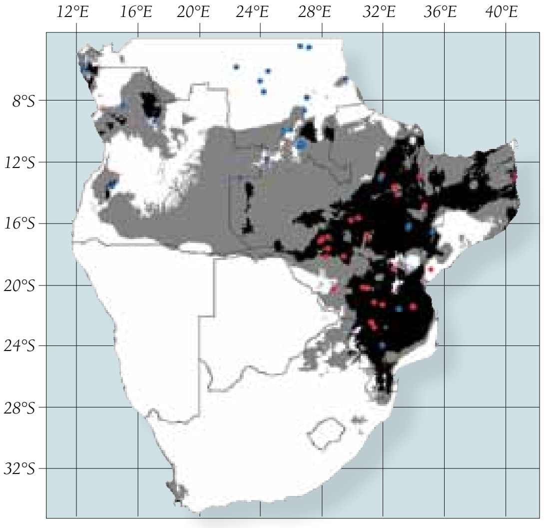
fig. 123b

fig. 123c

Rhinolophus landeri Martin 1838

Lander's horseshoe bat

Least Concern



Description: *Rhinolophus landeri* is a small bat with a mass of around 8 g. The pelage is buffy-brown with the underparts slightly lighter than the upper parts. A reddish-brown phase also exists and may be the dominant colour phase in parts of its range (Csorba *et al.* 2003). Adult males have characteristic axillary tufts of hair in the armpits. The wings are dark brown. The ears are medium-sized, rounded with a pointed tip. The lower lip has one mental groove, within poorly defined shallow grooves. The connecting process characteristically rises to a high point. The sexes are alike.

The skull is fairly robust with moderate zygomatic arches. The moderately inflated rostral swellings result in a rounded rostral profile. The frontal depression is shallow with poorly defined supra-orbital ridges. The sagittal crest is medium and the palatal bridge is of variable length, 28–37% of the upper toothrow (Csorba *et al.* 2003). The dental formula is 1123/2133 = 32. The first upper premolar is small and in the toothrow, separating the canine and second premolar.

Key identification features: The complicated noseleaf with the vertical connecting process distinguishes the genus *Rhinolophus* from all other southern African bats. *Rhinolophus landeri* is similar in size and appearance to several species (*R. simulator, R. blasii* and *R. darlingi)* but can be separated from these and all other southern African *Rhinolophus* by the high-rising, pointed connecting process. Confusion is most likely with *R. blasii*, but its connecting process is more sharply pointed than in *R. landeri*. Also, male *R. landeri* have obvious axillary tufts of hair in the armpit which are absent in *R. blasii*. Another useful character is the ratio of the metacarpal of the fourth finger to the first phalanx which is 4.87 (range 4.41–5.56) in *R. landeri* and 3.53 (range 3.09–3.81) in *R. blasii* (Happold *et al*. 1987).

Echolocation call: *Rhinolophus landeri* produces HD-CF echolocation calls with a high peak frequency (107.3±2 kHz, n = 2) and long duration (40±14.5 ms, n = 2) (Schoeman and Jacobs 2008; also see Aldridge and Rautenbach 1987).

Distribution, habitat and roosting: *Rhinolophus landeri* occurs in the northeast of the region from Pafuri, Kruger National Park, north through Zimbabwe, southeastern Zambia, southern Malawi, southern DRC and central and northern Mozambique. An isolated population occurs in western Angola. Although widespread, this species is not common anywhere in its southern African range. The model suggests that suitable conditions are extensive in southern Mozambique. The type specimen is from Bioko, Equatorial Guinea (BM 55.12.26.250, Holotype).

This species is not well represented in museums, with just over 60 specimens examined for this book.

External and cranial measurements (mm) and mass (g) for *Rhinolophus landeri,* males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	8.0	6.0	10.0	-	2	**Mass**[1]	8.2	7.0	9.5	0.81	7
FA[1]	44.3	42.0	47.8	2.02	7	**FA**[1]	43.7	42.0	46.3	1.72	8
Total[1]	77.0	-	-	-	1	**Total**[1]	76.2	70	80	3.37	6
Tail[1]	23.0	-	-	-	1	**Tail**[1]	22.0	21	25	1.40	6
Tibia[1]	20.6	-	-	-	1	**Tibia**	21.0	-	-	-	1
Ear[1]	17.0	-	-	-	1	**Ear**[1]	18.0	16	20	1.50	6
CI[1]	16.5	15.2	17.5	0.88	7	**CI**[1]	16.0	15.5	17.1	0.59	6

[1] Specimens measured by the authors

fig. 124a

fig. 124b

fig. 124c

fig. 124d

Figure 124. Skull and teeth of *Rhinolophus landeri:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8574).

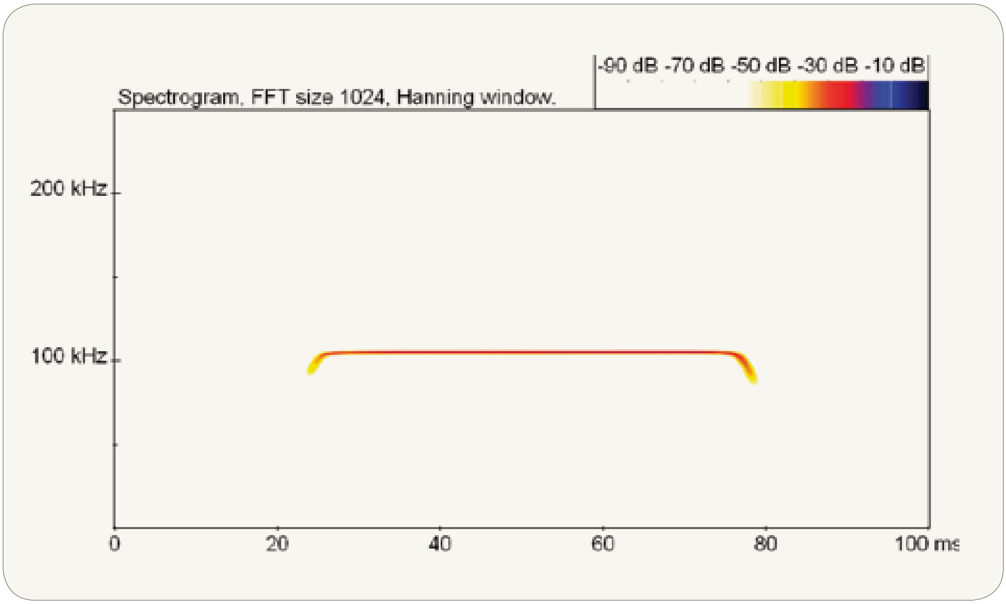


Figure 125. Echolocation call of *Rhinolophus landeri*.

It roosts in caves, mine adits and hollow trees (Smithers and Wilson 1979), where it may be encountered in small groups of up to a dozen individuals (Smithers 1993). In southern Africa, this species is associated with riparian woodland (Smithers and Wilson 1979), but is primarily a forest inhabitant in Central and West Africa (Csorba *et al.* 2003).

Extralimital: *Rhinolophus landeri* occurs widely in sub-Saharan Africa including Tanzania, Kenya, DRC, Ethiopia, Sudan, Cameroon, Gabon, Nigeria, Togo, Ghana, Côte d'Ivoire, Burkina Faso, Guinea, Sierra Leone, Senegal, Gambia and Mali (Brown and Dunlop 1997, Csorba *et al*. 2003).

Foraging ecology: *Rhinolophus landeri* has short and broad wings with low wing loading (6.7 N.m^{-2}) and low aspect ratio (6.1) (Norberg and Rayner 1987, Aldridge and Rautenbach 1987; also see Schoeman and Jacobs 2008). It is a clutter forager. Its diet comprises mainly Lepidoptera (Fenton *et al*. 1977, M. C. Schoeman, unpublished data).

Reproduction: A pregnant female with a single foetus was taken in October in Zimbabwe (Smithers 1983).

SYSTEMATIC NOTES

1838. *Rhinolophus landeri* Martin, Proceedings of the Zoological Society, London (1837): 101, Fernando Poo (= Bioko).

The nominate subspecies and *R. landeri lobatus* are known from southern Africa (Meester *et al*. 1986, Csorba *et al*. 2003).

Rhinolophus landeri lobatus Peters 1852

1852. *Rhinolophus landeri lobatus* Peters, Reise nach Mossambique, Säugethiere: 41. Sena, Tete district, Mozambique.

This species complex requires revision. It is unclear if *axillaris* Allen, Lang and Chapin 1917 differs from West African *landeri* and from *dobsoni* Thomas 1904 (BM 1847.5.7.49 Holotype from Kordofan, Sudan). The type locality of *axillaris* is in the northeastern Congo (Aba, AMNH 49175 Holotype), so affinities of southern Congo specimens are unclear. This equatorial population likely differs from the southern savanna population represented by *lobatus*.

Ellerman *et al*. (1953) treated *R. angolensis* Seabra 1898, isolated in western Angola, as a full species; Hayman and Hill (1971) tentatively included *angolensis* in the *landeri* complex, and it was treated as one of three subspecies alongside *lobatus* and nominate *landeri* (Csorba *et al.* 2003). Given that the original classification of *angolensis* in the *landeri* complex was tentative, and that Seabra's types were destroyed in the Lisbon fire of 1978, the status of this Angolan population awaits appraisal, and will likely entail a redescription of the taxon with designation of new type material. We highlight this uncertainty here, in provisionally retaining angolensis in the landeri-lobatus complex."

It would appear that populations representing *landeri* are primarily forest-dwelling, in contrast to *lobatus* (represented by four syntypes in ZMB, from Sena, Mozambique), which is associated with savanna woodland. Phylogeographic comparisons of these two groups would be interesting.

The diploid number in *R. landeri* is 2n = 58 and aFN = 60 (Rautenbach 1986).

fig. 126a

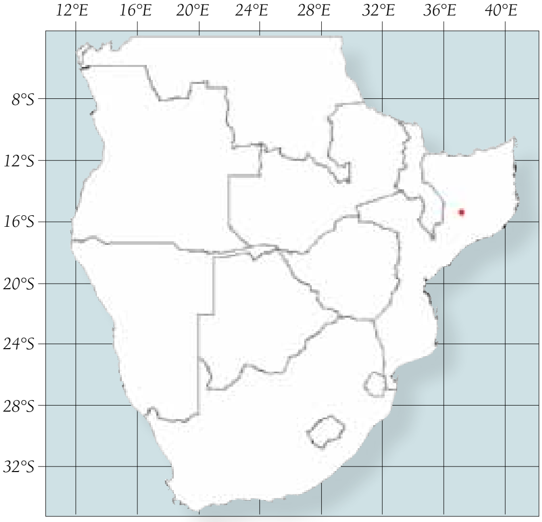
fig. 126b

Figure 126. *Rhinolophus landeri:* (a) portrait showing pointed connecting process, and (b) whole body of a male showing axillary tufts of orange hair in the armpit (a: © Merlin D. Tuttle, Bat Conservation International, www.batcon.org; b: DM 8575, © A. Monadjem).

Rhinolophus maendeleo Kock, Csorba & Howell 2000

Maendeleo horseshoe bat

Data Deficient



Description: *Rhinolophus maendeleo* is a medium-small bat with a mass of around 15 g. The pelage is dark brown on the upper parts and lighter on the underparts. The wings are dark brown. The ears are medium-sized, rounded with a pointed tip. In the two Mozambique specimens, the connecting process is rather high and rounded, not forming a continuous arch as described by Csorba *et al.* (2003). The lower lip has three distinct mental grooves. The sexes are alike.

The skull is slender with delicate zygomatic arches and a proportionately long rostrum. The well-developed anterior median narial swellings result in a concave rostral profile. There is a distinct depression in front of the occipital region. The frontal depression is moderately deep with strongly defined supra-orbital ridges. The sagittal crest is weak and the palatal bridge is of medium length, 37–39% of the upper toothrow. The dental formula is 1123/2133 = 32. The first upper premolar is small and in the toothrow, widely separating the canine and second premolar (Csorba *et al.* 2003).

External and cranial measurements (mm) and mass (g) for *Rhinolophus maendeleo*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	15.5	-	-	-	1
FA[1,2]	49.1	48.2	49.9	-	3
Total[2]	71.9	69	74	-	2
Tail[2]	24.4	23	25	-	2
Tibia[2]	19.2	18.9	19.4	-	2
Ear[2]	24.3	24	24	-	2
CI[1]	19.9	-	-	-	1

[1] Specimens measured by the authors
[2] Kock *et al.* (2000)

Key identification features: The complicated noseleaf with the vertical connecting process distinguishes the genus *Rhinolophus* from all other southern African bats. Confusion is most likely with the slightly larger *R. clivosus* (which also has a rounded connecting process) and the smaller *R. capensis*. It can be separated from *R. clivosus* by the presence and position of the minute first upper premolar, which is always present and in the toothrow in *R. maendeleo* manifesting in a gap between the canine and second premolar (this premolar lies outside the toothrow in *R. clivosus*). *R. simulator* is smaller (FA < 48 mm; FA > 48 mm in *R. maendeleo*). It can be distinguished from *R. capensis* based on its geographic distribution; *R. capensis* is restricted to the southwestern parts of South Africa, while *R. maendeleo* occurs from central Mozambique to Tanzania.

Echolocation call: The echolocation call of this species has not been recorded.

Distribution, habitat and roosting: In southern Africa, *Rhinolophus maendeleo* is known from two specimens collected at Mt Namuli in northern Mozambique and provisionally assigned morphologically to this species. Given the atypical montane habitat of these Mozambique specimens, further study may show them to be a new species. The type specimen is from Tanga, northeastern Tanzania (SMF 79643, Holotype).

This species is known from just four specimens, two collected in northeastern Tanzania and two from northern Mozambique. All four specimens have been collected from forests of the coastal belt of Tanzania and Mozambique, an area that is rich in floral diversity and harbours a number of endemic bats including *R. maendeleo.*

Extralimital: *Rhinolophus maendeleo* also occurs in coastal Tanzania.

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: No reproductive information is available.

SYSTEMATIC NOTES

2000. *Rhinolophus maendeleo*, Kock, Csorba and Howell. Senckenbergiana Biologica 80: 233–239. Amboni forest, 2.5 km west of Tanga, Tanzania.

Rhinolophus maendeleo belongs to the *adami* group (Csorba *et al.* 2003). The only other member of this group is *R. adami*, known from two sites just north of the Congo River in the Congo Republic; it may possibly occur in the extreme northwestern part of the southern African region.

The diploid number in *R. maendeleo* is not known.

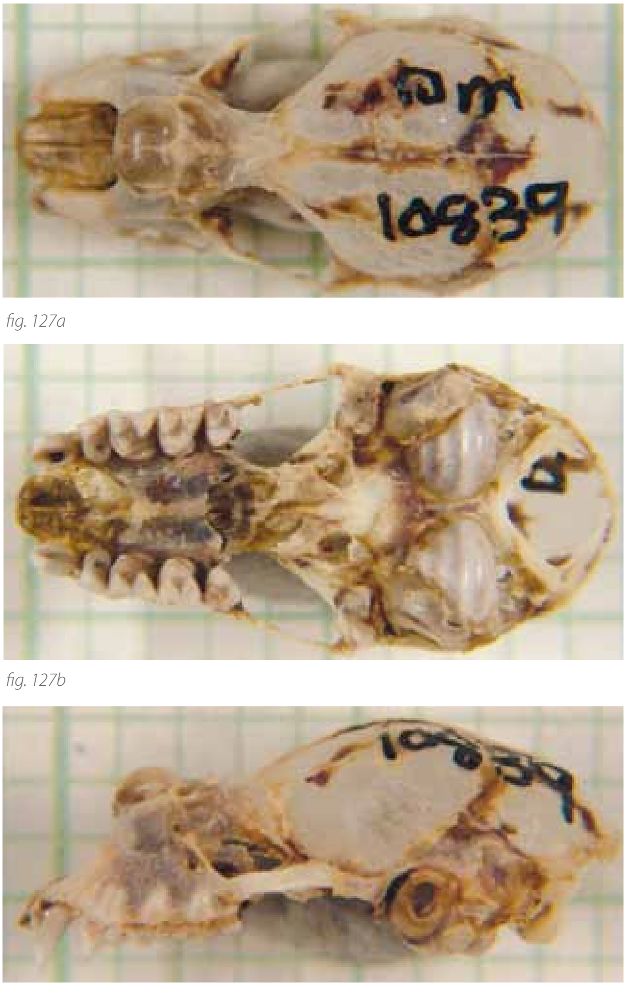


fig. 127a

fig. 127b

fig. 127c

Figure 127. Skull and teeth of *Rhinolophus maendeleo:* (a) dorsal view, (b) ventral view, and (c) lateral view (DM 10839).

fig. 128a

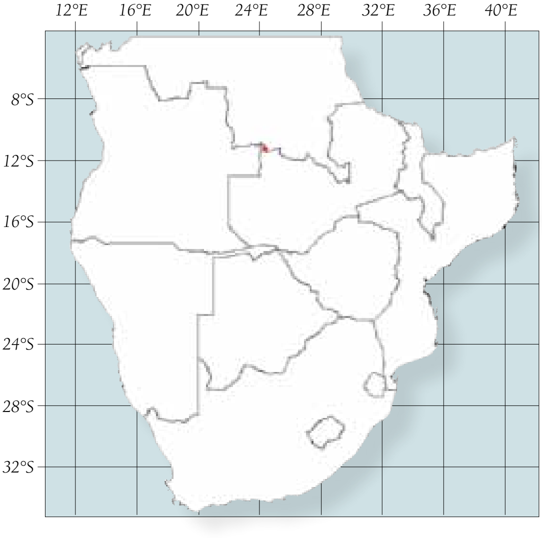
Figure 128. *Rhinolophus maendeleo* noseleaf, showing (a) frontal view of noseleaf, and (b) high rounded connecting process (DM 10833, © P. J. Taylor).

fig. 128b

Rhinolophus sakejiensis Cotterill 2002

Sakeji horseshoe bat

Data Deficient



Description: *Rhinolophus sakejiensis* is a medium-sized bat with a mass of around 20 g. The pelage is reddish-brown on the upper parts and lighter on the underparts. The wings are pale brown. The ears are small for the genus, rounded with a pointed tip. The connecting process is characteristically high and rising to a rounded point. The lancet is thin and long with parallel sides. The lower lip has one mental groove. No females have been collected yet, and this description is based on the holotype and two paratypes, which are the only known specimens of this species.

The skull is very robust with sturdy zygomatic arches. The poorly inflated rostral swellings result in a nearly horizontal rostral profile. The frontal depression is very shallow and the supra-orbital ridges are poorly defined. The sagittal crest and palatal bridge are relatively well developed, the latter is about 33% of the upper toothrow length. The dental formula is 1113/2123 = 28 in all three known specimens. The first upper premolar is absent in all known specimens, bringing the canine and second premolar in contact. The third lower premolar is also absent (Cotterill 2002a; Csorba *et al.* 2003).

External and cranial measurements (mm) and mass (g) for *Rhinolophus sakejiensis*, males only

	Mean	Min	Max	SD	N
Males					
Mass[1]	22.0	19.0	24.0	2.65	3
FA[1]	54.1	52.5	55.2	1.44	3
Total[1]	87.8	87	88	0.47	3
Tail[1]	30.2	29	31	1.11	3
Tibia	-	-	-	-	-
Ear[1]	21.0	19	21	1.29	3
CI	-	-	-	-	-
GSL[1]	25.2	24.6	25.6	-	3

[1] Cotterill (2002a)

Key identification features: The complicated noseleaf with the vertical connecting process distinguishes the genus *Rhinolophus* from all other southern African bats. *Rhinolophus sakejiensis* is a large member of the genus and is thus distinguished from the smaller species. It is most likely to be confused with *R. clivosus*, but can be distinguished by larger size (GSL > 24.6 mm; in *R. clivosus* GSL < 23.8 mm) and the pointed connecting process (much more rounded in *R. clivosus*). *Rhinolophus sakejiensis* is distinguished from *R. fumigatus* and the larger *R. hildebrandtii* by the narrower horseshoe (< 9 mm; in *R. fumigatus* and *R. hildebrandtii* > 9 mm) and connecting process (in *R. fumigatus* and *R. hildebrandtii* connecting process is low and broadly rounded).

Echolocation call: The echolocation call of this species has not been recorded.

Distribution, habitat and roosting: *Rhinolophus sakejiensis* is currently only known from the type locality Kavunda (11°17'S, 24°21'E) between the Sakeji and Zambezi rivers in northwestern Zambia. It may, however, be more widely distributed in northern Angola and the southern DRC (Cotterill 2002a).

This species is known from just three specimens collected during the day while they were roosting within the foliage of an evergreen tree (Cotterill 2002a). Communication with local hunters in the area suggested that this species may typically roost in hollow trees, but this requires verification (Cotterill 2002a). It is thought to be associated with gallery forest within mesic miombo woodland across the plateaus of south-central Africa.

Extralimital: *Rhinolophus sakejiensis* is currently only known from southern Africa, but may occur further north in the DRC (Cotterill 2002a).

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: No reproductive information is available.

SYSTEMATIC NOTES

2002. *Rhinolophus sakejiensis* Cotterill, Journal of Zoology, London 256: 165–179. Kavunda, Zambia.

The diploid number in *R. sakejiensis* is not known.

fig. 129a

fig. 129b

fig. 129c

fig. 129d

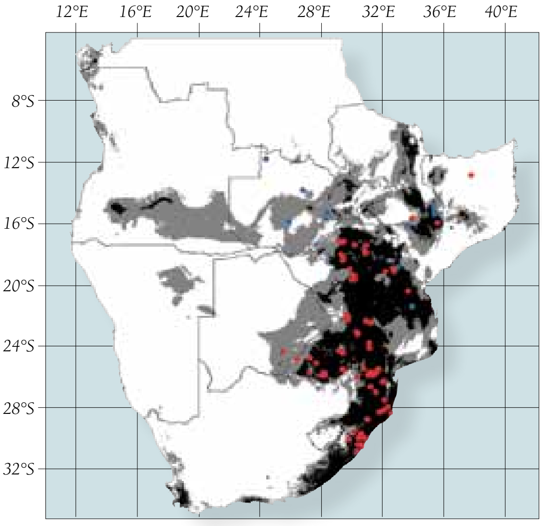
Figure 129. Skull and teeth of *Rhinolophus sakejiensis:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible. Scale bar = 10 mm (NMZB 29153, Holotype; © F. P. D. Cotterill).

Figure 130. *Rhinolophus sakejiensis,* holotype specimen showing the sharp, high and rounded connecting process (with rounded tip) and pointed lancet (© F. P. D. Cotterill).

Rhinolophus simulator K. Andersen 1904 ●

Bushveld horseshoe bat

Least Concern



Description: *Rhinolophus simulator* is a small bat with a mass of around 9 g. The pelage is light to reddish-brown on the upper parts and much paler fawn on the underparts. The wings are dark brown. The ears are medium-sized, rounded with a pointed tip. The connecting process is characteristically high and rounded. The lower lip has three mental grooves. The sexes are alike.

The skull is delicate with thin zygomatic arches. The well-developed rostral swellings result in a rounded rostral profile. The frontal depression is moderately deep with well-defined supra-orbital ridges. The sagittal crest is weak or absent and the palatal bridge is of medium length, 29–34% of the upper toothrow (Csorba *et al.* 2003). The dental formula is usually: 1123/2133 = 32, but the third lower premolar is minute or occasionally absent (Cotterill and Happold in press c). The first upper premolar is small and in the toothrow, separating the canine and second premolar.

Key identification features: The complicated noseleaf with the vertical connecting process distinguishes the genus *Rhinolophus* from all other southern African bats. Confusion is most likely with the similar-sized *R. darlingi* (which also has a rounded connecting process) with which it shares much of its southern African range. They can only be reliably separated by the presence and position of the minute first upper premolar, which is always present and in the toothrow in *R. simulator* manifesting in a gap between the canine and second premolar (this premolar lies outside the toothrow in *R. darlingi*). *Rhinolophus clivosus* is much larger (FA > 50 mm; in *R. simulator* FA < 48 mm). The diminutive *R. swinnyi* overlaps in FA length with *R. simulator* and skull length appears to be the only reliable way to distinguish them morphologically (in *R. simulator* CI > 16.2 mm; in *R. swinnyi* CI < 16.0 mm); however, they echolocate at completely different frequencies (see below).

Echolocation call: *Rhinolophus simulator* produces HD-CF echolocation calls with a high peak frequency (80.1±1.2 kHz, n = 10) and long duration (31.3±7.5 ms, n = 10) (Schoeman and Jacobs 2008; also see Aldridge and Rautenbach 1987, Taylor 1999a, Jacobs 2000, Monadjem *et al.* 2007). Besides the second harmonic, the fundamental and third harmonics may be present on the spectrogram.

Distribution, habitat and roosting: *Rhinolophus simulator* is widespread in the eastern parts of the region. It occurs from KwaZulu-Natal north through Swaziland, northern South Africa, Zimbabwe, southern Zambia, central Mozambique and southern Malawi. It may have been overlooked in southern Mozambique and the extreme east of Botswana. The type specimen is from the Upper Mazoe Valley, north of Harare, Zimbabwe (BM 2.2.7.10, Holotype).

External and cranial measurements (mm) and mass (g) for *Rhinolophus simulator,* males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	7.3	5.8	9.0	0.94	17	**Mass**[1]	9.98	6.0	11.0	1.20	18
FA[1]	44.1	42.0	46.5	1.27	33	**FA**[1]	45.1	42.5	48.0	1.25	37
Total[1]	72.4	65	86	6.49	24	**Total**[1]	74.7	61	88	6.23	31
Tail[1]	24.0	18	36	3.80	25	**Tail**[1]	25.0	19	35	4.30	30
Tibia[1]	18.9	-	-	-	1	**Tibia**	-	-	-	-	-
Ear[1]	19.4	16	23	1.76	25	**Ear**[1]	20.4	17	24	1.80	30
CI[1]	16.8	16.2	17.3	0.28	19	**CI**[1]	16.8	16.2	17.8	0.44	25

[1] Specimens measured by the authors

fig. 131a

fig. 131b

fig. 131c

fig. 131d

Figure 131. Skull and teeth of *Rhinolophus simulator:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (a–c: DM 7117; d: DM 8555).

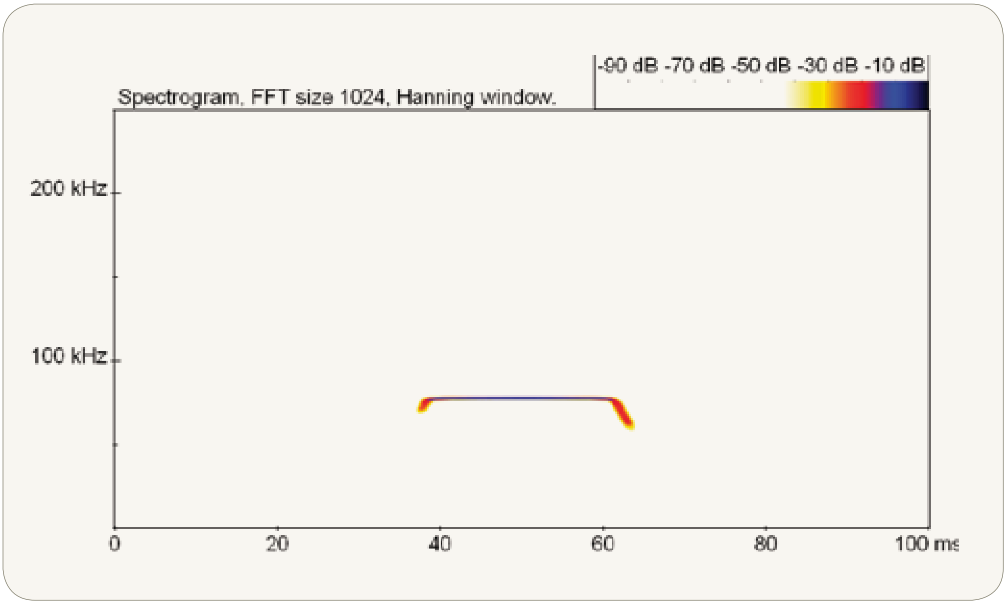


Figure 132. Echolocation call of *Rhinolophus simulator*.

This species is well represented in museums, with 300 specimens examined for this book.

It roosts in caves and mine adits, where it forms colonies of up to 300 individuals (Rautenbach 1982). However, it also frequently roosts either singly or in small groups within small caverns in rocky outcrops and culverts under the road (A. Monadjem, personal observation). In a colony of some 150 individuals in Doornhoek Tunnel (near Pietermaritzburg, South Africa), females migrated in spring to maternity roosts elsewhere and then returned in late summer, while males remained throughout the year (Wingate 1983). Both males and females appear to change their roosting positions in response to changes in the temperature and relative humidity. They selected temperatures ranging from 19–23°C, while relative humidity ranged from 83–100% (Skinner and Chimimba 2005). This species is associated with savanna woodland, where it is most commonly netted in riparian forest and along wooded drainage lines.

Extralimital: The nominate subspecies has been recorded from Kenya, Tanzania, Sudan and Ethiopia, while *R. simulator alticolus* is known from Cameroon, Nigeria and Guinea (Csorba *et al*. 2003).

Foraging ecology: *Rhinolophus simulator* has short and broad wings with low wing loading (5.4 N.m-2) and low aspect ratio (6.7) (Schoeman and Jacobs 2008, Cotterill and Happold in press c). It is a clutter forager. Its diet comprises predominantly Lepidoptera and lesser proportions of Coleoptera, Hemiptera, Isoptera and Orthoptera (Whitaker and Black 1976, Findley and Black 1983, Schoeman 2006).

Reproduction: In Zimbabwe, ovulation occurs in July and August. A period of retarded embryonic development (at the blastocyst stage) follows implantation and continues until early September. As a result, the gestation period ranges between 90–120 days. Parturition, which is highly synchronised, occurs from around mid-November (Cotterill 1998). The female gives birth to a single, naked young. Lactation does not exceed seven weeks.

SYSTEMATIC NOTES

1904. *Rhinolophus simulator* K. Andersen, Annals and Magazine of Natural History (7)14: 384. Mazoe, Mashonaland, Rhodesia (= Zimbabwe).

Only the nominate subspecies is recognised in the region.

Rhinolophus bembanicus Senna 1914 (type locality: Lake Bangweulu, northeastern Zambia) is a probable synonym, but the holotype in the Zoological Museum of the University of Naples, Italy, was destroyed during a bombing raid in 1944 (Ansell 1978). The subspecies *R. simulator alticolus* Sanborn 1936, which occurs in West Africa, is separated from the nominate subspecies by at least 2,000 km and may eventually be shown to be a separate species: *alticolus* differs from the nominate subspecies by having a triangular lancet, broader horseshoe and larger sella (Cotterill and Happold in press c).

The diploid number in *R. simulator* is 2n = 58 and aFN = 60 (Rautenbach 1986).

fig. 133a

fig. 133b

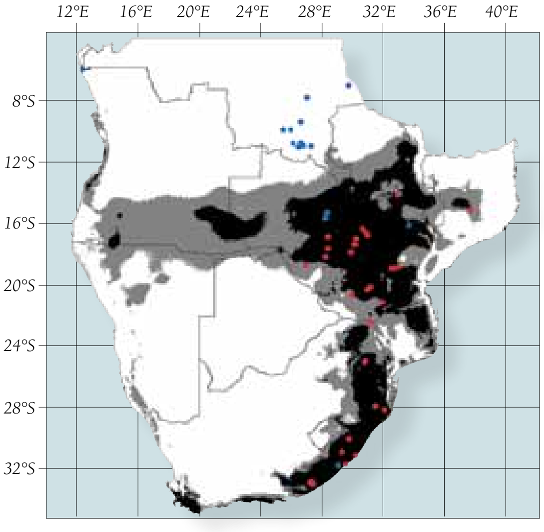
fig. 133c

Figure 133. *Rhinolophus simulator:* (a) portrait showing high and rounded connecting process, (b) whole body, and (c) juveniles in maternity roost (a: © E. C. J. Seamark; b: © L. Lumsden; c: © F. P. D. Cotterill).

Rhinolophus swinnyi Gough 1908

Swinny's horseshoe bat

Near Threatened



Description: *Rhinolophus swinnyi* is a small bat with a mass of around 7 g. The pelage is grey or pale brown on the upper parts and slightly paler on the underparts. The long dorsal hairs have white bases. The wings are pale. The ears are rounded with a sharply pointed tip. The connecting process is characteristically high and rounded. The lower lip has three mental grooves, but the lateral ones are often shallow or hard to distinguish. The sexes are alike.

The skull is delicate with thin zygomatic arches. The well-developed rostral swellings result in a rounded rostral profile. The frontal depression is shallow with poorly defined supra-orbital ridges. The sagittal crest is weak or absent and the palatal bridge is of medium length, 30–34% of the upper toothrow. The first upper premolar is small and in the toothrow, separating the canine and second premolar (Csorba *et al.* 2003). The dental formula is 1123/2133 = 32 (Cotterill in press b).

Key identification features: The complicated noseleaf with the vertical connecting process distinguishes the genus *Rhinolophus* from all other southern African bats. *Rhinolophus swinnyi* can easily be confused with the larger *R. simulator*. These two species overlap in external measurements (in *R. simulator* FA > 42 mm; in *R. swinnyi* FA < 44 mm) and the only reliable way to distinguish them is by their skulls (in *R. simulator* CI > 16.2 mm; in *R. swinnyi* CI < 16.0 mm) and echolocation call (see below). *Rhinolophus denti* is similar in size and morphology, but is pale cream (grey or pale brown in *R. swinnyi*) and their distributions do not overlap. *Rhinolophus darlingi* is larger (FA > 44 mm, CI > 17.0 mm) and has the first upper premolar outside of the toothrow (in the toothrow in *R. swinnyi*).

Echolocation call: *Rhinolophus swinnyi* produces HD-CF echolocation calls with a high peak frequency (106.6±0.4 kHz, n = 10) and long duration (22.2±3.3 ms, n = 10) (Schoeman and Jacobs 2008; also see Aldridge and Rautenbach 1987). Bats identified as *R. denti* by Fenton and Bell (1981) were *R. swinnyi*, as vouched for by ROM specimens.

Distribution, habitat and roosting: *Rhinolophus swinnyi* is widely but sparsely distributed in eastern parts of the region. It occurs from the Eastern Cape and KwaZulu-Natal north through northeast South Africa, Zimbabwe, central and southeast Zambia, southern DRC and central Mozambique. It may have been overlooked in Swaziland and southern Mozambique. The type specimen is from the Pirie Forest, Eastern Cape, South Africa (TM 1021, Holotype).

External and cranial measurements (mm) and mass (g) for *Rhinolophus swinnyi*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	6.6	5.0	8.3	1.00	12	**Mass**[1]	7.2	6.0	8.0	1.08	3
FA[1]	41.7	37.0	44.0	1.66	23	**FA**[1]	42.5	40.7	44.0	1.02	14
Total[1]	68.0	59	76	5.61	20	**Total**[1]	65.8	53	75	6.72	9
Tail[1]	22.0	15	29	4.10	20	**Tail**[1]	21.0	17	26	3.70	9
Tibia[1]	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	17.4	13	20	1.62	23	**Ear**[1]	16.7	15	19	1.25	14
CI[1]	15.7	15.1	16.0	0.32	10	**CI**[1]	15.6	15.1	16.0	0.36	6

[1] Specimens measured by the authors

fig. 134a

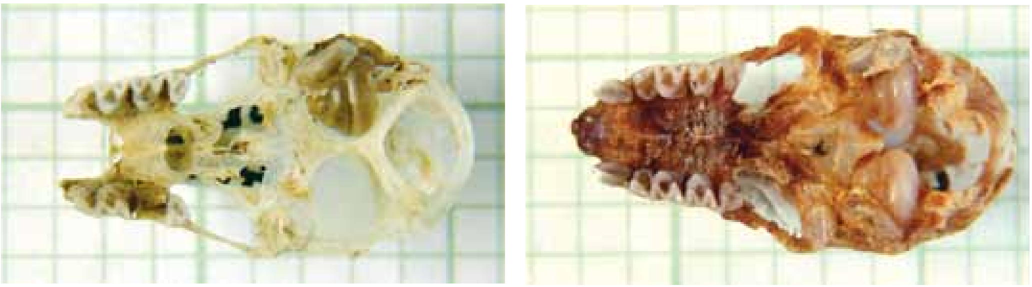


fig. 134b

fig. 134c

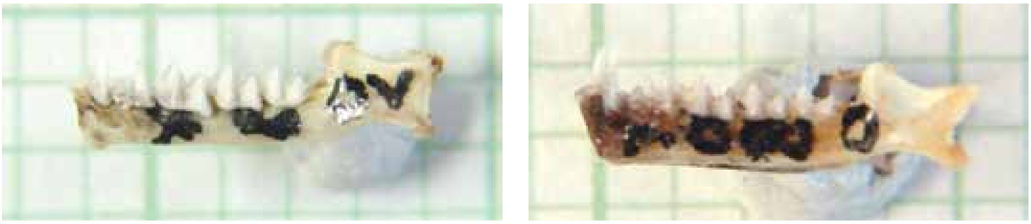


fig. 134d

Figure 134. Skull and teeth of *Rhinolophus swinnyi:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (left: DM 7084, canines, right bulla and premaxilla missing; right: DM 7080).

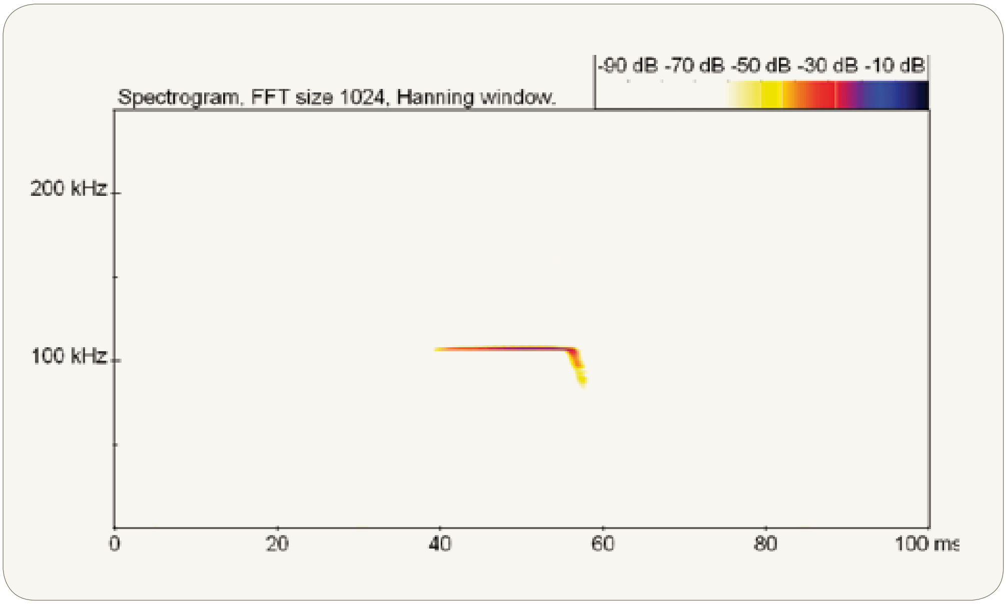


Figure 135. Echolocation call of *Rhinolophus swinnyi*.

Given its comparative rarity in the experience of the authors, this species is relatively well represented in museums, with over 80 specimens examined for this book.

It roosts singly or in small groups of up to five individuals in caves and old mines (Smithers and Wilson 1979, Cotterill 1996a). In the south of its range, it appears to be associated with temperate Afromontane forest (Bronner 1990), while to the north it occurs in savanna woodland (Skinner and Chimimba 2005). Suitable roosting sites appear to have more impact than vegetation type on the distribution of this species.

Extralimital: *Rhinolophus swinnyi* is a near-endemic to southern Africa, with records from the DRC and Tanzania (Csorba *et al*. 2003, Cotterill in press b).

Foraging ecology: *Rhinolophus swinnyi* has short and broad wings with low wing loading (6.3 $N.m^{-2}$) and low aspect ratio (6.6) (Norberg and Rayner 1987, Aldridge and Rautenbach 1987, Schoeman and Jacobs 2008). It is a clutter forager. Its diet comprises mainly Lepidoptera (M. C. Schoeman, unpublished data; also see Whitaker and Black 1976, Findley and Black 1983).

Reproduction: *Rhinolophus swinnyi* females give birth to a single young. In Malawi, three of four females were heavily pregnant and one was lactating in early November, the beginning of the hot, wet season (Cotterill in press b). In central Zimbabwe, a female had a full-term foetus in mid-November.

SYSTEMATIC NOTES

1908. *Rhinolophus swinnyi* Gough, Annals of the Transvaal Museum 1: 71. Nqgeleni District, West Pondoland (= Eastern Cape), South Africa.

Only the nominate subspecies is recognised (Csorba *et al.* 2003), and *piriensis* Hewitt 1913 and *rhodesiae* Roberts 1946 appear to be synonyms of *swinnyi*. Many historical records (e.g. Smithers and Wilson 1979) for Zimbabwe were previously misidentified as *R. denti*.

The diploid number in *R. swinnyi* is 2n = 58 and aFN = 62 (Rautenbach 1986).

Figure 136. Rhinolophus swinnyi, showing the complex morphology of the horseshoe (DM 7084, © P. J. Taylor).

SUBORDER PTEROPODIFORMES

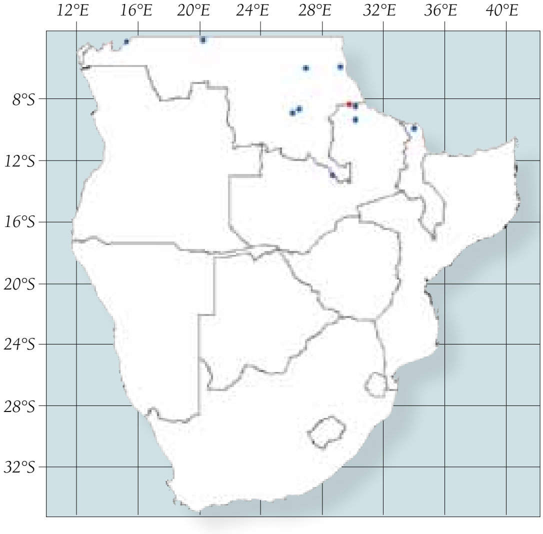
FAMILY MEGADERMATIDAE
FALSE VAMPIRE BATS

This family is represented in Africa by two species in two genera, of which one species, *Lavia frons*, occurs marginally in the extreme northern parts of the region. The second species, *Cardioderma cor*, is restricted to East Africa. The Megadermatidae have very large, rounded ears and a large noseleaf that covers the whole of the muzzle. Like the Nycteridae (which they superficially resemble, but to which they are not closely related), they are 'whispering' bats, emitting soft, low-intensity multi-harmonic low duty-cycle frequency-modulated (LD-FM) echolocation calls. Presumably, again like the nycterids, their large ears assist with detecting and locating prey, with echolocation calls 'switched off' during most of this process, thereby rendering them undetectable to prey (Hill and Smith 1984, Neuweiler 1990).

Lavia frons (E. Geoffroy Saint-Hilaire 1810)

Yellow-winged bat

Least Concern



Description: *Lavia frons* is a medium-sized bat with a mass of around 25 g. The pelage is blue-grey above and below. Individual hairs are unicoloured and long, standing away from the body giving it a woolly appearance. The wing and tail membranes are bright mustard-yellow, contrasting strongly with the grey body. The ears are very long (42 mm) and rounded, and the tragus is long (27 mm), pointed and bilobed. An elongated noseleaf runs along the top of the muzzle from its tip to the base of the ears. The eyes are the largest of any insectivorous bat in Africa. The foot is unusual, with the first toe having two joints, the other toes three. Two conspicuous veins, flowing from the foot, exhibit a unique architecture across the interfemoral membrane as they form an inverted V-shape from where they insert at the root of the tail (Rosevear 1965). The sexes are alike, but males are smaller than females.

External and cranial measurements (mm) and mass (g) for *Lavia frons*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	?	28	36	-	?
FA[2,3]	62.2	53.1	64.3	-	97
Total[2,3]	112.0	60	80	-	97
Tibia[3]	-	29	37	-	97
Ear[2,3]	41.0	33	47	-	97
GSL[3]	-	21.3	26.1	-	97

[1] Kingdon (1974)
[2] Happold *et al.* (1987)
[3] Vonhof and Kalcounis (1999)

As in all members of the Megadermatidae, the premaxillae are vestigial, with palatal and nasal branches absent, resulting in the absence of any upper incisors. The anterior margin of the palate is broadly emarginated. A wide frontal shield is present, similar to that found in *Nycteris*, formed from the supraorbital ridges and postorbital processes, which join with the relatively well-developed sagittal crest. The dental formula is 0113/2123 = 26. The upper canine has a well-developed cingulum and two secondary cusps. The lower incisors are trifid. The lower premolars are both well developed, with the posterior one larger than the anterior (Rosevear 1965).

Key identification features: This striking bat is not likely to be confused with any other African bat. The large size, bright yellow wings, contrasting grey body, large ears and characteristic noseleaf readily distinguish this species from all others in the region.

Echolocation call: *Lavia frons* produces low intensity, multi-harmonic LD-FM echolocation calls with an intermediate main peak frequency (37.5±1 kHz, n = 13 pulses from 1 individual, with additional peaks at around 18, 53 and 72 kHz), broad bandwidth (24±0.3 kHz, n = 13 pulses from 1 individual), and short duration (3.5±0.7 ms, n = 13 pulses from 1 individual) (Taylor *et al.* 2005).

Distribution, habitat and roosting: *Lavia frons* occurs marginally within southern Africa, having been recorded in southern DRC, the extreme northern parts of Zambia and Malawi. It may have been overlooked in parts of northern Angola. The type specimen is from Senegal (MNHN 928).

The southern African population of this species is very poorly represented in museums, with just five records examined for this book.

In East Africa, these bats roost in shrubs and trees within woodland savanna, often in exposed situations (A. Monadjem, personal observation), such as the relatively open foliage of *Acacia* trees, where their camouflage resembles large pods or birds' nests. This species avoids rainforest (Rosevear 1965).

Extralimital: *Lavia frons* occurs widely in tropical savannas across equatorial Africa including DRC, Tanzania, Kenya, Uganda, Sudan, Cameroon, Nigeria, Niger, Burkina Faso, Benin, Togo, Ghana, Sierra Leone, Guinea, Gambia and Senegal (Happold 1987, Kingdon 1974).

Foraging ecology: *Lavia frons* has rounded wings with high wing loading (12.0 N.m^{-2}) and low aspect ratio (5.4) (Norberg and Rayner 1987). It is a clutter-edge and clutter forager. It is distinctive in its diurnal activity. During late afternoons and early mornings (and presumably during the night), the bats make short foraging flights, returning to their feeding roost to eat their prey (Vaughan and Vaughan 1986). They feed on hard- and soft-bodied insects, usually < 20 mm in size, and

fig. 137a

fig. 137b

fig. 137c

fig. 137d

Figure 137. Skull and teeth of *Lavia frons*: (a) dorsal view, (c) ventral view, (c) lateral view, and (d) lateral view of mandible (NAKA 9520, Makerere University, Kampala). Note upper canine with large cingulum and two cusps, extreme reduction of premaxillae and loss of upper incisors.

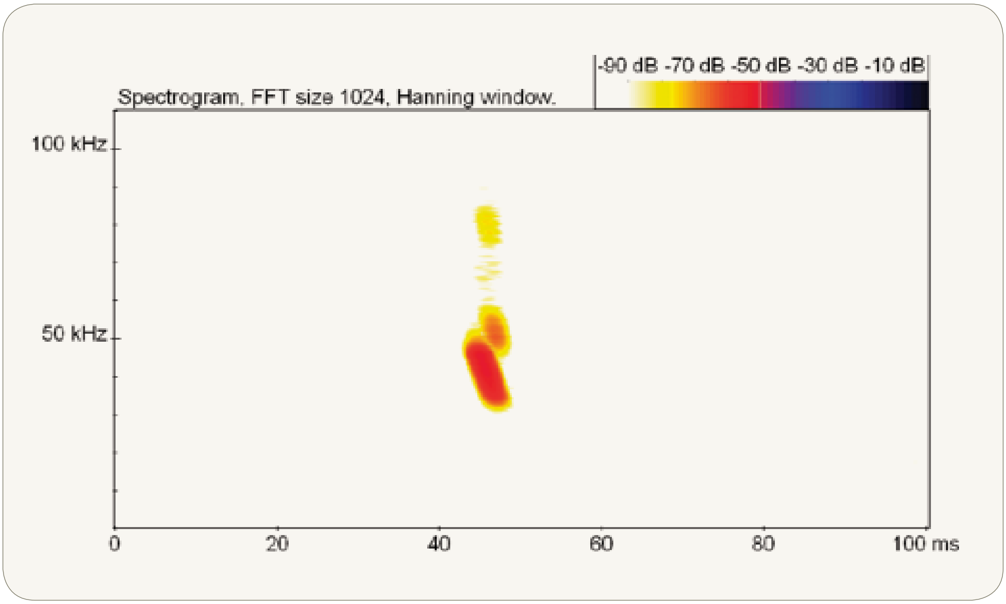


Figure 138. Echolocation call of *Lavia frons*.

their diet includes Isoptera, Coleoptera, Orthoptera, Lepidoptera and Diptera (Vonhof and Kalcounis 1999).

Reproduction: They are behaviourally monogamous and pair bonds are established and maintained during the breeding season, during which pairs defend territories. Young remain with the mother until fully grown. Births occur seasonally in Zambia (at the end of the dry season, in October) and in Kenya (at the beginning of the 'long rains' in April).

SYSTEMATIC NOTES

1810. *Megaderma frons* E. Geoffroy Saint-Hilaire, Ann. Mus. Hist. Nat. Paris 15: 192. Senegal.

The diploid number in *L. frons* is not known.

fig. 139a

Figure 139. *Lavia frons:* (a) portrait showing grey body and characteristic noseleaf, and (b) whole body showing grey body with contrasting yellow wings (a: © Kate Davidson; b: © Merlin D. Tuttle, Bat Conservation International, www.batcon.org).

fig. 139b

SUBORDER VESPERTILIONIFORMES

FAMILY EMBALLONURIDAE
SHEATH-TAILED BATS

Within Africa, this family comprises seven species in three genera, of which four species in three genera occur in southern Africa. Emballonurids are immediately recognisable by the particular configuration of the tail, which is only partly enclosed by the tail membrane proximally, but independent of the membrane distally (Figure 140a). Hence, the tail appears to protrude out from above the tail membrane. All members of this family also have large eyes and a plain face without noseleafs (Figure 140b).

Members of the genus *Taphozous* can be distinguished by the presence of a radio-metacarpal pouch (Figure 141), absent in *Coleura* and *Saccolaimus*. *Coleura* species are significantly smaller than *Taphozous*, while *Saccolaimus* species are much larger. Gular sacs are present in some species, but not others. In some species, such gular sacs are well developed in both sexes, while in other species they are only present in males. The development of gular sacs does not appear to be have taxonomical value. The wings of Emballonuridae are typically long and pointed – an adaptation for swift flight (Norberg and Rayner 1987). Echolocation calls emitted by this family are low duty-cycle, constant frequency (LD-CF) and quasi-constant frequency (LD-QCF) with multiharmonics (Hill and Smith 1984, Neuweiler 1990).

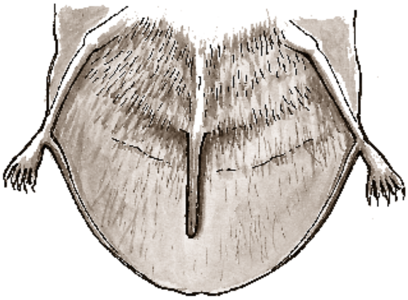


fig. 140a

fig. 140b

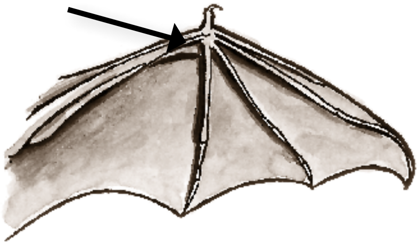


fig. 141

Figure 140. Typical Emballonuridae characteristics: (a) tail that is only partly enclosed by the tail membrane (dorsal view), and (b) face with large eyes and without noseleafs.

Figure 141. Radio-metacarpal pouch in a typical *Taphozous* species.

TABLE 12. IDENTIFICATION MATRIX FOR GENERA WITHIN THE FAMILY EMBALLONURIDAE

GENUS	FA (MM)	OTHER
Coleura	46–49	radio-metacarpal pouches absent; gular throat pouch absent
Taphozous	> 58	radio-metacarpal pouches between base of 5th finger and forearm
Saccolaimus	> 84	radio-metacarpal pouches absent; gular throat pouch present; uniformly jet black

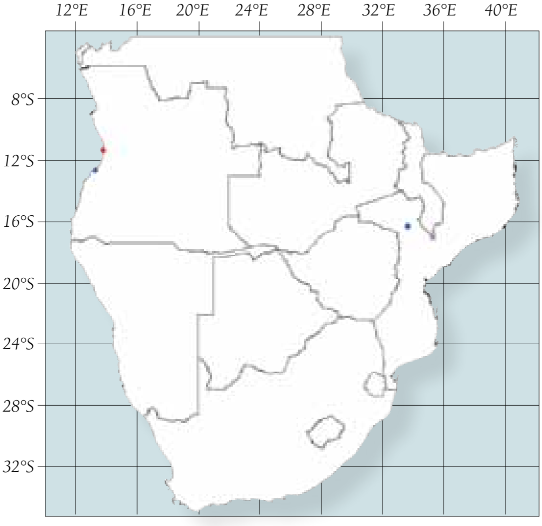
TABLE 13. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE GENUS *TAPHOZOUS* (EMBALLONURIDAE)

SPECIES	FA (MM)	DISTINGUISHING COLOUR AND MARKS	PF (KHZ)	ROOST	RANGE IN SOUTHERN AFRICA
T. mauritianus	58–66	white below, male with well-developed gular throat pouch, both sexes have radio-metacarpal pouches	~25	rock faces and tree trunks	widely distributed throughout eastern and northern parts
T. perforatus	62–63	not white below, gular throat pouch absent, both sexes have radio-metacarpal pouches	NA	rock crevices, caves, buildings	patchily distributed in northern and northeastern parts

Coleura afra (Peters 1852)

African sheath-tailed bat

Least Concern



Description: *Coleura afra* is a small bat with a mass of around 11 g. The pelage is deep brown on the upper parts and paler on the underparts. The fur is bicoloured, with hairs paler at the base than at the tip (Dunlop 1997). The wings are translucent and light brown. The ears are long and narrow with a characteristically shaped tragus. The muzzle is narrow and naked with nostrils projecting beyond the lower jaw. The eyes are strikingly large for a microbat. A gular sac and radio-metacarpal pouches are absent. Females are slightly larger than males (McWilliam 1987a).

The skull is delicate with relatively weak zygomatic arches. The braincase is rounded and elevated above the level of the rostrum. A shallow frontal depression is present, flanked by inflations of bones or each side of the rostrum. The sagittal crest is well developed and the lambdoid crest is weak or absent. The dental formula is 1123/3123 = 32 (Rosevear 1965).

Key identification features: The large eyes, plain muzzle (without a noseleaf) and characteristic arrangement of the tail identify bats of this family. *Coleura afra* is distinguished from all other emballonurids by the absence of a gular sac, lack of radiocarpal pouches, smaller size (FA < 55 mm) and three pairs of lower incisors.

Echolocation call: This species produces LD-QCF calls with an intermediate peak frequency (32.9±1.9 kHz, n = 3), short bandwidth (2.4±1.0 kHz, n = 3), and long duration (7.7±1.8 ms, n = 3) (Taylor *et al.* 2005). Besides the fundamental, the second harmonic is often present on the spectrogram.

Distribution, habitat and roosting: *Coleura afra* is known from just three localities in southern Africa, Tete in central Mozambique and two sites on the west coast of Angola. This species has almost certainly been overlooked in coastal Mozambique and Angola. The type series (represented by at least six Syntypes in ZMB) is from Tete, Mozambique.

The southern Africa population of this species is very poorly represented in museums, with just three literature records used for this book. The Tete specimens were collected more than 150 years ago in a dark cellar (Smithers and Lobão Tello 1976).

In East Africa, *Coleura afra* typically roosts in caves, where it selects partially lit areas near the entrance (Kingdon 1974), but has also taken to roosting in anthropogenic sites such as cellars and huts (J. Anderson in Rosevear 1965). Colony size may number in the hundreds (Rosevear 1965)

External and cranial measurements (mm) for *Coleura afra*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass	-	-	-	-	-	**Mass**	-	-	-	-	-
FA[1]	46.0				?	**FA**[1]	49.1				?
Total[2]	61.9	-	-	-	6	**Total**[2]	63.9	-	-	-	8
Tail[1]	14.5	-	-	-	6	**Tail**[1]	16.1	-	-	-	8
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	13.2	-	-	-	6	**Ear**[1]	13.1	-	-	-	8
CI	-	-	-	-	-	**CI**	-	-	-	-	-
GSL[3]	17.7	-	-	-	13	**GSL**[3]	17.9	-	-	-	9

[1] McWilliam (1987a)

[2] Harrison (1964a)

[3] Dunlop (1997)

fig. 142a

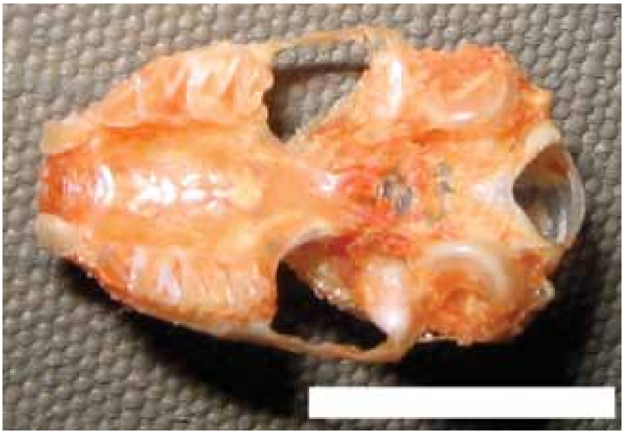


fig. 142b

fig. 142c

fig. 142d

Figure 142. Skull and teeth of *Coleura afra:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible. Scale bar = 10 mm (IICA 5233, © A. Monadjem)).

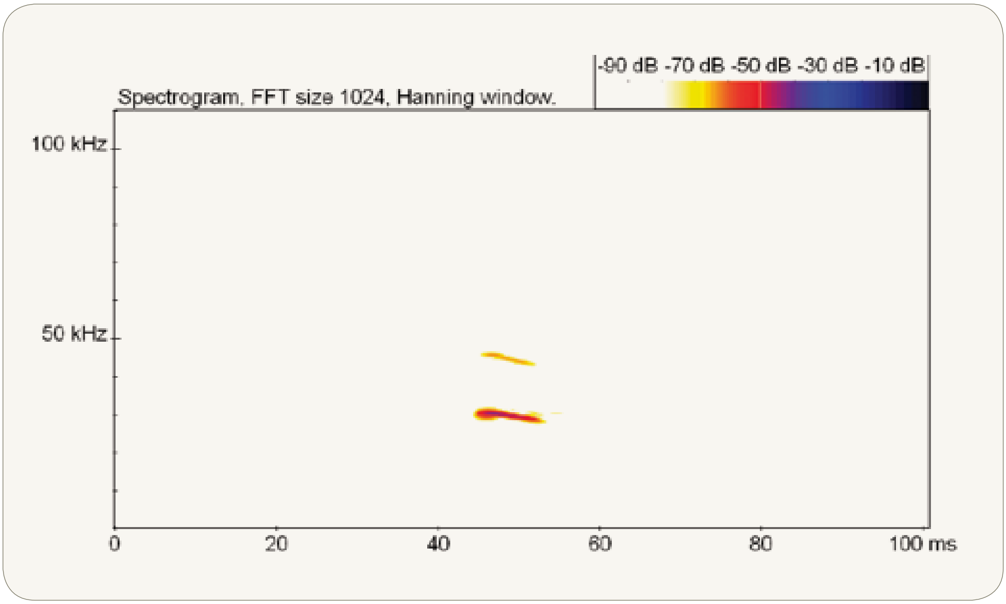


Figure 143. Echolocation call of *Coleura afra*.

or even thousands (Kingdon 1974). This species is closely tied to appropriate roost sites adjacent to the coast or to lakes (Dunlop 1997).

Extralimital: *Coleura afra* is predominantly an East African species with a patchy distribution in West Africa. It has been recorded from Kenya, Uganda, Tanzania, Sudan, Ethiopia, Somalia, Central African Republic, DRC, Nigeria, Togo, Ghana, Guinea, Guinea-Bissau (Meester *et al.* 1986, Happold 1987), and also in Madagascar. The closely related *C. seychellensis* is endemic to the Seychelles (Dunlop 1997).

Foraging ecology: There is no information available on the diet or foraging behaviour of this species in southern Africa.

Reproduction: No reproductive information is available for southern Africa. In coastal Kenya, however, parturition coincides with the two rainy seasons; some females give birth twice in a year, after a gestation period of about 114 days (McWilliam 1987a).

SYSTEMATIC NOTES

1852. *Emballonura afra* Peters, Reise nach Mossambique, Säugethiere: 51. Tete, Zambezi River, Mozambique.

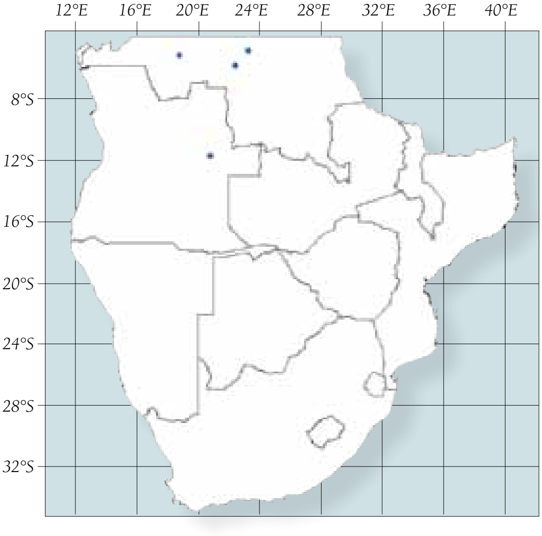
The diploid number in *C. afra* is not known.

Figure 144. Coleura afra, showing plain face and brown fur (© Merlin D. Tuttle, Bat Conservation International, www.batcon.org).

Saccolaimus peli (Temminck 1853)

Pel's pouched bat

Near Threatened



Description: *Saccolaimus peli* is a very large bat with a mass of around 90 g and wingspan exceeding 63 cm. The pelage is dark brown to blackish on the upper parts and slightly paler on the underparts. The wings are black. The ears are long and pointed. The muzzle is tapering with nostrils projecting beyond lower jaw. The eyes are strikingly large for a microbat. A gular sac is present and pronounced in adults of both sexes. Radio-metacarpal pouches are absent. Females are slightly larger than males (Rosevear 1965).

The skull is massive with moderate zygomatic arches. In lateral profile, the braincase rises gradually to a high point at the occiput. A distinct frontal depression is present. Both the sagittal and lambdoid crests are well developed. The dental formula is 1123/2123 = 30 (Rosevear 1965).

External measurements (mm) for *Saccolaimus peli*, sexes combined

	Mean	Min	Max	SD	N
	-	-	-	-	-
Mass	-	84.0	95.0	-	-
FA[1]	-	137.0	171.0	-	-
Total[*1]	-	27.0	36.0	-	-
Tail[1]	-	-	-	-	-
Tibia		22.0	27.0	-	-
Ear[1]	-	-	-	-	-
CI					

[1] Rosevear (1965)

[*] 'Total' length not given in Rosevear (1965), hence taken as 'head and body' + 'tail'

Key identification features: The large eyes, plain muzzle (without a noseleaf) and characteristic arrangement of the tail identify bats of this family. The very dark pelage and enormous size (FA > 85 mm; in *Taphozous mauritianus* and *T. perforatus* FA < 70 mm) sets *S. peli* apart from all other emballonurid bats in Africa.

Echolocation call: The echolocation call of this species has not been recorded from southern Africa and is not known from elsewhere in its range.

Distribution, habitat and roosting: *Saccolaimus peli* is a common rainforest inhabitant of Central and West Africa, but is marginal to southern Africa. It is known from just four localities in southern Africa, Inkongo, Kananga and Kikwit in the DRC (Schouteden 1947, Hayman *et al.* 1966) and Lago Calundo in Angola (Hayman 1963). This species has probably been overlooked in much of northern Angola and the southwestern DRC. It possibly occurs in northwestern Zambia. The type specimen is from the Boutray River, Ghana. A specimen in Cambridge Museum of Natural History, England, is registered as a type of *Saccolaimus peli* (CUMZ 5824A).

The southern Africa population of this species is very poorly represented in museums, with just five literature records used for this book.

Nothing is known about the roosting habits or habitat requirements of the southern African population. Elsewhere it is closely associated with rainforest and roosts in hollow trees (Rosevear 1965, Coe 1975).

Extralimital: *Saccolaimus peli* occurs widely in tropical Africa including the DRC, Cameroon, Nigeria, Ghana, Côte d'Ivoire, Liberia, Kenya and Uganda (Happold 1987, Kingdon 1974). Rosevear (1965) describes their flight as fast and agile, high above ground.

Foraging ecology: There is no information on the diet or foraging behaviour of this species in southern Africa.

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

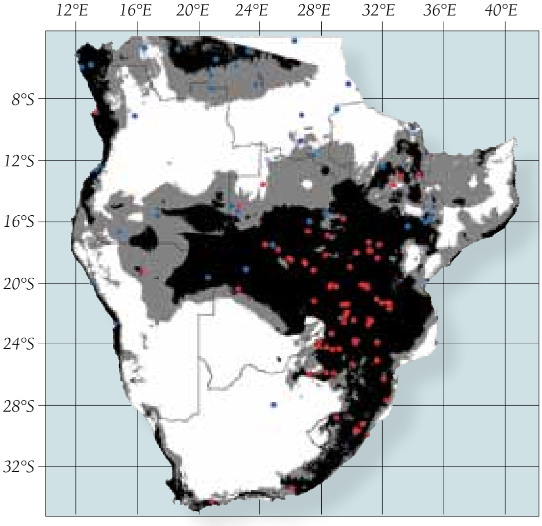
1852. *Taphozous peli* Temminck, Esquisses zool. sur la Côte de Guiné 1: 82. Boutry River, Ghana.

The diploid number in *S. peli* is not known.

Taphozous mauritianus E. Geoffroy Saint-Hilaire 1818

Mauritian tomb bat

Least Concern



Description: *Taphozous mauritianus* is a medium- to large-sized bat with a mass of around 26 g. The pelage is grizzled grey on the upper parts and pure white below. The grizzled effect on the back and head is due to the individual hairs being tricoloured with a brown base, grey middle and white tip. The wings are translucent and off-white. The ears are relatively short and rounded. The muzzle is naked, but the nostrils do not project beyond the lower jaw. The eyes are large for a microbat. A gular sac is present and pronounced in adult males, but reduced to a small fold of skin in females. Radio-metacarpal pouches are present in both sexes. The sexes differ only in the extent to which the gular sac is developed.

The skull is fairly robust with moderate zygomatic arches. The braincase is rounded and elevated above the level of the rostrum. There is a distinct frontal depression, flanked by anterior (lachrymal) and posterior (postorbital bar) inflations of bones on each side of the rostrum. Both the sagittal and lambdoid crests are weak, but clearly visible. The palate is marked by a distinctive deep v-shaped posterior margin. Prominent basisphenoid vacuities are separated by a very thin bridge. The dental formula is 1123/2123 = 30.

Key identification features: The large eyes, plain muzzle (without a noseleaf), and characteristic arrangement of the tail identify bats of this family. The presence of radio-metacarpal pouches distinguishes the genus *Taphozous* from the rest of the family. The grizzled upper parts separate *T. mauritianus* from the similar-sized *T. perforatus*, which has a plain brown back and head.

Echolocation call: *Taphozous mauritianus* produces multi-harmonic HD-QCF calls with a low peak frequency (25.9±0.9 kHz, n = 6), narrow bandwidth (2.8±0.9 kHz, n = 6), and intermediate duration (7.4±4.6 ms, n = 6) (Schoeman and Jacobs 2008; also see Fenton and Bell 1981, Aldridge and Rautenbach 1987, Taylor 1999a, Taylor *et al.* 2005). Besides the second harmonic, the third harmonic is often present on the spectrogram.

Distribution, habitat and roosting: *Taphozous mauritianus* is widespread in the eastern and northern parts of the region. It occurs from the Western and Eastern Cape, where it is known from just two localities, through KwaZulu-Natal, Swaziland and northern South Africa, to Zimbabwe, Zambia, Malawi, central Mozambique, DRC and western Angola. Specimens have also recently been collected and photographed in Namibia (M. Griffin in lit.). The model suggests that this species could occur across a large portion of southern Mozambique, from where it has not yet been recorded. The population in Angola and Namibia may be geographically isolated

External and cranial measurements (mm) and mass (g) for *Taphozous mauritianus*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	26.4	16.0	32.0	4.90	9	**Mass[1]**	27.7	21.0	34.0	4.93	8
FA[1]	61.3	58.3	63.0	1.39	14	**FA[1]**	62.7	58.0	66.0	2.17	10
Total[1]	104.1	85	123	8.50	15	**Total[1]**	109.8	82	143	15.0	10
Tail[1]	21.0	13	28	4.10	15	**Tail[1]**	20.4	14	24	3.74	8
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	17.2	13	23	2.62	17	**Ear[1]**	17.7	12	21	3.19	9

[1] Specimens measured by the authors

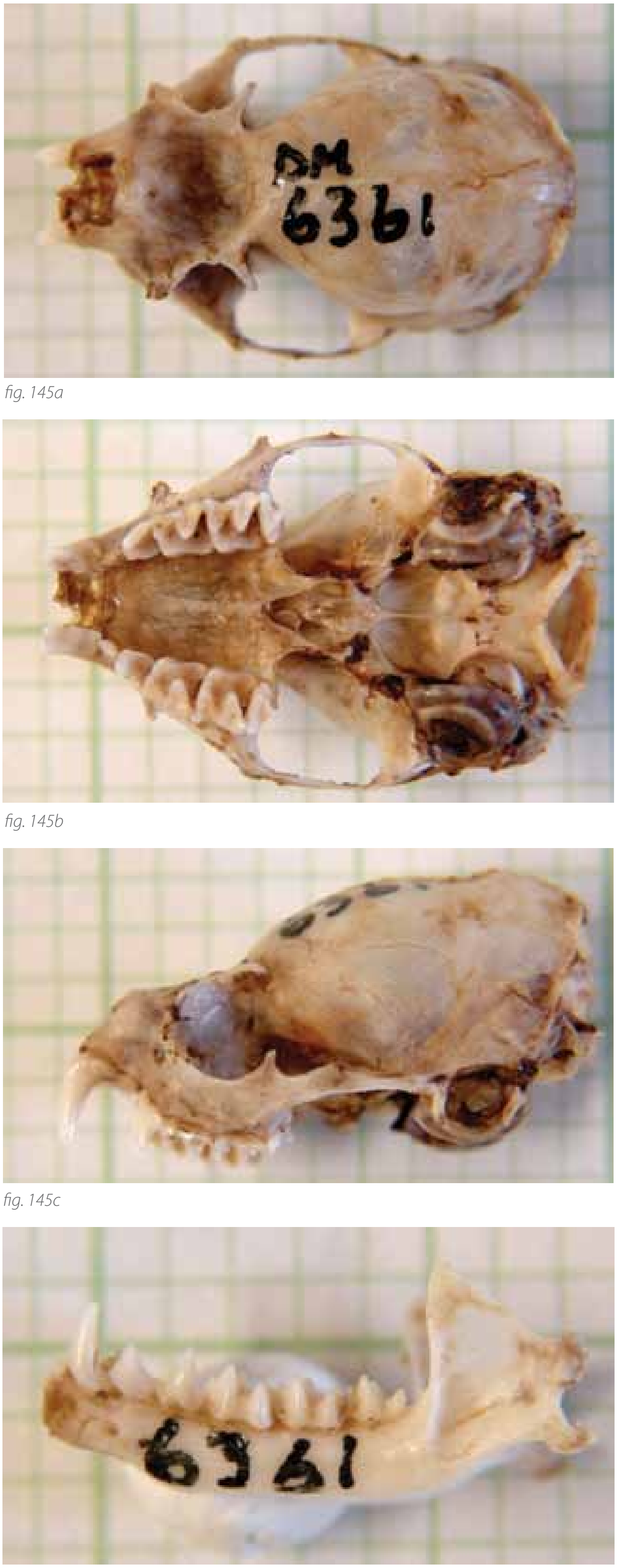


fig. 145a

fig. 145b

fig. 145c

fig. 145d

Figure 145. Skull and teeth of *Taphozous mauritianus:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 6361).

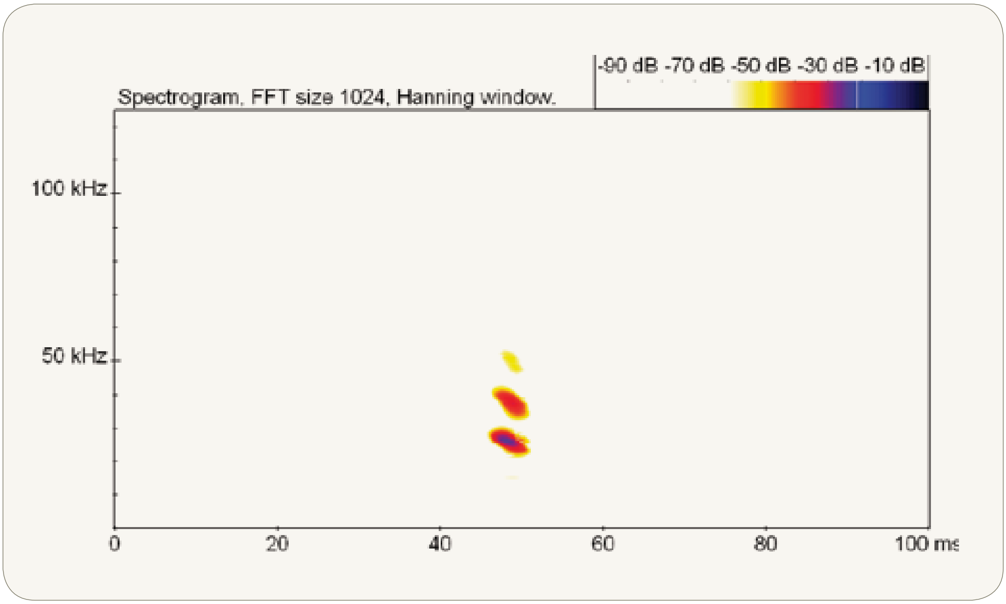


Figure 146. Echolocation call of *Taphozous mauritianus*.

from the rest of the range of the species. This species appears to be very scarce in the extreme south of its range. No specimens have been collected from the Western or Eastern Cape in well over 50 years. The type specimen is from Mauritius (MHNH A381-199).

This species is relatively well represented in museums, with over 150 specimens examined for this book.

Taphozous mauritianus roosts in a variety of locations, including rock faces, tree trunks, and walls, where it rests its belly on the surface of the roost with its head facing down. Favoured roost sites are usually in shade. Females roost in small colonies of 2–5 (up to 30) individuals (Taylor 1998, 2000), while males generally roost singly and separately from the females. The species occurs in a variety of savanna woodlands, preferring open habitats and avoiding closed forest interior. It is absent from arid savannas of the Kalahari, possibly owing to a dependence on surface water.

Extralimital: *Taphozous mauritianus* occurs widely in tropical Africa including the DRC, Cameroon, Nigeria, Ghana, Côte d'Ivoire, Liberia, Kenya, Uganda (Happold 1987, Kingdon 1974) and various islands in the western Indian Ocean.

Foraging ecology: *Taphozous mauritianus* has long, narrow wings with high wing loading (15.4 N.m^{-2}) and intermediate aspect ratio (10.1) (Fenton *et al*. 1980, Aldridge and Rautenbach 1987, Norberg and Rayner 1987, Schoeman and Jacobs 2008). It is an open-air forager. Its diet includes aerial insects such as Lepidoptera, Isoptera and Coleoptera (Allen *et al*. 1917, Kingdon 1974, Wilson 1975, Fenton *et al*. 1980, Happold and Happold 1988, Schoeman 2006).

Reproduction: *Taphozous mauritianus* is probably polyoestrous in southern Africa, with at least some females breeding twice per year. In Malawi, births occur in November–December and March–April (Happold and Happold 1990a). Similarly, in Zimbabwe, females have been recorded carrying young in October, while pregnant females have been collected in February (Smithers 1983). In KwaZulu-Natal, there is evidence of two peaks in births in October–December and February–March (Taylor *et al*. 1999). A single young is born at a time.

SYSTEMATIC NOTES

1818. *Taphozous mauritianus* E. Geoffroy Saint-Hilaire, Description de l'Egypte 2: 127. Mauritius.

The diploid number in *T. mauritianus* is 2n = 42 and aFN = 64 (Rautenbach *et al*. 1993).

fig. 147a

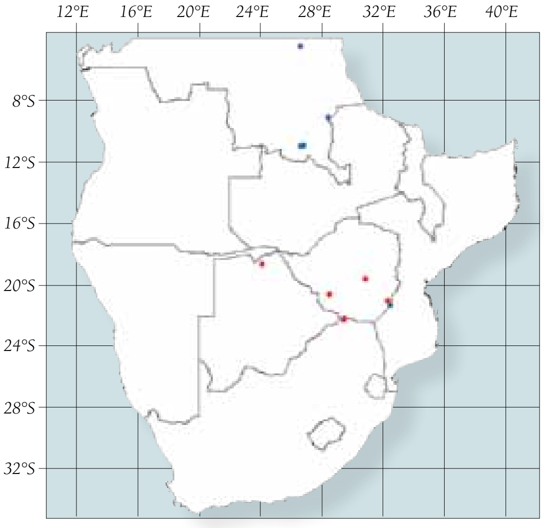
fig. 147b

Figure 147. *Taphozous mauritianus*: (a) frontal and (b) lateral portraits showing plain face and grizzled fur (Sudwala Caves, Mpumalanga, South Africa, © E. C. J. Seamark).

Taphozous perforatus E. Geoffroy Saint-Hilaire 1818

Egyptian tomb bat

Least Concern



Description: *Taphozous perforatus* is a medium- to large-sized bat with a mass of around 30 g. The pelage is plain brown on the upper parts and slightly paler below. The wings are mostly white, but black near the body. The ears are relatively short and slightly pointed. The muzzle is naked, but the nostrils do not project beyond the lower jaw. The eyes are large for a microbat. A gular sac is absent in both males and females. Radio-metacarpal pouches are present in both sexes. The sexes are similar.

The skull is fairly robust with moderate zygomatic arches. The braincase is rounded and elevated above the level of the rostrum. There is a distinct frontal depression, flanked by anterior (lachrymal) and posterior (postorbital bar) inflations of bones on each side of the rostrum. Both the sagittal and lambdoid crests are weak, but visible. The dental formula is 1123/2123 = 30.

Key identification features: The large eyes, plain muzzle (without a noseleaf) and characteristic arrangement of the tail identify bats of this family. The presence of radio-metacarpal pouches distinguishes the genus *Taphozous* from the rest of the family. The plain brown upper parts of *T. perforatus* separates it from the similar-sized *T. mauritianus*, which has grizzled upper parts.

Echolocation call: The echolocation call of this species has not been recorded in southern Africa.

Distribution, habitat and roosting: *Taphozous perforatus* is very patchily distributed in the north and east of southern Africa. It has been recorded in southern Zimbabwe and adjacent Mozambique. An isolated population occurs in the Okavango Delta of northern Botswana. It also occurs in the southern DRC and just across the border in Zambia. The type specimen for *T. perforatus* is from Egypt (MNHN A.372), while the type for the southern African subspecies is from Sudan (BM 2.7.4.2).

The southern African population of this species is poorly represented in museums, with just 28 records used for this book.

It roosts by crawling into dark crevices in rocky outcrops, caves, sandstone overhangs or buildings (Smithers 1971, Smithers and Wilson 1979), where it forms small groups of less than ten individuals, but in southern Zimbabwe may number in the hundreds. It occurs in savanna woodland, with a preference for open situations, where it is closely tied to suitable roosting sites.

Extralimital: *Taphozous perforatus* also occurs in the DRC, Uganda, Kenya, Tanzania, Somalia, Ethiopia, Sudan, Egypt, Central African Republic, Cameroon, Nigeria, Ghana, Senegal, Mauritania, Mali, Burkina Faso and Niger (Meester *et al.* 1986, Schlitter *et al.* 1982, Happold 1987).

Foraging ecology: *Taphozous perforatus* has long, narrow wings with high wing loading (13.0 $N.m^{-2}$) and intermediate aspect ratio (7.5) (Norberg and Rayner 1987). It is an open-air forager. In Ethiopia, this species feeds predominantly on Lepidoptera, but also on Isoptera, Coleoptera and Orthoptera in lower numbers (Rydell and Yalden 1997; also see Hill and Morris 1971). There is no information on the diet of this species in southern Africa.

Reproduction: In Zimbabwe, two pregnant females were collected in November (Smithers 1983).

External measurements for *Taphozous perforatus*, females only

	Mean	Min	Max	SD	N
Females					
Mass[1]	30.2	23.4	33.2	-	6
FA[1]	63	62	63	-	8
Total[1]	103	95	108	-	8
Tail[1]	26	22	30	-	8
Tibia	-	-	-	-	-
Ear[1]	18	15	20	-	8
CI	-	-	-	-	-

[1] Smithers and Wilson (1979)

fig. 148a

Figure 148. Taphozous perforatus: (a) showing plain face, and (b) uniformly coloured brown fur (© C. Dietz).

SYSTEMATIC NOTES

1818. *Taphozous perforatus* E. Geoffroy Saint-Hilaire, Description de l'Egypte 2: 126. Restricted to Ombos (= Kom Ombo) by Kock (1969), Egypt.

The subspecies *T. perforatus sudani* is the only one recognised in the region (Meester *et al.* 1986), and this presumably includes *swirae* Harrison 1958 (see below).

Taphozous perforatus sudani Thomas 1915

1915. *Taphozous perforatus sudani* Thomas, Annals and Magazine of Natural History (8)15: 561. Mongalla, Sudan.

Three subspecies of *Taphozous perforatus* have been named (Meester *et al.* 1986): the nominate subspecies from Egypt, *T. perforatus sudani* from Sudan, and *T. perforatus haedinus* Thomas 1915 from Kenya. It is unclear how these subspecies relate to one another and how they relate to the geographically isolated southern African population, for which the name *T. perforatus rhodesiae* Harrison 1964 is available. Originally described as a subspecies of *T. sudani* (which was recognised as specifically distinct at that time), *T. p. rhodesiae* replaces the preoccupied *T. p. australis* Harrison 1960 (NMZB 9932, Holotype) described from a type series totalling eight specimens from the Shashi–Limpopo confluence (Harrison 1964b: 2).

The diploid number in *T. perforatus* is not known.

fig. 148b

SUBORDER VESPERTILIONIFORMES

FAMILY NYCTERIDAE
SLIT-FACED BATS

In Africa, this family is represented by the single genus *Nycteris*, with about 12 species, of which 9 have been recorded in this region. Members of this genus are immediately recognisable by the arrangement of their noseleafs, which are covered by flaps of skin, giving the appearance of a slit running down the length of the muzzle (Figure 149b). This genus has another unique feature: the last vertebra of the tail is bifurcated at its tip, creating a 'T' effect, which assists with supporting the tail membrane (Figure 149a) (Hill and Smith 1984, Neuweiler 1990). The wings are characteristically broad with rounded tips, adaptations for slow, manoeuvrable flight (Norberg and Rayner 1987).

African species were originally classified in the genus *Petalia*. Andersen (1912b) grouped the then known species into four 'species-groups' based on tragus shape (Figure 151), size of the posterior lower premolar, and whether the upper incisors are bifid or trifid (Figure 150) (Rosevear 1965). This arrangement was amended by Aellen (1959) into five groups.

Convergent evolution appears conspicuous in *Nycteris*, because species that appear very similar in external characters are in fact divergent, cryptic species. The distinctiveness in bacular morphology between the very similar *N. woodi* and *N. parisii* reveals that the latter is more closely related to *N. macrotis*, whilst bacular characters in *N. woodi* point to its affinities with *N. thebaica* (Thomas *et al*. 1994). Previously, multivariate analyses of external measurements lead Van Cakenberghe and De Vree (1985) to conclude that *woodi* and *parisii* were conspecific.

Nycterids are aptly called 'whispering' bats, as they emit soft, low intensity multi-harmonic low duty-cycle frequency-modulated (LD-FM) echolocation calls (Neuweiler 1990). The distinctly elongated ears presumably assist with the detection of prey – often invertebrates that are taken off the ground (Bowie *et al*. 1999). The adaptive benefits of sensitive sonar and slow, manoeuvrable flight are exemplified in the tiny *N. woodi*, which gleans stationary insects (including long-horned orthopterans) from vegetation. The unique sensory ability of slit-faced bats invariably bypasses the visual crypsis that protects these insects from diurnal predators (F. P. D. Cotterill, unpublished data).

fig. 149a

fig. 149b

Figure 149. Typical Nycteridae characteristics: (a) bifurcated tail, and (b) long ears and uncovered noseleaf.

TABLE 14. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE SOLE GENUS *NYCTERIS* WITHIN THE FAMILY NYCTERIDAE

SPECIES	FA (MM)	DISTINGUISHING COLOUR AND MARKS	UPPER INCISORS	PF (KHZ)
N. nana	32–36	tragus shaped with a concave kink on its outer margin at half its length; well-developed posterior lower premolar	bifid	NA
N. intermedia	36–38	tragus shaped with a concave kink on its outer margin at half its length; well-developed posterior lower premolar	bifid	NA
N. woodi	38–41	tragus half-moon-shaped; venter and throat pure white in nearly all individuals	bifid	~43
N. hispida	38–43	tragus half-moon-shaped; ears < 24 mm	trifid	~81
N. arge	39–46	tragus shaped with a concave kink on its outer margin at half its length; well-developed posterior lower premolar	bifid	NA
N. thebaica	41–53	pyriform (finger-like) tragus	bifid	~70 or 90
N. major	47–50	tragus shaped with a concave kink on its outer margin at half its length; well-developed posterior lower premolar	bifid	NA
N. macrotis	50–53	tragus half-moon-shaped	bifid	~70 or 89
N. grandis	61–65	large size	trifid	~20 or 40

fig. 150a *fig. 150b*

Figure 150. Trifid (a) versus bifid (b) incisors of Nycteridae.

fig. 151a *fig. 151b*

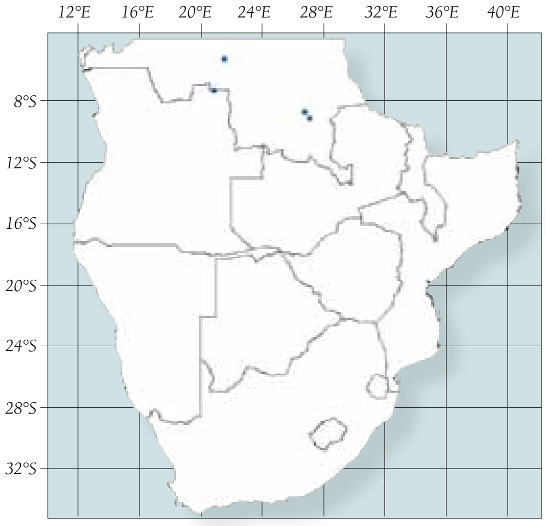
Figure 151. Ears of Nycteridae, showing (a) semi-lunate and (b) pyriform tragus shapes.

ROOST	RANGE IN SOUTHERN AFRICA
hollow trees	marginal to region, widespread in rainforests of Central and West Africa
not known	marginal to region, northern Angola and southwestern DRC
caves, mines, houses	widespread in northeastern parts at lower altitudes
hollow trees, caves, houses, dense bush	restricted to the northern and eastern parts
hollow trees, small caves	marginal to region, widespread in rainforests of Central and West Africa
hollow trees, caves, mines, houses, culverts, aardvark burrows	widespread throughout region
hollow trees	very patchily distributed; single record from Zambia
hollow trees, caves, culverts	widespread in northern parts
hollow trees, small caves	restricted to the northern and eastern parts

Nycteris arge Thomas 1903

Bates's slit-faced bat

Least Concern



Description: *Nycteris arge* is a small bat with a mass of around 11 g. The pelage is dark brown with little difference between the upper and underparts. The wings are dark grey and sparsely covered in hair. The ears are long, and the tragus is characteristically shaped with a concave kink on its outer margin at about half its length, distinguishing the *arge* group from all other *Nycteris* species. The sexes resemble each other.

The skull is fairly gracile with weak zygomatic arches. In lateral profile, it is strongly bowed, rising steeply to a high, rounded peak in the mid-parietal region. The sagittal crest is weakly developed anteriorly and absent posteriorly. The frontal depression is pronounced, flanked by well-developed supra-orbital ridges. The dental formula is 2113/3123 = 32. The upper incisors are bifid. The posterior lower premolar is well developed and in the toothrow (Rosevear 1965).

External and cranial measurements for *Nycteris arge*, sexes combined

	Mean	Min	Max	SD	N
Mass	-	-	-	-	-
FA[1][*]	41.9	33.7	49.1	2.30	145
Total[2]	-	92	128	-	-
Tail[2]	-	42	61	-	-
Tibia[1]	22.0	18.2	26.5	1.86	88
Ear[2]	-	25	33	-	-
CI	-	-	-	-	-
GSL[1]	19.2	18.0	20.3	0.56	123

[1] Van Cakenberghe and De Vree (1985)
[2] Rosevear (1965)
[*] It would appear that both the minimum and maximum forearm lengths presented by Van Cakenberghe and De Vree (1985) are uncharacteristically extreme. Most specimens typically have FA = 39–46 mm (Rosevear 1965).

Key identification features: The facial slit covering the noseleaf distinguishes this genus from other microbats in the region. The *arge* group can be distinguished from all other *Nycteris* species by the well-developed posterior lower premolar and the characteristic concave kink in the outer margin of the tragus. *Nycteris arge* is significantly larger (generally FA > 39 mm) than *N. nana* (FA < 36 mm), but only marginally larger than *N. intermedia* (FA < 38 mm). The larger *N. major* (GSL > 20.2 mm) overlaps marginally in size with the smaller *N. arge* (GSL < 20.3 mm).

Echolocation call: The echolocation call of this species has not been recorded in southern Africa.

Distribution, habitat and roosting: *Nycteris arge* is a common rainforest inhabitant of Central and West Africa, but is marginal to southern Africa. So far, it has only been recorded from the southern DRC and northeastern Angola. However, it may be more widely distributed in the far northern parts of Angola and the southwestern DRC. The type specimen is from Efulen, Cameroon (BM 4.2.8.2, Holotype).

In southern Africa, this species is very poorly represented in museums, with just four records examined for this book.

Nothing is known about its roosting habits in southern Africa. Elsewhere in its range, it roosts singly or in small family groups, preferring hollow trees with large trunks and an opening near the ground (Verschuren 1957a, Rosevear 1965). It also roosts in small caves (A. Monadjem, personal observation). *Nycteris arge* is predominantly associated with lowland rainforest, but in southern Africa also occurs in forest edge habitats.

Extralimital: *Nycteris arge* has been widely recorded from the tropical rainforest zone of Central and West Africa, including Tanzania, Kenya, Uganda, DRC, Sudan, Cameroon, Gabon, Congo, Nigeria, Togo, Ghana, Côte d'Ivoire, Liberia and Sierra Leone (Van Cakenberghe and De Vree 1985).

Foraging ecology: There is no information on the diet or foraging behaviour of this species in southern Africa.

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1903. *Nycteris arge* E. Geoffroy, Annals and Magazine of Natural History (7)12: 633–634. Efulen (= Efulan), Cameroon.

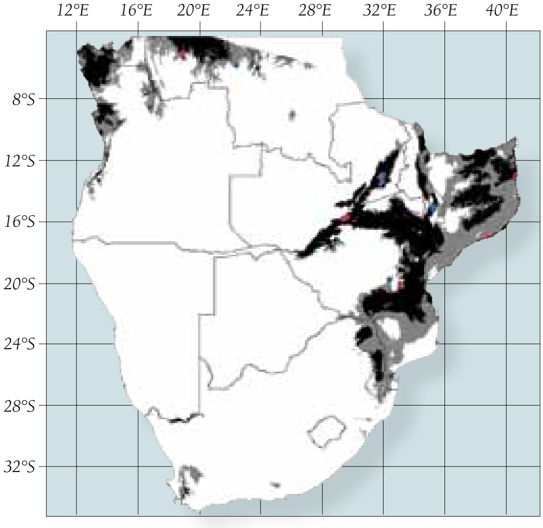
The diploid number in *N. arge* is not known.

Figure 152. Nycteris arge, showing very long ears and the 'slit' along the muzzle (Uganda, © A. Monadjem).

Nycteris grandis Peters 1865

Large slit-faced bat

Least Concern



Description: *Nycteris grandis* is a large bat with a mass of around 35 g. The pelage colour is variable, mostly dark beige to sepia-brown on the upper parts and slightly paler on the underparts. The wings are light brown and sparsely covered in hair. The ears are long and the tragus is characteristically more or less half-moon-shaped (semi-lunate). A net of collagen strands reinforces the wings and interfemoral membrane. The sexes resemble each other.

The skull is robust with sturdy zygomatic arches. In lateral profile, it is strongly bowed, rising steeply to a high, rounded peak in the mid-parietal region. The sagittal crest is strongly developed anteriorly. The frontal depression is pronounced, flanked by well-developed supra-orbital ridges. The palatal bridge is short. The coronoid processes of the mandible are well developed. The dental formula is 2113/3123 = 32. The upper incisors are trifid.

Key identification features: The facial slit covering the noseleaf distinguishes this genus from other microbats in the region. *Nycteris grandis* can be separated from all other congeners by its much larger size (FA > 57 mm) and trifid upper incisors (shared with the much smaller *N. hispida)*.

Echolocation call: *Nycteris grandis* produces low intensity, multi-harmonic LD-FM echolocation calls with a low main peak frequency (20±1 kHz, n = 32 pulses from 7 females, with additional peaks at around 40, 62 and 84 kHz), intermediate bandwidth (24±0.3 kHz, n = 32 pulses from 7 females), and short duration (3.5±0.7 ms, n = 32 pulses from 7 females) (Fenton *et al.* 1983; also see Fenton 1988).

Distribution, habitat and roosting: *Nycteris grandis* is present in the north and northeast of the region. It occurs sparsely in eastern and northern Zimbabwe, southeast Zambia, southern Malawi, and northern Mozambique; there are two isolated records from the southern DRC. This species may have been overlooked in the northern parts of Angola and central Mozambique, where the habitat-suitability model shows suitable climatic conditions to occur. The type specimen in the Leiden Museum is from Guinea (RMNH 27348).

This species is not well represented in museums, with just 22 specimens examined for this book. (There are, however, larger series collected from other parts of Africa.)

It typically roosts in hollows of large trees such as *Faidherbia albida* (Fenton *et al.* 1990) and *Adansonia digitata* (Ansell 1986, A. Monadjem, unpublished data), but may also use caverns and built structures such as a disused water tower (Fenton *et al.* 1987). It is predominantly a rainforest species, but also occurs in savannas along riparian forest and associated woodlands (Hickey and Dunlop 2000).

Extralimital: *Nycteris grandis* has also been recorded from Tanzania, Kenya, Uganda, DRC, Cameroon, Nigeria, Togo, Ghana, Liberia, Guinea and Senegal (Happold 1987).

External and cranial measurements (mm) and mass (g) for *Nycteris grandis*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	35.0	-	-	-	1	**Mass[1]**	30.0	-	-	-	1
FA[1]	62.3	61.0	65.0	1.89	4	**FA[1]**	61.3	61.0	61.5	-	2
Total[1]	155.5	155	156	-	2	**Total[1]**	-	-	-	-	-
Tail[1]	74.0	70	78	-	2	**Tail[1]**	-	-	-	-	-
Tibia	-	-	-	-	-	**Tibia**	33.7	-	-	-	1
Ear[1]	29.5	29	30	-	2	**Ear[1]**	-	-	-	-	-
CI[1]	24.0	23.9	24.0	-	2	**CI[1]**	23.4	-	-	-	1

[1] Specimens measured by the authors

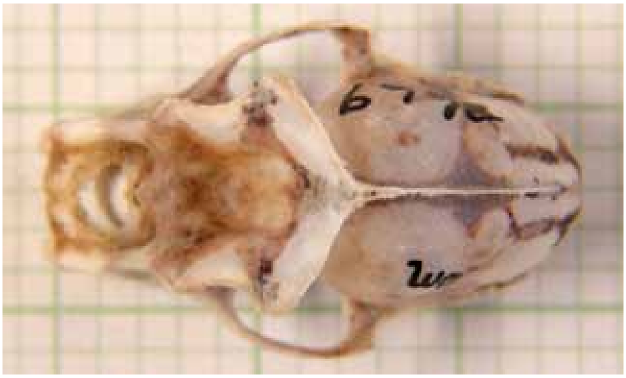


fig. 153a

fig. 153b

fig. 153c

fig. 153d

Figure 153. Skull and teeth of *Nycteris grandis:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8669).

fig. 154a

Foraging ecology: *Nycteris grandis* has relatively short and broad wings with high wing loading (11.4 $N.m^{-2}$) and low aspect ratio (5.2) (Norberg and Rayner 1987). It is a clutter and clutter-edge forager. It is the only truly carnivorous bat in Africa, capturing frogs, bats, birds and insects (Fenton *et al.* 1981, 1987, 1990, 1993; also see Bayefsky-Anand 2005).

Reproduction: Pregnant females have been recorded in late September in Zambia (Ansell 1986), while females with attached young have been recorded in early December in Zimbabwe (Fenton *et al.* 1987).

SYSTEMATIC NOTES

1865. *Nycteris grandis* Peters, Monatsberichte der Königlichen Preussischen Akademie der Wissenschaften zu Berlin: 358–359. Guinea.

Two subspecies are recognised:

Nycteris grandis grandis Peters 1865

Nycteris grandis marica Kershaw 1923

1923. *Nycteris marica* Kershaw, Ann. Mag. nat. Hist., ser. 9, 12 (70): 534. Tindiga, Kilosa, Tanzania.

Meester *et al.* (1986) recognised two subspecies, with the nominate subspecies occurring in Central and West Africa and *N. grandis marica* Kershaw 1923 (BM 23.8.2.1, Holotype) limited to southern Africa and Tanzania. Although Van Cakenberghe and De Vree (1993) rejected the proposed subdivision (because they found the complex to be very uniform throughout its range), two distinct allopatric populations are associated with forest and savanna respectively. We suggest that these forest and savanna forms may represent different evolutionary lineages (F. P. D. Cotterill, personal observation, as first discussed by Ansell 1967), as has been shown for several other species of bats such as *Hipposideros gigas* and *H. vittatus*.

The diploid number in *N. grandis* is not known.

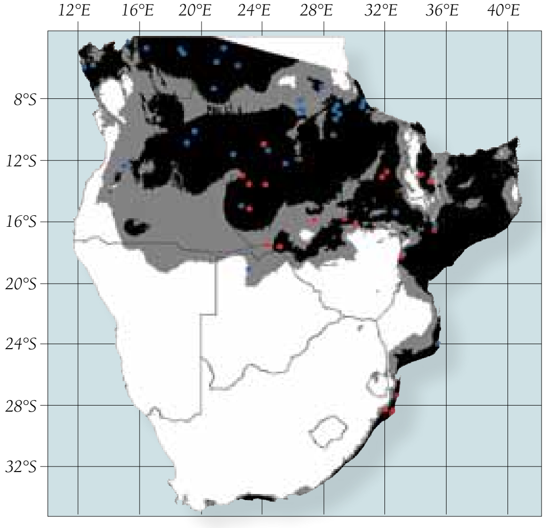
fig. 154b

Figure 154. *Nycteris grandis:* (a) showing very long ears and large size; (b) adult male from Sapi River, Zambezi valley, showing the large jaws and robust build characteristic of the population described as *N. g. marica* (a: DM 8669, © A. Monadjem; b: © F. P. D. Cotterill).

Nycteris hispida (Schreber 1774)

Hairy slit-faced bat

Least Concern



Description: *Nycteris hispida* is a small bat with a mass of around 10 g. The pelage is variable in colour, but mostly dark beige to sepia-brown on the upper parts and markedly paler on the underparts. The wings are light brown and sparsely covered in hair. The ears are short for this genus. The tragus is characteristically more or less half-moon-shaped (semilunate). The sexes resemble each other.

The skull is fairly gracile with weak zygomatic arches. In lateral profile, it is strongly bowed, rising steeply to a high, rounded peak in the mid-parietal region. The sagittal crest is weakly developed anteriorly and absent posteriorly. The frontal depression is pronounced, flanked by well-developed supra-orbital ridges. The palatal bridge is short. The coronoid processes of the mandible are weakly developed. The dental formula is 2113/3123 = 32. The upper incisors are trifid.

Key identification features: The facial slit covering the noseleaf distinguishes this genus from other microbats in the region. *Nycteris hispida* can be separated from all other congeners by its combination of trifid upper incisors (shared with the much larger *N. grandis)* and shorter ears (< 24 mm; > 26 mm in all other southern African species).

Echolocation call: *Nycteris hispida* produces low intensity, multi-harmonic LD-FM echolocation calls with a high main peak frequency (80.8±1 kHz, n = 2, with additional broad peaks at around 40 and 60 kHz), broad bandwidth (22±0.3 kHz, n = 2), and short duration (2±0.1 ms, n = 2) (P. J. Taylor, unpublished data).

Distribution, habitat and roosting: *Nycteris hispida* is confined to the northern and eastern parts of the region. It occurs sparsely in northern KwaZulu-Natal, Mozambique and northern Zimbabwe, but is widespread in Malawi, Zambia, central and northern Angola and the southern DRC. The model shows suitable conditions in much of central Mozambique, from where it has yet to be recorded. The type specimen from Senegal no longer exists (Rosevear 1965).

This species is not well represented in museums, with just 28 specimens examined for this book. (There are, however, large series collected from other parts of Africa.)

In contrast to most other *Nycteris* species, *N. hispida* does not require a darkened cavity for a day roost. It commonly roosts in dense bush (Rosevear 1965), but may also use houses, hollow trees, and caves (Skinner and Chimimba 2005). The habitat of this species is not easy to specify as it occupies a wide variety of vegetation types, including savanna, woodland and forest. Its absence from savanna habitats in most of Zimbabwe and northern South Africa is therefore puzzling. It avoids open grasslands and arid zones.

Extralimital: *Nycteris hispida* has been widely recorded from sub-Saharan Africa (Van Cakenberghe and De Vree 1993).

External and cranial measurements (mm) and mass (g) for *Nycteris hispida*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	7.0	-	-	-	1	**Mass**[1]	-	-	-	-	-
FA[1]	40.2	38.0	43.0	1.83	9	**FA**[1]	41.6	39.2	44.0	2.23	5
Total[1]	90.8	81	97	6.72	5	**Total**[1]	95.0	-	-	-	1
Tail[1]	42.0	34	47	5.40	5	**Tail**[1]	47.0	-	-	-	1
Tibia[1]	19.5	-	-	-	1	**Tibia**[1]	-	-	-	-	-
Ear[1]	21.1	19	24	1.91	9	**Ear**[1]	21.8	19	24	2.14	4
CI[1]	14.9	14.7	15.1	-	2	**CI**[1]	14.9	14.5	15.2	-	2

[1] Specimens measured by the authors

fig. 155a

fig. 155b

fig. 155c

fig. 155d

Figure 155. Skull and teeth of *Nycteris hispida:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (a–c: DM 8446; d: DM 8646).

Foraging ecology: *Nycteris hispida* has short and broad wings with low wing loading (5.4 N.m^{-2}) and low aspect ratio (4.8) (Norberg and Rayner 1987). It is a clutter forager. In East Africa and Mozambique, it eats small insects such as Lepidoptera and Coleoptera, gleaned from well-lit walls and window screens or from the ground (Kingdon 1974, M. C. Schoeman and D. Ribeiro, unpublished data).

Reproduction: A large juvenile was collected in late December in Zambia (Ansell 1973).

SYSTEMATIC NOTES

1774. *Vespertilio hispidus* Schreber, Die Säugethiere in Abbildungen nach der Natur mit Beschreibungen: 169–170. 56. Senegal.

Meester *et al.* (1986) recognised two subspecies, with the nominate subspecies occurring throughout Africa and *N. hispida villosa* Peters 1852 limited to south of the Zambezi River. However, these two subspecies do not appear to occupy geographically distinct regions. Furthermore, Van Cakenberghe and De Vree (1993) concluded that *N. hispida* is 'very uniform throughout its entire distribution area and therefore cannot be divided into subspecies' (although they were not able to examine specimens of the *villosa* form). Hence, in the absence of genetic data, we do not recognise any differentiation into subspecies.

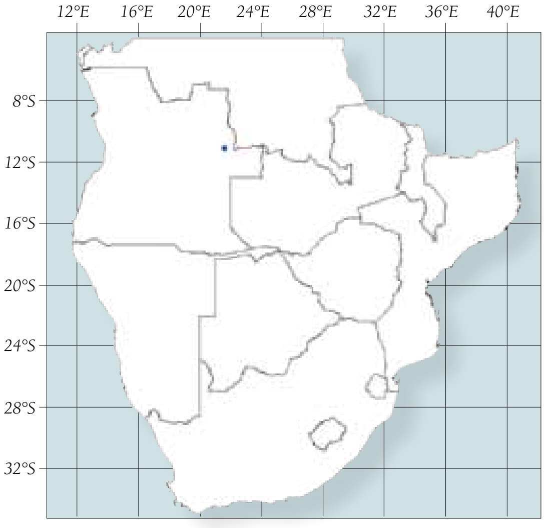
The diploid number in *N. hispida* is 2n = 42 and aFN = 78 (Lee *et al.* 1989).

Figure 156. Nycteris hispida, showing relatively short ears compared to other members of this genus (© Merlin D. Tuttle, Bat Conservation International, www.batcon.org).

Nycteris intermedia Aellen 1959 ●

Intermediate slit-faced bat

Near Threatened



Description: *Nycteris intermedia* is a small bat with an estimated mass of about 7 g. The pelage is dark brown with little difference between the upper and underparts. The wings are dark brown and sparsely covered in hair. The ears are long, and the tragus has a characteristic shape with a concave kink on its outer margin at about half its length, distinguishing the *arge* group from all other *Nycteris* species. The sexes resemble each other.

The skull of *N. intermedia* is similar to, but smaller than that of the closely related *N. arge*. The posterior lower premolar is well developed and in the toothrow (Rosevear 1965).

External and cranial measurements (mm) for *Nycteris intermedia*, sexes combined

	Mean	Min	Max	SD	N
Mass	-	-	-	-	-
FA[1]	36.2	33.7	38.0	1.01	21
Total	-	-	-	-	-
Tail[2]	-	51	55	-	-
Tibia[2]	-	21	21	-	-
Ear[2]	-	23.4	24.0	-	-
CI	-	-	-	-	-
GSL[1]	17.3	15.4	18.3	0.68	21

[1] Van Cakenberghe and De Vree (1985)

[2] Rosevear (1965)

Key identification features: The facial slit covering the noseleaf distinguishes this genus from other microbats in the region. The *arge* group can be distinguished from all other *Nycteris* species by the well-developed posterior lower premolar and the characteristic concave kink in the outer margin of the tragus. *Nycteris intermedia* is intermediate in size between *N. arge* (generally FA > 38 mm) and *N. nana* (FA < 36 mm), but there is some overlap.

Echolocation call: The echolocation call of this species has not been recorded in southern Africa.

Distribution, habitat and roosting: *Nycteris intermedia* is a rare rainforest inhabitant of Central and West Africa, and is marginal to southern Africa. So far, it has only been recorded from a single specimen in northeastern Angola. However, it may be more widely distributed in the far northern parts of Angola and the southwestern DRC. The type specimen is from Côte d'Ivoire (MHNG 923.94).

This species is predominantly associated with lowland rainforest.

Extralimital: *Nycteris intermedia* has been widely recorded from the tropical rainforest zone of Central and West Africa, including Tanzania, DRC, Cameroon, Gabon, Ghana and Côte d'Ivoire (Van Cakenberghe and De Vree 1985).

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1959. *Nycteris intermedia* Aellen, Archs. Sci. Geneve, 12: 218–219. Adiopodoume, Côte d'Ivoire.

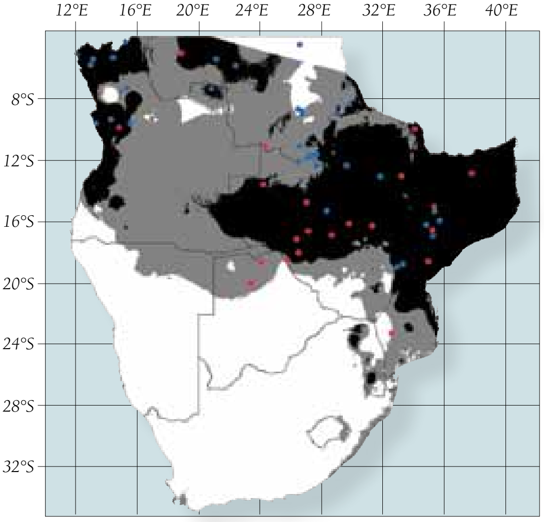
The diploid number in *N. intermedia* is not known.

Figure 157. *Nycteris intermedia*, showing very long ears and uncovered noseleaf (© J. Fahr).

Nycteris macrotis Dobson 1876 ●

Large-eared slit-faced bat

Least Concern



Description: *Nycteris macrotis* is a medium-sized bat with a mass of around 17 g. It resembles a robust *N. thebaica*. The pelage is light sandy-brown to orange-brown; fulvous individuals are known. The upper parts are slightly darker than the underparts. The wings are light brown and sparsely covered in hair. The ears are long and the tragus is characteristically half-moon-shaped (semi-lunate). The sexes resemble each other.

The skull is robust with sturdy zygomatic arches. In lateral profile, it is strongly bowed, rising steeply to a high, rounded peak in the mid-parietal region. The sagittal crest is strongly developed anteriorly. The frontal depression is pronounced, flanked by well-developed supra-orbital ridges. The palatal bridge is short. The coronoid processes of the mandible are well developed. The dental formula is 2113/3123 = 32. The upper incisors are bifid.

External and cranial measurements (mm) and mass (g) for *Nycteris macrotis*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	16.9	15.0	18.4	1.36	5
FA[1]	50.5	50.4	53.0	2.72	10
Total	-	-	-	-	-
Tail	-	-	-	-	-
Tibia[1]	26.5	25.5	27.5	0.87	4
Ear	-	-	-	-	-
CI[1]	19.0	18.8	19.2	0.14	6

Key identification features: The facial slit covering the noseleaf distinguishes this genus from other microbats in the region. *Nycteris macrotis* can be separated from *N. thebaica* by a combination of larger size (FA > 50 mm and CI > 18.8 mm; in areas where they overlap, *N. thebaica* FA < 50 mm, CI < 18.6 mm) and half-moon-shaped tragus. Note that *N. thebaica* from the Northern Cape and southern and central Namibia is similar in size to *N. macrotis*. However, *N. macrotis* is entirely absent from this region. *Nycteris hispida* has shorter ears (< 24 mm; in *N. macrotis* > 26 mm) and trifid upper incisors. *Nycteris woodi* is far smaller (FA < 41 mm), while *N. grandis* is larger (FA > 57 mm; in *N. macrotis* FA < 53 mm).

Echolocation call: *Nycteris macrotis* produces low intensity, multi-harmonic LD-FM echolocation calls with a high main peak frequency (89±13.2 kHz, n = 2, with additional broad peaks at around 29, 49 and 70 kHz), broad bandwidth (29.3±0.4 kHz, n = 2), and short duration (1.2±0.5 ms, n = 2) (Schoeman and Jacobs 2008).

Distribution, habitat and roosting: *Nycteris macrotis* has been recorded throughout the northern parts of the region. It occurs in northern Botswana in the Okavango swamps and along the Zambezi River in Zimbabwe. It is widespread in Zambia, Malawi and the southern DRC. The limited number of records from Angola and Mozambique may be an artefact of under-sampling. The bulk of the records are from north of the Zambezi River, but it occurs well south of this in Mozambique. The type specimen is from Sierra Leone (BM 66.2.2.2).

This species is poorly represented in museums, with less than 50 records examined for this book.

The roosting habits of *Nycteris macrotis* are not well known, but it roosts during the day in a variety of shelters, including caves, culverts under roads, and the trunks of large trees such as *Adansonia digitata*. Like *N. thebaica*, it presumably also uses night roosts. It appears to favour moist savannas in south-central Africa.

Extralimital: *Nycteris macrotis* has also been recorded from Tanzania, Kenya and southern Sudan, westwards through Central and West Africa to Senegal.

Foraging ecology: *Nycteris macrotis* has short and broad wings with intermediate wing loading (7.1 N.m^{-2}) and low aspect ratio (5.2) (Norberg and Rayner 1987). It is a clutter forager. In Zambia, its diet consisted of Orthoptera, Coleoptera, Isoptera, and Diptera (Findley and Black 1983).

Reproduction: No reproductive information is available for southern Africa.

[1] Specimens measured by the authors

fig. 158a

fig. 158b

fig. 158c

fig. 158d

Figure 158. Skull and teeth of *Nycteris macrotis:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8662).

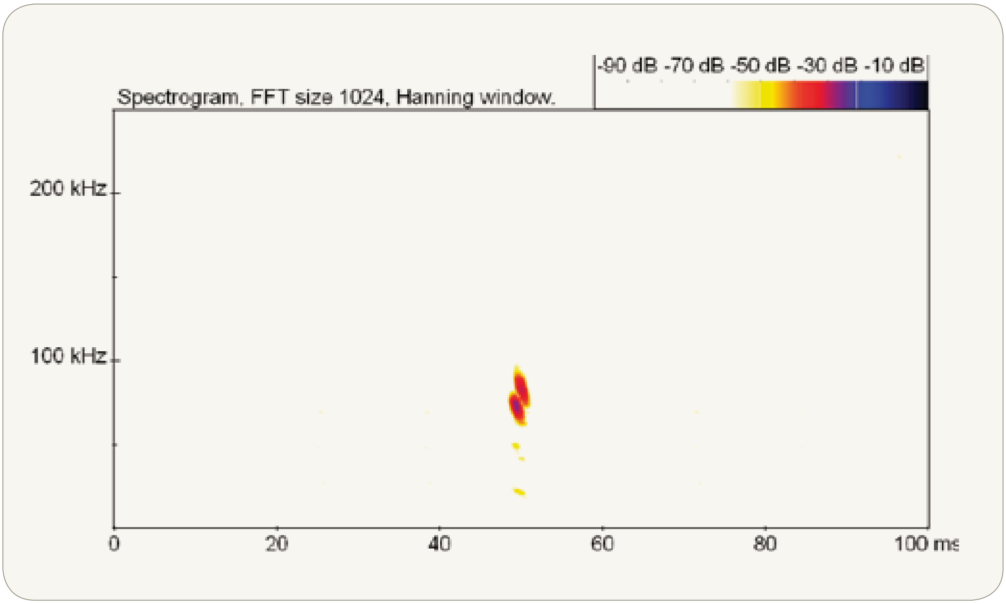


Figure 159. Echolocation call of *Nycteris macrotis*.

SYSTEMATIC NOTES

1876. *Nycteris macrotis* Dobson, Monograph of the Asiatic Chiroptera: 80. Sierra Leone.

One subspecies is recognised in the region (Meester *et al*. 1986).

Nycteris macrotis oriana Kershaw 1922

1922. *Nycteris macrotis oriana*, Kershaw, Annals and Magazine of Natural History (9) 10: 179. Chiromo, Shire Valley, Malawi (BM 22.4.25.3, Holotype).

At least five synonyms of *N. macrotis* have been described from West African populations (Hayman and Hill 1971). The taxon *vinsoni* (Dalquest 1965) was originally described as a distinct species from the south bank of the Save River, Mozambique, and is only known from the type locality. However, Koopman (1993) re-examined the type specimen (NHMUK 18739, Holotype) and paratype of *vinsoni* to reveal that this taxon is a synonym of *N. m. oriana*. Nevertheless, Bronner *et al.* (2003) and Skinner and Chimimba (2005) have treated *vinsoni* as a distinct species. On biogeographical and morphological grounds, *vinsoni* is unlikely to be a distinct species, and we treat it as a synonym of *N. m. oriana*.

The diploid number in *N. macrotis* is 2n = 40 and aFN = 78 (Rautenbach *et al.* 1993).

fig. 160a

Figure 160. *Nycteris macrotis:* (a) portrait showing fulvous colour phase and very long ears with semilunate tragus; (b) whole body showing grey colour; and (c) portrait of grey colour phase, Sakeji, northwestern Zambia (a: © F. P. D. Cotterill; b: DM 8662, © A. Monadjem; c: NMZB 29868, © F. P. D. Cotterill).

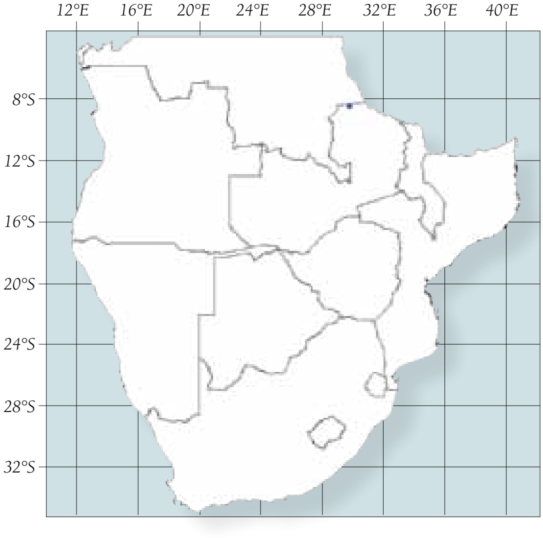
fig. 160b

fig. 160c

Nycteris major K. Andersen 1912

Dja slit-faced bat

Vulnerable



Description: *Nycteris major* is a small bat with an estimated mass of about 12 g. It closely resembles *N. arge*, from which it differs in being slightly larger (Rosevear 1965). The ears are long, and the tragus has a characteristic shape with a concave kink on its outer margin at about half its length, distinguishing the *arge* group from all other *Nycteris* species.

The skull is similar to, but larger than that of the closely related *N. arge*. The sagittal crest is well developed. The posterior lower premolar is well developed and in the toothrow (Rosevear 1965).

Key identification features: The facial slit covering the noseleaf easily distinguishes this genus from other microbats in the region. The *arge* group can be distinguished from all other *Nycteris* species by the well-developed posterior lower premolar and the characteristic concave kink in the outer margin of the tragus. *N. major* is the largest in the *arge* group, overlapping only marginally with *N. arge*.

External and cranial measurements (mm) for *Nycteris major*, sexes combined

	Mean	Min	Max	SD	N
Mass	-	-	-	-	-
FA[1]	46.9	44.0	48.5	1.52	6
Total	-	-	-	-	-
Tail[2]	-	59	64	-	-
Tibia[1]	25.3	24.2	26.1	0.76	6
Ear[2]	-	27	32	-	-
CI	-	-	-	-	-
GSL[1]	20.9	20.2	21.7	0.72	4

[1] Van Cakenberghe and De Vree (1985)
[2] Rosevear (1965)

Echolocation call: The echolocation call of this species has not been recorded in southern Africa.

Distribution, habitat and roosting: So far, *Nycteris major* has only been recorded from a single specimen in northeastern Zambia (Van Cakenberghe and De Vree 1985). The type specimen is from Cameroon (BM 1909.10.2.49). Virtually nothing is known about the roosting requirements and habitat of this species, except that most specimens have been collected from rainforest. However, the Zambian specimen was collected from Mweru Wantipa, which comprises mostly open lakeshore habitat, although gallery forests characterise rivers and streams in this region.

Extralimital: *Nycteris major* has been recorded from the DRC, Cameroon, Gabon, Benin and Côte d'Ivoire (Van Cakenberghe and De Vree 1985).

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1912. *Petalia major* K. Andersen, Annals and Magazine of Natural History 10(59): 547. Dja River, Cameroon.

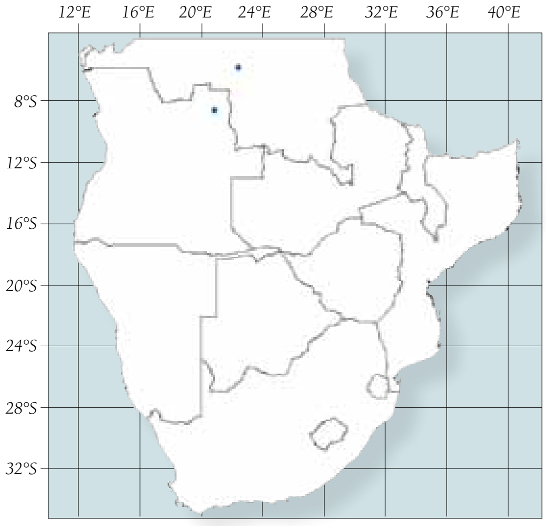
The diploid number in *N. major* is not known.

Figure 161. *Nycteris major*, showing very long ears (© J. Fahr).

Nycteris nana K. Anderson 1912

Dwarf slit-faced bat

Least Concern



Description: *Nycteris nana* is a small bat with a mass of 5–6 g. The pelage is dark brown with little difference between the upper and underparts. The wings are dark brown and sparsely covered in hair. The ears are long and the tragus has a characteristic shape with a concave kink on its outer margin at about half its length, distinguishing the *arge* group from all other *Nycteris* species. The sexes resemble each other.

The skull is gracile with weak zygomatic arches, and is strongly bowed in lateral profile, rising steeply to a high, rounded peak in the mid-parietal region. The sagittal crest is absent. The frontal depression is pronounced, flanked by well-developed supra-orbital ridges. The dental formula is 2113/3123 = 32. The upper incisors are bifid. The posterior lower premolar is well developed and in the toothrow.

External and cranial measurements (mm) for *Nycteris nana*, sexes combined

	Mean	Min	Max	SD	N
Mass	-	-	-	-	-
FA[1]	33.9	31.7	37.0	1.07	47
Total	-	74	92	-	-
Tail[2]	-	34	42	-	-
Tibia[1]	15.1	12.8	16.4	0.89	31
Ear[2]	-	20	22	-	-
CI	-	-	-	-	-
GSL[1]	15.9	15.1	16.7	0.32	48

[1] Van Cakenberghe and De Vree (1985)

[2] Rosevear (1965)

Key identification features: The facial slit covering the noseleaf distinguishes this genus from other bats in the region. The *arge* group can be distinguished from all other *Nycteris* species by the well-developed posterior lower premolar and the characteristic concave kink in the outer margin of the tragus. *Nycteris nana* is smaller (FA < 37 mm) than *N. arge* (FA > 38 mm), but overlaps somewhat with *N. intermedia* (FA mostly 36–38 mm).

Echolocation call: The echolocation call of this species has not been recorded in southern Africa.

Distribution: *Nycteris nana* is a common rainforest inhabitant of Central and West Africa, but is marginal to southern Africa. So far, it has only been recorded from the southern DRC and northeastern Angola. However, it may be more widely distributed in the far northern parts of Angola and the southwestern DRC. The type specimen is from Equatorial Guinea (BM 1900.2.5.46).

In southern Africa, this species is very poorly represented in museums, with just four records examined for this book.

Nothing is known about its roosting habits in southern Africa. Elsewhere in its range, *Nycteris nana* roosts singly or in small family groups, preferring hollow trees with large trunks and an opening near the ground (Verschuren 1957a, Rosevear 1965). This species is predominantly associated with lowland rainforest, but in southern Africa, it also occurs in forest edge habitats.

Extralimital: *Nycteris nana* has been widely recorded from the tropical rainforest zone of Central and West Africa, including Kenya, Uganda, Sudan, DRC, Cameroon, Ghana and Côte d'Ivoire (Van Cakenberghe and De Vree 1985).

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1912. *Petalia nana* K. Andersen, Annals and Magazine of Natural History 10(59): 547. Rio Muni (= Equatorial Guinea).

The diploid number in *N. nana* is not known.

fig. 162a

fig. 162b

fig. 162c

fig. 162d

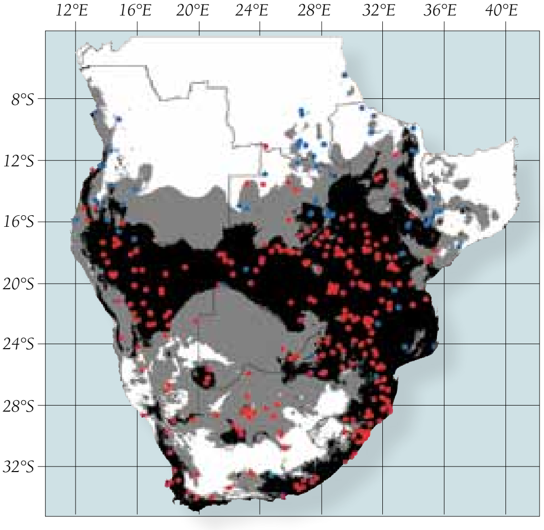
Figure 162. Skull and teeth of *Nycteris nana:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (KRM 2537, Makerere University, Kampala).

◂ **Figure 163**. *Nycteris nana* (© J. Fahr).

Nycteris thebaica E. Geoffroy 1813 ●

Egyptian slit-faced bat

Least Concern



Description: *Nycteris thebaica* is a small bat with a mass of around 10 g. The pelage is highly variable ranging from pale sandy-brown to rich orange or golden. The underparts are slightly paler than the upper parts. The wings are light brown and sparsely covered in hair. The ears are long and the tragus has a characteristic shape, elongated with a rounded tip, termed pyriform. The sexes resemble each other. Adult females are significantly, but only marginally, larger than males (Monadjem 2001).

The skull is moderately robust with moderate zygomatic arches, and is strongly bowed in lateral profile, rising steeply to a high, rounded peak in the mid-parietal region. The sagittal crest is low, but clearly visible, tapering posteriorly. The frontal depression is pronounced, flanked by well-developed supraorbital ridges. The palatal ridge is short. The mandible has moderately developed coronoid processes. The dental formula is 2113/3123 = 32. The upper incisors are bifid.

Key identification features: The facial slit covering the noseleaf distinguishes this genus from other microbats in the region. *Nycteris thebaica* can be separated from *N. macrotis* by a combination of its smaller size (where the two species overlap, *N. thebaica* FA < 50 mm, CI < 18.6 mm; in *N. macrotis* FA > 50 mm and CI > 18.8 mm) and the pyriform tragus. Note that *N. thebaica* from the Northern Cape and south-central Namibia is similar in size to *N. macrotis*. However, *N. macrotis* is entirely absent from this region. *N. hispida* has shorter ears (< 24 mm; in *N. thebaica* > 26 mm) and trifid upper incisors. *N. woodi* is a smaller bat (FA < 41 mm) and the tragus is half-moon-shaped. *N. grandis* is far larger (FA > 57 mm).

Echolocation call: *Nycteris thebaica* produces low intensity, multi-harmonic LD-FM echolocation calls with a high main peak frequency (90±1.3 kHz, n = 10, with additional peaks at around 50, 73 and 113 kHz), broad bandwidth (30.2±11.9 kHz, n = 10), and short duration (1.7±0.5 ms, n = 10) (Schoeman and Jacobs 2008; also see Fenton and Thomas 1980, Fenton and Bell 1981, Fenton *et al.* 1983, Aldridge and Rautenbach 1987, Aldridge *et al*. 1990, Taylor 1999a, Schoeman and Jacobs 2003).

Distribution, habitat and roosting: *Nycteris thebaica* has been recorded widely throughout the entire region, from all the southern African countries except Lesotho. However, it is absent from much of the plateau grasslands of South Africa, the central Karoo and the central Kalahari. The type specimen is from Egypt (MHNH 889-142).

This species is well represented in museums, with over 1,200 records examined for this book. This is partly due to its communal roosting habits, making it easy to collect.

External and cranial measurements (mm) and mass (g) for *Nycteris thebaica*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	10.2	6.0	13.0	1.48	46	**Mass**[1]	11.6	8.0	16.0	1.77	50
FA[1]	46.1	41.6	53.0	2.62	68	**FA**[1]	47.2	42.0	51.0	2.06	74
Total[1]	105.0	83	117	6.85	64	**Total**[1]	109.0	90	161	10.1	70
Tail[1]	51.0	38	60	4.70	65	**Tail**[1]	53.0	40	63	4.90	69
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	32.3	27	38	3.01	69	**Ear**[1]	32.5	26	39	3.35	73
CI[1]	17.9	16.2	18.9	0.54	34	**CI**[1]	18.0	16.6	19.2	0.61	22

[1] Specimens measured by the authors

fig. 164a

fig. 164b

fig. 164c

fig. 164d

Figure 164. Skull and teeth of *Nycteris thebaica:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8668).

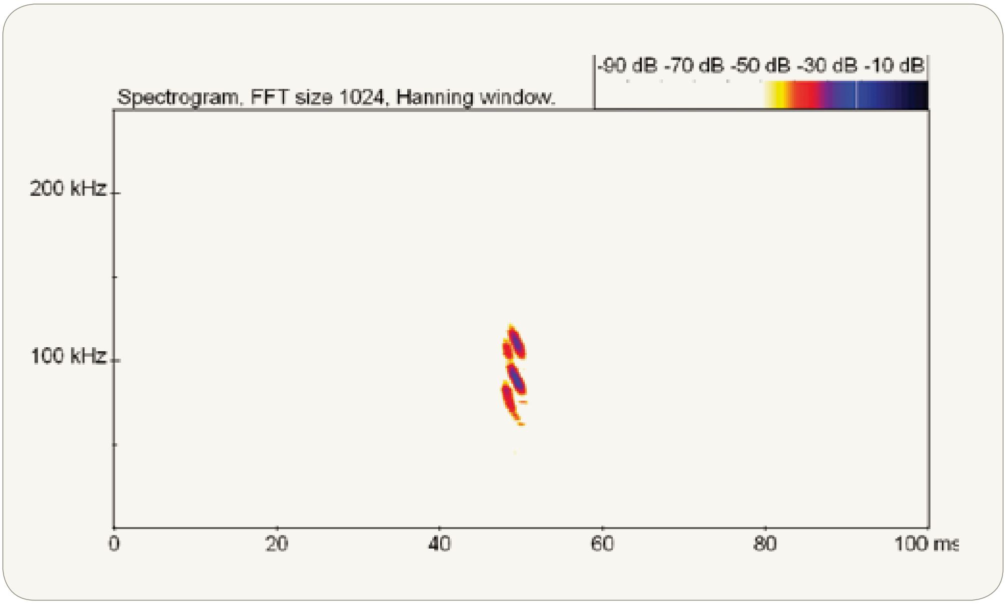


Figure 165. Echolocation call of *Nycteris thebaica*.

Nycteris thebaica roosts during the day in a variety of shelters including caves, aardvark (*Orycteropus afer*) burrows, culverts under roads, and the trunks of large trees such as *Adansonia digitata*. The day roost is often not completely dark and caves need not be extensive or deep. The species also utilises night roosts at which it consumes its prey and socialises with conspecifics (Monadjem *et al*. 2009). Both day and night roosts may contain several hundred bats (Monadjem 1998a), and a roost in Drotsky's Cave in northern Botswana had 600 individuals (Smithers 1971). Individuals appear to co-inhabit the same day roost over many years (Monadjem 2006a). In Swaziland individuals travel an average of 1.1 km between day roosts and foraging areas (Monadjem *et al*. 2009) where foraging home ranges are relatively small (12.9 ha) and overlap significantly with those of neighbouring bats (Monadjem *et al*. 2009). The habitat of this wide-ranging species is not easy to quantify. It appears to occur throughout the savanna and karoo biomes, but avoids open grasslands. It forages by flying low above the ground, listening for prey scurrying on the surface. This mode of foraging may make it susceptible to predation by owls, hence the requirement for tree cover. This species is capable of covering relatively large distances as highlighted by the recovery of a banded individual 100 km away from where it was originally captured (Monadjem 2006b).

Extralimital: *Nycteris thebaica* has also been widely recorded from the rest of Africa, and is only absent from the Sahara Desert and the Congo basin.

Foraging ecology: *Nycteris thebaica* has short, rounded wings with low wing loading (6.3 N.m^{-2}) and low aspect ratio (5.3) (Norberg and Rayner 1987; also see Schoeman and Jacobs 2003, 2008). It is a clutter forager. Its diet varies seasonally, with Orthoptera, Coleoptera and Lepidoptera predominating in most areas, but the bats also take a variety of other insects and arachnids in small proportions (Fenton *et al.* 1977, Fenton and Thomas 1980, LaVal and LaVal 1980, Aldridge *et al.* 1990, Bowie *et al.* 1999, Seamark and Bogdanowicz 2002, Schoeman and Jacobs 2003, Schoeman 2006).

Reproduction: Breeding is seasonal. Copulation takes place on the wing, while both bats are hovering (Lindeque 1987). In KwaZulu-Natal, females come into oestrous in June, at the peak period of sperm production in males. Copulation and fertilisation occur in late June. The young are born in November after a five-month gestation. Lactation lasts two months (Bernard 1982a). In other parts of southern Africa, births also occur in the early wet season, October–December (Smithers 1971, Smithers and Wilson 1979, Monadjem 1998a).

SYSTEMATIC NOTES

1813. *Nycteris thebaicus* E. Geoffroy, Annales du Muséum national d'histoire naturelle, Paris 20: 20. Egypt.

Meester *et al.* (1986) recognised three subspecies in the region; however, these three populations do not appear to occupy geographically isolated areas. Instead, they represent stages in a gradual cline in characters from east to west. Individuals in the east tend to be darker and smaller, while bats from the Northern Cape and Namibia are significantly larger and distinctly paler. Furthermore, the treatment of subspecies in this species is currently uncertain (Gray *et al.* 1999). For this reason, we do not recognise any subspecies in southern Africa.

The diploid number in *N. thebaica* is 2n = 42 and aFN = 78 (Rautenbach *et al.* 1993).

fig. 166a

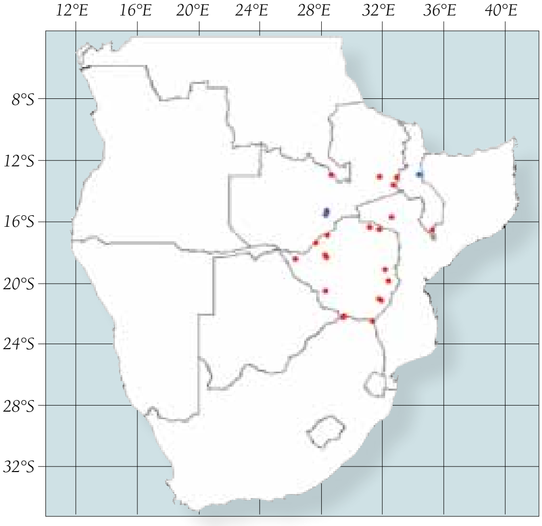
Figure 166. *Nycteris thebaica,* showing very long ears and characteristic pyriform tragus (a: SMG 15760, © E. C. J. Seamark; b: Merlin D. Tuttle, Bat Conservation International, www.batcon.org)

fig. 166b

Nycteris woodi K. Anderson 1914

Wood's slit-faced bat

Near Threatened



Description: *Nycteris woodi* is a small bat with a mass of around 7 g. The pelage is dark brown on the upper parts and paler underparts, which are pure white in the majority of Zimbabwe specimens examined. The wings are pale reddish-brown to grey-brown and sparsely covered in hair. The ears are long and the tragus is characteristically half-moon-shaped (semi-lunate). The sexes resemble each other.

The skull is gracile with weak zygomatic arches, and is strongly bowed in lateral profile, rising steeply to a high, rounded peak in the mid-parietal region. The sagittal crest is very weak or absent. The frontal depression is pronounced, flanked by well-developed supra-orbital ridges. The palatal bridge is short. The mandible has weakly developed coronoid processes. The dental formula is 2113/3123 = 32. The upper incisors are bifid.

Key identification features: The facial slit covering the noseleaf distinguishes this genus from other microbats in the region. *Nycteris woodi* can be distinguished from *N. macrotis*, with which it shares a semi-lunate tragus, by its smaller size (FA < 43 mm and CI < 16.5 mm; in *N. macrotis* FA > 50 mm, CI > 18.8 mm). *Nycteris thebaica* is slightly larger (FA > 42 mm; CI > 16.2 mm), with some overlap; however, the tragus of *N. thebaica* is characteristically pointed with a rounded tip. The similar *N. hispida* has shorter ears (< 24 mm; in *N. woodi* > 26 mm) and trifid upper incisors (bifid in *N. woodi*). The pure white colour of the venter and throat, present in nearly all specimens, is diagnostic.

Echolocation call: *Nycteris woodi* produces low intensity, multi-harmonic LD-FM echolocation calls with an intermediate main peak frequency (43 kHz, n = 5), intermediate bandwidth (20 kHz, n = 5), and short duration (2 ms, n = 5) (Fenton and Bell 1981; also see Fenton and Thomas 1980).

Distribution, habitat and roosting: *Nycteris woodi* has been recorded across the Limpopo and Zambezi valleys in the northeast of the region. It is restricted to the extreme northern parts of South Africa, southern and northern Zimbabwe, southern and eastern Zambia, the Tete Province of Mozambique and southern Malawi. The species appears to be absent from the Kalahari Plateau. The habitat-suitability model suggests that suitable conditions occur extensively in southern Mozambique, where the species may have been overlooked. The type specimen is from Zambia (BM 14.4.22.2, Holotype).

This species is poorly represented in museums, with just over 50 specimens examined for this book.

It roosts in family groups or colonies of up to 40 individuals in hollow *Adansonia digitata* trees, small sandstone caves, and mine adits, with a single record of a colony roosting in a storeroom (Cotterill 1996a). It appears to occupy semiarid

External and cranial measurements (mm) and mass (g) for *Nycteris woodi,* males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	6.3	5.0	7.0	0.83	5	**Mass[1]**	7.0	7.0	7.0	-	3
FA[1]	39.3	38.0	40.6	0.74	12	**FA[1]**	40.8	39.0	42.5	1.30	8
Total[1]	96.1	86	104	5.80	11	**Total[1]**	102.0	93	108	5.19	7
Tail[1]	50.0	44	54	2.90	11	**Tail[1]**	51.0	42	55	4.70	7
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	32.0	29	35	2.00	12	**Ear[1]**	32.0	30	34	1.50	8
CI[1]	16.0	15.6	16.3	0.40	4	**CI[1]**	16.0	15.7	16.4	0.27	6

[1] Specimens measured by the authors

fig. 167a

fig. 167b

fig. 167c

fig. 167d

Figure 167. Skull and teeth of *Nycteris woodi:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (TM 20408).

and moist savannas of south-central Africa, generally below 1,000 m above sea level, although the type specimen was collected at 1,250 m above sea level (Meester *et al*. 1986).

Extralimital: *Nycteris woodi* has also been recorded from Tanzania (Cotterill in press c).

Foraging ecology: *Nycteris woodi* has short, broad wings with low wing loading (5.0 $N.m^{-2}$) and low aspect ratio (5.44) (Cotterill in press c), allowing slow manoeuvrable flight. It is a clutter forager. Its diet consists mainly of Lepidoptera, Coleoptera and Diptera (Fenton and Thomas 1980; also see Whitaker and Black 1976, Findley and Black 1983).

Reproduction: It appears to breed at the beginning of the wet season with gravid females collected in November and females with young observed in January (Cotterill in press c).

SYSTEMATIC NOTES

1914. *Nycteris woodi* K. Anderson, Annals and Magazine of Natural History (8)13: 563. Chilanga, Zambia.

Meester *et al.* (1986) recognised two subspecies in the region, the nominate subspecies in Zambia and *N. woodi sabiensis* Roberts 1946 (TM 8578, Holotype) in Zimbabwe. Since these two populations do not appear to be geographically isolated, we do not distinguish any subspecies at present. Nevertheless, the phylogeography of the entire species (also in Tanzania) needs to be investigated. We do not agree with Van Cakenberghe and De Vree (1985), who treated *benuensis* Aellen 1952 (Cameroon) and *parisii* De Beaux 1924 (northeastern Africa) as synonyms of *N. woodi*; the difference in bacular morphology between *parisii* and *woodi* points to convergent evolution of two distant relatives (Thomas *et al.* 1994).

The diploid number in *N. woodi* is 2n = 42 and aFN = 78 (Rautenbach *et al.* 1993).

▲ **Figure 168**. *Nycteris woodi* (BM 14.4.22.2, Holotype; © F. P. D. Cotterill).

▶ **Figure 169.** A female *Nycteris woodi,* showing the very long ears and pure white throat and venter (NMZB 33750 © F. P. D. Cotterill).

SUBORDER VESPERTILIONIFORMES

Family Molossidae
Free-Tailed Bats

This family is represented by about 35 species in seven genera, of which 20 species in 7 genera have been recorded from southern Africa (Simmons 2005). Members of this family are immediately recognisable by the unique arrangement of the tail, which extends beyond the end of the tail membrane, giving rise to the common name of this group – free-tailed bats (Figure 174a). They have plain faces without noseleafs, but the upper lip is typically wrinkled in most molossids (except in the larger *Tadarida* species), giving them a bulldog appearance (Figure 174b). Pheromones are important in their social behaviour. Each species has a distinct, strong, often aromatic scent (Kingdon 1974). The family includes some the commonest *(Chaerephon pumilus)*, as well as rarest *(Tadarida lobata)*, bat species. Much of what we know about the more poorly known species reflects the devoted research of the late Randolph Peterson of the Royal Ontario Museum and Dr David L. Harrison.

Some African molossids, notably *Mops condylurus*, are locally abundant, but a surprising number of species number amongst the rarest and most poorly known of mammals; a situation exemplified by *Tadarida lobata* and *T. ventralis* (Figure 173). Their inconspicuous roosts and high-flying habits make them challenging to locate and study. By their very nature, many locality records of molossids reflect serendipitous collecting events, which are so sparse that our knowledge of even the basic biology of most species has not improved since their original discoveries; even though several of these poorly known species were made known to science over 150 years ago. These enigmatic circumstances are epitomised by the circumstances in which two new species of forest-dwelling African molossids were discovered a century ago:

> On 8 September 1910, a violent storm blew down a large hollow tree in the Ituri forest near the American Museum Congo expedition camp of Herbert Lang and James Chapin. Living inside the tree were two species of molossid bats, both later described by J. A. Allen as new to science, one as *Mops congicus* and the other as *Chaerephon russatus* (Allen *et al*. 1917). Both species have continued to be among the rarest in collections (Peterson 1971: 297).

Our knowledge of the biology of both *M. congicus* and *C. russatus* is still poor; it resides primarily in the museum records from across Africa's equatorial forest belt. The status of *Chaerephon gallagheri* is even more enigmatic. This small free-tailed bat still remains known solely from the type specimen (BM 1976.207, Holotype) collected on 14 November 1974 by Major M. D. Gallagher in Scierie Forest (3°10'S and 25°46'E) in the southern Congo basin during the Zaire River Expedition. The diagnostic characters of the skull morphology, interaural pouch and crest of *C. gallagheri* comprise adaptations unique amongst the known African Molossidae (Harrison 1975, Gallagher and Harrison 1977). These characters render the phylogenetic affinities of this most poorly known mammal distinctly mysterious; a lack of knowledge that we can only remedy by behavioural studies, additional museum specimens, and tissue for DNA sequencing. We highlight the possibility that this fascinating species could occur further south in the Congo basin, because the type locality of *C. gallagheri* lies ~90 km north of the northern boundary of our study region.

Within the southern African genera, the status of *Otomops* and *Sauromys* are generally not disputed. *Sauromys* was previously treated as a subgenus of

Platymops, which is restricted to East Africa (Peterson 1965). *Sauromys* has a noticeably dorsoventrally flattened skull, a feature which allows it to enter narrow rock crevices. *Otomops* has very large ears protruding beyond the end of the snout, which itself protrudes beyond the lower jaw. The majority of molossids share adaptations for crevice roosting – including stout, sturdy legs, and the specialised sensory hairs on the body and muzzle and ear margins. Moreover, the conspicuous combs of slightly curved hairs along the outer margins of the toes appear to have a sensory function, and are perhaps also used in grooming. Molossids can scuttle with surprising speed, forward and backward. They often reveal their presence in daytime by strident squeaks (Rosevear 1965). The wings are characteristically long and pointed – adaptations for agile, swift flight.

Echolocation calls are low duty-cycle, constant frequency (LD-CF) or quasi-constant frequency (LD-QCF), and most species emit calls of low frequency; a few even echolocate within the audible range of humans (i.e. < 20 kHz).

The taxonomic relationship between the genera *Chaerephon*, *Mops* and *Tadarida* is confused with some (or all) these genera being polyphyletic, and some authors treating them as subgenera of *Tadarida*. *Mops* and *Tadarida*, however, appear to present consistent features, and we have maintained these genera for convenience, until future evidence becomes known. *Mops* species have ears that are characteristically joined at the base by a flap of skin, while the ears in *Tadarida* species are separate right to their base. Furthermore, the larger *Tadarida* species (all except *T. aegyptiaca*) do not have wrinkled upper lips and exhibit well-developed, wide emarginations of the palate (Figure 175). There does not appear to be a unique set of characters uniting members of *Chaerephon*, and this genus may well prove to be polyphyletic. A possible explanation for this could be that *Chaerephon* is currently a dumping ground for those species that do not fit criteria for any of the other genera.

We do not view *Mormopterus acetabulosus* as being part of the southern African bat fauna, despite the existence of a specimen from Durban (South Africa), and therefore do not present it in a separate species account (see 'Classification and taxonomy' for further details).

fig. 170a

fig. 170b

fig. 170c

Figure 170. (a) Dorsal, (b) ventral and (c) lateral views of the skull of *Chaerephon gallagheri* (BM 1976.207, Holotype) illustrate the enlarged nasal tubercles, which appear to have a role in modulating the sonar calls of this poorly known free-tailed bat. Scale bar = 10 mm (© F. P. D. Cotterill).

Figure 171. Reconstruction of the head of *C. gallagheri* in lateral view illustrates the remarkable development of the interaural pouch. Scale bar = 10 mm (facsimile from *Mammalia* 1975 39: 314).

Figure 172. The wet specimen of *C. gallagheri* (BM 1976.207, Holotype) reveals the morphology of the interaural pouch (the head is orientated vertically) in dorsal view (© F. P. D. Cotterill).

fig. 171

fig. 172

Figure 173. A recent photograph of David L. Harrison comparing the first known southern African specimen (HZM 1.4244) of *Tadarida lobata* against a series of the equally rare *T. ventralis*. At the time of its discovery to science (in 1970) this was one of the only three specimens of *T. lobata* known. The diagnostic interscapular patch of white fur is clearly visible on the study skin (© Ariya Dejtaradol).

fig. 174a

fig. 174b

Figure 174. Illustrations of a typical Molossidae showing (a) tail extended beyond the tail membrane, and (b) face with wrinkled upper lip.

fig. 175a

fig. 175b

Figure 175. Anterior palatal emargination: (a) reduced emargination separated from the foramina by a bony bar, and (b) well-developed, wide emargination continuous with the foramina.

TABLE 15. IDENTIFICATION MATRIX FOR GENERA WITHIN THE FAMILY MOLOSSIDAE

GENUS	FA (MM)	EARS	DENTITION	ANTERIOR EMARGINATION OF PALATE	OTHER
Myopterus	33–36	widely separated	cusps of 3rd upper molar reduced to V-shape	not well developed	yellowish-white wing membrane contrasting with dark body (*Myopterus whitleyi*)
Chaerephon	36–51	joined above bridge of nose by band of skin	lower canines almost touching at their bases (more widely spaced in *Tadarida*); upper third molar with 3rd ridge > half as long as 2nd	usually reduced and separated from palatal foramina by bony bar	males with crest of stiff hairs on forehead (except *C. ansorgei* and *C. bivittatus*); narrow white or cream band on inner flanks where the wings join the body (except *C. ansorgei*)
Sauromys	42–46	ears separate	canine and posterior premolar well separated	anterior palatal emargination wide	head conspicuously flattened
Mops	27–66	joined above bridge of nose by band of skin	cusps of 3rd upper molar reduced to V-shape; 3rd leg noticeably shorter than 2nd leg	not well developed, separated from palatal foramina by bony bar	males with crest of stiff hairs on forehead (except *M. midas*); band of short hair in front of shoulders – appears naked (also present in *Chaerephon nigeriae*); narrow white or cream band on inner flanks where the wings join the body (except *M. condylurus*)
Tadarida	45–66	ears meet across bridge of nose – not joined by band of skin	cusps of 3rd upper molar N-shaped	well developed, width of emargination > diameter of upper incisor	with exception of *T. aegyptiaca*, lips not wrinkled
Otomops	62–73	large ears that meet on extended snout	upper anterior premolar separated from canine by a narrow diastema	palatal foramina merged to form a dorsoventrally elongated emargination with a very narrow neck at the anterior palatal margin	conspicuous paler shoulder band separating darker anterior and posterior upper regions

TABLE 16. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE GENUS *TADARIDA* (MOLOSSIDAE)

SPECIES	FA (MM)	DISTINGUISHING COLOUR AND MARKS	PF (KHZ)
T. aegyptiaca	45–54	ears not joined by flap of skin; upper lip wrinkled	~23
T. lobata	55–62	upper lip not wrinkled; white patch of fur on back between shoulders; gular sac on throat (naked patch); interdental palate markedly constricted between upper canines relative to width of anterior and posterior palate	NA
T. fulminans	56–62	upper lip not wrinkled; white band of hairs along flanks under wings; soles of feet with pads, gular sac on throat	~17
T. ventralis	61–65	upper lip not wrinkled, white band along flanks absent; gular sac on throat (naked patch); large tragus not concealed by anti-tragus	~19

TABLE 15. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE GENUS *MOPS* (MOLOSSIDAE)

SPECIES	FA (MM)	CREST ON HEAD	DISTINGUISHING COLOUR AND MARKS	PF (KHZ)
M. nanulus	27–31	absent	greyish-brown above with dark band on flanks	NA
M. thersites	36–41	absent	blackish-brown above with dark underparts and black flanks	NA
M. brachypterus	37	-	-	NA
M. niveiventer	42–47	mature male	grey-brown above with contrasting blackish crown	~20
M. condylurus	44–51	mature male	greyish-brown above, underparts paler becoming dirty white to white on the belly	~26
M. midas	60–66	absent	greyish-brown to dark brown above, flecked with white, short fur giving a smooth appearance	~11 or 16

TABLE 18. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE GENUS *CHAEREPHON* (MOLOSSIDAE)

SPECIES	FA (MM)	CREST ON HEAD	DISTINGUISHING COLOUR AND MARKS
C. major	39–50	mature male – conspicuous brown crest	brown above and in part below; venter brown with medial pale stripe; white or cream lateral flank stripe along inner border of wing; lappet-shaped interaural gland
C. chapini	38–42	mature male – conspicuous bicoloured crest	white band from throat to sternum; underparts and venter pure white or cream; white wings; small, white interaural gland in females
C. pumilus	38–42	mature male	white band on mid- belly extending as narrow band on chest variably present; cream band on inner flanks
C. ansorgei	43–51	absent	dorsal greyish-brown, paler below – contrasts with dark brown throat; lacks cream band on inner flanks
C. nigeriae	45–50	mature male	below and above dark coloured – no black throat, conspicuous band of long white fur along inner borders of wing
C. bivittatus	46–51	absent	upper parts slightly paler than under, white/ cream band along inner flanks, head and shoulders usually speckled with tiny white spots

ROOST	RANGE IN SOUTHERN AFRICA	OTHER
caves, rock crevices, hollow trees; roofs of buildings	widespread, and abundant throughout region	ears > 25 mm
crevices in rock faces; roofs of buildings	restricted to north and northeast	ears > 25 mm
crevices in rock faces; under exfoliating rock	restricted to northeastern parts	ears < 25 mm
crevices in rock faces	restricted to northeastern parts	ears < 25 mm

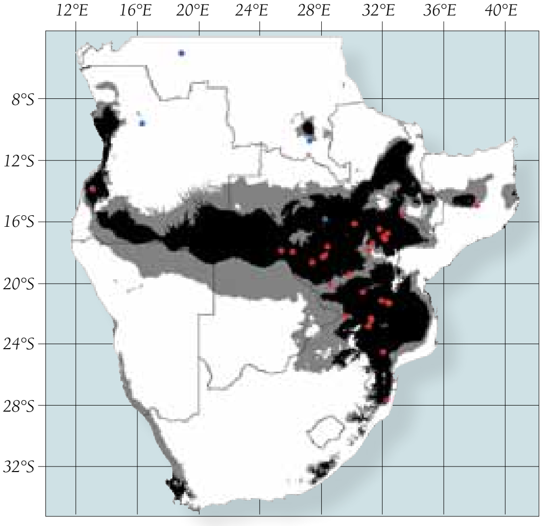
ROOST	RANGE IN SOUTHERN AFRICA	DENTITION
roofs of thatched houses; hollow trees	Congo basin	upper anterior premolar small, in toothrow
roofs of houses; hollow trees	Congo basin	upper anterior premolar small, in toothrow
-	single specimen from northern Mozambique	anterior upper premolar relatively well developed
narrow cracks in cliff faces, hollow trees, roofs of houses	restricted from southern Zambia to Angola and DRC, also Mozambique	anterior upper premolar distinctly shorter than cingulum of posterior premolar, within toothrow or slightly displaced labially; upper third molar with third ridge absent
narrow cracks in cliff faces, hollow trees, roofs of houses	widespread and abundant in eastern parts	anterior upper premolar is minute, lies external to the toothrow and in some specimens is missing; upper third molar with third ridge less than half length of second
narrow cracks in cliff faces, hollow trees, roofs of houses	widespread in warm northeastern and northern parts	anterior upper premolar distinctly shorter than cingulum of posterior premolar, within toothrow; upper third molar with third ridge absent

PF (KHZ)	RANGE IN SOUTHERN AFRICA
–	restricted to north
~20	restricted to northern parts of Zimbabwe, Botswana, and Namibia; scattered records in Angola, Zambia and DRC
~25	widespread and abundant in eastern and northern parts
~18	widespread, but sparse in eastern and northern parts
~17	restricted to central and north (absent from Mozambique)
~21	widespread, but sparse in eastern and northern parts

Chaerephon ansorgei (Thomas 1913)

Ansorge's free-tailed bat

Least Concern



Description: *Chaerephon ansorgei* is a small to medium-sized bat with a mass of around 20 g. The pelage is greyish-brown; some individuals are rufous. The underparts are slightly paler than the upper parts, which contrast with a dark brown throat. The wings are light brown. It lacks a narrow white or cream band on the inner flanks where the wings join the body. Typical of the family, the tail is not completely enclosed within the tail membrane. The head, shoulders and back may be speckled with tiny white spots, a feature shared with *C. bivittatus*. The upper lip is wrinkled, giving a bulldog appearance. Mature adult males do not have an erectile crest on top of the head. The ears are joined by a flap of skin.

In lateral profile, the braincase is slightly elevated, not as flat as in *T. aegyptiaca*. The supra-occipital (lambdoid) ridge is well developed, while the sagittal crest is present only as a thin line and not raised. The zygomatic bars are more slender than in *T. aegyptiaca*, and are not thickened dorsoventrally posteriorly. The anterior palate is emarginated, but less deeply than in *T. aegyptiaca*. The coronoid processes of the mandible are very poorly developed. The dental formula is 1123/2123 = 30. The lower incisors are bicuspid and may be crowded. The lower canines almost touch at their bases, as opposed to the more widely spaced canines of *T. aegyptiaca*. The upper third molar has the third ridge more than half as long as the second ridge.

Key identification features: In southern Africa, *Chaerephon ansorgei* can be confused with several other small molossids. *Tadarida aegyptiaca* is similar in size and colouration, but lacks the blackish beard. The absence of any white mid-ventral colouration distinguishes it from *Mops condylurus*. *Chaerephon bivittatus* is even more similar in appearance, but can also be distinguished by the absence of a black beard. *Chaerephon nigeriae* is much more darkly coloured and has a conspicuous white band of fur running longitudinally along the inner borders of the wings. *Chaerephon chapini* and *C. pumilus* are significantly smaller (FA < 42 mm).

Echolocation call: *Chaerephon ansorgei* produces LD-QCF calls with a low peak frequency (17.8 kHz, n = 5), narrow bandwidth (12 kHz, n = 5), and long duration (15 ms, n = 5) (Fenton and Bell 1981). Calls recorded from two individuals flying in a tent had a shorter duration (6.1±0.88 ms) and higher peak frequency (24.2±1.58 kHz) (P. J. Taylor, unpublished data). Besides the fundamental, the second and third harmonics may be present on the spectrogram.

Distribution, habitat and roosting: *Chaerephon ansorgei* occurs from northern KwaZulu-Natal, through the Kruger National Park to Zimbabwe and marginally into Zambia, DRC and Mozambique. An apparently geographically isolated population is restricted to western Angola. The habitat-suitability

External and cranial measurements (mm) and mass (g) for *Chaerephon ansorgei*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	20.9	19.0	23.0	1.46	8	**Mass**	17.6	15.0	19.5	1.89	4
FA[1]	47.2	42.8	51.0	2.82	12	**FA**[1]	46.0	44.8	49.0	1.47	7
Total[1]	116.0	102	123	7.25	9	**Total**[2]	106.0	102	113	6.08	3
Tail[1]	40.0	36	42	2.30	9	**Tail**[1]	37.0	36	39	1.70	3
Tibia[1]	15.1	-	-	-	1	**Tibia**	15.3	15.0	15.5	0.26	3
Ear[1]	21.0	20	22	0.70	9	**Ear**[1]	20.0	19	20	0.60	3
CI[1]	18.6	18.5	18.8	0.12	6	**CI**	18.1	17.6	19.0	0.47	6

[1] Specimens measured by the authors

fig. 176a

fig. 176b

fig. 176c

fig. 176d

Figure 176. Skull and teeth of *Chaerephon ansorgei:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8608).

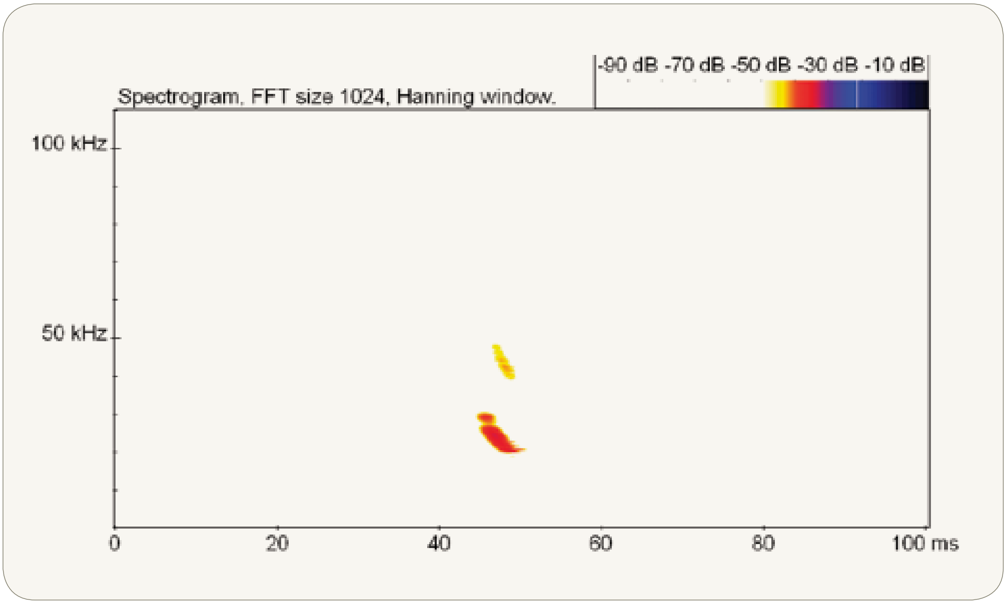


Figure 177. Echolocation call of a tent-flown *Chaerephon ansorgei.*

model suggests that suitable conditions occur in southern Mozambique. The type specimen is from Malanje, Angola (BM 1910.4.8.4).

This species is well represented in museums from within the core of its range in Zimbabwe, where more than 250 individuals were examined for this book. However, only 24 specimens have been collected outside of Zimbabwe.

It inhabits dry woodland savanna (Bouchard 2001a), in the vicinity of rugged hills and mountain ranges with rocky cliffs and precipices (F. P. D. Cotterill, unpublished data). This species roosts communally in small to medium-sized groups, which may number in the hundreds (Allen *et al.* 1917). Natural roost sites include narrow cracks in rocks, especially on cliff faces (Cotterill and Fergusson 1993), but the species has taken to roosting in buildings, particularly roofs of houses, and large colonies occupy the expansion joints between the concrete spans in high-level bridges (F. P. D. Cotterill, unpublished data).

Extralimital: *Chaerephon ansorgei* has also been recorded from the DRC, Cameroon, Uganda, Tanzania and Sudan (Bouchard 2001a).

Foraging ecology: They are fast-flying, high aerial feeders. In Zimbabwe, their diet comprised mainly Coleoptera, Trichoptera and Lepidoptera (Fenton 1985).

Reproduction: A single young is born in late November in Zimbabwe, followed by a second birth peak near the end of the hot-wet season (April). In Zimbabwe, gravid females have been collected in October, lactating females in November–January and April (F. P. D. Cotterill, unpublished data).

SYSTEMATIC NOTES

1913. *Nyctinomus ansorgei* Thomas, Annals and Magazine of Natural History (8) 11: 318. Malange (= Malanje), Angola.

Nyctinomus rhodesiae Roberts 1946 (TM9977, Holotype) is a synonym. The main character used to distinguish *Chaerephon ansorgei* (palatal emargination) has been shown to be unreliable; some specimens of *C. pumilus* (which typically lack emargination) from KwaZulu-Natal showed distinct palatal emargination (Taylor 1999b), in spite of genetically grouping with *C. pumilus* and not *C. ansorgei* (Jacobs *et al.* 2004). This variability also underlines the fluidity of generic boundaries between *Tadarida, Chaerephon* and *Mops*. Genetic studies in progress (J. Lamb, unpublished data) also seem not to support the monophyly of these genera; until the generic taxonomy can be unequivocally clarified, we retain the currently accepted genera.

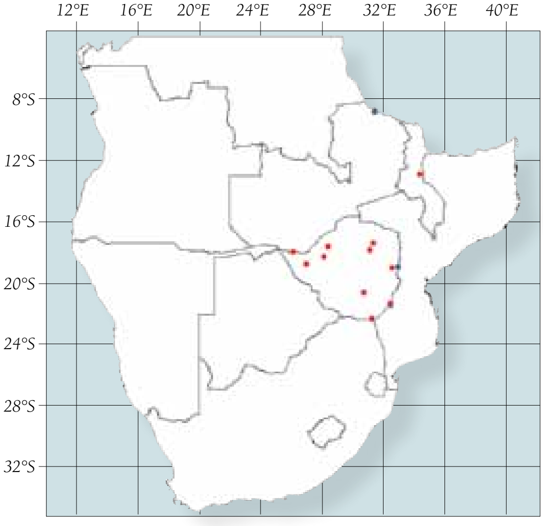
The diploid number of *C. ansorgei* (Cameroon) is 2n = 48 and aFN = 66, X = medium-sized subtelocentric, Y = small acrocentric (Smith *et al.* 1986); in South Africa, it is 2n = 48, aFN = 68, X = medium metacentric, Y = small acrocentric (Rautenbach *et al.* 1993).

Figure 178. Chaerephon ansorgei, showing darker-coloured neck collar (© F. P. D. Cotterill).

Chaerephon bivittatus (Heuglin 1861)

Spotted free-tailed bat

Least Concern



Description: *Chaerephon bivittatus* is a small bat with a mass of around 15 g. The pelage is reddish-brown to greyish-brown; some individuals are rufous. The underparts are slightly paler than the upper parts. The wings are light brown. It lacks a narrow white or cream band on the inner flanks where the wings join the body. Typical of the family, the tail is not completely enclosed within the tail membrane. The head, shoulders and back are speckled with tiny white spots, a feature shared with *C. ansorgei*. The upper lip is wrinkled giving a bulldog appearance. Mature adult males do not have an erectile crest on top of the head. The ears are joined by a flap of skin.

The skull is very similar in shape to that of *C. ansorgei,* with slight elevation of the braincase. The sagittal crest is reduced to a narrow mid-dorsal line, often incomplete in this species (always complete in *C. ansorgei*). The lambdoid crest is moderately developed. The anterior palate is emarginated as in *C. ansorgei*. The mastoid and zygomatic widths are broader in this species (>12 mm for both variables *cf.* < 12 mm in *C. ansorgei*). The dental formula is 1123/2123 = 30. In the third upper molar, the third ridge is almost as long as the second. The lower canines are well separated to almost touching; the cingula are not well developed.

External and cranial measurements (mm) and mass (g) for *Chaerephon bivittatus*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	18.1	15	32	-	104
FA[1]	49.4	46	51	-	131
Total[1]	114.7	106	129	-	136
Tail[1]	40	32	48	-	134
Tibia	-	-	-	-	-
Ear[1]	19.0	15	22	-	130
GLS[1]	20.5	19.5	21.3	-	128

[1] Eger and Peterson (1979)

Key identification features: In southern Africa, *Chaerephon bivittatus* can be confused with several other small molossids. *Tadarida aegyptiaca* is similar in size and colouration, but lacks the flecking on the head, shoulders and back. Absence of any white mid-ventral colouration distinguishes it from *Mops condylurus*. *Chaerephon ansorgei* is even more similar in appearance, but can also be distinguished by its black beard and slightly smaller skull (GSL: 18.5–20.5 mm, in *C. bivittatus* GSL: 19.5–21.5 mm) (Eger and Peterson 1979). *Chaerephon chapini* and *C. pumilus* are significantly smaller (FA < 42 mm).

Echolocation call: *Chaerephon bivittatus* produces LD-QCF echolocation calls. One individual from Zimbabwe, which was free-crawling in a large tent, emitted calls with a low peak frequency (21±0.8 kHz, n = 16 pulses), narrow bandwidth (14±1.32 kHz, n = 16 pulses), and intermediate duration (6.8±0.7 ms, n = 16 pulses) (P. J. Taylor, unpublished data). Besides the fundamental, the second and third harmonics may be present on the spectrogram.

Distribution, habitat and roosting: *Chaerephon bivittatus* occurs widely in Zimbabwe and marginally into Zambia, Malawi and Mozambique. A type specimen is from Kérén, Ethiopia (ZMB 2792a, Syntype).

This species is not well represented in museums, with just 84 specimens examined for this book, of which 80 were collected in Zimbabwe. This species roosts communally in small to medium-sized groups. This species occurs in savanna woodlands usually near exposed rocky outcrops of granite, basalt and sandstone, where they roost in inaccessible crevices often high up in vertical cliffs, or under overhangs. They are known to roost together with *C. ansorgei,* but in smaller numbers.

Extralimital: *Chaerephon bivittatus* has also been recorded from Eritrea, Uganda, Kenya, Tanzania and Sudan.

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

fig. 179a

fig. 179b

fig. 179c

Figure 179. Skull and teeth of *Chaerephon bivittatus:* (a) dorsal view, (b) ventral view, and (c) lateral view. Scale bar = 5 mm (LACM 27473; © F. P. D. Cotterill).

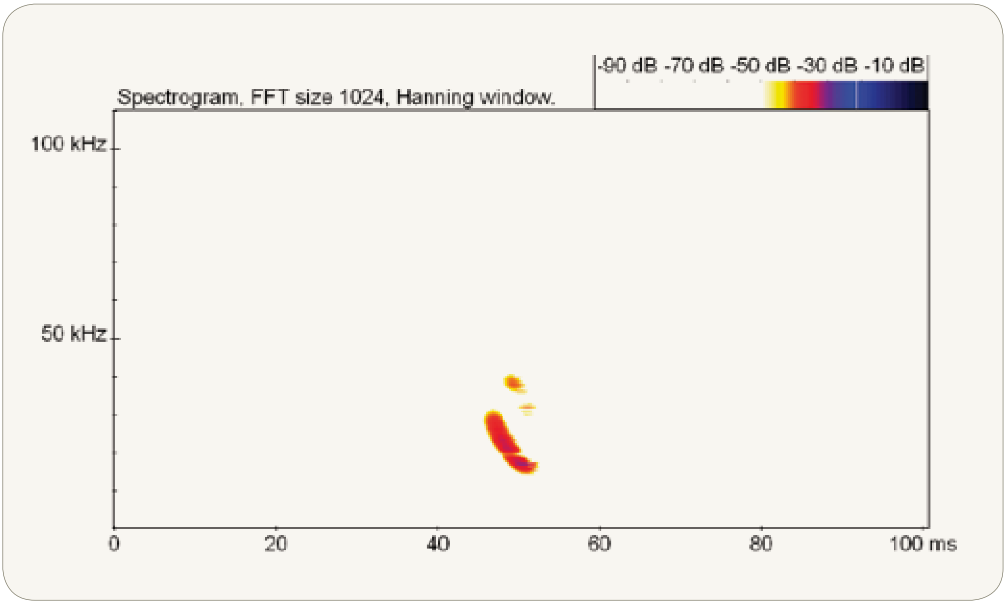


Figure 180. Echolocation call of a free-crawling *Chaerephon bivittatus*.

Reproduction: Pregnant females have been collected in Zimbabwe in October and November. There was, however, no evidence for a second birth peak, as adult females collected at the end of March in Harare were not pregnant or lactating (*cf. C. ansorgei* co-inhabiting the same roost where a second birth season was noted at this time) (F. P. D. Cotterill, unpublished data).

SYSTEMATIC NOTES

1861. *Nyctinomus bivittata* Heuglin, Nova acta Academiae Caesareae Leopoldino Carolinae germanicae naturae, Halle 29 (8): 4, 13. Kérén, Eritrea.

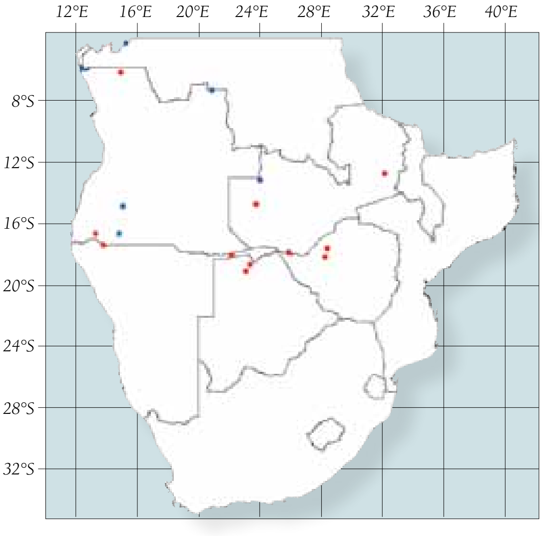
Chaerephon bivittatus can be distinguished from *C. ansorgei* on morphometric grounds using a discriminant function (Eger and Peterson 1979). Since they are so similar, it is likely that these two species have been confused in the literature in the past.

The diploid number in *C. bivittatus* is 2n = 48 and aFN = 54, X = subtelocentric, Y = acrocentric (Peterson and Nagorsen 1975).

Chaerephon chapini J. A. Allen 1917

Pale free-tailed bat

Data Deficient



Description: *Chaerephon chapini* is a small bat with a mass of around 10 g. The pelage is pale greyish to light brown. The underparts are paler than the upper parts, usually pure white, with a white band from the throat to the sternum. The wings are white. There is usually a narrow white or cream band on the inner flanks where the wings join the body. Typical of the family, the tail is not completely enclosed within the tail membrane. The upper lip is wrinkled giving a bulldog appearance. Mature adult males have a long bicoloured crest on the top of the head. This crest normally lies flat across the neck, but can be everted by contraction of the interaural skin fold to project the crest forward over the muzzle. The ears are joined by a flap of skin.

The braincase is distinctly rounded in dorsal view. The mastoids are not as distinct in dorsal view as in *T. aegyptiaca*. In lateral profile, the braincase is elevated above the rostral plane with a distinctly concave forehead (present in *C. bivittatus* and *C. ansorgei*, but not in *C. pumilus*, *C. nigeriae* or *T. aegyptiaca*, which have a flat profile). The zygomatic arches are relatively gracile and not thickened mid-dorsally as in *T. aegyptiaca*. Ventrally, the bony palate encloses separate palatal foramina. The palate is not emarginated. Basioccipital pits are particularly marked in this species. The dental formula is 1123/2123 = 30.

Key identification features: In southern Africa, the small size of *Chaerephon chapini* (FA < 42 mm, and mostly < 40 mm) should prevent confusion with other free-tailed bats except *C. pumilus*. Males of the latter species do not have a long bicoloured crest, while the females are generally much darker than *C. chapini* females, and nearly all lack the pure white underparts that correspond to the transparent, white wing membranes. *Myopterus whitleyi* and *Mops nanulus* are similarly small bats but neither has a crest.

Echolocation call: *Chaerephon chapini* produces LD-QCF calls with a low peak frequency (20 kHz, n = 5), narrow bandwidth (8 kHz, n = 5), and long duration (10 ms, n = 5) (Fenton and Bell 1981).

Distribution, habitat and roosting: *Chaerephon chapini* is sparsely distributed in the northwestern parts of the region, where it has been recorded from northern Botswana and northeastern Zimbabwe to western Zambia. It has also been collected from northern Namibia, western Angola and DRC, which may represent an isolated population. The type specimen is from Faradje, DRC (AMNH 48841, Holotype).

This species is poorly represented in museums, with just 34 specimens known from southern Africa. Fenton and Eger (2002) concluded that the roosting habits of this species were unknown in southern Africa, as all known specimens were

External and cranial measurements (mm) and mass (g) for *Chaerephon chapini*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	7.5	7.0	8.0	-	2	**Mass[1]**	9.3	8.0	12.0	1.89	4
FA[1]	38.9	37.6	40.0	0.99	4	**FA[1]**	38.3	34.7	42.0	1.97	11
Total[1]	98.0	97	99	-	2	**Total[1]**	94.8	90	103	5.68	4
Tail[1]	33.5	33	34	-	2	**Tail[1]**	37.3	33	42	4.51	3
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	18.0	18	18	-	2	**Ear[1]**	16.8	16	18	0.96	4
CI[1]	15.1	-	-	-	1	**CI[1]**	15.2	15.0	15.3	-	2

[1] Specimens measured by the authors

fig. 181a

fig. 181b

fig. 181c

Figure 181. Comparison of the type specimens of *Chaerephon shortridgei* (left: BM 1925.12.4.24, Holotype) and *C. lancasteri* (right: BM 1937.12.8.25, Holotype): (a) study skins of the type specimens (scale bar = 20 mm), (b) dorsal and (c) ventral views of the crania (scale bars = 5 mm) (© F. P. D. Cotterill).

netted; however, all southern African records are associated with cathedral mopane woodland (the type of *lancasteri* was collected in a hollow mopane tree). On release at dawn, at place of netting, in the Sengwa Wildlife Research Area, four females circled above the canopy and then flew into the crown of a tall mopane tree, to seek refuge in a horizontal crevice in a branch (Happold and Cotterill in press).

Extralimital: *Chaerephon chapini* has also been recorded from the DRC, Congo, Kenya, Uganda, Sudan and Ghana (Fenton and Eger 2002).

Foraging ecology: In Zimbabwe, its diet included Coleoptera, Lepidoptera and Diptera (Fenton and Thomas 1980, Fenton 1985).

Reproduction: In northern Botswana, Archer (1977) recorded that five of six females were lactating in early December. In western Zambia, one of five females carried a full-term foetus; four were lactating in early November. At Sengwa Wildlife Research Area, Zimbabwe, three females were heavily pregnant and also lactating in mid-January. These data indicate polyoestry with post-partum oestrus (Happold and Cotterill in press). The scales along the bases of the interaural crest hairs in males are highly modified. These hairs appear to have a function in dispersing pheromones released in the roost during courtship and perhaps territorial defence (Hickey and Fenton 1987).

SYSTEMATIC NOTES

1917. *Chaerephon chapini* J. A. Allen, Bulletin of the American Museum of Natural History 37: 461. Faradje, northeastern Belgian Congo (= DRC).

Hayman and Hill (1971) accepted three subspecies, two of which occur in southern Africa, but these were described based on just six specimens. How the southern African populations relate to the Congo population is not completely known, although Peterson *et al.* (1995) considered *C. chapini shortridgei* Thomas 1926 from Namibia to be specifically distinct (on the basis of distinctly larger skull size) from *C. chapini chapini* J. A. Allen 1917 from the Democratic Republic of Congo (DRC) (Figure 181). On this basis, Simmons (2005) recognised *C. shortridgei* and *C. chapini* as distinct species; should the Zambian/Zimbabwean subspecies *C. chapini lancasteri* Hayman 1938 be shown to be conspecific with the Namibian *C. c. shortridgei* (and distinct from the nominate Congo population), then all southern African populations would need to be named as *C. shortridgei*. Nevertheless, pending a thorough taxonomic review, we provisionally retain the name *chapini* to include all African populations. Within the caveats of insufficient material, it appears that *Chaerephon (Lophomops) langi* Roberts 1932 (*Ann. Transv. Mus.*, 15 (1): 17; TM 6554, Holotype) is a synonym of *shortridgei*, given its dusky belly and shorter interaural crest, but a thorough review is required of this species complex.

The diploid number in *C. chapini* is not known.

fig. 182a

fig. 182b

fig. 182c

Figure 182. Skull and dentition of *Chaerephon chapini:* (a) dorsal view, (b) ventral view, (c) lateral view (SMM 9899).

fig. 183a

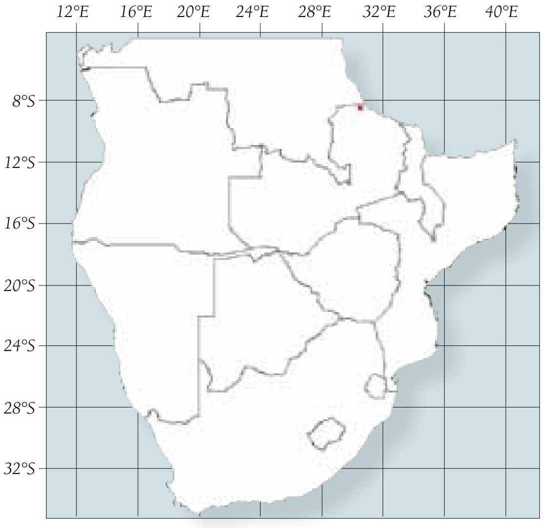
fig. 183b

Figure 183. *Chaerephon chapini:* (a) portrait of male showing bicoloured crest, and (b) whole body of female showing pale underparts (a: © Merlin D. Tuttle, Bat Conservation International, www.batcon.org; b: © F. P. D. Cotterill).

Chaerephon major (Trouessart, 1897)

Lappet-eared free-tailed bat

Least Concern



Description: *Chaerephon major* is a small bat with a mass of around 15 g and forearm length 39–50 mm. The uniform drab pelage of the back and flanks varies from grey-brown to russet-brown; this colouration extends on to the venter, which is bisected by a medial pale stripe (white to cream). The wing membranes are light brown. There is a narrow band of paler fur (white to cream) where the wings join the body. Typical of the family, the tail is not completely enclosed within the tail membrane. The upper lip is wrinkled giving a bulldog appearance. The ears are joined by a flap of skin, which is folded medially into a distinct lappet behind the junction of the inner margins. It can be erected on top of the head to project a crest of brown fur (~8 mm length). The sexes are similar, except for the more conspicuous crest in mature adult males. Females have a bare patch in place of the patch of modified fur. The interfemoral membrane is dark brown, and contrasts against the paler wing membranes.

The skull is relatively flattened, with the braincase relatively broad. The sagittal crest is inconspicuous and the supra-occipital crest moderate. The anterior palatal emargination is absent or minor; moderately shallow basisphenoid pits; auditory bullae of moderate size; zygomatic arches gracile. The anterior upper premolar is of moderate size. The third commissure of the posterior upper molar is just over half length of the second (Rosevear 1965, Freeman 1981, Happold in press).

External and cranial measurements (mm) and mass (g) for *Chaerephon major*, males and females combined

	Mean	Min	Max	SD	N
Mass[1]	15.3	10	28	-	55
FA[1]	42.4	39	50	-	120
Total[1]	100.1	85	113	-	107
Tail[1]	33.8	27	42	-	108
Tibia	-	-	-	-	-
Ear[1]	16.8	12	21	-	105
GSL[1]	18.0	17.0	19.3	-	45

[1] Happold (in press)

Key identification features: *Chaerephon major* is difficult to distinguish from other molossids of similar size. It is distinctively larger than *C. pumilus*. Its brown pelage sets it apart from most species, except *C. nigeriae*, which lacks the white medial ventral band and is uniform brown, even though both species have a white lateral body stripe. Both *C. ansorgei* and *C. bivittatus* lack the conspicuous lappet-lidded interaural pocket (with the distinct crest in males) of *C. major*, and this organ is of a distinctly different morphology in *C. nigeriae*.

Echolocation call: The echolocation call of this species has not been recorded.

Distribution, habitat and roosting: The majority of museum specimens are from Guinean and Sahelian savanna, centred on Liberia, Ghana, Nigeria, and Niger, with a cluster of records to the east in the White Nile valley (Sudan and Garamba, northeastern DRC). Scattered records are known from the environs of Lake Victoria (Uganda, Kenya and Tanzania), with a narrow band of records along the East African Coast between Dar es Salaam and Mombasa. It is unclear whether these big breaks in distribution between west, east equatorial and the east African coast represent collecting gaps or real allopatry (Happold in press). This species was not previously recorded in southern or Central Africa beyond eastern Tanzania. The type specimen is from northern Sudan (BM 49.2.8.36, Holotype).

While re-examining material in the British Museum, one of us (FWC) discovered two specimens of *C. major* that do not appear to have been reported previously. Apparently, they had been overlooked by previous researchers. These records constitute evidence of the occurrence of a new species in Zambia and south-central Africa. They were collected in the early 1920s from Sumbu on the southwest shore of Lake Tanganyika, northeast Zambia. Unfortunately, no field data is associated with their collection, but the dominant habitats of Sumbu National Park include savanna woodland and thicket on lacustrine sediments flanked by a rift valley escarpment, adjacent to Lake Tanganyika and perennial rivers. Throughout its range, *C. major* is associated with savanna woodlands. A series of specimens from Tanzania were collected in miombo woodland. *C. major* is likely more widespread, and might also occur in northern Mozambique.

fig. 184a

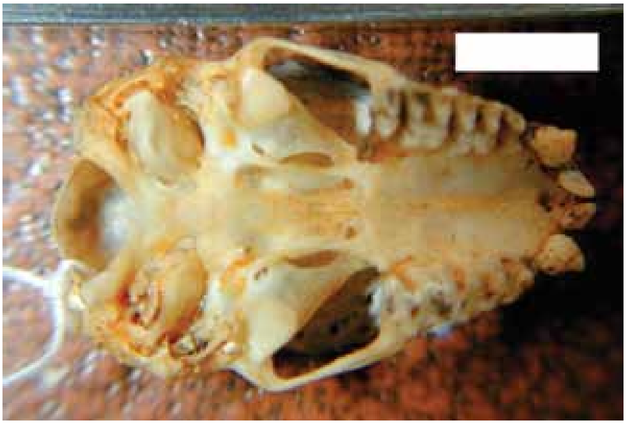


fig. 184b

fig. 184c

Figure 184. Skull and teeth of *Chaerephon major*: (a) dorsal view, (b) ventral view, (c) lateral view. Scale bar = 5 mm (BM 26.12.1.5; © F. P. D. Cotterill).

fig. 185a

fig. 184b

Figure 185. Study skin of female *Chaerephon major*: (a) dorsal view showing naked, lappet-shaped interaural gland; (b) ventral view showing pale fur along margins of body and the pale medial venter. Scale bar = 25 mm (BM 24.1.1.51 from Sagayo Mwanza, northwest Tanzania).

Figure 186. Miombo woodland on the western escarpment flanking the Tanganyika graben. Also note the narrow riparian fringe along the Lufubu River, which forms the southern boundary of Sumbu National Park, northeast Zambia. Two specimens of *Chaerephon major* were collected in this region early in the 20th century (© F. P. D. Cotterill).

Rosevear (1965) records colonies of 4 to more than 100 individuals. These bats roosted in rocky crevices, hollows in trees, and the roofs and walls of buildings.

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

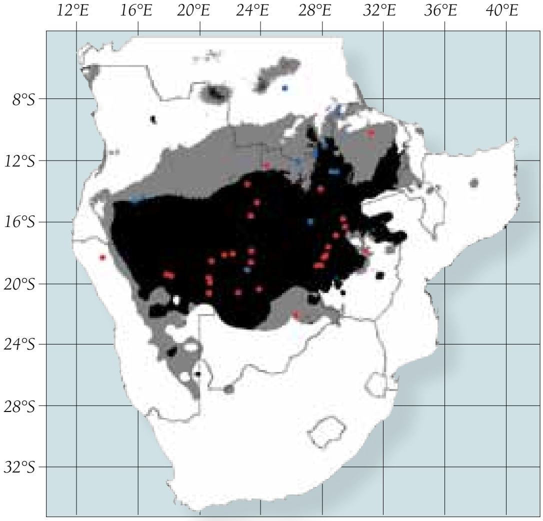
1897. *Chaerephon major* (Trouessart, 1897). Cat. Mamm. Viv. Foss., 1: 146. 5th Cataract of the Nile, northern Sudan.

Chaerephon (Lophomops) abae J. A. Allen 1917 (Aba, northeastern DRC) and *Nyctinomus emini* de Winton 1901 are synonyms. No subspecies are recognised, but the type specimen of *Nyctinomus emini* de Winton 1901 (*Ann. Mag. nat. Hist.* (ser. 7) 7: 40), was collected from Usambiro, Tanzania (BM 90.6.8.15, Holotype); it provides an available name for the East African population. The karyotype of this poorly known molossid is unknown.

Chaerephon nigeriae Thomas 1913 ●

Nigerian free-tailed bat

Least Concern



Description: *Chaerephon nigeriae* is a small bat with a mass of around 15 g. The pelage is dark sooty-brown to black. The underparts are as dark as the upper parts, which contrast strongly with the conspicuous bands of longer white hairs running along the inner flanks, where the whitish wings join the body. Typical of the family, the tail is not completely enclosed within the tail membrane. The upper lip has 5–7 (*C. n. spillmani)* or 7 or 8 (*C. n. nigeriae)* well-defined wrinkles on each side and many spoon-hairs (Cotterill and Happold in press a). Mature adult males have an erectile crest on top of the head. The ears are joined by a flap of skin. There may be a sparsely-haired patch of skin over the shoulders, as in *Mops condylurus*.

The skull is moderately dorsoventrally flattened, with a gradually sloping forehead and braincase, but lacking a distinctive depression in the interparietal region. The supraoccipital crest is moderately developed. The zygomatic arches are not dorsoventrally thickened. The sagittal crest is reduced, present only as thin line. The palate is not emarginated, and the palatal foramina are surrounded by bone. The dental formula is 1123/2123 = 30. The anterior upper premolar usually rises higher than the cingulum of the posterior premolar, within the toothrow or somewhat displaced. The canine and posterior premolar are well separated. The upper third molar has the third ridge larger than half the length of the second ridge. The lower incisors are bicuspid and may be crowded. The lower canines have cingula that are not greatly enlarged; the canines are not in contact, but sometimes nearly so.

Key identification features: In southern Africa, *Chaerephon nigeriae* can be confused with several other small molossids. *Tadarida aegyptiaca* is similar in size and colouration, but lacks the white band of hair on the flanks. *Chaerephon bivittatus* and *C. ansorgei* are paler and flecked without the white band on the flanks. *Chaerephon chapini* is smaller and much paler. *Chaerephon pumilus* is generally paler, but occasional specimens can be as dark as *C. nigeriae*. However, *C. pumilus* is significantly smaller (FA < 42 mm; in *C. nigeriae* FA > 45 mm). *Mops condylurus* is similar in size, but *C. nigeriae* can readily be distinguished from it by its uniform dark colour both above and below, and the white band on its flanks.

Echolocation call: *Chaerephon nigeriae* produces LD-QCF calls with a low peak frequency (17 kHz, n = 3), narrow bandwidth (10 kHz, n = 3), and long duration (10 ms, n = 3) (Fenton and Bell 1981; also see Fenton *et al.* 1998a).

Distribution, habitat and roosting: *Chaerephon nigeriae* occurs in northwestern Namibia, northern Botswana, Zimbabwe, Zambia and marginally in Angola and the southern DRC. The type specimen is from 'Zaria Province', northern Nigeria

External and cranial measurements (mm) and mass (g) for *Chaerephon nigeriae*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	14.5	14.0	16.0	1.00	4	**Mass**[1]	13.6	12.0	15.0	1.52	5
FA[1]	48.0	45.6	50.0	1.61	9	**FA**[1]	48.0	46.0	50.9	1.33	13
Total[1]	114.0	109	117	3.56	5	**Total**[1]	111.0	103	122	5.70	8
Tail[1]	43.0	40	48	3.00	5	**Tail**[1]	41.0	35	47	4.1	8
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	20.0	18	22	1.50	5	**Ear**[1]	20.0	18	23	1.50	8
CI[1]	18.0	17.2	18.9	0.70	4	**CI**[1]	18.6	17.8	19.2	0.40	12

[1] Specimens measured by the authors

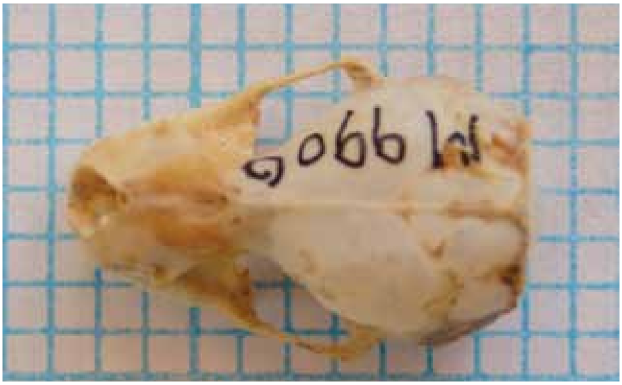


fig. 187a

fig. 187b

fig. 187c

fig. 187d

Figure 187. Cranium, mandible and teeth of *Chaerephon nigeriae:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (a, b, d: SMM 9900; c: SMM 11354).

(BM 11.3.22.1, Holotype), while the type specimen for the allopatric *spillmani* population is from Vila da Ponte, south-central Angola.

This species is not well represented in museums and just 80 individuals were examined for this book.

It roosts communally in small to medium-sized groups, which may be reasonably large (Ansell 1960a), in natural roost sites such as beneath the bark of dead trees (Smithers 1983, Cotterill and Happold in press a) and in small caves (Smithers 1971). It has also been recorded roosting in buildings, e.g. in roofs and eaves of houses in West Africa (Rosevear 1965). In southern Africa, this species appears to be largely associated with *Brachystegia* woodland (Willis *et al.* 2002); it has been recorded in *Acacia*, mopane and miombo woodlands, often in association with permanent water (Cotterill and Happold in press a). It may have been overlooked in northern Mozambique, which apparently has extensive tracts of suitable habitat, and would act as the link between the core of its distribution in Botswana, Zambia and Zimbabwe and the isolated record in southern Tanzania.

Extralimital: *Chaerephon nigeriae* has also been recorded from the DRC, Cameroon, Nigeria, Ghana, Togo, Benin, Niger, Ethiopia and Tanzania (Happold 1987, Willis *et al.* 2002).

Foraging ecology: *Chaerephon nigeriae* has long, narrow wings. It is an open-air forager. In Zimbabwe, its diet comprised mainly Coleoptera, and Lepidoptera in small numbers (Fenton *et al.* 1998b).

Reproduction: A juvenile was recorded in Zambia in January by Ansell (1960a). Pregnant females have been collected in Zimbabwe in late October, while lactating females have been collected in western Zambia in mid-November. A maternity roost discovered in December in the Okavango Delta, Botswana, comprised over 25 adults, including at least 13 lactating females, with two naked young and three furred young (Cotterill and Happold in press a).

SYSTEMATIC NOTES

1913. *Chaerephon nigeriae* Thomas, Annals and Magazine
of Natural History (8) 11: 319. Zaria Province, northern
Nigeria.

Two subspecies are recognised (Willis *et al.* 2002):

Chaerephon nigeriae nigeriae (Thomas, 1913)

*Chaerephon nigeriae spillmani (*Monard, 1932)

1932. *Nyctinomus spillmanni* Monard, Bulletin de la Société
des sciences naturelles de Neuchâtel 57: 51. Vila da
Ponte, south-central Angola.

The two subspecies are geographically separated by about 1,000 km. The nominate subspecies occurs north of the equator, while *spillmani* is virtually restricted to southern Africa, except for an isolated record from southern Tanzania.

The diploid number in *C. nigeriae* is 2n = 48 and aFN = 62 (Rautenbach *et al.* 1993).

▸ ***Figure 188.*** Male *Chaerephon nigeriae:* (a) portrait revealing the russet fur of the interaural crest, and (b) body showing dark reddish-brown underparts with conspicuous white flanks (© F. P. D. Cotterill).

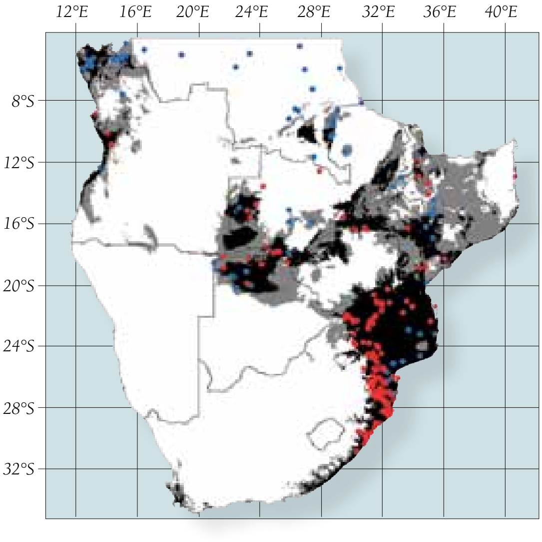
fig. 188a

fig. 188b

Chaerephon pumilus (Cretzschmar 1826)

Little free-tailed bat

Least Concern



Description: *Chaerephon pumilus* is a small bat with a mass of around 10 g. The pelage is greyish-brown to dark brown. The underparts are slightly paler than the upper parts, but white on the mid-dorsal part of the belly of the form *limbatus* (from Mozambique, Zambia, Malawi and much of East Africa), which may extend as a narrow band onto the chest. The wings are light brown (white in *limbatus*). A narrow white or cream band is usually present on the inner flanks where the wings join the body. Typical of the family, the tail is not completely enclosed within the tail membrane. The upper lip is wrinkled giving a bulldog appearance. Mature adult males have an erectile crest on top of the head. The ears are joined by a flap of skin. The interaural and muzzle area contains sebaceous glands that secrete odours used in sexual discrimination (Bouchard 2001b).

The skull is small with the braincase not distinctly elevated (i.e. the forehead is without the distinct concavity found in *C. chapini* and *C. bivittatus*), but with a shallow depression in the interparietal region. The supra-occipital crest is slightly developed. The sagittal crest is reduced to a thin, continuous mid-dorsal ridge. The zygomatic arches are slender. The basioccipital pits are rather shallow. The lack of emargination in the palatal area of the skull, with the palatal foramina enclosed by bone, is supposed to be a diagnostic trait of this species; however, Taylor (1999b) found high variability in this character in a series of specimens from KwaZulu-Natal, with some individuals showing partial or complete emargination. The dental formula is 1123/2123 = 30. The anterior upper premolar is particularly minute and tends to be displaced to the outside of the toothrow, with the cingula of the upper canine and posterior premolar almost touching. The lower incisors are bicuspid, crowded, but the second incisor barely so and much smaller than the first.

Key identification features: In southern Africa, the small size of *Chaerephon pumilus* (FA < 42 mm, and mostly < 40 mm) should prevent confusion with other free-tailed bats, except the rare *C. chapini*. Males of the latter species have a long bicoloured crest, while the females are generally much paler than *C. pumilus*.

Echolocation call: *Chaerephon pumilus* produces LD-QCF calls with a low peak frequency (25.6±1.5 kHz, n = 11), narrow bandwidth (15.7±2.3 kHz, n = 11), and long duration (12.4±0.9 ms, n = 11) (Taylor 1999a; also see Fenton *et al.* 1998a, 2004, Taylor *et al.* 2005, Schoeman and Jacobs 2008). Besides the fundamental, the second and third harmonics may be present on the spectrogram. Aspetsberger *et al.* (2003) reported a significantly lower peak frequency (21 kHz) for a population from Amani, Tanzania.

External and cranial measurements (mm) and mass (g) for *Chaerephon pumilus*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	9.8	6.5	13.0	1.47	40	**Mass**[1]	10.2	6.0	16.0	1.81	50
FA[1]	37.6	34.0	41.0	1.33	123	**FA**[1]	38.1	32.0	41.5	1.38	110
Total[1]	88.5	74	102	5.22	100	**Total**[1]	89.6	72	107	5.46	101
Tail[1]	31.2	24	40	3.21	103	**Tail**[1]	31.5	30	40	3.22	102
Tibia[1]	13.0	-	-	-	1	**Tibia**[1]	13.7	13.0	14.3	-	2
Ear[1]	14.0	9	19	2.21	98	**Ear**[1]	14.3	10	18	1.90	96
CI[1]	16.2	14.3	17.0	0.52	31	**CI**[1]	16.0	15.4	16.6	0.34	22

[1] Specimens measured by the authors

fig. 189a

fig. 189b

fig. 189c

fig. 189d

Figure 189. Skull and teeth of *Chaerephon pumilus:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 6301).

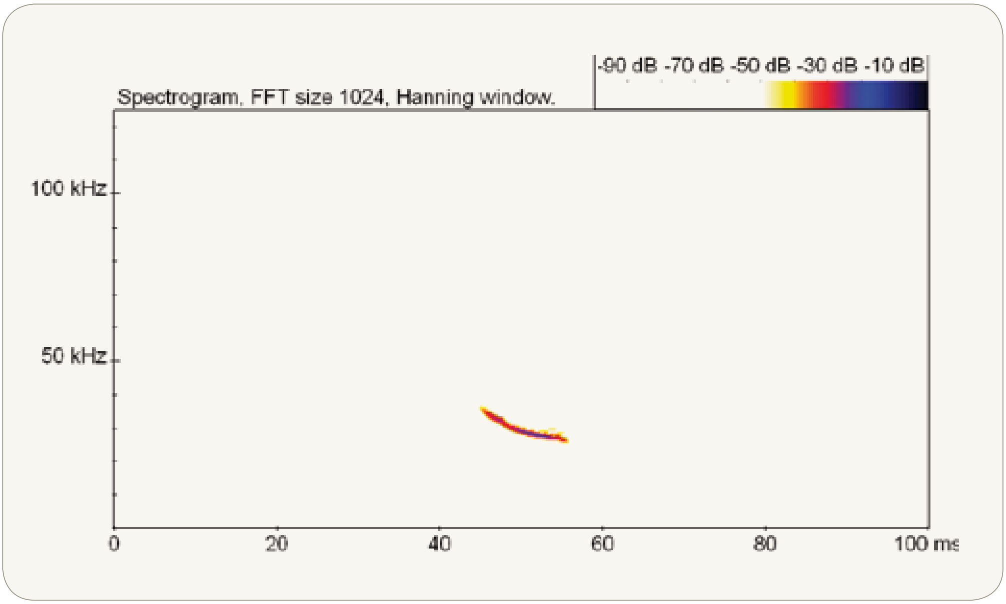


Figure 190. Echolocation call of *Chaerephon pumilus.*

Distribution, habitat and roosting: *Chaerephon pumilus* is widespread and abundant in the eastern parts of the region, where it has been recorded from KwaZulu-Natal and Swaziland, through the Kruger National Park to Zimbabwe, northern Botswana, Zambia, Malawi, DRC and Mozambique. A geographically isolated population is restricted to Angola and the DRC west of the escarpment. The model suggests that suitable conditions occur over much of southern Mozambique. It appears to be absent from elevations above 1,000 m. The type specimen is from 'Massawa', Eritrea (SM 4311, Lectotype).

This species is well represented in museums, with over 1,000 records examined for this book.

It roosts communally in small to extremely large groups, which may number in the thousands (Taylor 1998). Natural roost sites include narrow cracks in rocks and trees (Verschuren 1957a). However, the species has taken to roosting in buildings, in particular roofs of houses and other buildings where individuals often roost in crevices, e.g. between tiles and underlying plastic lining, rafters and brickwork (Taylor 1998).

Extralimital: *Chaerephon pumilus* occurs widely in sub-Saharan Africa, Madagascar and into Arabia (Bouchard 1998), although recent molecular data show the Malagasy population to be a distinct species (Taylor *et al.* 2009).

Foraging ecology: *Chaerephon pumilus* has long, narrow wings with high wing loading (11.8 $N.m^{-2}$) and intermediate aspect ratio (8.6) (Norberg and Rayner 1987; also see Schoeman and Jacobs 2008). It is an open-air forager. They feed on Coleoptera, Hemiptera, Lepidoptera, Hymenoptera and Diptera (Aldridge and Rautenbach 1987, Fenton *et al.*1998b; also see Kingdon 1974, Whitaker and Mumford 1978, Schoeman 2006). The diet of a population in Amani, Tanzania, comprised > 60% Blattodea (Aspetsberger *et al.* 2003).

Reproduction: After a 60-day gestation, a single young is born. There is a post-partum oestrus, which allows three births per year in the subregion (early November, late January and March–April (Van der Merwe *et al.* 1986, 1987, Monadjem 1998b). A third parturition event in May occurs in Malawi, and *C. pumilus* can breed up to five times within a year in equatorial forest habitat (Happold and Happold 1990a).

SYSTEMATIC NOTES

1826. *Dysopes pumilus* Cretzschmar, in Rüppell's Atlas zu der Reise im nördlichen Afrika, Säugethiere: 69. Massawa, Eritrea.

Simmons (2005) listed nine taxa as synonyms of *C. pumilus*; Peterson *et al.* (1995) treated the Malagasy *C. leucogaster* (A. Grandidier 1869) as distinct from *C. pumilus*, and included the following five African mainland taxa as synonyms of *C. leucogaster:*

Chaerephon pumila websteri Dollman 1908 (BM 1908.10.6.8, Holotype, from Bénoué river Yola, Nigeria at 09.15°N 12.48°E).

Chaerephon (Lophomops) cristatus J. A. Allen 1917 (AMNH 48844, Holotype, from Boma at the mouth of the Congo River (05.83°S 13.05°E).

Chaerephon frater J. A. Allen 1917 (AMNH 49275, Holotype, from Malela near Boma, DRC at 05.95°S 12.63°E).

Chaerophon (Lophomops) nigri Hatt (MNHN 736a, Holotype, from Bourem, Niger River, Mali at 16.98°N 00.33°W).

Tadarida (Chaerephon) faini Hayman 1951 (RMAC 20509, Holotype, from Wago Forest, Uele, DRC at ~1.73°N 30.65°E).

It is unlikely that these West African taxa represent the Malagasy *C. leucogaster*, and all populations of this species complex await thorough revision, so these are retained as synonyms of *C. pumilus* (following Koopman 1993). Although *Chaerephon (Lophomops) langi* Roberts 1932 was listed as a synonym of *C. pumilus* by Simmons (2005), we have tentatively listed this taxon as a synonym of *C. chapini* (see above) pending its reappraisal that ideally requires DNA sequencing.

The pelage is highly variable in *Chaerephon pumilus,* with the form *limbatus* showing the most amount of white on the belly and on the wings. This form is common in northern Mozambique and Malawi, as well as in East Africa. Jacobs *et al.* (2004) found only shallow mitochondrial DNA sequence divergence (0.9% in Cytochrome b) between pale and dark-winged haplotypes. Populations of *C. pumilus* from eastern Madagascar appear to be specifically distinct from mainland populations, based on mitochondrial DNA sequences. Cryptic mtDNA lineages occurring sympatrically in KwaZulu-Natal are suggestive of a species-complex (Taylor *et al.* 2009).

The diploid number in *C. pumilus* is 2n = 48 (Smith *et al.* 1986, Rautenbach *et al.* 1993).

fig. 191a

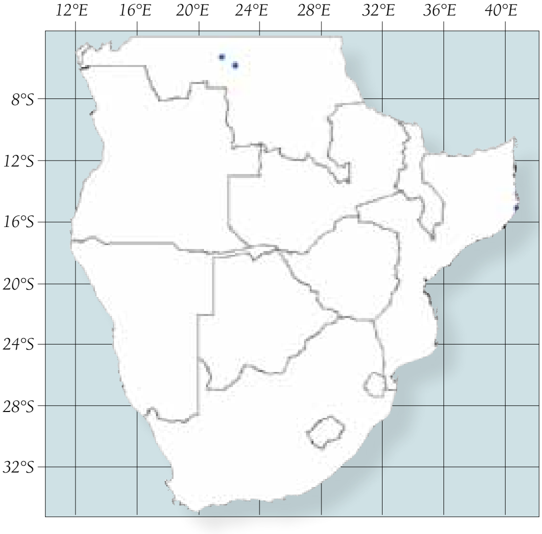
fig. 191b

Figure 191. *Chaerephon pumilus:* (a) greyish-brown phase and (b) rufous phase (a: © Merlin D. Tuttle, Bat Conservation International, www.batcon.org*;* b: © E. C. J. Seamark).

Mops brachypterus (Peters 1852)

Short-winged free-tailed bat

Least Concern



Description: *Mops brachypterus* is a small-sized bat. Typical of the family, the tail is not completely enclosed within the tail membrane. The upper lip is wrinkled giving a bulldog appearance. The ears are joined by a flap of skin.

This is the only one of the four members of the subgenus *Xiphonycteris* found in south-central Africa, which occurs outside the DRC. It has an emarginated palate (closed in other *Mops* species) and a moderately large anterior premolar (absent or highly reduced in other *Mops* species) (Dunlop 1999). The dental formula is 1123/2123 = 30. As in other *Mops* species the third commissure ('leg') on the upper third molar is present, but short.

Key identification features: Second to *Mops nanulus*, *Mops brachypterus* is the smallest *Mops* species (FA < 40 mm) in southern Africa; the other species are far larger (FA > 42 mm). It lacks the interaural crest that distinguishes *Chaerephon pumilus* and other small *Chaerephon* species. *Mops nanulus* is smaller (FA < 37 mm). (See the *Mops thersites* species account for differences between the species.)

Echolocation call: The echolocation call of this species has not been recorded.

Distribution, habitat and roosting: In southern Africa, *Mops brachypterus* is known only from the type specimen, which is from Mozambique Island, northern Mozambique (ZMB 536, Holotype, skin; ZMB 85537, Holotype, skull), and from two specimens in the DRC. This isolated eastern population (which may represent a distinct species) is restricted to the coastal plains of East Africa (Kenya to northern Mozambique) where it appears to be associated with forests (Burgess *et al*. 2000, Stanley 2008). The DRC specimens refer to the taxon *leonis* (see 'Systematic notes').

Extralimital: *Mops brachypterus* has also been recorded from coastal Tanzania and Kenya (Burgess *et al*. 2000).

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1852. *Dysopes brachypterus* Peters, Naturw. Reise Mossamb., Säugethiere: 59. Mozambique Island, Mozambique.

Nyctinomus leonis Thomas 1908 (BM 1862.12.23.3, Holotype, from Sierra Leone) and *Nyctinomus ochraceus* J. A. Allen 1917 (AMNH 48821, Holotype, from Medje DRC, 02.42°N 27.30°E) are treated as synonyms of *brachypterus* by Simmons (2005). Although *Mops brachypterus* has traditionally been treated as conspecific with *Mops leonis* from Central and West Africa, the two taxa are geographically isolated and occupy different habitats. The East African coastal population, extending from Kenya to northern Mozambique, possibly represents a unique evolutionary lineage and hence a distinct species. Nevertheless, the relationships of this East African population of *M. brachypterus* need to be carefully revised with respect to the recently discovered *M. bakarii* Stanley 2008, known only from Pemba Island, adjacent to northeastern Tanzania (Stanley 2008). Two other small morphologically similar species – *M. nanulus* J. A. Allen 1917 and *Mops thersites* (Thomas 1904) – are closely related to this species, and occur in the southwestern DRC (Schouteden 1947; Hayman *et al.* 1966).

The type specimen collected by Peters (1852) had a forearm of 37 mm. Greatest skull length varies from 17.0 to 20.6 mm (Dunlop 1999).

This Mozambique record was previously treated as *M. thersites* by Hayman and Hill (1971) and Smithers and Lobão Tello (1976).

The diploid number in *M. brachypterus* is not known.

fig. 192a

fig. 192b

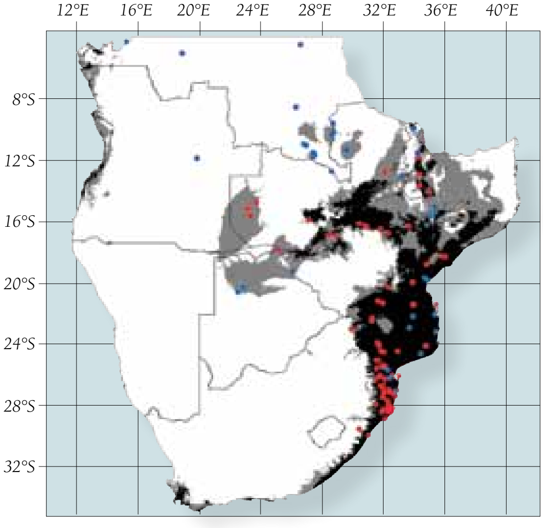
fig. 192c

Figure 192. Skull and teeth of *Mops brachypterus:* (a) dorsal view, (b) ventral view, and (c) lateral view ventral. Scale bar = 10 mm (LACM 27485; © F. P. D. Cotterill).

Mops condylurus (A. Smith 1833) ●

Angolan free-tailed bat

Least Concern



Description: *Mops condylurus* is a medium-sized bat with a mass of around 20 g. The pelage is greyish-brown above. The underparts are paler than the upper parts, becoming dirty white to white on the belly. A sparse-haired band extends between the shoulders. The wings are light brown. There is usually a narrow white or cream band on the inner flanks where the wings join the body. Typical of the family, the tail is not completely enclosed within the tail membrane. The upper lip is wrinkled giving a bulldog appearance. Mature adult males have an erectile crest on top of the head. The ears are joined by a flap of skin. The interaural and muzzle area contains sebaceous glands that secrete odours used in sexual discrimination (Bouchard 2001b).

The skull is robust with the sagittal crest usually well to very well developed and the supra-occipital (lambdoid) crest large and posteriorly projecting. The braincase tapers posteriorly to a 'helmet', as opposed to the rounded or blunt-ended shape that is typical of *Chaerephon* and *Tadarida*. In lateral view, the braincase is distinctly elevated above the rostral plane. The nasal aperture is large, and is prominent in dorsal view. The lachrymal process is moderately developed. The infra-orbital foramen is very large anteriorly, with a distinct posterior opening into the orbit. The zygomatic arches are sturdy, bowed outwards, and slightly flattened dorsoventrally. The incisive foramina are closed. The basioccipital pits are shallow and narrow, their widths much less than the ridge separating them. The mandible is sturdy with angular and articular processes well developed and posteriorly directed. The coronoid processes are small, but sturdy and anteriorly directed. The dental formula is 1123/2123 = 30. The third ridge of the third upper molar is poorly developed, less than half the length of the second ridge. The anterior upper premolar is minute, lies external to the toothrow and is missing in some specimens. The canine and posterior premolar are in contact.

Key identification features: The sparse-haired band across the shoulders separates *Mops* from *Tadarida* and most *Chaerephon* species. *Tadarida aegyptiaca* lacks this band and its ears are not connected by a flap of skin. The similar-sized *Chaerephon ansorgei* shows a shoulder band, but has a black throat. *Mops midas* is far larger (FA > 52 mm). The very similar *M. niveiventer* is distinguishable by its dark crown that contrasts with the greyer back; in *M. condylurus*, the crown is the same colour as the back.

Echolocation call: *Mops condylurus* produces LD-QCF and LD-CF echolocation calls with a low peak echolocation frequency (24.7±0.9 kHz, n = 10), narrow bandwidth (9.2±1.9 kHz, n = 10), and long duration (10±1.6 ms, n = 10) (Schoeman and Jacobs 2008; also see Taylor 1999a, Fenton *et al*. 1998a).

Distribution, habitat and roosting: *Mops condylurus* is widespread and abundant in the eastern parts of the region,

External and cranial measurements (mm) and mass (g) for *Mops condylurus*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	24.5	18.0	31.1	3.97	15	**Mass**[1]	20.4	13.0	31.0	5.14	12
FA[1]	47.0	44.0	51.0	1.60	37	**FA**[1]	45.9	42.2	49.6	1.78	55
Total[1]	113.0	102	131	8.07	19	**Total**[1]	108	95	132	7.52	32
Tail[1]	39.7	32	51	3.81	20	**Tail**[1]	38.9	31.0	46.0	3.38	30
Tibia[1]	17.5	15.9	20.1	2.27	3	**Tibia**[1]	-	-	-	-	-
Ear[1]	17.0	10	21	2.33	21	**Ear**[1]	16.7	10	20	2.01	32
CI[1]	19.0	17.9	19.9	0.51	17	**CI**[1]	18.3	16.5	19.4	0.78	13

[1] Specimens measured by the authors

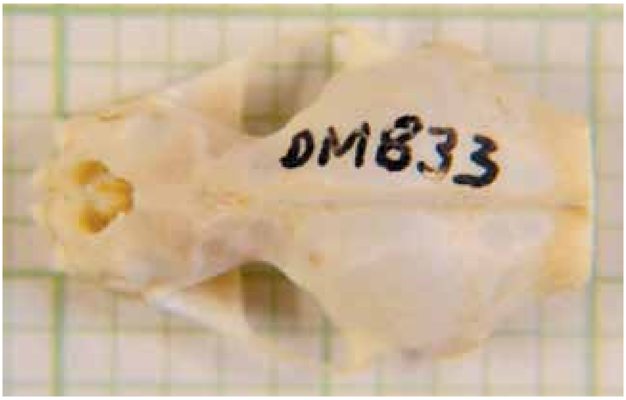


fig. 193a

fig. 193b

fig. 193c

fig. 193d

Figure 193. Skull and teeth of *Mops condylurus:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 833, female).

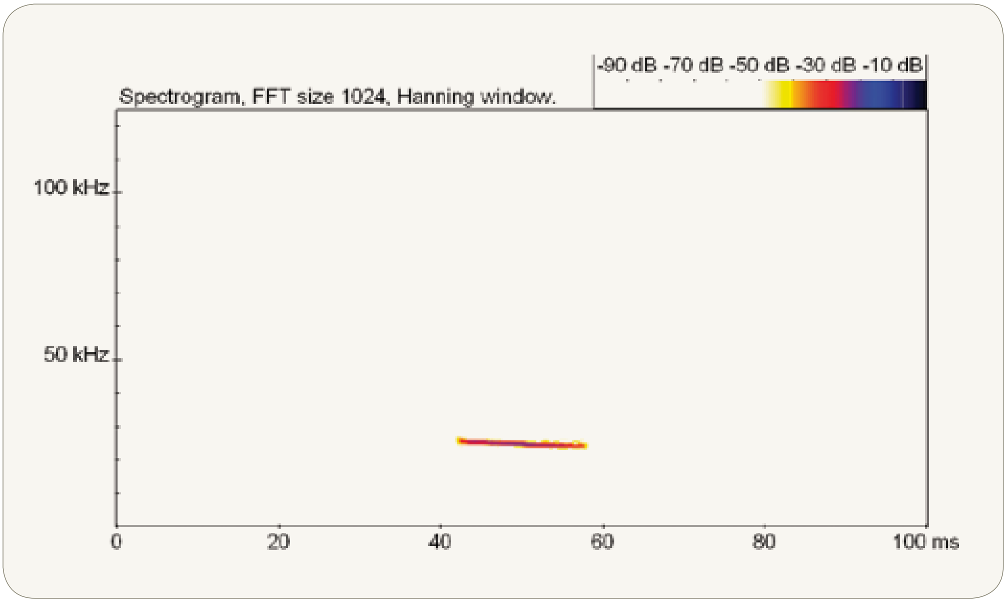


Figure 194. Echolocation call of *Mops condylurus*.

where it has been recorded from KwaZulu-Natal and Swaziland, through the Kruger National Park to Zimbabwe, northern Botswana, Zambia, Malawi, DRC, eastern Angola and Mozambique. The type specimen is from 'Port Natal' (= Durban), South Africa.

This species is well represented in museums, with almost 400 specimens examined for this book.

It roosts communally in small to extremely large groups, which may number in the thousands. Natural roost sites include narrow crevices in rock faces and caves, as well as hollows in trees (Fenton *et al*. 1994). However, the species has taken to roosting in anthropogenic structures, particularly roofs of houses and in the expansion joints of bridges.

Thermal preference studies suggest that under the hot daytime conditions found in the South African lowveld, these bats actively select temperature zones of 35–40°C within the roost, in which they can maintain basal metabolism. This allows them to minimise the energetic costs of thermoregulation. At higher temperatures they become dehydrated and have only moderate urine-concentrating abilities. At lower temperatures they are capable of entering torpor. They frequently enter torpor during day-time roosting in both summer and winter with body temperatures as low as 12°C. Their thermoregulation and osmoregulation parameters explain how this species can exploit a wide range of climatic conditions from semi-arid to mesic habitats (Bronner *et al*. 1999, Buffenstein *et al*. 1999, Maloney *et al*. 1999, Vivier and van der Merwe 2007).

Extralimital: *Mops condylurus* occurs widely in sub-Saharan African.

Foraging ecology: *Mops condylurus* has long, narrow wings with high wing loading (18 $N.m^{-2}$) and intermediate aspect ratio (9.1) (Norberg and Rayner 1987; also see Aldridge and Rautenbach 1987, Schoeman and Jacobs 2008). It is an open-air forager. It feeds predominantly on Coleoptera, Hemiptera and Lepidoptera (Fenton *et al*. 1998b, G. Bronner, personal communication; also see Whitaker and Mumford 1978). It often feeds throughout the night, leaving the roost at dusk and returning in a swarm at dawn.

Reproduction: Females are seasonally polyoestrus, with two birth seasons between early September and early May. Gestation is 85 days long. Following the December birth season there is a post-partum oestrus (Vivier and van der Merwe 1996, 1997).

SYSTEMATIC NOTES

1833. *Nyctinomus condylurus* A. Smith, South African Quarterly Journal 2(1): 54. Port Natal (= Durban), South Africa.

Nyctinomus angolensis Peters 1870 and *Mops (Allomops) osborni* J. A. Allen 1917 are synonyms. It is unclear whether *Mops angolensis orientis* G. M. Allen and Loveridge 1942 (MCZ 38829, Holotype, from Kitaya, Rovuma River, southeastern Tanzania) is a synonym of *M. condylurus* or *M. niveiventer*.

The diploid number in *M. condylurus* is 2n = 48 and aFN = 66 (Smith *et al*. 1986, Rautenbach *et al*. 1993).

fig. 195a

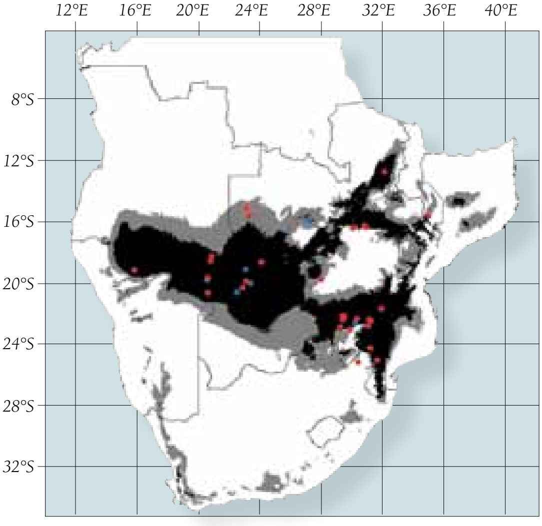
fig. 195b

Figure 195. *Mops condylurus,* showing wrinkled upper lips and flap of skin joining ears (a: © Merlin D. Tuttle / BCI; b: © E. C. J. Seamark).

Mops midas (Sundevall 1843)

Midas free-tailed bat

Least Concern



Description: *Mops midas* is a large-sized bat with a mass of around 45 g. The pelage is greyish-brown to dark brown above, flecked with white; its short fur gives it a smooth appearance. The underparts are paler than the upper parts, becoming dirty white on the belly. A sparse-haired band extends between the shoulders. The wings are light brown. There is a narrow white or cream band on the inner flanks where the wings join the body. Typical of the family, the tail is not completely enclosed within the tail membrane. The chin is invariably naked, with a button-shaped wart with short hairs (Cotterill and Happold in press b). The ears are very long, enclosing the muzzle and projecting beyond the snout when pressed flat. The upper lip is wrinkled giving a bulldog appearance. Mature adult males have an erectile crest on top of the head. The ears are joined by a flap of skin (Dunlop 1999).

The skull is robust and deep, similar in shape to that of *M. condylurus*, although larger; it is longer and wider in males (Peterson *et al*. 1995). The sagittal and supra-occipital crests are well developed (more so in males than females), the supra-occipital crest forming a tapering occipital 'helmet' in dorsal view, especially in adult males. The braincase is broad owing to the expanded mastoid processes. The zygomatic arches are robust and bowed outwards. The incisive foramina are enclosed. The basioccipital pits are prominent, relatively deep and large, and wider than the ridge separating them. The mandible is robust, similar in shape to that of *M. condylurus*. The dental formula is 1123/2123 = 30. The upper and lower canines are relatively long and robust. The third ridge of the upper third molar is absent. The first and second lower premolars are subequal in size. The lower canines are well separated at their bases.

Key identification features: The sparse-haired band across the shoulders separates *Mops* from *Tadarida* and most *Chaerephon* species. The large size (FA > 60 mm) of *M. midas* should prevent confusion with any other *Mops* species. Only two other *Mops* species (*M. congicus* and *M. niangarae)* have FA > 50 mm (but both < 57 mm); neither species has been recorded south of the equator. All *Chaerephon* species are much smaller (FA < 52 mm). The larger-sized *Tadarida* species (*T. ventralis*, *T. lobata* and *T. fulminans)* are easily separated by the lack of a wrinkled upper lip. *Otomops martiensseni* has long ears and a pale band running along the shoulders, which separates the darker head and back.

Echolocation call: *Mops midas* produces LD-QCF and LD-CF echolocation calls. Calls of bats leaving their roost had a duration of 12 ms and highest frequency of 30 kHz (Aldridge and Rautenbach 1987). In Gauteng, very large molossid bats assumed to be *M. midas* exhibited two call types both with low peak frequencies (15±0.3 kHz, n = 3 and

External and cranial measurements (mm) and mass (g) for *Mops midas*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	39.6	34.0	49.0	5.35	7	**Mass[1]**	38.7	30.0	46.0	6.48	9
FA[1]	63.8	60.0	66.0	2.05	9	**FA[1]**	61.5	60.0	64.0	1.26	7
Total[1]	151.0	136	165	10.20	9	**Total[1]**	141.0	115	161	14.30	7
Tail[1]	49.0	39	65	8.60	10	**Tail[1]**	51.0	45	55	3.30	7
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	28.0	21	32	3.8	10	**Ear[1]**	30.0	28	31	1.00	7
CI[1]	25.4	24.6	26.1	0.43	14	**CI[1]**	24.6	23.8	25.1	0.42	7

[1] Specimens measured by the authors

fig. 196a

fig. 196b

fig. 196c

fig. 196d

Figure 196. Cranium and teeth of *Mops midas:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8416).

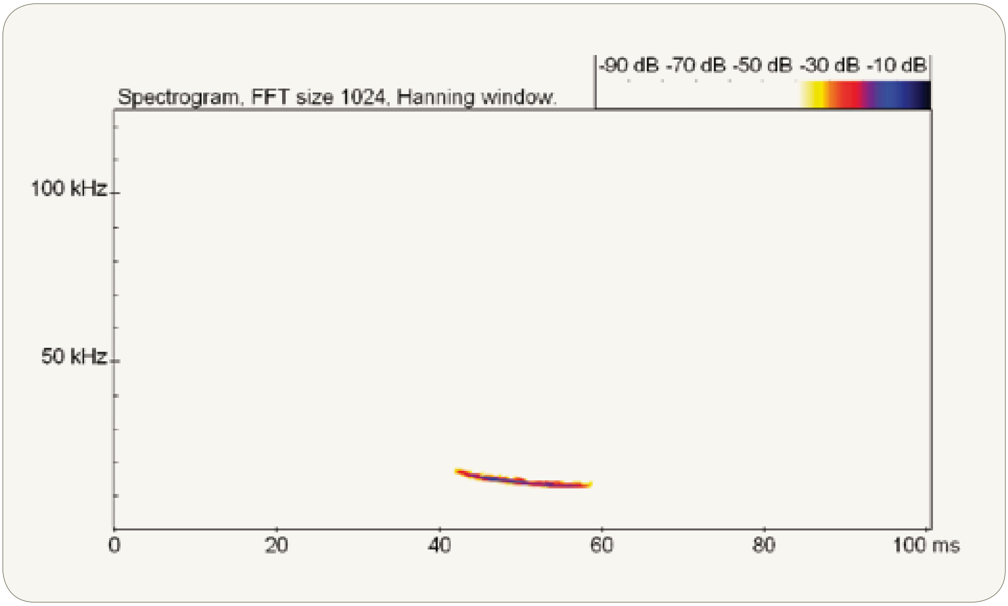


Figure 197. Echolocation call of *Mops midas* (15 kHz type).

11.5±0.1 kHz, n = 2), narrow bandwidths (4.8±0.7 kHz, n = 3 and 2.7±0.1 kHz, n = 2), and long duration (16.5±0.7 ms, n = 3, and 15.5±1.5 ms, n = 2) (W. Bogdanowicz, unpublished data; also see Fenton *et al*. 1998a).

Distribution, habitat and roosting: *Mops midas* is locally abundant in the eastern parts of the region, where it has been recorded from hot, low-lying river valleys and permanent water bodies in northeastern South Africa, through the Kruger National Park to Zimbabwe, northern Botswana, northern Namibia, southwestern Zambia and southern Malawi. The model suggests that suitable conditions occur in the western parts of southern Mozambique, but this species has yet to be collected from that country. The type material (including BM 1846.6.2.20, Syntype) is from southern Sudan.

This species is well represented in museums, with 270 specimens examined for this book.

It roosts communally in small to large groups, which may number in the hundreds (Smithers 1971). Natural roost sites include narrow cracks in rocks, especially on cliff faces, and they have been taken from hollow trees in the DRC (Verschuren 1957a). However, the species has taken to roosting in buildings, particularly roofs of houses. This species appears to be associated with hot, low-lying savanna and woodland.

Extralimital: *Mops midas* occurs widely in the Sahel region including Senegal, Burkina Faso, Nigeria, Chad, DRC, Sudan, Ethiopia, Uganda, Kenya, Rwanda and Madagascar.

Foraging ecology: *Mops midas* has long and narrow wings with a high wing loading (11.4 N.m^{-2}) and intermediate aspect ratio (8.9) (Aldridge and Rautenbach 1987; also see Fenton and Rautenbach 1986). It is an open-air forager. The robust skull, mandible, and dentition, as well as data from stomach contents, suggest that it feeds predominantly on Coleoptera (Archer 1977). The bats appear to fly all night, leaving at sunset and returning at dawn en masse (Cotterill and Happold in press b).

Reproduction: Limited data suggest a birth season from December to March in southern Africa, although lactating females or juveniles have been reported in April and June; current data cannot distinguish between seasonal monoestry with asynchronous births, or seasonal polyoestry (Cotterill and Happold in press b).

SYSTEMATIC NOTES

1843. *Dysopes midas* Sundevall, Kungliga Svenska Vetenskapsakademiens Handlingar, Stockholm (1842): 207. Jebel el Funj, between the White and Blue Nile, Sudan.

The entire continental population is considered part of the same subspecies, *M. midas midas*, while the Malagasy population is treated as the distinct *M. midas miarensis* A. Grandidier 1869 (Dunlop 1999). The southern African population is apparently geographically separated from the northern one by at least 1,000 km, suggesting that these two populations may represent distinct phylogenetic lineages. However, populations from South Africa and Madagascar do not differ genetically (Ratrimomanarivo *et al.* 2007), suggesting the possibility of movement between Madagascar and southern Africa.

The diploid number in *M. midas* is 2n = 48 and aFN = 66 (Smith *et al.* 1986, Rautenbach *et al.* 1993).

fig. 198a

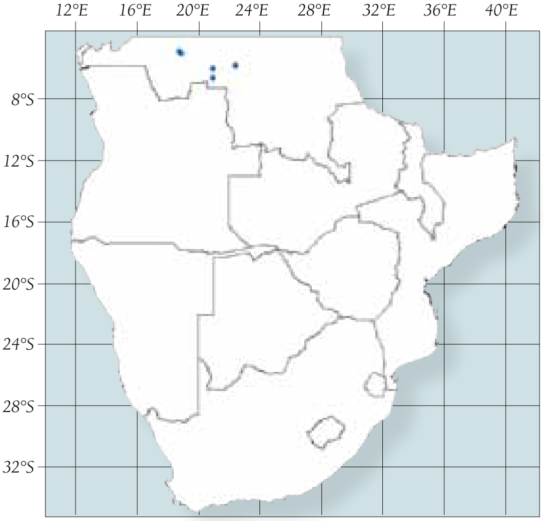
fig. 198b

Figure 198. *Mops midas*, showing wrinkled upper lip and flap of skin joining ears (a: TM 48104, © E. C. J. Seamark; b: © F. P. D. Cotterill).

Mops nanulus (Thomas 1903)

Dwarf free-tailed bat

Least Concern



Description: *Mops nanulus* is a small insectivorous bat; with an average forearm length of ~30 mm, this species is one of the smallest members of the Molossidae. The pelage varies from orange-brown, through grey-brown to blackish-brown; the lighter coloured underparts vary from yellow-brown and grey to white. This variation is exhibited across the species' range and locally. The flanks and rump are naked, revealing the black skin; the naked rump exhibits two tufts of long, sensory vibrissae. The wings are transparent to whitish; the tail membrane is brown. There is no pale flank stripe in *M. nanulus*, but instead a dark band. The ears are conjoined over the forehead, but there is no interaural crest. Typical of the free-tailed bats, the tail is not completely enclosed within the tail membrane. The upper lip has many spoon-shaped hairs, and its wrinkles give this bat a bulldog appearance.

The anterior of the braincase is flattened, only rising slightly above the lateral profile of the skull. The sagittal crest is weakly developed, whereas the lambdoid crest is weakly to well developed (forming a more strongly developed helmet in males). The incisive foramina are visible. The basisphenoid pits are of comparatively shallow depth. The dental formula is 1123/2123 = 30. The anterior upper premolar small, in the toothrow, fills the space between canine and second premolar. The upper third molar has the third ridge (commisure) absent. There are two lower incisors on each side, bicuspid and crowded, filling the space between the lower canines, which have cingula, are not greatly enlarged, and are sometimes almost in contact (Rosevear 1965, Happold in press).

External and cranial measurements (mm) for *Mops nanulus*, sexes combined

	Mean	Min	Max	SD	N
Mass	-	-	-	-	-
FA[1]	29.6	27.0	31.0	-	62
Total[1]	78.8	75.0	88.0	-	19
Tail[1]	21.0	19.0	24.0	-	19
Tibia[2]	-	10.0	11.5	-	-
Ear[1]	13.3	11.0	18.0	-	19
GSL[1]	16.2	15.1	17.3	-	62

[1] Happold (in press)
[2] Rosevear (1965)

Key identification features: The free-tail and long narrow wings distinguish Mops nanulus from vesper bats of similar size. This small molossid resembles *C. pumilus* in size, but besides distinct skull characters, the latter is distinguished by the interaural crest. *M. nanulus* is much smaller than *M. thersites* (FA > 36 mm; in *M. nanulus* FA < 32 mm), and is also smaller than all other forest-dwelling molossids grouped in subgenus *Xiphonycteris* by El-Rayah (1981), although it can only be distinguished by skull characters from the very similar *M. spurrelli* and *M. petersoni*.

Echolocation call: The echolocation call of this species has not been recorded.

Distribution, habitat and roosting: Known from four records in the southwestern Congo basin, *Mops nanulus* is primarily associated with closed forest habitats, but has been recorded in mesic savanna (Kingdon 1974). The type specimen is from northern Congo (AMNH 48864, Holotype) (Lang *et al.* 1917, Rosevear 1965).

Small colonies of this species have been recorded roosting in the roofs of thatched huts and in hollows in trees.

Extralimital: This species ranges east from Gambia and Guinea throughout the mesic margins of West Africa to Cameroon, and across the Congo basin to Kenya and Ethiopia (Rosevear 1965, Kingdon 1974, Simmons 2005).

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: No reproductive information is available for south-central Africa.

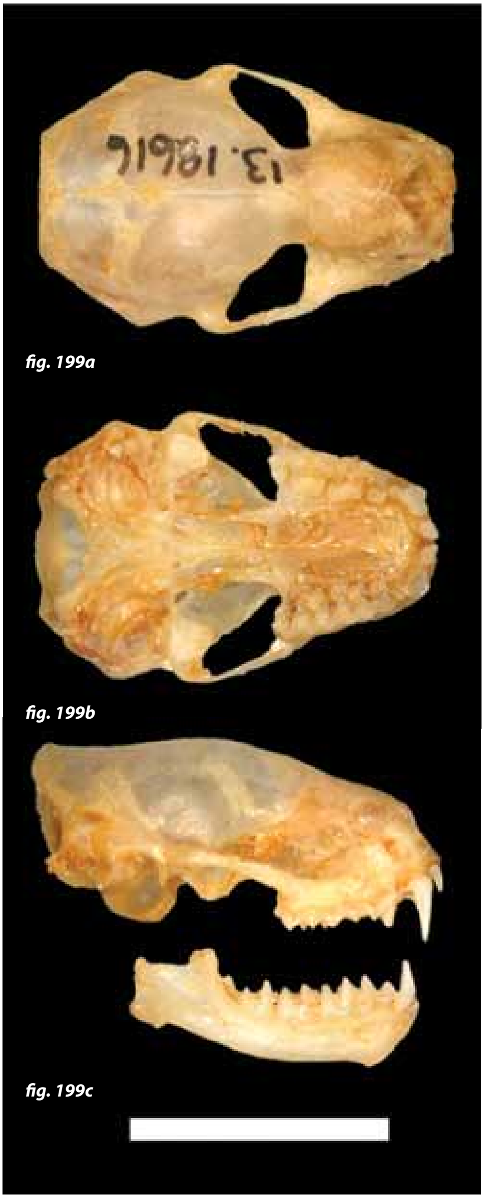


Figure 199. Skull and teeth of *Mops nanulus:* (a) dorsal view; (b) ventral view; (c) lateral view and (d) lateral view of mandible.
Scale bar = 10 mm (HZM 13.18616; © Malcolm Pearch, HZM).

SYSTEMATIC NOTES

1917. *Mops (Allomops) nanulus* J. A. Allen, Bull. Am. Mus. Nat. Hist., 37 (18): 477. Congo (Democratic Republic of the): Oriental province: Uele district: Niangara (03°24'N 27°52'E).

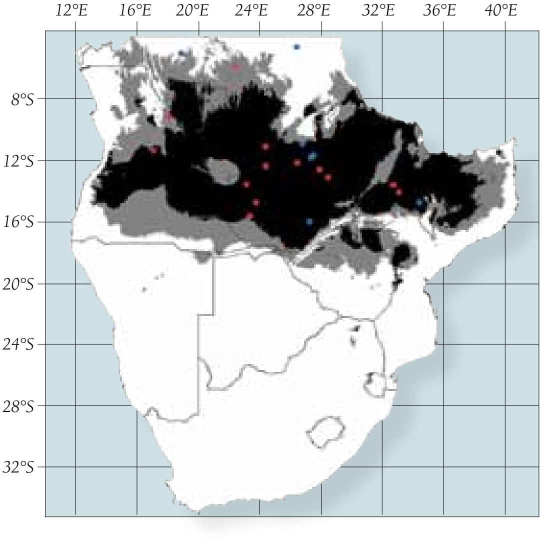
Mops calabarensis Hayman 1940 (BM 1939.318, Holotype, from Calalbar, Ikotmbo Nigeria, 05.05 N 18.32 E) is a synonym (Rosevear 1965). This species has been classified in the subgenus *Xiphonycteris*. Its relationship with the similar *M. spurrelli* (Dollman 1911) is unclear (Koopman 1989), as these two species only differ in the projection of the upper incisors relative to the canine cingula (El-Rayah 1981).

The diploid number in *M. nanulus* is 2n = 48 and FN = 54, X = submetacentric, Y = acrocentric (Smith *et al.* 1986)

Mops niveiventer Cabrera & Ruxton 1926

White-bellied free-tailed bat

Least Concern



Description: *Mops niveiventer* is a medium-sized bat with a mass of around 20 g. The pelage is greyish-brown above with a contrasting blackish crown. The underparts are mostly white. A sparse-haired band extends between the shoulders. The wings are light brown. There is usually a narrow white or cream band on the inner flanks where the wings join the body. Typical of the family, the tail is not completely enclosed within the tail membrane. The upper lip is wrinkled giving a bulldog appearance. Mature adult males have an erectile crest on top of the head. The ears are joined by a flap of skin.

The anterior of the braincase is not noticeably elevated above the plane of the rostrum. The sagittal crest is moderately developed, whereas the lambdoid crest is weakly to well developed (forming a more strongly developed helmet in males). The incisive foramina are visible. The basisphenoid pits are moderate in depth, their width ranging from equal to almost twice their distance apart. The dental formula is 1123/2123 = 30. The anterior upper premolar is distinctly shorter than the cingulum of the posterior premolar; it is within the toothrow or slightly displaced labially. The canine and posterior premolar are separated or in contact. The upper third molar has the third ridge absent. There are two lower incisors on each side, bicuspid and crowded. The lower canines, which have cingula, are not greatly enlarged, and are sometimes almost in contact.

Key identification features: The sparse-haired band across the shoulders separates *Mops* from *Tadarida* and most *Chaerephon* species. *Tadarida aegyptiaca* lacks this band and its ears are not connected by a flap of skin. The similarly sized *Chaerephon ansorgei* shows a shoulder band, but has a black throat. *Mops midas* is far larger (FA > 60 mm). The very similar *M. condylurus* is distinguishable by its grey crown, which does not contrast with the grey back; in *M. niveiventer* the crown is blackish, contrasting with the grey back, and the venter is a clean white. *Mops thersites* is smaller (FA < 41 mm; in *M. niveiventer* FA > 42 mm).

Echolocation call: *Mops niveiventer* produces LD-QCF and LD-CF echolocation calls with a low peak echolocation frequency (20.3±0.2 kHz, n = 6), narrow bandwidth (10.6±0.8 kHz, n = 6), and intermediate duration (8.1±0.6 ms, n = 6) (Schoeman and Jacobs 2008).

Distribution, habitat and roosting: *Mops niveiventer* is restricted to south-central Africa, extending from southern Zambia to Angola and the DRC. It has also been recorded from Mozambique, on the Zambian border. The model suggests that suitable conditions occur throughout much of Zambia. The type specimen is from 'Luluabourg' (= Kananga), DRC (BM 1926.7.6.109, Holotype).

External and cranial measurements (mm) for *Mops niveiventer*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass	-	-	-	-	-	**Mass**	-	-	-	-	-
FA[1]	45.7	42.7	47.1	1.45	8	**FA[1]**	45.5	44.3	46.7	1.11	4
Total	-	-	-	-	-	**Total**	-	-	-	-	-
Tail	-	-	-	-	-	**Tail**	-	-	-	-	-
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear	-	-	-	-	-	**Ear**	-	-	-	-	-
CI[1]	20.6	20.3	21.0	0.36	3	**CI[1]**	20.0	-	-	-	1

[1] Specimens measured by the authors

fig. 200a

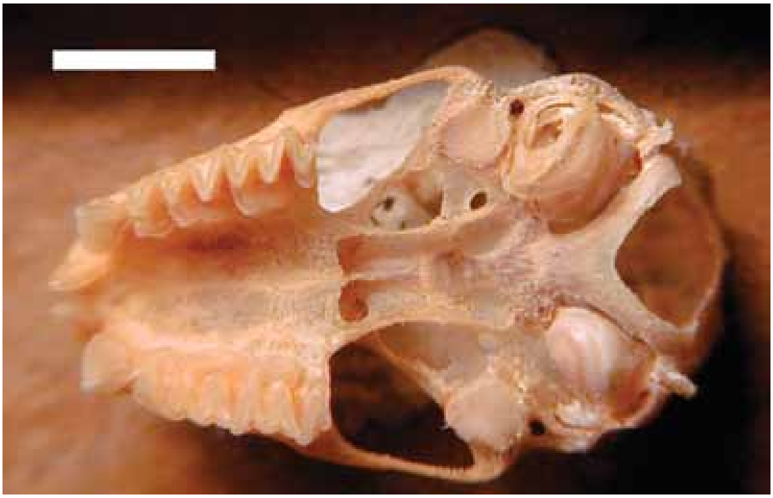


fig. 200b

fig. 200c

Figure 200. Cranium and teeth of *Mops niveiventer:* (a) dorsal view, (b) ventral view, and (c) lateral view. Scale bar = 5 mm (RMCA 82006M448, © F. P. D. Cotterill).

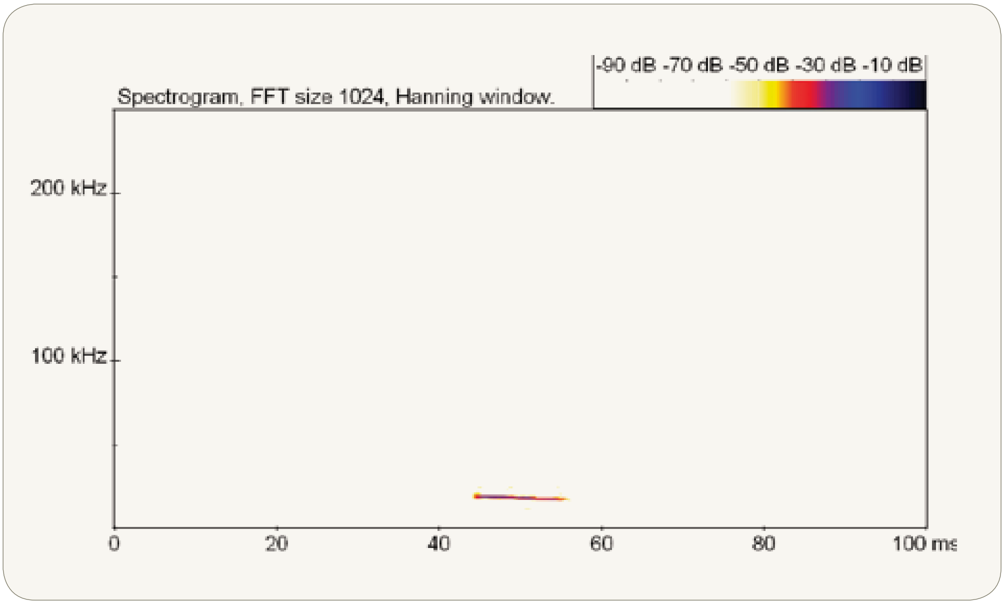


Figure 201. Echolocation call of *Mops niveiventer.*

This species is not well represented in museums, with just 42 records examined for this book.

It roosts communally in small groups. Natural roost sites include narrow cracks in rocks, especially on cliff faces. However, the species has taken to roosting in buildings, in particular roofs of houses. In the Ikelenge Pedicle, northwestern Zambia, a colony of seven adults (one male and six females) roosted high up in a hollow tree (*Brachystegia* sp.) (Cotterill 2001b). Colonies have also been recorded from attics and cracks in walls of buildings (Ansell 1967). This species appears to be associated with *Brachystegia* woodland, where it is sparsely and thinly distributed.

Extralimital: *Mops niveiventer* occurs widely in the DRC and Tanzania, with specimens from Rwanda and Burundi (Cotterill in press d).

Foraging ecology: *Mops niveiventer* has long, narrow wings with high wing loading (21.7 N.m^{-2}) and intermediate aspect ratio (7.4) (Schoeman and Jacobs 2008). It is an open-air forager. There is no information on the diet of this species.

Reproduction: In Zambia, pregnant females (near full-term) were recorded in October and November (Cotterill 2000, Cotterill 2001b). Four of six females had well-developed foetuses in January and lactating females and/or juveniles have been collected in January, February and March (Ansell 1967). Females give birth to a single young, which is pale-skinned in contrast to the dark-skinned neonates of M. condylurus (Ansell 1967).

SYSTEMATIC NOTES

1926. *Mops angolensis niveiventer* Cabrera and Ruxton, Ann. Mag. Nat. Hist., (9) 17: 594. St Joseph de Luluabourg (= Kananga), DRC.

Mops chitauensis J. Eric Hill 1937 (AMNH 88116, Holotype, from Chitau Angola, 11.25°S 17.02°E) is a synonym (Simmons 2005). It appears that *Mops angolensis orientis* G. M. Allen and Loveridge 1942 (AMNH 32289, Holotype, from Kitaya, Rovuma River, Tanzania) is also a synonym of *M. niveiventer.*

Koopman (1993) suggested that *Mops demonstrator* (Thomas 1903) might include *niveiventer*, but re-examination of the type specimens and comparative material of these taxa in the BM (F. P. D. Cotterill, unpublished data) discounts this suggestion.

Mature males of *M. demonstrator* are easily distinguished by the scent glands at the base of the penis. We have been unable to re-examine RMCA specimens from the southern Congo basin attributed to *M. demonstrator*; until evidence becomes available we suggest these records most likely represent *M. niveiventer,* alongside those discussed by Hayman *et al.* (1966).

The diploid number in M. niveiventer is not known.

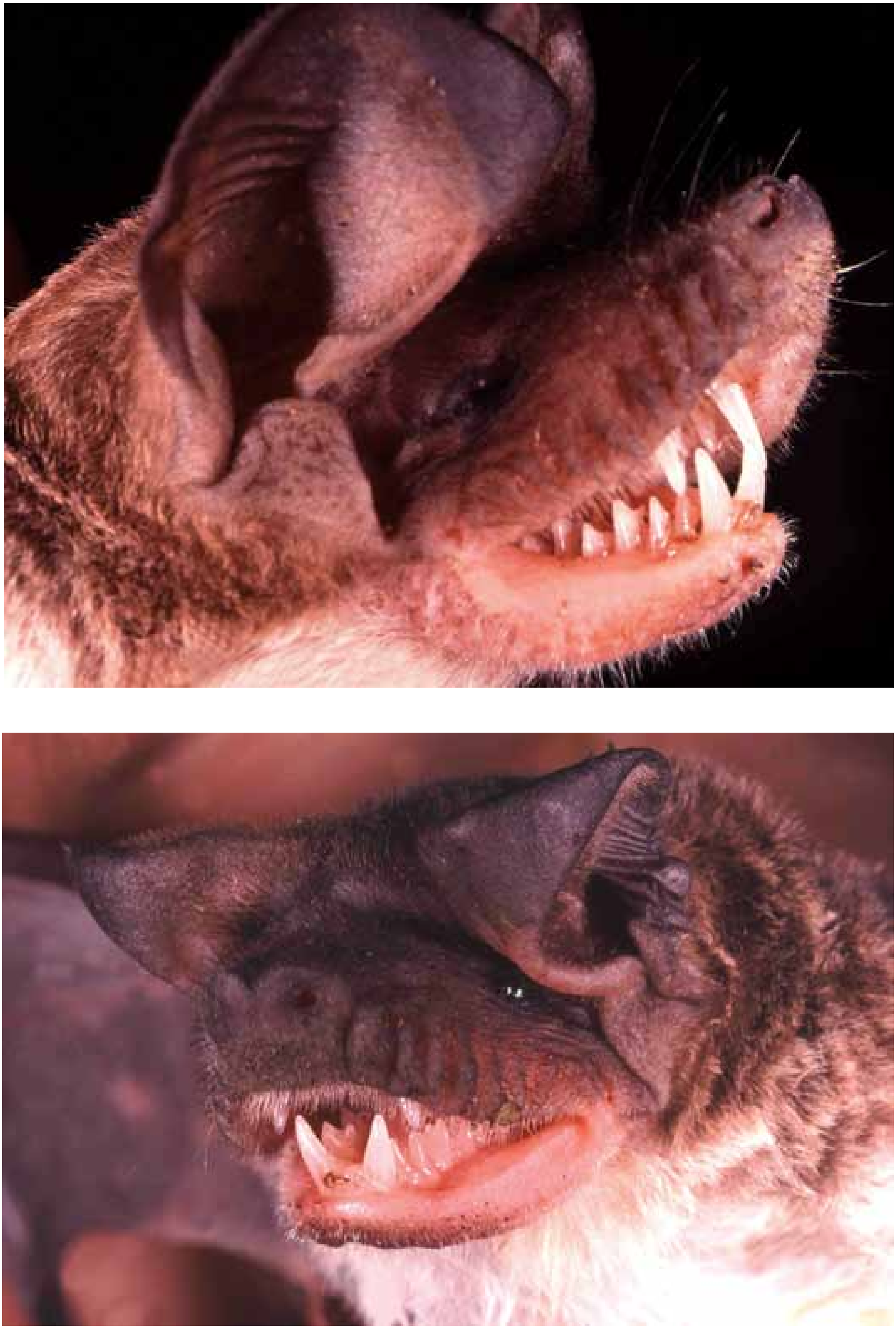
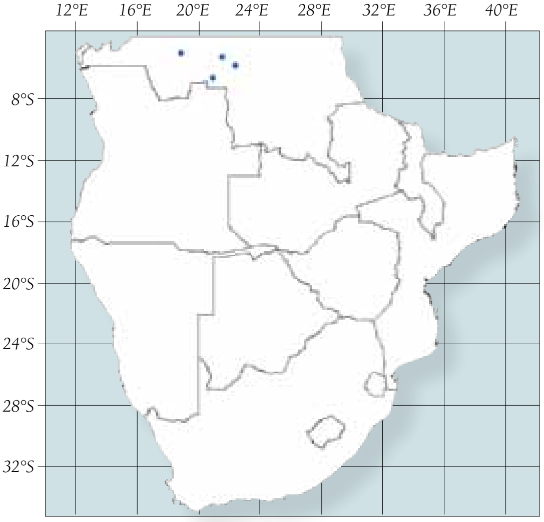


Figure 202. *Mops niveiventer* from Ikelenge, northwestern Zambia, showing wrinkled upper lips and flap of skin joining ears (© F. P. D. Cotterill).

Mops thersites (Thomas 1903)

● Railer free-tailed bat

Least Concern



Description: *Mops thersites* is a small insectivorous bat of average forearm length 39 mm. The pelage varies from reddish-brown to blackish-brown; the underparts are dark tending to black on the flanks, with no mid-ventral markings. The flanks and rump are naked, the skin black; the naked rump exhibits two tufts of long, sensory vibrissae, which are particularly conspicuous in this species, compared to *M. nanulus* and allies in subgenus *Xiphonycteris*. The wing membranes are dark, tending to black; the tail membrane varies from dark-brown to black. The ears are black to dark brown and conjoined over the forehead, but there is no interaural crest. Typical of the family, the tail is not completely enclosed within the tail membrane. The upper lip has many spoon-shaped hairs, and the wrinkled jowls give this bat a bulldog appearance.

The anterior of the braincase is flattened, only rising slightly above the lateral profile of the skull. The sagittal crest is moderately developed, whereas the lambdoid crest is weakly to well developed (forming a more strongly developed helmet in males). The incisive foramina are moderately shallow. The basisphenoid pits are of comparatively shallow depth. The dental formula is 1123/2123 = 30. The anterior upper premolar is small, in the toothrow, and fills space between canine and second premolar. The upper third molar has the third ridge (commissure) absent. There are two lower incisors on each side, bicuspid and crowded, filling the space between the lower canines, which have cingula, are not greatly enlarged, and are sometimes almost in contact (Rosevear 1965, Happold in press).

External and cranial measurements (mm) for *Mops thersites*, sexes combined

	Mean	Min	Max	SD	N
Mass	-	-	-	-	-
FA[1]	38.6	36.0	41.0	-	39
Total[1]	102.0	94.0	119.0	-	12
Tail[1]	29.0	25.0	34.0	-	14
Tibia[2]	-	13	15	-	-
Ear[1]	-	-	-	-	-
GSL[1]	19.4	18.3	21.5	-	37

[1] Happold (in press)
[2] Rosevear (1965)

Key identification features: The free tail and long narrow wings distinguish Mops thersites from vesper bats of similar size. It lacks the interaural crest characteristic of molossids of similar size in the genus *Chaerephon*. *M. thersites* is the largest of the small forest-dwelling molossids classified in subgenus *Xiphonycteris* by El-Rayah (1981); it is most similar to *M. brachypterus*. These two small molossids differ in colour of the underparts (paler in *M. brachypterus*, darker in *M. thersites*), relative position of the wing membranes on the body (higher in *M. thersites*), and the basisphenoid pits, which are deeper in *M. thersites* (El-Rayah 1981).

Echolocation call: The echolocation call of this species has not been recorded.

Distribution, habitat and roosting: *Mops thersites* is known from only four records in the southwestern Congo basin. Most records are associated with open forest, but *M. thersites* also occurs in mesic savanna and adjacent grassland habitats.

Colonies have been recorded roosting in hollow trees and also under roofs of houses (Rosevear 1965, Happold in press).

Extralimital: This species ranges from Guinea and Côte d'Ivoire east to Cameroon, across the Congo basin east to Uganda, Tanzania and coastal Kenya (Rosevear 1965, Kingdon 1974). The type specimen is from Cameroon (BM 1904.2.8.4, Holotype).

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: No reproductive information is available for south-central Africa.

SYSTEMATIC NOTES

1903. *Nyctinomus thersites* Thomas, Ann. Mag. nat. Hist., ser. 7, 12 (72): 634. Cameroon: Efulen (02.77°N 10.70° E).

Mops (Allomops) occipitalis J. A. Allen 1917 (AMNH 48851, Holotype, from Avakubi, DRC, 01.30°N 27.53°E) is a synonym. This species has been classified in subgenus *Xiphonycteris* Dollman 1911 by El-Rayah (1981).

The diploid number in *M. thersites* is $2n = 48$ and FN = 62 (Smith *et al.* 1986).

fig. 203a

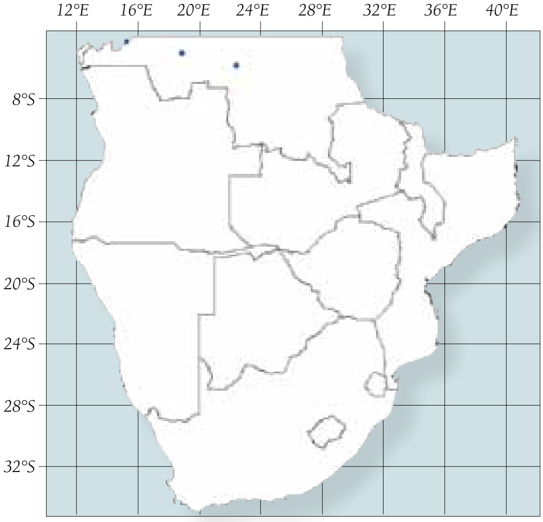
fig. 203b

Figure 203. Skull and teeth of *Mops thersites*: (a) ventral view and (b) lateral view. Scale bar = 5 mm (BM 4.2.8.4; © F. P. D. Cotterill).

Myopterus whitleyi (Scharff 1900)

Bini free-tailed bat

Least Concern



Description: *Myopterus whitleyi* is a very small free-tailed bat with a forearm length not exceeding 36 mm. The pelage is typically dark brown above, with contrasting pale off-white to white underparts. A white band is present on the flanks where the wings join the body. The wing membranes are yellowish-white and semi-translucent. The ears are narrow and pointed, and widely separated. An interaural crest is absent. Typical of the family, the tail is not completely enclosed within the tail membrane. The jowls and upper lip is smooth and conspicuously naked, although there is a fringe of hairs on its inner edge (Rosevear 1965).

The skull is low and small with relatively weak zygomatic arches; the braincase is not distinctly elevated. The sagittal crest is weakly developed or absent, whereas the lambdoid crest may be prominent, when viewed in lateral profile. The anterior palatal emargination is closed; the basisphenoid pits are deep. The dental formula is 1113/1123 = 26. The anterior upper premolar is absent. The upper third molar lacks the third ridge (commissure). There is only one incisor on each side of each jaw, bicuspid and not crowded; lower canines with cingula not greatly enlarged (Rosevear 1965).

External measurements (mm) for *Myopterus whitleyi*, sexes combined

	Mean	Min	Max	SD	N
Mass	-	-	-	-	-
FA[1]	-	33	36	-	-
Total[1]	-	81	99	-	-
Tail[1]	-	25	33	-	-
Tibia[1]	-	9.0	10.5	-	-
Ear	-	-	-	-	-
CL	-	-	-	-	-

[1] Rosevear (1965)

Key identification features: The free-tail and long narrow wings distinguish this bat from similar-sized vesper bats. The distinctly and widely separated ears should prevent confusion with all other molossids found in southern Africa, except *Sauromys petrophilus* from which *M. whitleyi* can be distinguished by a yellowish-white wing membrane (brown to grey-brown in *S. petrophilus*) which contrasts sharply with the dark brown back. Furthermore, the skull of *S. petrophilus* is extremely flattened, a characteristic not associated with the skull of *M. whitleyi*. The larger *Myopterus daubentoni* (FA > 48 mm; FA < 37 mm in *M. whitleyi*) has not been recorded from the southern Africa region.

Echolocation call: The echolocation call of this species has not been recorded.

Distribution, habitat and roosting: In southern Africa, *M. whitleyi* is known from only 13 specimens in the south-west Congo basin. This species is associated with open rainforest or forest edge (Rosevear 1965), and it appears that this species roosts in the foliage of trees (Rosevear 1965). The type specimen was collected from Nigeria (BM 1900.10.26.1, Holotype).

Extralimital: *Myopterus whitleyi* is known from a handful of records across the equatorial belt from Uganda and the DRC in the east to the Central African Republic, Cameroon, Gabon, Nigeria and Ghana in the west (Hayman *et al*. 1966, Happold 1987, Adam *et al*. 1993, Van Cakenberghe *et al*. 1999).

Foraging ecology: There is no information on the diet or foraging behaviour of this species in southern Africa.

Reproduction: No reproductive information available for this species anywhere in Africa.

SYSTEMATIC NOTES

1900. *Mormopterus whitleyi* Scharff, Ann. Mag. nat. Hist., ser. 7, 6 (36): 569.

The diploid number is *M. whitleyi* is not known.

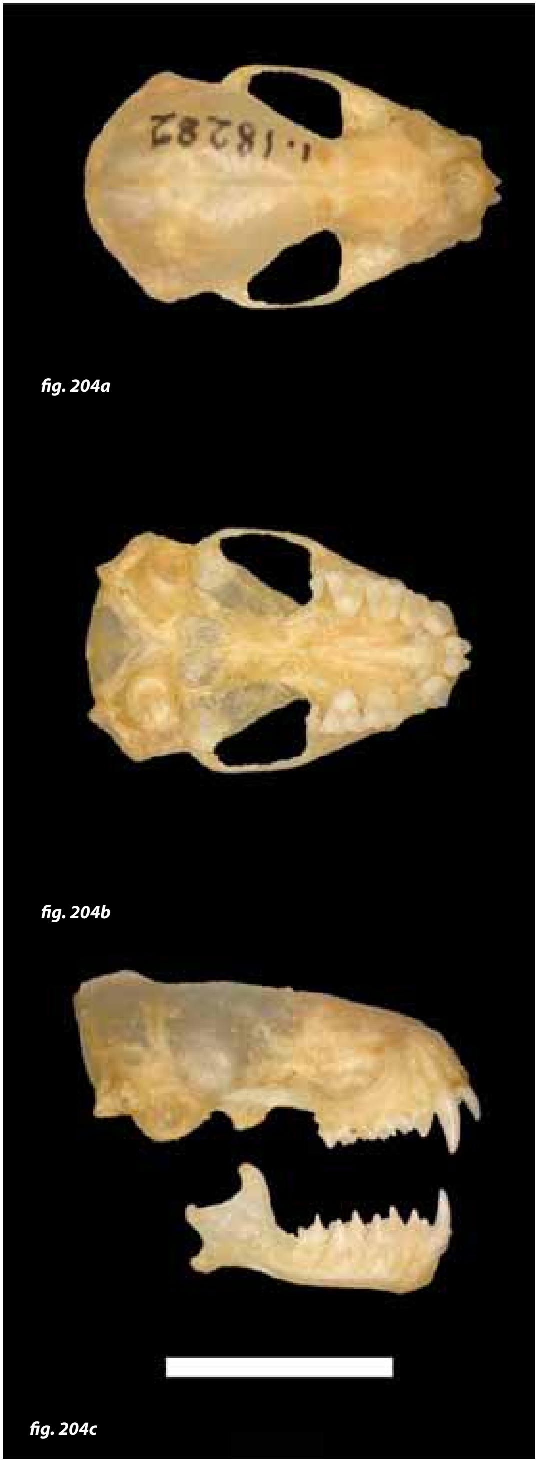
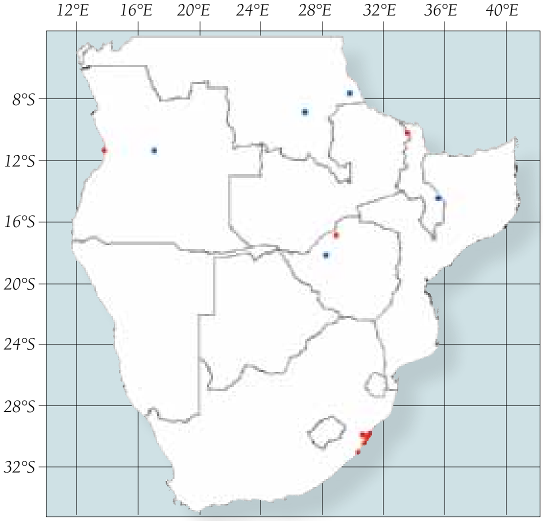


Figure 204. Skull and teeth of *Myopterus whitleyi:* (a) dorsal view; (b) ventral view; (c) lateral view of skull and mandible. Scale bar = 10 mm (HZM 1.18282; © Malcolm Pearch, HZM).

Otomops martiensseni (Matschie 1897)

Large-eared giant mastiff bat

Near Threatened



Description: *Otomops martiensseni* is a large bat with a mass of around 30 g. The species is sexually dimorphic with males larger than females in body and skull size. The pelage is blackish-brown with a conspicuous whitish collar around the neck, which separates the dark back and head. A thin strip of white hair marks the juncture of the wing and dorsal body, between shoulder and knee. The underparts are slightly paler than the upper parts. The wings are light brown. There is no white or cream band on the inner flanks where the wings join the body. Typical of the family, the tail is not completely enclosed within the tail membrane. The ears are long and rounded, and project forward over the snout. It appears to have a protruding snout, caused by the longer upper jaw in relation to the lower jaw. The upper lip is wrinkled giving a bulldog appearance. Mature adult males do not have an erectile crest on top of the head. The ears are joined by a flap of skin on the snout.

The skull is elongate and gracile. The rostrum is proportionately longer than in other molossids. The sagittal and supra-occipital crests are absent. In lateral view, the braincase is elevated above the plane of the rostrum and the occipital region is high and domed, elevated above the plane of the parietal. The zygomatic arches are gracile and not bowed outwards, but dorsoventrally flattened, forming a conspicuous dorsal projection in middle section. The palatal foramina have merged to form a dorsoventrally elongated emargination with a very narrow neck at the anterior palatal margin. The basioccipital pits are very deep and prominent, separated by a very narrow bridge. The bullae are prominent and oriented longitudinal to the main skull axis. The dentary bone is narrow and the mandible is gracile with reduced processes. The dental formula is 1123/2123 = 30. The upper anterior premolar is separated from the canine by a narrow diastema. The lower anterior premolar is slightly smaller than the posterior premolar and separated by a slight gap.

Key identification features: *Otomops martiensseni* should not be confused with any other African bat: its large size, long ears, protruding snout and white collar render it unmistakable. The large *Tadarida* species (*T. fulminans*, *T. ventralis*, *T. lobata*) are easily distinguished by their lack of wrinkled upper lips. *Mops midas* is similar in size, but lacks the white collar and has shorter ears (< 32 mm; in *O. martiensseni* generally > 33 mm).

Echolocation call: *Otomops martiensseni* produces LD-QCF and LD-CF echolocation calls with a low peak echolocation frequency (10.8±2 kHz, n = 250 calls), narrow bandwidth (6.4±2.3 kHz, n = 250 calls), and long duration (24±14.8 ms, n = 250 calls) (Fenton *et al.* 2002; also see Taylor 1999a, Taylor *et al.* 2005, Schoeman and Jacobs 2008). The low frequency calls are audible to human observers. Fenton *et al.* (2004) demonstrated significant differentiation of individual calls of roost mates, suggesting that calls have a social function in recognition.

External and cranial measurements (mm) and mass (g) for *Otomops martiensseni*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	31.1	25.0	36.0	3.94	5	**Mass[1]**	27.8	20.0	31.5	3.27	12
FA[1]	64.1	56.7	67.7	3.15	21	**FA[1]**	62.8	59.2	66.0	1.79	32
Total[1]	137.0	120	153	11.2	13	**Total[1]**	138.0	114	150	10.4	15
Tail[1]	41.9	33	49	5.13	13	**Tail[1]**	42.1	32	48	3.79	16
Tibia[1]	17.9	17.6	18.2	0.31	5	**Tibia[1]**	18.1	16.0	19.1	1.1	3
Ear[1]	36.1	29	41	4.31	14	**Ear[1]**	35.3	28	40	4.52	15
CI[1]	25.7	25.5	26.5	0.38	7	**CI[1]**	23.7	22.8	25.3	0.76	10

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[1] Specimens measured by the authors

fig. 205a

fig. 205b

fig. 205c

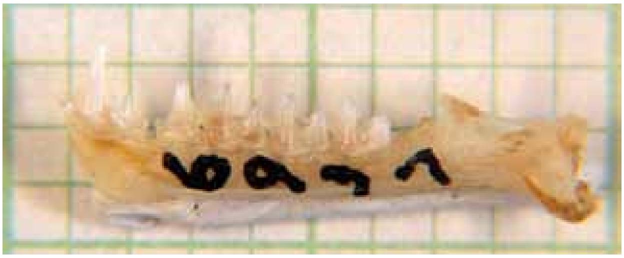


fig. 205d

Figure 205. Cranium and teeth of *Otomops martiensseni:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (a, c, d: DM 6937; b: DM 3886, © L. Richards).

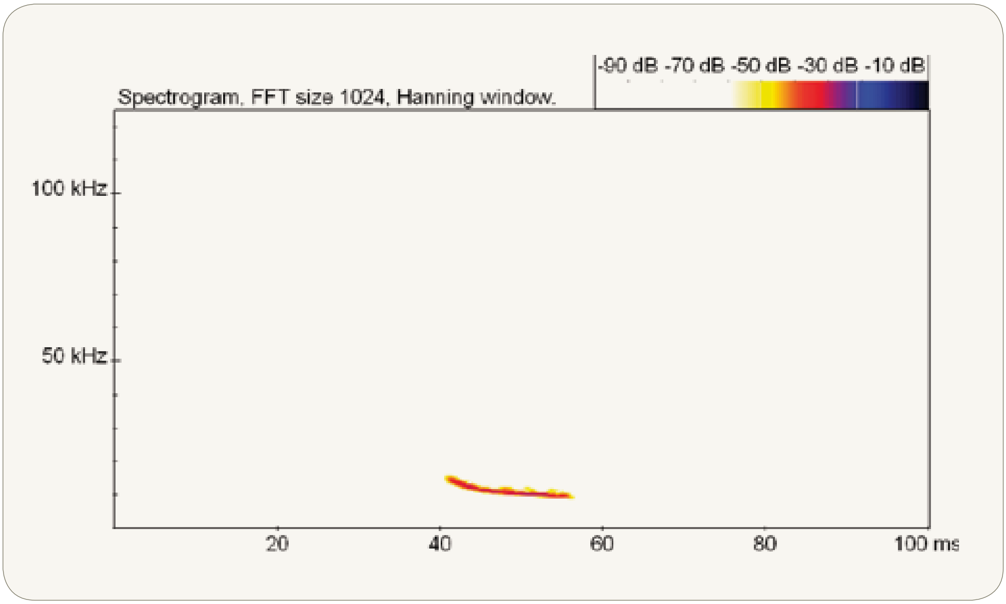


Figure 206. Echolocation call of *Otomops martiensseni*.

Distribution, habitat and roosting: *Otomops martiensseni* has a localised distribution in southern Africa. In South Africa, it is regularly observed only in the greater Durban area (Fenton *et al*. 2002). There are isolated records from Angola, Zimbabwe, Zambia, Malawi and the DRC. The type specimen is from northeastern Tanzania (ZMB 97523, Holotype).

Numerous specimens have been collected from Durban (in residential areas as well as areas bordering natural and agricultural habitats), where more than 80 individuals were examined for this book. However, fewer than ten specimens have been collected from other southern African sites.

In Kenya, this species roosts communally in caves – colonies may number in the tens of thousands (Kock *et al*. 2005). However, it has taken to roosting in the roofs of houses in the Durban area (Fenton *et al*. 2002), where it is not known to use caves. This species inhabits a variety of woodland types throughout its range (Long 1995).

Extralimital: *Otomops martiensseni* has also been recorded from the DRC, Côte d'Ivoire, Ghana, Central African Republic, Rwanda, Burundi, Uganda, Kenya, Tanzania, Ethiopia, Djibouti, Eritrea and Yemen (Lamb *et al*. 2008).

Foraging ecology: *Otomops martiensseni* has long, narrow wings with high wing loading (14.9 $N.m^{-2}$) and intermediate aspect ratio (9.3) (Norberg and Rayner 1987; also see Fenton *et al*. 2002, Schoeman and Jacobs 2008). It is an open-air forager. Its diet comprises predominantly Lepidoptera (M. C. Schoeman, unpublished data; also see Rydell and Yalden 1997).

Reproduction: Gestation in Kenya was three months (Mutere 1973). In South Africa, juveniles have been recorded between October and May, but it is not known whether individual females give birth more than once a year (Taylor 2000).

SYSTEMATIC NOTES

1897. *Nyctinomus martiensseni* Matschie, Archiv für Naturgeschiechte 63(1): 84. Magrotto plantation, southeastern Usambara Mountains, west of Tanga, northeast Tanzania.

Meester *et al.* (1986) recognised two subspecies: the nominate race is extralimital, and *O. m. icarus* Chubb 1917 (BM 16.10.9.1, Holotype, type locality Durban) occurs in South Africa, Zimbabwe and Angola. However, molecular, morphometric and ecological niche modelling evidence suggests recent or ongoing gene flow between widely scattered localities from the southern, eastern and western African populations (Lamb *et al.* 2006, 2008, L. Richards, unpublished data). Despite high genetic similarities, there is evidence for two Evolutionary Significant Units (ESUs), one from southern, central and western Africa, and the other from northeastern Africa and Arabia. Although Madagascar populations have been considered by some to be conspecific with *O. martiensseni,* recent genetic and morphometric evidence suggests that *O. madagascariensis* is a distinct species (Lamb *et al.* 2008, L. Richards, unpublished data).

The diploid number in *O. martiensseni* is 2n = 48 and aFN = 56 (Dulic and Mutere 1973).

fig. 207a

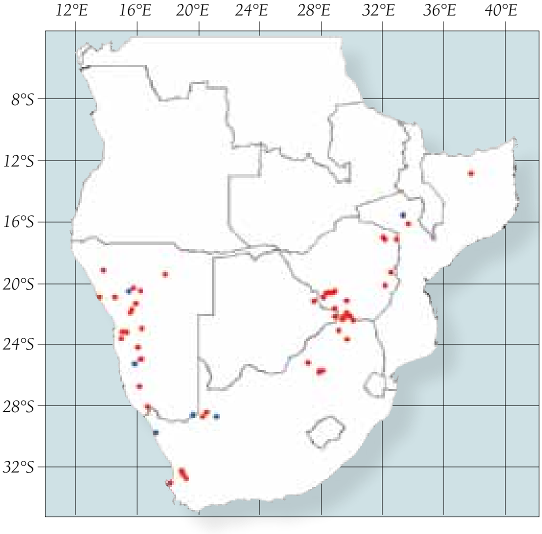
fig. 207b

Figure 207. Otomops martiensseni: (a) portrait showing large ears and protruding snout, and (b) roosting individuals showing contrasting white band on shoulders (a: © Merlin D. Tuttle, Bat Conservation International, www.batcon.org; b: © M. B. Fenton).

Sauromys petrophilus Roberts 1917

Roberts's flat-headed bat

Least Concern



Description: *Sauromys petrophilus* is a small bat with a mass of around 9 g. The pelage is pale greyish-brown to brown. The underparts are slightly paler than the upper parts. Bats from the western part of the range are paler than those from the east. The wings are light brown. Typical of the family, the tail is not completely enclosed within the tail membrane. The upper lip is smooth and has comparatively few coarse bristles (not spoon-hairs). The ears are large, broad and without complex folds; the inner margins are separated. The ears do not extend beyond muzzle. The antitragus is indistinct and the tragus is very small. No interaural crest or gular gland is present.

The skull is extremely dorsoventrally flattened, with a maximum height that is 32% (24–37%) of GLS (n = 22). The zygomatic arches are slender. The anterior of the braincase is not elevated above the plane of the rostrum. The sagittal crest is indistinct and depressed in a shallow parietal groove; the lambdoid crest is moderate. The lachrymal ridges are indistinct and form a comparatively small tubercle on each side of the rostrum. The anterior palatal emargination is wide. The basisphenoid pits are distinct, large, and their width is much greater than their distance apart. The coronoid processes of the mandible are well developed. The dental formula is 1123/2123 = 30. The upper incisors are well separated and pointing inwards, with a small secondary cusp on the lateral side, just below the gumline. The anterior upper premolar is within the toothrow. The canine and posterior premolars are well separated. In the upper third molar, the second and third ridges are equal in length. There are two lower incisors on each side. The lower canines possess cingula and are not greatly enlarged and not in contact.

Key identification features: In southern Africa, the small size of *Sauromys petrophilus* (FA < 43 mm) should prevent confusion with other free-tailed bats, except *C. pumilus* and the rare *C. chapini*. In both these species, the ears are joined by a flap of skin, while in *S. petrophilus* the ears are separate. *Tadarida aegyptiaca* is superficially similar, but larger (FA > 43 mm) and generally darker. The flattened skull is a useful feature distinguishing this species, but is not evident on a live animal. (See the *Myopterus whitleyi* species account for differences with that species.)

Echolocation call: *Sauromys petrophilus* produces LD-QCF echolocation calls with a low peak frequency (29.9±1.8 kHz, n = 10), narrow bandwidth (13.9±4.1 kHz, n = 10), and intermediate duration (5.3±2.5 ms, n = 10) (Schoeman and Jacobs 2003, 2008; also see Jacobs and Fenton 2002). Besides the fundamental, the second harmonic may be present on the spectrogram.

Distribution, habitat and roosting: *Sauromys petrophilus* is widespread and abundant in the arid western parts of Namibia and South Africa, extending south to the Western Cape

External and cranial measurements (mm) and mass (g) for *Sauromys petrophilus*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass¹	9.1	7.0	14.0	1.80	19	**Mass¹**	9.2	6.0	15.0	2.88	7
FA¹	39.5	35.9	43.0	1.99	21	**FA¹**	38.3	35.0	40.7	2.28	8
Total¹	101.0	92	110	5.75	23	**Total¹**	101.0	98	104	2.34	6
Tail¹	37.0	30	41	3.20	23	**Tail¹**	38.0	33	42	3.30	6
Tibia¹	12.3	-	-	-	1	**Tibia¹**	11.6	11.1	12.0	0.64	2
Ear¹	16.0	11	18	1.90	23	**Ear¹**	14.0	12	16	1.50	6
CI¹	16.9	15.3	17.6	0.56	33	**CI¹**	16.6	15.3	17.3	0.60	11

[1] Specimens measured by the authors

fig. 208a

fig. 208b

fig. 208c

fig. 208d

Figure 208. Cranium and teeth of *Sauromys petrophilus:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) mandible (DM 8612).

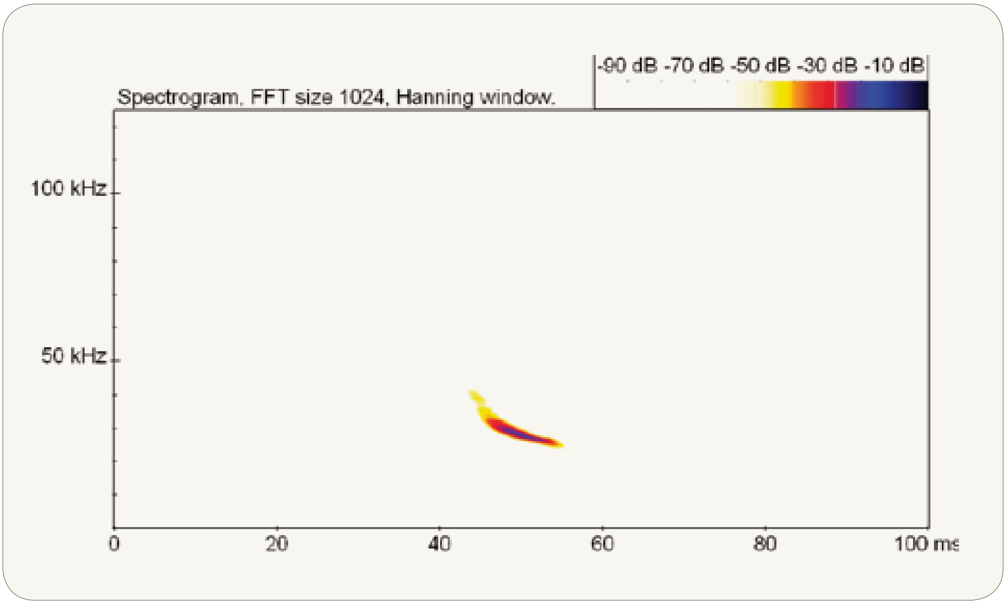


Figure 209. Echolocation call of *Sauromys petrophilus*.

(Jacobs and Fenton 2001). There is a separate population in northern South Africa, Zimbabwe and northern Mozambique. The type specimen is from the 'Transvaal' (= North West), South Africa. The apparent absence of this species from the Sebungwe Basin and Zambezi Valley in Zimbabwe is difficult to explain, considering the availability of daylight roosts in exposures of Karoo sandstones and quartzites.

This species is well represented in museums, with over 130 records examined for this book.

It roosts communally in small groups of up to 10 individuals (Rautenbach 1982). Their natural roost sites are in narrow cracks and under slabs of exfoliating rock (Jacobs and Fenton 2001). This species is closely associated with rocky habitats, usually in dry woodland, mountain fynbos or arid scrub.

Extralimital: *Sauromys petrophilus* is endemic to southern Africa.

Foraging ecology: *Sauromys petrophilus* has long, narrow wings with high wing loading (11.2 $N.m^{-2}$) and intermediate aspect ratio (7.2) (Jacobs and Fenton 2001, Schoeman and Jacobs 2003, 2008). It is an open-air forager. Its diet consists mainly of Diptera, Hemiptera and Coleoptera (Jacobs and Fenton 2001, Schoeman and Jacobs 2003, Schoeman 2006). Although often netted above or near water, in Namibia they do not appear to need regular access to water (Roer 1971 in Jacobs and Fenton 2001).

Reproduction: Pregnant and lactating females have been netted in mid-November near Mutoko in northeast Zimbabwe (F. P. D. Cotterill, unpublished data).

SYSTEMATIC NOTES

1917. *Sauromys petrophilus* Roberts, Annals of the Transvaal Museum 6: 4. Blesbop, near Rustenburg, 'western Transvaal' (= North West), South Africa.

Meester *et al.* (1986) recognised five subspecies from southern Africa, although there is doubt as to their validity. The distribution of this species is fragmented owing to the patchy nature of its habitat, and may have led to genetic isolation of principal populations. The western population is separated from the eastern one by 800 km and future studies may well show these to be genetically distinct.

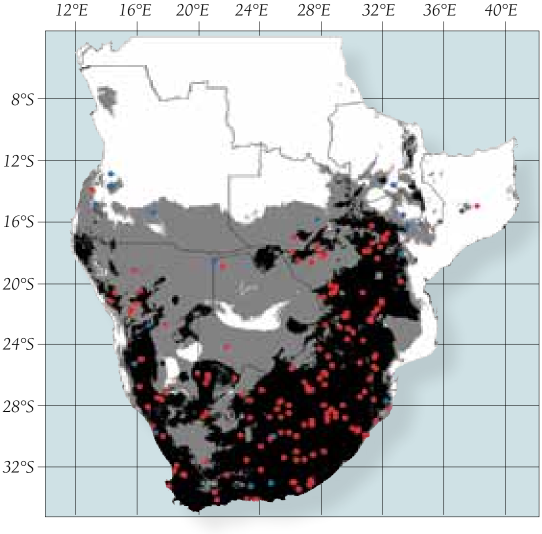
The diploid number in *S. petrophilus* (in Namibia and South Africa) is 2n = 48 and aFN = 62, X = medium-sized submetacentric, Y = small acrocentric (Rautenbach *et al.* 1993).

Figure 210. *Sauromys petrophilus,* showing inner margins of ears separated (Cedarberg, Western Cape, South Africa, © E. C. J. Seamark).

Tadarida aegyptiaca (E. Geoffroy 1818)

Egyptian free-tailed bat

Least Concern



Description: *Tadarida aegyptiaca* is a medium-small bat with a mass of around 15 g. The pelage is generally dark brown. The underparts are only slightly paler and the wings are light brown. Typical of the family, the tail is not completely enclosed within the tail membrane. The upper lip is wrinkled giving a bulldog appearance. The ears are not joined by a flap of skin, but meet close together, giving the false appearance of being joined.

The skull is moderately dorsoventrally flattened, the forehead and braincase gradually sloping upwards in lateral profile, with a distinctive depression in the interparietal region. The supra-occipital crest is moderately developed. The sagittal crest is reduced to a thin mid-dorsal line. The zygomatic arches are dorsoventrally thickened. The anterior palate has a deep emargination. On the mandible, the coronoid processes are reduced and the angular process projects posteriorly. The dental formula is 1123/2123 = 30. The lower canines are well separated at their bases.

Key identification features: *Tadarida aegyptiaca* is larger than *Sauromys petrophilus*, *Chaerephon pumilus* and *C. chapini* (all three species have FA < 43 mm). It can be confused with several *Chaerephon* species of similar size: *C. nigeriae* is uniform sooty-brown with a contrasting white band along the wing and body, which is absent in *T. aegyptiaca*; *C. ansorgei* has a black throat, whereas *C. bivittatus* is covered in conspicuous white spots.

Echolocation call: *Tadarida aegyptiaca* produces LD-QCF echolocation calls with a low peak frequency (22.7±2.2 kHz, n = 10), narrow bandwidth (11.7±6.1 kHz, n = 10), and long duration (9.6±3.4 ms, n = 10) (Schoeman and Jacobs 2003, 2008; also see Fenton and Bell 1981, Taylor 1999a, Fenton *et al*. 2004). Besides the fundamental, the second harmonic may be present on the spectrogram.

Distribution, habitat and roosting: *Tadarida aegyptiaca* is widespread and abundant throughout most of southern Africa. It occurs from the Western Cape of South Africa north through to Namibia and southern Angola; and through Zimbabwe to central and northern Mozambique. However, it appears to be restricted to western Botswana and southern Zambia. It is absent from Malawi, much of Mozambique, Botswana, Angola, Zambia and the southern DRC. The type specimen is from Egypt (MHNH A467).

This species is well represented in museums, with over 450 records examined for this book.

It roosts communally in small to medium-sized groups, which may number in the dozens to hundreds (Herselman and Norton 1985). They roost during the day in caves, rock crevices, under exfoliating rocks, in hollow trees, and behind the bark of dead trees (Shortridge 1934, Herselman and Norton 1985, Skinner and Chimimba 2005). However, the

External and cranial measurements (mm) and mass (g) for *Tadarida aegyptiaca*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	13.7	10.0	21.0	2.37	53	**Mass**[1]	15.7	9.0	22.0	3.37	27
FA[1]	45.9	42.0	50.0	1.74	94	**FA**[1]	47.1	43.7	51.8	1.97	43
Total[1]	108.0	91	136	6.97	96	**Total**[1]	109.0	90	131	8.09	40
Tail[1]	38.0	30	49	3.70	96	**Tail**[1]	38.0	30	50	4.40	40
Tibia[1]	17.2	-	-	-	1	**Tibia**[1]	16.1	-	-	-	1
Ear[1]	18.0	14	22	1.94	94	**Ear**[1]	18.2	13	22	2.27	40
CI[1]	17.7	16.2	20.4	0.64	81	**CI**[1]	18.1	16.8	19.8	0.90	32

[1] Specimens measured by the authors

fig. 211a

fig. 211b

fig. 211c

fig. 211d

Figure 211. Skull and teeth of *Tadarida aegyptiaca:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8618).

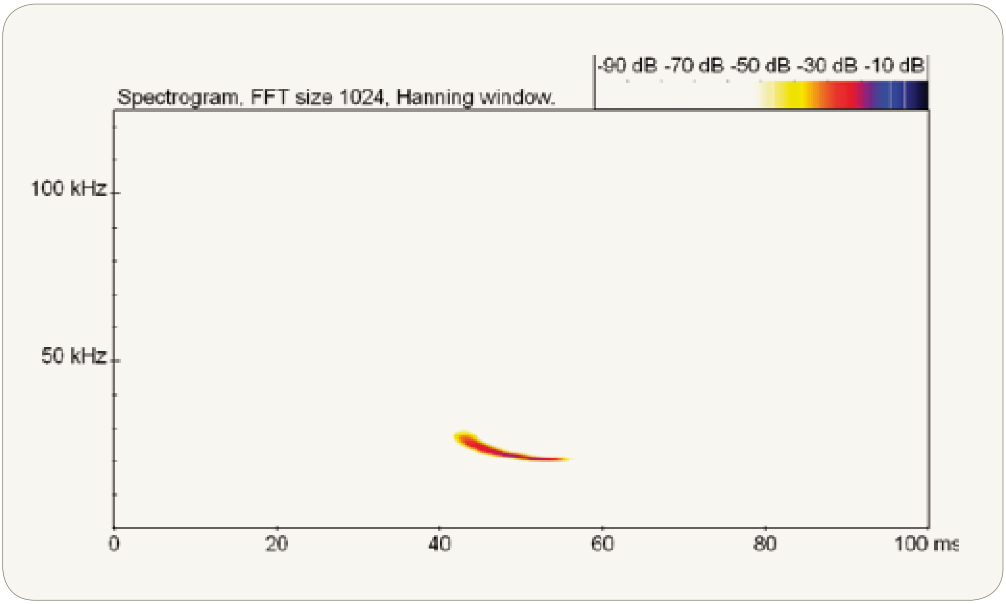


Figure 212. Echolocation call of *Tadarida aegyptiaca*.

species has taken to roosting in buildings, in particular roofs of houses (Taylor 1998). *Tadarida aegyptiaca* forages over a wide range of habitats, usually flying well above the canopy of the vegetation. It appears that the vegetation below has little influence on this species, as it forages over desert, semi-arid scrub, savanna, grassland and agricultural land, but avoids forests. In arid areas, its presence is strongly associated with permanent water bodies, which have concentrated densities of insect prey.

Extralimital: *Tadarida aegyptiaca* occurs widely in sub-Saharan African.

Foraging ecology: *Tadarida aegyptiaca* has long, narrow wings with high wing loading (13.1 N.m^{-2}) and intermediate aspect ratio (8.1) (Schoeman and Jacobs 2003, 2008). It is an open-air forager. Its diet consists mainly of Diptera, Hemiptera and Coleoptera and, to a lesser degree, Lepidoptera (Schoeman and Jacobs 2003, Schoeman 2006; also see Fenton and Thomas 1980, Fenton 1985).

Reproduction: After a gestation of four months, a single young is born, usually in November or December. Females give birth once a year. In males, spermatogenesis occurs from February to July and mating occurs in August (Bernard and Tsita 1995). Maternity colonies are apparently established by females in November (Herselman 1980).

SYSTEMATIC NOTES

1818. *Nyctinomus aegyptiacus* E. Geoffroy, Description de l'Egypt 2: 128, pl. 2 no. 2. Egypt.

The following names are synonyms: *brunneus* Seabra 1900 (= *brunnea* in Hayman *et al.* 1966), *geoffroyi* Temminck 1826, *talpinus* Heuglin 1877, *tongaensis* Wettstein 1916, *bocagei* Seabra 1900, *anchietae* Seabra 1900, *sindica* Wroughton 1919, *thomasi* Wroughton 1919, *gossei* Wroughton 1919 and *tragatus* Dobson 1874.

The diploid number in *T. aegyptiaca* is 2n = 48 and aFN = 68 (Rautenbach *et al.* 1993).

fig. 213a

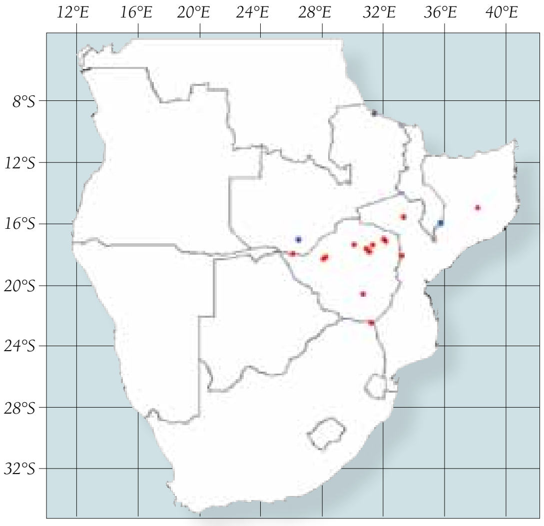
fig. 213b

Figure 213. Tadarida aegyptiaca: portraits showing (a) wrinkled upper lip, and (b) separate ears arising close together on the muzzle (a: © P. J. Taylor; b: TM 47723, © L. Lumsden).

Tadarida fulminans (Thomas 1903) ●

Malagasy free-tailed bat

Least Concern



Description: *Tadarida fulminans* is a large bat with a mass of around 35 g. Its pelage colour is sexually dimorphic. Upper parts are generally reddish-brown (males) to chocolate-brown (females). Adult males have a fulvous-pinkish ventral colour, while that of younger males and females is pure white to cream. There is a clear demarcation between the darker back and sides and the white to fulvous belly. A white band of hairs is present along the flanks under the wings. The wings are light brown. Typical of the family, the tail is not completely enclosed within the tail membrane; in fact, most of the tail protrudes from the membrane. The soles of the feet have plantar pads (not found in the similar *T. ventralis*) (F. P. D. Cotterill, unpublished data). The upper lip is not wrinkled and the ears are not joined by a flap of skin, but meet close together giving the false appearance of being joined. There is a naked patch of skin (gular gland) on the throat of adult males (Harrison 1971, Cotterill 2001b).

The skull is robust and not dorsoventrally flattened. The rostrum is markedly narrower than the laterally expanded braincase (owing to the expanded mastoid). The sagittal crest is minute (males) to absent (females). The supraorbital (lambdoid) crest is moderately developed. In lateral profile, the braincase is somewhat elevated above the rostral plane (concave forehead) and there is a depression in the interparietal region. The zygomatic arches are dorsoventrally flattened. There are distinct lachrymal ridges that separate the infraorbital foramina and anterior orbit. The palatal emargination is deep. The basioccipital pits are rather deep and wide (the width of each pit is greater than the ridge separating them). The mandible is robust with low coronoid processes and a well-developed angular process. The morphology of the interdental palate is diagnostic. The dental formula is 1123/2123 = 30. The anterior upper premolar separates the canine and posterior upper premolar, which is slightly displaced outside the toothrow. The two lower incisors are trifid. The lower canines have cingula that are almost touching.

Key identification features: The three large *Tadarida* species are easily distinguished from other large molossids by their unwrinkled upper lips. *Tadarida fulminans* is distinguished from *T. lobata* by its shorter ears (< 25 mm; > 25 mm in *T. lobata*), and from *T. ventralis* by its smaller size (FA > 61 mm in *T. ventralis*), and also the presence of plantar pads (which are absent in *T. ventralis*) and a white band along the wing and flank (absent in *T. ventralis*). There is some overlap in forearm size between the two species, but differences in greatest skull length appear not to overlap, with the skull length of *T. fulminans* shorter (< 24.0 mm) than that of *T. ventralis* (> 24.5 mm). The basisphenoid pits are not as well developed in *T. fulminans* as in *T. ventralis* (Harrison 1971).

External and cranial measurements (mm) and mass (g) for *Tadarida fulminans*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	33.7	30.0	39.0	2.57	9	**Mass[1]**	34.8	32.0	38.0	1.89	11
FA[1]	59.8	56.4	62.0	1.80	18	**FA[1]**	60.2	57.1	62.0	1.31	13
Total[1]	151.0	125	163	14.1	12	**Total[1]**	156.0	151	163	3.74	10
Tail[1]	59.0	53	65	3.60	12	**Tail[1]**	59.0	56	64	2.30	10
Tibia[1]	-	-	-	-	-	**Tibia[1]**	22.3	-	-	-	1
Ear[1]	24.0	19	25	1.80	13	**Ear[1]**	23.0	22	25	1.10	10
CI[1]	22.9	22.3	23.4	0.43	7	**CI[1]**	22.1	21.5	22.5	0.28	10

[1] Specimens measured by the authors

fig. 214a

fig. 214b

fig. 214c

fig. 214d

Figure 214. Cranium, mandible and teeth of *Tadarida fulminans*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8619).

Echolocation call: *Tadarida fulminans* produces LD-QCF echolocation calls with a low peak frequency (17 kHz, n = 1), narrow bandwidth (13 kHz, n = 1), and long duration (15 ms, n = 1) (Fenton and Bell 1981; also see Aldridge and Rautenbach 1987).

Distribution, habitat and roosting: *Tadarida fulminans* is restricted to the northeast of southern Africa. It occurs from the Pafuri region of the Kruger National Park in northern South Africa through Zimbabwe to central and northern Mozambique and southern Malawi, with an isolated record in northeast Zambia. The type material is from Madagascar, where the species is known from only two specimens (BM 82.3.1.34, Holotype, and FMNH 166074) (Goodman and Cardiff 2004).

Although locally distributed, this species is relatively well represented in museums, with 125 specimens examined for this book.

It roosts communally in small to medium-sized groups, which may number over 30 individuals (Cotterill 2001b). Natural roost sites include crevices in vertical rock faces, which may be > 60 m above the ground (Cotterill and Fergusson 1993), and spaces under exfoliating rock (Cotterill 2001b). This species occupies savanna woodlands, particularly miombo and mopane, interspersed with steep-sided inselbergs or mountains (Cotterill 2001b). In Zimbabwe, the species is associated with exposures of dolomite, basalt and granite (Cotterill 1996b).

Extralimital: *Tadarida fulminans* has also been recorded from Rwanda, Burundi, DRC, Tanzania, Kenya and Madagascar.

Foraging ecology: *Tadarida fulminans* has long, narrow wings with high wing loading of 18.1 $N.m^{-2}$ (15.1–22.1, n = 14) and high aspect ratio of 9.1 (8.5–11.2, n = 14) (F. P. D. Cotterill, unpublished data). It is an open-air forager. Together with *T. ventralis*, *T. fulminans* has the longest, narrowest wing tips of all molossids – adaptations for fast, agile flight (Freeman 1981). There is no information on the diet of this species in southern Africa.

Reproduction: Like many other free-tailed bats, females give birth to a single young at a time and they are capable of having two birth seasons in a year (seasonally polyoestrus). Unlike other species, *Tadarida fulminans* females give birth not only during the warm-wet season (October–November), but also during the cool-dry season in May–June (at least in Zimbabwe). This second birth period (inferred from pregnant and lactating females, rather than direct observation of juveniles) is followed by a post-partum oestrus in June–July (inferred from the presence of lactating females in early pregnancy). Gestation is 100–110 days (Cotterill and Fergusson 1993).

SYSTEMATIC NOTES

1903. *Nyctinomus fulminans* Thomas, Annals and Magazine of Natural History (7) 12: 501. Fianarantsoa, eastern Betsileo, Madagascar.

Owing to the large geographic separation, the mainland population may eventually be shown to be different from that on Madagascar. Should this be the case, the available name for the mainland population is *Nyctinomus mastersoni* Roberts 1946 (TM 9976, Holotype). Subject to available population samples, the two populations do, however, overlap in cranial and external features (Goodman and Cardiff 2004).

The diploid number in *T. fulminans* is 2n = 48 and aFN = 66 (Rautenbach *et al.* 1993).

fig. 215a

Figure 215. *Tadarida fulminans:* (a) female and (b) male, showing unwrinkled upper lips, and (c) whole body showing contrasting white underparts (a, b:© F. P. D. Cotterill; c: DM 8619, © A. Monadjem).

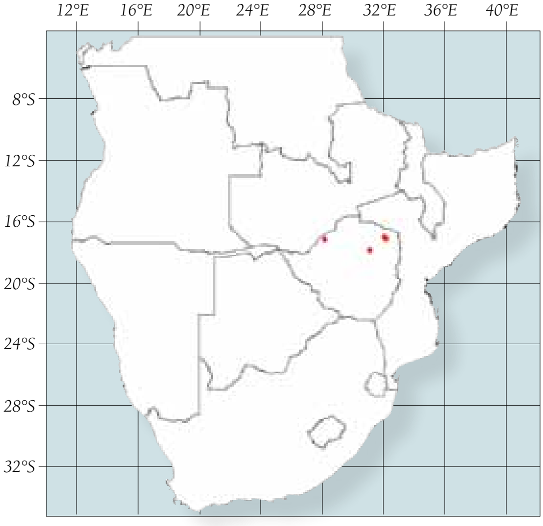
fig. 215b

fig. 215c

Tadarida lobata (Thomas 1891)

Big-eared free-tailed bat

Data Deficient



Description: *Tadarida lobata* is a large bat with a mass of over 25 g. The pelage is short and generally dark brown on the back and sides, with a white belly of variable width. There is a diagnostic white patch of fur on the back between the shoulders of mature adults. A white band of hair is present on the flanks under the wings. The wings are light brown. The upper lip is not wrinkled. The ears are very large, protruding well beyond the nose when laid flat, and are not joined by a flap of skin, but meet close together giving the false appearance of being joined. Adults have a naked patch of skin (gular gland) on the throat (Cotterill 2001b).

The anterior of the braincase is not noticeably elevated above the rostrum in lateral view. The sagittal crest is weakly developed or inconspicuous; the lambdoid crests are distinct in both sexes. The anterior palatal emargination is wide. The interdental palate is broader posteriorly, constricted at the level of the posterior premolars. The basisphenoid pits are shallow to moderate in depth, medium-sized and their width is slightly greater to slightly less than their distance apart. The dental formula is 1123/2123 = 30. The upper incisors are moderate in length and close together. The dental palate is distinctly constricted between the anterior upper premolars. The anterior upper premolar extends above the cingulum of the posterior premolar and is within the toothrow. The canine and posterior premolar are well separated. The upper third molar has the third ridge more than half the length of the second ridge. There are two lower incisors on each side, both minute and crowded. The lower canines are slender and separated by the incisors; the cingula are not enlarged.

External and cranial measurements (mm) and mass (g) for *Tadarida lobata*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	26	23	33	-	8
FA[1]	57.2	55.7	59.1	-	9
Total[1]	129	124	136	-	8
Tail[1]	53	51	56	-	8
Tibia	-	-	-	-	-
Ear[1]	27	25	28	-	9
CI	-	-	-	-	-
GSL[1]	22.75	22.33	23.15	-	9

[1] Cotterill (1996b, 2001b, in press e)

Key identification features: The three large *Tadarida* species are easily distinguished from other large molossids by their unwrinkled upper lips. *Tadarida lobata* is distinguished from *T. ventralis* and *T. fulminans* by its longer ears (> 25 mm; < 25 mm in *T. ventralis* and *T. fulminans*), which extend beyond the nose when laid flat. *Tadarida lobata* also has a white interscapular patch of hair on its back, which is absent in the other two species.

Echolocation call: The echolocation call of *Tadarida lobata* has not been recorded, but bats converging over water tanks in Kenya uttered distinctive single or double-noted loud squeaks (Peterson 1974), audible to humans, similar to what has been recorded for *Otomops martiensseni*.

Distribution, habitat and roosting: *Tadarida lobata* is very sparsely distributed across Africa, where it is known from only two countries. In southern Africa, it has been recorded from four sites in north and northeast Zimbabwe. The type specimen is from Kenya (BM 1893.2.3.7).

This is one of Africa's rarest bats, previously known from only three specimens (Peterson and Harrison 1970 (Figure 173), one of which was from Zimbabwe (Smithers 1983). Recently, a series of eight specimens was collected from northeast Zimbabwe, bringing the total number of specimens known from southern Africa to 11 (Cotterill 1996b, 2001b).

It appears to occupy the same type of habitat as *T. ventralis*, namely semi-arid savanna, broken with rocky hills and inselbergs (Cotterill 1996b).

Extralimital: *Tadarida lobata* has also been recorded from Kenya where the majority of specimens have been collected (Peterson 1974, Skinner and Chimimba 2005).

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: In Zimbabwe, eight lactating females were collected in November (Cotterill in press e).

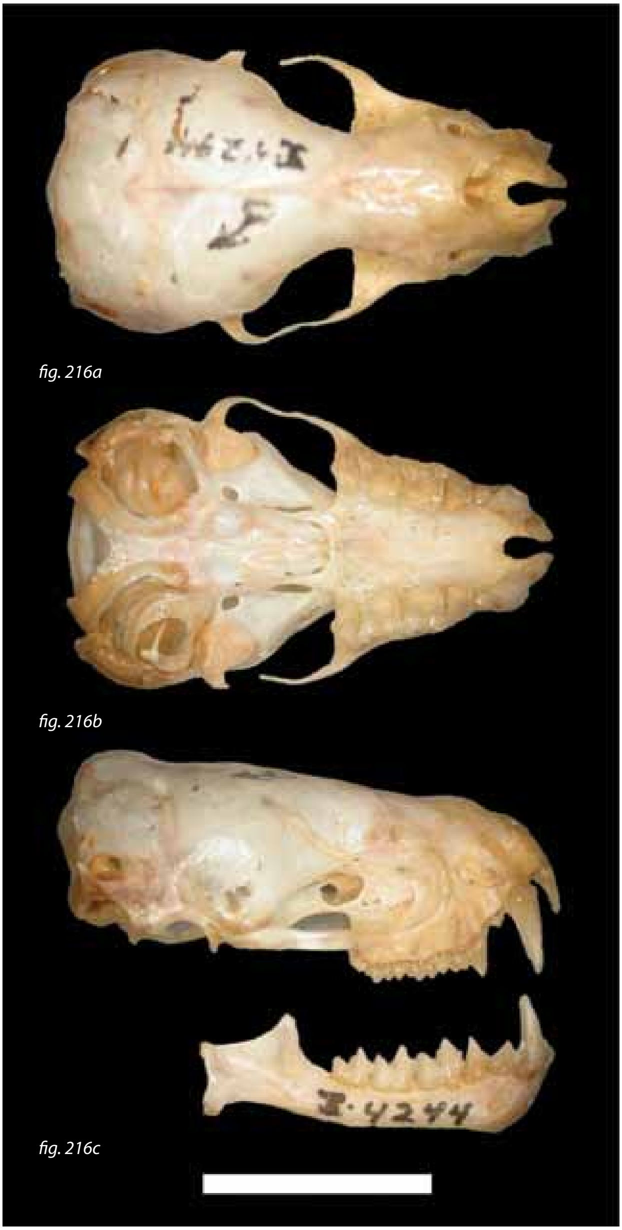


Figure 216. Skull and teeth of *Tadarida lobata:* (a) dorsal view, (b) ventral view, and (c) lateral view of skull and mandible. Scale bar = 10 mm (HZM 1.4244; © Malcolm Pearch, HZM).

fig. 218a

SYSTEMATIC NOTES

1891. *Nyctinomus lobatus* Thomas, Annals and Magazine of Natural History (6)7: 303. Turkwell Gorge, West Pokot, Kenya.

The diploid number in *T. lobata* is unknown.

Figure 217. Study skins of *Tadarida lobata* (specimen on left; note white patch between shoulders) and *Tadarida ventralis* (the three specimens on the right). The specimens are from Lake Manyara, Tanzania (Harrison 1974). Note the distinct difference in ear morphology of the two species. Scale bar = 30 mm (© Ariya Dejtaradol).

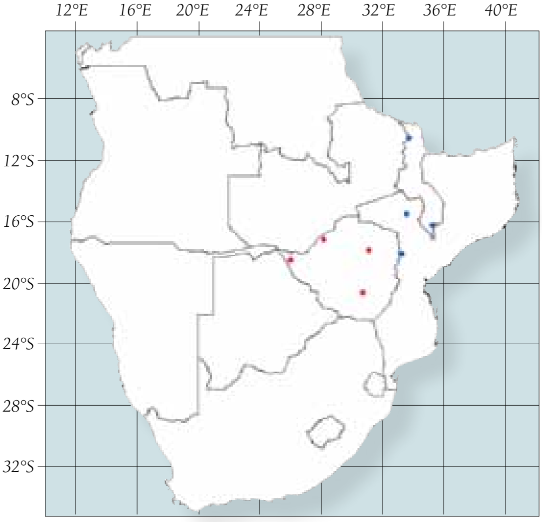
fig. 218b

Figure 218. Tadarida lobata, showing unwrinkled upper lip and very large ears protruding beyond the nose (© F. P. D. Cotterill).

Tadarida ventralis (Heuglin 1861)

Giant free-tailed bat

Near Threatened



Description: *Tadarida ventralis* is a large bat with a mass of around 45 g. The pelage of the upper parts is short and varies from dark to reddish-brown. The underparts are paler with a pure white to cream mid-ventral stripe. There is also an orange colour phase, which is orange-brown above and yellowish below. A white band is absent from the flanks under the wings. The wing and tail membranes are semi-translucent, dark brown to almost black. The upper lip is not wrinkled and the ears are not joined by a flap of skin, but meet close together giving the false appearance of being joined. The tragus is large, roughly rectangular and not concealed by the antitragus. There is a naked patch of skin (gular gland) on the throat of adults (Harrison 1971, Cotterill 2001b).

The anterior of the braincase is not noticeably elevated above the rostrum in lateral profile. The sagittal crest is very weakly developed. The anterior palatal emargination is wide. The interdental palate is broad, narrowing slightly to the canines. The basisphenoid pits are deep, medium-sized, and their width greater than their distance apart. The dental formula is 1123/2123 = 30. The upper incisors are long and close together. The anterior upper premolar is variable, sometimes in the toothrow or slightly displaced labially. The canine and posterior premolars are sometimes in contact. The upper third molar has a third ridge that is more than half the length of the second ridge. There are two lower incisors on each side, both bicuspid and crowded. The lower canines are well developed; the cingula are enlarged and in contact or almost so.

External and cranial measurements (mm) and mass (g) for *Tadarida ventralis,* sexes combined

	Mean	Min	Max	SD	N
Mass³	43.2	31	55	-	33
FA²	63.2	60.8	65.2	1.46	9
Total³	153.3	142	168	-	36
Tail³	58.3	51	66	-	36
Tibia	-	-	-	-	-
Ear³	24.7	18	29	-	36
CI	-	-	-	-	-
GSL³	23.8	23.4	26.1		51

[1] Males are slightly heavier on average (45 g) compared with females (39 g) (F. P. D. Cotterill, unpublished data).

[2] Cotterill (1996b)

[3] Cotterill (in press f)

Key identification features: The three large *Tadarida* species are easily distinguished from other large molossids by their unwrinkled upper lips. *Tadarida ventralis* is distinguished from *T. lobata* by its shorter ears (< 25 mm; > 25 mm in *T. lobata*), and from *T. fulminans* by its larger size (FA < 61 mm in *T. fulminans*), as well as the absence of a white band along the wing and flank (Figure 216). There is some overlap in forearm size between the two species, but differences in greatest skull length appear not to overlap, with the skull length in *T. fulminans* shorter (< 24.0 mm) than that of *T. ventralis* (> 24.5 mm). The basisphenoid pits are well developed in *T. ventralis*, but not in *T. lobata* (Harrison 1971).

Echolocation call: *Tadarida ventralis* produces LD-QCF echolocation calls with a low peak frequency (19.3±2.3 kHz, n = 11 pulses from one individual), narrow bandwidth (4±2.1 kHz, n = 11 pulses from one individual), and long duration (9±3.2 ms, n = 11 pulses from one individual) (Taylor *et al*. 2005). Besides the fundamental, the second harmonic may be present on the spectrogram.

Distribution, habitat and roosting: *Tadarida ventralis* is sparsely distributed in the northeast of southern Africa. It is known from four sites in Zimbabwe, two sites in central Mozambique, one site in southern Malawi, and one site in northeast Zambia. No vouchers can be located for the two localities in Mozambique mapped by Smithers and Lobão Tello (1976). The type specimen is from Kérén, Eritrea (MNS 982).

This species is one of the most poorly collected bats in southern Africa with just 5 specimens (of 8 southern African records) examined for this book, although 37 specimens are known from Kenya (Cotterill 2001b).

In Zimbabwe, a specimen has been collected from under a rock crevice about 20 m above ground level, a roost shared with *T. fulminans* and *Chaerephon ansorgei*. There is a single record of a specimen collected from the roof of a house, but this

fig. 219a

fig. 219b

fig. 219c

Figure 219. Skull and teeth of *Tadarida ventralis:* (a) dorsal view, (b) ventral view illustrating the deep, conspicuous basisphenoid pits, and (c) lateral view. Scale bar = 10 mm (LACM 52001, © F. P. D. Cotterill).

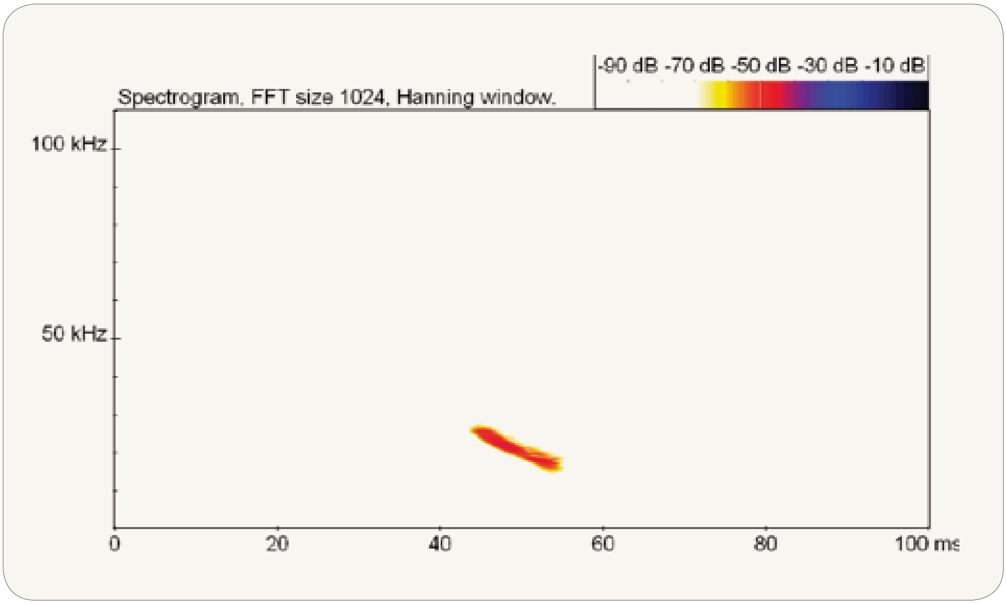


Figure 220. Echolocation call of *Tadarida ventralis*.

appears to be unusual behaviour in this species (Cotterill 1996b). The habitat of this species appears to be semi-arid savanna, associated with rocky hills and inselbergs (Cotterill 1996b, 2001b), but studies of actual roosting behaviour is a prerequisite for an accurate assessment of its habitat requirements.

Extralimital: *Tadarida ventralis* has also been recorded from Ethiopia, Eritrea, Sudan, DRC, Tanzania and Kenya.

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: A pregnant female specimen (with one foetus) was collected from a rock crevice in northeastern Zambia in mid-November (Ansell 1986).

SYSTEMATIC NOTES

1861. *Nyctinomus ventralis* Heuglin, Nova acta Academiae Caesareae Leopoldino Carolinae germanicae naturae cursiosorum, Halle 29(8): 4, 11. Kérén, Eritrea.

This species was formerly known as *Tadarida africana* (Dobson 1876), until this name was shown to be a junior synonym of *T. ventralis* (Kock 1975); the locality of the type specimen of *africana* (BM 75.11.19.1) is imprecisely recorded as 'Transvaal', and is not shown on the distribution map.

The diploid number in *T. ventralis* is not known.

Figure 221. *Tadarida ventralis*, showing unwrinkled upper lip (© P. J. Taylor).

SUBORDER VESPERTILIONIFORMES

FAMILY MINIOPTERIDAE
LONG-FINGERED BATS

Until recently, the Miniopteridae were treated as a subfamily of the Vespertilionidae. However, this family differs in a number of morphological, embryological, immunological, and genetic ways from the Vespertilionidae (Eick *et al*. 2005). For example, the best-known character of this group is the uniquely elongated second phalanx of the third digit, which allows the wing to 'bend' back onto itself, hence the alternative name 'bent-wing bats'. The second phalanx is more than three times the length of the first phalanx; in vespertilionid bats, by contrast, it is usually not more than twice the length of the preceding phalanx. The lengthening of this digit (Figure 222a) gives the wing its long and narrow shape, allowing it to fly swiftly and efficiently in open areas. This family typically also has a raised braincase (Figure 222b). Recent molecular studies have revealed that this group does indeed deserve familial status, having diverged from their closest relatives, the Vespertilionidae, about 38–49 million years ago (Miller-Butterworth *et al*. 2007). The Molossidae diverged from these two lineages about 10 million years earlier.

This family is represented by the single genus *Miniopterus*. Of the six African species, four have been recorded in southern Africa. Although members of this genus are readily identifiable in the field owing to the greatly elongated third finger, distinguishing between the species is often difficult. The four southern African species differ in size, but this is only absolute for skull size. They emit low duty-cycle, frequency-modulated (LD-FM) echolocation calls. Analysis of cytochrome-*b* sequences indicate that the largest and smallest of the three South African species, *M. inflatus* and *M. fraterculus*, are each other's closest relatives, while *M. natalensis* (which overlaps in size with both these species) is more distantly related (Miller-Butterworth *et al*. 2005).

fig. 222a

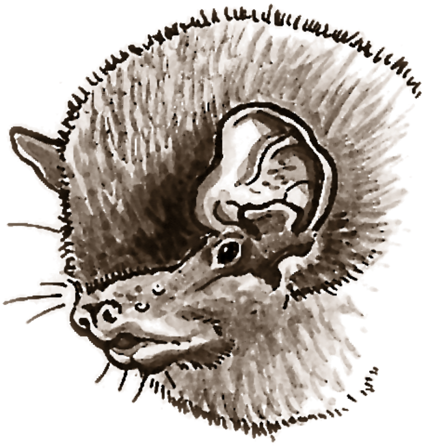


fig. 222b

Figure 222. *Miniopterus natalensis:* (a) wing showing elongated second phalanx of third digit, and (b) face showing rounded braincase and absence of noseleafs.

TABLE 19. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE GENUS *MINIOPTERUS* (MINIOPTERIDAE)

SPECIES	FA (MM)	DISTINGUISHING COLOUR AND MARKS	PF (KHZ)	ROOST
M. minor	36–39	slate-brown above, paler below	NA	NA
M. fraterculus	42–45	slate-brown or almost black above and paler grey-brown below	~63	caves, mines
M. natalensis	45–50*	dark or slate-brown above and paler grey-brown below; upper parts may have russet look	~50	caves, mines, road culverts
M. inflatus	46–50	medium or dark-brown above and paler grey-brown below	~50	caves, mines

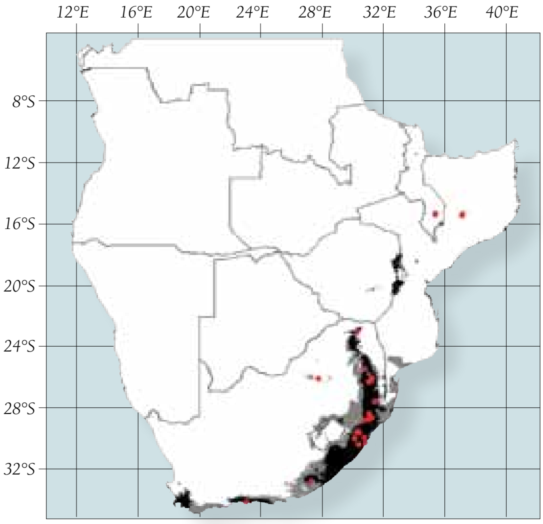
*But mostly 43–48

RANGE IN SOUTHERN AFRICA	OTHER
Congo basin	GSL < 14 mm
restricted to eastern parts	GSL (greatest skull length) ~14.0 mm
widespread and abundant throughout, sparse in arid western parts	GSL ~15.0 mm
restricted to eastern and northern parts	GSL ~16.0 mm

Miniopterus fraterculus Thomas & Schwann 1906

Lesser long-fingered bat

Least Concern



Description: *Miniopterus fraterculus* is a small bat with a mass of about 8 g, which closely resembles the slightly larger *M. natalensis* in appearance. The pelage colour is usually slate-brown or almost black on the upper parts and paler grey-brown below. The individual hairs are faintly bicoloured, slightly paler at the tip than at the base. The wings are dark brown to black and long with pointed tips, owing to the elongation of the second phalanx of the third digit, which is more than three times the length of the first phalanx (see family account). The face is plain, without any noseleafs. The ears are small, and have a relatively long, parallel-sided tragus with a rounded tip. The sexes are alike.

The skull is fragile with very weak zygomatic arches. In lateral profile, the braincase is greatly inflated and elevated well above the line of the rostrum. The sagittal crest is low, but visible anteriorly, tapering posteriorly. The lambdoid crest is weak or absent. The dental formula is 2123/3133 = 36. A third vestigial upper premolar is sometimes present on each side of the jaw (van der Merwe 1997).

Key identification features: Members of the genus *Miniopterus* can be distinguished by the extremely elongated second phalanx of the third digit, which is more than three times the length of the phalanx preceding it. Identification of the three South African species is problematic in the field. Total length of adults differs between the two smaller species, being greater in *M. natalensis* (> 100 mm) than in *M. fraterculus* (<105 mm), with some overlap between them. Several cranial and dental measurements are useful to distinguish these two species, specifically greatest skull length (*M. fraterculus*: 13.6–14.3 mm; *M. natalensis*: 14.7–15.6 mm) (Goodman *et al.* 2007; also see Stoffberg *et al.* 2004). Forearm length separates the larger *M. inflatus* (FA > 46.0 mm) from *M. fraterculus* (FA < 46.0 mm). The echolocation call of *M. fraterculus* has a higher peak frequency than that of either *M. natalensis* or *M. inflatus* (see below). The equatorial *M. minor* does not overlap in distribution and has a shorter wing length (FA < 40 mm; in *M. fraterculus* FA > 41 mm).

Echolocation call: *Miniopterus fraterculus* produces LD-FM echolocation calls with an intermediate peak frequency (62.3±1.9, kHz, n = 11), broad bandwidth (41.8±10.1 kHz, n = 11), and intermediate duration (3.7±0.7 ms, n = 11) (Miller-Butterworth *et al.* 2005; also see Schoeman and Jacobs 2008). Besides the fundamental, the second harmonic may be present on the spectrogram.

Distribution, habitat and roosting: *Miniopterus fraterculus* occurs widely in the eastern parts of South Africa and in Swaziland. It has been recorded from Knysna in the Western Cape, east and north along the coast to southern and western KwaZulu-Natal, in western Swaziland and north along the Drakensberg to northern South Africa. The model suggests

External and cranial measurements (mm) and mass (g) for *Miniopterus fraterculus*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	8.3	7.0	10.0	0.81	10	**Mass[1]**	8.2	7.0	9.0	0.81	6
FA[1]	43.3	41.8	44.7	0.82	21	**FA[1]**	43.4	41.4	45.7	1.08	14
Total[1]	98.8	92	104	3.73	19	**Total[1]**	101.3	95	107	3.34	12
Tail[1]	46.4	37	52	3.93	18	**Tail[1]**	49.3	39	56	5.47	12
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	9.5	7.5	11.5	1.29	18	**Ear[1]**	9.9	7.7	11.5	1.62	11
CI[1]	13.8	13.1	14.1	0.30	16	**CI[1]**	13.6	13.0	14.0	0.27	16

[1] Specimens measured by the authors

fig. 223a

fig. 223b

fig. 223c

fig. 223d

Figure 223. Skull and teeth of *Miniopterus fraterculus:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8383).

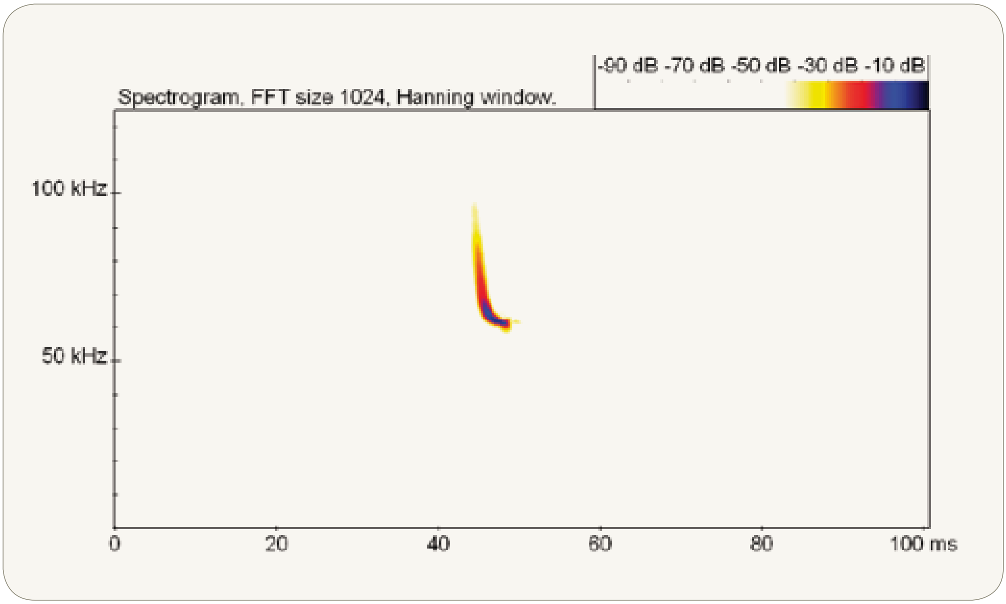


Figure 224. Echolocation call of *Miniopterus fraterculus*.

that suitable conditions also occur in the eastern highlands of Zimbabwe; however, all specimens in the Transvaal Museum assigned to this species from that region were found to have been misidentified. The outlier is a record from Krugersdorp, which is vouched for by three specimens collected in 1944 and deposited in the Amathole Museum (KM 6060–6062). Based on skull length, all three specimens belong to *M. fraterculus*. Still, the possibility that these specimens have been misidentified cannot be ruled out. The records from Malawi and northern Mozambique may refer to a separate taxon (see 'Systematic notes'). The type specimen is from Knysna, South Africa (BM 1905.5.7.18, Holotype).

This species is not well represented in museums, with 55 specimens examined for this book.

Miniopterus fraterculus is predominantly a temperate species with the core of its distribution in the montane grasslands of the South African escarpment. It is cave-dependent and hence the availability of suitable roosting sites is a critical factor in determining its distribution. It congregates in far smaller numbers than *M. natalensis*. This species probably uses separate caves as winter hibernacula and summer maternity roosts, as in *M. natalensis*.

Extralimital: *Miniopterus fraterculus* is endemic to southern Africa and possibly endemic to South Africa and Swaziland.

Foraging ecology: *Miniopterus fraterculus* has short wings with low wing loading (6.1 $N.m^{-2}$) and low aspect ratio (6.3) (Miller-Butterworth *et al.* 2005, Schoeman and Jacobs 2008). It is a clutter-edge forager. It feeds on a variety of aerial prey including Lepidoptera, Diptera, Hemiptera and Coleoptera (Miller-Butterworth *et al.* 2005; also see Fenton *et al.* 1977, Schoeman 2006).

Reproduction: Breeding is seasonal, with mating and fertilisation occurring in May–June, followed by a period of delayed implantation until mid-August and parturition in November–December (Bernard 1980). A single young is born.

SYSTEMATIC NOTES

1906. *Miniopterus fraterculus* Thomas and Schwann, Proc. Zool. Soc. Lond. 1: 162. Knysna, South Africa.

Although *Miniopterus fraterculus* is morphologically very similar to *M. natalensis*, these two are genetically distinct, have different echolocation calls and are not each other's closest relatives (Miller-Butterworth *et al.* 2005). The specimens from Malawi and northern Mozambique fall within the size range of *M. fraterculus*, but owing to the large geographical gap, may represent separate evolutionary lineages. Interestingly, these specimens are significantly larger than *M. minor* from the DRC and may therefore represent an undescribed species. The population from Madagascar has been shown to be specifically distinct from *fraterculus* (Goodman *et al.* 2007), possibly rendering *fraterculus* a South African endemic.

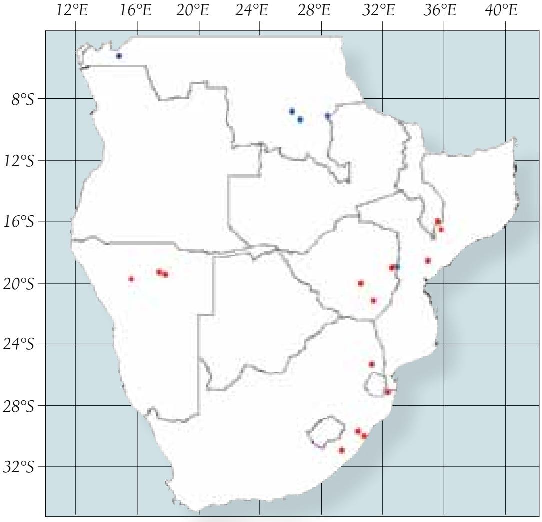
The diploid number in *M. fraterculus* from South Africa is 2n = 46 and aFN = 50 (Rautenbach *et al.* 1993).

Figure 225. Miniopterus fraterculus, profile showing rounded braincase (Malolotja Nature Reserve, Swaziland, © A. Monadjem).

Miniopterus inflatus Thomas 1903 ●

Greater long-fingered bat

Least Concern



Description: *Miniopterus inflatus* is a medium-small bat with a mass of about 12 g, which closely resembles the slightly smaller *M. natalensis* in appearance. The pelage is usually medium or dark brown on the upper parts and paler grey-brown below. The individual hairs are faintly bicoloured, slightly paler at the tip than at the base. The wings are dark brown to black and long with pointed tips, owing to the elongation of the second phalanx of the third digit, which is more than three times the length of the first phalanx (see family account). The face is plain, without any noseleafs. The ears are small and have a relatively long, parallel-sided tragus with a rounded tip. The sexes are alike.

The skull is moderately fragile with weak zygomatic arches. In lateral profile, the braincase is greatly inflated and elevated well above the line of the rostrum. The sagittal crest is low, but visible anteriorly, tapering posteriorly. The lambdoid crest is weak or absent. The dental formula is 2123/3133 = 36. A third vestigial upper premolar is occasionally present on each side of the jaw (van der Merwe 1997).

Key identification features: Members of the genus *Miniopterus* can be distinguished by the extremely elongated second phalanx of the third digit, which is more than three times the length of the phalanx preceding it. Identification of the four southern African species is problematic in the field. Forearm length separates the larger *M. inflatus* (FA > 46.0 mm) from *M. fraterculus* and *M. minor* (FA < 46.0 mm) and greatest skull length (GSL > 16.0 mm) separates it from *M. natalensis* (GSL <16.0 mm). The echolocation call of *M. inflatus* has a peak frequency that may be lower than that of either *M. natalensis* or *M. fraterculus* (see below).

Echolocation call: *Miniopterus inflatus* produces LD-FM echolocation calls. ANABAT recordings of calls typically sweep from 100–45 kHz with characteristic frequency (Fc) of 47.4 kHz and a short duration of 2–3 ms (Table 3, A. Monadjem, unpublished data).

Distribution, habitat and roosting: *Miniopterus inflatus* occurs widely, but very sparsely, in the eastern and northern parts of the region. There are clusters of isolated records from KwaZulu-Natal, northern South Africa, central Mozambique, southern Malawi, northern Zambia, southern DRC, Zimbabwe and northern Namibia. This species is more widespread than previously thought and it may have been overlooked in Angola. The type specimen is from Efulen, Cameroon (BM 1903.2.4.8).

Miniopterus inflatus is poorly represented in museums, with just 24 specimens examined for this book.

It appears to be associated with savanna habitats, where suitable roosting sites occur. It is cave-dependent and congregates in small groups of up to 50 individuals (Churchill *et al.* 1997).

External and cranial measurements (mm) and mass (g) for *Miniopterus inflatus*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	12.3	11.0	13.5	-	2	**Mass**[1]	12.9	12.2	14.2	0.94	4
FA[1]	48.6	48.0	49.4	0.66	6	**FA**[1]	47.3	46.0	48.0	0.95	5
Total[1]	116.5	115	118	-	2	**Total**[1]	117.8	116	121	2.22	4
Tail[1]	56.0	55	57	-	2	**Tail**[1]	56.8	53	58	2.50	4
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	11.0	-	-	-	1	**Ear**[1]	12.0	12	12	-	4
CI[1]	15.8	15.4	16.0	0.27	4	**CI**[1]	15.7	15.6	15.8	0.10	4

[1] Specimens measured by the authors

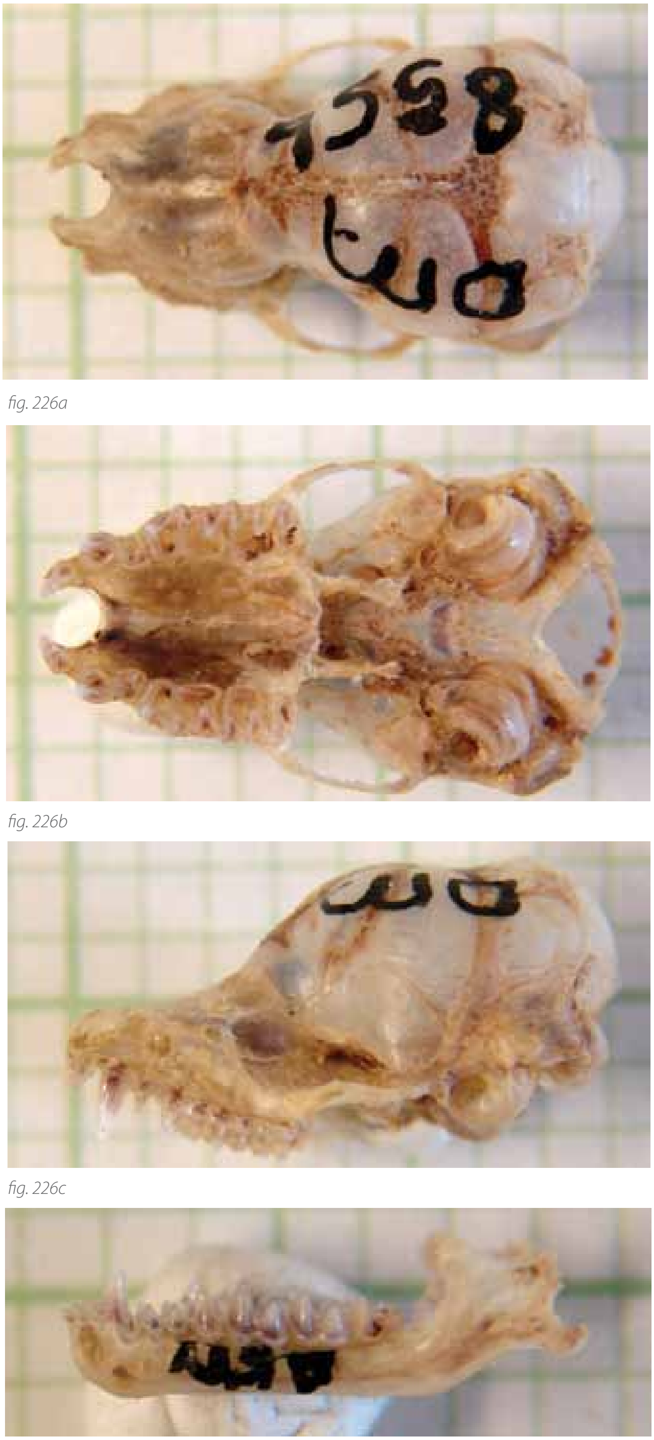


fig. 226a

fig. 226b

fig. 226c

fig. 226d

Figure 226. Skull and teeth of *Miniopterus inflatus:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8556).

fig. 227a

Extralimital: *Miniopterus inflatus* has also been recorded from Kenya, Somalia, Ethiopia, Cameroon, Gabon, Nigeria and Liberia (Happold 1987, Monadjem and Fahr 2007).

Foraging ecology: *Miniopterus inflatus* has long and narrow wings with high wing loading (12.6 N.m^{-2}) and intermediate aspect ratio (8.6) (Norberg and Rayner 1987). It is a clutter-edge forager. There is no information on the diet of this species.

Reproduction: In Zimbabwe, pregnant females have been collected in October, each carrying a single foetus (Smithers 1983). In East Africa, mating is followed by a period of reproductive dormancy during hibernation (Onyango *et al*. 1995).

SYSTEMATIC NOTES

1903. *Miniopterus inflatus* Thomas, Ann. Mag. Nat. Hist. (7)12: 634. Efulen, Cameroon.

Meester *et al.* (1986) recognised a southern African subspecies, *M. i. rufus*, as distinct from the nominate *M. inflatus*:

Miniopterus rufus Sanborn 1936, Zool. Ser. Field Mus. Nat. Hist. 20: 112. Katobwe, Upemba Swamps, Katanga, DRC (FMNH 29416, Holotype).

Molecular data suggests that this species' closest relative in southern Africa is *M. fraterculus* (Miller-Butterworth *et al*. 2005). The diploid number in *M. inflatus* is 2n = 46 and aFN = 50 (Ruedas *et al.* 1990).

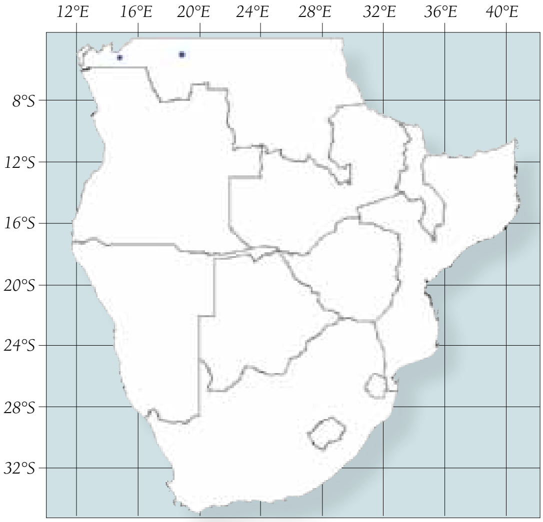
fig. 227b

Figure 227. *Miniopterus inflatus,* showing rounded braincase (a: © Merlin D. Tuttle, Bat Conservation International, *www.batcon.org;* b: DM 8527, © A. Monadjem).

Miniopterus minor Peters 1867

Least long-fingered bat

Near Threatened



Description: *Miniopterus minor* is a very small miniopterid with a mass of about 5 g. The pelage colour is slate-brown to almost black on the upper parts and paler grey-brown below. The wings are dark and long with pointed tips due to the elongation of the second phalanx of the third digit, which is more than three times the length of the first phalanx (see family account). The face is plain, without any nose-leafs. The ears are small, and have a relatively long, parallel-sided tragus with a rounded tip. The sexes are alike.

Key identification features: Members of the genus *Miniopterus* can easily be distinguished by the extremely elongated second phalanx of the third digit, which is more than three times the length of the phalanx preceding it. Distinguishing between the different species of *Miniopterus* can be difficult in the field. However, *M. minor* is generally far smaller than any of the other three species, with FA < 40 mm (FA > 40 mm in the other three *Miniopterus* species).

External measurements (mm) for *Miniopterus minor*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	5.5	5.0	6.0	-	2
FA[1]	39.7	39.6	39.7	-	2
Total	-	-	-	-	-
Tail	-	-	-	-	-
Tibia[1]	15.4	14.4	16.3	-	2
Ear	-	-	-	-	-
CI[2]	13.1			0.16	7

[1] Van Cakenberghe *et al.* (1999)
[2] Juste and Ibanez (1992)

Echolocation call: The echolocation call of this species has not been recorded.

Distribution, habitat and roosting: *Miniopterus minor* is a very poorly known bat, with verified specimens having been collected from just two localities in southern Africa (both in the DRC) and a handful of others in east Africa. The type specimen is from Tanzania (ZMB 3268).

Extralimital: This species has also been recorded in Kenya and Tanzania.

Foraging ecology: There is no information on the diet or foraging behaviour of this species in southern Africa.

Reproduction: No reproductive information is available for southern Africa, but the reproduction of this species was studied in detail in coastal Kenya (McWilliam 1988, 1990).

SYSTEMATIC NOTES

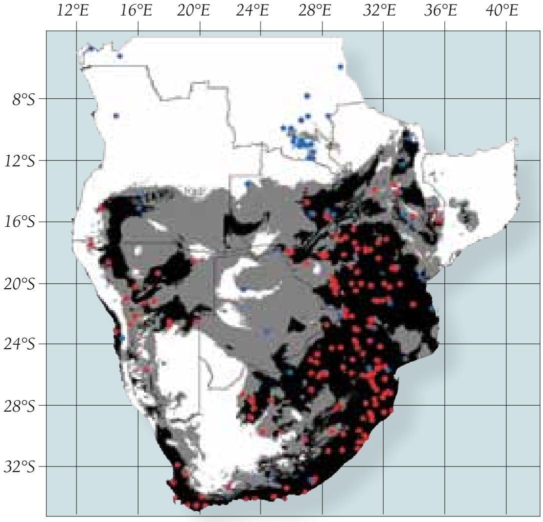
1867. *Miniopterus minor* Peters, Monatsb. K. preuss. Akad. Wiss. Berlin 870. Coast opposite Zanzibar Island, Tanzania.

The diploid number in *M. minor* is not known.

Miniopterus natalensis (A. Smith 1833)

Natal long-fingered bat

Near Threatened



Description: *Miniopterus natalensis* is a small bat with a mass of about 11 g, which closely resembles other *Miniopterus* species in appearance. The pelage colour is usually dark or slate-brown on the upper parts and paler grey-brown below. Some individuals may have a reddish tinge to the upper parts, giving them a russet look. The individual hairs are faintly bicoloured, slightly paler at the tip than at the base. The wings are dark brown to black and long with pointed tips, owing to the elongation of the second phalanx of the third digit, which is more than three times the length of the first phalanx (see family account). The face is plain, without any noseleafs. The ears are small and have a relatively long, parallel-sided tragus with a rounded tip. The sexes are alike.

The skull is fragile with very weak zygomatic arches. In lateral profile, the braincase is greatly inflated and elevated well above the line of the rostrum. The sagittal crest is low, but visible anteriorly, tapering posteriorly. The lambdoid crest is weak or absent. The dental formula is 2123/3133 = 36. A third vestigial upper premolar is occasionally present on each side of the jaw (van der Merwe 1985).

Key identification features: Members of the genus *Miniopterus* can be distinguished by the extremely elongated second phalanx of the third digit, which is more than three times the length of the phalanx preceding it. Identification of the three South African species is problematic in the field. Total length of adults differs between the two smaller species, being greater in *M. natalensis* (> 100 mm) than in *M. fraterculus* (<105 mm), with some overlap between them. Several cranial and dental measurements are useful to distinguish these two species, specifically greatest skull length (*M. fraterculus*: 13.6–14.3 mm; *M. natalensis*: 14.7–15.6 mm) (Goodman *et al*. 2007; also see Stoffberg *et al*. 2004). Greatest skull length also separates the larger *M. inflatus* (GSL > 16.0 mm) from *M. natalensis* (GSL < 16.0 mm). The echolocation call of *M. natalensis* has a peak frequency that is far lower than that of *M. fraterculus*, but may be slightly higher than that of *M. inflatus* (see below). The equatorial *M. minor* is far smaller (FA < 40 mm and GSL < 14 mm).

Echolocation call: *Miniopterus natalensis* produces LD-FM echolocation calls with an intermediate peak echolocation frequency (49.7±1.0 kHz, n = 10), broad bandwidth (34.5±9.7 kHz, n = 10), and intermediate duration (5.3±0.8 ms, n = 10) (Miller-Butterworth *et al*. 2005; also see Jacobs 1999, 2000, Schoeman and Jacobs 2003, 2008). Besides the fundamental, the second harmonic may be present on the spectrogram.

Distribution, habitat and roosting: *Miniopterus natalensis* occurs widely in the region, but with more records in the southern and eastern parts than in the arid west. It has been recorded from the southern tip of South Africa east and northwards through much of the country and neighbouring Lesotho

External and cranial measurements (mm) and mass (g) for *Miniopterus natalensis*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	10.6	7.5	14.0	1.52	52	**Mass**[1]	11.3	8.5	14.5	1.35	40
FA[1]	45.2	42.0	50.0	1.55	94	**FA**[1]	46.0	43.0	48.0	1.52	70
Total[1]	107.2	91	123	7.04	81	**Total**[1]	107.9	95	121	5.91	58
Tail[1]	49.8	38	60	5.03	76	**Tail**[1]	50.1	42	56	3.46	53
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	10.2	7.0	12.5	1.29	78	**Ear**[1]	10.2	7.5	13.0	1.15	52
CI[1]	14.8	13.8	15.7	0.40	70	**CI**[1]	14.8	14.1	15.8	0.44	31

[1] Specimens measured by the authors

fig. 228a

fig. 228b

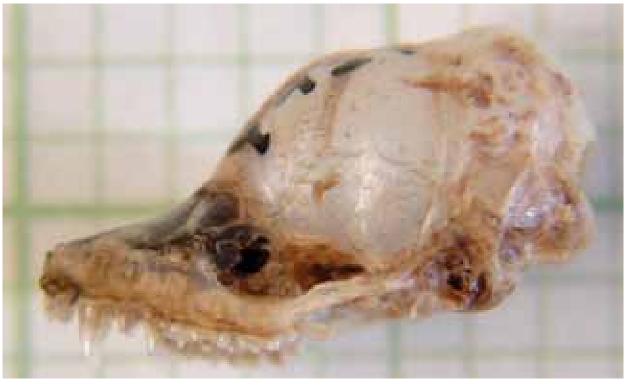


fig. 228c

fig. 228d

Figure 228. Skull and teeth of *Miniopterus natalensis:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 7921).

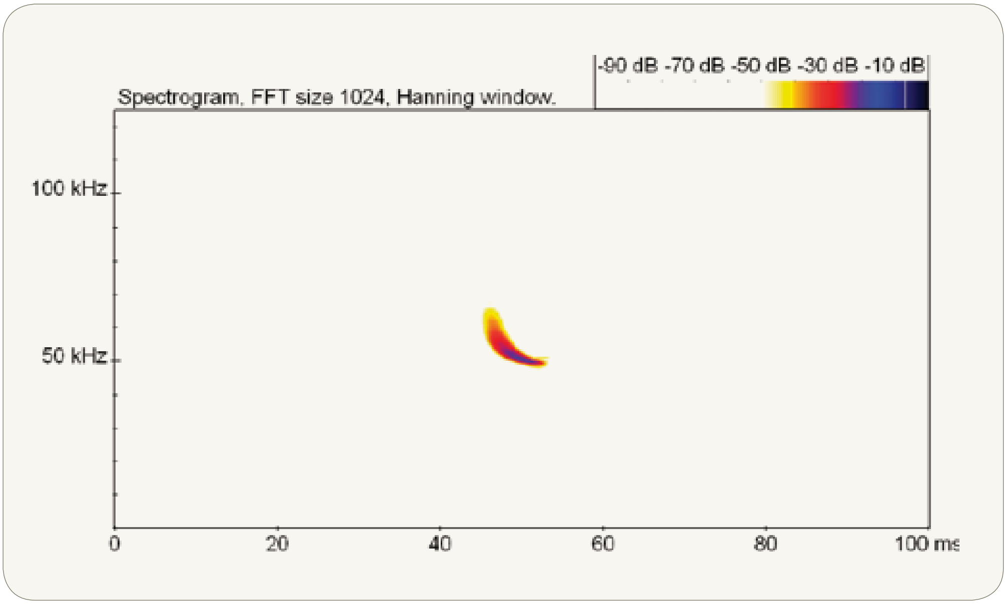


Figure 229. Echolocation call of *Miniopterus natalensis*.

fig. 230a

Figure 230. *Miniopterus natalensis*, showing rounded braincase (a: © E. C. J. Seamark; b: © A. S. Taylor).

fig. 230b

and Swaziland to Zimbabwe, southern and eastern Zambia, southern DRC, central Mozambique and Malawi, with an isolated record from southern Mozambique. It also occurs widely in Namibia and southern and western Angola, but appears absent from much of the Kalahari. The type specimen is from Durban, South Africa (BM 1848.6.12.19).

This species is very well represented in museums, with over 800 specimens examined for this book.

Miniopterus natalensis is predominantly a temperate or subtropical species with the core of its distribution in the savannas and grasslands of southern Africa. It is cave-dependent and hence the availability of suitable roosting sites may be more critical in determining its presence in an area than the surrounding vegetation. It congregates in huge numbers with about 260,000 bats using the De Hoop Guano Cave seasonally in the Western Cape, South Africa. It utilises separate caves as winter hibernacula and summer maternity roosts (van der Merwe 1973 a, b, 1975), with hibernacula generally being cooler and at higher altitudes. Females typically migrate seasonally between these caves, which may be separated by up to 150 km (van der Merwe 1973b, Miller-Butterworth *et al*. 2003).

Extralimital: *Miniopterus natalensis* is widely, but very sparsely, recorded from East and West Africa, but owing to taxonomic confusion over species limits within this genus, its African distribution beyond southern Africa is currently unclear.

Foraging ecology: *Miniopterus natalensis* has long, narrow wings with intermediate wing loading (10.7 $N.m^{-2}$) and intermediate aspect ratio (7.0) (Norberg and Rayner 1987; also see Jacobs 1999, 2000, Schoeman and Jacobs 2003, 2008, Miller-Butterworth *et al*. 2005). It is a clutter-edge forager. It feeds on a variety of aerial prey including Diptera, Hemiptera, Coleoptera, Lepidoptera and Isoptera (Fenton *et al*. 1977, Fenton and Thomas 1980, McDonald *et al*. 1990b, Jacobs 1999, 2000, Schoeman and Jacobs 2003, Miller-Butterworth *et al*. 2005, Schoeman 2006).

Reproduction: Breeding is strongly seasonal and varies slightly with latitude (Happold and Happold 1990a, Bernard and Cumming 1997). Mating and fertilisation generally occur in March–April, followed by a period of delayed implantation until July–August and parturition in October–December (Van der Merwe 1979, 1980, Bernard 1980, 1994, Bernard and Davidson 1996, Bernard *et al*. 1996). Females congregate at maternity roosts where each one gives birth to a single young.

SYSTEMATIC NOTES

1833. *Vespertilio natalensis* A. Smith, S. Afr. Quart. J., ser. (2)2: 59. Durban, South Africa.

Miniopterus natalensis was previously included as a subspecies of *M. schreibersii*, from which it is genetically distinct (Miller-Butterworth *et al.* 2005). The latter species is now restricted to

North Africa and Europe (Appleton *et al.* 2004), with *M. natalensis* occurring in sub-Saharan Africa. The names *breyeri* Jameson 1909, *dasythrix* (Temminck 1840) and *scotinus* (Sundevall 1846) are synonyms. The West African *villiersi* V. Aellen 1956 (Rosevear 1965), recognised as a subspecies of *M. natalensis*, may be a distinct species (Fahr *et al.* 2006). The Namibian and Angolan bats appear to be geographically isolated from those to the east and south, and may represent a distinct phylogenetic lineage, but molecular studies are necessary to resolve this. This lineage is possibly represented by *smitianus* Thomas 1927 (BM 1926.12.7.15, Holotype, from Witvlei, 64 km west of Gobabis, Namibia).

The diploid number in *M. natalensis* is 2n = 46 and aFN = 50 (Rautenbach *et al.* 1993).

SUBORDER VESPERTILIONIFORMES

FAMILY VESPERTILIONIDAE
PLAIN-FACED BATS

This is the largest family of bats, with 89 species in 17 genera recorded from Africa, of which 36 species in 13 genera occur in southern Africa. Three of the four genera not found in southern Africa are European species that extend only marginally into Africa north of the Sahara (Simmons 2005).

Members of the Vespertilionidae, sometimes called 'evening bats' (owing to their time of activity), are characterised by the absence of noseleafs, a long tail fully enclosed within the tail membrane (Figure 231), and a conspicuous tragus of variable shape and size (Figure 233). With the Miniopteridae elevated to full family status, there are just two subfamilies within the southern African vespertilionids: Vespertilioninae and Kerivoulinae.

The Kerivoulinae comprise one genus, *Kerivoula*, which is identified by its woolly fur and funnel-shaped ears with a long, narrow tragus (Figure 232). The southern African species possess a fringe of hair on the outer margin of the tail membrane, a feature that is unique amongst vespertilionids of this region. These are small, inconspicuous bats, which have been poorly collected; hence, little is known about the details of their biology (Hill and Smith 1984).

Vespertilionids emit low duty-cycle, frequency-modulated (LD-FM), quasi-constant frequency (LD-QCF) and constant frequency (LD-CF) echolocation calls, at intermediate to high peak frequencies. Their echolocation, together with their average wingspans and wing areas, means that most vesper bats are flexible in their foraging behaviour and often switch between open-air and clutter-edge space (Fenton 1990).

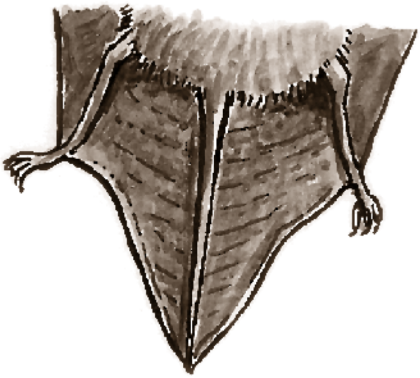


Figure 231. A typical Vespertilionidae tail completely enclosed by the tail membrane.

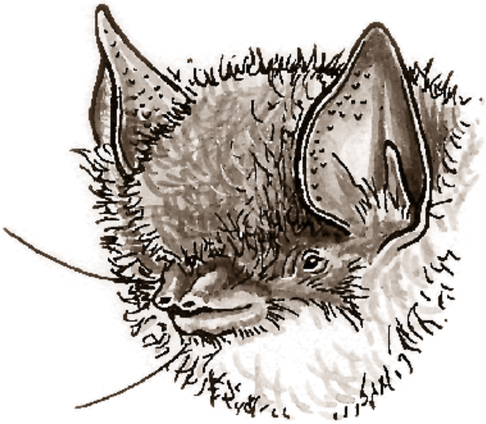


Figure 232. The face of a typical *Kerivoula* species showing the long, narrow tragus and absence of noseleafs.

fig. 233a

fig. 233b

Figure 233. Vespertilionid ears: (a) *Scotophilus dinganii* showing long, narrow tragus with a projecting forward tip, and (b) *Eptesicus hottentotus* showing short, knife-shaped tragus.

The relationships among the many genera of vespertilionids are not well established. Volleth and Heller (1994) provide a phylogeny based on karyology, which includes representatives of most genera. Trujilla *et al.* (2009) presented a molecular phylogeny of the genus *Scotophilus* that included all but one described African species from this genus and others from Madagascar and Asia; they proposed an additional three putative new *Scotophilus* species from East and West Africa, based on maternally and paternally inherited DNA sequences of specimens identified as *dinganii* and *viridis*. Karyological and bacular (penis bone) morphology have proved useful for clarifying relationships among the smaller-sized vespertilionid species, many of which are extremely difficult to distinguish in the field. The phylogenetic relevance of the baculum in the Vespertilioninae was quantified in the landmark revision by Hill and Harrison (1987). Such an approach applied to southern African species (Kearney *et al.* 2002) resulted in classifying species that were hitherto included in the two genera *Eptesicus* or *Pipistrellus*, into four genera: *Eptesicus*, *Hypsugo*, *Neoromicia* and *Pipistrellus*. Similarly, in recent years, the genus *Cistugo* has been recognised as being distinct from *Myotis* based on the presence of wing glands, distinct pelage colour and unique karyotype (Bronner *et al.* 2003).

TABLE 20. IDENTIFICATION MATRIX FOR GENERA WITHIN THE

GENUS	FA (MM)	DENTITION	
		NO. UPPER/ LOWER PREMOLARS	NO. UPPER/ LOWER INCISORS
Pipistrellus	27–38	2/2	2/3
Hypsugo	28–32	2/2	2/3
Mimetillus	28–32	1/2	2/3
Nycticeinops	28–33	1/2	1/3
Neoromicia	28–38	1/2*	2/3
Kerivoula	28–39	3/3	2/3
Scotoecus	30–31	1/2	1/3
Cistugo	32–35	3/3	2/3
Laephotis	35–40	1/2	2/3
Glauconycteris	36–45	1/2	2/3
Myotis	41–58	3/3	2/3
Scotophilus	43–80	1/2	1/3
Eptesicus	46–50	1/2	2/3

**(N. nana = 2/2)*

TABLE 21. IDENTIFICATION MATRIX FOR SPECIES WITHIN

SPECIES	FA (MM)
C. seabrae	29–35
C. lesueuri	33–38

TABLE 22. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE

SPECIES	FA (MM)
G. beatrix	36–40
G. argentata	40–44
G. variegata	40–45

TRAGUS	HAIR	LENGTH AND SHAPE OF SNOUT	OTHER
short, broad	bicoloured	average	baculum frequently diagnostic; *P. rueppellii* has white wings and venter
club-shaped, rounded tip	bicoloured	average	baculum diagnostic
short, blunt, club-shaped	short and sleek; unicoloured	short and blunt	3rd digit of wing is shorter than length of head and body; broad, flattened skull
indented on inner surface with 2 small lobes on outer edge	unicoloured	average	-
short, broad	bicoloured	average	baculum diagnostic
long, narrow, sharply pointed	woolly hair with curled tips; bicoloured	average	funnel-shaped ears; nostrils normal not tubular
club-shaped	unicoloured	short and blunt	3rd digit of wing is longer than length of head and body; *S. albofuscus* has white wings
long, narrow	long, soft, stands away from body; bicoloured	average	glands on wings
large, triangular-shape	bicoloured	average	ears ≥ 16 mm
short, rounded tip	tricoloured	very short	*G. variegatus* has wing membranes with reticulated pattern
slender, spear-shaped	bicoloured	short	-
long and fine with tip projecting forwards	unicoloured	average	-
knife-shaped	bicoloured	average	-

THE GENUS *CISTUGO* (VESPERTILIONIDAE)

DISTINGUISHING COLOUR AND MARKS	SKULL LENGTH (MM)	PF (KHZ)	ROOST	RANGE IN SOUTHERN AFRICA
pale sandy-brown above and pale cream below	CI < 13.4	~47	buildings	endemic to west coast of southern Africa
dull yellow to yellow-beige above and paler yellow-cream below	CI > 13.1	~46.5	rock crevices	endemic to South Africa and Lesotho

GENUS *GLAUCONYCTERIS* (VESPERTILIONIDAE)

DISTINGUISHING COLOUR AND MARKS	PF (KHZ)	ROOST	RANGE IN SOUTHERN AFRICA
wing membranes without reticulated pattern	NA	NA	northern Angola and Congo basin
wing membranes without reticulated pattern	NA	NA	restricted to far northwestern parts
wing membranes with reticulated pattern	~38	dense foliage	patchily distributed in eastern and northern parts

TABLE 23. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE GENUS *KERIVOULA* (VESPERTILIONIDAE)

SPECIES	FA (MM)	DISTINGUISHING COLOUR AND MARKS	SKULL LENGTH (MM)	PF (KHZ)	ROOST
K. lanosa	28–31	brown grizzled with grey or white above	CI < 13.5	85–140	weaver and sunbird nests
K. argentata	35–40	reddish-chestnut above	CI > 13.5	90–120	weaver nests

TABLE 24. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE GENUS *LAEPHOTIS* (VESPERTILIONIDAE)

SPECIES	FA (MM)	DISTINGUISHING COLOUR AND MARKS	EAR LENGTH (MM)	PF (KHZ)	ROOST
L. botswanae	33–37	buffy-brown above and paler below	16–21	~32	NA
L. angolensis	35	buffy-brown above and paler below	16	NA	NA
L. namibensis	35–40	pale/buffy-brown above and paler below	22–25	~22	narrow crevices in cliff faces
L. wintoni	37–40	buffy-brown above and paler below	21–24	NA	NA

TABLE 25. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE GENUS *MYOTIS* (VESPERTILIONIDAE)

SPECIES	FA (MM)	DISTINGUISHING COLOUR AND MARKS	PF (KHZ)	ROOST
M. bocagii	37–40	copper to orange above and cream below	~45	furled banana leaves (in West Africa and northern Mozambique)
M. tricolor	47–52	copper to orange above and paler below	~50	caves, mines
M. welwitschii	52–59	wings strikingly marked with copper and black tones contrasting with bright orange body	~34	furled banana leaves, dense bushes, caves

TABLE 26. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE GENUS *NEOROMICIA* (VESPERTILIONIDAE)

SPECIES	FA (MM)	DISTINGUISHING COLOUR AND MARKS	PF (KHZ)	ROOST
N. nana	26–34	dark red/brown above and paler buffy-brown to grey-brown below; well-developed callous at base of each thumb	~70	furled banana leaves, also other furled leaves, e.g. *Strelitzia*
N. tenuipinnis	28–32	slate-brown/black above and white below; wings white and translucent	NA	hollows in trees, thatched roofs
N. zuluensis	28–32	grey to dark brown above and pale grey/off-white below; black wing membranes	~48	NA
N. capensis	28–38	pale dark brown above and pale grey/brown to off-white below; presence of occipital helmet in adults	~38	under bark of trees, base of aloe leaves, roofs of houses
N. rendalli	33–38	buffy-yellow above and off-white below; white hair on edge of flanks; wings white and translucent; rostrum broad and short	~37	dense vegetation, thatched roofs
*N. cf. melckorum**	34–39	As in *N. capensis*	NA	NA

*This species has not yet been formally described. (See species account for further details.)

RANGE IN SOUTHERN AFRICA
patchily distributed in eastern parts
northern and eastern parts

RANGE IN SOUTHERN AFRICA	OTHER
widely but sparsely distributed in northern parts	four cranial measurements can separate it from *L. angolensis*
restricted to Angola and DRC	
endemic to arid western parts	
restricted to high altitudes of Lesotho and Free State	

RANGE IN SOUTHERN AFRICA
restricted to eastern and far northern parts
widely distributed throughout eastern parts
restricted to eastern and far northern parts

RANGE IN SOUTHERN AFRICA
widely distributed throughout northern and eastern parts
marginal into region: southwestern DRC and northern Angola
widespread in northern parts
widespread and abundant throughout region
patchy distribution at few isolated locations in savanna/woodland; associated with wetlands
NA

TABLE 27. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE GENUS *PIPISTRELLUS* (VESPERTILIONIDAE)

SPECIES	FA (MM)	DISTINGUISHING COLOUR AND MARKS	PF (KHZ)	ROOST
P. rusticus	26–30	pale rust above and paler grey/ rust below	~53	hollows and crevices in trees
P. grandidieri	31–37	pale to medium brown above, unicoloured fur	NA	NA
P. hesperidus	32–35	pale to dark brown above and cream below	~50	cracks of exfoliating rock, loose bark of dead trees
P. nanulus	25–31	reddish-brown above, paler below	NA	NA
P. rueppellii	32–39	pale grey/brown above and white below	~37	NA

TABLE 28. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE GENUS *SCOTOECUS* (VESPERTILIONIDAE)

SPECIES	FA (MM)	DISTINGUISHING COLOUR AND MARKS	PF (KHZ)	ROOST
S. albofuscus	31–34	wing membranes translucent or white	~39	NA
S. hindei/albigula	32–38	wing membranes dark brown	~40	NA

TABLE 29. IDENTIFICATION MATRIX FOR SPECIES WITHIN THE GENUS *SCOTOPHILUS* (VESPERTILIONIDAE)

SPECIES	FA (MM)	DISTINGUISHING COLOUR AND MARKS	PF (KHZ)	ROOST
S. leucogaster	46–52	cream or off-white underparts	~40	holes in trees
S. viridis	47–52	bright or orange-yellow underparts	~44	holes in trees, roofs of houses
S. dinganii	51–58	bright or orange-yellow underparts	~33	holes in trees, roofs of houses
S. nigrita	77–79	yellow underparts	~30	artificial bat houses at Komatipoort

RANGE IN SOUTHERN AFRICA	OTHER
widely distributed throughout north and east, woodland and savanna	can be separated from *P. hesperidus* using a combination of 12 cranial characters (see species account)
few records in DRC, Angola, Malawi	falciform tragus
widely distributed throughout north and east, restricted to well-wooded habitats	short, hooked tragus with rounded tip
Congo basin	individual hairs characteristically unicoloured above and bicoloured below
widely distributed throughout northern parts	short, curved tragus with rounded tip, inner incisors deeply bifid

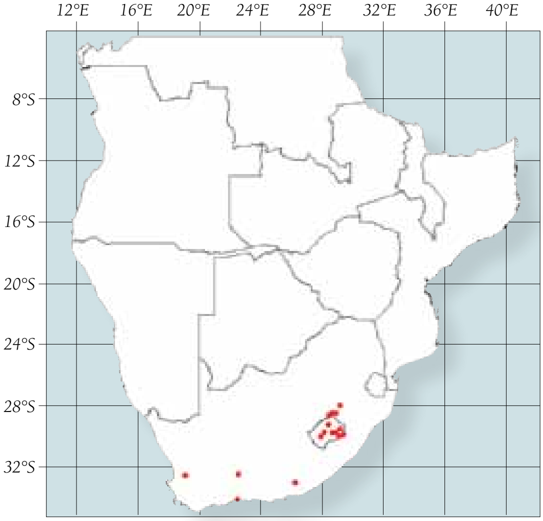
RANGE IN SOUTHERN AFRICA
restricted to low-lying, humid savannas of the coastal plains of Mozambique and northern KwaZulu-Natal
sparsely distributed in northern and northeastern parts

RANGE IN SOUTHERN AFRICA
sparsely in central savannas
restricted to eastern parts
widespread and abundant throughout region, absent from grassland plateau, karoo, and fynbos
scattered records in the northeast

Cistugo lesueuri Roberts 1919 ●

Lesueur's wing-gland bat

Vulnerable



Description: *Cistugo lesueuri* is a small bat with a mass of around 6 g and very similar in appearance to the smaller *C. seabrae*. The individual hairs are long and stand away from the body, giving the fur a soft feel. It is dull yellow to yellow-beige above and paler yellow-cream below. The individual hairs are dark at their base and yellowish at their tips. The wings are dark brown with a conspicuous gland present in the membrane on each side. The face is plain, without any noseleafs. The ears are brown and moderately sized, with a long, narrow tragus. The sexes are alike.

The skull is delicate with weak zygomatic arches. In lateral view, the braincase rises slightly above the rostrum, with a smoothly concave forehead. There is a further concavity in the parietal region, owing to an occipital bulge. The sagittal and lambdoid crests are weak or absent. The mastoid processes are not evident in dorsal view. The dental formula is 2133/3133 = 38. The first two upper premolars are very small to minute, while the third upper premolar is sharply pointed and rises above the molars.

Key identification features: The soft yellow-washed fur and long, narrow tragus distinguish *Cistugo* from other vespertilionids. This genus also has two tiny anterior upper premolars, a feature shared only with *Myotis*; however, these two teeth lie below the gumline and are therefore not generally visible in the live animal (E. Seamark, personal communication). *Myotis bocagii* is similar in size, but lacks the wing gland and does not occur in the same geographical area. *Myotis tricolor* and *M. welwitschii* are much larger (FA > 47 mm, CI > 16.5 mm). Furthermore, *Myotis* species have a coppery wash to the pelage, while *Cistugo* species have a yellowish wash. The two species of *Kerivoula* overlap in size with *Cistugo*, also have soft fur and a long, narrow tragus; in addition, *K. argentata* has an orange-chestnut wash. *Kerivoula*, however, has longer fur of which the individual hairs have curled tips, as well as a fringe of fur on the outer margin of the tail membrane (only true for southern African species), larger anterior premolars, and a highly domed cranium. The two species of *Cistugo* are very similar and may be conspecific. However, their distributions do not overlap and *C. lesueuri* is slightly larger (FA > 33.0 mm, CI > 13.1 mm; in *C. seabrae* FA < 35.5 mm, CI < 13.4 mm) and richer in colour.

Echolocation call: *Cistugo lesueuri* produces LD-FM echolocation calls with an intermediate peak frequency (46.5±1.8 kHz, n = 5), broad bandwidth (45.8±22.7 kHz, n = 5), and short duration (2.9±0.2 ms, n = 5) (Schoeman and Jacobs 2003, 2008).

Distribution, habitat and roosting: *Cistugo lesueuri* is endemic to South Africa and Lesotho. It occurs widely in Lesotho, north into the Free State, and east into the Drakensberg of KwaZulu-Natal (a single record from Kamberg). It is present in the Cedarberg in the Western Cape (Seamark and Brand 2005), with scattered records between this population and the

External and cranial measurements (mm) and mass (g) for *Cistugo lesueuri*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	6.7	4.5	8.5	1.24	7	**Mass[1]**	6.6	4.0	9.0	1.73	13
FA[1]	35.9	33.0	38.0	1.71	8	**FA[1]**	36.2	34.0	39.0	1.69	14
Total[1]	94.5	83	102	7.23	6	**Total[1]**	94.3	87	107	5.53	13
Tail[1]	42.0	33	51	6.10	6	**Tail[1]**	45.0	40	51	3.60	12
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	14.0	11	19	2.80	6	**Ear[1]**	11.0	8	13	1.50	12
CI[1]	13.9	13.1	14.6	0.46	8	**CI[1]**	13.9	13.4	14.5	0.36	14

[1] Specimens measured by the authors

fig. 234a

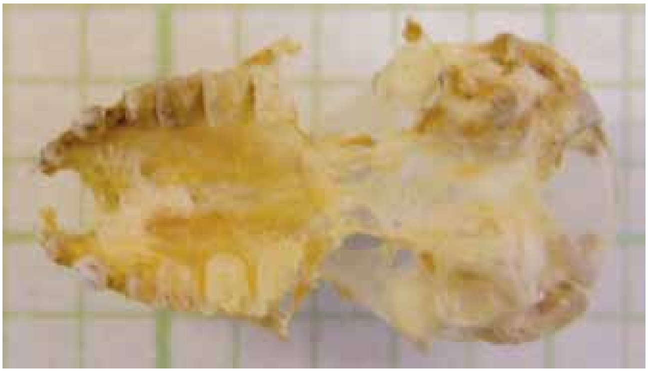


fig. 234b

fig. 234c

fig. 234d

Figure 234. Skull and teeth of *Cistugo lesueuri:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (TM 29511).

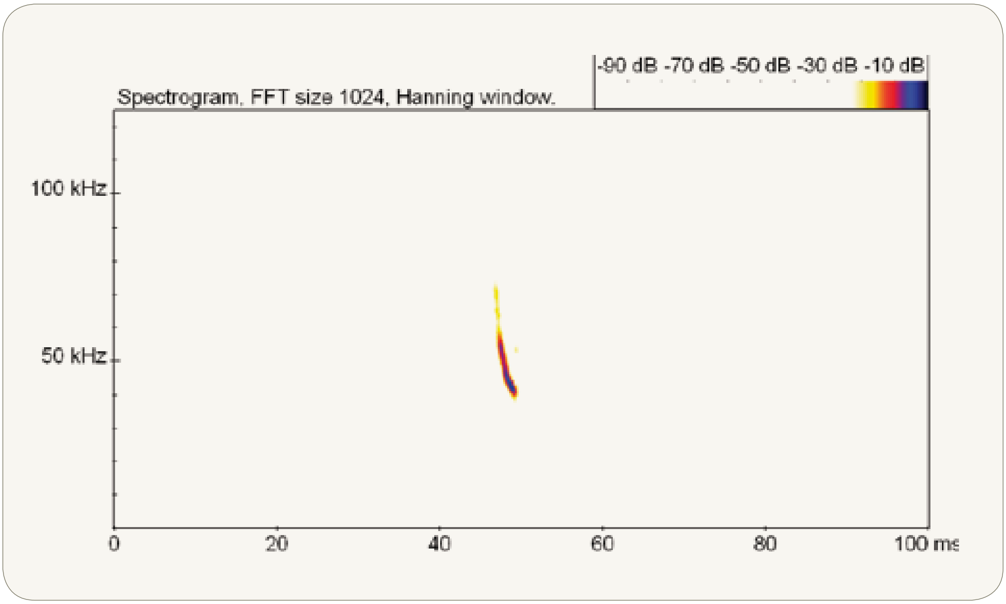


Figure 235. Echolocation call of *Cistugo lesueuri*.

one in Lesotho. The type specimen is from Franschhoek valley, near Paarl, South Africa (TM 2286).

This species is poorly represented in museums, with just 24 specimens examined for this book.

Cistugo lesueuri roosts in rock crevices, usually near water (Lynch 1994, Watson 1998). It appears to be associated with broken terrain in high-altitude montane grasslands (> 1,500 m above sea level) with suitable rock crevices and water in the form of dams, rivers or marshes.

Extralimital: *Cistugo lesueuri* is endemic to southern Africa.

Foraging ecology: *Cistugo lesueuri* has relatively short and broad wings with intermediate wing loading (7.5 N.m^{-2}) and low aspect ratio (6.5) (Schoeman and Jacobs 2003, 2008). It is a clutter-edge forager. Limited observations in the Western Cape suggest that it feeds predominantly on Diptera and Hemiptera (Schoeman and Jacobs 2003).

Reproduction: In Lesotho, pregnant females have been collected in October and December (Lynch 1994), while in the Cedarberg, Western Cape, a post-lactating female was collected in late January (Seamark and Brand 2005).

SYSTEMATIC NOTES

1919. *Cistugo lesueuri* Roberts, Ann. Transv. Mus., 6: 112.
Franschhoek valley, South Africa.

The taxonomic relationship between *C. lesueuri* and *C. seabrae* has not yet been fully resolved. They are separated by 30 cytochrome-*b* substitutions and, pending further revision, we retain them as separate species (Stadelmann *et al*. 2004).

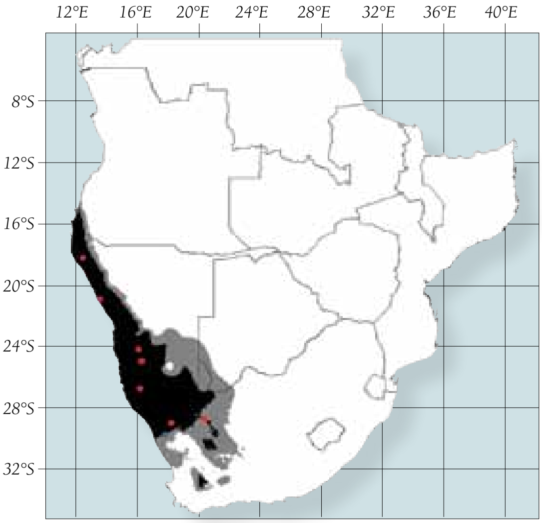
The diploid number in *C. lesueuri* is 2n = 50 and aFN = 48 (Rautenbach *et al.* 1993).

Figure 236. Cistugo lesueuri (© E. C. J. Seamark).

Cistugo seabrae Thomas 1912

Angolan wing-gland bat

Near Threatened



Description: *Cistugo seabrae* is a very small bat with a mass of around 4 g and very similar in appearance to the larger *C. lesueuri*. The individual hairs are long and stand away from the body, giving the fur a soft feel. It is a pale sandy-brown above and pale cream below. The upper parts are washed with yellow-orange. The individual hairs are dark at their base and yellow-orange at their tips. The wings are dark brown with a conspicuous gland present in the membrane on each side between the forearm and the fifth metacarpal (Seamark and Kearney 2006). The face is plain, without any noseleafs. The ears are brown and moderately sized, with a long, narrow tragus. The sexes are alike.

The skull is delicate with weak zygomatic arches, distinctly smaller than in *C. lesueuri*. In lateral view, the braincase rises slightly above the rostrum, with a smoothly concave forehead. There is a further concavity in the parietal region, owing to an occipital bulge. The sagittal and lambdoid crests are weak or absent. The mastoid processes are not evident in dorsal view. The dental formula is 2133/3133 = 38. The first two upper premolars are very small to minute, while the third upper premolar is sharply pointed and rises above the molars.

Key identification features: The soft yellow-washed fur and long, narrow tragus distinguish *Cistugo* from other vespertilionids. This genus also has two tiny anterior upper premolars, a feature shared only with *Myotis*; however, unlike in *Myotis*, these two premolars lie below the gumline and are therefore not generally visible in the live animal (E. Seamark, personal communication). *Myotis bocagii* is larger (FA > 37 mm, CI > 14.0 mm), lacks the wing gland, and does not occur in the same geographical area. *Myotis tricolor* and *M. welwitschii* are very much larger (FA > 47 mm, CI > 16.5 mm). Furthermore, *Myotis* species have a coppery wash to the pelage, while *Cistugo* species have a yellowish wash. The two species of *Kerivoula* overlap in size with *Cistugo*, also have soft fur and a long, narrow tragus; in addition, *K. argentata* has an orange-chestnut wash. *Kerivoula*, however, has longer fur of which the individual hairs have curled tips, as well as a fringe of fur on the outer margin of the tail membrane (only true for southern African species), larger anterior premolars, and a highly domed cranium. The two species of *Cistugo* are very similar and may be conspecific. However, their distributions do not overlap and *C. seabrae* is slightly smaller (FA < 35.5 mm, CI < 13.4 mm; in *C. lesueuri* FA > 33.0 mm, CI > 13.1 mm) and much paler.

Echolocation call: *Cistugo seabrae* produces LD-FM calls. Calls of room-flown individuals have an intermediate peak frequency (47±1.8 kHz, n = 2), broad bandwidth (24.4±10.8 kHz, n = 2), and short duration (3.1±0.7 ms, n = 2) (Schoeman and Jacobs 2008).

External and cranial measurements (mm) and mass (g) for *Cistugo seabrae*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1,2]	3.8	3.1	4.5	0.60	4	**Mass[1,2]**	3.5	3.0	4.0	0.42	4
FA[1,2]	33.0	29.4	34.9	2.02	8	**FA[1,2]**	33.3	31.5	35.4	1.18	16
Total[1]	90.0	-	-	-	1	**Total[1]**	86.3	82	91	3.02	13
Tail[1]	36.9	34	40		2	**Tail[1]**	42.2	39	48	2.27	13
Tibia[2]	12.5	12.5	12.5	-	2	**Tibia[2]**	12.2	-	-	-	1
Ear[1]	11.5	11	12	-	2	**Ear[1]**	11.6	11	12	0.38	12
CI[1]	12.8	12.0	13.1	0.41	6	**CI[1]**	12.6	12.1	13.4	0.45	12

[1] Specimens measured by the authors

[2] Seamark and Kearney (2006)

fig. 237a

fig. 237b

fig. 237c

fig. 237d

Figure 237. Skull and teeth of *Cistugo seabrae*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (TM 37550).

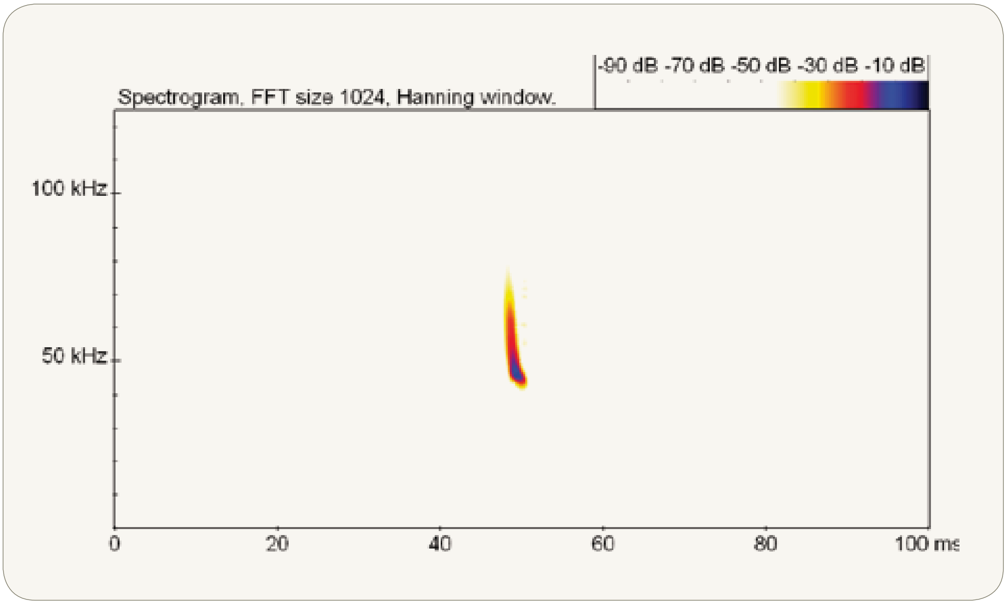


Figure 238. Echolocation call of a room-flown *Cistugo seabrae.*

fig. 239a

Figure 239. Cistugo seabrae: (a) whole animal showing the characteristic wing gland (arrowed), and (b) and (c) portraits (a, b: © E. C. J. Seamark; c: © M. Ruedi).

Distribution, habitat and roosting: *Cistugo seabrae* is endemic to the West Coast of southern Africa, extending from the extreme northwest of South Africa, through western Namibia to the extreme southwest of Angola. The type specimen is from Mossamedes (= Namibe), southwestern Angola (BM 1906.1.3.3).

This species is poorly represented in museums, with just 26 specimens examined for this book.

Cistugo seabrae is restricted to the arid western parts of southern Africa, typically in desert and semi-desert conditions (< 100 mm rainfall per annum), where it has been netted in riverine vegetation along dry river beds (Seamark and Kearney 2006). It has also been collected from a Church in Berseba Village, Namibia, where it was suspected of roosting in the steeple (Shortridge 1934).

Extralimital: *Cistugo seabrae* is endemic to southern Africa.

Foraging ecology: *Cistugo seabrae* has short and broad wings with low wing loading (5.7 $N.m^{-2}$) and low aspect ratio (6.9) (Schoeman and Jacobs 2008). It is a clutter-edge forager. At Goodhouse, in the Northern Cape, its diet comprised Diptera, Trichoptera, Hemiptera and Coleoptera (Schoeman 2006).

Reproduction: No reproductive information is available.

SYSTEMATIC NOTES

1912. *Cistugo seabrae* Thomas, Ann. Mag. Nat. Hist., ser. 8, 10 (56): 205. Mossamedes (= Namibe), southwestern Angola.

The taxonomic relationship between *C. lesueuri* and *C. seabrae* has not yet been fully resolved. They are separated by 30 cytochrome-*b* substitutions and, pending further revision, we retain them as separate species (Stadelmann *et al.* 2004).

The diploid number in *C. seabrae* is 2n = 50 and aFN = 48 (Rautenbach *et al.* 1993).

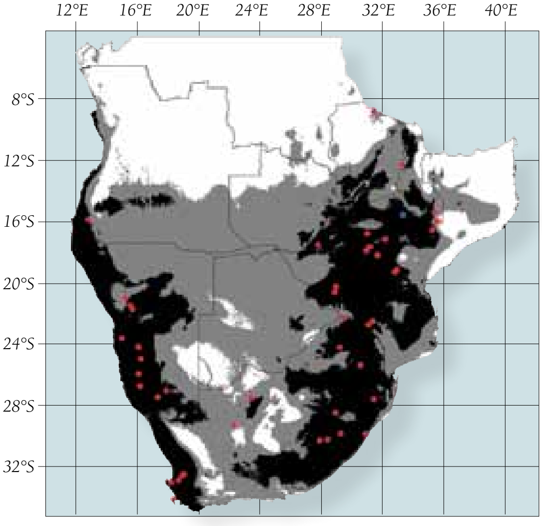
fig. 239b

fig. 239c

Eptesicus hottentotus (A. Smith 1833)

Long-tailed serotine

Least Concern



Description: *Eptesicus hottentotus* is a medium-small bat with a mass of around 16 g. The pelage colour varies geographically, with individuals from Namibia and the Northern Cape much paler than those from the east. In the west, it is fawn or sandy-brown above and grey-cream below. In the east, it is dark brown above and paler below. The individual hairs are long and bicoloured with a dark base and pale tip. The wings are dark brown. The face is plain, without any noseleafs. The ears are brown and moderately sized, with a short tragus with a rounded tip. The sexes are alike, with females slightly larger than males. In a Namibian sample, females were significantly larger than males in forearm length and third metacarpal length, but not in cranial measurements, whilst in South Africa, three cranial measurements differed significantly (Kearney 2005).

The skull is fairly robust with a broad rostrum and is adapted for reasonably strong jaw action, with pronounced coronoid processes of the mandible and bowed zygomatic arches. The pronounced sagittal crest forms a distinctively swollen 'helmet', which projects posteriorly just beyond the line of the occipital bone (as in *Scotophilus*, but not as pronounced). The dental formula is 2113/3123 = 32. The posterior upper incisor is much smaller than the anterior.

Key identification features: Owing to its large size (FA > 47 mm), *Eptesicus hottentotus* is unlikely to be confused with any of the other serotine species in southern Africa (genus *Neoromicia*, FA < 40 mm), which are all significantly smaller. *Eptesicus hottentotus* could possibly be confused with *Miniopterus*, but *Miniopterus* has an obviously elongated second phalanx of the third digit and a rounded skull. The most likely confusion is with *Scotophilus*, but members of this genus have unicoloured hair, sleek pelage, usually with yellow underparts, a long and narrow tragus, and only one upper incisor (two in *E. hottentotus*, the posterior one often only visible on a cleaned skull).

Echolocation call: *Eptesicus hottentotus* produces LD-FM and LD-QCF echolocation calls with an intermediate peak frequency (30.6±1.7 kHz, n = 10), narrow bandwidth (16.8±5.5 kHz, n = 10), and intermediate duration (5.5±2.1 ms, n = 10) (Schoeman and Jacobs 2003, 2008).

Distribution, habitat and roosting: *Eptesicus hottentotus* occurs widely but sparsely in the region. It has been recorded from western Namibia and extreme southwestern Angola, south to the Northern and Western Cape, east to Lesotho and KwaZulu-Natal, and north to Zimbabwe, with isolated records in Zambia, central Mozambique, and southern Malawi. The patchy nature of its distribution is probably a function of its roosting requirements (see below). The type specimen is from Uitenhage, Eastern Cape, South Africa (it is not shown on the

External and cranial measurements (mm) and mass (g) for *Eptesicus hottentotus*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	15.6	13.0	19.0	2.24	10	**Mass**[1]	16.3	12.0	20.5	2.77	6
FA[1]	48.8	46.9	52.0	1.63	15	**FA**[1]	51.0	49.0	53.0	1.15	14
Total[1]	120.0	110	135	7.66	11	**Total**[1]	123.0	103	131	9.17	10
Tail[1]	48.0	41	58	4.11	11	**Tail**[1]	52.0	48	58	3.40	10
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	17.9	15	20	1.58	11	**Ear**[1]	18.1	15	20	1.38	10
CI[1]	18.9	17.0	19.9	0.88	13	**CI**[1]	19.5	18.4	20.1	0.52	14

[1] Specimens measured by the authors

fig. 240a

fig. 240b

fig. 240c

fig. 240d

Figure 240. Skull and teeth of *Eptesicus hottentotus:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 1888).

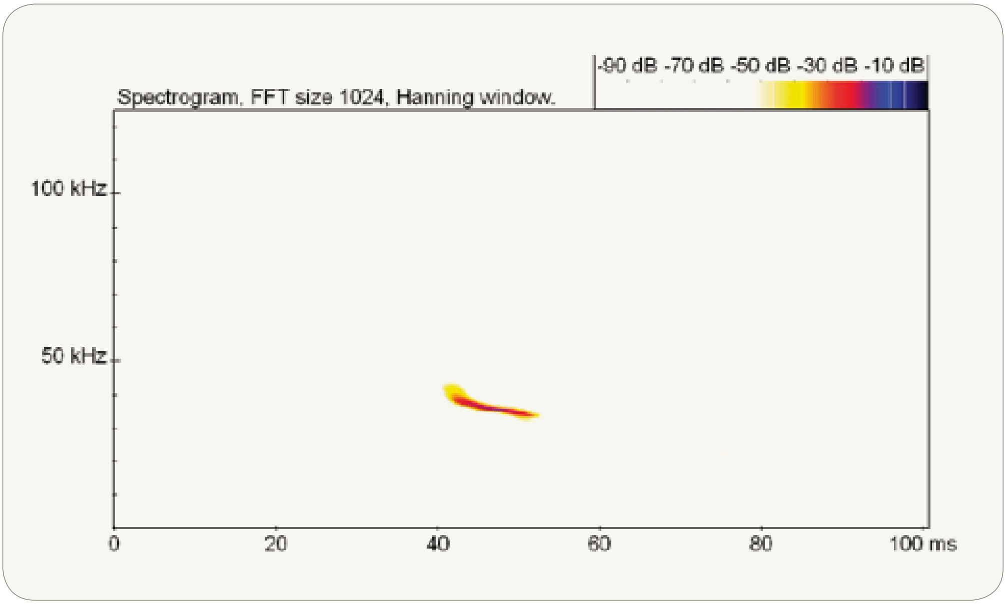


Figure 241. Echolocation call of *Eptesicus hottentotus*.

distribution map because the voucher specimen could not be traced).

This species is relatively well represented in museums, with over 60 specimens examined for this book.

Eptesicus hottentotus roosts in small groups of two to four individuals in caves (Skinner and Chimimba 2005) and rock crevices (Herselman and Norton 1985), suggesting that it may require suitable roosting sites in rocky outcrops. In Zimbabwe, it occurs in miombo woodland in gorges and granitic hills (Cotterill 1996a), while in South Africa it is usually captured near rocky outcrops.

Extralimital: An isolated population, recognised as the separate subspecies *E. h. portavernus*, occurs in Kenya (Schlitter and Aggundey 1986).

Foraging ecology: *Eptesicus hottentotus* has wings with intermediate wing loading (10.3 $N.m^{-2}$) and low aspect ratio (6.3) (Schoeman and Jacobs 2003, 2008). It is a clutter-edge forager. Its diet comprises mainly Coleoptera (Schoeman and Jacobs 2003, Schoeman 2006).

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1833. *Vespertilio hottentota* A. Smith, S. Afr. Quart. J. ser. 2: 59. Uitenhage, South Africa.

Three subspecies have been described from southern Africa (Meester *et al.* 1986), but *pallidior* (Shortridge 1942) was synonymised with *hottentotus* by Schlitter and Aggundey (1986), leaving two subspecies in the region: *E. h. hottentotus* and *E. h. bensoni* (Roberts 1946). (*E. h. portavernus* occurs extralimitally in Kenya.)

Eptesicus hottentotus hottentotus (A. Smith 1833)

Eptesicus hottentotus bensoni Roberts 1946

1946. *Eptesicus hottentotus bensoni* Roberts, Ann. Transv. Mus. 20: 305. Ncheu, Malawi (TM 9167, Holotype).

The subspecies *E. h. bensoni* occurs in the east of the region, while the nominate subspecies is restricted to Namibia, Angola, Northern and Western Cape. These two subspecies differ mainly in the colour of the pelage, but owing to their geographic isolation, they may represent different phylogenetic lineages. Further molecular studies are required. Bacular and chromosomal studies support the contention that *E. hottentotus* is the only member of the genus in southern Africa (Kearney *et al.* 2002).

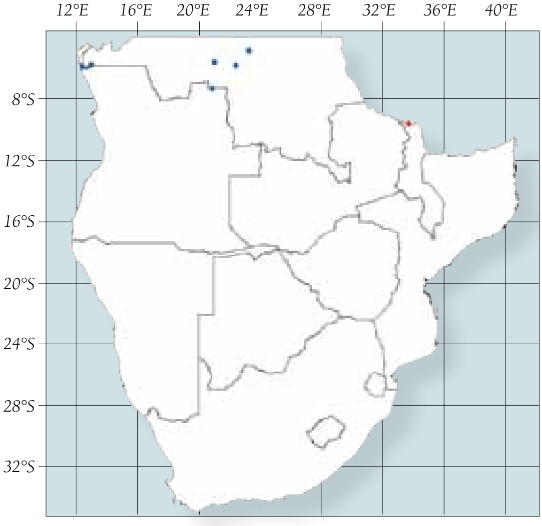
The diploid number in *E. hottentotus* is 2n = 50 and aFN = 48 (Rautenbach *et al.* 1993).

Figure 242. Eptesicus hottentotus (© E. C. J. Seamark).

Glauconycteris argentata (Dobson 1875)

Common butterfly bat

Least Concern



Description: *Glauconycteris argentata* is a small bat that closely resembles *G. variegata* in appearance and size. The pelage colour is usually a sandy, light brown on the upper parts and greyish below. The individual hairs are tricoloured with a dark base, white middle and sandy tip (Rosevear 1965). In contrast to *G. variegata*, the wings are plain uniform brown and are not patterned with reticulation, although there may be indistinct reticulation close to the body. There is usually a pale line running along the body above the wing membrane; it can be distinct or faint (Hayman 1963). The face is plain, without any noseleafs. The ears are small, light brown with a short tragus with a rounded tip. The sexes are alike.

The skull is moderately delicate with very weak zygomatic arches. The rostrum is obviously shortened, more so than in *G. variegata*. In lateral profile, the braincase is domed, rising above the level of the rostrum. The dental formula is 2113/3123 = 32. The sharply pointed upper premolar rises above the molars (Rosevear 1965).

External measurements (mm) for *Glauconycteris argentata*, sexes combined

	Mean	Min	Max	SD	N
Mass	-	-	-	-	-
FA[1]	-	40	44	-	-
Total[1]	-	95	105	-	-
Tail[1]	-	45	51	-	-
Tibia[1]	-	18.0	19.5	-	-
Ear	-	-	-	-	-
CL	-	-	-	-	-

[1] Rosevear (1965)

Key identification features: In general appearance, including the shape and size of the head, *Glauconycteris* closely resembles *Miniopterus*. However, the second phalanx of the third digit is greatly elongated in *Miniopterus*, and their dentitions differ profoundly. *Glauconycteris* may also be confused with *Myotis*, in which some species may be washed with yellow or yellow-orange, but the tragus is long and narrow in members of *Myotis* (short and broad in *Glauconycteris*). Confusion between *G. argentata* and *G. variegata* is eliminated by the distinctive wing pattern of *G. variegata*. *G. beatrix* is smaller (FA < 41 mm) and much darker.

Echolocation call: The echolocation call of this species has not been recorded.

Distribution, habitat and roosting: *Glauconycteris argentata* occurs widely in the far northwest of the region, and has been recorded from southwestern DRC and northern Angola (Sanborn 1951, Hayman 1963), with an isolated record from northern Malawi. The type specimen is from Cameroon (BM 1871.7.10.5).

The southern African population of this species is poorly represented in museums, with just six records examined for this book.

Glauconycteris argentata is a tropical species associated with forest and moist woodland (Rosevear 1965). Nothing is known about its roosting requirements in southern Africa, but it has been recorded roosting in large groups of up to 30 bats clinging to the midrib of palm fronds, 2–4 bats per leaf (Loveridge in Rosevear 1965).

Extralimital: *Glauconycteris argentata* is widely distributed in Central Africa, including Cameroon, DRC, Uganda, western Kenya and Tanzania.

Foraging ecology: There is no information on the diet or foraging behaviour of this species in southern Africa.

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1875. *Chalinolobus argentata* Dobson, Proc. Zool. Soc. Lond., 385. Mount Cameroon, Cameroon.

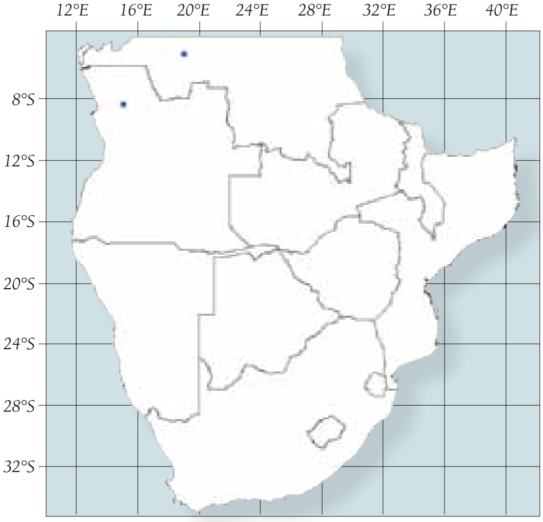
Chalinolobus congicus Noack 1889 (SMF 2516, Holotype, Banana Creek, Netonna, Bas Congo) is a synonym (Hayman and Hill 1971).

The diploid number in *G. argentata* is not known.

Glauconycteris beatrix Thomas 1901

Beatrix butterfly bat

Near Threatened



Description: *Glauconycteris beatrix* is a small blackish-brown vesper bat, with brown wings. The pelage is uniform dark brown above and below; some specimens are blotched with white patches and have white shoulder tufts (eastern population *humeralis*). Ears are very rounded and small. The individual hairs are tricoloured with a dark base, paler middle and buffy tips, but these colours vary. Wings are plain uniform brown and are not patterned with reticulation. The face is plain, without any noseleafs. The ears are small, light brown with a short, upright tragus with a sharp, tip, the outside edge curved. The sexes are alike.

The skull is short and broad, with very weak zygomatic arches. The braincase is prominently developed, characteristic of *Glauconycteris*, and it rises high above the short rostrum; the interdental palate is deeply indented and domed. The rostrum is distinctly shortened, more so than in *G. variegata*. In lateral profile, the braincase is domed, rising above the level of the rostrum. The dental formula is 2113/3123 = 32. The sharply pointed upper premolar rises above the molars; lower incisors trifid (Rosevear 1965).

Key identification features: In general appearance (head shape and size), all species of darker-coloured *Glauconycteris* closely resemble *Miniopterus*, but the second phalanx of the third digit is greatly elongated in *Miniopterus*, and their dentitions differ profoundly. *Glauconycteris* may also be confused with *Myotis*, in which some species may be washed with yellow or yellow-orange, but the tragus is long and narrow in all *Myotis* (short and broad in *Glauconycteris*). *G. beatrix* is distinguished from *G. argentata* by the small, rounded ears, darker pelage and shorter skull. *G. variegata* exhibits a distinctive wing pattern. The white shoulder tufts resemble *G. poensis*, and cranial differences and the darker pelage distinguish *G. beatrix* from the similar *G. curryae*. *G. beatrix* also lacks the lateral stripe of *G. alboguttatus*, which together with *G. curryae* might occur in forest in southern Congo and northern Angola.

Echolocation call: The echolocation call of this species has not been recorded.

Distribution, habitat and roosting: *Glauconycteris beatrix* is comparatively rare in collections. All records are associated with moist forests and riparian fringes in the forest zone. There is one record from northern Angola, and one from the DRC. The type specimen is from Equatorial Guinea (BM 1898.5.4.19, Holotype). The daylight roosts of *G. beatrix* are not known, but these bats probably roost in foliage, the characteristic behaviour of *Glauconycteris*.

Extralimital: Known from the Côte d'Ivoire, Cameroon, and the forest belt of the Congo basin (Central African Republic, DRC) with an outlying record from Entebbe, Uganda (Hayman and Hill 1971, Adam and Aellen 1975, Lunde *et al*. 2001).

External and cranial measurements (mm) and mass (g) for two populations of *Glauconycteris beatrix*, sexes combined

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
G. b. humeralis						***G. b. beatrix***					
Mass[1]	5.3	4.0	7.0	0.85	17	**Mass**[1]	4.0	-	-	-	1
FA[1]	37.5	35.8	40.1	1.15	28	**FA**[1]	38.6	35.6	41.6	1.98	6
Total[1]	90.8	82.0	98.0	4.36	19	**Total**[1]	94.3	88.0	99.0	4.57	4
Tail[1]	47.6	38.0	59.0	4.67	20	**Tail**[1]	43.5	35.0	51.0	6.61	4
Tibia[1]	17.9	16.0	19.7	0.95	25	**Tibia**[1]	19.4	17.8	21.3	1.24	6
Ear[1]	10.1	7.0	12.0	1.33	19	**Ear**[1]	10.7	10.0	11.0	0.48	4
CI[1]	11.2	10.8	11.6	0.21	28	**CI**[1]	11.3	11.0	11.7	0.25	6

[1] Eger and Schlitter (2001)

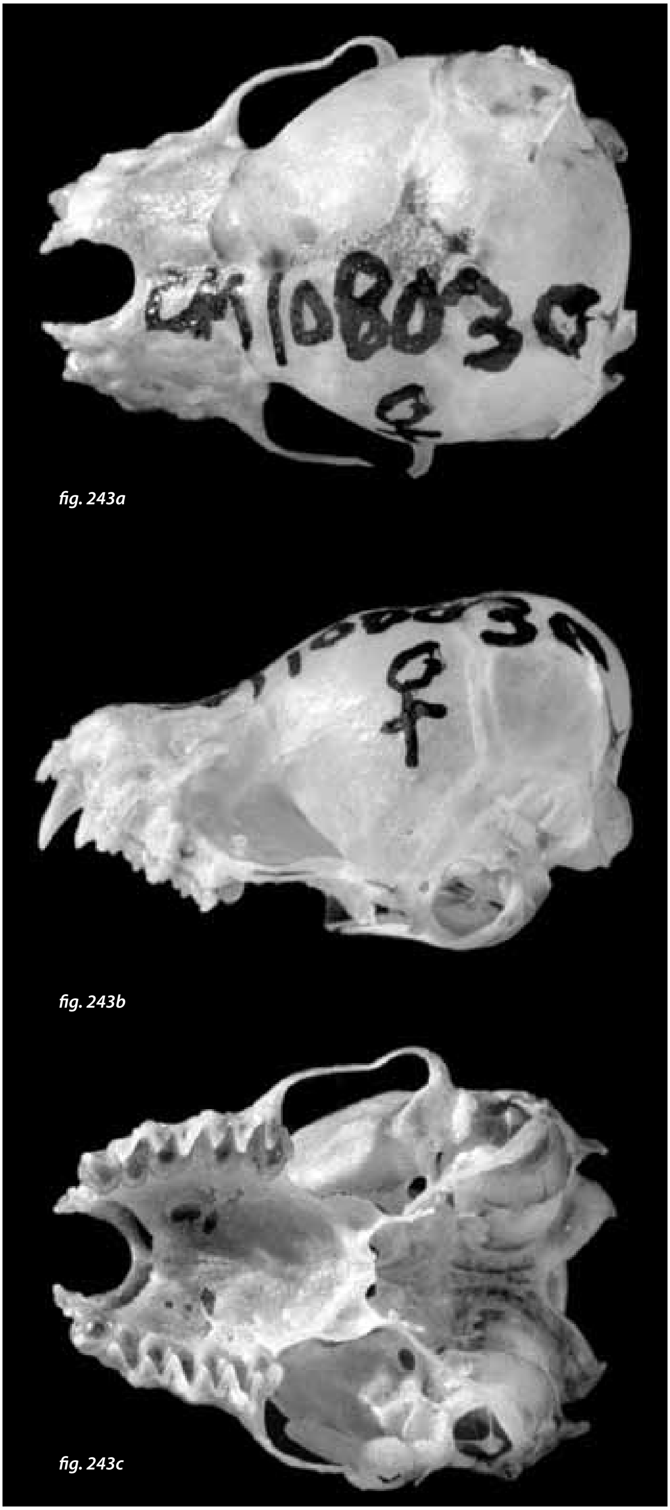


Figure 243. Skull and teeth of *Glauconycteris beatrix:* (a) dorsal view; (b) lateral view and (c) ventral view (CM108030; from *Acta Chiropt.* 2001).

Foraging ecology: There is no information on the diet or foraging behaviour of this species in southern Africa.

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1901. *Glauconycteris beatrix* Thomas, Ann. Mag. nat. Hist., ser. 7, 8 (45): 256. Equatorial Guinea: Rio Muni, Benito River, 15 miles (24 km) from Delta.

G. beatrix is one of no less than ten described forms of Butterfly bats. Most are poorly known and are restricted to the moist, equatorial forest belt; all these bats exhibit a dichotomous patterning of the pelage, variously exhibited in pale (white, yellow to orange) stripes, spots or blotches against a dark medium (Rosevear 1965, Hayman and Hill 1971). This character reaches a striking, and beautiful, extreme in the very rare species, *G. superba* Hayman 1939 (including *sheila* Hayman 1947) known by just two specimens from the northeastern DRC and Ghana. The white blotches and spots on the dorsum and venter contrast against the black fur. This disruptive colouration in *Glauconycteris* likely constitutes adaptive camouflage in these foliage-roosting bats; it is hypothesised the patchy pattern of distribution of these butterfly bats, extending across forests from Uganda to Senegal, reflects a process of allopatric speciation in historically isolated forest patches.

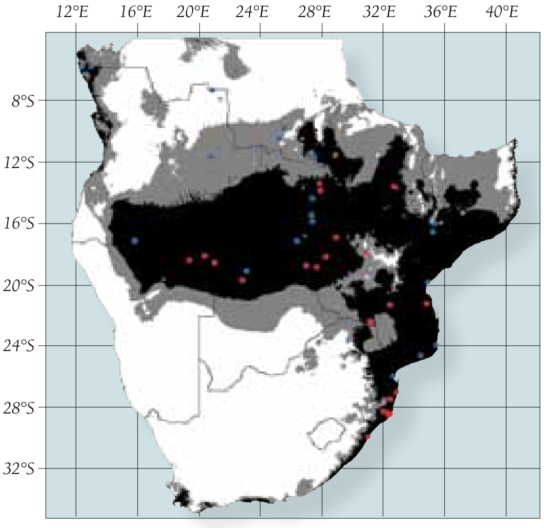
Although *G. beatrix* is distinct from the recently described *G. curryae* Eger and Schlitter 2001, Eger and Schlitter (2001) treated *G. humeralis* J. A. Allen 1917 as a subspecies of *G. beatrix*, assigning all material from Uganda and eastern Congo to *G. b. humeralis*, which exhibits white shoulder spots. The relationships between all these forest-dwelling *Glauconycteris*, which are similar to *G. beatrix*, notably *G. humeralis* and *G. poensis* (Gray 1842) are difficult to resolve on current evidence; this endorses molecular sequencing and more museum material, as there are large gaps in geographical representation of all taxa; many remain rare in collections.

◂ ***Figure 244.*** *Glauconycteris beatrix* (CM108030; from *Acta Chiropt.* 2001).

Glauconycteris variegata (Tomes 1861)

Variegated butterfly bat

Least Concern



Description: *Glauconycteris variegata* is a beautiful small bat with a mass of around 12 g. The pelage colour is usually yellowish or pale fawn on the upper parts and pale cream below. The individual hairs are tricoloured with a dark base, cream middle, and light brown or yellow tip. The wings are characteristically patterned and are pale yellow with distinct dark reticulations. The face is plain, without any noseleafs. The ears are small, light brown with a short tragus with a rounded tip. The sexes are alike.

The skull is broad and moderately robust for its size with weak zygomatic arches. The rostrum is obviously shortened. In lateral profile, the braincase is domed, rising above the level of the rostrum. The dental formula is 2113/3123 = 32. The sharply pointed upper premolar rises above the molars. The posterior upper incisor is minute and difficult to see without magnification on a cleaned skull.

Key identification features: The beautiful patterning of the wing membranes makes *Glauconycteris variegata* difficult to confuse with any other bat in the region. Some *Myotis* species may be washed yellow or yellow-orange with a bold wing pattern, but none have the reticulated pattern characteristic of *G. variegata*. The head of *Glauconycteris* closely resembles that of *Miniopterus*, but the wing pattern in *G. variegata* easily distinguishes this species.

Echolocation call: *Glauconycteris variegata* produces LD-FM calls with an intermediate peak frequency (41.1 kHz, n = 1), broad bandwidth (21.1 kHz, n = 1), and short duration (2.3 ms, n = 1 ms) (Schoeman and Jacobs 2008; also see Obrist *et al*. 1989). Besides the fundamental, the second harmonic may be present on the spectrogram.

Distribution, habitat and roosting: *Glauconycteris variegata* occurs widely, but patchily, in the eastern and northern parts of the region. It has been recorded from the northern KwaZulu-Natal coast, north through southern Mozambique, extreme northeastern South Africa to Zimbabwe, northern Botswana and Namibia, Zambia, southern Malawi, southern DRC, and from isolated sites in Angola. The model suggests that suitable conditions occur in southeastern Angola and adjoining parts of Zambia. The type specimen is from Namibia (BM 1907.1.1.437).

This species is not well represented in museums, with about 40 specimens examined for this book.

Glauconycteris variegata is a savanna or open woodland species, often associated with riparian or coastal forest in southern Africa. It roosts singly or in pairs in dense foliage (Rautenbach *et al*. 1979). In Zimbabwe, Obrist *et al*. (1989)

External and cranial measurements (mm) and mass (g) for *Glauconycteris variegata*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						Females					
Mass[1]	11.4	10.0	13.5	1.39	5	**Mass[1]**	14.2	13.7	15.0	-	3
FA[1]	43.7	40.5	45.1	1.37	11	**FA[1]**	44.2	43.1	46.5	1.08	7
Total[1]	104.0	90	112	7.38	7	**Total[1]**	102.0	-	-	-	1
Tail[1]	44.0	32	52	6.30	7	**Tail[1]**	44.5	44	45	-	2
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	13.0	9	15	2.30	7	**Ear[1]**	10.0	-	-	-	1
CI[1]	14.0	13.8	14.2	0.18	8	**CI[1]**	13.8	13.0	14.2	0.43	6

[1] Specimens measured by the authors

fig. 243a

fig. 243b

fig. 243c

fig. 243d

Figure 245. Skull and teeth of *Glauconycteris variegata*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 7037).

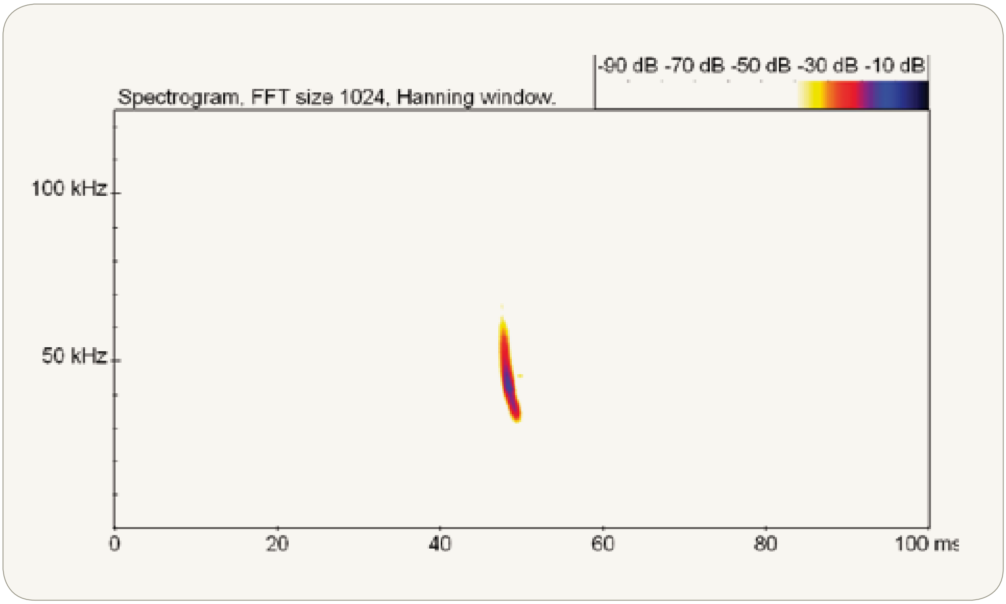


Figure 246. Echolocation call of *Glauconycteris variegata*.

fig. 247a

recorded a group of eight individuals roosting within the foliage of a Natal mahogany *(Trichilia emetica)* about 7.5 m above the ground.

Extralimital: *Glauconycteris variegata* is widely distributed in East Africa, including Kenya, Tanzania, Uganda, DRC, Ethiopia, Nigeria, Benin, Ghana and Senegal (Happold 1987).

Foraging ecology: *Glauconycteris variegata* has wings with intermediate wing loading (8.6 N.m^{-2}) and low aspect ratio (6.2) (Schoeman and Jacobs 2008; also see Obrist *et al*. 1989). It is a clutter-edge forager. In Zimbabwe, its diet comprised mainly Lepidoptera (Fenton *et al*. 1977; also see Kingdon 1974).

Reproduction: In Zimbabwe, a female carrying a single young was captured in November (Obrist *et al*. 1989).

SYSTEMATIC NOTES

1861. *Scotophilus variegatus* Tomes, Proc. Zool. Soc. Lond., 36. Otjoro (= Otjihoro, Damaraland), Namibia.

The names *papilio* Thomas 1905 and *phalaena* Thomas 1915 are synonyms. Simmons (2005), following Hayman and Hill (1971), lists *G. machadoi* Hayman 1963 (BM 62.2074, Holotype, from Lago Calundo) as a valid species pending further evidence, although Koopman (1971) treated this taxon as a subspecies of *G. variegata,* possibly a melanistic form. Crawford-Cabral (1989) doubted the specific validity of *machadoi*, stating that 'the occurrence in Angola of an endemic species outside of the Angolan Plateau or Escarpment Zone is not likely to be accepted'. Nevertheless, comparisons with *G. variegata* led Hayman (1963: 107) to conclude 'The contrast in overall colour with the pale creamy buff of the dorsal surface, and whitish head, of *G. variegata* and *G. v. papilio,* both of which have been recorded from Angola, is so striking that I feel the only possible taxonomic treatment is to regard this as a distinct species, in spite of the obvious relationship to *G. variegata.*' Here we treat it as part of *G. variegata,* but suggest that a detailed study of this species group is necessary to resolve this matter.

Koopman (1971) reclassified Afrotropical *Glauconyteris* into *Chalinolobus*, and was followed by Meester *et al.* (1986) who renamed all African species accordingly. Based on evidence of bacular morphology, recent treatments have not accepted this arrangement (Hill and Harrison 1987; Simmons 2005).

The diploid number in *G. variegata* is 2n = 18 and aFN = 32 (Rautenbach *et al.* 1993).

fig. 247b

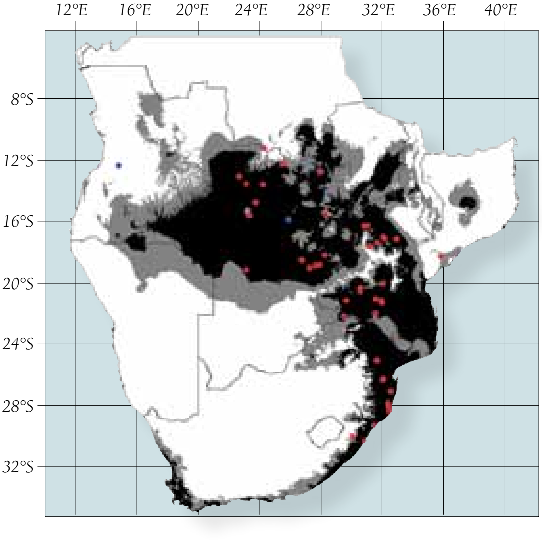
fig. 247c

Figure 247*. Glauconycteris variegata:* (a) portrait showing orange-yellow colour and rounded tragus, and (b) and (c) outstretched wings showing dark reticulations (a, b: DM 9374, © A. Monadjem; c: © M. C. Schoeman).

Hypsugo anchietae (Seabra 1900)

Anchieta's pipistrelle

Least Concern



Description: *Hypsugo anchietae* is a small bat with a mass of around 5 g and is very similar in size and appearance to *Pipistrellus hesperidus*. The pelage colour is dark brown above and greyish-brown below. The individual hairs on the back are bicoloured with a dark base and light brown tip. The wings are dark brown. The face is plain, without any noseleafs. The ears are brown and moderately sized, with a short tragus with a rounded tip. The sexes are not generally significantly different in cranial or body size, although two cranial and one external measurement showed slight significant sexual dimorphism, with females 5–6% larger than males (Kearney 2005).

The skull is rather fragile with thin zygomatic arches, a rounded braincase and a broad rostrum. The palate is longer than broad and not as widely emarginated as in *P. rusticus*. In lateral profile, the braincase is slightly elevated above the level of the rostrum, but not as markedly as in *Neoromicia nana*. The sagittal and lambdoid crests are weakly developed. The dental formula is 2123/3123 = 34. The small anterior upper premolars are typically broad and flat-crowned.

Key identification features: *Hypsugo anchietae* is extremely difficult to distinguish from *Pipistrellus hesperidus*, both in external appearance and features of the cranium and dentition (Kearney and Taylor 1997, Kearney 2005). Kearney (2005) provided a two-group discriminant function classification for *H. anchietae* and *P. hesperidus* based on 12 cranial measurements for populations, which allowed 100% of specimens to be identified correctly. However, this was based on mean values, while individuals showed considerable overlap. The species can only be identified with certainty by examination of the baculum (Cotterill 1996a, Kearney and Taylor 1997) or the karyotype (*H. anchietae*: 2n = 26; *P. hesperidus*: 2n = 42).

Echolocation call: This species produces LD-FM echolocation calls with an intermediate peak frequency (55.7 kHz, n = 1), broad bandwidth (35.2 kHz, n = 1), and short duration (2.1 ms, n = 1) (Schoeman and Jacobs 2008).

Distribution, habitat and roosting: *Hypsugo anchietae* occurs widely but sparsely in the region. It has been recorded from coastal KwaZulu-Natal and eastern Swaziland, north through northern South Africa to Zimbabwe and western Zambia, with isolated records from central Mozambique, northern Botswana and western Angola. The model suggests that suitable conditions occur in southeastern Angola. Interestingly, the type specimen (BM 1906.1.3.1) is from Cahata in western Angola – atypical conditions compared against the rest of the records for the species.

This species is relatively well represented in museums, with over 100 specimens examined for this book. However, these specimens were mostly collected from just a handful of sites. All specimens examined were netted so there is no information on roosting sites.

External measurements (mm) and mass (g) for *Hypsugo anchietae*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1,2]	4.7	4.0	5.5	0.47	12	**Mass[1,2]**	4.9	3.2	5.7	0.77	11
FA[1,2]	30.2	28.0	32.0	1.36	13	**FA[1,2]**	30.6	28.2	32.6	1.50	13
Total[1]	77.3	73	80	-	3	**Total[1]**	83.0	78	87	3.74	4
Tail[1]	34.3	34	35	-	3	**Tail[1]**	36.0	32	39	3.16	4
Tibia[1]	13.4	13.3	13.5	-	2	**Tibia[1]**	-	-	-	-	-
Ear[1]	11.3	10	12	0.96	4	**Ear[1]**	11.9	11	13	0.9	7
CI	-	-	-	-	-	**CI**	-	-	-	-	-

[1] Specimens measured by the authors

[2] Cotterill (1996a)

fig. 248a

fig. 248b

fig. 248c

fig. 248d

Figure 248. Skull and teeth of *Hypsugo anchietae*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 5362).

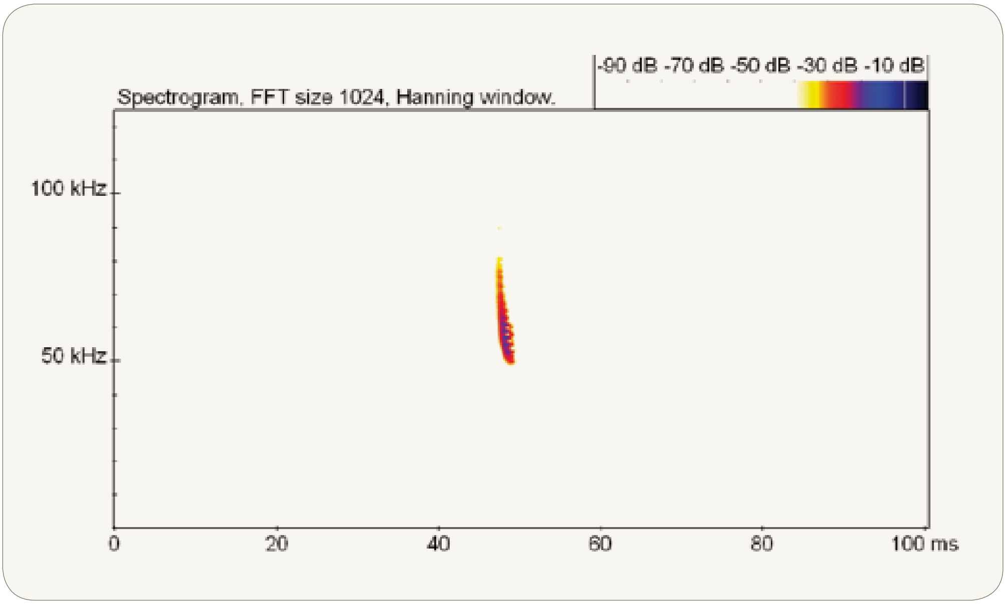


Figure 249. Echolocation call of *Hypsugo anchietae.*

Hypsugo anchietae is collected predominantly in well-wooded locations such as riparian vegetation, especially when nets and harp traps are placed above water (Kearney and Taylor 1997, A. Monadjem, unpublished data). Hence, its inferred habitat is riparian forest in savanna and woodland. It is locally common along the riparian fringe of large rivers (Mzingwane) in southern Zimbabwe (F. P. D. Cotterill, unpublished data).

Extralimital: Most records of *Hypsugo anchietae* are from southern Africa. Its restricted distribution may be due to the difficulty in identifying this species, both the live animal and museum specimens (Kearney and Taylor 1997). A specimen identified as *H. anchietae* was collected in Ethiopia (deposited in the Natural History Museum of Zimbabwe, Bulawayo: NMZB 32685), while specimens from Madagascar have also been identified as *H. anchietae* (Bates *et al*. 2006). It may therefore prove to have a much wider distribution than currently known, at a minimum extending into East Africa.

Foraging ecology: *Hypsugo anchietae* has short and broad wings with low wing loading (6.7 $N.m^{-2}$) and low aspect ratio (5.4) (Schoeman and Jacobs 2008). It is a clutter-edge and clutter forager. At Sudwala Caves, Mpumalanga, its diet comprised Hemiptera, Diptera and Coleoptera (Schoeman 2006).

Reproduction: A pregnant female with two foetuses was collected in October in KwaZulu-Natal (Kearney and Taylor 1997).

SYSTEMATIC NOTES

1900. *Vesperugo anchieta* Seabra, J. Sci. mat. Phys. Nat., Lisboa (2)6: 26, 120. Cahata, Angola.

Bacular and chromosomal studies support the contention that this species should be placed in its own genus, *Hypsugo* (Volleth *et al.* 2001, Kearney *et al.* 2002, Kearney 2005). Molecular studies on this species and on the *Neoromicia/Pipistrellus* group are necessary.

The diploid number in *H. anchietae* is 2n = 26 and aFN = 32 (Rautenbach *et al.* 1993, Kearney *et al.* 2002). While Rautenbach *et al.* (1993) described the X chromosome as a medium-sized submetacentric autosome, Kearney *et al.* (2002) found the X chromosome to be a small metacentric.

fig. 250a

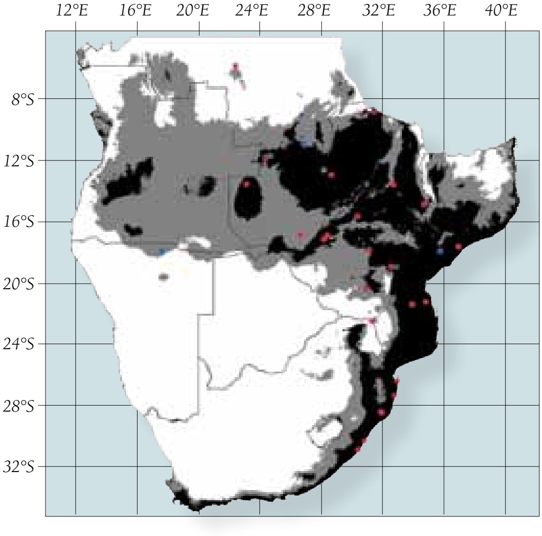
fig. 250b

Figure 250. *Hypsugo anchietae*: (a) whole body, and (b) portrait showing plain face (a: DM 10025, © M. C. Schoeman; b: Western Zambia, © F. P. D. Cotterill).

Kerivoula argentata Tomes 1861 ●

Damara woolly bat

Least Concern



Description: Although it is the larger of the two southern African *Kerivoula* species, *Kerivoula argentata* is nonetheless a small bat with a mass of around 7 g. It has the long, soft, woolly pelage characteristic of this genus. The individual hairs on the upper parts are a rich chestnut-brown, many of which have light tips, giving the bat a grizzled appearance. Individual hairs have a dark brown base fading to buff and finally to light brown. The underparts are white to greyish-white. The wings are dark brown and sparsely covered in hair. The hind margin of the tail membrane carries a fringe of stiff hairs that curl inwards at their tips. The ears are funnel-shaped with a deep emargination below the tip. The tragus is long and tapers to a sharp point. The face lacks any noseleafs and is covered in long hairs. The sexes are alike.

The skull is fragile with very weak zygomatic arches. In lateral profile, the braincase is greatly inflated, rounded and elevated well above the line of the rostrum. The sagittal and lambdoid crests are very weak or absent. The dental formula is 2133/3133 = 38. The first two upper premolars are of similar size, but the third is long and resembles the canine.

External and cranial measurements (mm) and mass (g) for *Kerivoula argentata*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	7.6	6.0	9.0	-	6
FA[2]	37.7	34.7	40.3	1.47	21
Total[2]	94.0	86	101	6.81	5
Tail[2]	43.8	40	47	2.77	5
Tibia[2]	8.9	7.5	10.0	1.03	4
Ear[2]	14.2	11	16	1.92	5
CI[2]	14.2	13.5	14.8	0.46	8

[1] Smithers and Wilson (1979)

[2] Specimens measured by the authors

Key identification features: The funnel-shaped ears, long, sharply pointed tragus, long, soft, woolly hair with curled tips, and the fringe of hair on the outer margin of the tail membrane distinguish the two southern African species of *Kerivoula* from other microbats in the region. *Kerivoula argentata* can be separated from *K. lanosa* by a combination of larger size (FA > 34.5 mm and CI > 13.5 mm; *K. lanosa*: FA < 33.5 mm and CI < 13.0 mm) and pelage colour. In *K. argentata*, the dorsal pelage is reddish-chestnut, while in *K. lanosa* it is brownish and grizzled with grey or white.

Echolocation call: *Kerivoula argentata* produces low intensity LD-FM calls with a high peak frequency (range 90–118 kHz), broad bandwidth (35 kHz), and short duration (2 ms) (Fenton and Bell 1981). A room-flown individual produced calls with a peak frequency of 92 kHz, 36 kHz bandwidth, and 2.3 ms duration (G. Delcros, P. J. Taylor and M. C. Schoeman, unpublished data).

The calls of *K. lanosa* are similar in frequency and duration to those of *K. argentata*, but the calls of *K. argentata* generally sweep down from a lower frequency at ~120 kHz.

Distribution, habitat and roosting: *Kerivoula argentata* has been recorded in the eastern parts of the region, ranging from Durban northwards through eastern KwaZulu-Natal and Mozambique into Zimbabwe, Zambia, southern DRC and Malawi. The model suggests that extensive tracts of land in southern and central Mozambique have conditions suitable for this species. The type specimen is from northern Namibia.

Of the 49 specimens collected in southern Africa, and examined for this book, only a handful have been captured after 1980, with about one-third having been collected prior to 1940. At least 16 specimens were taken whilst roosting in weavers' nests (Oschadleus 2008). Considering the abundance of these nests, it is not likely that their distribution is restricted by roost availability.

Typical of all woolly bats, the pelage of *K. argentata* aids camouflage when the bats roost in foliage (F. P. D. Cotterill, unpublished data); groups of *K. argentata* (2–4 individuals) resemble the nests of mud wasps, with the group clinging tightly together in a tight cluster under the eaves of buildings and amongst leaves (Roberts 1951, Kingdon 1974). In addition, the long, dense fur may also be a physiological adaptation to extreme temperatures, experienced when these small bats roost in foliage or birds' nests.

Very little information is available on the preferred habitat of *Kerivoula argentata*. The species appears closely associated with the miombo woodlands of Zambia, Angola, Zimbabwe and Mozambique. Indeed, the two specimens from Malawi

fig. 251a

fig. 251b

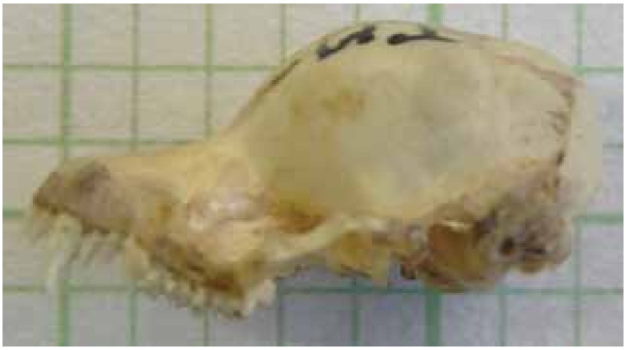


fig. 251c

fig. 251d

Figure 251. Skull and teeth of *Kerivoula argentata:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (TM 3786).

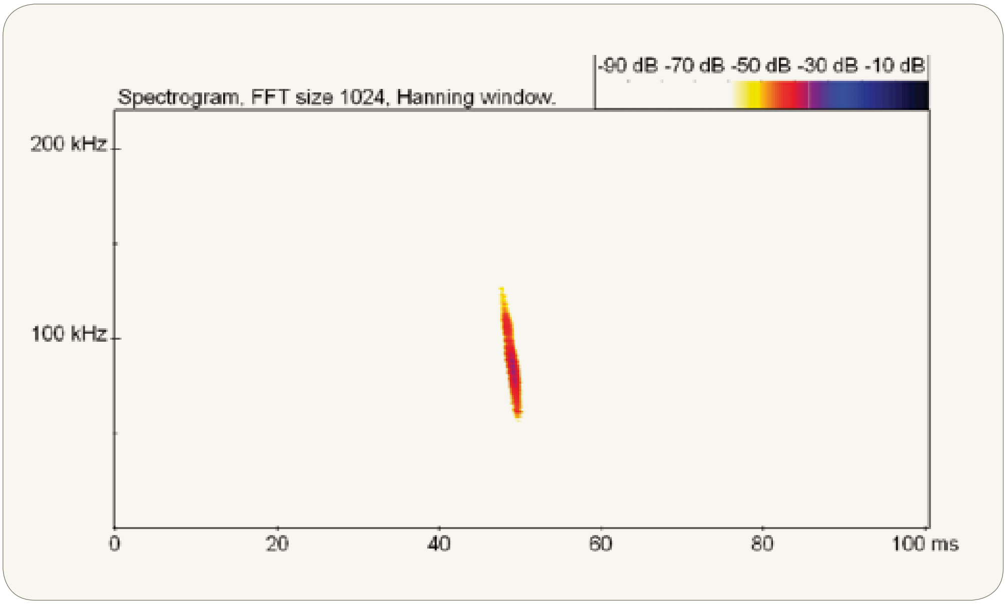


Figure 252. Echolocation call of a room-flown *Kerivoula argentata*.

were both collected in *Brachystegia* woodland, while the Pafuri specimen (northern Kruger National Park, South Africa) was netted in riparian forest. Two other specimens for which habitat information is available were captured in coastal forest in southern Mozambique and riparian woodland in central Mozambique (A. Monadjem, unpublished data).

Extralimital: *Kerivoula argentata* has also been recorded from the DRC, Tanzania, Kenya, Senegal and Côte d'Ivoire.

Foraging ecology: *Kerivoula argentata* has short and broad wings with low wing loading (6.6 N.m-2) and low aspect ratio (6.1) (Norberg and Rayner 1987; also see Aldridge and Rautenbach 1987). It is a clutter forager. There is no information on the diet of this species in southern Africa.

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1861. *Kerivoula argentata* Tomes, Proceedings of the Zoological Society, London: 32. Otjoro (= Otjihoro?), Ovamboland, Namibia.

Meester *et al.* (1986) recognised three subspecies in the region:

Kerivoula argentata argentata Tomes 1861

Kerivoula argentata nidicola (Kirk 1865)

1865. *Nycticejus nidicola*, Kirk, Proceedings of the Zoological Society, London (1864): 651. Shupanga (= Chupanga), Zambezi River, Mozambique (1864.1.9.37–39, Syntypes).

Kerivoula argentata zuluensis Roberts 1924

1924. *Kerivoula nidicola zuluensis* Roberts, Annals of the Transvaal Museum 10: 61. White Umfolosi River, Zululand, Natal (TM 3025, Holotype).

Owing to the limited number of specimens available, the validity of these subspecies cannot currently be determined. However, external appearance and measurements do not obviously vary with geography, and the collection of new specimens may bring into question these subspecies.

The taxonomic relationships within the African species of *Kerivoula* are unclear and *K. argentata* has not yet been karyotyped. However, only two African species have a fringe of hair on the hind margin of the tail membrane, *K. argentata* and *K. lanosa*, suggesting a closer affinity between them than with other members of the genus.

Figure 253. *Kerivoula argentata* showing funnel-shaped ears and woolly pelage washed with orange-brown (a: DM 9375, © A. Monadjem; b: Siabuwa, northwestern Zimbabwe, © F. P. D. Cotterill).

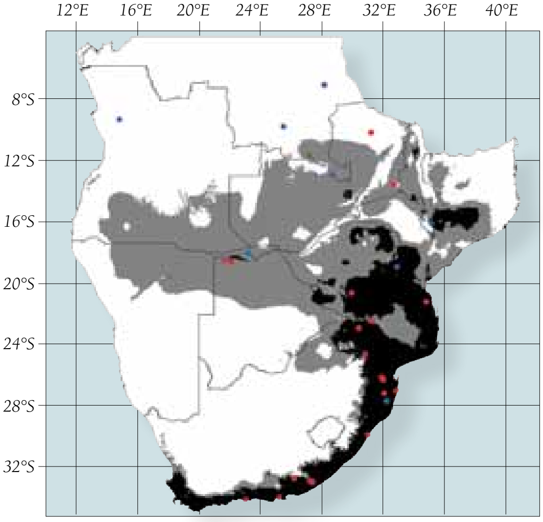
fig. 253a

fig. 253b

Kerivoula lanosa (A. Smith 1847) ●

Lesser woolly bat

Least Concern



Description: *Kerivoula lanosa* is a very small bat with the long, soft, woolly pelage characteristic of this genus. The individual hairs on the upper parts are brownish or greyish, many of which end in light tips and giving the bat a grizzled appearance. Individual hairs have a dark brown base, fading to light brown and finally to grey or white. The underparts are white to greyish-white. The wings are dark brown and sparsely covered in hair. The hind margin of the tail membrane carries a fringe of stiff hairs that curl inwards at their tips. The ears are funnel-shaped with a deep emargination below the tip. The tragus is long and tapers to a sharp point. The face lacks any noseleafs and is covered in long hairs. The sexes are alike.

The skull is fragile with very weak zygomatic arches. In lateral profile, the braincase is greatly inflated, rounded and elevated well above the line of the rostrum. The sagittal and lambdoid crests are very weak or absent. The dental formula is 2133/3133 = 38. The first two upper premolars are of similar size, but the third is long and resembles the canine.

External and cranial measurements (mm) and mass (g) for *Kerivoula lanosa*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	4.8	4.5	5.0	-	2
FA[1]	31.5	28.0	33.1	1.23	22
Total[1]	76.1	68	90	6.30	9
Tail[1]	36.0	30	40	3.00	8
Tibia[1]	6.5	6.0	7.0	-	2
Ear[1]	12.0	10	13	1.20	8
CI[1]	12.2	9.0	12.9	1.10	11

[1] Specimens measured by the authors

Key identification features: The funnel-shaped ears, long, sharply pointed tragus, long, soft, woolly hair with curled tips, and the fringe of hair on the outer margin of the tail membrane distinguish the two southern African species of *Kerivoula* from other microbats in the region. *Kerivoula lanosa* can be separated from *K. argentata* by a combination of smaller size (FA < 33.5 mm and CI < 13.0 mm; in *K. argentata* FA > 34.5 mm and CI > 13.5 mm) and pelage colour. In *K. argentata*, the dorsal pelage is reddish-chestnut, while in *K. lanosa* it is brownish and grizzled with grey or white.

Echolocation call: *Kerivoula lanosa* produces low intensity LD-FM echolocation calls. ANABAT recordings of calls typically range from 85–140 kHz with a short duration of 2 ms (A. Monadjem, unpublished data; Table 3). The calls of *K. lanosa* are similar in frequency and duration to those of *K. argentata*, but the calls of *K. argentata* generally sweep down from a lower frequency at ~120 kHz.

Distribution, habitat and roosting: *Kerivoula lanosa* has been recorded in the eastern parts of the region, ranging from Knysna in South Africa, northwards through eastern KwaZulu-Natal, Swaziland and Mozambique, and into Zimbabwe, northern Botswana, Zambia, southern DRC and Malawi. The type material is from Knysna (BM 1907.1.1.538–539, Syntypes).

This species is poorly represented in museums and only 37 specimens have been collected in southern Africa, all of which were examined for this book. Of these, only seven have been captured since 1980. As in *K. argentata*, a number of specimens were taken whilst roosting in weaver and sunbird nests (Oschadleus 2008). Considering the abundance of these nests, it is not likely that their distribution is restricted by roost availability.

Very little information is available on the preferred habitat of *Kerivoula lanosa*. The Hlane (Swaziland) specimen was captured in a harp trap in riparian forest. It is likely that this species, like *K. argentata*, has been significantly overlooked, as it is very rarely caught in mist nets. The use of harp traps may improve capture rates and it is probably not a coincidence that all five *Kerivoula* specimens captured by A. Monadjem (unpublished data) in the past two years were harp trapped. The distribution of this species across southern and eastern Zimbabwe and extending south to the Soutpansberg and Mpumalanga could reflect an association with patchy afromontane habitat along the 'Limpopo Escarpment Extension' (Cotterill 1996a).

Extralimital: *Kerivoula lanosa* has also been recorded from Liberia, Côte d'Ivoire, Ghana, Gabon, Cameroon, Central African Republic, Ethiopia, Kenya, Tanzania and the DRC.

fig. 254a

fig. 254b

fig. 254c

fig. 254d

Figure 254. Skull and teeth of *Kerivoula lanosa:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (TM 7128).

fig. 255a

fig. 255b

Foraging ecology: *Kerivoula lanosa* has short and broad wings with low wing loading (5.8 N.m^{-2}) and low aspect ratio (4.6) (G. Delcros, P. J. Taylor and M. C. Schoeman, unpublished data). It is a clutter forager.

There is no information on the diet of this species in southern Africa.

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1847. *Vespertilio lanosus* A. Smith, Illustrations of the Zoology of South Africa. Cape coast, 320 km east of Cape Town.

Two subspecies are recognised in the region (Meester *et al.* 1986):

Kerivoula lanosa lanosa (A. Smith 1847)

Kerivoula lanosa lucia Hinton 1920

1920. *Kerivoula lucia* Hinton, Annals and Magazine of Natural History (9)6: 240. Ndola, Zambia (BM 1920.11.3.27, Holotype).

Owing to the limited number of specimens available, the validity of these subspecies cannot currently be determined. However, external appearance and measurements do not obviously vary with geography, and the availability of new specimens may obviate their validity.

The taxonomic relationships within the African species of *Kerivoula* have yet to be determined.

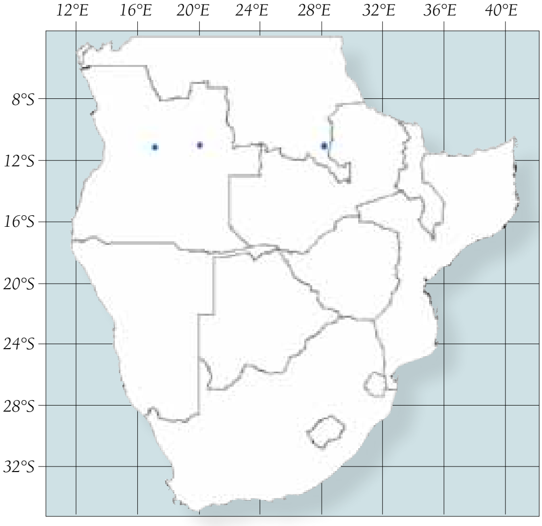
The diploid number in *K. lanosa* is 2n = 50 (Rautenbach *et al.* 1993).

Figure 255. Kerivoula lanosa, showing (a) funnel-shaped ears and grizzled woolly pelage, and (b) the long, sharp tragus (a: NMZB 29664, © F. P. D. Cotterill; b: DM 8424, © L. Lumsden).

Laephotis angolensis Monard 1935

Angolan long-eared bat

Near Threatened



Description: *Laephotis angolensis* is a small bat with an estimated mass of around 5–6 g. It is very similar in size and appearance to the slightly larger *L. botswanae*, from which it cannot be reliably separated on external characters (Kearney and Seamark 2005). The pelage is buffy-brown on the upper parts and slightly paler on the underparts. The individual hairs are long and bicoloured, with a dark base and pale tip. The wings are dark brown (Monard 1935). The face is plain, without any noseleafs. The ears are long, with the large triangular tragus characteristic of this genus.

The skull is delicate with weak zygomatic arches. In lateral profile, the braincase rises slightly above the rostrum. The dental formula is 2113/3123 = 32. The upper premolar is sharply pointed and rises above the molars.

External measurements (mm) for *Laephotis angolensis*, sexes combined

	Mean	Min	Max	SD	N
Mass	-	-	-	-	-
FA[1]	34.9	34.3	35.5	-	2
Total	-	-	-	-	-
Tail	-	-	-	-	-
Tibia	-	-	-	-	-
Ear[1]	16.0	15.9	16.0	-	2
CI	-	-	-	-	-

[1] Kearney and Seamark (2005)

Key identification features: The genus *Laephotis* is distinguished from all other African vespertilionid bats by the relatively long ears (> 16.5 mm, almost half the length of the FA) and large triangular tragus. However, distinguishing the four species of *Laephotis* from each other is not currently possible on external features. Kearney and Seamark (2005) identified four cranial measurements based on a multivariate morphometric analysis to separate *L. botswanae* from the other three congeners. The post-palatal measurement of the distance from a line across the rear margins of the third upper molar to the anterior edge of the mesopterygoid fossa is shorter than the distance from the anterior edge of the mesopterygoid fossa to the tips of the pterygoid hamulars in the *L. botswanae*/*L. angolensis* group, but longer in the *L. namibensis*/*L. wintoni* group (Hill 1974a, Stanley and Kock 2004, Kearney and Seamark 2005). There is a slight difference in mean size between *L. botswanae* and *L. angolensis*, with the former being larger, but this difference may be due to the very small sample size of measured *L. angolensis*.

Echolocation call: The echolocation call of this species has not been recorded.

Distribution, habitat and roosting: *Laephotis angolensis* is known from just four specimens collected at three localities (Kearney and Seamark 2005) in Angola and the DRC. The type specimen (in MHNC) is from Tyihumbwe, Angola.

Nothing is known about the habitat or roosting sites of this species.

Extralimital: *Laephotis angolensis* is endemic to southern Africa (Kearney and Seamark 2005).

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: No reproductive information is available.

SYSTEMATIC NOTES

1971. *Laephotis angolensis* Monard, Arq. Mus. Bocage, Lisboa, 6: 45. Tyihumbwe, Angola.

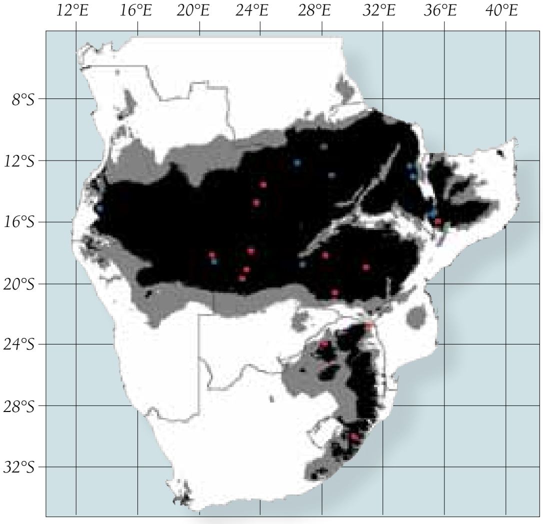
Laephotis botswanae and *L. angolensis* may be conspecific, which would make the former a larger race of the latter (Peterson 1973, Kearney and Seamark 2005). This possibility is reflected in records of both taxa from southeastern Katanga, DRC.

The diploid number in *L. angolensis* is not known, but it is likely to be 2n = 34 as in other species of *Laephotis*. Bacular studies have also failed to show differences between some species of *Laephotis* (Kearney *et al.* 2002). Hence, molecular studies may be necessary to sort out the current confusion over species limits within this genus.

Laephotis botswanae Setzer 1971

Botswana long-eared bat

Least Concern



Description: *Laephotis botswanae* is a small bat with a mass of around 6–7 g. It is very similar in size and appearance to other members of the genus and cannot be reliably separated on external characters. The pelage is buffy-brown on the upper parts and slightly paler on the underparts. The individual hairs are long, and bicoloured with a dark base and pale tip. The wings are dark brown. The face is plain, without any noseleafs. The ears are brown and long, with the large triangular tragus characteristic of *Laephotis*. The sexes are alike.

The skull is delicate with weak zygomatic arches. In lateral view, the braincase rises slightly above the rostrum. The sagittal crest is absent and the lambdoid crest is very weak. The dental formula is 2113/3123 = 32. The upper premolar is sharply pointed and rises above the molars.

Key identification features: The genus *Laephotis* is distinguished from all other African vesper bats by the relatively long ears (> 16.5 mm, half the length of the FA) and large triangular tragus. However, distinguishing the four species of *Laephotis* from each other is not currently possible on external features. Kearney and Seamark (2005) identified four cranial measurements based on a multivariate morphometric analysis to separate *L. botswanae* from the other three congeners. The post-palatal measurement of the distance from a line across the rear margins of the third upper molar to the anterior edge of the mesopterygoid fossa is shorter than the distance from the anterior edge of the mesopterygoid fossa to the tips of the pterygoid hamulars in the *L. botswanae*/*L. angolensis* group, but longer in the *L. namibensis*/*L. wintoni* group (Hill 1974a, Stanley and Kock 2004, Kearney and Seamark 2005). There is a slight difference in size between *L. botswanae* and *L. angolensis*, with the former being larger, but this difference may be due to the very small sample size of measured *L. angolensis*. **Echolocation call:** *Laephotis botswanae* produces LD-FM echolocation calls with an intermediate peak frequency (33 kHz), broad bandwidth (22 kHz), and intermediate duration (5 ms). Besides the fundamental, the second and third harmonics are often present on the spectrogram (Fenton and Bell 1981; also see Fenton and Thomas 1980).

Distribution, habitat and roosting: *Laephotis botswanae* occurs widely but sparsely in the northern parts of the region. It occurs in northern South Africa, north to Zimbabwe, Zambia, Malawi, northern Botswana, and the Caprivi of Namibia, with isolated records from southwestern Angola, the extreme south of the DRC and KwaZulu-Natal (Kearney and Seamark 2005). The well known naturalist T. N. Liversedge collected the type specimen from Shakawe, northern Botswana (USNM 00425349, Holotype).

External and cranial measurements (mm) and mass (g) for *Laephotis botswanae*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	6.0	5.0	7.5	1.08	5	**Mass[1]**	7.2	-	-	-	1
FA[1,2]	35.5	33.0	37.0	1.16	11	**FA[1,2]**	36.6	34.2	38.2	1.39	10
Total[1,2]	95.0	90	109	6.33	8	**Total[1,2]**	100.0	93	113	9.20	4
Tail[1,2]	42.1	40	44	1.84	8	**Tail[1,2]**	45.1	44	46	1.18	4
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1,2]	18.6	16.5	21.1	1.32	11	**Ear[1,2]**	18.6	17.1	20.5	1.14	9
CI[1]	14.2	13.9	14.5	0.25	6	**CI[1]**	14.6	14.2	15.1	-	3

[1] Specimens measured by the authors

[2] Kearney and Seamark (2005)

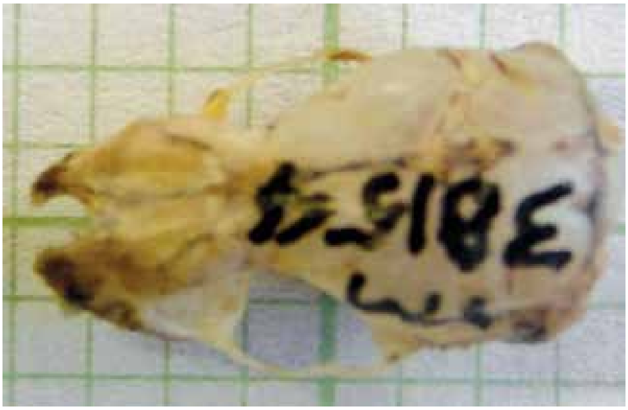


fig. 256a

fig. 256b

fig. 256c

fig. 256d

Figure 256. Skull and teeth of *Laephotis botswanae:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (TM 38154).

fig. 257a

fig. 257b

It is poorly represented in museums, with just 49 records examined for this book.

All specimens examined had been netted, so there is no information on roosting sites. This species appears to be associated with open woodland and savanna habitats where it has been netted near water.

Extralimital: *Laephotis botswanae* is near-endemic to southern Africa, occurring marginally beyond this region in the extreme southwest of Tanzania (Kearney and Seamark 2005).

Foraging ecology: In Zimbabwe, *Laephotis botswanae* has been recorded feeding on Coleoptera, Lepidoptera and Trichoptera (Fenton *et al*. 1977, Fenton and Thomas 1980).

Reproduction: No reproductive information is available.

SYSTEMATIC NOTES

1971. *Laephotis botswanae* Setzer, Proc. Biol. Soc. Washington, 84: 260. Southwest of Shakawe, Botswana.

Laephotis botswanae and *L. angolensis* may be conspecific, which would make the former a larger race of *L. angolensis* (Peterson 1973, Kearney and Seamark 2005).

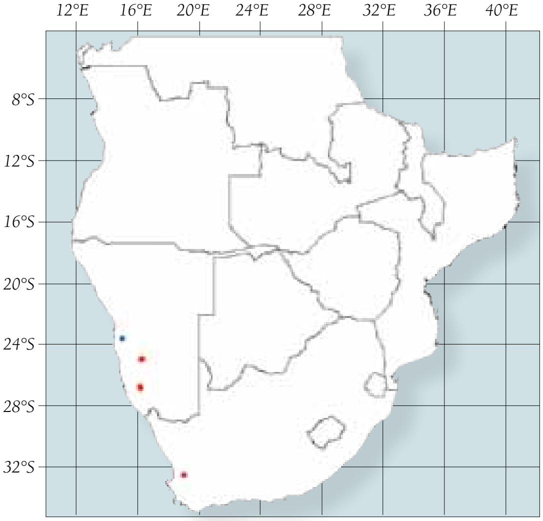
The diploid number in *L. botswanae* is 2n = 34 and aFN = 50 (Rautenbach *et al.* 1993, Kearney and Taylor 1997), although this does not help to distinguish it from other species of *Laephotis*. Bacular studies have also failed to show differences between the species (Kearney *et al.* 2002). Hence, molecular studies may be necessary to resolve the prevailing confusion over species limits within the genus *Laephotis*.

Figure 257. *Laephotis botswanae*, showing its very long ears (a: © Merlin D. Tuttle, Bat Conservation International, www.batcon.org; b: © F. P. D. Cotterill).

Laephotis namibensis Setzer 1971

Namibian long-eared bat

Least Concern



Description: *Laephotis namibensis* is a small bat with a mass of around 10 g and is very similar in size and appearance to *L. wintoni*, from which it cannot be reliably separated on external or cranial characters. The pelage varies geographically: the upper parts are pale brown in the Namib, but buffy-brown in the Western Cape; the underparts are slightly paler. The individual hairs are long and bicoloured, with a dark base and pale tip. The wings are medium brown. The face is plain, without any noseleafs. The ears are dark brown and long, with the large triangular tragus characteristic of this genus. The sexes are alike.

The skull is delicate with weak zygomatic arches. In lateral view, the braincase rises slightly above the rostrum. The dental formula is 2113/3123 = 32. The upper premolar is sharply pointed and rises above the molars.

External and cranial measurements (mm) and mass (g) for *Laephotis namibensis*, sexes combined[1]

	Mean	Min	Max	SD	N
Mass[2]	11.0	-	-	-	1
FA[2,3]	37.7	35.9	39.5	1.25	10
Total[2,3]	102.7	91	111	-	3
Tail[2,3]	43.7	38	47	-	3
Tibia	-	-	-	-	-
Ear[2,3]	23.2	22.0	25.0	0.93	8
CI[2]	15.7	15.3	16.4	0.43	8

[1] Five bats of both sexes weighed in the Western Cape had a mean mass of 10.3g (Jacobs *et al.* 2005)

[2] Specimens measured by the authors

[3] Kearney and Seamark (2005)

Key identification features: The genus *Laephotis* is distinguished from all other African vesper bats by the relatively long ears (> 16.5 mm, half the length of the FA) and large triangular tragus. However, distinguishing the four species of *Laephotis* from each other is not currently possible on external features. The post-palatal measurement of the distance from a line across the rear margins of the third upper molar to the anterior edge of the mesopterygoid fossa is shorter than the distance from the anterior edge of the mesopterygoid fossa to the tips of the pterygoid hamulars in the *L. botswanae/L. angolensis* group, but longer in the *L. namibensis/L. wintoni* group (Hill 1974a, Stanley and Kock 2004, Kearney and Seamark 2005).

Echolocation call: *Laephotis namibensis* produces low intensity LD-FM echolocation calls with a low peak frequency (22±0.6 kHz, n = 5), narrow bandwidth (13.5±2.9 kHz, n = 5), and short duration (2.6±0.8 ms, n = 5) (Jacobs *et al.* 2005; also see Schoeman and Jacobs 2008). Besides the fundamental, the second harmonic is often present on the spectrogram.

Distribution, habitat and roosting: *Laephotis namibensis* is endemic to South Africa and Namibia, occurring in the arid western parts of the region (Kearney and Seamark 2005). It is known from the Namib Desert with an isolated population in the Western Cape. The type specimen is from Gobabeb, Namibia (USNM 342152, Holotype).

It is poorly represented in museums, with just 10 records examined for this book.

Laephotis namibensis appears to be associated with arid desert and fynbos habitats where it has been netted near water. Based on radio-tracking studies, Jacobs *et al.* (2005) showed that this species uses narrow crevices in vertical rock faces as day roosts.

Extralimital: *Laephotis namibensis* is endemic to southern Africa (Kearney and Seamark 2005).

Foraging ecology: *Laephotis namibensis* has relatively broad wings with intermediate wing loading (7.0 N.m^{-2}) and low aspect ratio (5.7) (Jacobs *et al.* 2005; also see Schoeman and Jacobs 2008). It is a clutter-edge forager. In the Cedarberg, Western Cape, its diet comprised mainly Lepidoptera and Coleoptera (Jacobs *et al.* 2005, Schoeman 2006).

Reproduction: In the Cedarberg, Western Cape, a pregnant female was caught in November (Jacobs *et al.* 2005) and a post-lactating female was collected in late January (Seamark and Brand 2005).

fig. 258a

fig. 258b

fig. 258c

fig. 258d

Figure 258. Skull and teeth of *Laephotis namibensis:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (TM 37548).

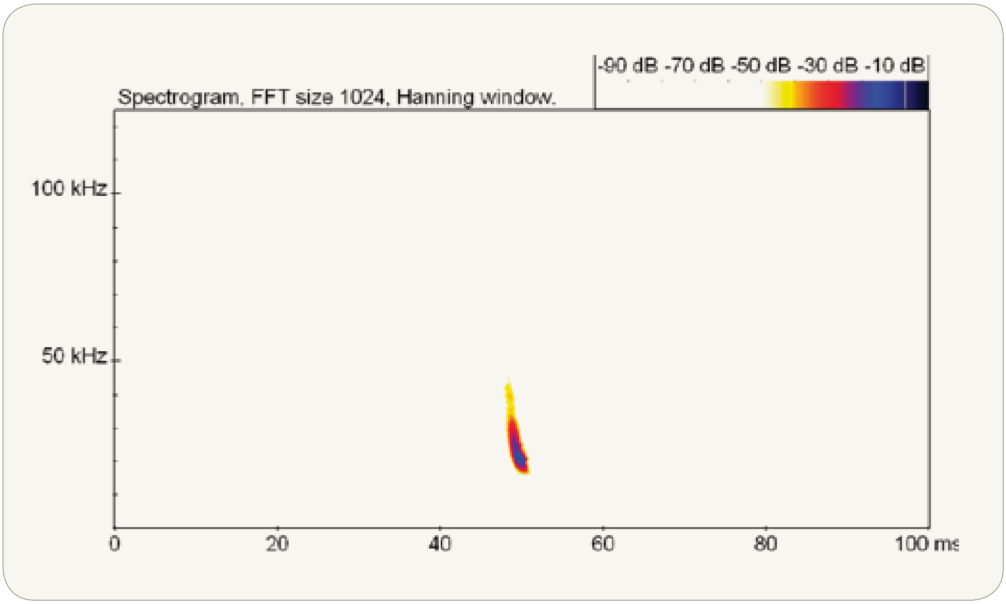


Figure 259. Echolocation call of *Laephotis namibensis.*

SYSTEMATIC NOTES

1971. *Laephotis namibensis* Setzer, Proc. Biol. Soc. Washington, 84: 259. Gobabeb, Namib Desert, Namibia.

Laephotis namibensis and *L. wintoni* may be conspecific, which would make the former a paler, western race of *L. wintoni* (Kearney and Seamark 2005).

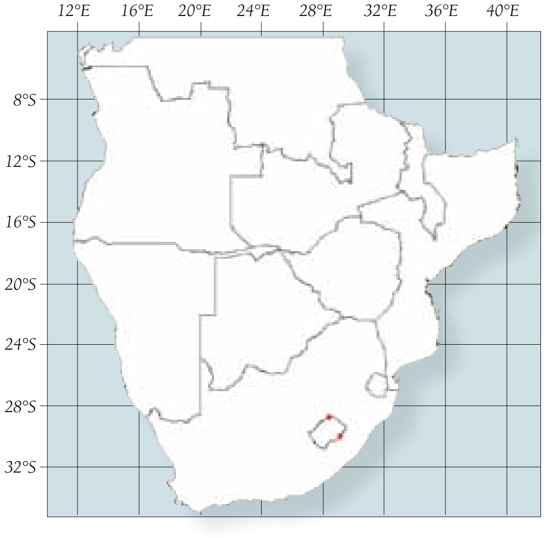
The diploid number in *L. namibensis* is 2n = 34 and aFN = 50 (Rautenbach *et al.* 1993), which does not help to distinguish it from other species of *Laephotis*. Bacular studies have also failed to show differences between selected species of *Laephotis* (Kearney *et al.* 2002). Kearney and Seamark (2005) could not find a clear distinction between *L. namibensis* and *L. wintoni* and echoed the suggestion that they might be geographic races of the same species (Peterson 1973). These results endorse the use of molecular studies to clarify the current confusion over species limits within this genus.

Figure 260. *Laephotis namibensis,* showing very long ears (© M. C. Schoeman).

Laephotis wintoni Thomas 1901

De Winton's long-eared bat

Least Concern



Description: *Laephotis wintoni* is a small bat with a mass of around 10 g. It is very similar in size and appearance to the paler *L. namibensis*, from which it cannot be reliably separated on external or cranial characters. The pelage is buffy-brown on the upper parts and slightly paler on the underparts. The individual hairs are long and bicoloured, with a dark base and pale tip. The wings are medium brown. The face is plain, without any noseleafs. The ears are dark brown and long, with the large triangular tragus characteristic of this genus. The sexes are alike.

The skull is delicate with weak zygomatic arches. In lateral view, the braincase rises slightly above the rostrum. The dental formula is 2113/3123 = 32. The upper premolar is sharply pointed and rises above the molars.

External and cranial measurements (mm) and mass (g) for *Laephotis wintoni*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	9.1	7.7	11.0	1.11	7
FA[1,2]	39.4	37.2	40.0	1.00	8
Total[1,2]	104.6	91	111	6.55	7
Tail[1,2]	46.3	38	50	3.90	7
Tibia	-	-	-	-	-
Ear[1,2]	22.3	21.0	24.0	1.25	7
CI[1]	15.8	15.6	16.0	0.15	7

[1] Specimens measured by the authors
[2] Kearney and Seamark (2005)

Key identification features: The genus *Laephotis* is distinguished from all other African vespertilionid bats by the relatively long ears (> 16.5 mm, half the length of the FA) and large triangular tragus. However, distinguishing the four species of *Laephotis* from each other is not currently possible on external features. The post-palatal measurement of the distance from a line across the rear margins of the third upper molar to the anterior edge of the mesopterygoid fossa is shorter than the distance from the anterior edge of the mesopterygoid fossa to the tips of the pterygoid hamulars in the *L. botswanae*/*L. angolensis* group, but longer in the *L. namibensis*/*L. wintoni* group (Hill 1974a, Stanley and Kock 2004, Kearney and Seamark 2005).

Echolocation call: The echolocation call of this species has not been recorded.

Distribution, habitat and roosting: *Laephotis wintoni* occurs at high altitude (> 1,500 m above sea level) in Lesotho and the Free State (Kearney and Seamark 2005), where it has been collected from montane grasslands. In Lesotho, it was netted over water (Lynch 1994). The type specimen is from Kitui, Kenya (BM 1901.5.6.5, Holotype).

This species is poorly represented in museums, with just seven specimens examined for this book.

The day roosts of this species are not known; presumably, it utilises crevices in rock faces, as does *L. namibensis* (Jacobs *et al.* 2005).

Extralimital: *Laephotis wintoni* occurs widely but sparsely in East Africa, including Tanzania, Kenya and Ethiopia (Kearney and Seamark 2005).

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: In Lesotho, a pregnant female was collected in November (Lynch 1994).

SYSTEMATIC NOTES

1901. *Laephotis wintoni* Thomas, Ann. Mag. Nat. Hist., ser. (7)7: 460. Kitui, Kenya.

Laephotis namibensis and *L. wintoni* may be conspecific, which would make the former a paler, western race of the latter (Kearney and Seamark 2005).

The diploid number in *L. wintoni* is 2n = 34 and aFN = 50 (Rautenbach *et al.* 1993); however, this does not help to distinguish it from other species of *Laephotis*. Bacular studies have also failed to show differences between some species of *Laephotis* (Kearney *et al.* 2002). Kearney and Seamark (2005) tentatively identified the Lesotho and Free State specimens as *cf. wintoni* since they are more similar to the type specimen from Kenya than to *namibensis* from the Namib. (See discussion under *Laephotis namibensis*.)

fig. 261a

fig. 261b

fig. 261c

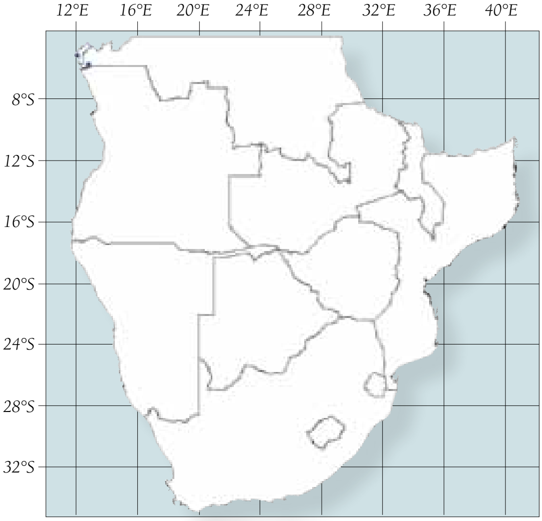
fig. 261d

Figure 261. Skull and teeth of *Laephotis wintoni:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (NMB 6687).

Mimetillus moloneyi (Thomas 1891) ●

Moloney's flat-headed bat

Least Concern



Description: *Mimetillus moloneyi* is a small bat with an estimated mass around 10 g. The pelage is short, sleek and dark brown; individual hairs are unicoloured. The wing membranes are dark brown. The face is plain, without any noseleafs and stout muzzle due to the broad and flattened skull. There is a wide swollen pad on each upper lip between the nostril and the eye. The ears are small with a characteristically club-like tragus. The wing is short and very narrow due to the reduction in the length of the third and fifth digits. The sexes are alike (Rosevear 1965).

The skull of *Mimetillus* is relatively robust for its size with weak zygomatic arches. In lateral profile it is flattened, with the braincase hardly rising above the level of the rostrum. The rostrum is almost as broad as the braincase. The sagittal crest is very weak or absent, while the lambdoid crest is relatively well developed. The dental formula is: 2113/3123 = 32.

External and cranial measurements (mm) for *Mimetillus moloneyi*, sexes combined

	Mean	Min	Max	SD	N
Mass	-	-	-	-	-
FA[1]	28.2	27.1	29.5	0.64	19
Total[2]	-	76	92	-	-
Tail[2]	-	26	32	-	-
Tibia[2]	-	9.5	11.0	-	-
Ear[2]	-			-	-
GSL[3]	13.3	11.8	14.5	-	54

[1] Specimens measured by the authors
[2] Rosevear (1965)
[3] Cotterill (2001e)

Key identification features: The combination of a broad, flattened skull, club-shaped tragus, presence of two upper incisors and the short, narrow wings distinguish this species from all other southern African bats. *Scotoecus* also has a broad, flattened skull with club-shaped tragus, but only has a single upper incisor and the wing is not particularly short or narrow (the third digit is shorter than the head and body length in *M. moloneyi*, but longer in *Scotoecus*). *Mimetillus moloneyi* is very similar in appearance and size to *M. thomasi*, however their distributions do not overlap; furthermore, *M. moloneyi* is associated with rainforest while *M. thomasi* is a savanna species.

Echolocation call: The echolocation call of this species has not been recorded in southern Africa.

Distribution, habitat and roosting: In southern Africa, *Mimetillus moloneyi* is only known from only two localities in the western DRC. Elsewhere in its range it is typically associated with tropical rainforest and forest edge, and is known to roost in roofs of houses (Rosevear 1965) and presumably under exfoliating bark of trees (Kingdon 1974). The type specimen is from Lagos, Nigeria (BM 91.5.5.2, Holotype).

Extralimital: This species is widely distributed in equatorial Africa. In West Africa it occurs from Sierra Leone and Liberia in the west through Côte d'Ivoire and Ghana to Nigeria and Cameroon. It also occurs widely in East Africa in Ethiopia, Sudan, Uganda, Kenya and Tanzania.

Foraging ecology: No information on diet or foraging available for southern Africa, however, the narrow wings suggest that these bats are fast fliers (Cotterill 2001e).

Reproduction: No reproductive information available for southern Africa. In East Africa, they appear to breed twice a year giving birth during the rains (Kingdon 1974).

SYSTEMATIC NOTES

1891. *Mimetillus moloneyi* Thomas, Ann. Mag. nat. Hist., ser. 6, 7 (42): 528. Lagos, Nigeria.

Mimetillus moloneyi was previously listed as conspecific with *Mimetillus thomasi* (Hayman and Hill 1971). These two taxa, however, appear to represent two distinct evolutionary lineages and *M. thomasi* is now generally accepted as a valid species (Cotterill 2001e) – see the discussion under *M. thomasi. M. moloneyi* represents a forest lineage and *M. thomasi* a savanna one.

The diploid number in *M. moloneyi* is not known.

fig. 262a

fig. 262b

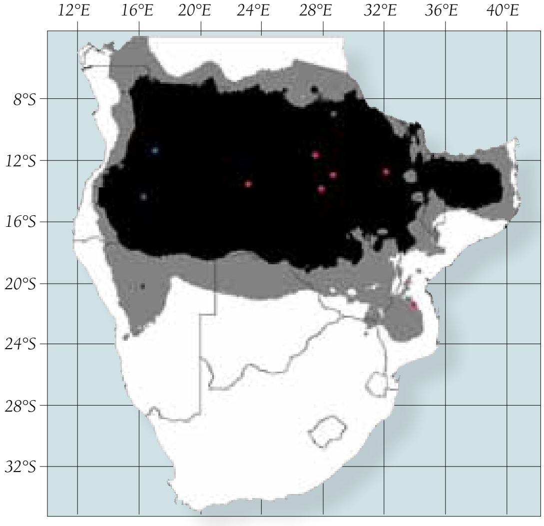
fig. 262c

Figure 262. Skull and teeth of *Mimetillus moloneyi:* (a) dorsal view, (b) ventral view and (c) lateral view. Scale bar = 10 mm (a, b: LACM 28010; c: LACM 36528; © F. P. D. Cotterill).

Mimetillus thomasi Hinton 1920

Thomas's flat-headed bat

Least Concern



Description: *Mimetillus thomasi* is a small bat with an estimated mass of around 10 g. The pelage is short, sleek and dark brown with individual hairs unicoloured. The wing membranes are light brown. The face is plain, without any noseleafs, and has a stout muzzle owing to the broad and flattened skull. There is a wide swollen pad on each upper lip between the nostril and the eye. The ears are small with a characteristic club-like tragus. The wing is short and very narrow, owing to the reduction in the length of the third and fifth digits. The sexes are alike.

The skull of *Mimetillus* is relatively robust for its size with weak zygomatic arches. In lateral profile, it is flattened, with the braincase hardly rising above the level of the rostrum. The rostrum is almost as broad as the braincase. The sagittal crest is very weak or absent, while the lambdoid crest is relatively well developed. The dental formula is 2113/3123 = 32.

External and cranial measurements (mm) for *Mimetillus thomasi*, sexes combined

	Mean	Min	Max	SD	N
Mass	-	-	-	-	-
FA[1]	30.1	27.9	31.4	1.04	8
Total[1]	90.7	85	96	4.08	6
Tail[1]	33.2	31	36	2.14	6
Tibia[1]	10.0	-	-	-	-
Ear[1]	12.3	12	13	0.39	7
CI[1]	14.1	13.7	14.3	0.27	5

[1] Specimens measured by the authors

Key identification features: The combination of a broad, flattened skull, club-shaped tragus, presence of two upper incisors, and the short, narrow wings distinguish *Mimetillus thomasi* from all other southern African bats. *Scotoecus* also has a broad, flattened skull with a club-shaped tragus, but has only a single upper incisor and the wing is not particularly short or narrow (the third digit is shorter than the head and body length in *M. thomasi*, but longer in *Scotoecus*). The lateral position of the mammae, located posteriorly midway along the body, is a useful character to identify females.

Echolocation call: The echolocation call of this species has not been recorded.

Distribution, habitat and roosting: *Mimetillus thomasi* has been sparsely recorded from the northern parts of the region. It is known from Zinave National Park in southern Mozambique, Zambia and adjoining parts of the DRC, and in central Angola. The type specimen is from Ndola, Zambia (BM 1928.11.3.28).

This species is very poorly represented in museums, with just 14 records examined for this book.

The flattened skull and lateral position of the mammae suggest adaptations for crevice roosting in these small bats. A single specimen in Zambia was collected from its day roost in an *Adansonia digitata* tree, but it is unknown whether the bat was roosting in a hollow or a crevice in the tree. In West Africa, *M. moloneyi* roosts in the roofs of thatched huts, and also under the bark of dead trees; three specimens from Liwale, southern Tanzania, were collected from a roost under loose bark on a *Brachystegia* tree. Although the Mozambique specimen was collected in mopane woodland, this species appears to be associated with the moist miombo belt of south-central Africa, but too few specimens have been captured for a quantitative assessment of its habitat (Cotterill 2001e).

Extralimital: *Mimetillus thomasi* is a near-endemic to the region, occurring marginally outside of it in southern Tanzania (Cotterill 2001e).

Foraging ecology: *Mimetillus thomasi* has short, narrow wings with high wing loading (18.0 $N.m^{-2}$) and low aspect ratio (6.7) (Norberg and Rayner 1987). It is a clutter-edge forager. In East Africa, it feeds on small insects such as Isoptera (Kingdon 1974).

Reproduction: No reproductive information is available for southern Africa. In East Africa, *Mimetillus thomasi* appears to breed twice a year, giving birth during the rains (Kingdon 1974).

fig. 263a

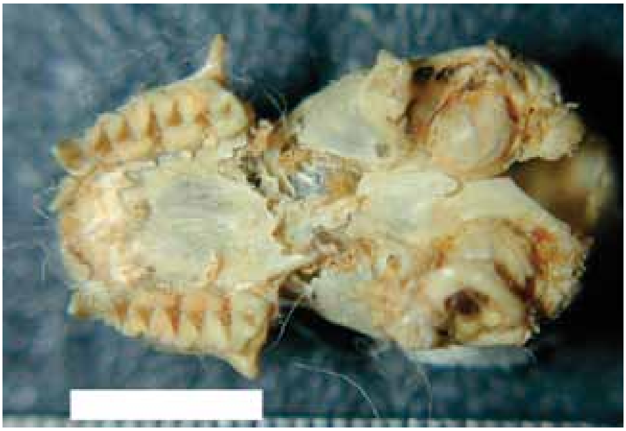


fig. 263b

fig. 263c

Figure 263. Skull and teeth of *Mimetillus thomasi:* (a) dorsal view, (b) ventral view, and (c) lateral view. Scale bar = 5 mm (NMZB 63199; © F. P. D. Cotterill).

Figure 264. *Mimetillus thomasi*, showing broad muzzle (© F. P. D. Cotterill).

SYSTEMATIC NOTES

1920. *Mimetillus thomasi* Hinton, Ann. Mag. Nat. Hist., ser. 9, 6 (32): 240. Ndola, Zambia.

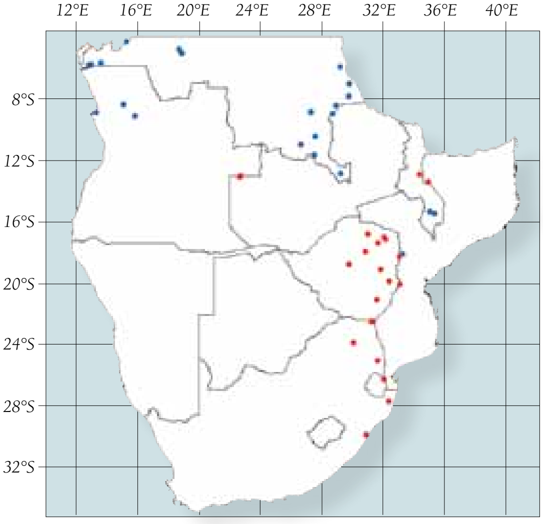
Mimetillus thomasi was previously listed as a subspecies of *Mimetillus moloneyi* (Hayman and Hill 1971). These two taxa, however, appear to represent two distinct evolutionary lineages and *M. thomasi* is now generally accepted as a valid species (Cotterill 2001e) – *M. moloneyi* represents a forest and *M. thomasi* a savanna lineage. The taxon *berneri* Monard 1933, described from Angola, is indistinguishable from *thomasi* and is therefore recognised as its synonym (Cotterill 2001e); it is not a valid subspecies.

The diploid number in *M. thomasi* is not known.

Myotis bocagii (Peters 1870)

Rufous myotis

Least Concern



Description: *Myotis bocagii* is a small bat with a mass of around 8 g and is very similar in appearance to the larger *M. tricolor*. The individual hairs are long and stand away from the body, giving the fur a soft feel. It is coppery to orange above and cream with a rufous wash below. The individual hairs are dark at their base and strikingly coppery-red at their tips. The wings are dark brown, contrasting with the bright body. The face is plain, without any noseleafs. The ears are grey and moderately sized, with a long, narrow tragus. The sexes are alike in size and appearance.

The skull is delicate with weak zygomatic arches. In lateral view, the braincase is obviously inflated and rises well above the rostrum. The sagittal and lambdoid crests are weak or absent. The dental formula is 2133/3133 = 38. The first two upper premolars are small to very small and internal to the toothrow (the first is larger than the second), while the third upper premolar is sharply pointed and rises above the molars.

Key identification features: The soft orangish fur and long, narrow tragus distinguish *Myotis* from other vespertilionids. This genus also has two tiny anterior upper premolars, a feature shared only with *Cistugo*, visible in the live animal with a hand lens. *Myotis tricolor* and *M. welwitschii* are both significantly larger (FA > 47 mm, CI > 16.5 mm) with no overlap in size with *M. bocagii* (FA < 44 mm, CI < 15.5 mm). The closely related genus *Cistugo* has an obvious gland in the wing and does not overlap in distribution with *M. bocagii*. The two species of *Kerivoula* overlap in size with *M. bocagii*, also have soft fur, a long, narrow tragus, and *K. argentata* has an orange-chestnut wash. These two genera, however, are easily distinguished, as *Kerivoula* has longer fur with individual hairs that have curled tips, a fringe of fur on the outer margin of the tail membrane (only true for southern African species), larger anterior premolars, and a highly domed cranium.

Echolocation call: *Myotis bocagii* produces LD-FM echolocation calls with an intermediate peak frequency (44.6±2.4 kHz, n = 5), broad bandwidth (23.6±02.9 kHz, n = 5), and short duration (2.5±0.5 ms, n = 5) (Schoeman and Jacobs 2008).

Distribution, habitat and roosting: *Myotis bocagii* is sparsely distributed in the eastern and far northern parts of the region. It occurs from eastern KwaZulu-Natal, through eastern Swaziland and northeastern South Africa to the eastern half of Zimbabwe. It has also been recorded in southern Malawi and neighbouring northern Mozambique, the extreme northwest of Zambia, southern DRC, and northern Angola. It is probably more widely distributed than shown in the map, and may have been overlooked in much of Mozambique and eastern Zambia, and is probably widespread in northern Angola. The type specimen, collected from Duque de Bragança and depos-

External and cranial measurements (mm) and mass (g) for *Myotis bocagii*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	8.1	6.0	9.0	1.02	7	**Mass**[1]	8.7	7.0	10.5	1.14	9
FA[1]	39.1	37.0	40.1	0.84	12	**FA**[1]	40.4	39.0	42.8	1.28	11
Total[1]	95.2	87	101	4.25	10	**Total**[1]	100.0	88	105	4.71	9
Tail[1]	41.1	33	49	4.14	10	**Tail**[1]	41.9	37	48	3.03	9
Tibia[1]	20.0	-	-	-	1	**Tibia**[1]	20.0	19.6	20.3	-	2
Ear[1]	15.4	13.0	16.5	1.10	10	**Ear**[1]	15.2	14.0	16.0	0.67	9
CI[1]	14.8	14.0	15.1	0.35	10	**CI**[1]	14.8	14.3	15.2	0.30	8

[1] Specimens measured by the authors

fig. 265a

fig. 265b

fig. 265c

fig. 265d

Figure 265. Skull and teeth of *Myotis bocagii:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8559).

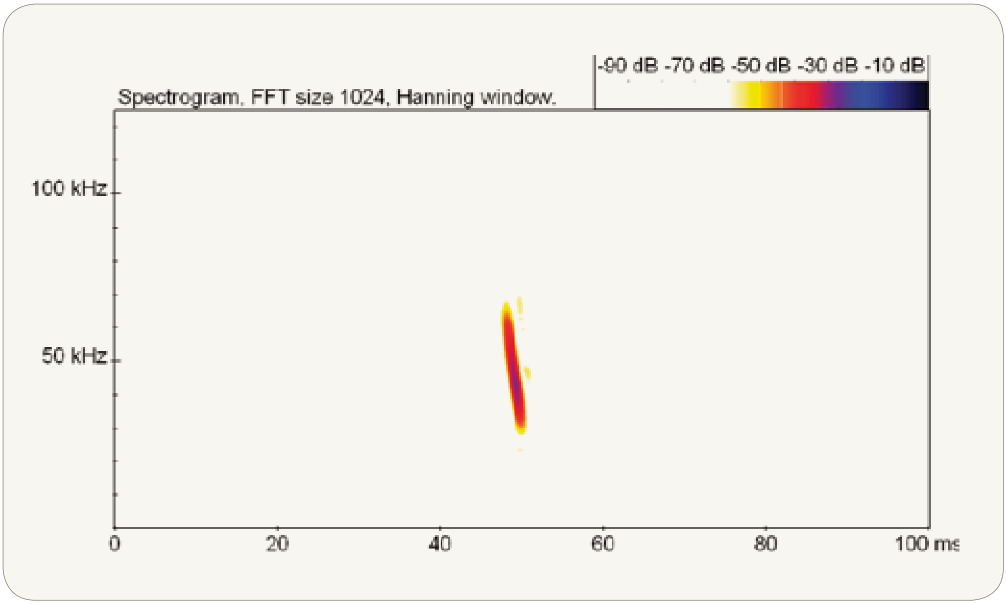


Figure 266. Echolocation call of *Myotis bocagii.*

ited in the Museu Bocage, was lost when the museum was burnt down in 1978, but there is a surviving type specimen (ZMB 3973, Lectotype) (Turni and Kock 2008).

This species is not well represented in museums, with only 60 records examined for this book. This is partly due to its close association with wetlands, where it appears to forage low over open water, making it difficult to capture. It seems to be associated with low-lying wetlands within a savanna or woodland vegetation matrix.

Its roosting habits are not known in southern Africa; however, in West Africa it has been captured in furled banana leaves (Monadjem and Fahr 2007). In northern Mozambique, it has been netted in a banana plantation (A. Monadjem, unpublished data), where it was probably roosting. It is often mentioned in southern African papers (e.g. Happold *et al*. 1987, Skinner and Chimimba 2005) that this species occurs singly or in pairs. However, in Central and West Africa, it lives in harem groups (Brosset 1976, Monadjem and Fahr 2007) and this may be the case in southern Africa.

Extralimital: *Myotis bocagii* is widely distributed in tropical Africa and has been recorded from DRC, Tanzania, Kenya, Uganda, Rwanda, Burundi, Central African Republic, Cameroon, Gabon, Nigeria, Niger, Benin, Togo, Ghana, Côte d'Ivoire, Liberia and Sierra Leone.

Foraging ecology: *Myotis bocagii* has broad wings with low wing loading (6.4 N.m^{-2}) and low aspect ratio (6.5) (Aldridge and Rautenbach 1987, Norberg and Rayner 1987; also see Schoeman and Jacobs 2008). It is a clutter-edge and clutter forager. It feeds mainly on Coleoptera, Hemiptera, Diptera and Lepidoptera (M. C. Schoeman, unpublished data; also see Whitaker and Mumford 1978).

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1870. *Vespertilio bocagii* Peters, J. Sci. mat. Phys. Nat., Lisboa, ser. 1, 3(10): 125. Duque de Bragança, northern Angola.

The nominate subspecies occurs in southern Africa, while *M. b. cupreolus* Thomas 1904 occurs in West Africa.

The diploid number in *M. bocagii* is 2n = 44 and aFN = 50 (Rautenbach *et al.* 1993).

Figure 267. *Myotis bocagii,* showing long, narrow tragus and long fur washed orange (a: © E. C. J. Seamark; b: DM 8557, © A. Monadjem; c: © F. P. D. Cotterill).

fig. 267a

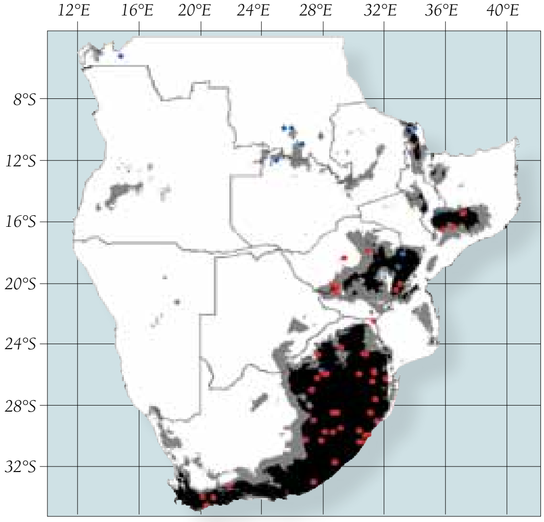
fig. 267b

fig. 267c

Myotis tricolor (Temminck 1832)

Temmink's myotis

Least Concern



Description: *Myotis tricolor* is a small bat with a mass of around 12 g. The individual hairs are long and stand away from the body, giving the fur a soft feel. It is coppery to orange above and slightly paler below. The individual hairs are dark at their base and coppery-red at their tips. The wings are dark brown and contrast with the bright body. The face is plain, without any noseleafs. The ears are brown and moderately sized, with a long, narrow tragus. The sexes are alike, although the females are slightly larger than the males.

The skull is delicate with weak zygomatic arches. In lateral view, the braincase is obviously inflated and rises well above the rostrum, forming almost a right angle at the forehead. The sagittal and lambdoid crests are weak or absent. The dental formula is 2133/3133 = 38. The first two upper premolars are small to very small and internal to the toothrow (the first is larger than the second), while the third upper premolar is sharply pointed and rises above the molars.

Key identification features: The soft orangish fur and long, narrow tragus distinguish *Myotis* from other vespertilionids. This genus also has two tiny anterior upper premolars, a feature shared only with *Cistugo*, visible in the live animal with a hand lens. *Myotis bocagii* is smaller (FA < 44 mm, CI < 15.5 mm; in *M. tricolor* FA > 47 mm, CI > 16.5 mm), while *M. welwitschii* is larger (FA > 52 mm, CI > 18.0 mm), with little overlap in size between these two species. Furthermore, *M. welwitschii* has a distinctive wing pattern of coppery-orange and black markings (the wing is more or less uniformly dark grey-brown in *M. tricolor*). The closely related genus *Cistugo* has an obvious gland in the wing and is far smaller (FA < 40 mm).

Echolocation call: *Myotis tricolor* produces LD-FM echolocation calls with an intermediate peak frequency (47.8±3.1 kHz, n = 10), broad bandwidth (46±23.9 kHz, n = 10), and short duration (3.3±0.6 ms, n = 10) (Schoeman and Jacobs 2008; also see Taylor 1999a, Schoeman and Jacobs 2003, Stoffberg and Jacobs 2004).

Distribution, habitat and roosting: *Myotis tricolor* is widely distributed over the eastern part of the interior of the region. It occurs from Cape Town in the southwest of South Africa, east along the coast to the Eastern Cape (Herselman and Norton 1985), then north through Lesotho and the Free State (Watson 1990) to northern South Africa and east to western KwaZulu-Natal and Swaziland. It has also been recorded from mostly mountainous areas in southwestern and eastern Zimbabwe, central Mozambique, northern Zambia, southern DRC and Malawi. The whereabouts of the type specimen, from Cape Town, South Africa, is unknown.

This species is relatively well represented in museums, with over 80 specimens examined for this book.

Myotis tricolor roosts gregariously in caves. It switches between winter hibernacula and summer maternity caves, where it may congregate in groups of up to 1,500 individuals (McDonald *et al.* 1990a, Taylor 1998). It is restricted to

External and cranial measurements (mm) and mass (g) for *Myotis tricolor*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	11.8	8.0	14.0	2.08	7	**Mass**[1]	13.4	10.0	20.0	1.98	22
FA[1]	49.6	47.0	52.0	1.49	14	**FA**[1]	50.4	47.0	55.0	1.77	35
Total[1]	104.0	95	111	6.18	10	**Total**[1]	106.0	96	121	5.55	34
Tail[1]	44.0	35	50	3.90	10	**Tail**[1]	46.0	39	55	4.20	34
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	16.1	15	19	1.29	10	**Ear**[1]	16.7	14	20	1.75	28
CI[1]	17.5	16.6	18.1	0.48	11	**CI**[1]	17.7	16.9	18.5	0.40	21

[1] Specimens measured by the authors

fig. 268a

fig. 268b

fig. 268c

fig. 268d

Figure 268. Skull and teeth of *Myotis tricolor:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8552).

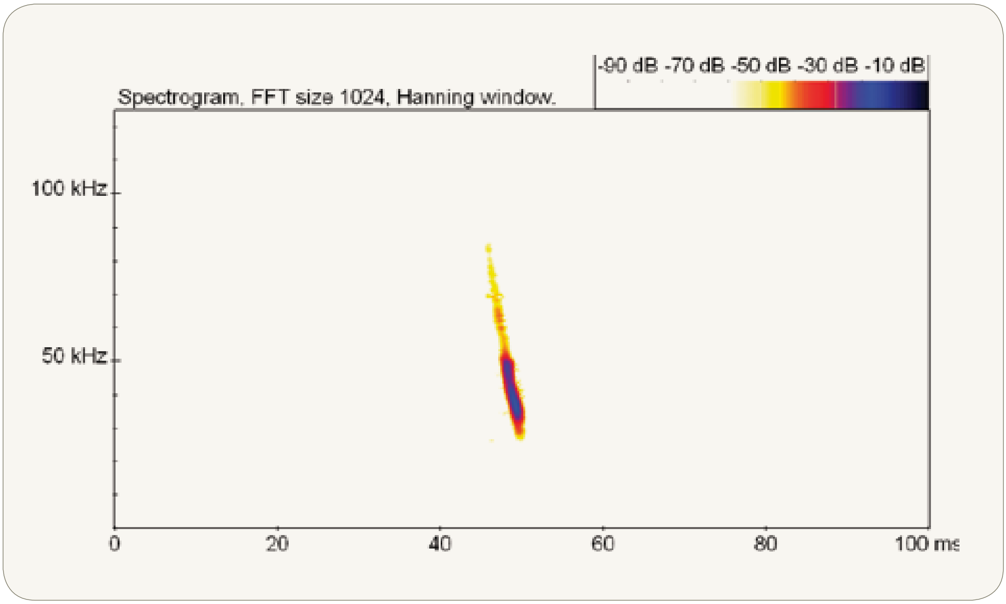


Figure 269. Echolocation call of *Myotis tricolor.*

fig. 270a

areas with suitable caves, which may explain its absence from flat and featureless terrain; its close association with mountainous areas may therefore be due to its roosting requirements.

Extralimital: *Myotis tricolor* is sparsely distributed in East Africa, and has been recorded from DRC, Kenya, Uganda and Ethiopia.

Foraging ecology: *Myotis tricolor* has relatively broad wings with intermediate wing loading (8.2 $N.m^{-2}$) and low aspect ratio (6.2) (Norberg and Rayner 1987; also see Schoeman and Jacobs 2008), and is restricted to capturing aerial prey (Stoffberg and Jacobs 2004). It is a clutter-edge forager. Its diet includes Coleoptera, Hemiptera, Diptera, Neuroptera and Hymenoptera (Schoeman and Jacobs 2003, Schoeman 2006).

Reproduction: In KwaZulu-Natal, copulation occurred in April, followed by a period of sperm storage by the female until fertilisation in September and parturition in November–December. The lactation period is about six weeks (Bernard 1982b). Females congregate at maternity roosts, where each one gives birth to a single young.

SYSTEMATIC NOTES

1832. *Vespertilio tricolor* Temminck, in Smuts, Enumer. Mamm. Capensium: 106. Cape Town, South Africa.

Eptesicus lovenii Granvik 1924 is a synonym.

The diploid number in *M. tricolor* is 2n = 44 and aFN = 50 (Rautenbach *et al.* 1993).

fig. 270b

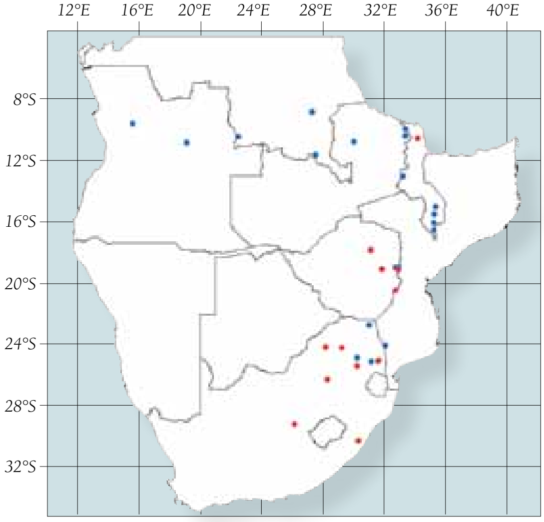
Figure 270. *Myotis tricolor:* (a) portrait showing long, narrow tragus, and (b) and (c) whole body showing long fur washed with orange (a, c: © F. P. D. Cotterill; b: © E. C. J. Seamark).

fig. 270c

Myotis welwitschii (Gray 1866)

Welwitsch's myotis

Least Concern



Description: *Myotis welwitschii* is a small to medium-sized bat with a mass of around 15 g. The individual hairs are long and stand away from the body, giving the fur a soft feel. It is coppery to orange above and paler below. The individual hairs are dark at their base and coppery-red at their tips. The wings are strikingly marked with copper and black tones and contrast with the bright body. The colour of the wing membranes is generally black with copper along the finger bones and along the sides of the body. Where the membranes are copper-coloured, they are dotted with black spots and blotches. The face is plain, without any noseleafs, but has a series of black dots on the muzzle. The ears are orange-brown and moderately sized, with a long, narrow tragus. The sexes are alike.

The skull is moderately robust with fairly moderate zygomatic arches. In lateral view, the braincase is obviously inflated and rises well above the rostrum. The sagittal and lambdoid crests are weak, but clearly visible. The dental formula is 2133/3133 = 38. The first two upper premolars are small to minute and in the toothrow (with the first larger than the second), while the third upper premolar is sharply pointed and rises above the molars.

External and cranial measurements (mm) and mass (g) for *Myotis welwitschii*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	17.2	-	-	-	1
FA[1]	56.0	52.0	59.3	2.17	9
Total[1]	116.0	105	127	7.43	7
Tail[1]	56.0	45	62	5.90	7
Tibia[1]	25.5	-	-	-	1
Ear[1]	20.0	15	23	3.00	6
CI[1]	18.9	18.1	19.4	0.50	5

[1] Specimens measured by the authors

Key identification features: The soft orangish fur and long, narrow tragus distinguish *Myotis* from other vespertilionids. This genus also has two tiny anterior upper premolars, a feature shared only with *Cistugo*, visible in the live animal with a hand lens. *Myotis bocagii* is much smaller (FA < 44 mm, CI < 15.5 mm; in *M. welwitschii* FA > 52 mm, CI > 18.0 mm). There is a little overlap in size with the smaller *M. tricolor* (FA < 55 mm, CI < 18.5 mm), but the latter species has wing membranes that are more or less uniformly dark grey-brown. The closely related genus *Cistugo* has an obvious gland in the wing and is far smaller (FA < 40 mm).

Echolocation call: *Myotis welwitschii* produces LD-FM echolocation calls with an intermediate peak frequency (34 kHz, n = 1), broad bandwidth (19.4 kHz, n = 1), and short duration (2.4 ms, n = 1) (Schoeman and Jacobs 2008).

Distribution, habitat and roosting: *Myotis welwitschii* is sparsely distributed over the eastern and far northern parts of the region. There are two records from KwaZulu-Natal and the Free State, with a number of scattered records in northern South Africa, eastern Zimbabwe, Malawi, central Mozambique, northeastern Zambia, southern DRC and northern Angola (Fahr and Ebigbo 2003). The type specimen is from Angola (BM 66.4.12.2).

Myotis welwitschii is poorly represented in museums, with just 30 records examined for this book.

Its roosting habitats are poorly known; it has been collected from furled banana leaves (Smithers and Wilson 1979), hanging in bushes (Rautenbach 1982), and a single individual from Makapan's Cave in northern South Africa. This species appears to be tied to mountains ('paramontane') in areas covered by woodland or woodland-forest mosaic vegetation (Fahr and Ebigbo 2003).

Extralimital: *Myotis welwitschii* is sparsely distributed in East Africa and has been recorded from DRC, Tanzania, Kenya, Uganda, Rwanda, Burundi, Sudan and Ethiopia, with a recently discovered isolated population in Guinea, West Africa (Fahr and Ebigbo 2003).

Foraging ecology: *Myotis welwitschii* has broad wings with intermediate wing loading (7.5 $N.m^{-2}$) and low aspect ratio (5.7) (Schoeman and Jacobs 2008). It is a clutter-edge forager. Based on limited observations in Mpumalanga, its diet comprises aerial prey such as Coleoptera and Hemiptera (M. C. Schoeman, unpublished data).

Reproduction: No reproductive information is available.

fig. 271a

fig. 271b

fig. 271c

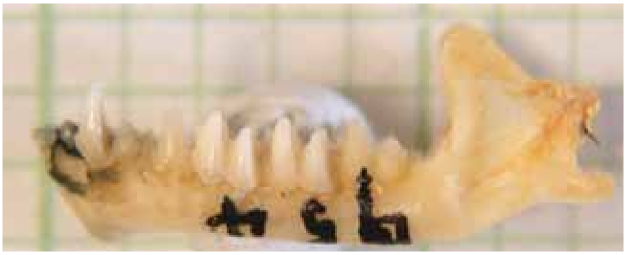


fig. 271d

Figure 271. Skull and teeth of of *Myotis welwitschii*: (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 954).

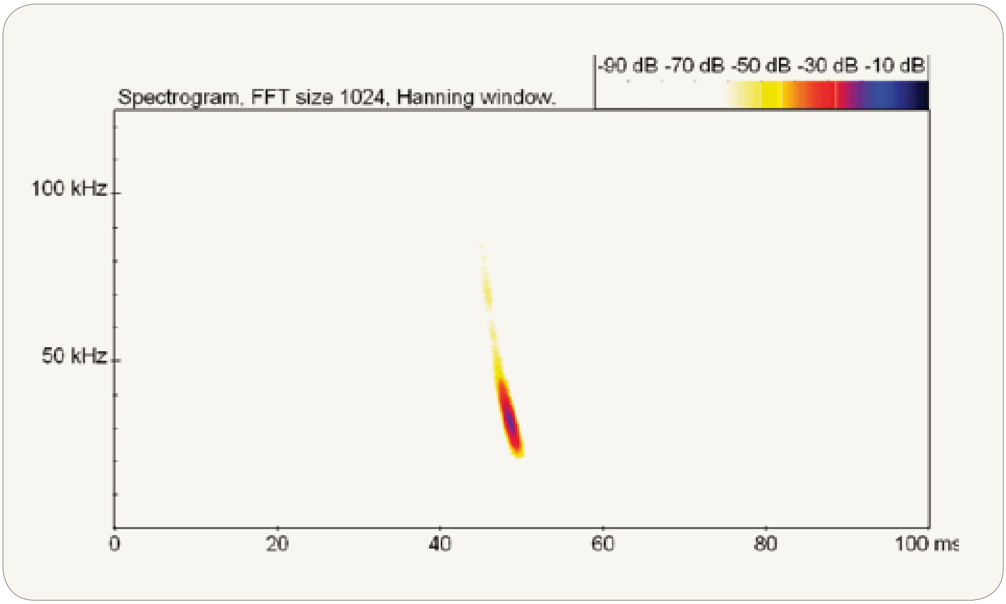


Figure 272. Echolocation call of *Myotis welwitschii.*

SYSTEMATIC NOTES

1866. *Scotophilus welwitschii* Gray, Proc. Zool. Soc. Lond. 211. Angola.

Vespertilio venustus Matschie 1899 (ZMB 54653, Holotype, from Kinole, Ukami Mountains, Tanzania) is a synonym.

The diploid number in *M. welwitschii* is 2n = 44 and aFN = 50 (Rautenbach *et al.* 1993).

fig. 273a

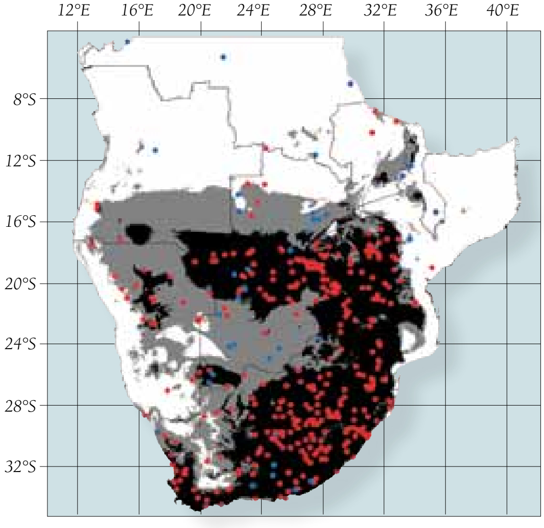
fig. 273b

Figure 273. *Myotis welwitschii*: (a) portrait showing long, narrow tragus and black spots on muzzle, and (b) dorsal view showing distinctive wing pattern (TM 47968, © E. C. J. Seamark).

Neoromicia capensis (A. Smith 1829)

Cape serotine

Least Concern



Description: *Neoromicia capensis* is a small bat with a mass of about 7 g. The pelage varies considerably from pale to dark brown above and paler grey-brown or off-white below. The hairs are bicoloured, with a dark base and paler tip. The wings are dark brown to black. The face is plain, without any nose-leafs. The ears are dark brown and rounded, with a short, broad tragus. Females are larger than males in certain cranial and external measurements (Kearney 2005). The measurements presented in the table below are taken from a large sample and hence the maximum and minimum figures are, unexpectedly, extreme. For example, only 7 individuals (out of 208) had forearm lengths < 30 mm with only two < 29 mm (and all 7 individuals may have been subadults).

The skull has thin zygomatic arches and a broad rostrum. In lateral view, the forehead is flat, sloping upwards gradually to the braincase and occiput, but with a distinct dome or 'helmet' formed by the occipital and parietal bones. The palate is noticeably broad and conspicuously indented. The sagittal crest is poorly developed or absent and the lambdoid crest is weakly developed. The mastoid processes are visible in dorsal view as distinct projections. The dental formula is 2113/3123 = 32. The posterior upper incisor is less than half that of the anterior. The anterior upper premolar is absent.

Key identification features: *Neoromicia capensis* cannot be identified with certainty in the field, as its distinguishing features are dental, cranial and bacular. The absence of a tiny upper premolar separates it from *Pipistrellus* and *Hypsugo*, but this feature is not easy to inspect in a live animal. It is separated from *N. zuluensis* by the presence of an occipital 'helmet', which is clearly visible in the skull of adults, but may not be fully developed in juveniles and subadults (T. Kearney, personal communication).

Echolocation call: *Neoromicia capensis* produces LD-FM echolocation calls with an intermediate peak frequency (39.4±1.6 kHz, n = 10), narrow bandwidth (14.4±3 kHz, n = 10), and intermediate duration (5.1±1.3 ms, n = 10) (Schoeman and Jacobs 2008; also see Fenton and Bell 1981, Aldridge and Rautenbach 1987, Fenton *et al.* 1998a, Taylor 1999a Schoeman and Jacobs 2003, Taylor *et al.* 2005). Besides the fundamental, the second harmonic may be present on the spectrogram.

Distribution, habitat and roosting: *Neoromicia capensis* may have the most widespread distribution of any southern African bat occurring throughout the region. Its absence in central and western Angola and much of the southern DRC likely reflects under-sampling, but it appears to be genuinely absent or rare over much of Mozambique (A. Monadjem, unpublished data). The type specimen is from Grahamstown, South Africa (BM 1848.8.16.21, Lectotype).

External and cranial measurements (mm) and mass (g) for *Neoromicia capensis,* males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	6.5	3.6	9.2	1.11	80	**Mass**[1]	7.4	3.4	10.1	1.42	86
FA[1]	32.8	28.0	38.0	1.95	115	**FA**[1]	34.5	26.0	39.0	2.17	93
Total[1]	81.9	60	96	6.58	124	**Total**[1]	87.2	62	107	7.06	91
Tail[1]	31.3	18	40	4.42	126	**Tail**[1]	33.8	21	48	4.18	92
Tibia[1]	13.4	-	-	-	1	**Tibia**[1]	-	-	-	-	-
Ear[1]	11.5	7	14	1.59	125	**Ear**[1]	11.7	7	15	1.50	92
CI[1]	13.6	11.7	14.8	0.55	82	**CI**[1]	13.9	12.7	15.5	0.52	56

[1] Specimens measured by the authors

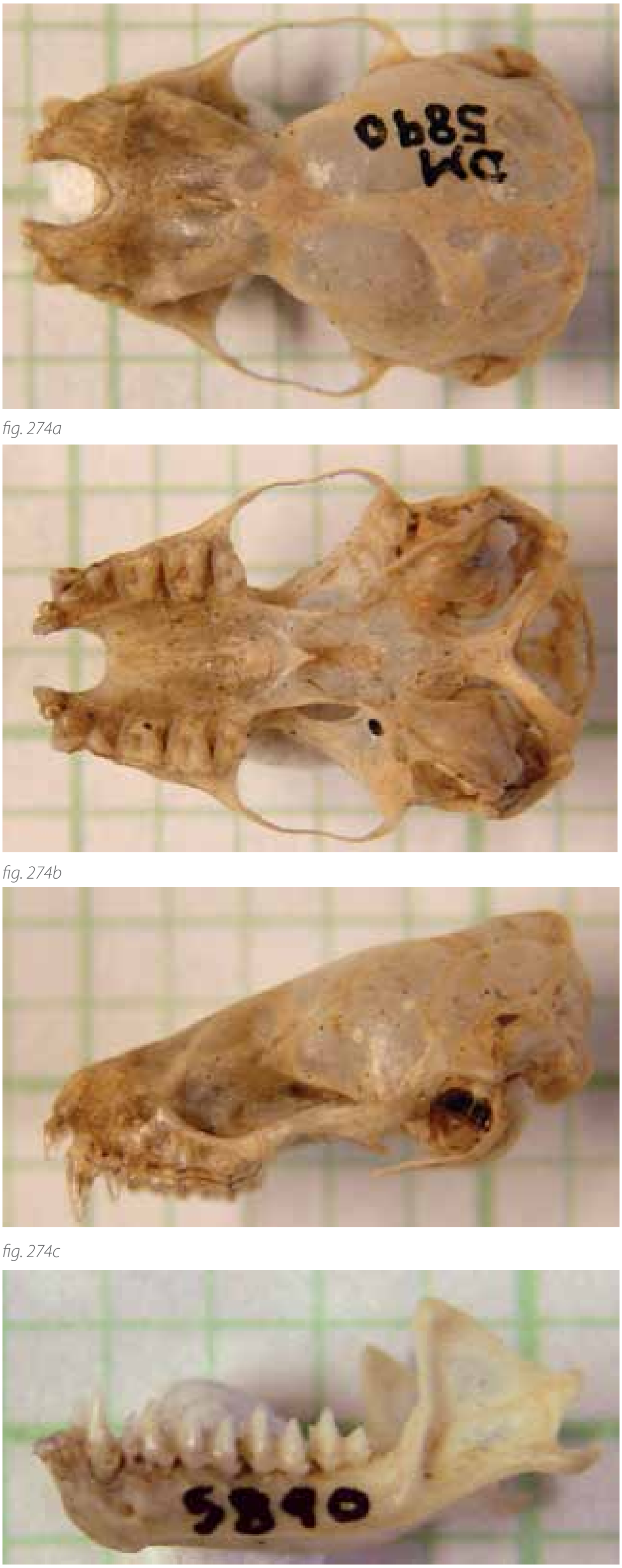


fig. 274a

fig. 274b

fig. 274c

fig. 274d

Figure 274. Skull and teeth of *Neoromicia capensis:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 5890).

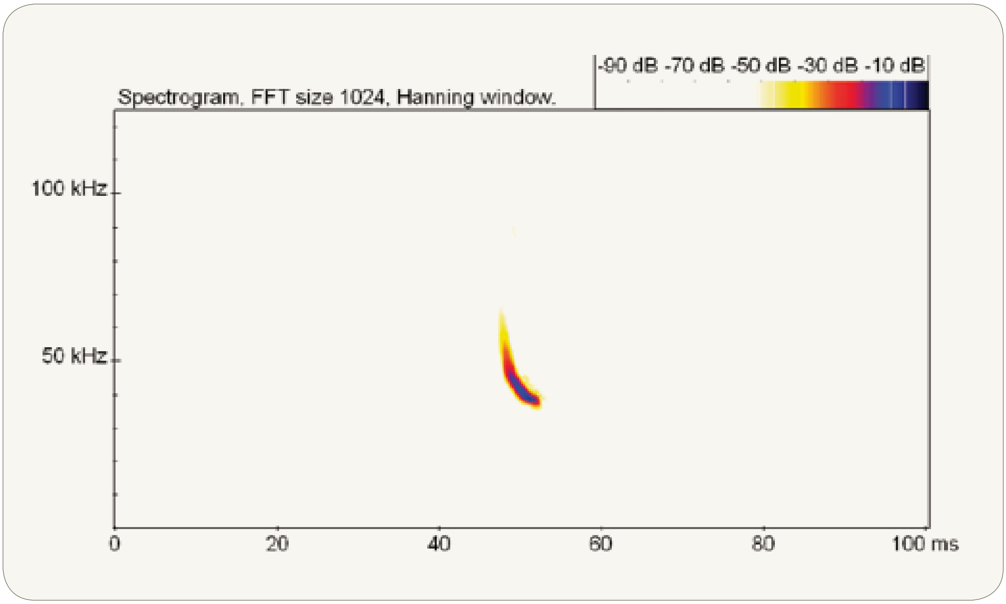


Figure 275. Echolocation call of *Neoromicia capensis*.

This species is very well represented in museums, with over 800 specimens examined for this book.

It roosts singly or in small groups of two or three individuals under the bark of trees (Smithers 1971, Jacobsen 1977), at the base of aloe leaves (Roberts 1951), and under the roofs of houses (Lynch 1983, Monadjem 1998a). In Zimbabwe, large colonies (at least 100 individuals) have been found roosting in houses, above the ceiling over a veranda at Esigodini (F. P. D. Cotterill, unpublished data). It appears to tolerate a wide range of environmental conditions from arid semi-desert areas to montane grasslands (up to 1,600 m above sea level), forests, and savannas (Smithers 1971, Taylor 1998). However, it appears to be less abundant in low-lying, hot savannas in the far east of the region.

Extralimital: *Neoromicia capensis* is widespread and abundant throughout sub-Saharan Africa, occurring from Guinea in the west (Barnett and Prangley 1997) to Ethiopia and Somalia in the east, and south to southern Africa.

Foraging ecology: *Neoromicia capensis* has relatively short and broad wings with intermediate wing loading (7.1 N.m^{-2}) and low aspect ratio (6.4) (Aldridge and Rautenbach 1987, Norberg and Rayner 1987, Schoeman and Jacobs 2003, 2008). It is a clutter-edge forager. Its diet may vary seasonally and geographically, and comprises aerial prey such as Coleoptera, Hemiptera, Diptera, Lepidoptera and Neuroptera (Fenton *et al*. 1977, Fenton and Thomas 1980, Aldridge and Rautenbach 1987, Fenton *et al*. 1998b, Schoeman 2006, Schoeman and Jacobs 2003).

Reproduction: *Neoromicia capensis* females have a single oestrus period and birth period; young are born during the warm, wet summer months. In Limpopo, South Africa, sperm production occurs from December until April and spermatozoa are released into the cauda epididymis from March. Mating takes place from the end of March until the beginning of April. Spermatozoa are stored in the uterine horns of the female from April until August, when ovulation and fertilisation occurs. They give birth to twins during late October and November (van der Merwe 1994a). Although twins are common, singletons, triplets and even quadruplets have been recorded (Lynch 1989, van der Merwe 1990, 1994a). In Zimbabwe, females give birth at the beginning of the hot-wet season (November–December). Reproductively active males secrete a white fluid from the facial glands (F. P. D. Cotterill, unpublished data).

Figure 276. Neoromicia capensis, showing plain face (SMG 15768, © E. C. J. Seamark).

SYSTEMATIC NOTES

1829. *Vespertilio capensis* A. Smith, Zool. Journ., 4: 435. Grahamstown, South Africa.

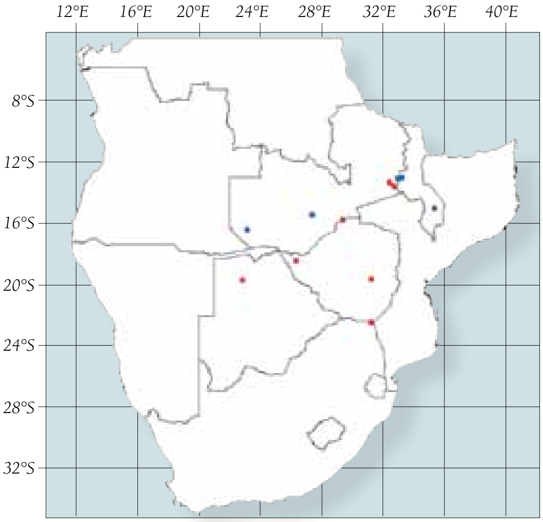
Vesperus damarensis (Noack 1889), *Eptesicus garambae* J. A. Allen 1917, *Vesperus gracilior* Thomas and Schwann 1905, *Eptesicus capensis nkatiensis* Roberts 1932 and *Scabrifer notius* G. M. Allen 1908 are synonyms. Given that *N. capensis* is one of the most common bats in the region, and has changed genus, it is important to clarify its convoluted taxonomic history. It was formerly classified as *Eptesicus capensis,* but Hill and Harrison (1987) revealed its generic distinctiveness and reclassified it as *Neoromicia capensis,* alongside *N. somalicus, N. tenuipinnis* and *N. zuluensis. Neoromicia guineensis* (Bocage, 1889) is specifically distinct, but the southern limit to its range in the Congo basin is uncertain (Simmons 2005). Petersen *et al.* (1995) and Bates *et al.* (2006) regard *N. matroka* from Madagascar as a distinct species. Although now recognised as subgenerically distinct, *Pipistrellus (Afropipistrellus) grandidieri* (Dobson 1876), was previously treated as a synonym or subspecies of *N. capensis. Neoromicia capensis* is a highly variable species in both morphology and ecology, and may turn out to comprise more than one species.

The diploid number in *N. capensis* is 2n = 32 and aFN = 50 (Rautenbach *et al.* 1993, Kearney *et al.* 2002).

*Neoromicia cf. melckorum**

Kruger serotine

Data Deficient



Description: This is an undescribed species that closely resembles *N. capensis*, but differs from it by being somewhat larger with a different karyotype (see 'Systematic notes'). It has a mass of about 9–10 g.

The skull is similar in shape to that of *N. capensis*, only slightly larger-sized. The dental formula is 2113/3123 = 32. The posterior upper incisor is less than half that of the anterior. The anterior upper premolar is absent.

Key identification features: *Neoromicia cf. melckorum* can be differentiated from most other species of *Neoromicia* by its larger size (FA > 34 mm, CI > 14.1 mm) and unique karyotype. *Neoromicia rendalli* is similar in size, but has white wings. *Neoromicia capensis* is also similar in size, and may possibly only be distinguished with certainty on karyotype (Kearney *et al*. 2002).

Echolocation call: The echolocation call of this species has not been recorded.

Distribution, habitat and roosting: *Neoromicia cf. melckorum* appears to be widely but sparsely distributed in the northern parts of the region. There is no information on habitat requirements or roost site selection in this species.

Extralimital: The distribution of *Neoromicia cf. melckorum* beyond southern Africa is not known.

Foraging ecology: The diet of this species consists of Coleoptera, Hemiptera, Diptera, and Lepidoptera (Aldridge and Rautenbach 1987, Fenton *et al*. 1998b).

Reproduction: No reproductive information is available.

SYSTEMATIC NOTES

This species awaits formal description. It differs from the closely related *N. capensis* by karyotype and its larger size (Kearney 2005). This species should not be confused with reported individuals of *N. melckorum* (from the southwestern parts of South Africa; type locality Kersefontein Farm on the Berg River) which has been shown to be conspecific with *N. capensis* (Kearney 2005). Angolan records were referable to *N. flavescens,* but this is a confused taxon and a *nomen dubium*, and the Angolan records were shown instead to belong to the valid taxon *Pipistrellus (Afropipistrellus) grandidieri* (Thorn *et al.* 2007). Furthermore, the relationship of *N. cf. melckorum* to *N. grandidieri* (Thorn *et al.* 2007) is also unknown and needs to be investigated.

The diploid number in *N. cf. melckorum* is 2n = 40 and aFN = 50 (Rautenbach *et al.* 1993).

External and cranial measurements (mm) and mass (g) for *Neoromicia cf. melckorum,* males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	9	-	-	-	1	**Mass[1]**	-	-	-	-	-
FA[2]	35.1	33.7	36.3	0.95	7	**FA[2]**	37.2	36.1	38.7	0.84	8
Total	-	-	-	-	-	**Total**	99.0	96.0	101.0	2.65	3
Tail[2]	34.6	29.7	37.5	3.09	7	**Tail[2]**	34.9	32.5	37.0	2.11	5
Tibia[2]	12.6	12.2	13.3	0.39	7	**Tibia[2]**	12.9	12.5	13.5	0.44	5
Ear	-	-	-	-	-	**Ear**	11.0	10.0	12.0	1.00	3
CI[2]	14.5	14.2	14.8	0.22	8	**CI[2]**	14.7	14.3	15.0	0.28	9

[1] Specimens measured by the authors

[2] Kearney (2005)

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* Pending formal taxonomic description

fig. 277a

fig. 277b

fig. 277c

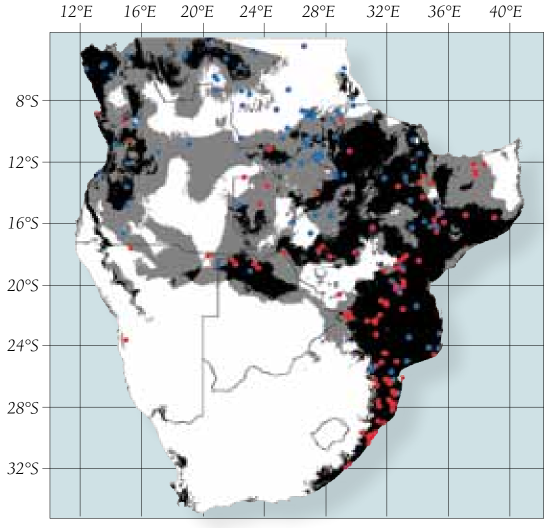
fig. 277d

Figure 277. Skull and teeth of *Neoromicia cf. melckorum:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (TM 37924).

Neoromicia nana (Peters 1852) ●

Banana bat

Least Concern



Description: *Neoromicia nana* is a very small bat with a mass of just 4 g. The pelage varies considerably from light to dark brown or reddish-brown above and paler buffy-brown to grey-brown below. The hairs are bicoloured, with a dark base and paler tip. The wings are dark brown to black. The face is plain, without any noseleafs. The ears are dark brown and triangular, with a short, broad tragus. At the base of each thumb, there is a well-developed callous that is swollen and resembles a suction pad. The soles of the feet are similarly calloused and swollen. These two features allow the bats to cling to smooth leaf surfaces. The sexes are alike, although females are significantly larger than males in two cranial measurements (Kearney 2005).

The braincase is distinctly elevated above the level of the rostrum with a very concave forehead; this character is noticeably more pronounced than in other species of *Neoromicia*, *Hypsugo* and *Pipistrellus*. The palate is longer than broad and not as widely emarginated as in *P. rusticus*. The sagittal crest is poorly developed or absent, and replaced dorsally by a smooth occipital bulge. The lambdoid crests are weakly developed. The dental formula is 2123/3123 = 34. The posterior upper incisor is almost as long as the anterior and shallowly bifid in shape. The small anterior upper premolar is typically pointed.

Key identification features: *Neoromicia nana* can be distinguished from all other southern African pipistrelles (*Pipistrellus*, *Neoromicia* and *Hypsugo*) by the presence of swollen thumb pads.

Echolocation call: *Neoromicia nana* produces LD-FM echolocation calls with a high peak frequency (69.4±1.5 kHz, n = 10), narrow to broad bandwidth (17.8±5.7 kHz, n = 10), and intermediate duration (4.6±0.9 ms, n = 10) (Schoeman and Jacobs 2008; also see Fenton and Bell 1981, Fenton *et al.* 1998a, Aldridge and Rautenbach 1987, Taylor 1999a, Taylor *et al.* 2005).

Distribution, habitat and roosting: *Neoromicia nana* occurs widely in the well-watered eastern and northern parts of the region, but is absent from the arid southwest. It has been recorded from Port St Johns in the Eastern Cape, north through KwaZulu-Natal, Swaziland, southern Mozambique and northern South Africa to Zimbabwe, Zambia, northern Botswana, northeast Namibia, southern DRC, Malawi and central and northern Mozambique. It is also known from western and central Angola. The type specimen is from Inhambane, Mozambique (BM 1907.1.1.421, Syntype).

This species is very well represented in museums, with over 500 specimens examined for this book.

Its roosting habits have been studied in detail in Malawi (Happold and Happold 1990b, 1996) and South Africa (LaVal and LaVal 1977, van der Merwe and Stirnemann 2009). This

External and cranial measurements (mm) and mass (g) for *Neoromicia nana*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass¹	3.3	2.4	4.2	0.38	29	**Mass¹**	4.0	2.9	6.5	1.06	21
FA¹	29.8	26.0	34.1	1.72	51	**FA¹**	31.1	27.2	34.0	1.67	46
Total¹	74.5	61	80	4.26	30	**Total¹**	78.8	71	94	5.25	27
Tail¹	32.2	23	37	3.78	30	**Tail¹**	33.9	29	39	2.85	28
Tibia¹	11.5	10.1	13.3	1.38	9	**Tibia¹**	11.6	10.5	12.9	0.93	9
Ear¹	9.7	7.0	12.0	1.37	30	**Ear¹**	9.5	6.9	12.0	1.24	28
CI¹	10.8	10.4	11.3	0.29	10	**CI¹**	11.0	10.3	11.6	0.43	8

[1] Specimens measured by the authors

fig. 278a

fig. 278e

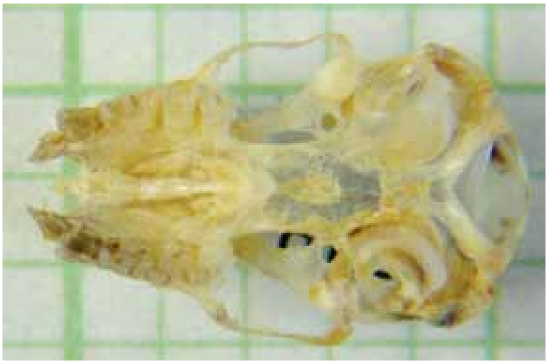


fig. 278b

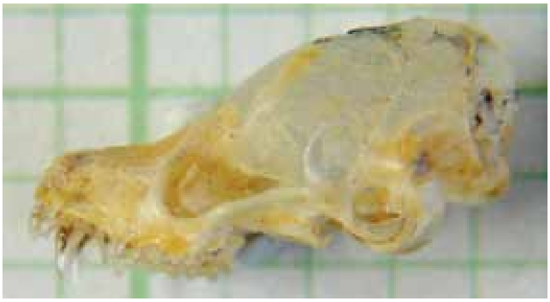


fig. 278c

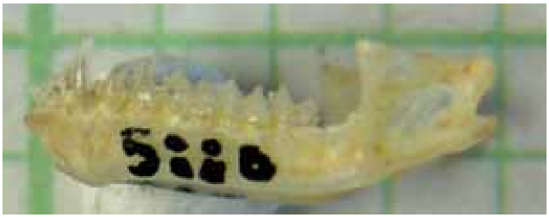


fig. 278d

Figure 278. Skull and teeth of *Neoromicia nana:* (a) dorsal view, (b) ventral view, (c) lateral view (d) lateral view of mandible, (e) toothrow showing shallowly bifid posterior incisor which is subequal to the anterior incisor (a–d: DM 5880; e: DM 8795).

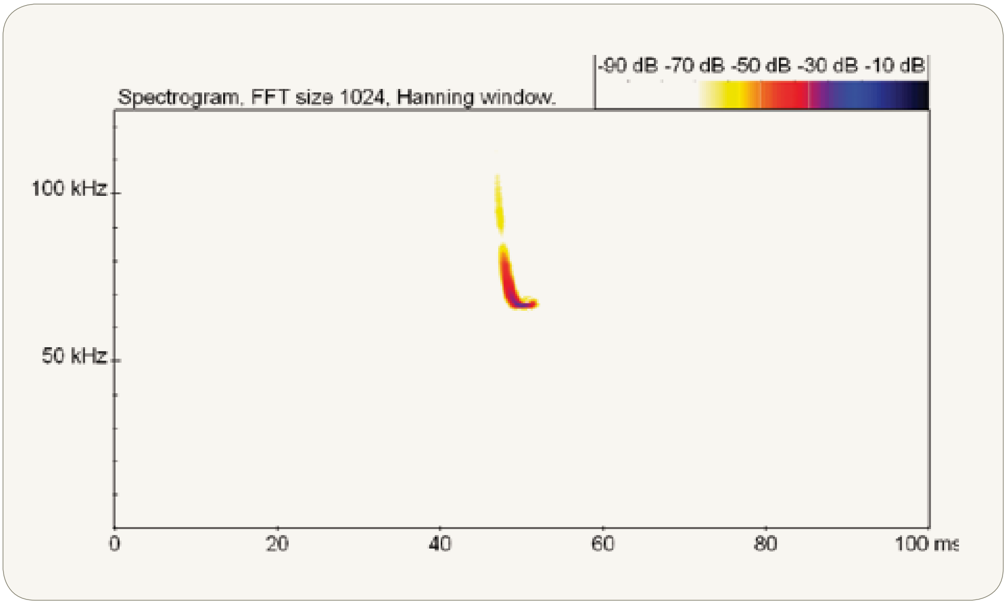


Figure 279. Echolocation call of *Neoromicia nana*.

species typically roosts in furled banana leaves, hence its common name. Males roost singly, except during the mating season when they form harem groups. Lactating females roost with their offspring or in maternity groups. It is not, however, restricted to banana leaves, and may roost in the leaves of other plants, as well as in roofs, in particular those constructed of thatch or palm leaves (Rosevear 1965, Monadjem and Fahr 2007). It appears to be associated with well-wooded habitats such as riparian vegetation and forest patches, especially in the proximity of water (Monadjem and Reside 2008). The single central Namib record is from the Kuiseb River, Gobabeb.

Extralimital: *Neoromicia nana* is widespread and abundant throughout sub-Saharan Africa, occurring from Senegal in the west to Ethiopia and Somalia in the east and south to southern Africa.

Foraging ecology: *Neoromicia nana* has relatively short and broad wings with low wing loading (4.9 $N.m^{-2}$) and intermediate aspect ratio (7.3) (Schoeman and Jacobs 2008; also see Aldridge and Rautenbach 1987). It is a clutter-edge forager. Its diet comprises mostly of small Coleoptera and Lepidoptera, but may also include Diptera (Fenton *et al*. 1977, Fenton and Thomas 1980, Schoeman 2006).

Reproduction: In southern Africa, *Neoromicia nana* females have a single oestrus and birth period, with births taking place at the beginning of the wet season (LaVal and LaVal 1977, Happold and Happold 1990a, 1996, Bernard *et al*. 1997, van der Merwe and Stirnemann 2007). In KwaZulu-Natal, mating occurs in May, followed by sperm storage by the females until mid-August, ovulation and fertilisation in September and birth in November and early December (LaVal and LaVal 1977). Most births involve twins (Shortridge 1934, LaVal and LaVal 1977, Smither and Wilson 1979, Happold and Happold 1990a, Bernard *et al*. 1997). In Malawi, sperm production occurs between February and September, during which time the testes of all males become scrotal. Spermatozoa are released into the cauda epididymis at the beginning of the cool-dry season (May) (Bernard *et al*. 1997). Thereafter, they begin to live with one or more adult females (Happold and Happold 1990b). Mating begins in mid-June and all females have mated by early July. Spermatozoa are stored by the females until ovulation and fertilisation takes place in late August to early September. Sperm competition may occur in this species; during the period of sperm storage by the females when females roost with several different males, more than one male may mate with each female and therefore the twins may have different fathers. Lactation lasts for about eight weeks and the young are suckled until mid-January. Young are reproductively mature in time for the next breeding season (Bernard *et al*. 1997).

Figure 280. *Neoromicia nana,* showing plain face (© E. C. J. Seamark).

SYSTEMATIC NOTES

1852. *Vespertilio nanus* Peters, Naturw. Reise Mossamb., Säugethiere: 63. Inhambane, Mozambique.

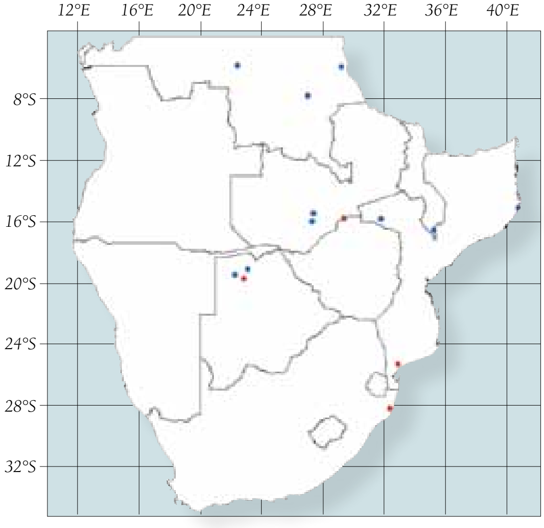
The generic position of *nana* is still unclear, as it shares characteristics with *Pipistrellus* and *Hypsugo* (e.g. the presence of a tiny upper premolar) and *Neoromicia* (chromosomal characters). *Pipistrellus fouriei* Thomas 1926, *Pipistrellus africanus meesteri* Kock 2001 and *Vesperugo pusillulus* Peters 1870 are synonyms (Kearney *et al.* 2002, Simmons 2005). The species has a number of unique features, including enlarged thumb pads, a high, domed skull, and a very high frequency echolocation call, and may be best placed in its own genus. The epithet *africanus* predates *nana*, but we follow Decision 2120 of the International Commission on Zoological Nomenclature (ICZN) (Anonymous 2005) in retaining *nana* on the grounds of nomenclatural stability (based on Happold's (2003) original application, Case 3240). Furthermore, the type locality of *africanus* is in Ethiopia and therefore its conspecificity with southern African populations is unlikely.

The diploid number in *N. nana* is 2n = 36 and aFN = 50 (Rautenbach *et al.* 1993, Kearney *et al.* 2002).

Neoromicia rendalli (Thomas 1889)

Rendall's serotine

Least Concern



Description: *Neoromicia rendalli* is a small bat with a mass of about 8 g. In South African specimens, the pelage is typically creamy buff-yellow to buff on the upper parts. The hairs are bicoloured, with dark bases and light tips. The individual hairs on the underparts are long and have dark bases with pure white tips, while those on the very edge of the flanks are pure white throughout. The wing membranes are conspicuously white and translucent. The face is plain, without any noseleafs. The ears are light brown, rounded, with a short, broad tragus. Sexes are alike.

The zygomatic arches are thin. The rostrum is noticeably broader and shorter than in other southern African species of *Neoromicia*, *Pipistrellus* or *Hypsugo*. The forehead slopes gradually upwards from the nasal to occipital region and is not concave at the forehead. The sagittal and lambdoid crests are present, but not well developed. The mastoid processes are visible in dorsal view as distinct projections. The dental formula is 2113/3123 = 32. The posterior upper incisor is just over one half of the length of the anterior. The anterior upper premolar is absent.

External and cranial measurements (mm) and mass (g) for *Neoromicia rendalli*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	8.1	6.0	10.8	1.54	12
FA[1]	35.6	33.0	37.9	1.44	11
Total[1]	95.6	91	102	3.78	11
Tail[1]	40.0	37	45	2.50	11
Tibia	-	-	-	-	-
Ear[1]	12.0	11	14	1.00	10
CI[1]	13.0	12.8	13.2	-	2

[1] Specimens measured by the authors

Key identification features: *Neoromicia rendalli* can be distinguished from all other pipistrelles (*Neoromicia*, *Pipistrellus*, *Hypsugo)* by its white or translucent wings, a feature shared with the similar *N. tenuipinnis*. These two species can be separated by examining the contrast between the wing membranes and the body: in *N. tenuipinnis* the contrast is striking owing to the almost black pelage, while in *N. rendalli* it is not as striking as the pelage is much paler brown. Furthermore, *N. tenuipinnis* is a rainforest species while *N. rendalli* is associated with savannas and woodlands. *Scotoecus albofuscus* also has white wings, but is pale buffy-brown on the flanks (pure white in *N. rendalli)*, has unicoloured hairs above (bicoloured in *N. rendalli)*, a broad, flattened muzzle, and only one upper incisor.

Echolocation call: *Neoromicia rendalli* produces LD-FM echolocation calls. Its call has not been recorded in southern Africa.

Distribution, habitat and roosting: *Neoromicia rendalli* has a very patchy distribution in southern Africa and occurs at a few widely separated locations. It has been recorded from Bonamanzi Game Reserve in KwaZulu-Natal (Kearney and Taylor 1997), Palmiera in southern Mozambique, Chiromo in southern Malawi, Mana Pools National Park in northern Zimbabwe (Rautenbach and Fenton 1992), the Okavango Delta in northern Botswana, the southern DRC, and south-central Zambia. It occurs in woodland savanna habitats, but is closely associated with water. All southern specimens appear to have been netted at or near large rivers or wetlands. The type specimen is from Bathurst, Gambia (BM 1889.3.2.3).

In southern Africa, this species is very poorly represented in museums, with just 17 records examined for this book.

Nothing is known about its roosting habits in southern Africa. Elsewhere in its range, it roosts singly or in small groups in thatched roofs or dense vegetation, including in the dense fronds of palm trees (Rosevear 1965).

Extralimital: *Neoromicia rendalli* has been widely recorded from sub-Saharan Africa, including Kenya, Tanzania, Ethiopia, Somalia, Sudan, DRC (Meester *et al*. 1986), Nigeria, Niger, Benin, Togo, Ghana, Côte d'Ivoire, Sierra Leone, Gambia and Senegal (Happold 1987).

Foraging ecology: There is no information on the diet of *Neoromicia rendalli* in southern Africa. In Kenya, its diet comprised mainly Lepidoptera (Whitaker and Mumford 1978).

Reproduction: In KwaZulu-Natal, a pregnant and lactating female with two foetuses was taken in December (Taylor 1998).

fig. 281a

fig. 281b

fig. 281c

fig. 281d

Figure 281. Skull and teeth of *Neoromicia rendalli:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 5877).

SYSTEMATIC NOTES

1889. *Vesperugo rendalli* Thomas, Ann. Mag. Nat. Hist. (6)3: 362. Gambia.

Neoromicia phasma G. M. Allen 1911, *Neoromicia faradjius* J. A. Allen 1917 and *Vesperus hösemanni* Turni and Kock 2008 are synonyms.

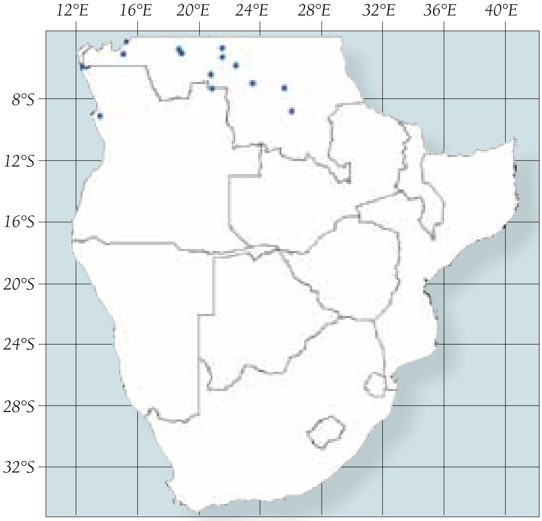
The diploid number in *N. rendalli* is 2n = 38 and aFN = 50 (Rautenbach and Fenton 1992).

Figure 282. *Neoromicia rendalli*, showing plain face and creamy buff fur (DM 8666, © A. Monadjem)

Neoromicia tenuipinnis (Peters 1872)

White-winged serotine

Least Concern



Description: *Neoromicia tenuipinnis* is a very small bat with a mass of 3–4 g. The pelage is slate-brown to black on the upper parts; the hairs are unicoloured. The individual hairs on the underparts are long and bicoloured, with dark bases and pure white tips, while those on the flanks are pure white throughout. The wing membranes are translucent or white, and contrast strikingly with the dark body. The face is plain, without any noseleafs. The ears are dark brown, rounded, with a short, broad tragus. Sexes are alike.

The rostrum is broad and short, the forehead concave, with the braincase sloping gradually upwards posteriorly to the occiput. There is no sagittal or lambdoid crest. The dental formula is 2113/3123 = 32. The anterior upper incisor is about twice as long as the posterior and may be trifid or bifid.

External measurements (mm) and mass (g) for *Neoromicia tenuipinnis*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	3.0	-	-	-	1
FA[1,2]	29.4	28	32	-	-
Total[2]	-	64	87	-	-
Tail[2]	-	26	34	-	-
Tibia	-	-	-	-	-
Ear[1]	-	8	12	-	-
CI	-	-	-	-	-

[1] Specimens measured by the authors

[2] Rosevear (1965)

Key identification features: *Neoromicia tenuipinnis* can be distinguished from all other pipistrelles (*Neoromicia*, *Pipistrellus*, *Hypsugo)* by its white or translucent wings, a feature shared with the similar *N. rendalli*. These two species can be separated by examining the contrast between the wing membranes and the body: in *N. tenuipinnis* the contrast is striking owing to the almost black pelage, while in *N. rendalli* it is not as striking, as the pelage is grey-brown. Furthermore, *N. tenuipinnis* is a rainforest species while *N. rendalli* is associated with savannas and woodlands. *Scotoecus albofuscus* also has white wings, but is larger, has only one upper incisor and is pale buffy-brown above (slate-brown to black in *N. tenuipinnis)*.

Echolocation call: *Neoromicia tenuipinnis* produces LD-FM echolocation calls. Calls sweep from about 62 kHz down to 37 kHz with a 1.5 ms duration (Novick 1958). Its call has not yet been recorded in southern Africa.

Distribution, habitat and roosting: *Neoromicia tenuipinnis* is a widespread rainforest inhabitant of Central and West Africa, but is marginal to southern Africa. So far, it has been recorded only from southern DRC and northern Angola. It may, however be more widely distributed in the far northern parts of Angola. The type specimen is from 'Guinea', West Africa (ZMB 4096, Holotype).

In southern Africa, this species is poorly represented in museums, with 14 records examined for this book.

Nothing is known about its roosting habits in southern Africa. Elsewhere in its range, it roosts singly or in small groups, using hollows in trees (Rosevear 1965) or thatched roofs (Monadjem and Fahr 2007). This species is predominantly associated with lowland rainforest.

Extralimital: *Neoromicia tenuipinnis* has been widely recorded from the tropical rainforest zone of Central and West Africa, including Kenya, Uganda, Tanzania, Ethiopia, DRC, Gabon, Cameroon, Nigeria, Ghana, Côte d'Ivoire, Liberia, Sierra Leone and Guinea (Happold 1987).

Foraging ecology: There is no information on the diet or foraging behaviour of this species in southern Africa.

Reproduction: In Uganda, Kingdon (1974) recorded lactating females in January and scrotal males during June, October and November. When males are in scrotal condition, their facial glands are enlarged and secrete a greasy orange fluid, which apparently tints the entire animal, including its wings, with a pinkish colour.

fig. 283a

fig. 283b

fig. 283c

fig. 283d

Figure 283. Skull and teeth of *Neoromicia tenuipinnis:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (KRM 2948, Makerere University, Kampala).

SYSTEMATIC NOTES

1872. *Vesperus tenuipinnis* Peters, Monatsb. K. preuss. Akad. Wiss. Berlin: 263. 'Guinea', West Africa.

South-central African specimens might be referable to *Vesperus bicolor* Bocage 1889 (BM 1889.5.1.3, Syntype, from Caconda, Angola) – a taxon that Simmons (2005) treated, alongside *Eptesicus ater* J. A. Allen 1917, as synonyms of *N. tenuipinnis.*

The diploid number in *N. tenuipinnis* is 2n = 36 and aFN = 52 (McBee *et al.* 1987).

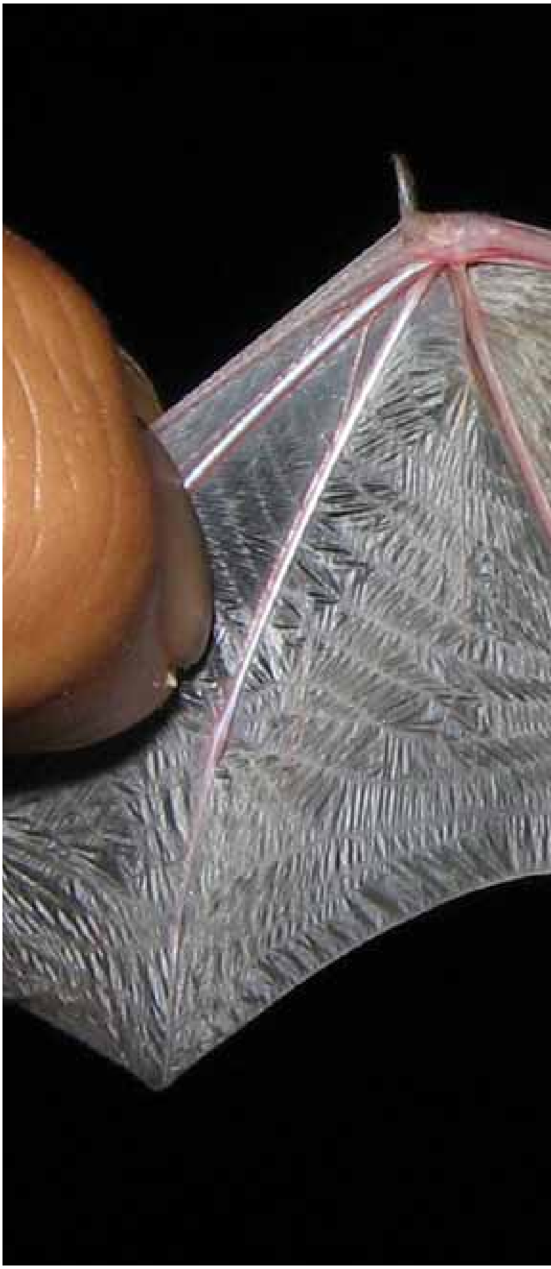
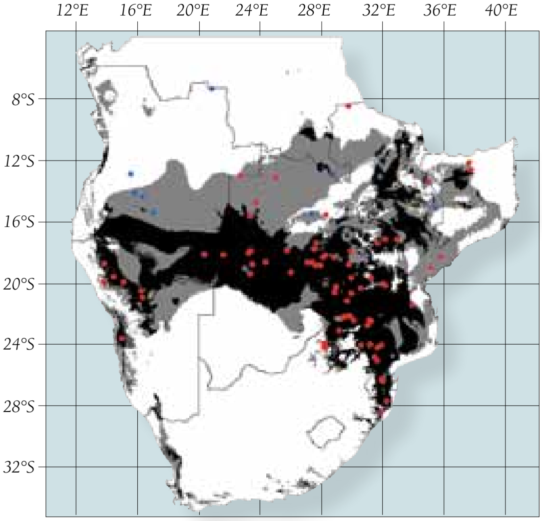


Figure 284. *Neoromicia tenuipinnis*, showing translucent wing membrane and long white flank hairs (Liberia, © A. Monadjem).

Neoromicia zuluensis (Roberts 1924)

Zulu serotine

Least Concern



Description: *Neoromicia zuluensis* is a very small bat with a mass of about 4 g. The pelage is grey-brown to dark-brown above and paler greyish or off-white below. The hairs are bicoloured with a dark base and paler tip. The wings are dark brown to black. The face is plain, without any noseleafs. The ears are dark brown, triangular, but rounded at the tip, with a short tragus that is narrower than that of *N. capensis*. Sexes are alike, although in five cranial measurements, females were significantly larger than males (by 2–5%; Kearney 2005).

The forehead is concave with the braincase slightly elevated above the rostral plane, without the distinct occipital dome or 'helmet' found in *N. capensis*. The palate is not as widely indented as in *N. capensis*. The sagittal crest is poorly developed or absent and the lambdoid crests are weakly developed. The mastoid processes are visible in dorsal view as distinct projections. The dental formula is 2113/3123 = 32 (Skinner and Chimimba 2005). The posterior upper incisor is less than half that of the anterior. The anterior upper premolar is absent.

Key identification features: *Neoromicia zuluensis* cannot be identified with certainty in the field, as its distinguishing features are dental, cranial and bacular. The absence of a tiny upper premolar separates it from *Pipistrellus* and *Hypsugo* species, but this feature is not easy to inspect on a live animal. *Neoromicia rendalli* and *N. tenuipinnis* have white wing membranes (black in *N. zuluensis)*. *Neoromicia capensis* is slightly larger (in adults, CI > 12 mm; in *N. zuluensis* CI < 12 mm), and skulls of adults show a distinct occipital helmet, which is lacking in *N. zuluensis*. In the field, this species is difficult or impossible to separate from *Pipistrellus hesperidus* or *Hypsugo anchietae*, but can be distinguished from *N. nana* by the absence of swollen thumb pads.

Echolocation call: *Neoromicia zuluensis* produces LD-FM echolocation calls with an intermediate peak echolocation frequency (48.4±1.1 kHz, n = 2), broad bandwidth (27±17.7 kHz, n = 2), and short duration (2.7±0.4 ms, n = 2) (Schoeman and Jacobs 2008).

Distribution, habitat and roosting: *Neoromicia zuluensis* is widespread in the northern parts of the region. It occurs from northern KwaZulu-Natal and Swaziland, north through the extreme northeast of South Africa, to Zimbabwe, northern Botswana, northern and northeastern Namibia, Zambia, southern Malawi, and central and northern Mozambique. An isolated record from central Angola probably indicates that it has been overlooked in much of that country, as well as in the southern DRC. The type specimen is from Umfolozi Game Reserve, KwaZulu-Natal, South Africa (TM 3024, Holotype).

This species is well represented in museums, with over 160 specimens examined for this book.

Most specimens have been netted or shot, hence its roosting sites are not well known. Roberts (1924) collected

External and cranial measurements (mm) and mass (g) for *Neoromicia zuluensis*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	4.2	4.0	4.5	0.26	6	**Mass[1]**	4.2	4.0	4.9	0.34	9
FA[1]	30.0	28.3	31.9	0.83	16	**FA[1]**	30.2	28.4	33.3	1.37	11
Total[1]	74.6	70	81	3.85	6	**Total[1]**	80.0	76	86	3.58	6
Tail[1]	33.1	30	36	2.06	6	**Tail[1]**	34.7	31	38	2.66	6
Tibia[1]	13.0	12.5	14.0	0.68	4	**Tibia[1]**	12.4	11.9	12.7	0.33	5
Ear[1]	10.3	9	12	1.08	6	**Ear[1]**	11.4	11	12	0.49	6
CI[1]	11.6	11.3	12.3	0.34	7	**CI[1]**	11.9	11.6	12.3	0.26	6

[1] Specimens measured by the authors

fig. 285a

fig. 285b

fig. 285c

fig. 285d

Figure 285. Skull and teeth of *Neoromicia zuluensis:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8539).

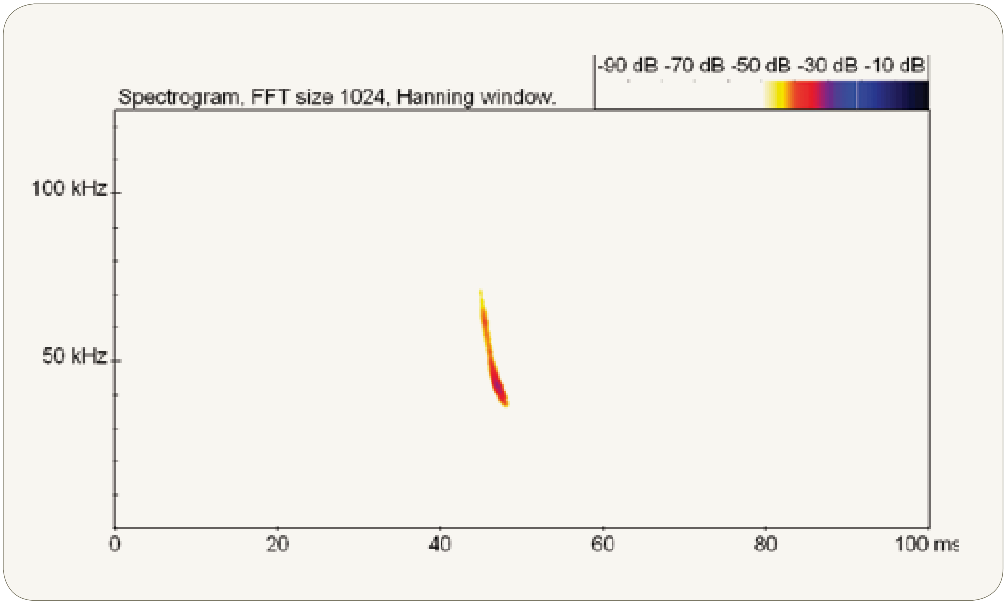


Figure 286. Echolocation call of *Neoromicia zuluensis.*

the original specimen while it was flitting over his camp and recorded in the original description of the species that it was the Cape serotine bat, *N. capensis*, that he found in the aloe. He used the name 'aloe bat' and it has remained associated with *N. zuluensis* (Skinner and Chimimba 2005). It appears to be associated with woodland savanna, where it is closely tied to riparian habitats (A. Monadjem, unpublished data).

Extralimital: The taxonomic status of *Neoromicia zuluensis* is not clear, hence there is some doubt as to its African distribution. However, it also appears to occur in East Africa (T. Kearney, personal communication).

Foraging ecology: *Neoromicia zuluensis* has relatively short and broad wings with low wing loading (5.7 $N.m^{-2}$) and low aspect ratio (6.4) (Norberg and Rayner 1987, Aldridge and Rautenbach 1987; also see Schoeman and Jacobs 2008). In the Kruger National Park their diet included predominantly Coleoptera and, to a lesser extent, Lepidoptera (Aldridge and Rautenbach 1987; also see Fenton *et al*. 1998a, Schoeman 2006). Their faeces may contain vegetative matter (Seamark and Bogdanowicz 2002).

Reproduction: In the region, young are born towards the end of November and the first half of December (Skinner and Chimimba 2005).

SYSTEMATIC NOTES

1924. *Eptesicus zuluensis* Roberts, Ann. Transv. Mus., 10: 60. 'Umfolosi Game Reserve, Zululand' (= Hluhluwe-imFolozi Park), South Africa.

Neoromicia vansoni Roberts 1932 is a synonym (TM6553, Holotype, from Tsotsoroga Pan, Ngamiland, Botswana). *Neoromicia zuluensis* is closely related to *N. somalica* (Thomas 1901) described from Somalia (BM 1898.6.9.1, Holotype, from Hargeisa). Earlier authorities, including Meester *et al.* (1986), considered the species to be conspecific, but they differ in karyotype; Smithers (1983) listed both species (as *Eptesicus somalicus* and *E. zuluensis*) as occurring in southern Africa, but *zuluensis* was treated as a subspecies of *E. somalicus* by Skinner and Smithers (1990).

Neoromicia somalicus is not currently known to occur in southern Africa, but may possibly have been overlooked (E. Seamark, personal communication), particularly in the northern parts of the region. Note that any reference to *N. somalicus* in southern Africa prior to the early 1990s refers to *N. somalicus zuluensis*, which has now been elevated to *N. zuluensis*.

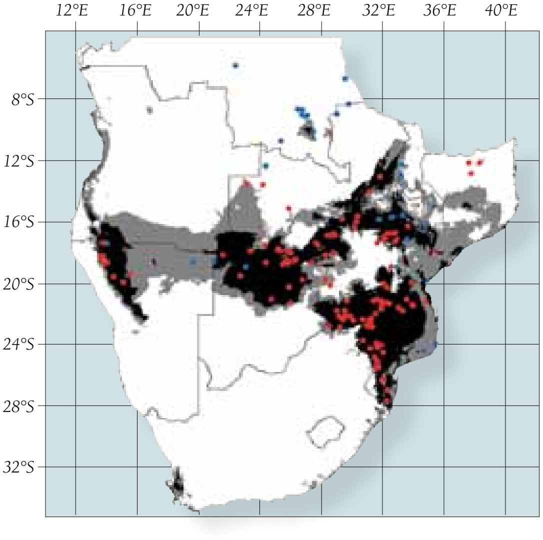
The diploid number in *N. zuluensis* is $2n = 28$ and $aFN = 50$ (i.e. 1 acrocentric and 12 biarmed autosomes) (Rautenbach *et al.* 1993, Kearney *et al.* 2002), while it is $2n = 26$ in *N. somalicus* (McBee *et al.* 1987).

Figure 287. *Neoromicia zuluensis:* (a) portrait showing plain face, and (b) whole body showing diminutive size (a: TM 48097, © E. C. J. Seamark; b: DM 8506, © A. Monadjem).

Nycticeinops schlieffeni (Peters 1859)

Schlieffen's twilight bat

Least Concern



Description: *Nycticeinops schlieffeni* is a small bat with a mass of around 5 g. The pelage colour is bright, gingery to fawn-brown above and paler below. The individual hairs are unicoloured, setting this bat apart from similar-sized pipistrelle species. The wings are dark brown and contrast with the pale body. The face is plain, without any noseleafs and the muzzle is relatively broad. The ears are brown and moderately sized, with a short, hooked tragus. The sexes are alike.

The skull is delicate with very weak zygomatic arches, a broad rostrum and distinct mastoid projections evident in dorsal view. The braincase rises slightly and gradually above the level of the rostrum. The sagittal and lambdoid crests are weak. The dental formula is 1113/3123 = 30.

Key identification features: *Nycticeinops schlieffeni* is distinguished from similar-sized pipistrelles in the genus *Neoromicia*, *Pipistrellus* and *Hypsugo* by its unicoloured fur and the presence of a single upper incisor. Other vespertilionid genera in southern Africa with unicoloured fur are *Scotophilus* (much larger, FA > 45 mm), *Scotoecus* and *Mimetillus*. Members of the last two genera are similar in size to *N. schlieffeni*, but have a very broad muzzle and a characteristically club-shaped tragus. The similarly sized *Myotis bocagii* has bicoloured fur and a long, pointed tragus.

Echolocation call: *Nycticeinops schlieffeni* produces LD-FM echolocation calls with an intermediate peak echolocation frequency (42.5±0.3 kHz, n = 2), narrow bandwidth (16.1±1.3 kHz, n = 2), and short duration (3.5±0.2 ms, n = 2) (Schoeman and Jacobs 2008; also see Fenton and Bell 1981, Aldridge and Rautenbach 1987, Taylor 1999a, Taylor *et al.* 2005). Besides the fundamental, the second and third harmonics may be present on the spectrogram.

Distribution, habitat and roosting: *Nycticeinops schlieffeni* occurs widely in the eastern and northern parts of the region, but is absent from the arid west and from the tropical forests of the extreme north. It has been recorded from northern KwaZulu-Natal and eastern Swaziland, north through northern South Africa to Zimbabwe, Zambia, central and northern Mozambique, Malawi and the southern DRC. An isolated population occurs in northern Namibia. The occurrence of *N. schlieffeni* may have been overlooked in much of southern and eastern Angola. The type specimen is from Cairo, Egypt (ZMB 585, Holotype).

This species is well represented in museums, with over 300 specimens examined for this book.

It appears to be closely associated with low-lying savannas, where it may be abundant in well-wooded places such as

External and cranial measurements (mm) and mass (g) for *Nycticeinops schlieffeni*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	4.7	3.5	6.0	0.83	12	**Mass[1]**	5.8	4.2	9.0	1.16	19
FA[1]	31.3	29.0	33.6	1.14	21	**FA[1]**	31.1	29.0	33.0	1.16	21
Total[1]	75.8	68	81	3.38	18	**Total[1]**	79.4	70	89	5.78	18
Tail[1]	30.8	26	35	2.31	18	**Tail[1]**	30.9	24	37	2.67	18
Tibia[1]	12.3	-	-	-	1	**Tibia[1]**	12.9	12.1	13.9	0.80	5
Ear[1]	11.1	10	13	0.69	15	**Ear[1]**	11.4	10	13	0.76	15
CI[1]	12.2	11.8	12.5	0.21	22	**CI[1]**	12.2	11.8	12.9	0.30	27

[1] Specimens measured by the authors

fig. 288a

fig. 288b

fig. 288c

fig. 288d

Figure 288. Skull and teeth of *Nycticeinops schlieffeni:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8486).

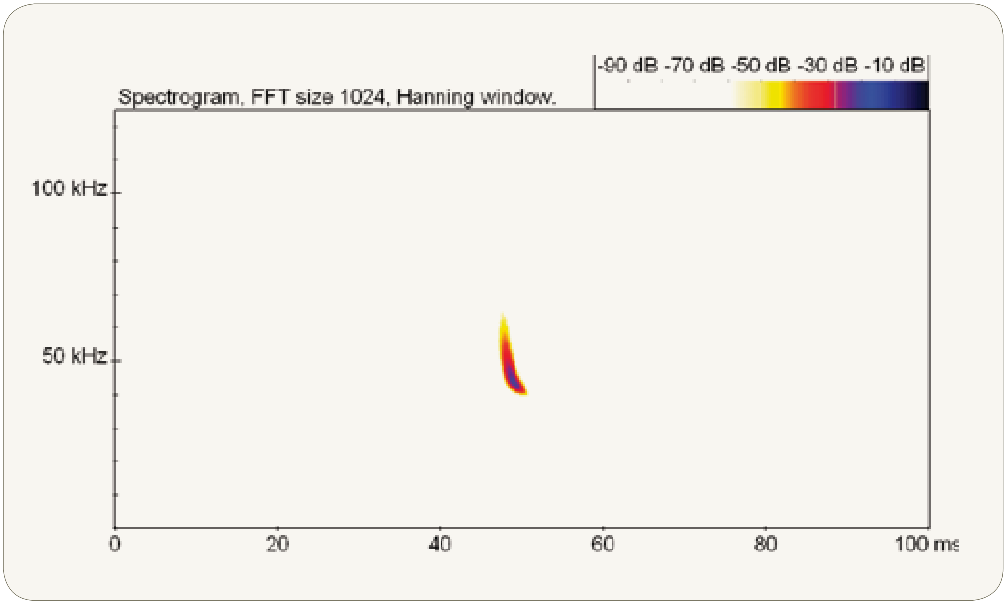


Figure 289. Echolocation call of *Nycticeinops schlieffeni*.

riparian vegetation along rivers and drainage lines (Monadjem and Reside 2008). It roosts in crevices in trees (Verschuren 1957a) and in houses (Rosevear 1965); these small bats are often very numerous in mopane woodland in northern Zimbabwe (F. P. D. Cotterill, unpublished data).

Extralimital: *Nycticeinops schlieffeni* occurs widely in the savannas of East and West Africa, and has been recorded from Tanzania, Kenya, Uganda, Ethiopia, Somalia, Sudan, Egypt, Chad, Central African Republic, DRC, Niger, Nigeria, Burkina Faso, Togo, Benin, Ghana, Côte d'Ivoire and Senegal (Happold 1987, Meester *et al*. 1986). It also occurs in the Arabian Peninsula.

Foraging ecology: *Nycticeinops schlieffeni* has relatively broad wings with low wing loading (6.7 $N.m^{-2}$) and low aspect ratio (6.9) (Norberg and Rayner 1987; also see Aldridge and Rautenbach 1987, Schoeman and Jacobs 2008). It is a clutter-edge forager. It feeds on aerial insects such as Coleoptera, Diptera, Lepidoptera, Trichoptera and Hymenoptera (Fenton *et al*. 1977, 1998b, Fenton and Thomas 1980, Aldridge and Rautenbach 1987).

Reproduction: In South Africa, copulation occurred in June, followed by a period of sperm storage by the female, until fertilisation in August and parturition in November. Females give birth to up to three young at a time (Van der Merwe and Rautenbach 1986, 1987, 1990a).

SYSTEMATIC NOTES

1859. *Nycticejus schlieffeni* Peters, Monatsb. k. preuss. Akad. Wiss. Berlin, 223. Cairo, Egypt.

This species was originally classified in *Nycticeius*, but was placed in its own monotypic genus *Nycticeinops* by Hill and Harrison (1987). Two subspecies have been described from the region: *N. s. australis* (Thomas and Wroughton 1908) from Coguno, Inhambane, Mozambique, and *N. s. fitzsimonsi* (Roberts 1932). In our opinion, the validity of these taxa is in doubt. *N. s. fitzsimonsi* was described from near Tsotsoroga Pan, northern Botswana (TM 6550, Holotype) and includes material from northern Namibia (Meester *et al.* 1986); however, from a biogeographic perspective, northern Botswana is connected to the main eastern distribution of this species, whereas the northern Namibian population appears isolated. Hence the Namibian population might represent a unique evolutionary lineage, but collection of specimens from what appears to be this distributional 'gap' in north-central Namibia and molecular studies are a prerequisite to resolving this question.

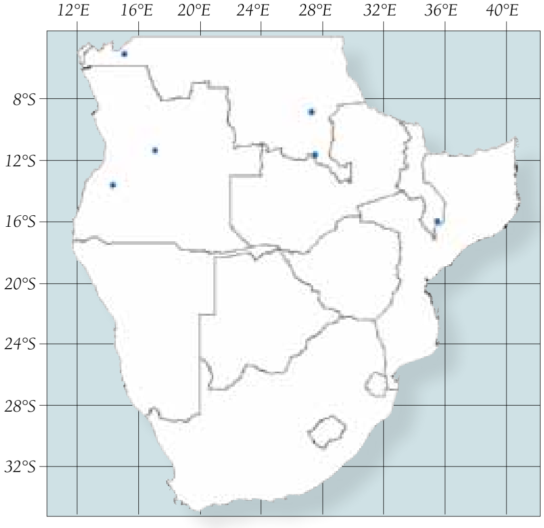
The diploid number in *N. schlieffeni* from South Africa is 2n = 42 and aFN = 50 (Rautenbach *et al.* 1993), while the karyotype of specimens from Somalia is 2n = 34 and aFN = 52 (Ruedas *et al.* 1990), indicating the possible presence of cryptic species.

Figure 290. Nycticeinops schlieffeni, showing plain face and unicoloured fur (TM 48141, © E. C. J. Seamark).

Pipistrellus (Afropipistrellus) grandidieri (Dobson 1876) ○

Dobson's pipistrelle

Not Evaluated



Description: *Pipistrellus grandidieri* is a rare bat, whose taxonomic status has been shrouded in obscurity for well over a century (see 'Systematic notes'). The pelage above is pale to medium brown, somewhat short (~3 mm) and unicoloured, much as in *Nycticeinops schlieffeni*. The wings, tail membrane and ears are dark brown. The tragus is falciform and rounded on top (Thorn *et al*. 2007). The face is plain, without any noseleafs.

The skull has a broad rounded rostrum and broad braincase, which is not distinctly elevated above the plane of the rostrum. The sagittal and lambdoid crests are low and there is no occipital 'helmet' as in *Neoromicia capensis*. The dental formula is 2113/3123 or 2123/3123 = 32–34. The posterior upper incisor is two-thirds the height of that of the anterior incisor. The canine is stout and touches the posterior premolar. The anterior upper premolar is usually absent, but may be present on one or both sides, squeezed internally between the canine and posterior premolar (Thorn *et al*. 2007).

Key identification features: *Pipistrellus grandidieri* can be differentiated from most other small African vespertilionid species based on its short, unicoloured pelage and uniquely shaped and elongated baculum (Thorn *et al*. 2007). The pelage is similar to that of *Nycticeinops schlieffeni*, but *P. grandidieri* is larger (FA mostly > 33 mm) and has two upper incisors (one in *N. schlieffeni*).

Echolocation call: The echolocation call of this species has not been recorded.

Distribution, habitat and roosting: Just six records are known for the region, one from Malawi, two from Angola and three from the southern DRC. The Angolan records were previously referred to as *N. flavescens* (but see 'Systematic notes'). The Malawian specimens were netted over a pool in montane evergreen forest and in remnant riparian forest at 750 m and 1,000 m above sea level. The Tanzanian specimens were netted at altitudes between 120 m (lowland forest) and 800 m (submontane forest), including secondary forest and often near water (Thorn *et al*. 2007). The type specimen is from Zanzibar, Tanzania (MNHN 1996-2129, Holotype).

Extralimital: *Pipistrellus grandidieri* has also been recorded from Cameroon, Burundi, Kenya, Uganda, Tanzania, Zanzibar.

Foraging ecology: There is no information on the diet or foraging behaviour of this species.

Reproduction: In Tanzania, pregnancies occurred in late January and early February (Thorn *et al*. 2007).

External and cranial measurements (mm) for *Pipistrellus grandidieri*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass	-	-	-	-	-	**Mass**	-	-	-	-	-
FA[1]	34.2	31.7	37.0	1.5	10	**FA**[1]	34.2	31.0	36.0	1.41	18
Total	-	-	-	-	-	**Total**	-	-	-	-	-
Tail	-	-	-	-	-	**Tail**	-	-	-	-	-
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	9.8	-	-	-	1	**Ear**[1]	-	-	-	-	-
GLS[1,2]	13.8	12.9	14.7	0.51	11	**GLS**[1,2]	13.5	12.3	14.4	0.5-	16

[1] Thorn *et al*. (2007)

[2] GLS = greatest skull length

SYSTEMATIC NOTES

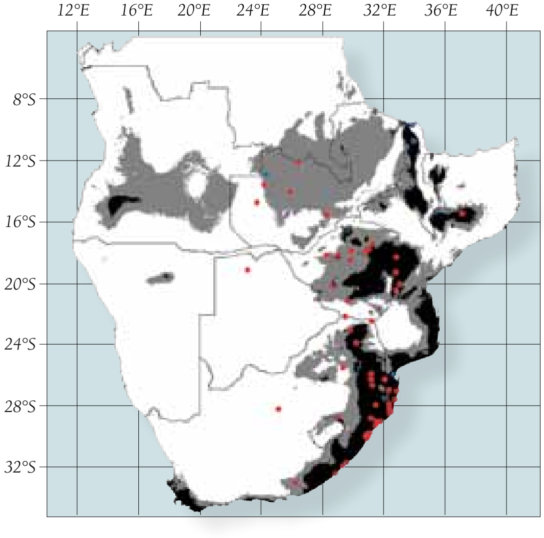
1876. *Vesperugo grandidieri* Dobson, Ann. Mag. nat. Hist., ser. 4, 18: 500. Zanzibar, Tanzania.

Thorn *et al.* (2007) assign specimens from western and southern Africa to *P. g. angolensis* Thorn, Kock and Cuisin 2007; its representative specimens are slightly larger than those of the nominate East African population. Many previous authors included *Pipistrellus grandidieri* as a synonym of *Neoromicia capensis*; however, Thorn *et al.* (2007) established the validity and phylogenetic affinities of *P. grandidieri*. They erected a new subgenus, *Afropipistrellus*, to accommodate this species, based principally on its unique bacular morphology. Moreover, the form *flavescens*, which has been affiliated with *grandidieri* in the past, was shown to be a *nomen dubium*: the syntype of '*flavescens*' from Angola was referred to *grandidieri* by Thorn *et al*. (2007).

Pipistrellus hesperidus Temminck 1840

Dusky pipistrelle

Least Concern



Description: *Pipistrellus hesperidus* is a small bat with a mass of around 6 g and is very similar in appearance to the slightly smaller *Pipistrellus rusticus*. The pelage varies from light to dark brown above and greyish-brown to buffy-white below. The individual hairs on the back are bicoloured, with a dark base and light brown tip, while those on the underparts have a dark base with creamish tips. The wings are dark brown to black. The face is plain, without any noseleafs. The ears are brown and moderately sized, with a short, hooked tragus that has a rounded tip. Females are slightly larger on average than males in body and cranial size and there is significant sexual dimorphism in certain cranial (including CI) and external measurements (Kearney 2005).

The skull has thin zygomatic arches and a proportionately narrower rostrum than in *P. rusticus* and *Hypsugo anchietae*. The braincase is slightly elevated above the level of the rostrum, and the forehead is not as markedly concave as in *Neoromicia nana*. The sagittal and lambdoid crests are present and moderately developed. The mastoid processes are visible in dorsal view as distinct projections. The palate is longer than broad. The dental formula is 2123/3123 = 34 (Skinner and Chimimba 2005). The posterior upper incisor is markedly smaller than the anterior, barely extending beyond its cingulum. The anterior upper premolar is a pointed tooth rising above the cingulum of the canine, but not above the cingulum of the posterior upper premolar.

Key identification features: *Pipistrellus hesperidus* is extremely difficult to distinguish in the field from other *Pipistrellus*, *Hypsugo* or *Neoromicia* species (Kearney 2005). Although slightly larger than *P. rusticus* (*P. hesperidus*: CI 11.8–13.2 mm, n = 45; *P. rusticus*: 10.8–12.2 mm, n = 45; Kearney 2005), it overlaps in external and cranial measurements with this species and also has identical diploid (2n) and fundamental (aNF) chromosomal numbers and bacular morphology (Kearney 2005). The two species can be distinguished using a discriminant function classification method based on 12 cranial characters provided by Kearney (2005). Kearney (2005) also pointed out the largely allopatric distribution of these two species, with *P. hesperidus* more forest-restricted and *P. rusticus* more woodland savanna-restricted. The presence of a tiny upper premolar generally distinguishes it from *Neoromicia* species. The baculum is the best morphological feature for separating it from *Hypsugo anchietae*, from which it also differs in karyotype (*P. hesperidus*: 2n = 42; *H. anchietae*: 2n = 26).

Echolocation call: *Pipistrellus hesperidus* produces LD-FM echolocation calls with an intermediate peak echolocation frequency (50.1±1.5 kHz, n = 10), broad bandwidth (30.1±6.8 kHz, n = 10), and short duration (2.5±0.2 ms, n = 10) (Schoeman and Jacobs 2008; also see Taylor 1999). Besides the fundamental, the second harmonic may be present on the spectrogram.

External and cranial measurements (mm) and mass (g) for *Pipistrellus hesperidus*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	5.9	4.6	7.6	0.70	19	**Mass**[1]	6.2	4.0	9.0	1.15	17
FA[1]	32.4	29.6	35.0	1.29	27	**FA**[1]	32.9	30.9	34.9	1.12	22
Total[1]	80.5	61	88	6.36	25	**Total**[1]	81.7	70	91	5.59	21
Tail[1]	31.9	24	41	3.96	25	**Tail**[1]	32.8	22	37	4.18	21
Tibia[1]	12.7	-	-	-	1	**Tibia**[1]	12.7	-	-	-	1
Ear[1]	10.2	6	13	1.74	25	**Ear**[1]	10.4	7	12	1.51	21
CI[1]	12.8	11.8	13.3	0.54	6	**CI**[1]	12.2	11.5	12.6	0.61	3

[1] Specimens measured by the authors

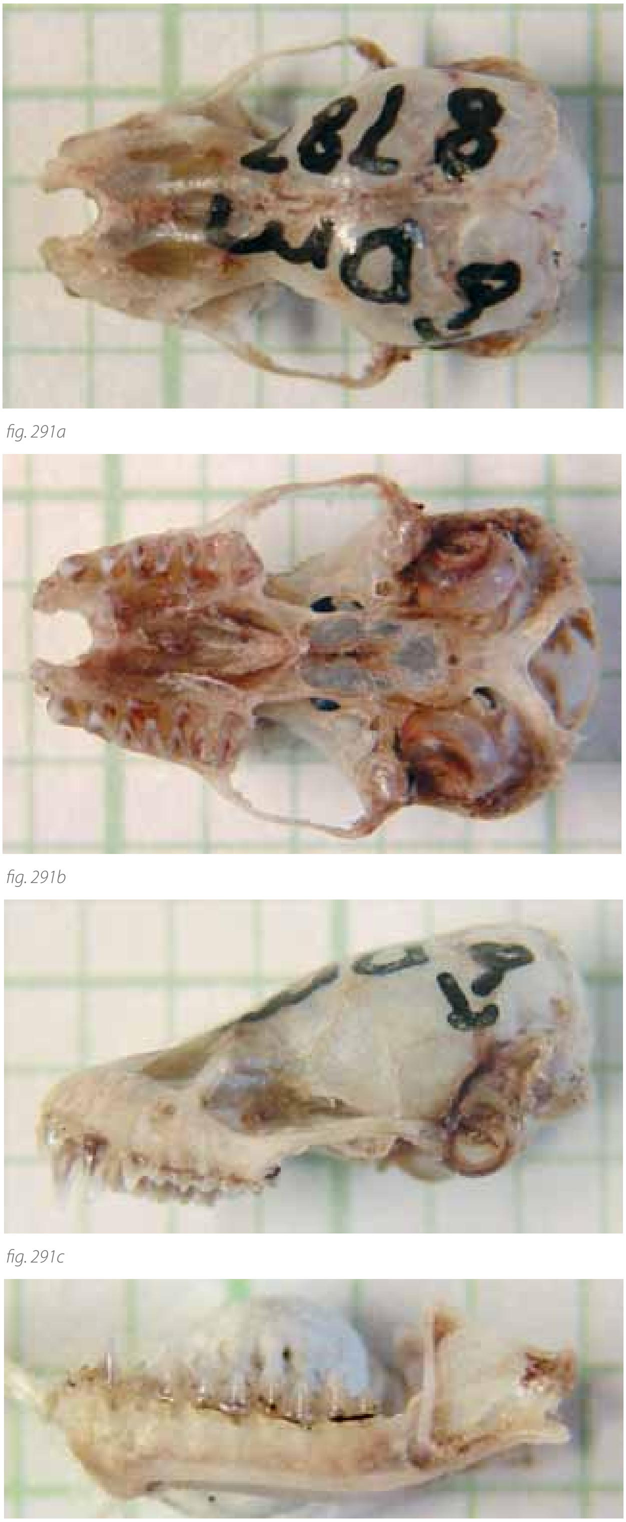


fig. 291a

fig. 291b

fig. 291c

fig. 291d

Figure 291. Skull and teeth of *Pipistrellus hesperidus:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8787).

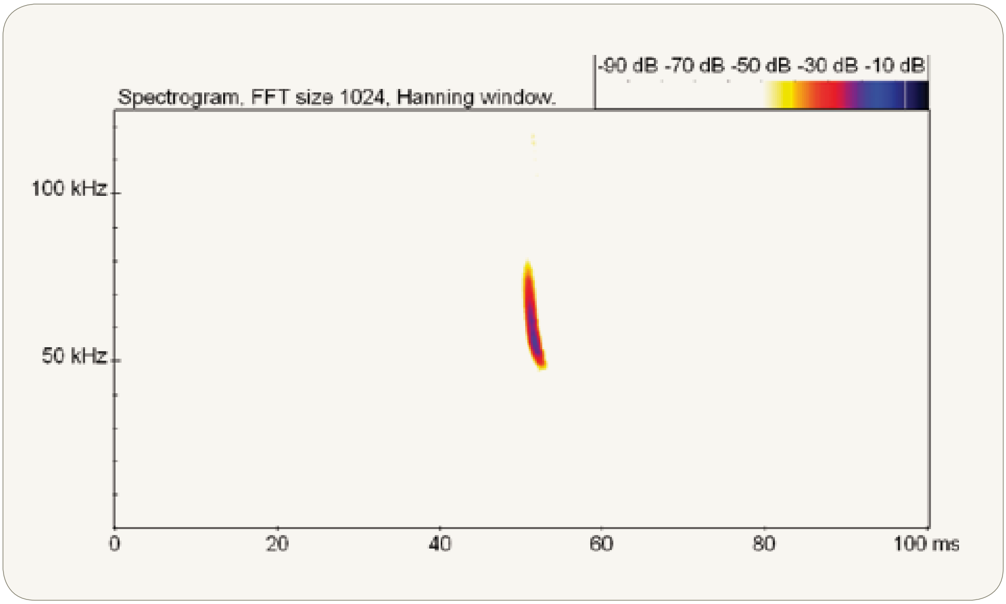


Figure 292. Echolocation call of *Pipistrellus hesperidus*.

Distribution, habitat and roosting: *Pipistrellus hesperidus* occurs widely in the eastern parts of the region. It has been recorded from the Eastern Cape, north through KwaZulu-Natal, Swaziland and northern South Africa, to Zimbabwe, Zambia, Malawi and northern Mozambique. Single records from the Okavango, northern Botswana, and from Boshof in the western Free State indicate that this species probably has a broader distribution than previously thought, and has therefore been widely overlooked. The type specimen is from Shoa, Eritrea (SMF 12381, Lectotype).

This species is relatively well represented in museums, with over 100 specimens examined for this book.

Its roosting habits are poorly known in southern Africa. It has been collected in a narrow crack in exfoliating granitic rock (Smithers and Wilson 1979), where there was a small group of about 12 bats (Skinner and Chimimba 2005). Other specimens were found under the loose bark of dead trees (Smithers 1971). It appears to be associated with well-wooded locations such as riparian vegetation and forest patches (Happold *et al*. 1987), especially in the proximity of water (Skinner and Chimimba 2005, Monadjem and Reside 2008).

Extralimital: *Pipistrellus hesperidus* is widely distributed in East Africa, with records from Tanzania, Kenya, Rwanda, DRC, Ethiopia, Sudan and Somalia, with an isolated population in Cameroon, Central Africa. It has also been recorded from Madagascar (Bates *et al*. 2006). Specimens from north of the Sahara and Europe belong to the closely related species *P. kuhlii*.

Foraging ecology: *Pipistrellus hesperidus* has relatively short and broad wings with low wing loading (5.4 N.m^{-2}) and intermediate aspect ratio (8.5) (Schoeman and Jacobs 2008). It is a clutter-edge forager, with a diet that includes Coleoptera, Hemiptera, Diptera and Lepidoptera (Schoeman 2006).

Reproduction: A pregnant female with two foetuses was collected in KwaZulu-Natal in October (Taylor 1998).

SYSTEMATIC NOTES

1840. *Pipistrellus hesperida* Temminck, Monogr. Mamm., 2: 211. Shoa, Eritrea.

Pipistrellus kuhlii fuscatus Thomas 1901 (BM 1901.8.9.96, Holotype, from Naivasha, Kenya) and *Pipistrellus (Romicia) kuhlii broomi* Roberts 1848 (TM 1085, Holotype, from Malvern, Durban, South Africa) are synonyms. *Pipistrellus hesperidus* was previously known as *P. kuhlii* Kuhl 1817 (Skinner and Smithers 1990), but was given specific status by Kock (2001b), based on differences in morphology and karyotype (Kearney *et al.* 2002).

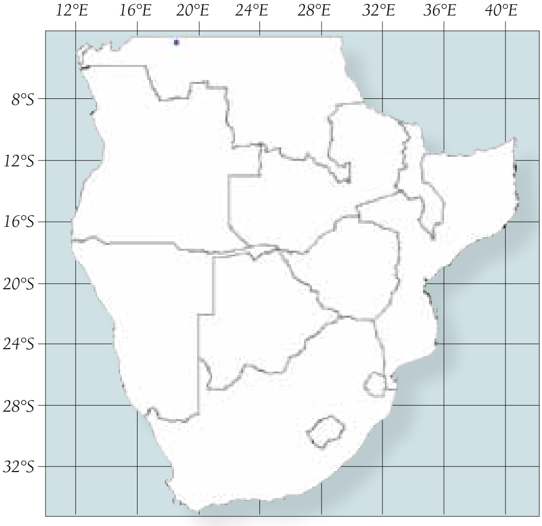
The diploid number in *P. hesperidus* is 2n = 42 and aFN = 50 (Rautenbach *et al.* 1993, Kearney *et al.* 2002), but is 2n = 44 in *P. kuhlii* (Volleth *et al.* 2001).

Figure 293. *Pipistrellus hesperidus*, showing plain face (© Merlin D. Tuttle, Bat Conservation International, www.batcon.org).

Pipistrellus nanulus (Thomas 1904)

Tiny pipistrelle

Least Concern



Description: *Pipistrellus nanulus* is tiny bat with an estimated mass of less than 5 g. The pelage is reddish-brown above and off-white below. The individual hairs are unicoloured above, but bicoloured below being dark at the base and whitish at the tips. The ears are characteristically small and rounded with a relatively straight-sided tragus. The dental formula is: 2123/3123 = 34 (Rosevear 1965).

Key identification features: *Pipistrellus nanulus* is distinguishable from other southern African pipistrelles (*Pipistrellus*, *Neoromicia* and *Hypsugo*) by the unicoloured hairs on the back and bicoloured hairs below, the short, rounded ears and the shape of the tragus (Rosevear 1965).

Echolocation call: The echolocation call of this species has not been recorded in southern Africa.

External and cranial measurements (mm) for *Pipistrellus nanulus*, sexes combined

	Mean	Min	Max	SD	N
Mass	-	-	-	-	-
FA[1]	-	25.5	31.0	-	-
Total[1]	-	-	-	-	-
Tail[1]	-	25.0	27.5	-	-
Tibia[1]	-	10.0	13.5	-	-
Ear	-	-	-	-	-
GSL[1]	-	11.6	11.8	-	-

[1] Rosevear (1965)

Distribution, habitat and roosting: In southern Africa, *Pipistrellus nanulus* is only known from one locality in the southern DRC. Elsewhere in its range it is typically associated with tropical rainforest. The type specimen is from Efulen, Cameroon (BM 1904.2.8.8).

Extralimital: This species is widely distributed in equatorial Africa. In West Africa it occurs from Senegal, Sierra Leone and Liberia in the west through Côte d'Ivoire and Ghana to Cameroon and Gabon. An isolated population occurs in East Africa in Uganda and Kenya.

Foraging ecology: No information on diet or foraging available for southern Africa.

Reproduction: No reproductive information available for southern Africa.

SYSTEMATIC NOTES

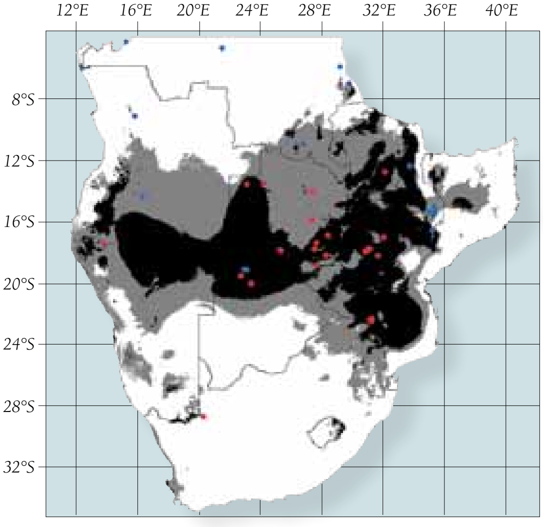
1904. *Pipistrellus nanulus* Thomas, Ann. Mag. nat. Hist., ser. ser. 7, 14 (81): 198. Efulen, Cameroon.

The diploid number in *P. nanulus* is not known.

Pipistrellus rueppellii (Fisher 1829)

Rüppell's pipistrelle

Least Concern



Description: *Pipistrellus rueppellii* is a small bat with a mass of 6 g and distinctively white underparts. The pelage varies geographically: most bats in the region have deep sepia upper parts and the individual hairs have a dark base and paler tips; in northern Botswana, however, the upper parts are pale grey-brown. The underparts are pure white with unicoloured individual hairs; there is a clear demarcation between the white underparts and the darker upper parts. The wings are pale brown. The face is plain, without any noseleafs. The ears are dark and triangular, with a short, curved tragus that has a rounded tip. The sexes are alike.

The skull is rather gracile with weak zygomatic arches. The braincase is rounded and slightly elevated above the rostral plane, with a slightly concave forehead. The coronoid processes of the mandible are small. The sagittal and lambdoid crests are absent or weakly developed. The dental formula is 2123/3123 = 34. The anterior upper incisor is deeply bifid, while the posterior incisor is much smaller.

External and cranial measurements (mm) and mass (g) for *Pipistrellus rueppellii*, sexes combined

	Mean	Min	Max	SD	N
Mass[1,2]	6.8	5.2	7.3	-	6
FA[1]	34.9	32.4	39.3	2.39	7
Total[1]	85.3	77	90	6.18	4
Tail[1]	37.0	32	42	4.76	4
Tibia	-	-	-	-	-
Ear[1]	13.3	13	14	0.47	4
CI[1]	13.3	11.9	14.0	0.83	4

[1] Specimens measured by the authors

[2] Smithers and Wilson (1979)

Key identification features: *Pipistrellus rueppellii* is distinguished by its small size and pure white underparts. Some *Scotoecus* species may have white underparts, but these differ by their broad muzzle, club-shaped tragus, unicoloured fur above, and the presence of a single, undivided upper incisor (two upper incisors in *P. rueppellii*, the anterior one is deeply bifid).

Echolocation call: *Pipistrellus rueppellii* produces LD-FM echolocation calls with an intermediate peak frequency (37.3±0.8 kHz, n = 22 pulses from 1 individual), broad bandwidth (27.1±3.4 kHz, n = 22 pulses from 1 individual), and intermediate duration (7±1 ms, n = 22 pulses from 1 individual) (Taylor *et al*. 2005; also see Fenton and Bell 1981, Aldridge and Rautenbach 1987). Besides the fundamental, the second harmonic may be present on the spectrogram.

Distribution, habitat and roosting: *Pipistrellus rueppellii* occurs widely across the northern parts of the region. It has been recorded from the northern Kruger National Park through to Zimbabwe, Zambia, Malawi, southern DRC, northern Botswana and west to Angola and the extreme north of Namibia. An isolated record from the Augrabies National Park, Northern Cape, may represent a vagrant or an overlooked population. The model suggests that suitable conditions occur widely in northern Namibia and adjoining parts of southern Angola, and along the Zambezi River in Mozambique. The type specimen is from Dongola, Sudan (SMF 4308, Lectotype).

This species is not well represented in museums, with just 60 records examined for this book.

It appears to be associated with large rivers and wetlands in dry savanna or woodland habitats. Nearly all the southern African specimens were netted, so their roosting habits are not known, but a single specimen was collected from behind a notice board.

Extralimital: *Pipistrellus rueppellii* occurs widely across Africa and into the Middle East, but is absent from the rainforest zone.

Foraging ecology: *Pipistrellus rueppellii* has relatively short and broad wings with low wing loading (6.8 $N.m^{-2}$) and low aspect ratio (6.3) (Norberg and Rayner 1987, Aldridge and Rautenbach 1987). It is a clutter-edge forager. In the Kruger National Park, their diet consisted of Coleoptera (Aldridge and Rautenbach 1987), while at Sengwa, Zimbabwe, it comprised Coleoptera, Lepidoptera, Trichoptera and Diptera (Fenton and Thomas 1980, Fenton 1985; also see Fenton *et al.* 1998b). This bat often hunts over open water. Archer (1977, 1979) described the foraging behaviour of this species in the

fig. 294a

fig. 294b

fig. 294c

fig. 294d

Figure 294. Skull and teeth of *Pipistrellus rueppellii:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (TM 36791).

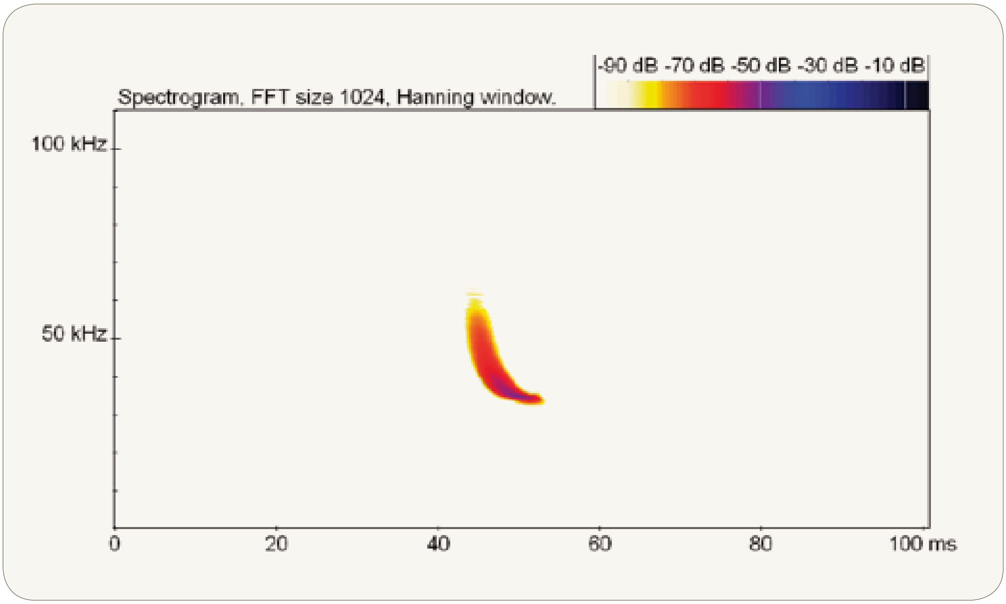


Figure 295. Echolocation call of *Pipistrellus rueppellii.*

Okavango Delta: individuals were observed gleaning floating insects off the water surface in Xugana Lagoon; some individuals also landed in the water. This behaviour awaits detailed study.

Reproduction: No reproductive information is available for southern Africa.

SYSTEMATIC NOTES

1829. *Vespertilio rüppellii* Fisher, Synopsis Mamm.: 109.
Dongola, Sudan.

Pipistrellus rueppellii is classified in subgenus *Vansonia* Roberts 1946. The subspecies *vernayi* Roberts 1932 was described from Maun, Botswana (TM 6546, Holotype), and this epithet appears to be applicable to all the specimens in the southern African region, and would include *Pipistrellus leucomelas* Monard 1933 (type locality: Vila da Ponte, Angola) as a synonym.

The diploid number in *P. rueppellii* is 2n = 36 and aFN = 54 (Rautenbach *et al.* 1993).

fig. 296a

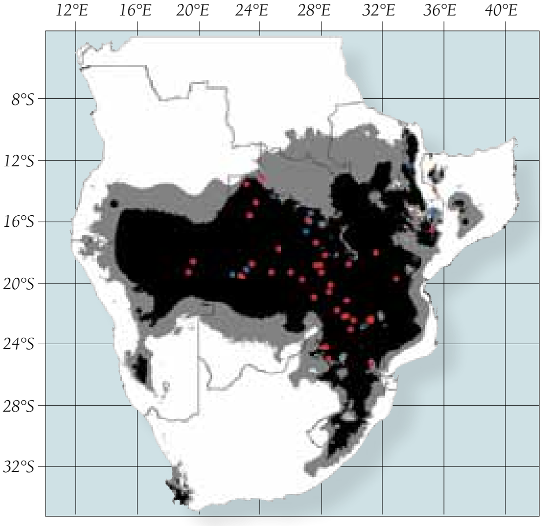
fig. 296b

Figure 296. *Pipistrellus rueppellii,* showing contrasting white underparts (a: © Merlin D. Tuttle; b: © F. P. D. Cotterill).

Pipistrellus rusticus (Tomes 1861)

Rusty pipistrelle

Least Concern



Description: *Pipistrellus rusticus* is a very small bat with a mass of around 4 g and is very similar in appearance to the slightly larger *Pipistrellus hesperidus*. The pelage is pale rust above and paler greyish-rust below. The individual hairs are bicoloured, with a dark base and pale tip. The wings are dark brown to black. The face is plain, without any noseleafs. The ears are brown and moderately sized, with a short, hooked tragus that has a rounded tip. There is slight sexual dimorphism in external and cranial size (only significant in the case of braincase height), with females larger than males (Kearney 2005).

The skull has thin zygomatic arches and a broad rostrum. The forehead is noticeably flat, sloping gradually upwards to the braincase and occiput. The sagittal crest is slightly developed posteriorly; the lambdoid crests are relatively well developed. The mastoid processes are visible in dorsal view as distinct projections. The palate is noticeably broad and conspicuously indented, at least as broad as long. The dental formula is 2123/3123 = 34 (Skinner and Chimimba 2005). The posterior upper incisor is not much smaller than the anterior. The anterior upper premolar is present as a pointed tooth rising above the cingulum of the canine.

Key identification features: *Pipistrellus rusticus* is extremely difficult to distinguish in the field from other *Pipistrellus*, *Hypsugo* or *Neoromicia* species (Kearney 2005). (See account for *P. hesperidus* for separation of these species.) The presence of a tiny upper premolar generally distinguishes it from *Neoromicia* species, while the baculum is the best morphological feature for separating it from *Hypsugo anchietae* (Cotterill 1996a, Kearney and Taylor 1997), from which it also differs in karyotype (*H. anchietae*: 2n = 26; *P. rusticus*: 2n = 42). It is smaller than *P. hesperidus* (*P. hesperidus*: CI > 11.5 mm; *P. rusticus*: CI usually < 11.5 mm; Kearney 2005).

Echolocation call: *Pipistrellus rusticus* produces LD-FM echolocation calls with an intermediate peak echolocation frequency (55.7±2.9 kHz, n = 10), narrow bandwidth (15.9±7.6 kHz, n = 10), and intermediate duration (4.5±2.2 ms, n = 10) (Schoeman and Jacobs 2008; also see Fenton *et al*. 1998a, Taylor 1999a). Besides the fundamental, the second harmonic may be present on the spectrogram.

Distribution, habitat and roosting: *Pipistrellus rusticus* is widely distributed in the northern and central parts of the region. It occurs from northern South Africa north to Zimbabwe, northern Botswana, western Zambia and northeastern Namibia, with an isolated population in Malawi. It may have been overlooked in southeast Angola and central

External and cranial measurements (mm) and mass (g) for *Pipistrellus rusticus*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	3.6	3.4	4.0	0.31	4	**Mass[1]**	4.4	3.5	5.1	0.55	9
FA[1]	28.6	26.1	29.9	1.13	10	**FA[1]**	29.1	27.5	31.2	1.12	14
Total[1]	71.7	65	77	3.99	7	**Total[1]**	74.3	69	84	4.16	12
Tail[1]	28.9	25	31	2.41	7	**Tail[1]**	30.9	27	38	3.00	12
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	10.0	9.5	10.5	0.29	7	**Ear[1]**	9.9	7.7	12.0	1.04	14
CI[1]	11.2	10.8	11.4	0.29	4	**CI[1]**	11.1	10.8	11.3	0.22	4

[1] Specimens measured by the authors

fig. 297a

fig. 297b

fig. 297c

fig. 297d

Figure 297. Skull and teeth of *Pipistrellus rusticus:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 5318).

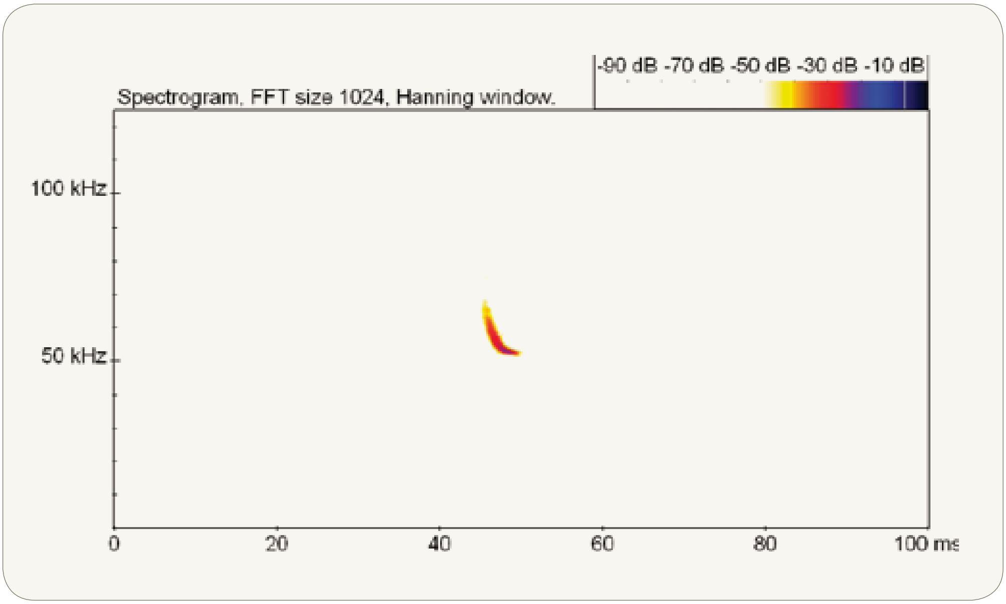


Figure 298. Echolocation call of *Pipistrellus rusticus*.

Mozambique. The type specimen is from Damaraland, Namibia (BM 1907.1.1.419, Lectotype).

This species is relatively well represented in museums, with over 150 specimens examined for this book.

It occurs in savanna woodland, where it is associated with open water bodies, but is absent from moist miombo woodland and arid savanna. Its roosting habits are not well known, but it has been collected in crevices in trees (Roberts 1951), and a group of three individuals was taken together from a hollow tree in Zambia (Taylor 2000). In the Limpopo valley, this species is locally common in mopane woodland where rocky habitat (Clarens sandstones) is also present.

Extralimital: *Pipistrellus rusticus* is widely distributed in the Sahel, occurring in Somalia, Ethiopia, Sudan, Central African Republic, Cameroon, Burkina Faso and Senegal.

Foraging ecology: *Pipistrellus rusticus* has relatively short and broad wings with low wing loading (6.8 $N.m^{-2}$) and intermediate aspect ratio (7.0) (Norberg and Rayner 1987; also see Schoeman and Jacobs 2008). It is a clutter-edge forager. Its diet consists of Coleoptera, Diptera and Lepidoptera (Aldridge and Rautenbach 1987, Fenton *et al*. 1998b).

Reproduction: In Limpopo, South Africa, at 23°S, copulation occurs in April. Thereafter, in spite of an apparent absence of winter hibernation in this species, females store sperm for five months, after which ovulation and fertilisation occur in August and September. Following gestation of eight weeks, twins are born in November (van der Merwe and Rautenbach 1990b, van der Merwe 1994b).

SYSTEMATIC NOTES

1861. *Scotophilus rusticus* Tomes, Proc. Zool. Soc. Lond., I: 31, 35. Damaraland, Namibia.

Pipistrellus marrensis Thomas and Hinton 1923 (BM 1923.1.1.15, Holotype, from Jebel Marra, Darfur, Sudan) is a synonym. *Pipistrellus rusticus* is very similar to *P. hesperidus*; both species have the same karyotype, and their bacular and cranial morphology are similar (Kearney *et al.* 2002, Kearney 2005). Nevertheless, *P. rusticus* can be distinguished by cranial size. Molecular studies are required to resolve the taxonomic relationships between these two taxa.

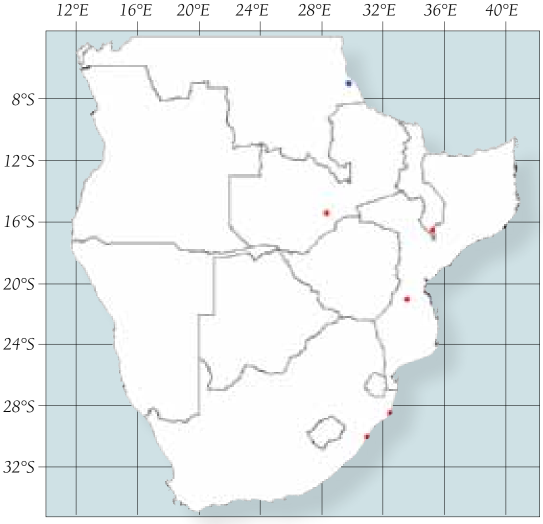
The diploid number in *P. rusticus* is 2n = 42 and aFN = 50 (Rautenbach *et al.* 1993, Kearney *et al.* 2002).

Figure 299. *Pipistrellus rusticus,* showing the plain face (TM 48130, © E. C. J. Seamark).

Scotoecus albofuscus (Thomas 1890)

Thomas's house bat

Data Deficient



Description: *Scotoecus albofuscus* is a small bat with a mass of 8–10 g. The pelage is pale buffy-brown; the individual hairs are unicoloured. The underparts are paler cream-brown or off-white. The fur is short and sleek. The wing membranes are translucent or white. The face is plain, without any noseleafs, and the muzzle is stout owing to the broad and flattened skull. The ears are relatively long with a characteristically club-like tragus. Males have an extremely long penis (> 25% of head and body length). The sexes are alike.

For its small size, the skull is relatively robust with weak, but complete, zygomatic arches. The braincase rises slightly and gradually above the level of the rostrum. The rostrum is almost as wide as the braincase. The sagittal and lambdoid crests are moderately developed. The dental formula is 1113/3123 = 30. There is a single upper premolar (van der Merwe 1997) and a single upper incisor.

External and cranial measurements (mm) and mass (g) for *Scotoecus albofuscus*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	9.5	-	-	-	1
FA[1]	32.6	31.0	34.1	-	2
Total[1]	85.0	-	-	-	1
Tail[1]	32.0	-	-	-	1
Tibia[1]	14.4	-	-	-	1
Ear[1]	9.0	-	-	-	1
CI[1]	14.2	-	-	-	1

[1] Specimens measured by the authors

Key identification features: The combination of a broad, flattened skull, a club-shaped tragus and the presence of only one upper incisor distinguishes *Scotoecus* from all other southern African vespertilionids. *Mimetillus* also has a broad, flattened skull and a club-shaped tragus, but has two upper incisors, while the wings are short and narrow (the third digit is shorter than the head and body length in *M. thomasi*, but longer in *Scotoecus*). The white or translucent wing membrane separates *S. albofuscus* from other African *Scotoecus* species. *Neoromicia rendalli* and *N. tenuipinnis* also have white wings, but differ in having two upper incisors and pure white flanks (*S. albofuscus* has a single upper incisor with pale brown flanks).

Echolocation call: *Scotoecus albofuscus* produces LD-FM echolocation calls with an intermediate peak frequency (39.3 kHz, n = 1), broad bandwidth (24 kHz, n = 1), and short duration (3.3 ms, n = 1) (Schoeman and Jacobs 2008). Besides the fundamental, the second harmonic may be present on the spectrogram.

Distribution, habitat and roosting: *Scotoecus albofuscus* has been sparsely recorded from the eastern parts of the region. It is known from St Lucia (Kearney and Taylor 1997), a suburb of Durban (Taylor *et al.* 2004), from Zinave National Park in southern Mozambique (Cotterill 2001d), Lusaka in Zambia, Moba in the DRC, and from Chiromo in Malawi (Happold *et al.* 1987). The type specimen of *S. albofuscus* is from Bathurst, Gambia (BM 1889.12.12.2, Holotype).

This species is very poorly represented in museums, with just six records examined for this book. One specimen (NMZB 63199) of the two reported by Smithers and Lobão Tello (1976) from Zinave proved to be a misidentified *Mimetillus thomasi* (Cotterill 2001e).

It appears to be associated with low-lying, humid savannas of the coastal plains of Mozambique and northern KwaZulu-Natal, especially where large rivers or wetlands occur. The Malawi specimen was taken from the leaves of a *Hyphaene* palm tree in a forest (Happold *et al.* 1987).

Extralimital: *Scotoecus albofuscus* has been collected from a few scattered localities across Africa, including Kenya (Aggundey and Schlitter 1984), Nigeria, Benin, Sierra Leone, Gambia and Senegal (Happold 1987).

Foraging ecology: *Scotoecus albofuscus* has wings with high wing loading (12.3 $N.m^{-2}$) and low aspect ratio (5.3) (Schoeman and Jacobs 2008). It is a clutter-edge and open-air forager. Its diet consists mainly of Hemiptera, but also includes Diptera and Coleoptera (Whitaker and Mumford 1978, M. C. Schoeman, unpublished data).

Reproduction: In South Africa, a pregnant female collected in November gave birth to twins (Kearney and Taylor 1997, Taylor 1998).

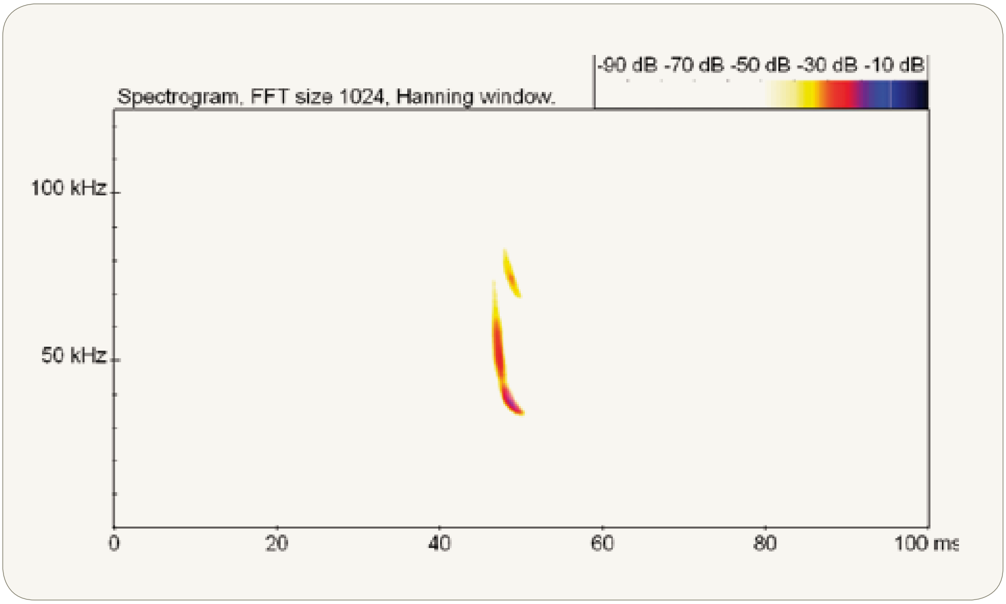


Figure 300. Echolocation call of *Scotoecus albofuscus*.

Figure 301. Skull and teeth of *Scotoecus albofuscus:* lateral view (DM 4885).

Figure 302. Scotoecus albofuscus, showing broad muzzle and sleek fur. The white wing membrane is not visible here (© M. C. Schoeman).

SYSTEMATIC NOTES

1890. *Scotophilus albofuscus* Thomas, Ann. Mus. Civ. Stor. Nat. Genoa, ser. 2a (29): 84. Bathurst, Gambia.

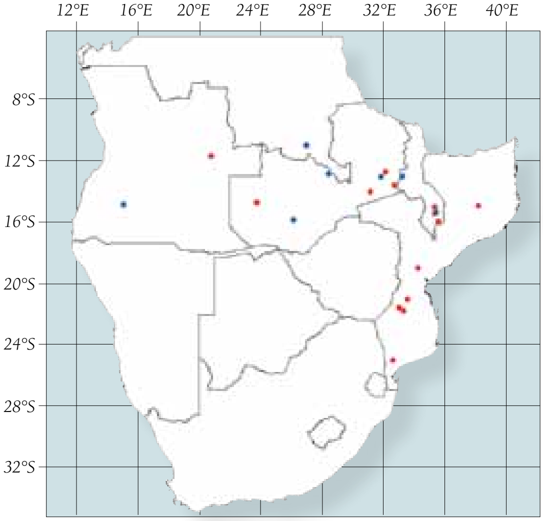
The subspecies *S. a. woodi* Thomas 1917 (BM 1917.2.1.1, Holotype, from Chiromo, Shire valley, Malawi) occurs in the region, but its relationship with the nominate subspecies is not currently clear, as too few specimens have been collected to enable a taxonomic assessment.

The diploid number in *S. albofuscus* is not known.

Scotoecus hindei/albigula Thomas 1901, 1909

Dark-winged lesser house bat

Data Deficient



Description: *Scotoecus hindei/albigula* is an unresolved species complex (see 'Systematic notes'). It is a small bat with a mass of 8–10 g. The pelage is pale sandy-brown to medium brown on the upper parts; the individual hairs are unicoloured. The underparts are white with a clear demarcation between the upper and lower parts. The pelage is short and sleek. The wing membranes are dark brown. The face is plain, without any noseleafs and the muzzle is stout owing to the broad and flattened skull. The ears are triangular with a characteristic club-like tragus. Males have an extremely long penis (> 25% of head and body length) up to 21 mm long (Ansell 1967). The sexes are alike.

For its small size, the skull is relatively robust, but with weak yet complete zygomatic arches. The braincase rises gradually above the level of the rostrum. The rostrum is almost as wide as the braincase. The sagittal and lambdoid crests are moderately developed. The dental formula is 1123/3123 = 32. The first upper premolar is vestigial and minute (van der Merwe 1997) or absent (Ansell 1973). There is a single upper incisor.

External and cranial measurements (mm) and mass (g) for *Scotoecus hindei/albigula*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	9.5	8.0	11.0	-	2
FA[1,2,3,4]	35.1	32.2	38.5	1.70	22
Total[4]	90.0	87	93	-	2
Tail[4]	35.0	33	37	-	2
Tibia[1]	13.3	12.6	14.0	-	2
Ear[4]	13.3	13.0	13.5	-	2
CI[1]	14.6	13.8	15.1	0.46	8

[1] Specimens measured by the authors
[2] Taylor and van der Merwe (1998)
[3] Cotterill (2001d)
[4] Hayman (1963)

Key identification features: The combination of a broad, flattened skull, a club-shaped tragus and the presence of one upper incisor distinguishes *Scotoecus* from all other southern African vespertilionids. Furthermore, *Scotoecus* males have the longest penises of any African bat, with the proportion of penis length to head and body length reaching or exceeding 25%. *Mimetillus* also has a broad, flattened skull with a club-shaped tragus, but has two upper incisors, while the wings are short and narrow (the third digit is shorter than the head and body length in *M. thomasi*, but longer in *Scotoecus*). The dark wing membranes of *S. hindei/albigula* separate it from *S. albofuscus* (which has white or translucent wing membranes). The white belly of *S. hindei/albigula* may cause confusion with *Pipistrellus rueppellii*, but the latter has two upper incisors (of which the anterior is deeply bifid) and bicoloured fur on the upper parts (unicoloured in *S. hindei/albigula*).

Echolocation call: *Scotoecus hindei/albigula* produces LD-FM echolocation calls with an intermediate peak frequency (39.9±0.3 kHz, n = 2), narrow bandwidth (17.3±9.2 kHz, n = 2), and intermediate duration (4.2±0.1 ms, n = 2) (Taylor *et al*. 2005).

Distribution, habitat and roosting: *Scotoecus hindei/albigula* has been sparsely recorded from the northern and eastern parts of the region. It is known from the vicinity of Zinave National Park, southern Mozambique, northern Mozambique, southern Malawi, eastern and western Zambia, extreme southern DRC, and Angola (Monard 1935, Hayman 1963, Happold *et al*. 1987, Cotterill 2001d, A. Monadjem, unpublished data). The type specimen for *hindei* is from Kitui, Kenya (BM 1901.2.5.1, Holotype), while the type for *albigula* is from Mount Elgon, Kenya.

It is very poorly represented in museums, with just 24 records examined for this book. In southern Africa, most records are from low-lying woodland savannas, particularly in the vicinity of rivers or wetlands.

Extralimital: *Scotoecus hindei/albigula* has been collected from a few scattered localities across Africa, including Ethiopia, Uganda (Hill 1974b), Tanzania, Kenya, Somalia, Sudan and Nigeria (Cotterill 2001d).

Foraging ecology: There is no information on the diet and foraging behaviour of this species in southern Africa.

Reproduction: No reproductive information is available for southern Africa.

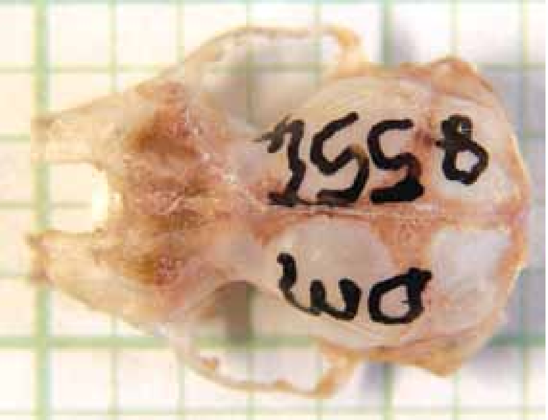


fig. 303a

fig. 303b

fig. 303c

fig. 303d

Figure 303. Skull and teeth of *Scotoecus hindei/ albigula:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8554).

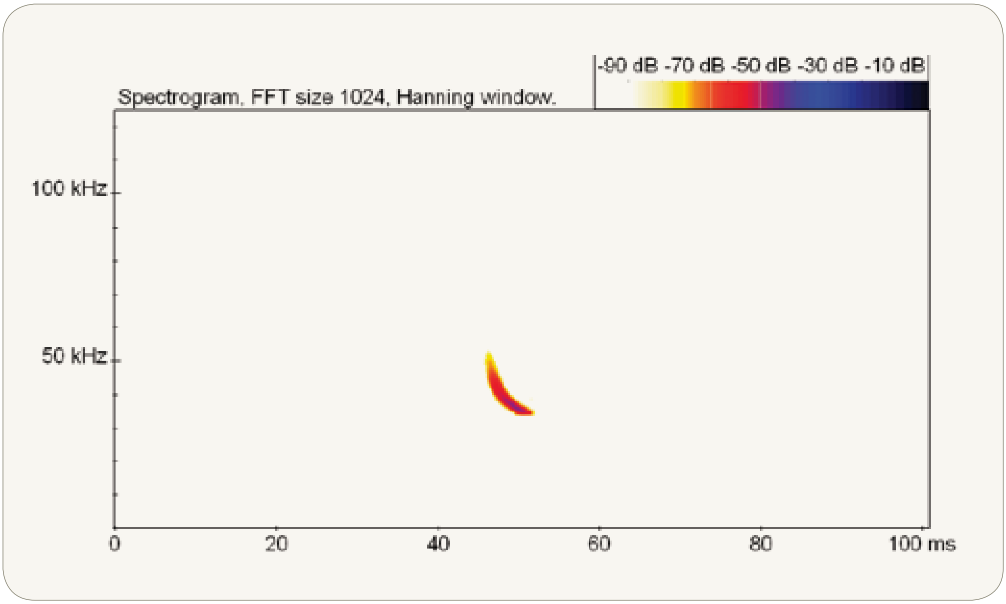


Figure 304. Echolocation call of *Scotoecus hindei/albigula.*

fig. 305a

Figure 305. Scotoecus hindei/albigula: (a) portrait showing club-shaped tragus, and (b) whole body showing broad muzzle and short, sleek pelage (a: © F. P. D. Cotterill; b: DM 8554, © A. Monadjem).

SYSTEMATIC NOTES

1901. *Scotoecus hindei* Thomas, Ann. Mag. nat. Hist., ser. 7 (39): 264. Kitui, Kenya.

1909. *Scotoecus albigula* Thomas, Ann. Mag. nat. Hist., ser. 4 (24): 544. Mount Elgon, Kenya.

The taxonomy of these dark-winged species of *Scotoecus* is still in dispute. Three or four taxa may be involved. *S. hirundo* (de Winton 1899) is the smallest bat in this species complex, but is currently not known from southern Africa. Two taxa, *S. hindei* and *S. albigula*, may both be present in southern Africa. They are both slightly larger than *S. hirundo*, and *S. albigula* has a more robust skull than *S. hindei*, with massive canines and cheek teeth. In Kenya, *S. albigula* is known from higher altitudes than *S. hindei* (Hill 1974b), but this does not appear to be the case in Malawi (Happold *et al.* 1987). It has been suggested that both species occur in southern Africa, based on cranial and dental features (Taylor and van der Merwe 1998, Cotterill 2001d), but species limits have not yet been resolved and it is not currently possible to map these two species separately.

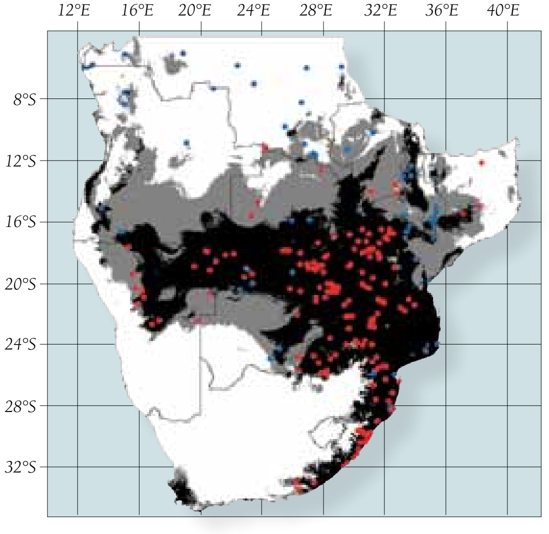
The diploid number in *S. hindei/albigula* is not known.

fig. 305b

Scotophilus dinganii (A. Smith 1833)

Yellow-bellied house bat

Least Concern



Description: *Scotophilus dinganii* is a medium-sized bat with a mass of around 26 g. The pelage is brown to dark brown above and bright yellow or orange-yellow below. The pelage is short and sleek with individual hairs unicoloured. The wings are dark brown. The face is plain, without any noseleafs. The ears are moderately sized, with a characteristically shaped long, narrow tragus. The sexes are alike.

In lateral profile, the skull is robust and deep. It is adapted for strong jaw action, with bowed zygomatic arches and pronounced coronoid processes of the mandible. The sagittal crest is pronounced and forms a distinctively swollen 'helmet', which projects posteriorly well beyond the line of the occipital bone. Ventrally, the anterior edge of the palate is deeply emarginated. The dental formula is 1113/3123 = 30. There is a single, prominent upper incisor. The anterior lower premolar is much smaller than the posterior, tightly squeezed between the canine and posterior premolar.

Key identification features: *S. dinganii* and *S. viridis* both have sleek fur, a long, narrow tragus, and yellow underparts, but *S. dinganii* is larger (in adults FA > 51 mm, and CI > 18.2 mm; *S. viridis*: FA < 51 mm, and CI < 18.2 mm). *Scotophilus nigrita* is much larger (FA > 70 mm), while *S. leucogaster* has cream or off-white underparts.

Echolocation call: *Scotophilus dinganii* produces LD-FM echolocation calls with an intermediate peak echolocation frequency (33.6±1.3 kHz, n = 10), narrow bandwidth (16.8±4.9 kHz, n = 10), and intermediate duration (4.9±0.6 ms, n = 10) (Schoeman and Jacobs 2008; also see Aldridge and Rautenbach 1987, Taylor 1999a, Taylor *et al*. 2005, Jacobs *et al*. 2006, Jacobs and Barclay 2009).

Distribution, habitat and roosting: *Scotophilus dinganii* is widespread in the region, but absent from the plateau grassland and karoo of South Africa and the Kalahari. It has been collected from the Eastern Cape, KwaZulu-Natal and Swaziland, through to northern South Africa, Zimbabwe, eastern and northern Botswana, northern Namibia, Zambia and Malawi. The model indicates that the specimens from northern Angola, the southern DRC and northern Zambia were collected in unsuitable conditions, suggesting that they may represent another species. Alternatively, this species has a wide tolerance for different environments. The exact location where the type specimen was collected is unknown, but its provenance was restricted somewhere along the north coast of KwaZulu-Natal between Durban and Maputo. The original specimen described by A. Smith 1833 could not be located, so a new type specimen (MNRM 1064, Neotype), also from 'Port Natal' and associated with the description of the homonym *Scotophilus dinganii* (Sundevall 1846) was selected by Robbins *et al*. (1985).

This species is well represented in museums, with over 700 records examined for this book. This is partly due to its habit of roosting in fabricated structures, including roofs of houses, making it easy to collect.

External and cranial measurements (mm) and mass (g) for *Scotophilus dinganii*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	23.9	15.2	31.0	4.25	26	**Mass**[1]	24.6	13.0	37.0	5.90	22
FA[1]	53.6	48.8	58.0	2.04	67	**FA**[1]	53.7	50.0	57.2	1.94	57
Total[1]	125.0	92	138	10.2	45	**Total**[1]	126.0	103	146	8.93	46
Tail[1]	48.0	29	59	6.50	51	**Tail**[1]	49.0	37	63	5.50	47
Tibia[1]	23.3	22.9	23.7	0.57	2	**Tibia**[1]	24.4	23.5	25.5	1.01	3
Ear[1]	15.5	11	19	2.13	49	**Ear**[1]	15.3	11	19	2.05	45
CI[1]	19.6	18.2	20.8	0.62	29	**CI**[1]	19.7	18.2	20.3	0.52	29

[1] Specimens measured by the authors

fig. 306a

fig. 306b

fig. 306c

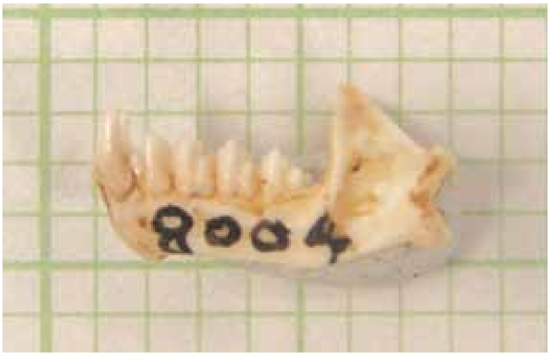


fig. 306d

Figure 306. Skull and teeth of *Scotophilus dinganii:* (a) dorsal view, (b) ventral view, (c) lateral view, (d) lateral view of mandible (DM 8004).

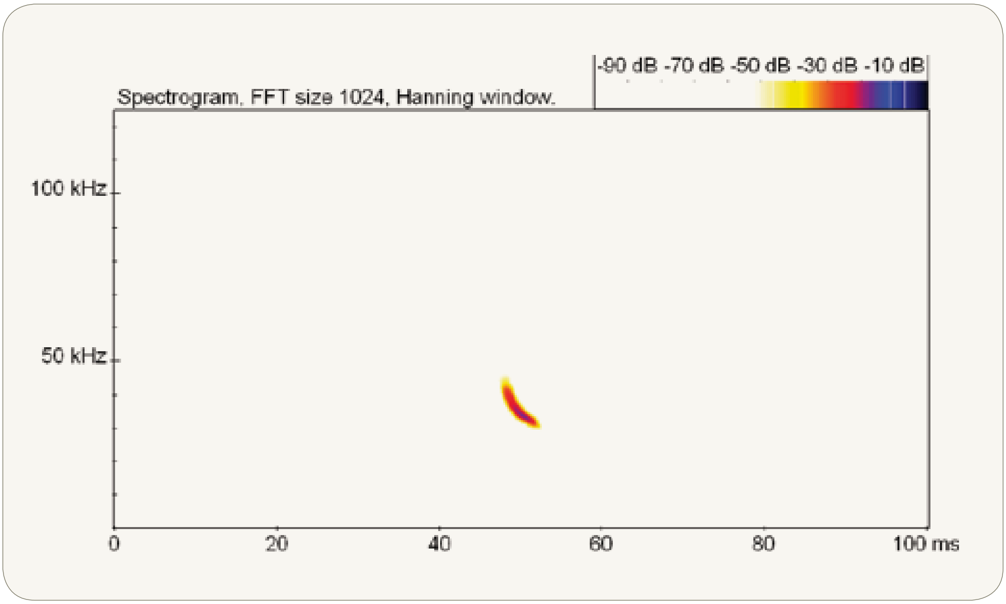


Figure 307. Echolocation call of *Scotophilus dinganii.*

It roosts during the day in a variety of shelters including holes in trees and roofs of houses (Jacobs and Barclay 2009, Jacobs *et al*. 2007b, Monadjem *et al*. submitted). The habitat of this wide-ranging species is not easy to quantify, but it appears to be tied to the presence of trees. These bats occur throughout the savanna biome, but avoid open habitats such as grasslands and karoo scrub. Its absence from open habitats may reflect the lack of roost sites. In Zimbabwe, they are apparently absent from the plateau (1,200–1,500 m above sea level) during the colder months of the year (June–August), but present at lower altitudes (600 m above sea level) in the southeast of the country (Skinner and Chimimba 2005).

Extralimital: *Scotophilus dinganii* has also been widely recorded throughout Africa; it is only absent from the Sahara and the forests of the Congo basin. However, based on molecular data, Trujillo *et al*. (2009) suggest that *dinganii* is restricted to southern Africa, so specimens identified as *dinganii* from East and West Africa represent two divergent cryptic species, which are possibly undescribed.

Foraging ecology: *Scotophilus dinganii* has relatively long wings with high wing loading (12.4 N.m-2) and intermediate aspect ratio (7.3) (Norberg and Rayner 1987, Aldridge and Rautenbach 1987; also see Schoeman and Jacobs 2008, Jacobs and Barclay 2009). It is a clutter-edge forager. Its diet comprises mainly medium-sized Coleoptera, but may also include Hemiptera, Hymenoptera, Isoptera and Diptera (Aldridge and Rautenbach 1987, Fenton *et al*. 1998b, Schoeman 2006, Jacobs and Barclay 2009; also see Kingdon 1974, Fenton *et al*. 1977, Whitaker and Mumford 1978).

Reproduction: *Scotophilus dinganii* is seasonally monoestrus, giving birth to between one and three young (typically twins) between November and December (extending into January in the case of captive bats in KwaZulu-Natal). Reproduction is delayed by a period of delayed embryonic implantation from late April until July (Taylor 1998, Van der Merwe *et al*. 2006).

SYSTEMATIC NOTES

1833. *Vespertilio dinganii* Smith, South African Quarterly Journal Ser. 2, 1(2): 59. Between Port Natal (= Durban) and Delagoa Bay (= Maputo).

Three subspecies are recognised in the region (Meester *et al.* 1986):

Scotophilus dinganii dinganii (A. Smith 1833)

Scotophilus dinganii herero Thomas 1906

1906. *Scotophilus dinganii herero,* Thomas, Annals and Magazine of Natural History (7) 17: 174. Olifants Vlei, Ovamboland, Namibia.

Scotophilus dinganii pondoensis Roberts 1946

1946. *Scotophilus dinganii* pondoensis Roberts, Annals of the Transvaal Museum 20: 304. Port St Johns, Eastern Cape.

Nycticejus planirostris Peters 1852 (ZMB 527, Holotype, from Tete, Mozambique) is a synonym (Turni and Kock 2008).
The validity of any of these subspecies cannot currently be determined. However, the taxa *herero* and *pondoensis* are geographically isolated from the nominate subspecies. A recent molecular study (Trujillo *et al.* 2009) suggested that *dinganii* is a species-complex comprising at least two additional cryptic species in East and West Africa, but its southern African samples originated

from a limited geographic region (Kruger National Park only); finer-scale geographic sampling is necessary to test for cryptic species within southern Africa.

In the historical literature, *S. dinganii* was called *S. nigrita* (see below). This name change is one reason for the taxonomic confusion that prevails over the real diversity of *Scotophilus* (see Meester *et al.* 1986 for a pithy overview). On morphological criteria (longer forearm), *S. dinganii* is distinct from the smaller *S. viridis* and *S. leucogaster*. Nevertheless, the study by Trujillo *et al.* (2009) revealed complex species relationships and at least three putative new species. According to Robbins *et al.* (1985), the small, white-bellied *Scotophilus* from Namibia (i.e. the form *damarensis*) is morphometrically closely related to *S. leucogaster* from other parts of Africa, making these a subspecies of *leucogaster*. Subject to further evidence, in this work we refer small individuals with cream-coloured bellies to *leucogaster*. Further, we consider the smaller, yellow-bellied form from southern Africa specifically distinct. It differs genetically and in echolocation call from *S. dinganii* (Jacobs *et al.* 2006), but is treated here as *S. viridis* (see *Scotophilus viridis* species account).

The genus *Scotophilus* is desperately in need of revision.

The diploid number in *S. dinganii* is 2n = 36 (Rautenbach *et al.* 1993).

fig. 308a

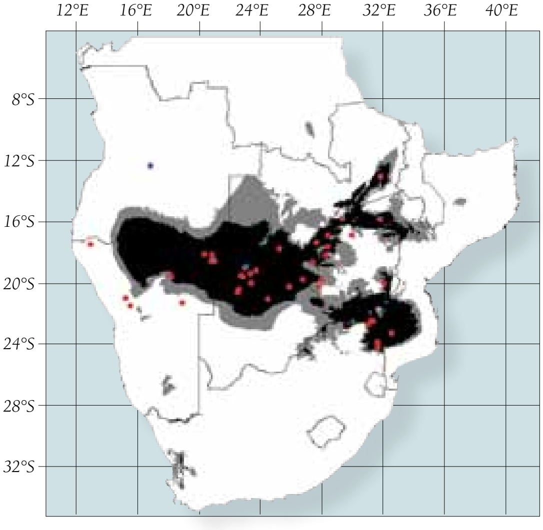
Figure 308. *Scotophilus dinganii,* (a) portrait showing long, narrow tragus, and (b) roosting individual showing yellow underparts (a: © Merlin D. Tuttle, Bat Conservation International, www.batcon.org; b: © F. P. D. Cotterill).

fig. 308b

Scotophilus leucogaster (Cretzschmar 1826)

White-bellied house bat

Least Concern



Description: *Scotophilus leucogaster* is a medium-sized bat with a mass of around 18 g. It is very similar in appearance to *S. viridis*. The pelage is short and sleek, pale to medium brown above, but white or cream below with individual hairs unicoloured. The wings are dark brown. The face is plain, without any noseleafs. The ears are moderately sized, with a characteristically shaped long, narrow tragus. The sexes are alike in size and appearance.

The sagittal and lambdoid crests are pronounced and form a distinctively swollen 'helmet', which projects posteriorly. In lateral profile, the cranium slopes gradually upwards from anterior to posterior. The dental formula is 1113/3123 = 30. There is a single large upper incisor. The canines are large and powerful. The anterior lower premolar is much smaller than the posterior premolar and tightly packed in the toothrow.

The W-pattern of the molar crown is poorly developed in all *Scotophilus* species; the posterior upper molar is shortened in length and only shows two legs of the W-pattern (Rosevear 1965).

Key identification features: The sleek fur and long, narrow tragus are shared by *Scotophilus leucogaster*, *S. dinganii* and *S. viridis*. *Scotophilus dinganii* is larger (FA > 50 mm, CI > 18.2 mm; *S. leucogaster*: FA < 51 mm, CI < 17.8 mm) and has a yellow belly. *Scotophilus nigrita* is very much larger (FA > 70 mm). *Scotophilus viridis* is similar in size to *S. leucogaster*, but *S. viridis* has yellow underparts. *Eptesicus hottentotus* bears a superficial resemblance to *S. leucogaster*, but has longer fur and possesses a minute second upper incisor (which is usually only observable on a cleaned skull with a hand-lens) and a short, rounded tragus.

Echolocation call: Owing to the taxonomic confusion that exists within this group, it is not clear whether the echolocation call of *Scotophilus leucogaster* has been recorded.

Distribution, habitat and roosting: *Scotophilus leucogaster* is sparsely and discontinuously distributed in the central savannas of the region. It occurs in northern South Africa, southern Mozambique, and southern Zimbabwe, with a separate population in northern Zimbabwe, central Mozambique, and southern Zambia, extending west to northern Botswana and Namibia. There is an isolated record from central Angola. The model suggests that suitable conditions occur in northern Namibia and adjoining parts of southern Angola where the species has not yet been recorded. The type specimens for *S. leucogaster* are from the Sudan (RMNH 27432, Holotype; SMF 4309, Lectotype); the type specimen for the subspecies *S. l. damarensis* is from northern Namibia (BM 1907.1.1.463, Holotype).

External and cranial measurements (mm) and mass (g) for *Scotophilus leucogaster*, males and females presented separately

	Mean	Min	Max	SD	N		Mean	Min	Max	SD	N
Males						**Females**					
Mass[1]	16.6	13.0	23.0	3.10	7	**Mass**[1]	17.8	15.0	21.0	2.49	8
FA[1]	49.2	45.7	51.9	1.71	16	**FA**[1]	50.3	48.0	51.5	0.93	13
Total[1]	120.0	115	126	3.50	10	**Total**[1]	123.0	117	131	4.27	11
Tail[1]	49.0	45	51	1.70	10	**Tail**[1]	50.0	45	53	3.00	11
Tibia	-	-	-	-	-	**Tibia**	-	-	-	-	-
Ear[1]	14.9	14	16	0.85	10	**Ear**[1]	15.3	14	16	0.65	11
CI[1]	17.1	16.6	17.7	0.35	17	**CI**[1]	17.1	16.5	17.6	0.33	12

[1] Specimens measured by the authors

fig. 309a

fig. 309b

fig. 309c

fig. 309d

Figure 309. Cranium and teeth of *Scotophilus leucogaster:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) mandible (DM 8576).

This species is not well represented in museums, with only 46 records examined for this book. This is partly due to its more restricted distribution compared with *S. dinganii*.

During the day, the bats roost in a variety of shelters, including holes in trees (Fenton 1983) and roofs of houses. Roost sites may be changed regularly (Fenton *et al*. 1985). This species has a strong association with cathedral mopane woodland, especially in the Limpopo, Sebungwe and Zambezi basins of Zimbabwe, where it is often the most abundant microbat (Fenton 1985).

Extralimital: *Scotophilus leucogaster* is widely distributed north of 5°N, and has been recorded from Kenya in the east to Senegal in the west (Robbins *et al*. 1985), but see 'Systematic notes' below.

Foraging ecology: At Sengwa Wildlife Research Station, Zimbabwe, the diet of *Scotophilus leucogaster* comprised mainly Hemiptera and Coleoptera, with Hymenoptera, Homoptera, Orthoptera, Lepidoptera and Diptera present in small numbers (Barclay 1985). Individuals foraged primarily over floodplains for an average of less than one hour at dusk and spent the rest of the night in small tree-cavity roosts (Barclay 1985; also see Fenton 1983).

Reproduction: The confusion over the true taxonomic affinities of these small house bats impinges on all aspects of our knowledge of their biology. In this respect, Van der Merwe and Rautenbach (1988) and Van der Merwe *et al*. (1988) reported that copulation and fertilisation in *Scotophilus borbonicus* takes place in April, followed by retardation of early embryonic development. But it remains unclear whether these *Scotophilus* studied in the Kruger National Park represent *S. leucogaster* or *S. viridis*. Cotterill and Giddings (1987) reported that parturition occurs in November (one or two young may be born) and lactation in December. Voucher specimens of the latter population, studied at Tashinga, Matusadona, by Cotterill and Giddings (1987) represent *S. leucogaster* (not *S. viridis*).

SYSTEMATIC NOTES

1826. *Nycticejus leucogaster* Cretzchmar, in Rüppell, Atlas Reise Nördl. Afr., Zool. Säugeth., 71. Kordofan, Sudan.

1906. *Scotophilus damarensis* O. Thomas 1906, Annals and Magazine of Natural History (7) 17: 175. Olifants Vlei (18°S, 17°30'E), Ovamboland, Namibia.

The relationship between *S. viridis* and *S. leucogaster* is difficult to discern in the field, although Robbins *et al.* (1985) concluded that they represent two distinct species. Meester *et al.* (1986) treated them as conspecific, as both are considerably smaller than *S. dinganii* and have white or cream bellies. Robbins *et al.* (1985) considered white-bellied specimens from Namibia *(damarensis)* to be conspecific with populations of *leucogaster* from other parts of Africa. Although *leucogaster* is supposed to be distinguishable on the grounds of a white belly, bats from West Africa referred by Rosevear (1965) to *leucogaster* typically have yellow bellies. The bats identified as *S. leucogaster* by Robbins *et al.* (1985) show a discontinuous African distribution, mostly absent from between 5°N and 12°S. This evidence suggests that the southern population is phylogenetically distinct, which would render *S. damarensis* specifically distinct as a southern African endemic.

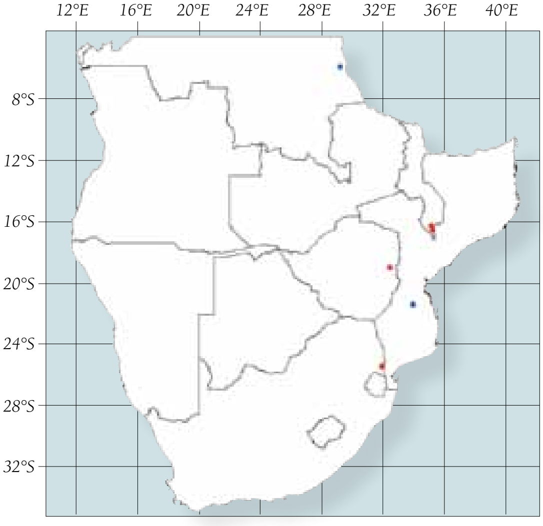
The diploid number in *S. leucogaster* is not known. The genetic sequences reported by Jacobs *et al.* (2006) for two specimens of *S. viridis* actually represent *S. leucogaster*, which confirms that the latter is distinct from the smaller house bats we classify here as *S. viridis*.

Figure 310. Scotophilus leucogaster, showing lack of yellow colouration on belly (DM 8576, © A. Monadjem).

Scotophilus nigrita (Schreber 1774) ●

Giant yellow house bat

Near Threatened



Description: *Scotophilus nigrita* is a very large bat with a mass of over 50 g. The pelage is short and sleek with individual hairs unicoloured. The upper parts are dark brown and sometimes tinged with yellow, red or grey. The underparts are yellow in adults and whitish in juveniles. The wings are dark brown. The face is plain, without any noseleafs. The ears are moderately sized, with a characteristically shaped long, narrow tragus. The sexes are alike.

The skull is similar in shape and dentition to other members of *Scotophilus*, but is much larger. It has a very prominent, vertically flattened, blade-like occipital 'helmet' formed by the posteriorly projecting sagittal crest. The zygomatic arches are very bowed. The mandible is robust with a thick mandibular arm and pronounced coronoid processes. Greatest skull length was 30.4–33.9 mm in seven specimens examined by Cotterill (1996a). The dental formula is 1113/3123 = 30.

External and cranial measurements (mm) and mass (g) for *Scotophilus nigrita*, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	53.0	-	-	-	1
FA[1,2]	77.9	77.0	78.7	-	2
Total[1,2]	175.0	175	175	-	2
Tail[1,2]	75.0	73	77	-	2
Tibia	-	-	-	-	-
Ear[1,2]	21.0	21	22	-	2
CI[1]	26.4	-	-	-	1

[1] Specimens measured by the authors

[2] Dalquest (1965)

Key identification features: The sleek fur, yellow underparts, long narrow tragus, and large size make *Scotophilus nigrita* unmistakeable. All other species of *Scotophilus* are much smaller (FA < 60 mm, CI < 21 mm; *S. nigrita*: FA > 70 mm). The only other insectivorous bats of a similar size – *Saccolaimus peli*, *Hipposideros vittatus* and *H. gigas* – differ completely in appearance.

Echolocation call: The echolocation call of this species has not been recorded.

Distribution, habitat and roosting: *Scotophilus nigrita* is sparsely, but widely, distributed in Africa, marginally entering southern Africa in the east. It has been recorded from Komatipoort and Malelane in South Africa, central Mozambique, eastern Zimbabwe and southern Malawi. The species is probably more evenly distributed than currently shown. The type specimen from Senegal cannot be located (Robbins *et al*. 1985); the type specimen of *S. gigas* Dobson 1875 is from Lagos, Nigeria (BM 1872.10.24.5, Holotype).

This species is poorly represented in museums, with only six records examined for this book.

Virtually nothing is known about its roosting behaviour and it is too thinly distributed for us to be able to comment on its habitat requirements. However, the Komatipoort and Malelane specimens were collected from bat houses and colonies are known from additional bat houses (N. Fernsby, personal communication).

Extralimital: Outside southern Africa, *Scotophilus nigrita* is widely but sparsely distributed in the DRC, Kenya, Tanzania, Sudan, Nigeria, Benin, Togo, Ghana and Senegal (Robbins *et al*. 1985).

Foraging ecology: A captive individual was observed feeding on very large Coleoptera (P. J. Taylor, personal observation).

Reproduction: An adult male handled on 17 November was scrotal (P. J. Taylor, personal observation).

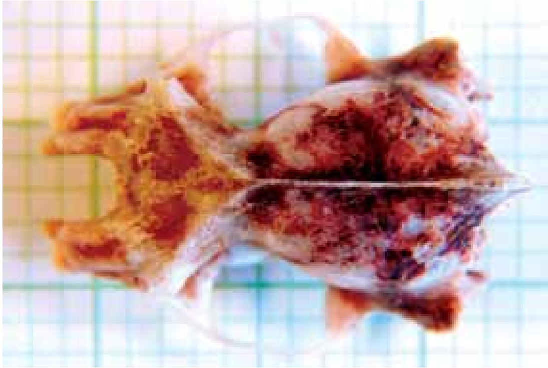


fig. 311a

fig. 311b

fig. 311c

fig. 311d

Figure 311. Skull and teeth of *Scotophilus nigrita:* (a) dorsal view, (b) ventral view, (c) lateral view, (d) lateral view of mandible (DM 9874).

SYSTEMATIC NOTES

1774. *Vespertilio nigrita* Schreber, Säugethiere 1: 171, pl. 58. Senegal.

Scotophilus nigrita was previously known as *S. gigas*, owing to a mistaken double description of two different species, but *nigrita* is the senior synonym. Confusingly, *S. dinganii* was for a while referred to as *S. nigrita* (particularly prior to 1978). Nevertheless, the taxonomic status of this species, the largest *Scotophilus*, is not in dispute. It follows that many references to *S. nigrita* in the literature constitute incorrect localities (e.g. Hutton 1986), and a specimen mapped in northeast Botswana is also incorrect, as they actually refer to *S. dinganii*. See Cotterill (1996a) in which a lapsus on the map plotted *S. nigrita* as incorrectly occurring in Botswana. Two subspecies are recognised by some authorities (e.g. Meester *et al.* 1986); these subspecies have widely disjunct distributions and may eventually be shown to be separate phylogenetic lineages. The southern African subspecies is *S. n. alvenslebeni* (NHMUK 18767, Holotype from Zinave, 212 km southwest of Beira, Mozambique, Dalquest 1965).

Scotophilus nigrita alvenslebeni Dalquest 1965

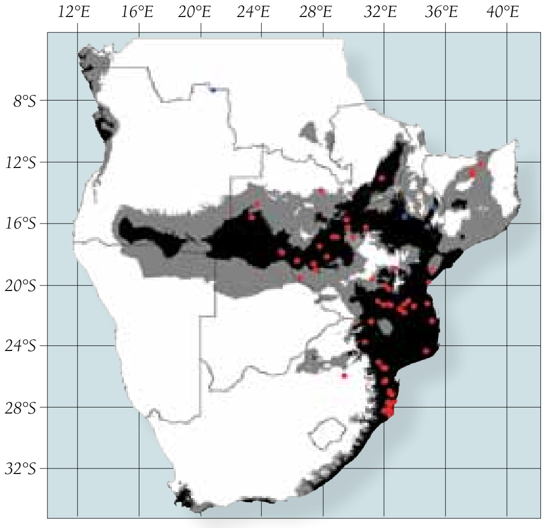
1965. *Scotophilus nigrita alvenslebeni*, Dalquest, J. Mammal., 46(2): 258. Zinave National Park, 212 km SW of Beira, Mozambique.

Figure 312. *Scotophilus nigrita,* showing the large size of this species (© P. J. Taylor).

Scotophilus viridis (Peters 1852)

Green house bat

Not Evaluated



Description: *Scotophilus viridis* is a medium-sized bat with a mass of around 20 g. It is very similar in appearance to, but distinctly smaller than, *S. dinganii*. The pelage is short and sleek, brown to dark brown above. The belly fur varies from light brown through to medium yellow; some specimens exhibit a bright yellow or orange-yellow venter. The individual hairs unicoloured. The wings are dark brown. The face is plain, without any noseleafs. The ears are moderately sized, with a characteristically shaped long, narrow tragus. The sexes are alike.

The skull is robust and deep in lateral profile, with bowed zygomatic arches and a mean condylo-incisor length of 19.6 mm (males) and 19.7 mm (females). The sagittal crest is pronounced, forming a distinctively swollen 'helmet', which projects posteriorly well beyond the line of the occipital bone. The coronoid processes of the mandible are pronounced. Ventrally, the anterior edge of the palate is deeply emarginated.

External and cranial measurements (mm) and mass (g) for Scotophilus viridis, sexes combined

	Mean	Min	Max	SD	N
Mass[1]	20.0	9.0	33.0	6.06	16
FA[1]	47.2	44.2	51.7	1.72	33
Total[1]	125.0	122	129	3.21	5
Tail[1]	45.0	33	53	6.80	8
Tibia[1]	20.7	19.1	22.8	1.06	8
Ear[1]	15.0	13	16	1.20	6
CI[1]	17.3	16.4	18.2	0.46	20

[1] Specimens measured by the authors

The dental formula is 1113/3123 = 30. A single, prominent upper incisor is present. The anterior lower premolar is much smaller than the posterior premolar, and is tightly squeezed between the canine and posterior premolar.

Key identification features: *Scotophilus viridis* and *S. dinganii* share sleek fur, a long, narrow tragus, and yellow underparts; but *S. viridis* is smaller (FA < 51 mm, CI < 18.2 mm; *S. dinganii*: FA > 51 mm, CI > 18.2 mm). *S. nigrita* is very much larger (FA > 70 mm), while *S. leucogaster* has cream or off-white underparts. *Eptesicus hottentotus* bears a superficial resemblance to *S. viridis*, but has longer fur, lacks the yellow underparts, and possesses a minute second upper incisor (which is usually only observable on a cleaned skull with a hand-lens), as well as a short, rounded tragus.

Echolocation call: Individuals attributed to *Scotophilus viridis* produced LD-FM echolocation calls with an intermediate peak echolocation frequency (40 kHz, n = 5), broad bandwidth (25 kHz, n = 5), and long duration (10 ms, n = 5) (Fenton and Bell 1981; also see Fenton *et al*. 1998a). In populations of small (FA < 51 mm) yellow-bellied *Scotophilus* (which we here call *viridis)* from St Lucia, the Kruger National Park and Zambia, individuals produced LD-FM calls with a mean dominant frequency of 44.3 kHz (n = 4) (Jacobs *et al*. 2006; also see Schoeman and Jacobs 2008, Jacobs and Barclay 2009). It is possible that the 40-kHz calls recorded by Fenton and Bell (1981) may have been attributed to *S. leucogaster* (the pale-bellied small species).

Distribution, habitat and roosting: *Scotophilus viridis* has a restricted distribution in the region and is confined mainly to the eastern parts. Its distribution extends from eastern and northern KwaZulu-Natal through Swaziland, the Kruger National Park, Mozambique and northern Zimbabwe. It has also been collected from southern Malawi and central Zambia. A single record is known from northeastern Angola. This species is almost certainly under-sampled and will probably be shown to be more widespread in the subtropical eastern and northern parts of the region. The type specimen for *S. viridis* is from Mozambique (ZMB 73610). The identities of specimens in NMZB is likely an under-representation of the range and abundance of *S. viridis* in Zimbabwe and Mozambique, subject to a thorough revision of all specimens (F. P. D. Cotterill, unpublished data).

This species is not well represented in museums, with only 41 records examined for this book. This is partly due to what appears to be its more restricted distribution compared with *S. dinganii*. Where it does occur, it is often numerically dominant to *S. dinganii*, as found in Swaziland and Mozambique (A. Monadjem, unpublished data).

During the day, the bats roost in a variety of shelters, including holes in trees (Monadjem *et al*. in press) and roofs of houses (Jacobs *et al*. 2007b, Jacobs and Barclay 2009). It

fig. 313a

fig. 313b

fig. 313c

fig. 313d

Figure 313. Skull and teeth of *Scotophilus viridis:* (a) dorsal view, (b) ventral view, (c) lateral view, and (d) lateral view of mandible (DM 8488).

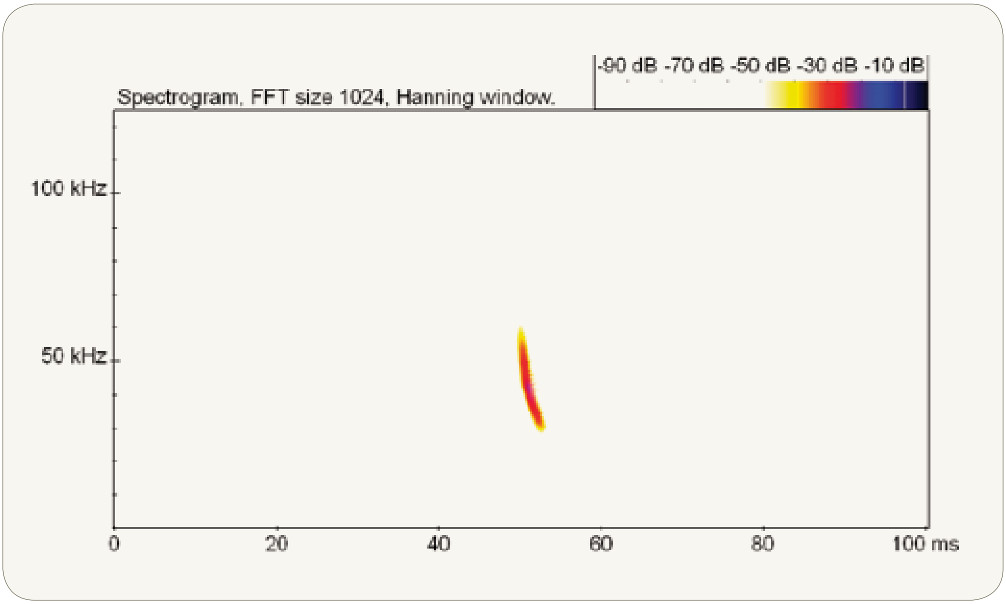


Figure 314. Echolocation call of *Scotophilus viridis*.

appears to be restricted to low-lying, hot savannas, avoiding open habitats such as grasslands. Its absence from open habitats may be due to the lack of roost sites. Many of the specimens from Zambia and Zimbabwe are associated with tall riparian woodland in the Zambezi, Luangwa and Limpopo valleys (F. P. D. Cotterill, unpublished data).

Extralimital: *Scotophilus viridis* has also been recorded from Tanzania and Kenya.

Foraging ecology: If taxonomic affinities are reliable, it appears that the diet of *Scotophilus viridis* comprises mainly Coleoptera, Lepidoptera and Hemiptera (Fenton *et al*. 1977, Fenton and Bell 1981, Fenton 1985; also see Whitaker and Mumford 1978, Jacobs and Barclay 2009).

Reproduction: Taxonomic confusion and uncertainty over the real identity of published data make it impossible to know whether the reproductive biology of *S. leucogaster*, *S. viridis* or perhaps an as yet undescribed species of house bat has been reported in the scientific literature. (Also see comments under *Scotophilus leucogaster* species account.)

SYSTEMATIC NOTES

1852. *Nycticejus viridis* Peters, Reise nach Mossambique, Säugethiere: 67. Mozambique Island, 15°S, Mozambique

We follow Robbins *et al.* (1985) and Simmons (2005) in recognising *Scotophilus viridis*, contingent on a thorough generic revision. Although *S. dinganii* appears to be separable on larger size, the relationship between *S. leucogaster* and *S. viridis* (both of similar size) awaits firm clarification of diagnostic characters, additional to pelage colouration and the multivariate analyses of Robbins *et al.* (1985). Nevertheless, the sonar calls of all three species (as currently recognised here, following Robbins *et al.* 1985) are diagnostic. (For further information, see below and the *Scotophilus dinganii* account.) A recent molecular study (Trujillo *et al.* 2009) suggested that *viridis* is a species-complex comprising at least one additional cryptic species in East Africa. The southern African samples originated from a limited geographic region (Kruger National Park), so finer-scale geographic sampling is necessary to test for cryptic species within southern Africa. Genetic sequences reported by Jacobs *et al.* (2006) for two specimens of *S. viridis* actually refer to *S. leucogaster*, and the latter study confirmed the genetic distinctiveness of the three taxa: *dinganii, leucogaster* and *viridis*.

The type specimen of *S. viridis* was not available to Robbins and earlier workers. Fortunately, it has been relocated in Berlin. Whilst this type of *viridis* appears to have a pale venter, this is a very old specimen (collected in 1845) and the yellow colour appears to have faded. Moreover, with respect to *S. viridis*, Robbins *et al*. (1985)

fig. 315a

concluded that '… the original description (Peters 1852) allows for consistent species identity as applied to all small African mainland specimens [of *Scotophilus*].' So, subject to further information, we conclude that *S. viridis* is the valid name for this small, yellow-bellied House bat that is widespread in the eastern parts of southern Africa. Any further research into these challenging problems of the diversity of African *Scotophilus* has to be founded on exhaustive scholarship; one that incorporates all published taxonomic knowledge. Any departures from this primary responsibility will only magnify existing taxonomic confusion. In this context the manuscript name *'S. mhlanganii'* (Jacobs *et al*. 2007, Jacobs and Barclay 2009) is a *nomen nudum*, because it lacks both type material and a legitimate taxonomic description, notably one detailing how it differs from all described Scotophilus species (see Gardner and Hayssen 2004 and Winston 1999 for minimum standards in taxonomic nomenclature).

The diploid number in *'S. viridis'* is 2n = 36 (Rautenbach *et al.* 1993); however, as discussed above under 'Echolocation', since *viridis* has been characterised as having a white or cream-coloured belly, it may be that specimens examined by Rautenbach *et al.* (1993) would perhaps be referable to the pale-bellied *S. leucogaster*. Eventual resolution of this taxonomic impasse requires a broader geographic scope (samples from southern, Eastern, Central and West Africa), combining molecular and morphological datasets, and comparisons that focus on DNA sequences of critical type material which vouches for the many available names for small-sized *Scotophilus* members. These need to include the several West African forms discussed by Rosevear (1965) and Robbins *et al.* (1985).

Figure 315. Scotophilus viridis: (a) showing long, narrow tragus and yellow underparts; (b) the yellow throat (characteristic of the venter) and the long sickle-shaped tragus typical of the genus (a: © L. Lumsden; b: © F. P. D. Cotterill).

fig. 315b

Figure 316. Scotophilus viridis type specimen, showing what appears to be a cream (not yellow) venter, in conflict with the original description of this taxon. The pelage of this study skin has faded since its preservation in 1845 (ZMB 73610; © H. Turni).

LIST OF SPECIMENS

The gazetteer is sorted in alphabetical order by family, genus, species, country and locality. It contains 6,000 records from 11 countries. Each record lists the following information:

- Museum accession number, if available.
- Locality name.
- Locality latitude and longitude.
- A ● symbol here indicates that the specimen was examined by one of the authors. These specimens are also represented by a red dot on the distribution maps. Specimens not inspected by one of the authors are represented by a blue dot on the maps.
- One or more references are given in cases where the specimen was not seen by one of the authors.
- ? indicates missing information, for example, where a specimen label had no accession number or locality data.
- Abbreviations: GR – Game Reserve, NP – National Park, NR – Nature Reserve, R – River

Accession numbers use the following museum acronyms:

AMNH	American Museum of Natural History, New York
BM	British Museum, London
CAS	California Academy of Sciences, San Francisco
CMNH	Carnegie Museum of Natural History, Pittsburgh
CUMZ	Cambridge University Museum of Zoology, Cambridge
DCHC	D. C. D. Happold Personal Collection
DM	Durban Natural Science Museum, Durban
FMNM	Field Museum, Chicago
HNHM	Hungarian Natural History Museum, Budapest
HZM	Harrison Zoological Museum, Sevenoaks, UK
IICA	Centro de Estudos do IICA, Angola
IICT	Centro de Zoologica do IICT, Lisbon
IRSN	Institut Royal des Sciences Naturelles de Belgique, Brussels
KM	Amathole Museum, King Williams Town, South Africa
LACM	Los Angeles County Museum, Los Angeles
MCZ	Museum of Comparative Zoology, Harvard
MD	Museu do Dundo, Angola
MHNC	Musée d'Histoire naturelle La Chaux-de-Fonds, Switzerland
MHNFCP	Museu de História Natural da Faculdade de Ciências do Porto, Portugal
MHNG	Muséum d'Histoire naturelle de la Ville de Genève, Switzerland
MLZA	Museu e Laboratório Zoológico e Antropológico, Lisbon
MMB	Museum of Malawi, Blantyre
MMK	McGregor Museum, Kimberley
MNHN	Muséum national d'Histoire naturelle, Paris
MNKB	Von Humboldt Museum of Natural History, Berlin
NHMUK	Museum of Natural History, Kansas
NM	Natal Museum, Pietermaritzburg
NMB	National Museum, Bloemfontein
NMBA	Naturhistorisches Museum, Basel
NMW	Naturhistorisches Museum, Wien
NMZ	National Museum of Zambia, Livingstone
NMZB	Natural History Museum of Zimbabwe, Bulawayo
RMCA	Royal Museum of Central Africa, Tervuren
RMNH	Rijksmuseum van Natuurlijke Historie, Leiden
ROM	Royal Ontario Museum, Toronto
SAM ZM	Iziko Museum, Cape Town
SMF	Senckenberg Museum, Frankfurt
SMM	National Museum, Windhoek, Namibia
TM	Transvaal Museum, Pretoria
USNM	National Museum of Natural History, Washington (Smithsonian Institute)
UZMZ	University of Zambia Museum of Zoology, Lusaka
ZMA	Zoölogisch Museum, Amsterdam
ZMB	Zoologisches Museum, Berlin
ZMMU	Zoological Museum, Moscow University, Moscow

EMBALLONURIDAE

Coleura

afra

ANGOLA
?, Benguela, -12.63, 13.38 (Crawford-Cabral 1986)
IICA5233, Novo Redondo (= Sumbe), -11.38, 13.88 ●
MOZAMBIQUE
?, Tete, -16.27, 33.58 (Smithers & Lobão Tello 1976)

Saccolaimus

peli

ANGOLA
?, Lago Calundo, -11.72, 20.80 (Crawford-Cabral 1986)
DRC
BM?, Inkongo, -4.92, 23.25 (Hayman *et al.* 1966)
RMCA14913, Kikwit, -5.22, 18.82 (Hayman *et al.* 1966)
RMCA7541, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)
BM?, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)

Taphozous

mauritianus

ANGOLA
?, Benguela, -12.63, 13.38 (Crawford-Cabral 1986)
?, Caiundo, -15.63, 17.38 (Crawford-Cabral 1986)
?, Catumbela, -12.38, 13.63 (Crawford-Cabral 1986)
?, Dundo, -7.38, 20.88 (Crawford-Cabral 1986)
?, Duque de Braganca (= Calandula), -9.13, 15.88 (Crawford-Cabral 1986)
?, Humbe, -16.63, 14.88 (Crawford-Cabral 1986)
IICA45, Luanda, -8.88, 13.38 ●
BOTSWANA
NMZB63745, Chobe NP, Kasane, -17.80, 25.15 ●
NMZB63749, Francistown, -21.15, 27.50 ●
NMZB63744, Sehitwa, 22 km W, -20.38, 22.63 ●
USNM00518614, Xugana, -19.08, 23.10 (Archer 1975)
DRC
RMCA148, Banana, -5.97, 12.45 (Hayman *et al.* 1966)
RMCA18567, Baudouinville (= Moba), -7.05, 29.70 (Hayman *et al.* 1966)
RMCA?, Boma, -5.83, 13.05 (Schouteden 1947)
RMCA19417, Elisabethville (= Lubumbashi), -11.68, 27.48 (Hayman *et al.* 1966)
RMCA6312, Inkongo, -4.92, 23.25 (Hayman *et al.* 1966)
RMCA22898, Kakanda, -10.78, 26.60 (Hayman *et al.* 1966)
IRSN10853, Kilwezi, -9.10, 26.70 (Hayman *et al.* 1966)
IRSN242, Landana, -5.23, 12.13 (Hayman *et al.* 1966)
RMCA9990, Leverville (= Lusanga), -4.83, 18.72 (Hayman *et al.* 1966)
RMCA1549, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)
RMCA12131, Luputa, -7.12, 23.72 (Hayman *et al.* 1966)
RMCA7333, Lusambo, -4.98, 23.43 (Hayman *et al.* 1966)
RMCA6553, Macaco, -5.47, 21.17 (Hayman *et al.* 1966)
RMCA18162, Makengo, -4.75, 16.50 (Hayman *et al.* 1966)
RMCA16247, Nyangwe, -4.25, 26.23 (Hayman *et al.* 1966)
RMCA6549, Tshikapa, -6.47, 20.80 (Hayman *et al.* 1966)
MALAWI
MMB?, Blantyre, -15.78, 35.00 (Happold *et al.* 1987)
MMB?, Chikwawa, -16.02, 34.78 (Happold *et al.* 1987)
MMB?, Karonga, -9.93, 33.93 (Happold *et al.* 1987)
DCHC?, Kasungu NP, -13.05, 33.15 (Happold *et al.* 1987)
NMZB63750, Kasungu NP, -13.05, 33.15 ●
DCHC?, Liwonde NP, -15.03, 35.25 (Happold *et al.* 1987)
KM11767, Nkhotakota, -12.93, 34.30 ●
MOZAMBIQUE
USNM00365457, Beira, 10 km N, -19.82, 34.87
NMZB63743, Save R Bridge, 30 km N, -21.63, 32.38 ●
?, Tete, -16.27, 33.58 (Smithers & Lobão Tello 1976)
NAMIBIA
Picture, Etosha NP, Halali, -19.13, 16.38 ●
NMZB63747, Katimo Mulilo, -17.50, 24.33 ●
?, Swakopmund, -22.63, 14.63 (M. Griffin pers. comm.)
SMM12486, Terrace Bay, -20.00, 13.10 (M. Griffin pers. comm.)
?, Tsumkwe, -19.63, 20.63 (M. Griffin pers. comm.)
SOUTH AFRICA
KM32581, Albany District, -33.30, 26.08 ●
TM17502, Bronkhorstspruit, -25.82, 28.75 ●
TM44063, Doorndraai Dam NR, -24.27, 28.72 ●
TM8725, Duiwelskloof, -23.70, 30.13 ●
TM25264, Duiwelskloof, 8 km E, -23.70, 30.27 ●
DM15, Durban, -29.85, 31.00 ●
TM2353, Durban, -29.85, 31.00 ●
TM27685, Ellisras, 10 km SE, -23.75, 27.83 ●
TM3491, Greytown, -29.13, 30.63 ●
TM44196, Hans Strydom Dam NR, -24.03, 27.77 ●
?, Hartswater, -27.88, 24.88 (Erasmus & Rautenbach 1984)
SAM ZM34195, Heidelberg, -34.13, 20.88 ●
DM3268, Howick, -29.50, 30.23 ●
TM38381, Howick, -29.50, 30.23 ●
NMZB56049, Klipfontein, Waterberg, -24.13, 28.30 ●
TM39573, Kruger NP, Letaba Bridge, -23.82, 31.58 ●
TM36594, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM36781, Kruger NP, Punda Milia, 16 km NE, -22.68, 31.03 ●
TM39730, Kruger NP, Skukuza, -24.98, 31.58 ●
TM44201, Messina NR, -22.38, 30.07 ●
TM38107, Mkhuze GR, -27.60, 32.21 ●
TM35443, Pietermaritzburg, Town Bush, -29.55, 30.35 ●
TM23340, Potgietersrus (= Mokopane), 25 km ESE, -24.25, 29.13 ●
TM13104, Pretoria, -25.75, 28.25 ●
TM41432, Roossenekal, -25.21, 29.97 ●
DM2478, Royal Natal NP, -28.68, 28.93 ●
TM19631, Rustenburg, 18 km S, -25.82, 27.27 ●
TM23335, Steilloop, 18 km N, -23.27, 28.62 ●
TM1097, Tzaneen, -23.83, 30.17 ●
TM34133, Waterberg District, -22.53, 29.43 ●
SWAZILAND
DM5817, Mlawula NR, -26.19, 32.01 ●
ZAMBIA
NMZ3457, Chilanga, -15.55, 28.27 (Ansell 1986)
KM9668, Fort Jameson (= Chipata), -13.62, 32.65 ●
NMZB8293, Kabompo Boma, -13.58, 24.20 ●
NMZB28143, Kalabo, -14.97, 22.68 ●
?, Lake Mweru, -8.70, 29.00 (Ansell 1978)
NMZ2898, Lochinvar, -15.98, 27.25
NMZ?, Mwandi, -17.52, 24.82 (Ansell 1967)
UZMZ504, Nabwalia Village, -12.40, 31.97 (Ansell 1969)
NMZB30904, Nansai Farm, Choma, -16.62, 27.12 ●
FMNH95217, Sihole, -15.32, 22.57 (Ansell 1967)
FMNH95214, Sikongo, -15.00, 22.17 (Ansell 1967)
ZIMBABWE
NMZB56962, Bulawayo Natural History Museum, -20.13, 28.58 ●
NMZB9825, Bulawayo, Lakeside, -20.13, 28.58 ●
NMZB30715, Chikwarakwara, -22.35, 31.10 ●
NMZB56967, Chiredzi Research Station, -21.02, 31.57 ●
SAM ZM13752, Chishawasha, -17.88, 31.13 ●
NMZB56198, Denja Camp, Matetsi, -18.38, 25.88 ●
NMZB56958, Dete, -18.62, 26.85 ●
NMZB79461, Doddieburn Ranch, -21.40, 29.35 ●
NMZB56944, Eirene Farm, Marondera, -18.37, 31.62 ●
NMZB30002, Enyandeni, -20.25, 28.50 ●
NMZB56337, Esigodini, Falcon College, -20.22, 28.92 ●
NMZB56936, Fishans, Lower Runde R, -21.25, 32.25 ●
NMZB56312, Gem Farm, Beitbridge, -21.87, 29.62 ●
NMZB56953, Gonarezhou NP, Chipinda Pools, -21.27, 31.90 ●
NMZB56951, Great Zimbabwe, -20.28, 30.93 ●
NMZB56933, Harare, -17.83, 31.07 ●
NMZB60776, Hillandale, Kwekwe, -18.93, 29.82 ●
NMZB56963, Hwange NP, Bumbusie, -18.50, 26.00 ●
NMZB56961, Hwange NP, Main Camp, -18.73, 26.95 ●
NMZB56957, Hwange NP, Ngamo Pan, -19.13, 27.47 ●
NMZB56959, Lake Kyle NP, -20.17, 30.92 ●
NMZB56955, Mana Pools NP, Nyamepi, -15.80, 29.37 ●
NMZB77686, Matusadona NP, Tashinga, -16.87, 28.37 ●
NMZB56937, Mrewa, -17.50, 31.75 ●
NMZB59374, Mtshabezi Bridge, -21.37, 29.62 ●
NMZB56971, Mushandike NP, Matema Camp, -20.12, 30.62 ●
NMZB56947, Sabi-Lundi (= Save-Runde) R Confluence, -21.28, 32.38 ●
NMZB56949, Sabi-Lundi (= Save-Runde) R Confluence, -21.28, 32.38 ●
NMZB31362, Save-Lunde R Confluence, Marhumbini, -21.28, 32.38 ●
NMZB56945, Selous, -18.00, 30.25 ●
NMZB59300, Sengwa Wildlife Research Station, -18.17, 28.22 ●
NMZB30859, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB56942, Virginia Farm, Glendale, -17.33, 31.05 ●
NMZB56943, Virginia Farm, Glendale, -17.33, 31.05 ●

perforatus

BOTSWANA
NMZB63759, Savuti R, -18.62, 24.12 ●
DRC
BM?, Jadotville (= Likasi), -10.97, 26.78 (Hayman *et al.* 1966)
RMCA22487, Kakontwe, -10.98, 26.63 (Hayman *et al.* 1966)
RMCA29209, Kasongo, -4.52, 26.58 (Hayman *et al.* 1966)
RMCA26709, Pempéré, -10.97, 26.78 (Hayman *et al.* 1966)
MOZAMBIQUE
?, Save-Lunde R Confluence, Marhumbini, -21.28, 32.38 (Smithers & Lobão Tello 1976)
ZAMBIA
HZM44.8597, Kilwa Is, Lake Mweru, -9.13, 28.38 (Ansell 1978)

ZIMBABWE
NMZB56984, Chiribira Falls, Save R, -21.00, 32.25 ●
NMZB9934, Limpopo-Shashi R Confluence, -22.22, 29.37 ●
NMZB56977, Matobo NP, Whitewaters Dam, -20.58, 28.47 ●
NMZB29962, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB56985, Shashi Rocks, 30 km from Mvuma, -19.60, 30.80 ●

HIPPOSIDERIDAE

Cloeotis

percivali

BOTSWANA
BM56.550, Kanye, -24.75, 25.25 (Smithers 1971)
AMNH?, Livingstone's cave, Molepolole, -24.25, 25.50 (Smithers 1971)
DRC
MHNG1046.98, Kaboyaboya, -9.93, 25.97 (Hayman *et al.* 1966)
IRSN10792, Kiamokoto, -9.17, 27.07 (Hayman *et al.* 1966)
RMCA27906, Likasi, -11.08, 26.55
IRSN10777, Masombwe, -9.08, 27.10 (Hayman *et al.* 1966)
RMCA27907, Shinkolobwe, -11.10, 26.55 (Hayman *et al.* 1966)
BM?, Shinkolobwe, -11.10, 26.55 (Hayman *et al.* 1966)
MOZAMBIQUE
?, Vila de Manica (= Manica), 10 km N, -18.83, 32.95 (Smithers & Lobão Tello 1976)
SOUTH AFRICA
TM39774, Figaro Mine, 11 km NE of Malelane, -25.45, 31.63 ●
TM34577, Howell Davies Cave, Zebediela, -24.38, 29.38 ●
DM4703, Jozini Dam, -27.41, 31.89 ●
TM17503, Komatipoort, -25.43, 31.93 ●
DM1616, Mkhuze GR, Mantuma, -27.59, 32.22 ●
TM2101, Pretoria, -25.68, 28.20 ●
TM1669, Thabazimbi, Mooimijsiesfontein, -25.02, 27.62 ●
TM47615, Waterval-Boven, -25.87, 30.32 ●
SWAZILAND
DM8026, Wylesdale, -25.82, 31.29 ●
TM1987, Wylesdale, -25.82, 31.29 ●
ZAMBIA
HZM5.3176, Kafue Gorge, -15.77, 28.35 (Ansell 1969)
NMZB20189, Missale Old Mine, -14.12, 32.87 ●
NMZ3437, Ngwerere Cave, -15.30, 28.33 (Ansell 1986)
UZMZ133, Ngwerere Siding, -15.32, 28.32 (Ansell 1969)
ZIMBABWE
USNM00154589, Bulawayo, -20.12, 28.58
NMZB31143, Chinhoyi, Kaukua Cave, -17.03, 30.09 ●
NMZB56205, Esigodini, Falcon College, -20.22, 28.92 ●
NMZB58498, Great Zimbabwe, -20.28, 30.93 ●
?, Gwanda, -20.88, 29.13 (Hayman 1960)
NMZB58474, Lake McIlwaine, -17.90, 30.78 ●
NMZB58507, MacDougall's Tunnel, Triangle, -21.12, 31.37 ●
NMZB58175, Mutare, Asbestos Mine, -18.92, 32.62 ●
NMZB25859, Mutare, Old Mine, -19.08, 32.70 ●
NMZB58506, North Mine, Mutare, -18.87, 32.62 ●
HZM1.2601, Peak Mine, Belingwe, -20.47, 29.85 ●
NMZB64808, Sengwa Wildlife Research Station, -18.17, 28.22 ●

Hipposideros

caffer

ANGOLA
?, Bimbe, -11.88, 15.88 (Crawford-Cabral 1986)
?, Caiala, -12.38, 17.13 (Crawford-Cabral 1986)
?, Caluquembe, -13.88, 14.63 (Crawford-Cabral 1986)
?, Congulu, -10.88, 14.38 (Crawford-Cabral 1986)
IICA7850, Equinima, -13.38, 12.63 (Crawford-Cabral 1986)
?, Hanha Estate, -12.38, 13.88 (Crawford-Cabral 1986)
?, Lobito, -12.38, 13.63 (Crawford-Cabral 1986)
?, Novo Redondo (= Sumbe), -11.38, 13.88 (Crawford-Cabral 1986)
IICA493, Pedra Grande, Caraculo, -15.13, 12.63 ●
NMZB63480, Salazar (= N'Dalatando), Agronomic Station, -9.38, 14.88 ●
SMM6705, Tchivinguiro, -15.13, 13.38 ●
BOTSWANA
USNM00462297, Chobe NP, Kasane, -17.80, 25.15
NMZB64283, Chobe NP, Kasane, -17.80, 25.15 ●
TM39268, Maun, 12 km NE, -19.87, 23.12 ●
DRC
RMCA 21478, Banana, -5.97, 12.45 (Hayman *et al.* 1966)
RMCA16183, Elisabethville (= Lubumbashi), -11.68, 27.48 (Hayman *et al.* 1966)
RMCA16185, Elisabethville (= Lubumbashi), -11.68, 27.47 (Hayman *et al.* 1966)
RMCA5382, Funda Biabo, -9.83, 25.53 (Hayman *et al.* 1966)
RMCA27537, Jadotville (= Likasi), -10.97, 26.78 (Hayman *et al.* 1966)
RMCA9166, Kabalo, -6.03, 26.92 (Hayman *et al.* 1966)
IRSN 10727, Kafwe, -9.15, 27.07 (Hayman *et al.* 1966)
RMCA22489, Kakontwe, -10.98, 26.63 (Hayman *et al.* 1966)
RMCA10850, Kakyelo, -12.35, 29.60 (Hayman*et al.*1966)
IRSN 7743, Kalenda, -7.05, 23.50 (Hayman *et al.* 1966)
RMCA22191, Kapolowe, -11.05, 26.95 (Hayman *et al.* 1966)
RMCA23803, Kasenga, road, km 106, -10.73, 28.43 (Hayman *et al.* 1966)
RMCA 29201, Kasongo, -4.52, 26.58 (Hayman *et al.* 1966)
RMCA14917, Kele, -5.52, 14.60 (Hayman *et al.* 1966)
RMCA 16225, Kiambi, -7.23, 27.87 (Hayman *et al.* 1966)
IRSN 10761, Kiamokoto, -9.17, 27.07 (Hayman *et al.* 1966)
RMCA6563, Kisantu, -5.13, 15.15 (Hayman *et al.* 1966)
RMCA23809, Kyasala cave, -9.93, 25.97 (Hayman *et al.* 1966)
IRSN 208b, Landana, -5.23, 12.13 (Hayman *et al.* 1966)
RMCA31128, Leopoldville (= Kinshasa), -4.30, 15.30 (Hayman *et al.* 1966)
RMCA18127, Leopoldville (= Kinshasa), -4.30, 15.30 (Hayman *et al.* 1966)
IRSN208f, Lufa, -5.87, 13.88 (Hayman *et al.* 1966)
RMCA27199, Lula, -7.42, 22.55 (Hayman *et al.* 1966)
RMCA7567, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)
IRSN10753, Mabwe, -8.70, 26.48 (Hayman *et al.* 1966)
IRSN10774, Masombwe, -9.08, 27.10 (Hayman *et al.* 1966)
IRSN10799, Mount Sombwe, -9.17, 26.72 (Hayman *et al.* 1966)
RMCA28193, Mpopola, -9.93, 25.97 (Hayman *et al.* 1966)
RMCA11522, Mulungwishi, -10.78, 26.63 (Hayman *et al.* 1966)
RMCA29199, Mwanakusu cave, -4.58, 27.13 (Hayman *et al.* 1966)
RMCA6561, Ngombe, -6.67, 20.95 (Hayman *et al.* 1966)
IRSN10735, Pelenge, -8.67, 26.83 (Hayman *et al.* 1966)
RMCA18244, Sakania, -12.73, 28.57 (Hayman *et al.* 1966)
RMCA27909, Shinkolobwe, -11.10, 26.55 (Hayman *et al.* 1966)
BM?, Thysville (= Banza-Ngungu), -5.27, 14.88 (Hayman *et al.* 1966)
RMCA 22584, Thysville (= Banza-Ngungu), -5.27, 14.88 (Hayman *et al.* 1966)
IRSN 6119, Tshapona, -7.25, 23.72 (Hayman *et al.* 1966)
RMCA6562, Tshikapa, -6.47, 20.80 (Hayman *et al.* 1966)
RMCA8854, Tumbwe (= Tembwe), -6.50, 29.48 (Hayman *et al.* 1966)
RMCA150a, Zambi, -5.85, 12.87 (Hayman *et al.* 1966)
RMCA150c, Zambi, -5.85, 12.87 (Hayman *et al.* 1966)
MALAWI
MMB?, Chiromo, -16.53, 35.15 (Happold *et al.* 1987)
MMB?, Kasungu NP, -13.05, 33.15 (Happold *et al.* 1987)
DCHC?, Lengwe NP, -16.20, 34.78 (Happold *et al.* 1987)
MMB?, Liwonde NP, -15.03, 35.25 (Happold *et al.* 1987)
TM41780, Liwonde NP, -15.03, 35.25 ●
MMB?, Mapera (= Maperera), -16.12, 34.88 (Happold *et al.* 1987)
NMZB64282, Mugesse, Misuku, -9.62, 33.62 ●
KM1842, Nsanje, -16.53, 35.15 ●
MOZAMBIQUE
IICT4800715, Chicualacuala, -22.63, 31.63 (Lopes & Crawford-Cabral 1990)
NMZB63464, Estatuane, -26.37, 32.12 ●
DM8588, Gorongosa, E of, -18.56, 34.87 ●
USNM00352042, Inyoka Mountain, Magude, 45 km SW, -25.03, 32.65
SAM ZM38836, Lorenzo Marques (= Maputo), -25.88, 32.63 ●
NMZB33594, Marromeu, 40 km W, -18.25, 35.50 ●
USNM00365242, Massamba, 16 km E, -16.13, 33.63
DM8586, Massangena, -21.56, 32.96 ●
TM1637, Mazambo, -23.38, 32.37 ●
DM8587, Mepuze, -23.21, 32.50 ●
TM14666, Muchena, -15.63, 33.88 ●
DM8589, Niassa GR, -12.87, 37.69 ●
DM8590, Niassa GR, Maputo Camp, -12.18, 37.55 ●
DM8591, Niassa GR, Nkuli Camp, -12.17, 38.24 ●
TM41544, Tete, 17 km E, -16.50, 33.70 ●
USNM00365228, Tete, 3 km E, -16.27, 33.60
USNM00479262, Vila Gamito, 10 km N, -14.08, 33.02
IICT5520262, Vilanculos, -22.00, 35.28 (Lopes & Crawford-Cabral 1990)
NMZB34020, Zinave NP, -21.37, 33.87 ●
NMZB63448, Zinave NP, 3 km SSW, -21.39, 33.89 ●
NAMIBIA
SMM6719, Andara, Okavango, -18.13, 21.38 ●
SMM3991, Arnhem Cave, -22.70, 18.10 ●
SMM12224, Daan Viljoen NP, -22.63, 16.88 ●
SMM2385, Etosha NP, Halali, -19.13, 16.38 ●
SMM8084, Etosha NP, Namutoni, -18.80, 16.97 ●
DM25, Kaoko-Otavi, -18.28, 13.72 ●
TM16369, Karibib, SE of, -22.35, 31.10 ●
KM1846, Katima Mulilo, -17.50, 24.33 ●
SMM7856, Klein Okombhe, Omaruru, -20.88, 15.63 ●
SMM7605, Namib-Naukluft NP, Bat's Hole, -22.65, 15.52 ●
TM28904, Namib-Naukluft NP, Bat's Hole, -22.65, 15.52 ●
SMM6782, Okongava, -22.13, 15.88 ●
LACM052731, Omaruru, 30 km NW, -20.97, 15.30 ●
SMM1164, Ombalantu, -17.38, 14.88 ●
SMM8095, Ombika, -19.38, 15.88 ●
LACM058986, Opuwo, 70 km S, -17.47, 13.03 ●
KM1872, Opuwo, S of, -18.70, 13.92 ●
SMM3519, Otjikoko-Sud, -21.88, 16.88 ●

KM28207, Outjo, -20.11, 16.15 ●
LACM052700, Rehoboth, 20 km NW, -22.67, 16.83 ●
SMM3856, Sinclair Mine, Luderitz, -25.63, 16.63 ●
SMM11962, Tsumamas, Outjo, -20.13, 15.63 ●
SMM4331, Waterberg, 416, -20.63, 17.38 ●
TM5799, Windhoek, -22.63, 17.13 ●
SOUTH AFRICA
TM45420, Alldays, 32 km NE, -22.33, 29.37 ●
KM23715, Babanango, -28.38, 31.08 ●
TM36358, Babanango District, -28.30, 31.02 ●
TM2475, Barberton, -25.82, 31.12 ●
TM24067, Blouberg NR, -23.03, 29.12 ●
DM5073, Dlinza Forest, Eshowe, -28.91, 31.45 ●
TM30136, Dumisa Gold Mine, Umzinto, -30.27, 30.35 ●
TM1047, Durban, Malvern, -29.78, 31.03 ●
DM4778, Entumeni, -28.83, 31.37 ●
DM5076, Esperanza Tunnel, Umkomaas, -30.45, 30.64 ●
TM39781, Figaro Mine, 11 km NE of Malelane, -25.45, 31.63 ●
DM5533, Harold Johnson NR, -29.21, 31.42 ●
TM1048, Hectorspruit, -25.43, 31.68 ●
DM5751, Hella Hella GR, -29.90, 30.08 ●
KM23716, Hlabisa, -28.18, 31.95 ●
DM5613, Hluhluwe-Imfolozi Park, Egodeni, -28.07, 32.03 ●
DM8054, Hluhluwe-Imfolozi Park, Mpofu Pan, -28.34, 31.77 ●
TM7121, Ingwavuma, -27.13, 32.03 ●
DM5995, Itala NR, -27.52, 31.37 ●
DM5098, Jozini Dam Tunnel, -27.42, 32.07 ●
DM1272, Krantzkloof NR, -29.77, 30.83 ●
TM36962, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
KM31375, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM30546, Kruger NP, Levuvhu R, -22.43, 31.18 ●
TM39771, Kruger NP, Lower Sabie, -25.19, 32.03 ●
TM36893, Kruger NP, Olifants, -24.02, 31.65 ●
TM13473, Kruger NP, Skukuza, -24.98, 31.58 ●
TM30048, Kruger NP, Stolznek, -25.38, 31.38 ●
TM39735, Kruger NP, Tshokwane, -24.78, 31.95 ●
TM1493, Leydsdorp, -23.98, 30.52 ●
TM34338, Lind Valley Game Ranch, -30.72, 30.27 ●
TM19835, Loskopdam NR, -25.42, 29.33 ●
TM38567, Makalali Farm, Letaba, -23.88, 30.38 ●
TM47616, Malelane, 12 km SW, -25.53, 31.54 ●
TM39228, Manyaleti GR, Main Camp, -24.63, 31.47 ●
SAM ZM13544A, Mfongosi, -28.63, 30.88 ●
KM23717, Mhlabatini, -28.23, 31.77 ●
DM4584, Mkhuze GR, Bube Hide, -27.63, 32.23 ●
DM4572, Mkhuze GR, Kumsinga Hide, -27.63, 32.24 ●
TM35300, Mkhuze GR, Msinga Pan, -27.60, 32.20 ●
DM5599, Mooiplaas (SAPPI), -28.56, 31.15 ●
TM3035, Mooketsi, -23.67, 30.08 ●
TM40351, Mtubatuba, 6 km NE, -28.30, 32.22 ●
TM7469, Mutale R, -22.50, 30.83 ●
DM4065, Nagle Dam, -29.58, 30.62 ●
TM1046, Ngqueleni District, -31.67, 29.03 ●
DM22, Ngxwala Hill, -27.57, 32.08 ●
TM24256, Phalaborwa, 13 km S, -24.05, 31.10 ●
DM8796, Phinda GR, Bayete Camp, -27.78, 32.31 ●
KM23724, Pietermaritzburg, E of, -29.60, 30.52 ●
DM7858, Pongola Reserve, Mpalane Lodge, -27.39, 31.89 ●
SAM ZM5574, Port St. Johns, -31.63, 29.55 ●
TM7804, Port St. Johns, -31.63, 29.55 ●
TM45094, Shashe-Limpopo R Confluence, -22.22, 29.37 ●
DM4431, Shongweni Dam, -29.85, 30.72 ●
TM44233, Soekmekaar, 5 km S, -23.53, 29.93 ●
TM4905, Soutpansberg, -22.98, 29.88 ●
USNM00468412, Thabazimbi, 20 km SE, -24.67, 27.37
TM45220, Thabazimbi, 24 km SW, -24.69, 27.21 ●
TM1640, Thabazimbi, Mooimijsiesfontein, -25.02, 27.62 ●
TM27509, The Downs, -24.13, 30.18 ●
TM3019, Umfolosi GR (= Hluhluwe-Imfolozi Park), -28.35, 31.98 ●
DM5457, Umtamvuna Gorge NR, -31.06, 30.17 ●
TM29794, Vernon CrooSwaziland
TM47721, Hlane NP, Bhubesi, -26.18, 31.86 ●
DM8431, Hlane NP, Ndlovu, -26.26, 31.88 ●
DM7918, Kubuta, -26.88, 31.47 ●
NMB11568, Maguga Dam, -26.13, 31.13 ●
BM1989.0039, Mlawula NR, -26.19, 32.01 ●
DM5823, Mlawula NR, -26.19, 32.01 ●
TM44898, Mlawula NR, -26.19, 32.01 ●
TM1985, Wylesdale, -25.82, 31.29 ●
ZAMBIA
?, Chavuma area, -13.08, 22.68 (Ansell 1978)
NMZB33390, Chikwa, Lundazi, -11.67, 32.78 ●
NMZB11545, Chikwa, Lundazi, -11.67, 32.78 ●
NMZB12262, Chilanga, -15.55, 28.27 ●
KM1841, Fort Jameson (= Chipata), -13.62, 32.65 ●
NMZB10080, Kafue Gorge, -15.77, 28.35 ●
?, Kafue NP, -15.87, 25.87 (Ansell 1978)
UZMZ?, Kapongo Cave, -15.77, 28.35 (Ansell 1969)
NMZB11766, Karabe, Lake Tanganyika, -8.62, 30.62 ●
KM9650, Kasama, -10.22, 31.17 ●
NMZB8195, Kasanka NP, -12.58, 30.25 ●
?, Kasempa Boma, -13.47, 25.85 (Ansell 1978)
?, Kasempa, NW of, -13.13, 25.00 (Ansell 1978)
?, Kilwa Is, Lake Mweru, -9.13, 28.38 (Ansell 1978)
UZMZ?, Leopard's Hill Cave, -15.55, 28.72 (Ansell 1969)
NMZB11530, Luangwa NP, Nsefu, -12.87, 32.12 ●
?, Luanshya, -13.13, 28.42 (Ansell 1978)
NMZB63499, Missale Old Mine, -14.12, 32.87 ●
?, Mongu, SE of, -16.70, 24.50 (Ansell 1978)
?, Ndola, -12.97, 28.63 (Ansell 1978)
NMZ3451, Ngwerere Cave, -15.30, 28.33 (Ansell 1986)
UZMZ?, Ngwerere Siding, -15.32, 28.32 (Ansell 1969)
NMZB64838, Nkambwa Hill, -13.37, 32.62 ●
NMZB29837, Sakeji School, -11.12, 24.37 ●
NMZB63518, Sasare Old Mine, Petauke, -13.92, 31.37 ●
KM9654, Serenje, -13.38, 30.13 ●
?, Solwezi, -12.18, 26.42 (Ansell 1978)
UZMZ?, South Luangwa Valley, Mfuwe, -13.08, 31.78 (Ansell 1969)
NMZ2955, Sumbu, -8.52, 30.48
NMZB11567, Tembwe Village, -11.37, 32.93 ●
NMZB29841, Zambezi Rapids Ikelenge, -11.13, 24.20 ●
ZIMBABWE
NMZB58541, Bulawayo, -20.12, 28.58 ●
NMZB63516, Bulawayo, -20.12, 28.58 ●
NMZB57424, Chete, Eastern Section, -17.37, 27.62 ●
NMZB31142, Chinhoyi, Kaukua Cave, -17.03, 30.09 ●
NMZB58561, Chipingayi Bridge, Save Valley, -20.12, 32.37 ●
NMZB58622, Chiredzi 24 km E, -19.00, 32.50 ●
NMZB58700, Chiredzi, 24 km E, -21.00, 31.75 ●
NMZB31586, Chiredzi, Lone Star Ranch, -21.12, 31.87 ●
NMZB64777, Chirisa SA, Magurazino R, -17.62, 28.37 ●
NMZB58521, Chizarira NP, Baruri Gorge, -17.50, 27.75 ●
NMZB58526, Chizarira NP, Manzituba, -17.50, 27.75 ●
NMZB29680, Dibutibu R, Batoka, -17.94, 26.12 ●
NMZB58705, Eirene Farm, Marondera, -18.37, 31.62 ●
NMZB32151, Esigodini, Falcon College, -20.22, 28.92 ●
NMZB32355, Esigodini, Willow Park, -20.28, 28.83 ●
NMZB58535, Frog Mine, Mupfure R, -17.87, 29.87 ●
NMZB58576, Gonarezhou NP, Mabalauta, -21.93, 31.47 ●
NMZB58669, Great Zimbabwe, -20.28, 30.93 ●
NMZB58562, Guluene, S of, -21.87, 31.87 ●
NMZB30083, Gwayi R Bridge, -18.62, 27.10 ●
TM34982, Gwayi R Bridge, -18.62, 27.10 ●
NMZB58556, Harare, -17.83, 31.07 ●
NMZB58549, Harare, 19 km NW, -17.50, 31.50 ●
NMZB84378, Hoya River Camp, Muzarabani, -16.25, 31.25 ●
NMZB84379, Hoya River Camp, Muzarabani, -16.25, 31.25 ●
NMZB58531, Hwange NP, Main Camp, -18.73, 26.95 ●
NMZB58548, Hwange NP, Ngamo Pan, -19.13, 27.47 ●
NMZB12709, Ingwe Mine, 22 km W of Filabusi, -20.62, 29.37 ●
NMZB58534, Kanyemba, -15.65, 30.33 ●
NMZB80264, Katombora Rapids, -17.88, 25.33 ●
NMZB9565, Lake Kariba Heights, -16.52, 28.78 ●
NMZB82362, Lake Kariba Island, -16.75, 28.25 ●
NMZB31337, Lake Kariba, Gatshe Gatshe Bay, -16.87, 28.87 ●
NMZB62078, Lake Kariba, Gatshe Gatshe Bay, -16.87, 28.87 ●
NMZB58704, Lake Kariba, Mwenda, -17.12, 27.87 ●
NMZB31811, Lucilia Port, Shurugwi, -19.62, 30.12 ●
NMZB57613, Lusulu Tsetse Station, Sebungwe, -18.12, 27.87 ●
NMZB30657, Mabura 2 Cave, Munyati R, -18.12, 29.37 ●
NMZB59411, Makovani Estate, Fort Rixon, -20.12, 29.37 ●
NMZB58578, Mana Pools NP, Nyamepi, -15.80, 29.37 ●
NMZB58557, Marondera, -18.12, 31.62 ●
DM1102, Matusadona NP, -16.87, 28.37 ●
NMZB58559, Matusadona NP, Tashinga, -16.87, 28.37 ●
NMZB58551, Mazoe R, Chimanda, -17.13, 30.88 ●
USNM00425288, Mount Selinda, -20.45, 32.67
NMZB58555, Msitive-Mtoroshanga R Confluence, -16.75, 30.50 ●
NMZB58552, Munyati Bridge, -18.65, 29.77 ●
NMZB58591, Mushandike NP, Matema Camp, -20.12, 30.62 ●
NMZB58545, Mutare, -18.75, 32.50 ●
DM4615, Mutare, -19.08, 32.70 ●
NMZB58532, Mutare, Asbestos Mine, -18.92, 32.62 ●
DM3684, Mutare, Old Mine, -19.08, 32.70 ●
NMZB30567, Muzvezve NR, -18.00, 29.25 ●
NMZB57751, Nyamunyeche, Mvurwi, -16.77, 30.95 ●
NMZB32594, Nyashato Dam, -17.12, 32.12 ●
NMZB58529, Nyazura, -18.72, 32.17 ●

NMZB58573, Penhalonga, -18.87, 32.62 ●
NMZB30524, Sengereri Hills, -17.62, 31.12 ●
NMZB64783, Sengwa Wildlife Research Station, -18.17, 28.22 ●
DM76, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB30795, Sentinel Ranch, Tongani R, -22.12, 29.62 ●
NMZB57191, Shamva, 48 km NE, -17.00, 31.90 ●
NMZB30509, Tsungwesi Gauno Cave, Mutanda, -19.12, 32.12 ●
NMZB56250, Tuli Camp, -21.90, 29.22 ●

fuliginosus

DRC
BM?, Ngombe, -6.67, 20.95 (Hayman *et al.* 1966)

gigas

ANGOLA
?, Benguela, -12.63, 13.38 (Crawford-Cabral 1986)

ruber

ANGOLA
?, Ambaca, -9.38, 15.38 (Crawford-Cabral 1986)
MD5043, Dundo, -7.38, 20.88 (Hayman, 1963)
IICA364, Jau, -15.13, 13.63 ●
?, Massangano, -9.63, 14.13 (Crawford-Cabral 1986)
IICA350, Sa da Bandeira (= Lubango), -14.88, 13.38 ●
IICA7989, Salazar (= N'Dalatando), Agronomic Station, -9.38, 14.88 ●
IICA74, Tchivinguiro, -15.13, 13.38 ●
?, Uije (= Uige), -7.63, 15.13 (Crawford-Cabral 1986)
SMM5499, Vila Arriaga, -14.63, 13.38 ●
DRC
RMCA?, Gombe, -6.67, 20.95 (Schouteden 1947)
RMCA26246, Jadotville (= Likasi), -10.97, 26.78 (Hayman *et al.* 1966)
RMCA22851, Kakanda, -10.78, 26.60 (Hayman *et al.* 1966)
IRSN14563, Kakanda, -10.78, 26.60 (Hayman *et al.* 1966)
MHNG1047.67, Kakanda, -10.78, 26.60 (Hayman *et al.* 1966)
MHNG922.96, Kakontwe, -10.98, 26.63 (Hayman *et al.* 1966)
RMCA 22638, Kakontwe, -10.98, 26.63 (Hayman *et al.* 1966)
RMCA21278, Kasaji Malonga, -10.45, 23.63 (Hayman *et al.* 1966)
IRSN14583, Kasoma, -9.42, 26.62 (Hayman *et al.* 1966)
MHNG1047.75, Kasoma, -9.42, 26.62 (Hayman *et al.* 1966)
RMCA22090, Kimembe R, -10.75, 25.37 (Hayman *et al.* 1966)
RMCA2416a, Kisantu, -5.13, 15.15 (Hayman *et al.* 1966)
MHNG922.97, Kyasala, -9.93, 25.97 (Hayman *et al.* 1966)
RMCA26865, Kyasala cave, -9.93, 25.97 (Hayman *et al.* 1966)
IRSN 14590, Kyasala cave, -9.93, 25.97 (Hayman *et al.* 1966)
?, Leopoldville (= Kinshasa), -4.30, 15.30 (Allen 1917)
RMCA 22654, Lubudi cave, -9.93, 25.97 (Hayman *et al.* 1966)
RMCA25612, Lula, -7.42, 22.55 (Hayman *et al.* 1966)
RMCA13708, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)
BM?, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)
IRSN14581, Mulungwishi, -10.78, 26.63 (Hayman *et al.* 1966)
MHNG922.95, Mulungwishi, -10.78, 26.63 (Hayman *et al.* 1966)
IRSN14576, Musosa, -9.00, 29.00 (Hayman *et al.* 1966)
RMCA22730, Mwanakusu cave, -4.58, 27.13 (Hayman *et al.* 1966)
RMCA?, Tshikapa, -6.47, 20.80 (Schouteden 1947)
MALAWI
DCHC?, Kasungu NP, -13.05, 33.15 (Happold *et al.* 1987)
KM11689, Nkhotakota, -12.93, 34.30 ●
DCHC?, Zomba, -15.38, 35.32 (Happold *et al.* 1987)
MOZAMBIQUE
DM8549, Gurue, -15.46, 37.02 ●
DM8550, Meponda, Lake Niassa, -13.40, 34.87 ●
DM11481, Mount Mabu, -16.29, 36.40 ●
USNM00365244, Vila Gamito, 10 km N, -14.08, 33.02
ZAMBIA
NMZB33399, Ikelenge, -11.23, 24.27 ●
TM41877, Lusaka, -15.42, 28.27 ●
NMZB29836, Sakeji School, -11.12, 24.37 ●
NMZB22889, Sasare Old Mine, Petauke, -13.92, 31.37 ●

vittatus

ANGOLA
?, Canhoca, -9.13, 14.63 (Crawford-Cabral 1986)
?, Catumbela, -12.38, 13.63 (Crawford-Cabral 1986)
?, Congulu, -10.88, 14.38 (Crawford-Cabral 1986)
?, Humbe, -16.63, 14.88 (Crawford-Cabral 1986)
IICA2, Luanda, -8.88, 13.38 ●
?, Malange (= Malanje), -9.63, 16.38 (Crawford-Cabral 1986)
IICA6310, Sa da Bandeira (= Lubango), -14.88, 13.38 ●
BOTSWANA
?, Chobe NP, Kasane, -17.80, 25.15 (Smithers 1971)
USNM00322898, Drotsky Caves, -20.12, 21.37
NMZB63379, Drotsky Caves, -20.12, 21.37 ●
TM14755, Kaikai, 30 km SE, -19.88, 21.38 ●
USNM00295191, Kaikai, 35 km SE, -20.13, 21.63
NMZB65201, Maun, 12 km NE, -19.87, 23.12 ●
NMZB59223, Pom Pom, Okavango, -19.50, 22.75 ●
DRC
RMCA410, Congo da Lemba, -5.70, 13.67 (Hayman *et al.* 1966)
RMCA33261, Ganda Sundi, -4.78, 12.90 (Hayman *et al.* 1966)
BM?, Kakontwe, -10.98, 26.63 (Hayman *et al.* 1966)
RMCA22686, Kakontwe, -10.98, 26.63 (Hayman *et al.* 1966)
RMCA27891, Kasaji, -10.45, 23.63 (Hayman *et al.* 1966)
RMCA495, Lofoi, -10.20, 25.45 (Hayman *et al.* 1966)
ZMB?, Mpala, -6.72, 29.52 (Hayman *et al.* 1966)
RMCA2621 1, Panda, -10.98, 26.78 (Hayman *et al.* 1966)
MALAWI
MMB?, Blantyre, -15.78, 35.00 (Happold *et al.* 1987)
DCHC?, Lengwe NP, -16.20, 34.78 (Happold *et al.* 1987)
DCHC?, Liwonde NP, -15.03, 35.25 (Happold *et al.* 1987)
MMB?, Monkey Bay, -14.07, 34.92 (Happold *et al.* 1987)
DCHC?, Zomba, -15.38, 35.32 (Happold *et al.* 1987)
MOZAMBIQUE
DM8645, Gorongosa, E of, -18.56, 34.87 ●
NMZB63384, Gruta Magochene, -21.37, 34.87 ●
MNKB37150, Ibo Island, Querembas, -12.64, 40.60 ●
NMZB64271, Nyaboa Caves, -20.37, 33.62 ●
TM1027, Zimbita, Beira, -19.84, 34.88 ●
NMZB63387, Zinave NP, -21.37, 33.87 ●
NAMIBIA
SMM13668, Aigamas cave, Grootfontein, -19.88, 17.63 ●
SMM6808, Arnhem Cave, -22.70, 18.10 ●
TM2436, Etosha NP, Namutoni, -18.80, 16.97 ●
SMM8102, Etosha NP, Okaukuejo, -19.13, 15.88 ●
KM1840, Gobabis, -22.45, 19.87 ●
KM31439, Grootfontein, NW of, -19.34, 17.34 ●
TM3495, Okahandja, NE of, -21.13, 17.13 ●
SMM6837, Okatjiho, Okahandja, -21.88, 16.63 ●
TM37635, Omaruru, 48 km NE, -21.30, 16.45 ●
SMM6839, Otjihauera, -22.13, 17.13 ●
LACM056258, Outjo, 40 km NE, -19.90, 16.30 ●
SMM6828, Windhoek, -22.63, 17.13 ●
SOUTH AFRICA
TM38882, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM39492, Kruger NP, Punda Milia, -22.77, 31.02 ●
ZAMBIA
NMZB25860, Chilanga Cave, -15.55, 28.27 ●
NMZB12260, Chipongwe Cave, -15.63, 28.23 ●
NMZ3688, Kilwa Is, Lake Mweru, -9.13, 28.38 (Ansell 1974)
UZMZ?, Leopard's Hill Cave, -15.55, 28.72 (Ansell 1969)
NMZB22974, Lochinvar Ranch, -15.87, 27.12 ●
USNM00294787, Luanshya, -13.13, 28.42
BM66.5455, Missale Old Mine, -14.12, 32.87 (Ansell 1967)
?, Mongu, SE of, -16.70, 24.50 (Ansell 1978)
NMZB20252, Sasare Old Mine, Petauke, -13.92, 31.37 ●
ZIMBABWE
NMZB33609, Benzie's Bridge, Shangani R, -18.81, 27.90 ●
NMZB65148, Buffalo Range, Chiredzi, -21.03, 31.53 ●
NMZB9846, Bulawayo, -20.12, 28.58 ●
NMZB65159, Bulawayo, 20 km N, -19.90, 28.58 ●
DM3937, Chinhoyi Caves, -17.37, 30.08 ●
NMZB31141, Chinhoyi, Bashungwe Cave, -17.12, 29.12 ●
NMZB64775, Chirisa SA, Magurazino R, -17.62, 28.37 ●
NMZB67034, Chiwore SA, -16.00, 30.00 ●
NMZB33400, Eirene Farm, Marondera, -18.37, 31.62 ●
NMZB65152, Gonarezhou NP, Chitove Tsetse Camp, -21.00, 32.00 ●
NMZB65162, Great Zimbabwe, -20.28, 30.93 ●
NMZB65151, Harare, -17.83, 31.07 ●
NMZB65145, Hwange Safari Lodge, -18.67, 26.92 ●
NMZB33611, Kabuba Camp, Manjolo, -18.28, 28.08 ●
NMZB33597, Mabura 1 Cave, Ngondoma R, -18.37, 29.37 ●
NMZB30339, Mabura 2 Cave, Munyati R, -18.12, 29.37 ●
NMZB67041, Matobo NP, Gordon Park, -20.47, 28.53 ●
NMZB65147, Matusadona NP, Tashinga, -16.87, 28.37 ●
TM41875, Mazoe Estates, -17.38, 30.88 ●
NMZB65149, Mushandike NP, -20.13, 30.63 ●
NMZB65155, Mutare, -18.97, 32.70 ●
NMZB65150, Mutare, Quaggas Hoek, -18.75, 32.50 ●
NMZB57609, Nyamunyeche, Mvurwi, -16.77, 30.95 ●
NMZB32396, Nyashato Dam, -17.12, 32.12 ●
NMZB65144, Odzi, -18.95, 32.38 ●
USNM00470253, Sabi-Lundi (= Save-Runde) R Confluence, -21.28, 32.38
NMZB65143, Sengwa Wildlife Research Station, -18.17, 28.22 ●
NMZB63390, Shabani (= Zvishavane), 24 km N, -20.00, 29.90 ●
NMZB32669, Shangani R, Mzola Camp, -18.62, 27.37 ●
NMZB54164, Victoria Falls, Zambezi Camp, -17.92, 25.83 ●

Triaenops

persicus

DRC
MNHN1968-412, Loudima, Doumboula cave, -4.42, 13.00 (Aellen & Brosset 1968)

MOZAMBIQUE
DM8639, Balama Coutada, -13.42, 38.04 ●
DM8635, Buzi R, -19.93, 33.83 ●
DM8636, Gorongosa, E of, -18.56, 34.87 ●
NMZB63523, Gruta Magochene, -21.37, 34.87 ●
?, Manica, -18.93, 32.88 (Smithers & Lobão Tello 1976)
TM14572, Massamba, 16 km E, -16.13, 33.63 ●
USNM00365301, Massamba, 16 km E, -16.13, 33.63
DM8637, Namapa, -13.49, 39.78 ●
DM8638, Namapa, -13.49, 39.78 ●
DM8634, Niassa GR, -12.87, 37.69 ●
DM8642, Niassa GR, 23 km S of Kiboko, -12.62, 37.66 ●
DM8641, Niassa GR, Nkuli Camp, -12.17, 38.24 ●
USNM00365278, Tete, 3 km E, -16.27, 33.60
TM14570, Tete, 3 km E, -16.27, 33.60 ●
ZAMBIA
NMZB20179, Missale Old Mine, -14.12, 32.87 ●
ZIMBABWE
NMZB84335, Bopoma River Camp, Chimanda, -16.50, 32.25 ●
TM34814, Mutare, Old Mine, -19.08, 32.70 ●

MEGADERMATIDAE

Lavia

frons

DRC
RMCA29298, Albertville (= Kalemie), -5.95, 29.17 (Hayman *et al.* 1966)
RMCA?, Dubulu, -4.23, 20.27 (Schouteden 1947)
RMCA9173, Kabalo, -6.03, 26.92 (Hayman *et al.* 1966)
RMCA18724, Leopoldville (= Kinshasa), -4.30, 15.30 (Hayman *et al.* 1966)
IRSN10690, Mabwe, -8.70, 26.48 (Hayman *et al.* 1966)
RMCA18045, Maka, -8.93, 26.07 (Hayman *et al.* 1966)
MALAWI
HZM14.2622, Karonga, -9.93, 33.93 (Happold *et al.* 1987)
ZAMBIA
BM65.536, Bulaya, -8.53, 30.13 (Ansell 1967)
NMZB33481, Chisela Dambo, Mporokoso, -8.38, 29.75 ●
?, Mporokoso, -9.37, 30.12 (Ansell 1978)
?, Ndola, -12.97, 28.63 (Ansell 1978)

MINIOPTERIDAE

Miniopterus

fraterculus

MALAWI
DCHC?, Zomba, -15.38, 35.32 (Happold *et al.* 1987)
KM11747, Zomba Plateau, -15.33, 35.32 ●
DCHC?, Zomba Plateau, -15.33, 35.32 (Happold *et al.* 1987)
MOZAMBIQUE
DM8484, Gurue, -15.46, 37.02 ●
SOUTH AFRICA
TM36410, Babanango District, -28.30, 31.02 ●
TM30138, Dumisa Gold Mine, Umzinto, -30.27, 30.35 ●
DM5604, Emphisini NR, -30.21, 30.79 ●
TM41637, Entabeni State Forest, -23.01, 30.26 ●
DM6897, Hella Hella GR, -29.90, 30.08 ●
TM47112, Howick, -29.50, 30.23 ●
TM31810, Itala NR, -27.52, 31.37 ●
TM25462, Karkloof Forest, -29.40, 30.28 ●
DM8358, Knysna, -34.03, 23.05 ●
SAM ZM8946, Knysna, -34.03, 23.05 ●
TM1103, Knysna, -34.03, 23.05 ●
KM6062, Krugersdorp, -26.02, 27.73 ●
DM5108, Mooiplaas (SAPPI), -28.56, 31.15 ●
KM23781, Nkandla, -28.67, 30.98 ●
KM23799, Pietermaritzburg, Town Bush, -29.55, 30.35 ●
DM8363, Shongweni Dam, -29.85, 30.72 ●
KM31807, Stutterheim, W of, -32.67, 27.29 ●
TM46447, Sudwala Caves, -25.37, 30.70 ●
TM36127, Tugela R, Nqubevu Mine, -28.73, 30.63 ●
SWAZILAND
DM5785, Barites Mine, -26.22, 31.03 ●
TM47722, Malolotja NR, -26.16, 31.11 ●
DM8050, Nottinghill Mine, -25.96, 31.17 ●

inflatus

DRC
MHNG1046.94, Kasoma, -9.42, 26.62 (Hayman *et al.* 1966)
FMNH?, Katobwe, -8.85, 26.08 (Hayman *et al.* 1966)
RMCA?, Thysville (= Banza-Ngungu), -5.27, 14.88 (Schouteden 1947)
MALAWI
TM41802, Likabula Mission, Mulanje, -15.95, 35.48 ●
MOZAMBIQUE
DM8556, Gorongosa, E of, -18.56, 34.87 ●
?, Manica, -18.93, 32.88 (Smithers & Lobão Tello 1976)
DM8779, Mount Chiperone, -16.51, 35.73 ●
NAMIBIA
SMM14580, Dante Cave, -19.40, 17.89 ●
SMM14582, Otgrot, -19.71, 15.70 ●
MG4014, Uris, -19.27, 17.52 ●
SOUTH AFRICA
DM7085, Insizwe Mine, -30.80, 29.28 ●
TM40329, Nelspruit, Legogot, -25.22, 31.25 ●
TM33392, Pietermaritzburg, Town Bush, -29.55, 30.35 ●
DM5726, Pongola R Bridge, -27.03, 32.26 ●
DM5663, Shongweni Dam, -29.85, 30.72 ●
ZAMBIA
NMZ3757, Kilwa Is, Lake Mweru, -9.13, 28.38 (Ansell 1974)
ZIMBABWE
NMZB59694, Limestone Cave, Kyle, -20.00, 30.50 ●
NMZB59684, MacDougall's Tunnel, Triangle, -21.12, 31.37 ●
NMZB59557, Mutare, -19.00, 32.50 ●
NMZB59551, Mutare, Asbestos Mine, -18.92, 32.62 ●

minor

DRC
?, Kitwit, -5.08, 18.91 (Van Cakenberghe *et al.* 1999)
RMCA18016, Thysville (= Banza-Ngungu), -5.27, 14.88 (Hayman *et al.* 1966)

natalensis

ANGOLA
?, Cambissa, -15.13, 16.13 (Crawford-Cabral 1986)
?, Golungo, -9.13, 14.63 (Crawford-Cabral 1986)
IICA1884, Huila, -15.13, 13.63 ●
?, Kuvangu Mission (= Cubango), -14.38, 16.38 (Crawford-Cabral 1986)
BOTSWANA
?, Chobe NP, Kasane, -17.80, 25.15 (Smithers 1971)
?, Kuchwe Pan, -23.13, 24.38 (Smithers 1971)
?, Lake Ngami, -20.38, 22.88 (Smithers 1971)
?, Mabate, -22.13, 29.13 (Smithers 1971)
DRC
RMCA29303, Albertville (= Kalemie), -5.95, 29.17 (Hayman *et al.* 1966)
MHNG922.71, Baya, cave, -11.87, 27.12 (Hayman *et al.* 1966)
BM?, Jadotville (= Likasi), -10.97, 26.78 (Hayman *et al.* 1966)
MHNG1046.92, Kaboyaboya, -9.93, 25.97 (Hayman *et al.* 1966)
RMCA28166, Kakanda, -10.78, 26.60 (Hayman *et al.* 1966)
MHNG1046.72, Kakontwe, -10.98, 26.63 (Hayman *et al.* 1966)
RMCA27553, Kalumbu, -10.85, 26.65 (Hayman *et al.* 1966)
RMCA27568, Kambove, -10.83, 26.65 (Hayman *et al.* 1966)
MHNG1046.79, Kando, -10.82, 26.12 (Hayman *et al.* 1966)
RMCA26782, Kandu, -9.93, 25.97 (Hayman *et al.* 1966)
RMCA23820, Kapolowe, -11.05, 26.95 (Hayman *et al.* 1966)
RMCA23899, Kasapa, -11.50, 27.40 (Hayman *et al.* 1966)
MHNG?, Kasoma, -9.42, 26.62 (Hayman *et al.* 1966)
RMCA27293, Kiamokoto, -9.17, 27.07 (Hayman *et al.* 1966)
IPNCW1462, Kisala, -4.77, 13.00 (Hayman *et al.* 1966)
IRSN14610, Kyamakonde, cave, -9.93, 25.97 (Hayman *et al.* 1966)
MHNG1046.86, Kyantapo, -9.93, 25.97 (Hayman *et al.* 1966)
MHNG1046.84, Kyasala, -9.93, 25.97 (Hayman *et al.* 1966)
RMCA27574, Likasi, -10.98, 26.80 (Hayman *et al.* 1966)
MHNG1046.85, Lubudi cave, -9.93, 25.47 (Hayman *et al.* 1966)
RMCA26804, Lusolo, -9.93, 25.47 (Hayman *et al.* 1966)
RMCA28191, Mpopola, -9.93, 25.97 (Hayman *et al.* 1966)
MHNG1046.87, Mulonga, -7.85, 27.02 (Hayman *et al.* 1966)
RMCA28215, Pempéré, cave, -10.97, 26.78 (Hayman *et al.* 1966)
IRSN14602, Salomoni, cave, -10.98, 27.28 (Hayman *et al.* 1966)
RMCA27914, Shinkolobwe, -11.10, 26.55 (Hayman *et al.* 1966)
MHNG1046.88, Tantara, -11.03, 26.48 (Hayman *et al.* 1966)
IRSN14625, Tenke, -10.50, 26.17 (Hayman *et al.* 1966)
RMCA10061, Thysville (= Banza-Ngungu), -5.27, 14.88 (Hayman *et al.* 1966)
LESOTHO
NMB8159, Mahlanapeng, Thaba-Tseka, -29.63, 28.63 ●
MALAWI
TM41788, Likabula Mission, Mulanje, -15.95, 35.48 ●
DCHC?, Liwonde NP, -15.03, 35.25 (Happold *et al.* 1987)
KM11760, Zomba Plateau, -15.33, 35.32 ●
MOZAMBIQUE
USNM00365454, Chiutu, -15.57, 33.28
?, Dondo, W of, -19.63, 34.38 (Smithers & Lobão Tello 1976)
?, Manica, -18.93, 32.88 (Smithers & Lobão Tello 1976)
USNM00354448, Massamba, 16 km E, -16.13, 33.63
USNM00352116, Moamba, -25.60, 32.23
TM14695, Muchena, -15.63, 33.88 ●
?, Pafuri, S of, -22.88, 31.38 (Smithers & Lobão Tello 1976)
NMZB63127, Ressano Garcia, 10 km SSE, -25.37, 32.05 ●
?, Save-Lunde R Confluence, -21.28, 32.38 (Smithers & Lobão Tello 1976)

USNM00365453, Vila Gamito, 10 km N, -14.08, 33.02
?, Vilanculos, N of, -21.63, 35.13 (Smithers & Lobão Tello 1976)
?, Xai-Xai, W of, -24.88, 33.38 (Smithers & Lobão Tello 1976)
NMZB63128, Zinave NP, -21.37, 33.87 ●

NAMIBIA

SMM6535, Arnhem Cave, -22.70, 18.10 ●
USNM00537300, Gobabeb, Namib Desert, -23.55, 15.05
KM2234, Gobabis, -22.45, 19.87 ●
KM31458, Grootfontein, NW of, -19.34, 17.34 ●
SMM14579, Munsterland, -20.24, 15.88 ●
SMM7585, Namib-Naukluft NP, Bat's Hole, -22.65, 15.52 ●
TM28900, Namib-Naukluft NP, Bat's Hole, -22.65, 15.52 ●
TM4666, Okahandja, NE of, -21.13, 17.13 ●
SMM2724, Okongava, -22.13, 15.88 ●
LACM052699, Omaruru, 30 km NW, -20.97, 15.30 ●
LACM058993, Opuwo, 70 km NW, -17.47, 13.03 ●
KM2236, Opuwo, SE of, -18.63, 14.15 ●
SMM11317, Pipistrelle cave, Omaruru, -21.30, 16.45 ●
TM37649, Pipistrelle cave, Omaruru, -21.30, 16.45 ●
SMM2685, Rooibank, -23.13, 14.63 ●
KM2243, Rundu, S of, -18.60, 19.70 ●
SMM3868, Sinclair Mine, Luderitz, -25.63, 16.63 ●
KM28251, Windhoek, E of, -22.48, 18.10 ●

SOUTH AFRICA

TM35149, Algeria Forest Research Station, -32.40, 19.13 ●
DM85, Amanzimtoti, -30.05, 30.88 ●
TM20016, Assen, 5 km NE, -25.12, 27.62 ●
TM30140, Babanango, -28.38, 31.08 ●
TM1992, Barberton, -25.82, 31.12 ●
KM21112, Bathurst, -33.58, 26.89 ●
KM30484, Bredasdorp, NW of, -34.38, 19.81 ●
NMZB63064, Bredasdorp, NW of, -34.38, 19.81 ●
SAM ZM14563D, Bushman Cave, Montagu, -33.83, 20.17 ●
NMB5942, Butata, Zastron, -30.13, 26.88 ●
TM35880, Buxton Mine, -27.62, 24.62 ●
MMK2455, Danielskuil, 10 km N, -28.10, 23.55 ●
TM25327, De Hoop Private NR, -24.95, 29.95 ●
USNM00342646, De Hoop, 25 km NNE, -38.38, 20.38
SAM ZM35669, De Hoop, NR, -34.43, 20.42 ●
TM30132, Dumisa Gold Mine, Umzinto, -30.27, 30.35 ●
KM24317, East London, -33.15, 21.92 ●
TM23424, Echo Caves, -24.56, 30.61 ●
TM41640, Entabeni State Forest, -23.01, 30.26 ●
TM39785, Figaro Mine, 11 km NE of Malelane, -25.45, 31.63 ●
DM8369, Fort Yellond Farm, -28.85, 31.21 ●
USNM00424105, Graaff Reinet, 30 km SE, -32.45, 24.75
DM4449, Greater St. Lucia Wetlands Park, Eastern Shores, -28.27, 32.48 ●
DM5956, Greater St. Lucia Wetlands Park, Mission Rocks, -28.28, 32.49 ●
MMK2434, Griekwastad, 25 km NNE, -28.63, 23.30 ●
KM21183, Hankey, -33.82, 24.85 ●
TM1133, Hectorspruit, -25.43, 31.68 ●
TM42459, Hermanus, -34.38, 19.27 ●
NMB8585, Hopetown, -29.63, 24.13 ●
MMK2492, Hotazel, 15 km WNW, -27.18, 22.82 ●
TM39005, Huhea cave, -22.94, 30.10 ●
KM23873, Humansdorp, -33.98, 23.65 ●
TM7129, Ingwavuma, -27.13, 32.03 ●
TM40052, Irene, -25.87, 28.23 ●
DM5898, Itala NR, -27.52, 31.37 ●
NMB7582, Jagersfontein Commonage, -29.63, 25.38 ●
DM7111, Jozini Dam, -27.41, 31.89 ●
DM5508, Kersefontein Farm, Hopefield, -32.90, 18.33 ●
KM24396, King William's Town, -32.87, 27.37 ●
USNM00344272, King William's Town, 18 km NW, -32.72, 27.28
TM1100, Knysna, -34.03, 23.05 ●
NMB7516, Koegelbeen Cave, -28.68, 23.37 ●
TM36894, Kruger NP, Bangu Gorge, -24.08, 31.73 ●
TM40050, Kruger NP, Kruger Gate, -24.98, 31.48 ●
TM29820, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM30025, Kruger NP, Malelane, -25.47, 31.50 ●
TM29949, Kruger NP, Punda Milia, -22.77, 31.02 ●
TM13470, Kruger NP, Skukuza, -24.98, 31.58 ●
TM12043, Krugersdorp, -26.02, 27.73 ●
MMK2367, Kuruman, 10 km SW, -27.57, 23.37 ●
MMK2460, Kuruman, 26 km S, -27.70, 23.43 ●
USNM00381612, Kuruman, the Eye, -27.45, 23.42
MMK2368, Kuruman, the Eye, -27.45, 23.42 ●
TM35761, Kuruman, the Eye, -27.45, 23.42 ●
TM19877, Loskopdam NR, -25.42, 29.33 ●
TM19721, Maasstroom, 20 km NW, -22.68, 28.25 ●
NMB5876, Maclear, -30.88, 28.38 ●
TM12561, Makapans Cave, -24.15, 29.18 ●
USNM00381647, Malelane, 12 km SW, -25.53, 31.54
TM47624, Malelane, 12 km SW, -25.53, 31.54 ●
KM30839, Montagu, -33.83, 20.17 ●
DM5598, Mooiplaas (SAPPI), -28.56, 31.15 ●
TM41019, Mooketsi, -23.67, 30.08 ●
KM26115, Mount Ayliff, -30.80, 29.28 ●
TM47625, Mpumalanga, -25.48, 31.61 ●
USNM00479536, Nelspruit, 7 km E, -25.50, 31.03
TM39851, Ngome Forest, -27.83, 31.42 ●
DM717, Northam, -24.97, 27.27 ●
TM36337, Nqubeva Mine, -28.73, 30.63 ●
TM25292, Ofcolaco, 13 km SW, -24.20, 30.28 ●
DM5529, Oribi Gorge NR, -30.72, 30.27 ●
USNM00221423, Ottoshoop, -25.75, 25.90
TM25595, Phalaborwa, 40 km N, -23.72, 31.08 ●
TM36215, Pietermaritzburg, Town Bush, -29.55, 30.35 ●
DM7039, Pietermaritzburg, Town Bush, -29.55, 30.35 ●
DM5730, Pongola R Bridge, -27.03, 32.26 ●
KM19408, Port Elizabeth, S of, -34.02, 25.60 ●
TM45128, Potgiestersrus (= Mokopane), 37 km NW, -24.20, 28.58 ●
KM22961, Pretoria, -25.85, 27.93 ●
USNM00376760, Pretoria, Fountains, -25.75, 28.20
TM2441, Pretoria, Garsfontein, -25.88, 28.13 ●
TM1105, River Cave, -25.80, 29.88 ●
TM19645, Rustenburg, 18 km S, -25.82, 27.27 ●
DM7035, Shongweni Dam, -29.85, 30.72 ●
DM8362, Shongweni Dam, -29.85, 30.72 ●
TM25823, Sihlangwane, -27.13, 32.38 ●
TM12213, Skurweberg Cave, Pretoria, -25.80, 27.98 ●
KM25640, Somerset East, -33.27, 25.68 ●
DM1119, Songimvelo NR, -26.01, 30.92 ●
NMB7888, Sterkfontein Dam, NE of, -28.13, 28.88 ●
KM20075, Stutterheim, -32.65, 27.53 ●
TM1120, Thabazimbi, 21 km E, -24.60, 27.62 ●
TM20594, Thabazimbi, 24 km E, -24.58, 27.67 ●
TM1127, Tzaneen, -23.83, 30.17 ●
TM16162, Uitkomst Cave, -25.96, 30.58 ●
TM3017, Umfolosi GR (= Hluhluwe-Imfolozi Park), -28.35, 31.98 ●
TM37157, Underberg, -29.78, 29.33 ●
USNM00342642, Van Rhynsdorp, 7 km SE, -31.78, 18.62
DM4998, Van Rhynsdorp, 7 km SE, -31.78, 18.62 ●
TM2071, Venterskroon, -26.88, 27.27 ●
TM28832, Vernon Crookes NR, -30.27, 30.60 ●
DM6994, Vryheid Hill NR, -27.76, 30.79 ●
NMB7707, Waterval, Warden, -27.88, 29.13 ●
TM13747, Wynberg Cave, -33.93, 18.47 ●

SWAZILAND

DM7190, Ezulwini, -26.36, 31.17 ●
DM7917, Kubuta, -26.88, 31.47 ●
DM8028, Mlawula NR, -26.19, 32.01 ●
TM47746, Mlawula NR, Siweni, -26.18, 32.05 ●
DM8038, Piggs' Peak Mine, -25.95, 31.21 ●
TM47713, Rosecraft, -26.63, 31.29 ●
DM8048, Wylesdale, -25.82, 31.29 ●

ZAMBIA

?, Balovale (= Zambezi), -13.55, 23.12 (Ansell 1978)
NMZB11966, Blue Lagoon Ranch, -15.50, 27.37 ●
USNM00156334, Chilanga Cave, -15.55, 28.27
NMZB25851, Chilanga Cave, -15.55, 28.27 ●
NMZB10323, Chipongwe Cave, -15.63, 28.23 ●
NMZB63992, Chipongwe Cave, -15.63, 28.23 ●
NMZB31166, Fort Jameson (= Chipata), -13.62, 32.65 ●
NMZB10089, Kafue Gorge, -15.77, 28.35 ●
NMZ3755, Kilwa Is, Lake Mweru, -9.13, 28.38 (Ansell 1974)
?, Kipushi, -11.90, 27.36 (Ansell 1978)
UZMZ M154, Leopard's Hill Cave, -15.55, 28.72 (Ansell 1974)
?, Lundazi, -12.30, 33.20 (Ansell 1978)
NMZB63103, Missale Old Mine, -14.12, 32.87 ●
NMZB6918, Mumbwa Caves, -14.75, 27.00 ●
UZMZ M181, Naleza, -15.45, 27.33 (Ansell 1974)
UZMZ M177, Namantombwa Hill, -15.48, 27.30 (Ansell 1974)
UZMZ M137, Ngwerere Cave, -15.30, 28.33 (Ansell 1974)
NMZ3751, Nyika NP, -10.58, 33.65 (Ansell 1974)
NMZB63008, Sasare Old Mine, Petauke, -13.92, 31.37 ●

ZIMBABWE

NMZB57650, Beitbridge, -22.13, 29.88 ●
NMZB84194, Bubye R, Chikwarakwara, -22.35, 31.10 ●
NMZB59622, Buchwa Iron Mine, -20.47, 30.15 ●
NMZB34014, Bulawayo, -20.12, 28.58 ●
NMZB31144, Chinhoyi, Badze Cave, -17.17, 29.19 ●
NMZB59602, Chinhoyi, Baruka Cave, -17.37, 30.08 ●
NMZB59706, Chiredzi, Lone Star Ranch, -21.12, 31.87 ●
NMZB59695, Chiribira Falls, Save R, -21.00, 32.25 ●
NMZB29684, Chisuma, Dibutibu R, -18.00, 26.00 ●
NMZB59690, Eirene Farm, Marondera, -18.37, 31.62 ●
NMZB56297, Esigodini, Falcon College, -20.22, 28.92 ●

NMZB2786, Gowlay Block Lonely Mine, -19.62, 28.62 ●
NMZB6921, Graveshead Farm, Bembesi, -19.87, 28.77 ●
NMZB59535, Harare, -17.83, 31.07 ●
NMZB59565, Harare, -17.83, 31.07 ●
NMZB30501, Haroni-Rusitu R Confluence, -20.03, 33.02 ●
NMZB32836, Hippo Valley, Old Village, -21.15, 31.58 ●
NMZB31356, Hwange NP, Main Camp, -18.73, 26.95 ●
NMZB31326, Lake Kariba, Gatshe Gatshe Bay, -16.87, 28.87 ●
NMZB63082, Lake McIlwaine, -17.90, 30.78 ●
NMZB59691, Limestone Cave, Kyle, -20.00, 30.50 ●
NMZB56236, Lusulu Tsetse Station, Sebungwe, -18.12, 27.87 ●
NMZB33711, Lutope-Ngolangola R Confluence, -18.28, 28.08 ●
NMZB82292, Mabura 2 Cave, Munyati R, -18.12, 29.37 ●
NMZB59685, MacDougall's Tunnel, Triangle, -21.12, 31.37 ●
NMZB32965, Makonde Hill, Save Valley, -20.00, 32.00 ●
NMZB3432, Makwiro, -17.75, 30.25 ●
NMZB63007, Mangwindi Gorge, Mtilikwe R, -20.13, 31.13 ●
NMZB25845, Manyambara, -17.00, 29.50 ●
NMZB31430, Matobo Hills, Lumane Valley, -20.58, 28.83 ●
NMZB30686, Matobo Hills, Mtshavezi Valley, -20.62, 28.87 ●
NMZB59530, Mhangura, 8 km N, -16.50, 30.00 ●
NMZB59611, Musemu Farm, Norton, -17.75, 30.75 ●
TM34677, Mutare, -19.08, 32.70 ●
DM3687, Mutare, -19.00, 32.70 ●
NMZB59667, Mutare, Asbestos Mine, -18.92, 32.62 ●
NMZB59686, Mvuma, 6 km SW, -19.25, 30.25 ●
NMZB32705, Ntabanende farm, Esigodini, -20.25, 28.75 ●
NMZB32522, Nyagui R, 2 km N of Chenjerai confluence, -17.37, 31.62 ●
NMZB32523, Nyashato Dam, -17.12, 32.12 ●
NMZB82356, Redbank, Nyamandlovu, -20.25, 28.75 ●
NMZB60773, Rifle Range, Kwekwe, -18.92, 29.80 ●
NMZB6926, Sabi (= Save) R, -20.25, 32.33 ●
NMZB59547, Sengwa Wildlife Research Area, -18.17, 28.22 ●
NMZB30041, Sengwa Wildlife Research Station, -18.17, 28.22 ●
NMZB30669, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB58955, Shabani (= Zvishavane), 24 km N, -20.00, 29.90 ●
NMZB57636, Shambayetu Farm, Beitbridge, -21.75, 29.50 ●
NMZB59519, The Park, -19.00, 32.50 ●
NMZB59237, Victoria Falls, -17.85, 25.75 ●

MOLOSSIDAE

Chaerephon

ansorgei

ANGOLA
SMM6599, Dolondolo, -13.88, 13.13 ●
BM?, Malange (= Malanje), -9.63, 16.38 (Crawford-Cabral 1986)
DRC
?, Kitwit, -5.08, 18.91 (Van Cakenberghe *et al.* 1999)
MHNG1046.25, Mwandingusha, -10.75, 27.23 (Hayman *et al.* 1966)
MOZAMBIQUE
USNM00365471, Chiutu, -15.57, 33.28 ●
DM8608, Ribaue, 40 km W, -14.97, 38.08 ●
SOUTH AFRICA
TM38275, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM39635, Kruger NP, Nwanedzi, -24.45, 31.97 ●
TM39493, Kruger NP, Punda Milia, -22.77, 31.02 ●
TM35351, Mkhuze GR, Msinga Pan, -27.60, 32.20 ●
ZAMBIA
UZMZ?, Kafue Bridge, -15.83, 28.23 (Ansell 1978)
ZIMBABWE
TM9980, Bindura, 10 km SSW, -17.38, 31.28 ●
NMZB59908, Bulawayo, -20.12, 28.58 ●
NMZB30703, Chewore R, Mkanga Bridge, -16.12, 30.12 ●
NMZB30220, Chikupu Caves, Bindura, -17.38, 31.28 ●
NMZB60018, Chikwarakwara, Pesu R Gorge, -22.28, 31.20 ●
NMZB59984, Chiredzi, Lone Star Ranch, -21.12, 31.87 ●
NMZB64815, Chirisa SA, Magurazino R, -17.62, 28.37 ●
NMZB29732, Dibutibu R, Batoka, -17.94, 26.12 ●
NMZB59906, Fishans, Lower Runde R, -21.25, 32.25 ●
NMZB30027, Guhudza Mountain, Chivi, -20.58, 30.67 ●
NMZB6934, Gweru, -19.42, 29.78 ●
NMZB60025, Harare, -17.83, 31.07 ●
NMZB33612, Lutope-Ngolangola R Confluence, -18.28, 28.08 ●
NMZB84291, Nyadire River Camp, Pfungwe, -16.75, 32.25 ●
NMZB32613, Nyadiri R, -17.12, 32.12 ●
NMZB84268, Nyandia Dam, -17.00, 32.00 ●
NMZB32596, Nyashato Dam, -17.12, 32.12 ●
NMZB84353, Ruya R, -16.50, 31.75 ●
NMZB31358, Save-Lunde R Confluence, Marhumbini, -21.28, 32.38 ●
NMZB59932, Sengwa Wildlife Research Station, -18.17, 28.22 ●
NMZB29612, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB32025, Shangani Bridge, Lubimbi, -18.62, 27.37 ●
NMZB60683, Zambezi-Namakunda R Confluence, Katombora, -17.87, 25.37 ●

bivittatus

MALAWI
NMZB20211, Nkhotakota, -12.93, 34.30 ●
MOZAMBIQUE
IICT4800507, Manica, -18.93, 32.88 (Lopes & Crawford-Cabral 1990)
ZAMBIA
?, Abercorn (= Mbala), -8.85, 31.38 (Ansell 1978)
ZIMBABWE
NMZB59904, Chikupu Caves, Bindura, -17.38, 31.28 ●
NMZB60017, Chikwarakwara, Pesu R Gorge, -22.28, 31.20 ●
NMZB64819, Chirisa SA, Magurazino R, -17.62, 28.37 ●
NMZB29729, Dibutibu R, Batoka, -17.94, 26.12 ●
NMZB29640, Guhudza Mountain, Chivi, -20.58, 30.67 ●
NMZB59933, Harare, -17.83, 31.07 ●
NMZB59907, Hwange NP, Main Camp, -18.73, 26.95 ●
HZM4.4521, Lundi (= Runde) R, -21.38, 32.38 (Ansell 1986)
NMZB33620, Lutope-Ngolangola R Confluence, -18.28, 28.08 ●
NMZB59973, Mutare, -19.00, 32.50 ●
NMZB31357, Save-Lunde R Confluence, Marhumbini, -21.28, 32.38 ●

chapini

ANGOLA
?, Capelongo, -14.88, 15.13 (Hill & Carter 1941)
IICA6005, Chitado, -17.38, 13.88 ●
?, Dundo, -7.38, 20.88 (Crawford-Cabral 1986)
?, Forte Rocadas, -16.63, 14.88 (Monard 1935)
NMZB62517, Mavoio, -6.20, 15.01 ●
IICA6046, Oncocua, -16.63, 13.38 ●
BOTSWANA
NMZB62618, Selinda Spillway, -18.62, 23.37 ●
USNM00518727, Xugana, -19.08, 23.10 ●
DRC
IRSN14535, Banana, -5.97, 12.45 (Hayman *et al.* 1966)
IRSN14536, Leopoldville (= Kinshasa), -4.30, 15.30 (Hayman *et al.* 1966)
NAMIBIA
TM31096, Omega, -18.05, 22.18 ●
SMM9899, Omega, -18.05, 22.18 ●
ZAMBIA
KM3732, Livingstone, -17.85, 25.87 ●
LACM070045, Luangwa Valley, -12.75, 32.08 ●
BM52.1505, Mblundu R, Kabompo, -13.20, 24.00 (Ansell 1969)
NMZB33070, Ndanda School, Mongu, 70 km NE, -14.75, 23.75 ●
ZIMBABWE
NMZB64821, Chirisa SA, Magurazino R, -17.62, 28.37 ●
TM34947, Sengwa Wildlife Research Station, -18.17, 28.22 ●

major

ZAMBIA
BM26.12.1.5, Nsumbu, N Lake Bangweulu, -8.52, 30.48 ●

nigeriae

ANGOLA
?, Kuvangu Mission (= Cubango), -14.38, 16.38 (Crawford-Cabral 1986)
?, Osi (= Osse), -14.63, 15.88 (Crawford-Cabral 1986)
BOTSWANA
NMZB54117, Four Rivers Camp, Okavango, -19.12, 23.12 ●
NMZB63879, Makalamabedi Resource Area, -20.37, 23.87 ●
NMZB63875, Sehitwa, 22 km W, -20.58, 22.53 ●
NMZB63878, Selinda Spillway, -18.62, 23.37 ●
NMZB63876, Serowe, 40 km NW, -22.00, 26.29 ●
USNM00518698, Xugana, -19.08, 23.10 (Archer 1975)
DRC
RMCA16191, Elisabethville (= Lubumbashi), -11.68, 27.48 (Hayman *et al.* 1966)
RMCA21480, Kabongo, -7.33, 25.57 (Hayman *et al.* 1966)
MHNG923.8, Kinke, -11.45, 27.48 (Hayman *et al.* 1966)
RMCA22462, Kitubulushi, -12.75, 28.92 (Hayman *et al.* 1966)
RMCA26290, Musonge, -11.07, 28.13 (Hayman *et al.* 1966)
IRSN14534, Musosa, -9.00, 29.00 (Hayman *et al.* 1966)
BM?, Sakania, -12.73, 28.57 (Hayman *et al.* 1966)
NAMIBIA
SMM12427, Eiseb R, -20.63, 20.63 ●
LACM041684, Grootfontein, 40 km WNW, -19.38, 17.88 ●
SMM13704, Grootfontein, NE, -19.50, 18.20 ●
SMM12620, Kwetche, Kavango R, -18.13, 21.63 ●
SMM11349, Makuri Pan, Bushmanland, -19.63, 20.63 ●
TM39797, Nama Pan, Bushmanland, -19.92, 20.72 ●
SMM11354, Nama Pan, Bushmanland, -19.92, 20.72 ●
SMM9900, Omega, -18.05, 22.18 ●
LACM056351, Otavi, 8 km S, -18.30, 13.77 ●
LACM058955, Rundu, 66 km S, -18.53, 20.83 ●
SMM13605, San Michelle, -17.88, 23.38 ●
ZAMBIA
MMK1025, Balovale (= Zambezi), -13.55, 23.12 ●

KM9663, Kasama, -10.22, 31.17 ●
NMZ2876, Lochinvar, -15.98, 27.25 (Ansell 1973)
BM55.1084, Muozi (= Mwoji) R, -12.38, 24.38 ●
NMZB33073, Ndanda School, Mongu, 70 km NE, -14.75, 23.75 ●
NMZB62503, Pwira Pan, -13.87, 27.87 ●
NMZB33083, Senenga, 50 km NE, -15.62, 23.37 ●
BM?, Solwezi, -12.18, 26.42 (Ansell 1957)
ZIMBABWE
NMZB33608, Benzie's Bridge, Shangani R, -18.81, 27.90 ●
NMZB64822, Chirisa SA, Magurazino R, -17.62, 28.37 ●
NMZB31746, Lake Kariba, Kanyati Camp, -16.87, 28.87 ●
NMZB59898, Lake McIlwaine, -17.90, 30.78 ●
NMZB33606, Lutope-Ngolangola R Confluence, -18.28, 28.08 ●
TM45058, Mana Pools NP, -15.80, 29.33 ●
NMZB59900, Sengwa Wildlife Research Station, -18.17, 28.22 ●
TM34978, Sengwa Wildlife Research Station, -18.17, 28.22 ●
TM45067, Urungwe Safari Area, -16.31, 29.45 ●
NMZB32019, Volunteer Farm, Main Camp, -18.82, 27.63 ●

pumilus
ANGOLA
IICA33, Cacuaco, -8.88, 13.38 ●
?, Catumbela, -12.38, 13.63 (Crawford-Cabral 1986)
NMZB62518, Gabela, -10.88, 14.38 ●
IICA4726, Mumbondo, -10.13, 14.13 ●
?, Uije (= Uige), -7.63, 15.13 (Crawford-Cabral 1986)
BOTSWANA
USNM00367775, Chobe NP, Kasane, -17.80, 25.15
NMZB6920, Chobe NP, Kasane, -17.80, 25.15 ●
NMZB62720, Chobe NP, Serondela, -17.87, 24.87 ●
NMZB54113, Four Rivers Camp, Okavango, -19.12, 23.12 ●
USNM00367778, Maun, -19.98, 23.42
NMZB63886, Maun, 12 km NE, -19.87, 23.12 ●
USNM00367818, Nokaneng, 21 km N, -19.42, 22.27
NMZB63915, Savuti R, -18.62, 24.12 ●
USNM00425372, Shakawe, 70 km SW, -18.55, 21.03
NMZB80222, Shishikola, -18.25, 23.25 ●
NMZB54115, Sumsum, Okavango, -19.12, 23.12 ●
USNM00367807, Tsau, -20.15, 22.43
NMZB62734, Tsodilo Hills, -18.87, 21.62 ●
USNM00518705, Xugana, -19.08, 23.10 (Archer 1975)
DRC
RMCA29305, Albertville (= Kalemie), -5.95, 29.17 (Hayman *et al.* 1966)
RMCA20753, Banana, -5.97, 12.45 (Hayman *et al.* 1966)
RMCA6598, Boma, -5.83, 13.05 (Hayman *et al.* 1966)
AMNH48844, Boma, -5.83, 13.05 (Allen 1917)
RMCA26918, Bondo, -5.40, 12.90 (Hayman *et al.* 1966)
RMCA15251, Bukama, -9.22, 25.87 (Hayman *et al.* 1966)
RMCA22466, Chibambo, -10.22, 28.73 (Hayman *et al.* 1966)
RMCA12140, Elisabethville (= Lubumbashi), -11.68, 27.48 (Hayman *et al.* 1966)
RMCA9164, Kabalo, -6.03, 26.92 (Hayman *et al.* 1966)
BM?, Kasenga, -10.37, 28.60 (Hayman *et al.* 1966)
RMCA26227, Kashiobwe, -9.63, 28.68 (Hayman *et al.* 1966)
RMCA16201, Kasongo, -4.52, 26.58 (Hayman *et al.* 1966)
RMCA6578, Kidada, -5.37, 14.53 (Hayman *et al.* 1966)
RMCA6599, Kisantu, -5.13, 15.15 (Hayman *et al.* 1966)
RMCA?, Kisantu, -5.13, 15.32 (Schouteden 1947)
?, Kitwit, -5.08, 18.91 (Van Cakenberghe *et al.* 1999)
RMCA3435, Kondue, -5.00, 23.33 (Hayman *et al.* 1966)
RMCA1 532a, Leopoldville (= Kinshasa), -4.30, 15.30 (Hayman *et al.* 1966)
RMCA?, Leopoldville (= Kinshasa), -4.30, 15.30 (Schouteden 1947)
RMCA7542, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)
IRSN10711, Mabwe, -8.70, 26.48 (Hayman *et al.* 1966)
RMCA6579, Makaia Ntete, -5.55, 13.03 (Hayman *et al.* 1966)
RMCA?, Makaia Ntete, -5.55, 13.03 (Schouteden 1947)
RMCA18152, Makengo, -4.75, 16.50 (Hayman *et al.* 1966)
AMNH49275, Malela, -5.95, 12.63 (Allen 1917)
RMCA22000, Manono, -7.30, 27.40 (Hayman *et al.* 1966)
RMCA161, Moliro, -8.20, 30.57 (Hayman *et al.* 1966)
RMCA?, Moliro, -8.20, 30.57 (Schouteden 1947)
RMCA17757, Mvuazi, -5.45, 14.90 (Hayman *et al.* 1966)
RMCA9231, Nyonga, -8.58, 26.30 (Hayman *et al.* 1966)
RMCA21618, Thysville (= Banza-Ngungu), -5.27, 14.88 (Hayman *et al.* 1966)
BM?, Thysville (= Banza-Ngungu), -5.27, 14.88 (Hayman *et al.* 1966)
RMCA16151, Vaku, -5.25, 13.22 (Hayman *et al.* 1966)
MALAWI
MMB?, Chididi Mission, -16.92, 35.20 (Happold *et al.* 1987)
TM9180, Chinteche, -11.83, 34.17 ●
MMB?, Fort Johnston (= Mangochi), -14.48, 35.27 (Happold *et al.* 1987)
DCHC?, Kasungu NP, -13.05, 33.15 (Happold *et al.*1987)
DCHC?, Lake Malawi NP, Cape Maclear, -14.03, 34.83 (Happold *et al.* 1987)
DCHC?, Lengwe NP, -16.20, 34.78 (Happold *et al.* 1987)
DCHC?, Liwonde NP, -15.03, 35.25 (Happold *et al.* 1987)
MMB?, Luwazi Mission, -11.52, 34.15 (Happold *et al.* 1987)
MMB?, Matope, -15.35, 34.95 (Happold *et al.* 1987)
NMZB62732, Monkey Bay, -14.07, 34.92 ●
NMZB22822, Nkhotakota, -12.93, 34.30 ●
DCHC?, Zomba, -15.38, 35.32 (Happold *et al.* 1987)
MOZAMBIQUE
TM42019, Bazaruto Island, -21.38, 35.38 ●
USNM00365466, Beira, 10 km N, -19.82, 34.87
USNM00365479, Boane, -26.13, 32.38
IICT3263002, Boane, -26.13, 32.38 (Lopes & Crawford-Cabral 1990)
?, Chigubo, -22.88, 33.63 (Smithers & Lobão Tello 1976)
USNM00352117, Chigubo, -22.88, 33.63
USNM00352226, Chimonzo, -24.92, 33.25
NMZB63962, Chitengo, 100 km E, -18.75, 34.75 ●
USNM00352252, Coguno, -24.55, 34.38
NMZB62535, Cruz Dabacua Setache, Zinave, -21.00, 33.50 ●
NMZB62539, Estatuane, -26.37, 32.12 ●
?, Funhalouro, -23.13, 34.38 (Smithers & Lobão Tello 1976)
NMZB62870, Gorongosa NP, -18.87, 34.37 ●
TM12450, Inhaca Island, Research Station, -26.02, 32.97 ●
USNM00352199, Inhaca Island, Research Station, -26.02, 32.97
USNM00352237, Magude, -25.03, 32.65
NMZB62574, Malucas, -21.75, 33.25 ●
DM60, Mapinhane, -22.32, 35.05 ●
IICT5520243, Maputo, -25.88, 32.63 (Lopes & Crawford-Cabral 1990)
NMZB31370, Maputo, -25.88, 32.63 ●
NMZB83934, Marromeu Town, -18.25, 35.94 ●
USNM00352246, Massinga, -23.13, 35.38
DM8614, Meponda, Lake Niassa, -13.40, 34.87 ●
USNM00352238, Moamba, -25.60, 32.23
DM8615, Pemba, -12.97, 40.57 ●
NMZB62577, Ressano Garcia, 10 km SSE, -25.37, 32.05 ●
TM14649, Tete, 3 km E, -16.27, 33.60 ●
USNM00365460, Tete, 3 km E, -16.27, 33.60
NMZB62519, Zinave NP, -21.37, 33.87 ●
NAMIBIA
SMM13543, Buffalo Camp, Kavango R, -18.13, 21.63 ●
SMM13678, Katima Mulilo, -17.50, 24.33 ●
SOUTH AFRICA
DM7247, Komatipoort, -25.43, 31.93 ●
SOUTH AFRICA
DM7335, Albert Falls NR, -29.43, 30.38 ●
TM38593, Albert Falls NR, -29.43, 30.38 ●
DM7231, Amanzimtoti, -30.05, 30.88 ●
DM7386, Ballito, -29.53, 31.22 ●
DM4433, Bonamanzi GR, -28.10, 32.30 ●
DM6872, Durban, -29.85, 31.00 ●
TM36158, Durban, -29.85, 31.00 ●
DM7537, Durban International Airport, -29.87, 31.00 ●
DM5089, Durban, Isipingo, -29.85, 31.00 ●
DM7077, Durban, Westville, -29.83, 30.93 ●
DM4456, Durban, Westville, -29.83, 30.93 ●
TM5571, Emseleni, -27.63, 32.13 ●
DM4492, Eshowe, -28.90, 31.47 ●
TM47717, Fleur de Lys, Limpopo, -24.63, 31.13 ●
TM40084, Futululu, -28.42, 32.27 ●
TM39003, Gazunkulu, Elim Hospital, -23.15, 30.05 ●
TM40720, Greater St. Lucia Wetlands Park, Cape Vidal, -28.13, 32.55 ●
DM7526, Greater St. Lucia Wetlands Park, Charters Creek, -28.20, 32.42 ●
DM2268, Greater St. Lucia Wetlands Park, False Bay, -27.97, 32.38 ●
DM6789, Greater St. Lucia Wetlands Park, Iphiva Camp, -28.35, 32.43 ●
DM5951, Greater St. Lucia Wetlands Park, Iphiva Camp, -28.35, 32.43 ●
TM35369, Greater St. Lucia Wetlands Park, Mission Rocks, -28.28, 32.49 ●
TM24574, Hans Merensky NR, -23.67, 30.68 ●
DM4471, Harold Johnson NR, -29.21, 31.42 ●
TM24884, Hectorspruit, 10 km NE, -25.33, 31.83 ●
DM6283, Hell's Gate Military Base, -28.04, 32.43 ●
KM28122, Hlabisa, -28.18, 31.95 ●
TM43870, Hoedspruit, -24.45, 31.03 ●
TM43867, Jozini Dam, -27.41, 31.89 ●
DM5104, Jozini Dam Tunnel, -27.42, 32.07 ●
TM38485, Jozini Dam Tunnel, -27.42, 32.07 ●
DM6925, Kloof, -29.82, 30.83 ●
TM46051, Komatipoort, Ngwenya Lodge, -25.37, 31.86 ●
TM25980, Kosi Bay NR, -26.96, 32.83 ●
DM6815, Kosi Bay NR, -26.96, 32.83 ●
TM39580, Kruger NP, Letaba, -23.85, 31.57 ●
TM39615, Kruger NP, Letaba, 8 km SE, -23.90, 31.57 ●
TM36931, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM36511, Kruger NP, Levuvhu R, -22.43, 31.18 ●
TM30008, Kruger NP, Malelane, -25.47, 31.50 ●
TM39596, Kruger NP, Olifants, 7 km W, -24.02, 31.65 ●
TM29958, Kruger NP, Pafuri, -22.70, 31.02 ●
KM31384, Kruger NP, Pafuri, -22.45, 31.30 ●

TM29845, Kruger NP, Pafuri, -22.45, 31.30 ●
TM13538, Kruger NP, Punda Milia, -22.77, 31.02 ●
TM12993, Kruger NP, Punda Milia, -22.77, 31.02 ●
TM39623, Kruger NP, Satara, 8 km E, -24.40, 31.83 ●
TM30067, Kruger NP, Skukuza, -24.98, 31.58 ●
TM30042, Kruger NP, Stolznek, -25.38, 31.38 ●
TM33368, Lake Bangazi, 9 km N, -27.38, 32.68 ●
TM46008, Magoebaskloof, -23.83, 30.17 ●
TM2485, Malelane, -25.47, 31.52 ●
DM8001, Manor Gardens Primary School, -29.87, 31.00 ●
TM39231, Manyaleti GR, Main Camp, -24.63, 31.47 ●
DM4012, Mapelane, -28.41, 32.43 ●
USNM00351385, Maputa, -27.00, 32.75
DM3270, Masimba Camp, Corridor Reserve, -28.08, 32.03 ●
TM44199, Messina NR, -22.38, 30.07 ●
TM20337, Messina, 32 km E, -22.28, 30.28 ●
DM7373, Mkhuze GR, Umpila Cave, -27.60, 32.30 ●
TM47156, Mooketsi, -23.67, 30.08 ●
TM8908, Mooketsi, -23.67, 30.08 ●
DM6344, Mount Moreland, -29.63, 31.08 ●
TM40367, Mtubatuba, 6 km NE, -28.30, 32.22 ●
DM5343, Mtunzini, Twin Streams, -28.95, 31.77 ●
DM8029, Nagle Dam, -29.58, 30.62 ●
TM35230, Ndumu GR, -26.88, 32.27 ●
TM7139, Ndumu Store, -26.88, 32.38 ●
DM6379, New Germany, -29.78, 30.88 ●
TM46448, Ngala GR, -24.38, 31.32 ●
TM33362, Oribi Gorge NR, -30.72, 30.27 ●
TM25556, Phalaborwa, 40 km N, -23.72, 31.08 ●
DM8789, Phinda GR, Bayete Camp, -27.78, 32.31 ●
DM5340, Pinetown, -29.82, 30.87 ●
DM7857, Pongola GR, Mpalane Lodge, -27.39, 31.89 ●
TM24044, Sabie Sands GR, -24.75, 31.43 ●
DM4298, Scottburgh, -30.28, 30.75 ●
DM2442, St. Lucia Village, -28.38, 32.42 ●
DM3679, Stainbank NR, -29.92, 30.93 ●
TM41903, Sudwala Caves, -25.37, 30.70 ●
DM4800, Tembe Elephant GR, HQ, -27.04, 32.42 ●
TM45327, Tembe Elephant GR, HQ, -27.04, 32.42 ●
TM40719, Umgeni Hatchery, -29.58, 30.62 ●
DM7244, Umkomaas, -30.20, 30.80 ●
TM39426, Verulam, Hazelmere Dam, -29.60, 31.02 ●
TM40718, Ziqhumene, -28.18, 31.95 ●

SWAZILAND

TM44895, Big Bend, -26.77, 31.90 ●
TM45538, Ebenezer Primary School, -26.95, 31.38 ●
TM45705, Edwaleni, -26.55, 31.27 ●
TM45688, Franson Christian School, -27.18, 31.38 ●
TM45311, Hlane NP, Sundwini, -26.25, 31.94 ●
TM44893, Luyengo, -26.58, 31.20 ●
TM45776, Maloma Primary School, -27.02, 31.65 ●
TM45443, Mkhaya GR, -26.63, 31.77 ●
TM45686, Mkhuzweni Primary School, -26.88, 31.52 ●
TM44894, Mlawula NR, -26.19, 32.01 ●
DM5827, Mlawula NR, -26.19, 32.01 ●
DM6232, Motshane, -26.24, 31.04 ●
TM45690, Ndabasezwe High School, -27.27, 31.80 ●
TM45779, Nisela GR, -27.02, 31.95 ●
TM45691, Nkwene High School, -26.87, 31.32 ●
TM45689, Our Lady of Sorrows School, -27.27, 31.53 ●
TM45310, Sikhunyana School, -26.03, 31.58 ●
TM45685, Sithobela Primary School, -26.88, 31.60 ●
TM45687, St. Florence Mission, -26.23, 31.43 ●
TM45309, St. Joseph's Mission, -26.23, 31.43 ●
TM45544, St. Peregrines Mission, -26.05, 31.45 ●
DM5975, Tshaneni, -25.97, 31.72 ●
DM5978, UNISWA, Kwaluseni campus, -26.48, 31.30 ●
DM8042, Wylesdale, -25.82, 31.29 ●

ZAMBIA

NMZB11750, Chief Chiawa's, -15.62, 29.37 ●
NMZB29900, Chingola, Mushishima Farm, -12.62, 27.87 ●
?, Fort Jameson (= Chipata), -13.62, 32.65 (Ansell 1978)
NMZB8294, Kabompo Boma, -13.58, 24.20 ●
BM?, Kafue NP, Chunga, -15.13, 25.88 (Ansell 1969)
BM?, Kafue NP, Ngoma, -15.88, 25.88 (Ansell 1969)
BM?, Kalabo, -14.97, 22.68 (Ansell 1969)
?, Lake Mweru, -8.70, 29.00 (Ansell 1978)
MMK1011, Limulunga, -15.15, 23.17 ●
BM?, Livingstone, -17.85, 25.87 (Ansell 1969)
NMZ2903, Lochinvar NP, -15.88, 27.38 (Ansell 1973)
BM?, Mongu, -15.15, 23.17 (Ansell 1969)
KM2452, Mongu, -15.15, 23.17 ●
?, Nchelenge, -9.35, 28.75 (Ansell 1978)
NMZB33011, Ndanda School, Mongu, 70 km NE, -14.75, 23.75 ●
?, Samfya, -11.33, 29.53 (Ansell 1978)
NMZB33026, Senenga, 50 km NE, -15.62, 23.37 ●

ZIMBABWE

NMZB32968, Beitbridge, -22.13, 29.88 ●
NMZB59436, Chikwarakwara, -22.35, 31.10 ●
NMZB84109, Chikwarakwara, Pesu R Gorge, -22.28, 31.20 ●
NMZB57655, Chiredzi Research Station, -21.02, 31.57 ●
NMZB59462, Dagati Pan, Save R, -21.12, 31.87 ●
NMZB57750, Gem Farm, Beitbridge, -21.87, 29.62 ●
NMZB59419, Gonarezhou NP, Chipinda Pools, -21.27, 31.90 ●
NMZB55662, Gonarezhou NP, Mabalauta, -21.93, 31.47 ●
NMZB59502, Hippo Valley, Cistrus Estates, -21.15, 31.58 ●
NMZB59443, Hippo Valley, Kutanga Estates, -21.12, 31.87 ●
NMZB81202, Humani Ranch, -20.25, 32.25 ●
NMZB59437, Kazangula, -17.83, 25.27 ●
NMZB59466, Mahenge, Lower Save, -21.12, 32.37 ●
NMZB59506, Malipati, -22.07, 31.43 ●
NMZB59464, Malugwe Pan, -21.62, 31.87 ●
NMZB30779, Matetsi SA, Westwood Lodge, -18.50, 25.75 ●
NMZB84403, Musengezi R Confluence, -16.25, 30.75 ●
NMZB29759, Muzarabani, Arda Office, -16.37, 30.12 ●
NMZB29757, Muzarabani, Staff House, -16.37, 30.87 ●
NMZB59468, Samba Ranch, -20.62, 31.37 ●
TM41617, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB30833, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●

Mops

brachypterus

DRC

RMCA6607, Luebo, -5.33, 21.55 (Hayman *et al.* 1966)
RMCA7542, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)

MOZAMBIQUE

?, Mozambique Island, -15.13, 40.63 (Smithers & Labao Tello 1976)

condylurus

ANGOLA

IICT3157028, Luso (Moxico), -11.88, 19.88 (Lopes & Crawford-Cabral 1990)

BOTSWANA

NMZB63872, Chobe NP, Kasane, -17.80, 25.15 ●
USNM00367819, Chobe NP, Kasane, -17.80, 25.15
USNM00382688, Kwebe Hills, 26 km NW, -20.27, 22.87
USNM00382689, Sehitwa, 22 km W, -20.58, 22.53
USNM00382692, Tamafupi, 33 km N, -19.25, 26.00

DRC

RMCA22459, Chibambo, -10.22, 28.73 (Hayman *et al.* 1966)
RMCA16191, Elisabethville (= Lubumbashi), -11.68, 27.48 (Hayman *et al.* 1966)
RMCA27541, Jadotville (= Likasi), -10.97, 26.78 (Hayman *et al.* 1966)
RMCA22438, Kapolowe, -11.05, 26.95 (Hayman *et al.* 1966)
RMCA23920, Kasapa, -11.50, 27.40 (Hayman *et al.* 1966)
BM?, Kasenga, -10.37, 28.60 (Hayman *et al.* 1966)
RMCA26307, Kashiobwe, -9.63, 28.68 (Hayman *et al.* 1966)
RMCA29165, Kasongo, -4.52, 26.58 (Hayman *et al.* 1966)
AMNH49230, Kinshasa, -4.30, 15.30 (Allen 1917)
?, Kitwit, -5.08, 18.91 (Van Cakenberghe *et al.* 1999)
RMCA9230, Nyonga, -8.58, 26.30 (Hayman *et al.* 1966)
RMCA26213, Pempéré, cave, -10.97, 26.78 (Hayman *et al.* 1966)
RMCA22442, Sakania, -12.73, 28.57 (Hayman *et al.* 1966)
RMCA23906, Wasseige, -11.83, 27.33 (Hayman *et al.* 1966)

MALAWI

MMB?, Chileka, -15.65, 34.92 (Happold *et al.* 1987)
TM9174, Chinteche, -11.83, 34.17 ●
ROM36474, Chitale, -13.67, 34.27 ●
MMB?, Karonga, -9.93, 33.93 (Happold *et al.* 1987)
DCHC?, Kasungu NP, -13.05, 33.15 (Happold *et al.* 1987)
DCHC?, Lake Malawi NP, Cape Maclear, -14.03, 34.83 (Happold *et al.* 1987)
DCHC?, Lengwe NP, -16.20, 34.78 (Happold *et al.* 1987)
DCHC?, Liwonde NP, -15.03, 35.25 (Happold *et al.* 1987)
MMB?, Luwazi Mission, -11.52, 34.15 (Happold *et al.* 1987)
NMZB62205, Monkey Bay, -14.07, 34.92 ●
KM11781, Nkhotakota, -12.93, 34.30 ●
NMZB22816, Nkhotakota, -12.93, 34.30 ●
ROM57555, Nsanje, 16.92, 35.27 ●
MMB?, Zomba, -15.38, 35.32 (Happold *et al.* 1987)

MOZAMBIQUE

DM5940, Bazaruto Island, -21.38, 35.38 ●
NMZB63864, Beira, -19.84, 34.88 ●
USNM00365580, Beira, 10 km N, -19.82, 34.87
DM105, Bela Vista, -25.97, 32.50 ●
IICT3263011, Boane, -26.13, 32.38
DM8620, Buzi R, -19.93, 33.83 ●
?, Chigubo, -22.88, 33.63 (Smithers & Lobão Tello 1976)
NMZB63870, Chitengo, 100 km E, -18.75, 34.75 ●
USNM00352180, Coguno, -24.55, 34.38
NMZB62459, Covane, -21.37, 33.87 ●

USNM00365613, Dondo, -19.65, 34.65
TM12449, Inhaca Island, -26.02, 32.97 ●
?, Lagoa Banamana, -22.13, 33.88 (Smithers & Lobão Tello 1976)
DM8621, Limpopo Bridge, Chokwe, -24.41, 32.88 ●
NMZB83937, Marromeu Town, -18.25, 35.94 ●
NMZB84011, Marromeu, Coutada 11 HQ, -18.25, 35.75 ●
USNM00352132, Massinga, -23.13, 35.38
USNM00352152, Moamba, -25.60, 32.23
USNM00352169, Panda, -24.05, 34.70
DM112, Panda, -24.05, 34.70 ●
NMZB62468, Ressano Garcia, 10 km SSE, -25.37, 32.05 ●
TM14612, Tete, 3 km E, -16.27, 33.60 ●
USNM00365470, Tete, 3 km E, -16.27, 33.60
USNM00352163, Vilanculos, -22.00, 35.28
NMZB62469, Zinave NP, -21.37, 33.87 ●
NMZB33451, Zinave NP, 3 km SSW, -21.39, 33.89 ●
SOUTH AFRICA
DM7036, Albert Falls NR, -29.43, 30.38 ●
DM4432, Bonamanzi GR, -28.10, 32.30 ●
TM40353, Dukuduku Forest Station, -28.30, 32.22 ●
DM7538, Durban International Airport, -29.87, 31.00 ●
DM6024, Greater St. Lucia Wetlands Park, Cape Vidal, -28.13, 32.55 ●
DM5954, Greater St. Lucia Wetlands Park, Iphiva Camp, -28.35, 32.43 ●
TM33359, Greater St. Lucia Wetlands Park, Mission Rocks, -28.28, 32.49 ●
DM6990, Hell's Gate Military Base, -28.04, 32.43 ●
KM28119, Hlabisa, -28.18, 31.95 ●
TM40721, Hluhluwe-Imfolozi Park, Imfolozi, -28.32, 31.83 ●
USNM00468416, Komatipoort, -25.43, 31.93
TM33446, Kosi Bay NR, -26.96, 32.83 ●
TM29986, Kruger NP, Crocodile Bridge, -25.33, 31.87 ●
TM39744, Kruger NP, Kruger Gate, -24.98, 31.48 ●
TM39583, Kruger NP, Letaba, -23.85, 31.57 ●
TM36868, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM36881, Kruger NP, Levuvhu R, -22.43, 31.18 ●
TM30016, Kruger NP, Malelane, -25.47, 31.50 ●
TM39644, Kruger NP, Nwanedzi, -24.45, 31.97 ●
TM39595, Kruger NP, Olifants, -24.02, 31.65 ●
TM39659, Kruger NP, Satara, -24.40, 31.77 ●
TM30062, Kruger NP, Skukuza, -24.98, 31.58 ●
TM25718, Lake Sibaya, -27.35, 32.72 ●
USNM00351383, Maputa, -27.00, 32.75
TM35261, Mkhuze GR, Msinga Pan, -27.60, 32.20 ●
DM7856, Mpalane Lodge, Pongola Reserve, -27.39, 31.89 ●
TM7143, Ndumu NR, -26.88, 32.27 ●
TM39139, Ngome Forest, -27.83, 31.42 ●
DM6332, Phinda GR, -27.86, 32.27 ●
DM7107, Pongola NR, Mkaya Camp, -27.39, 31.89 ●
DM7251, Pongola R Bridge, -27.03, 32.26 ●
DM5981, Richards Bay, -28.78, 32.08 ●
KM31382, Soutpansberg, -22.98, 29.88 ●
TM40436, St. Lucia Village, -28.38, 32.42 ●
DM8502, Tembe Elephant GR, Pumphouse, -27.06, 32.45 ●
SWAZILAND
TM45541, Bar Circle Ranches, -26.68, 31.88 ●
TM45702, Mbutfu Primary School, -27.08, 31.95 ●
DM8514, Mkhaya GR, -26.63, 31.77 ●
TM44892, Mlawula NR, -26.19, 32.01 ●
TM45778, Nisela GR, -27.02, 31.95 ●
TM8378, Ranches, -26.02, 31.72 ●
TM45684, St. Florence Mission, -26.23, 31.43 ●
DM5974, Tshaneni, -25.97, 31.72 ●
ZAMBIA
MMK1023, Limulunga, -15.15, 23.17 ●
NMZB22756, Lochinvar Ranch, -15.87, 27.12 ●
LACM080048, Luangwa Valley, -12.75, 32.08 ●
KM2510, Mongu, -15.15, 23.17 ●
NMZB33053, Ndanda School, Mongu, 70 km NE, -14.75, 23.75 ●
NMZ2879, Samfya, -11.33, 29.53 (Ansell 1973)
NMZB33058, Senenga, 50 km NE, -15.62, 23.37 ●
ZIMBABWE
NMZB84141, Chikwarakwara, Pesu R Gorge, -22.28, 31.20 ●
NMZB57469, Gonarezhou NP, Chipinda Pools, -21.27, 31.90 ●
NMZB59897, Hippo Valley, Cistrus Estates, -21.15, 31.58 ●
NMZB81185, Humani Ranch, -20.25, 32.25 ●
TM41874, Lake Kariba, -16.88, 28.38 ●
NMZB30722, Lake Kariba, Gatshe Gatshe Bay, -16.87, 28.87 ●
NMZB58465, Matusadona NP, Nyanumi R, -16.87, 28.37 ●
NMZB84404, Musengezi R Confluence, -16.25, 30.75 ●
NMZB30066, Muuye-Muonye R, Dande, -16.12, 30.37 ●
NMZB29742, Muzarabani, Staff House, -16.37, 30.87 ●
NMZB84292, Nyadire River Camp, Pfungwe, -16.75, 32.25 ●
NMZB84346, Ruya R, -16.50, 31.75 ●

midas

BOTSWANA
NMZB63810, Kwebe Hills, 26 km NW, -20.27, 22.87 ●
USNM00382693, Kwebe Hills, 26 km NW, -20.27, 22.87
USNM00425370, Maun, -19.98, 23.42
NMZB62428, Maun, 12 km NE, -19.87, 23.12 ●
NMZB63809, Savuti R, -18.62, 24.12 ●
USNM00382694, Sehitwa, 22 km W, -20.58, 22.53
USNM00518735, Xugana, -19.08, 23.10 (Archer 1975)
MALAWI
ROM35794, Chileka, -15.65, 34.92 ●
NAMIBIA
TM36513, Dose Pan, 3 km S, -18.23, 20.88 ●
SMM12352, Eiseb R, -20.63, 20.63 ●
SMM8115, Etosha NP, Okaukuejo, -19.13, 15.88 ●
USNM00295195, Gaucha, -19.78, 20.58
LACM058977, Rundu, 75 km SE, -18.53, 20.83 ●
SMM2722, Tsumkwe, -19.63, 20.63 ●
SOUTH AFRICA
TM45412, Alldays, 32 km NE, -22.33, 29.37 ●
TM45507, Klaserie NR, -24.20, 31.15 ●
TM36613, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM36873, Kruger NP, Levuvhu R, -22.43, 31.18 ●
TM30582, Kruger NP, Punda Milia, -22.77, 31.02 ●
(Skukuza), Kruger NP, Skukuza, -24.98, 31.58 ●
TM41302, Langjan NR, -22.83, 29.20 ●
TM43421, Lydenburg District, -25.13, 30.38 ●
TM20331, Messina, 32 km E, -22.28, 30.28 ●
KM31383, Soutpansberg, -22.98, 29.88 ●
USNM00384305, Tshipise, 2 km NE, -22.60, 30.20
ZAMBIA
NMZ2874, Lochinvar, -15.98, 27.25 (Ansell 1973)
LACM070051, Luangwa Valley, -12.75, 32.08 ●
KM2502, Mongu, -15.15, 23.17 ●
NMZB33084, Senenga, 50 km NE, -15.62, 23.37 ●
ZIMBABWE
NMZB59840, Bubye R, Chikwarakwara, -22.35, 31.10 ●
NMZB59864, Chikwarakwara, -22.35, 31.10 ●
NMZB33441, Chikwarakwara, -22.35, 31.10 ●
HZM1.4517, Malugwe Pan, -21.62, 31.87 ●
NMZB84400, Musengezi R Confluence, -16.25, 30.75 ●
NMZB29733, Muzarabani Clinic, -16.37, 30.87 ●
NMZB29760, Muzarabani, Arda Office, -16.37, 30.12 ●
NMZB30860, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB59303, Shashe Agricultural Scheme, -22.12, 29.37 ●
NMZB34005, St James Mission, Nyamandlovu, -19.75, 28.00 ●

nanulus

DRC
RMCA97.021-M-0816, Kinzambi Mission, -4.98, 18.78
?, Kitwit, -5.08, 18.91 (Van Cakenberghe *et al.* 1999)
RMCA97.021-M-0817, Kitwit Itpk, -6.67, 20.95
RMCA1548, Luluabourg (= Kananga), -5.88, 22.43
RMCA16451, N'gombe, -6.07, 20.95

niveiventer

ANGOLA
AMNH85525, Chitau, -11.38, 17.13 ●
IICA5411, Cuango, -9.13, 18.13 ●
DRC
MHNG923.1, Elisabethville (= Lubumbashi), -11.68, 27.48 (Hayman *et al.* 1966)
MHNG1046.29, Jadotville (= Likasi), -10.97, 26.78 (Hayman *et al.* 1966)
RMCA26218, Keyberg, -11.72, 27.42 (Hayman *et al.* 1966)
?, Kitwit, -5.08, 18.91 (Van Cakenberghe *et al.* 1999)
BM26.7.6.104, Luluabourg (= Kananga), -5.88, 22.43 ●
RMCA29206, Samba, -4.68, 26.38 (Hayman *et al.* 1966)
RMCA26225, Wasseige, -11.83, 27.33 (Hayman *et al.* 1966)
MOZAMBIQUE
USNM00365468, Vila Coutinho, -14.73, 34.37
ZAMBIA
BM37.1.4.13, Balovale (= Zambezi), -13.55, 23.12 ●
NMZB30303, Chingola, Mushishima Farm, -12.62, 27.87 ●
KM2504, Fort Jameson (= Chipata), -13.62, 32.65 ●
NMZB20151, Fort Jameson (= Chipata), -13.62, 32.65 ●
NMZB4072, Fort Jameson (= Chipata), -13.62, 32.65 ●
FMNH96272, Fort Jameson (= Chipata), -13.62, 32.65 ●
NMZB22858, Kalichero, -13.62, 32.62 ●
NMZ2880, Lochinvar, -15.98, 27.25 (Ansell 1973)
BM168171, Luanshya, -13.13, 28.42 ●
NMZB20110, Missale Customs Post, -14.07, 33.00 ●
BM55.1091, Muozi (= Mwoji) R, -12.38, 24.38 ●
NMZB33075, Ndanda School, Mongu, 70 km NE, -14.75, 23.75 ●
NMZB30302, Sakeji Mavunda, -11.12, 24.37 ●
NMZB33057, Senenga, 50 km NE, -15.62, 23.37 ●
KM17200, Solwezi, -12.18, 26.42 ●

NMZB3213, Solwezi, -12.18, 26.42 ●

thersites

DRC

?, Kitwit, -5.08, 18.91 (Van Cakenberghe *et al.* 1999)
RMCA97.021-M-0824, Kitwit Itpk, -6.67, 20.95
RMCA6607, Luebo, -5.33, 21.55 (Schouteden 1947)
RMCA7542, Luluabourg (= Kananga), -5.88, 22.43 (Schouteden 1947)

Mormopterus

acetabulosus

SOUTH AFRICA

MNHN1984-1201, Durban, -29.85, 31.00 ●

Myopterus

whitleyi

DRC

?, Kitwit, -5.08, 18.91 (Van Cakenberghe *et al.* 1999)
IRSN7478, Leopoldville (= Kinshasa), -4.30, 15.30 (Hayman *et al.* 1966)
RMCA7588, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)

Otomops

martiensseni

ANGOLA

AMNH?, Chitau, -11.38, 17.13 (Crawford-Cabral 1986)
IICA5237, Novo Redondo (= Sumbe), -11.38, 13.88 ●

DRC

IRSN10704, Buye Bala, -8.88, 26.88 (Hayman *et al.* 1966)
NMZ3395, Lufuko Stream, -7.67, 29.77 (Ansell 1974)

MALAWI

NMZ3228, Mangochi Mountain, -14.45, 35.48
NMZ3228, Mangochi Mountain, -14.45, 35.48

SOUTH AFRICA

AMNH?, Durban, -29.85, 31.00 (Hayman 1941)
DM6936, Durban, La Lucia, -29.85, 31.00 ●
DM5911, Durban, Westville, -29.83, 30.93 ●
DM2747, Hillcrest, -29.77, 30.60 ●
HZM3.3077, Margate, -30.92, 30.33 ●
DM29, Mount Edgecombe, -29.70, 31.07 ●
DM5605, Park Rynie, -30.32, 30.73 ●
DM4270, Umhlanga Rocks, -29.73, 31.08 ●
DM6238, Warner Beach, -30.07, 30.87 ●

ZAMBIA

?, Mafinga Mountain, -10.25, 33.50 ●

ZIMBABWE

NMZB59834, Lake Kariba, Gatshe Gatshe Bay, -16.87, 28.87 ●
ROM83979, Sengwa Wildlife Research Station, -18.17, 28.22 (Lamb *et al.* 2008)

Sauromys

petrophilus

BOTSWANA

NMZB63760, Francistown, -21.15, 27.50 ●
USNM00425369, Francistown, -21.15, 27.50
TM14094, Tuli Block, -22.13, 28.88 ●

MOZAMBIQUE

USNM00365659, Chiutu, -15.57, 33.28
TM14712, Chiutu, near, -16.13, 33.63 ●
DM8612, Niassa GR, -12.87, 37.69 ●

NAMIBIA

TM37537, Aus, 3 km W, -26.65, 16.22 ●
USNM00537301, Ganab Waterhole, -20.50, 15.52
TM27601, Gobabeb, Namib Desert, -23.55, 15.05 ●
NMZB62511, Gobabeb, Namib Desert, -23.55, 15.05 ●
USNM00342154, Gobabeb, Namib Desert, -23.55, 15.05
LACM041723, Grootfontein, 40 km WNW, -19.38, 17.88 ●
TM32488, Lutzputs, 12 km NW, -28.32, 20.57 ●
USNM00498136, Maltahohe, 110 km WSW, -25.20, 15.92
TM37595, Maltahohe, 70 km W, -24.90, 16.28 ●
SMM11245, Maltahohe, W of, -24.88, 16.38 ●
SMM10521, Namib-Naukluft NP, De Valle, -24.13, 16.13 ●
SMM7580, Namib-Naukluft NP, Ganab, -23.13, 15.13 ●
TM28891, Namib-Naukluft NP, Ganab, -23.13, 15.13 ●
KM31816, Omaruru, -21.28, 16.00 ●
TM9504, Ombu, Eronga Mountain, -21.67, 15.73 ●
KM28272, Otjiwarongo, -20.46, 16.31 ●
KM28296, Outjo, SW of, -20.30, 15.83 ●
SMM10096, Rosh Pinah, -27.97, 16.77 ●
TM32667, Rosh Pinah, -27.97, 16.77 ●
SMM8317, Sesfontein, -19.13, 13.88 ●
SMM12484, Skeleton Coast NP, -20.88, 13.63 ●
SMM7581, Tsumasberg, -23.13, 15.38 ●
TM16393, Usakos, -21.88, 15.63 ●
LACM047283, Windhoek, 81 km SW, -22.92, 16.37 ●
SMM10016, Witwatersrand, Damaraland, -20.88, 14.63 ●

SOUTH AFRICA

TM28298, Algeria Forest Research Station, -32.37, 19.05 ●
TM45372, Alldays, 32 km NE, -22.33, 29.37 ●
TM16979, Augrabies Falls NP, -28.60, 20.33 ●
TM24081, Blouberg NR, -23.03, 29.12 ●
TM28495, Brits, -25.63, 27.88 ●
KM2436, Clanwilliam, -32.13, 18.95 ●
TM13124, Hartebeestpoort Dam, -25.75, 27.85 ●
TM47570, Kliphuis Camp, -32.14, 19.00 ●
USNM00380569, Louisvale. Orange R, 2 km N, -28.60, 21.20
TM33473, Messina NR, -22.38, 30.07 ●
TM8969, Mitchell's Pass, Ceres, -32.63, 19.25 ●
KM2435, Namaqualand, -32.90, 18.23 ●
TM24279, Pietersburg (= Polokwane), 40 km N, -23.60, 29.67 ●
TM39011, Pilanesberg NP, -25.13, 27.13 ●
TM788, Pretoria, -25.63, 28.10 ●
TM41418, Shashe-Limpopo R Confluence, -22.22, 29.37 ●
USNM00342650, Springbok, 14 km W, -29.67, 17.28
USNM00451063, Stolzenfels, Orange R, -28.50, 19.70

ZIMBABWE

NMZB32539, Chinanga Dam, Maramba, -17.12, 32.87 ●
NMZB32974, Chishakwe Ranch, -20.12, 32.12 ●
NMZB30583, Dwala Ranch, Bubiana, -21.12, 29.62 ●
NMZB58127, Gem Farm, Beitbridge, -21.87, 29.62 ●
NMZB59835, Mangwe, Vashu Farm, -20.87, 28.12 ●
DM3693, Matobo Hills, Bale Hill Cave, -20.55, 28.48 ●
TM35032, Matobo Hills, Bale Hill Cave, -20.55, 28.48 ●
NMZB30464, Matobo Hills, Diana's Pool, -20.47, 28.87 ●
NMZB30683, Matobo Hills, Mtshavezi Valley, -20.62, 28.62 ●
NMZB32816, Matobo Hills, Tendele R, -20.63, 28.30 ●
NMZB30484, Matobo Hills, Totololo R, -20.55, 28.83 ●
NMZB63762, Matobo NP, Whitewaters Dam, -20.58, 28.47 ●
NMZB59837, Msandane Hill, Shashi R, -21.62, 28.87 ●
NMZB61232, Nottingham Estates, Beitbridge, -22.12, 29.87 ●
NMZB84247, Nyandia Dam, -17.00, 32.00 ●
NMZB32540, Nyashato Dam, -17.12, 32.12 ●
NMZB59839, Ranelia, -19.25, 32.50 ●
NMZB57595, River Farm, -22.13, 29.88 ●
NMZB9878, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB30815, Sentinel Ranch, Tongani R, -22.12, 29.62 ●

Tadarida

aegyptiaca

ANGOLA

?, Caquindo, -15.38, 17.13 (Crawford-Cabral 1986)
SMM6603, Dolondolo, -13.88, 13.13 ●
?, Galanga, -13.63, 14.38 (Crawford-Cabral 1986)
MD5841, Marco de Canavezes, -12.88, 14.38 (Hayman, 1963)
IICA6307, Sa da Bandeira (= Lubango), -14.88, 13.38 ●
IICA8622, Vila Arriaga, -14.88, 13.38 (Crawford-Cabral 1986)

BOTSWANA

USNM00425390, Shakawe, 70 km SW, -18.55, 21.03
NMZB62887, Tsabong, -26.12, 22.37 ●
NMZB65192, Tsane, -24.12, 21.87 ●
USNM00479538, Tsodilo Hills, -18.87, 21.62
NMZB65194, Tsodilo Hills, -18.87, 21.62 ●

LESOTHO

NMB8683, Holomo, -28.88, 28.38 ●

MOZAMBIQUE

USNM00365480, Chiutu, -15.57, 33.28
NMZB63966, Mucrera R, -19.87, 33.12 ●
DM8618, Ribaue, 40 km W, -14.97, 38.08 ●
USNM00479953, Tete, 3 km E, -16.27, 33.60
USNM00365503, Vila Gouveia, -18.07, 33.18

NAMIBIA

TM37556, Aus, 3 km W, -26.65, 16.22 ●
SMM11191, Aus, 3 km W, -26.65, 16.22 ●
SMM10117, Bethanie, -27.38, 17.38 ●
TM32691, Bethanie, -27.38, 17.38 ●
KM32656, Bethanie, E, -27.50, 17.67 ●
SMM9786, Brandberg Wes Mine, -21.13, 14.38 ●
SMM10029, Driekrone 516, Damaraland, -20.63, 14.63 ●
SMM8098, Etosha NP, Okaukuejo, -19.13, 15.88 ●
SMM13627, Gorraris 99, Maltahohe, -24.88, 16.38 ●
TM32549, Keetmanshoop, 35 km SSW, -26.95, 17.93 ●
TM32541, Lutzputs, 12 km NW, -28.32, 20.57 ●
USNM00498134, Maltahohe, 110 km WSW, -25.20, 15.92
TM37606, Maltahohe, 70 km W, -24.90, 16.28 ●
SMM11276, Maltahohe, Zwartmodder 101, -24.88, 16.38 ●
SMM7282, Okatumba, -22.63, 17.88 ●
KM31821, Omaruru, -21.28, 16.00 ●
TM9513, Ombu, Eronga Mountain, -21.67, 15.73 ●
KM28324, Otjiwarongo, -20.46, 16.31 ●
USNM00379805, Rehoboth, -22.68, 16.83
SMM10100, Rosh Pinah, -27.97, 16.77 ●

TM32671, Rosh Pinah, -27.97, 16.77 ●
TM16398, Usakos, -21.88, 15.63 ●
SMM3954, Welverdiend 328, Keetmanshoop, -25.78, 19.98 ●
SOUTH AFRICA
KM32659, Albany District, -33.30, 26.52 ●
DM6753, Albert Falls NR, -29.43, 30.38 ●
TM35153, Algeria Forest Research Station, -32.40, 19.13 ●
TM28340, Algeria Forest Research Station, -32.37, 19.05 ●
NMB7787, Arcadia, Lindley, -27.88, 28.13 ●
NMB7903, Arrarat, Sterkfontein Dam, -28.38, 28.88 ●
TM27464, Augrabies Falls NP, -28.60, 20.33 ●
KM25022, Barkley East, -31.08, 27.45 ●
NMB4589, Barkley East, -31.08, 27.45 ●
KM2552, Bedford, SE, -32.88, 26.24 ●
NMB2985, Bethlehem, E of, -28.13, 28.63 ●
USNM00342648, Brakfontein, 18 km N, -33.12, 23.45
TM4573, Burghersdorp, -30.88, 26.38 ●
KM29023, Calvinia, -31.54, 20.49 ●
TM20840, Christiana, 25 km NNE, -27.68, 25.23 ●
KM2542, Clanwilliam, -32.12, 18.45 ●
DM6347, Clarens, -28.38, 28.38 ●
KM24579, De Aar, -30.53, 24.08 ●
USNM00342649, De Hoop, 24 km NNE, -38.38, 20.38
NMB7879, Dennergeur, Boshof, -28.13, 25.13 ●
TM32274, Diepwalle State Forest, -33.95, 23.17 ●
DM6368, Durban, -29.85, 31.00 ●
NMB3023, Eldorado District, Bultfontein, -28.38, 25.88 ●
TM7384, Eshowe, -28.90, 31.47 ●
NMB7565, Excelsior, -28.88, 27.38 ●
TM1134, Florida, -26.13, 27.88 ●
TM39002, Gazankulu, Elim Hospital, -23.15, 30.05 ●
DM3670, Gillitts, -29.80, 30.80 ●
NMZB62004, Grahamstown, -33.32, 26.53 ●
TM6836, Grahamstown, -33.32, 26.53 ●
TM24607, Hans Merensky NR, -23.67, 30.68 ●
NMB3170, Helena, Vredefort Basin, -26.88, 27.38 ●
NMB3617, Hexrivier, Reddersburg, -29.88, 26.38 ●
TM39282, Hilton, -29.56, 30.30 ●
DM3269, Hluhluwe-Imfolozi Park, Mansiya, -28.08, 32.30 ●
NMB11939, Hoopstad, -27.88, 25.88 ●
TM41532, Hotazel, 15 km WNW, -27.18, 22.82 ●
KM24812, Humansdorp, -33.98, 23.65 ●
DM5998, Itala NR, -27.52, 31.37 ●
TM31729, Itala NR, -27.52, 31.37 ●
NMB7583, Jagersfontein Commonage, -29.63, 25.38 ●
USNM00451062, Jansenville, 12 km E, -32.90, 24.75
TM35622, Kalahari Gemsbok NP, -25.88, 20.63 ●
TM15573, Kalahari Gemsbok NP, Twee Rivieren, -26.45, 20.52 ●
TM16462, Kalahari Gemsbok NP, Twee Rivieren, 30 km NW, -26.13, 20.63 ●
SAM ZM13355, King William's Town, -32.87, 27.37 ●
KM24407, King William's Town, S of, -33.04, 27.23 ●
TM2287, Klaver, Van Rhynsdorp, -31.78, 18.62 ●
NMB7509, Koegelbeen Cave, -28.68, 23.37 ●
TM36807, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM34183, Kruger NP, Levuvhu R, -22.43, 31.18 ●
TM36979, Kruger NP, Levuvhu R, -22.43, 31.18 ●
TM35455, Kruger NP, Stolznek, -25.38, 31.38 ●
TM35704, Kuruman, 10 km SW, -27.57, 23.37 ●
KM29471, Ladismith, -33.51, 21.10 ●
NMB4355, Ladybrand, -29.13, 27.38 ●
TM41301, Langjan NR, -22.83, 29.20 ●
NMB4164, Letsoana, Fourisburg, -28.63, 28.38 ●
USNM00344267, Luchoff. Knoffelfontein. 22 km S, -29.90, 24.90
TM47157, Lydenburg, -25.11, 30.48 ●
TM19713, Maasstroom, 20 km NW, -22.68, 28.25 ●
TM2487, Malelane, -25.47, 31.52 ●
NMB5077, Maniba, Dordrecht, -31.38, 26.88 ●
TM39232, Manyaleti GR, Main Camp, -24.63, 31.47 ●
NMB1657, Middelwater, Hoopstad, -27.62, 25.37 ●
USNM00351436, Mkhuze GR, Msinga Pan, -27.60, 32.20
KM25040, Molteno, -31.40, 26.36 ●
KM24673, Murraysburg, E of, -32.05, 24.08 ●
TM17291, Newington, 10 km N, -24.75, 31.42 ●
SAM ZM9037, Newlands, Barkley West, -28.63, 24.63 ●
DM5087, Nottingham Road, -29.35, 30.00 ●
TM39550, Nylstroom, -24.70, 28.42 ●
KM24586, Philipstown, -30.06, 24.67 ●
KM2543, Piet Retief, -27.00, 30.80 ●
DM5672, Pietermaritzburg, Town Bush, -29.55, 30.35 ●
TM33400, Pietermaritzburg, Town Bush, -29.55, 30.35 ●
TM25604, Pietersburg (= Polokwane), 40 km N, -23.60, 29.67 ●
DM7494, Pongola Bush NR, -27.32, 30.47 ●
TM39334, Port Nolloth, 20 km ENE, -29.22, 17.07 ●
TM1136, Potchefstroom, -26.70, 27.08 ●
USNM00156338, Potchefstroom, -26.70, 27.08
SAM ZM34203, Potchefstroom, -26.70, 27.08 ●
TM44959, Potchefstroom, 14 km SSE, -26.92, 27.17 ●
TM4667, Pretoria, Brooklyn, -25.75, 28.14 ●
TM2880, Pretoria, Muckleneuk, -25.73, 28.18 ●
TM27273, Prieska, 20 km SE, -29.83, 22.78 ●
NMB9280, Qwa-Qwa, -28.63, 28.88 ●
KM29476, Riversdale, -34.02, 21.22 ●
NMB3003, Roodepoort, Edenburg, -29.63, 25.88 ●
TM24959, Rust de Winter, 16 km SE, -25.30, 28.67 ●
TM24958, Sabie Sands GR, -24.75, 31.43 ●
NMB6322, Spitskop, Boshof, -28.63, 25.38 ●
USNM00342659, Springbok, 14 km W, -29.67, 17.28
TM28221, Springbok, 28 km SSE, -29.88, 17.75 ●
KM25648, Steynsburg, -31.26, 25.57 ●
TM29757, Storms R State Forest, -33.97, 23.88 ●
TM44916, Suikerbosrand NR, -26.53, 28.20 ●
NMB2952, Tha Banchu, -29.13, 26.88 ●
TM24748, Vaalwater, 32 km NW, -24.22, 27.87 ●
TM19596, Van Riebeeck NR, -25.88, 28.28 ●
TM8310, Van Wyk's Vlei, -32.38, 21.88 ●
TM29777, Ventersdorp, -26.38, 26.88 ●
TM2073, Venterskroon, -26.88, 27.27 ●
KM24766, Victoria West, -31.40, 23.12 ●
TM5261, Vryburg, -26.88, 24.13 ●
NMB7709, Warden, E of, -27.88, 29.38 ●
TM19790, Waterpoort, 8 km E, -22.90, 29.70 ●
TM40847, West Coast NP, Geelbek, -33.13, 18.13 ●
DM6921, Winterton, 14 km N, -28.70, 29.54 ●
NMB5932, Woodcliff, Maclear, -30.88, 28.13 ●
NMZB62875, Woodlands Herberts Hope, -32.87, 26.12 ●
TM20529, Zeerust, 13 km N, -25.48, 26.07 ●
KM19089, Zwelitsha, -32.72, 27.29 ●
SWAZILAND
TM47723, Malolotja NR, -26.16, 31.11 ●
ZAMBIA
?, Fort Jameson (= Chipata), -13.62, 32.65 (Ansell 1978)
NMZB30893, Kalomo, 24 km E, -17.00, 26.25 ●
BM?, Mazabuka, -15.83, 27.73
ZIMBABWE
NMZB84195, Bubye R, Chikwarakwara, -22.35, 31.10 ●
NMZB55621, Bulawayo, -20.12, 28.58 ●
NMZB60000, Chikombedzi, -21.62, 31.62 ●
NMZB31353, Chikupu Caves, Bindura, -17.38, 31.28 ●
NMZB60014, Chikwarakwara, Pesu R Gorge, -22.28, 31.20 ●
NMZB84094, Chikwarakwara, Pesu R Gorge, -22.28, 31.20 ●
NMZB59936, Chiredzi, Lone Star Ranch, -21.12, 31.87 ●
NMZB64809, Chizarira NP, Mucheni Gorge, -17.50, 27.75 ●
NMZB30555, Dibutibu R, Batoka, -17.94, 26.12 ●
NMZB59974, Eirene Farm, Marondera, -18.37, 31.62 ●
NMZB30697, Esigodini, Falcon College, -20.22, 28.92 ●
NMZB59304, Gem Farm, Beitbridge, -21.87, 29.62 ●
NMZB59425, Gonarezhou NP, Chipinda Pools, -21.27, 31.90 ●
NMZB30081, Guhudza Mountain, Chivi, -20.58, 30.67 ●
NMZB82293, Harare, -17.83, 31.07 ●
TM12587, Harare, Borrowdale, -17.83, 31.07 ●
NMZB84365, Hoya River Camp, Muzarabani, -16.25, 31.25 ●
NMZB59931, Hwange NP, Inyantue, -18.50, 26.50 ●
NMZB59979, Lake McIlwaine, -17.90, 30.78 ●
NMZB33621, Lutope-Ngolangola R Confluence, -18.28, 28.08 ●
NMZB55657, Malapati, -21.88, 31.38 ●
NMZB59935, Mangwe, Vashu Farm, -20.87, 28.12 ●
NMZB30496, Matobo Hills, Diana's Pool, -20.47, 28.87 ●
NMZB30674, Matobo Hills, Lumane Valley, -20.58, 28.83 ●
NMZB30466, Matobo Hills, Totololo R, -20.55, 28.83 ●
NMZB60002, Matobo NP, Lower Outspan, -20.62, 28.62 ●
NMZB32484, Murehwa Caves, -17.62, 31.78 ●
NMZB84284, Nyadire River Camp, Pfungwe, -16.75, 32.25 ●
NMZB84260, Nyandia Dam, -17.00, 32.00 ●
NMZB32606, Nyashato Dam, -17.12, 32.12 ●
NMZB33727, Samalanga Pan, -17.95, 27.82 ●
NMZB33444, Sengwa Wildlife Research Station, -18.17, 28.22 ●
TM34891, Sengwa Wildlife Research Station, -18.17, 28.22 ●
NMZB29570, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB30813, Sentinel Ranch, Tongani R, -22.12, 29.62 ●
NMZB32022, Shangani Bridge, Lubimbi, -18.62, 27.37 ●

fulminans
MALAWI
HZM7.15089, Likabula R, Mulanje, -15.92, 35.67 (Happold *et al.* 1987)
MOZAMBIQUE
USNM00365472, Chiutu, -15.57, 33.28 ●
DM8619, Ribaue, 40 km W, -14.97, 38.08 ●
USNM00365476, Vila Gouveia, -18.07, 33.18 ●

SOUTH AFRICA
TM37083, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM37033, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
ZAMBIA
?, Abercorn (= Mbala), -8.85, 31.38 (Ansell 1957)
NMZ?, Kalomo, 21 km NW, -17.03, 26.48 (Ansell 1967)
ZIMBABWE
TM34819, Bindura, 10 km SSW, -17.38, 31.28 ●
DM3688, Chikupu Caves, Bindura, -17.38, 31.28 ●
NMZB30219, Chikupu Caves, Bindura, -17.38, 31.28 ●
HZM4.3898, Chinhoyi Caves, -17.37, 30.08 ●
NMZB29727, Dibutibu R, Batoka, -17.94, 26.12 ●
NMZB30028, Guhudza Mountain, Chivi, -20.58, 30.67 ●
NMZB59916, Harare, -17.83, 31.07 ●
HZM3.3881, Harare, -17.83, 31.07 ●
NMZB30205, Harare, Cleveland Dam, -17.75, 31.00 ●
NMZB82265, Harare, Cleveland Dam, -17.75, 31.00 ●
NMZB59923, Henderson Research Station, -17.62, 30.87 ●
NMZB33605, Lutope-Ngolangola R Confluence, -18.28, 28.08 ●
NMZB32621, Nyadiri R, -17.12, 32.12 ●
NMZB84237, Nyandia Dam, -17.00, 32.00 ●
ROM83980, Sengwa Wildlife Research Station, -18.17, 28.22 ●

lobata
ZIMBABWE
HZM1.4244, Harare, Hatfield, -17.83, 31.07 ●
NMZB32591, Nyadiri R, -17.12, 32.12 ●
NMZB84251, Nyandia Dam, -17.00, 32.00 ●
NMZB32588, Nyashato Dam, -17.12, 32.12 ●
?, Siabuwa, -17.13, 28.13 ●

ventralis
MALAWI
MMB267, Zoa Estate, -16.23, 35.20 (Ansell & Dowsett 1988)
MOZAMBIQUE
?, Tete, N of, -15.50, 33.50 (Smithers & Lobão Tello 1976)
?, Vila Gouveia, -18.07, 33.18 (Smithers & Lobão Tello 1976)
SOUTH AFRICA
BM1875.11.19.1, 'Transvaal' (Cotterill 1996b, Van Cakenberghe & Seamark 2008) ●
ZAMBIA
NMZ2253, Nyika NP, -10.58, 33.65 (Ansell 1986)
ZIMBABWE
NMZB29639, Guhudza Mountain, Chivi, -20.58, 30.67 ●
NMZB59924, Harare, -17.83, 31.07 ●
NMZB59915, Hwange NP, Bumbusie, -18.50, 26.00 ●
?, Siabuwa, -17.13, 28.13 ●

NYCTERIDAE

Nycteris

arge
ANGOLA
MD5206b, Dundo, -7.38, 20.88 (Hayman, 1963)
DRC
IRSN10838, Kiamokoto, -9.17, 27.07 (Hayman *et al.* 1966)
RMCA6555, Luebo, -5.33, 21.55 (Hayman *et al.* 1966)
IRSN10835, Munoi, -8.75, 26.77 (Hayman *et al.* 1966)

grandis
DRC
TM45568, Kitwit, -5.08, 18.91 ●
TM45569, Kitwit, -5.08, 18.91 ●
BM?, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)
MALAWI
DCHC?, Liwonde NP, -15.03, 35.25 (Happold *et al.* 1987)
MMB?, Liwonde NP, -15.03, 35.25 (Happold *et al.* 1987)
MMB?, Liwonde R, 16 km S, -15.20, 35.17 (Happold *et al.* 1987)
MOZAMBIQUE
?, Espungabera, NW of, -20.13, 33.13 (Smithers & Lobão Tello 1976)
TM45950, Moebase, -16.97, 38.67 ●
DM8669, Pemba, SW of, -13.01, 40.52 ●
ZAMBIA
HZM14.11460, Chinzombo, -13.10, 31.77 (Ansell 1986)
BM68.123, Luangwa Valley, Chisombo, -13.38, 31.88 (Ansell 1969)
NMZB22778, Luangwa Valley, Mfuwe, -13.08, 31.78 ●
HZM15.11503, Luangwa Valley, Nsefu, -12.93, 31.93 (Ansell 1986)
ZIMBABWE
NMZB60539, Haroni-Rusitu R Confluence, -20.03, 33.02 ●
NMZB5259, Mana Pools NP, -15.80, 29.33 ●
NMZB60540, Mana Pools NP, -15.80, 29.33 ●
TM41863, Mana Pools NP, -15.80, 29.33 ●
NMZB31571, Mana Pools NP, Nyamepi, -15.80, 29.37 ●
NMZB30659, Mana Pools NP, Sapi R, -15.67, 29.58 ●
USNM00425278, Ngorima Reserve, -19.75, 32.33

hispida
ANGOLA
?, Alto Chicapa, -10.88, 19.13 (Crawford-Cabral 1986)
?, Alto Cuilo, -10.13, 19.63 (Crawford-Cabral 1986)
MD5004, Dundo, -7.38, 20.88 (Hayman, 1963)
IICT3158025, Lago Dilolo, Moxico, -11.63, 22.13 (Crawford-Cabral 1986)
?, Monte Moco, -12.38, 15.13 (Crawford-Cabral 1986)
BOTSWANA
USNM00518626, Xugana, -19.08, 23.10 (Archer 1975)
DRC
RMCA20750, Banana, -5.97, 12.45 (Hayman *et al.* 1966)
RMCA2486, Boma, -5.83, 13.05 (Hayman *et al.* 1966)
RMCA13699, Kasenga, -10.37, 28.60 (Hayman *et al.* 1966)
IRSN10808, Kaswabilenga, -8.80, 26.68 (Hayman *et al.* 1966)
RMCA11323, Kiambi, -7.23, 27.87 (Hayman *et al.* 1966)
RMCA11402, Kisale, lake, -8.17, 26.42 (Hayman *et al.* 1966)
?, Kitwit, -5.08, 18.91 (Van Cakenberghe *et al.* 1999)
RMCA1536, Leopoldville (= Kinshasa), -4.30, 15.30 (Hayman *et al.* 1966)
RMCA9986, Leverville (= Lusanga), -4.83, 18.72 (Hayman *et al.* 1966)
RMCA11470, Lukonzolwa, -8.75, 28.67 (Hayman *et al.* 1966)
RMCA7545, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)
IRSN10839, Mabwe, -8.70, 26.48 (Hayman *et al.* 1966)
RMCA18161, Makengo, -4.75, 16.50 (Hayman *et al.* 1966)
RMCA162, Moliro, -8.20, 30.57 (Hayman *et al.* 1966)
RMCA16193, Mukishi, -5.65, 21.05 (Hayman *et al.* 1966)
IRSN14461, Musosa, -9.00, 29.00 (Hayman *et al.* 1966)
RMCA11550, Mweka, -4.75, 21.53 (Hayman *et al.* 1966)
RMCA5441b, Pweto, -8.47, 28.87 (Hayman *et al.* 1966)
MALAWI
BM55.12.26.252, Chiromo, -16.53, 35.15 ●
KM11679, Nkhotakota, -12.93, 34.30 ●
MMB?, Zoa Estate, -16.23, 35.20 (Happold *et al.* 1987)
MOZAMBIQUE
?, Cahora Bassa, -15.38, 32.63 (Smithers & Lobão Tello 1976)
?, Inhambane, -23.90, 35.40 (Smithers & Lobão Tello 1976)
DM8646, Meponda, Lake Niassa, -13.40, 34.87 ●
?, Vila Gouveia, -18.07, 33.18 (Smithers & Lobão Tello 1976)
NAMIBIA
KM17146, Katima Mulilo, -17.50, 24.33 ●
TM12347, Nampini, -17.63, 25.13 ●
SOUTH AFRICA
DM2431, Greater St. Lucia Wetlands Park, Mission Rocks, -28.28, 32.49 ●
KM25969, Hlabisa, -28.18, 31.95 ●
KM23584, Ngwavuma, -27.27, 32.73 ●
DM2458, St. Lucia Forest Station, -28.38, 32.42 ●
ZAMBIA
KM1671, Balovale (= Zambezi), -13.55, 23.12 ●
NMZB10174, Chingi, Chavuma, -13.02, 22.73 ●
BM68.123, Chinzombo, -13.10, 31.77 ●
NMZB8295, Kabompo Boma, -13.58, 24.20 ●
NMZ2936, Kalabo, -14.97, 22.68 (Ansell 1973)
NMZB22971, Lochinvar NP, -15.88, 27.38 ●
LACM069840, Luangwa Valley, -12.75, 32.08 ●
KM8049, Mongu, -15.15, 23.17 ●
NMZ3686, Nchelenge, -9.35, 28.75 (Ansell 1986)
?, Nyansowe R, -12.22, 25.53 (Ansell 1974)
NMZ3687, Sakeji headwaters, -11.38, 24.38 (Ansell 1974)
NMZB11554, Salujinga, -10.97, 24.12 ●
HNHM76.155.1, Sumbu, -8.52, 30.48 (Ansell 1974)
ZIMBABWE
HZM48.5092, Mana Pools NP, -15.80, 29.33 ●
NMZB32126, Mashumbi Pools, -16.17, 30.07 ●
NMZB60538, Pungwe-Rwera R Confluence, -18.25, 33.00 ●

intermedia
ANGOLA
BM?, Lucano, -11.13, 21.63 (Van Cakenberghe & De Vree 1985)

macrotis
ANGOLA
?, Bungo, -7.38, 15.38 (Van Cakenberghe & De Vree 1985)
IICA6589, Cabuta, -9.88, 14.88 ●
?, Cassoalala, -9.38, 14.38 (Van Cakenberghe & De Vree 1985)
?, Cunga, -9.63, 13.38 (Van Cakenberghe & De Vree 1985)
MD5003, Dundo, -7.38, 20.88 (Hayman, 1963)
?, Landana (= Cacongo), -5.13, 12.13 (Crawford-Cabral 1986)
?, Pungo Andongo, -9.63, 15.63 (Van Cakenberghe & De Vree 1985)
BOTSWANA
NMZB64232, Maun, -19.98, 23.42 ●
NMZB64217, Savuti R, -18.62, 24.12 ●
DRC
RMCA23796, Baya, cave, -11.87, 27.12 (Hayman *et al.* 1966)
RMCA6066, Boma, -5.83, 13.05 (Hayman *et al.* 1966)
RMCA10844, Kakyelo, -12.35, 29.60 (Hayman *et al.* 1966)
RMCA20101, Kalina, -4.30, 15.28 (Hayman *et al.* 1966)
RMCA26230, Kasenga road, km 36, -11.62, 27.67 (Hayman *et al.* 1966)

RMCA29164, Kasongo, -4.52, 26.58 (Hayman *et al.* 1966)
IRSN10811, Kateke, -9.07, 26.72 (Hayman *et al.* 1966)
HZM37.7849, Katupila, Lufira R, -8.83, 26.73 (Gallagher & Harrison 1977)
RMCA23800, Keyberg, -11.72, 27.42 (Hayman *et al.* 1966)
RMCA?, Kidada, -5.37, 14.53 (Van Cakenberghe & De Vree 1985)
RMCA6556, Kidada, -5.37, 14.53 (Hayman *et al.* 1966)
RMCA22441, Kimilolo, -11.70, 27.42 (Hayman *et al.* 1966)
TM45614, Kitwit, -5.08, 18.91 ●
RMCA18129, Leopoldville (= Kinshasa), -4.30, 15.30 (Hayman *et al.* 1966)
RMCA7108, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)
IRSN10847, Mabwe, -8.70, 26.48 (Hayman *et al.* 1966)
RMCA7296, Macaco, -5.47, 21.17 (Hayman *et al.* 1966)
BM?, Moba, -7.07, 29.75 (Hayman *et al.* 1966)
IRSN14490, Musosa, -9.00, 29.00 (Hayman *et al.* 1966)
IRSN14491, Shinkolobwe, -11.10, 26.55 (Hayman *et al.* 1966)
RMCA6557, Temvo, -5.47, 13.22 (Hayman *et al.* 1966)

MALAWI
MMB?, Chididi Mission, -16.92, 35.20 (Happold *et al.* 1987)
NMZB64251, Chipeta Village, -10.00, 34.00 ●
BM22.4.25.3, Chiromo, -16.53, 35.15 ●
NMZB64248, Kasungu NP, -13.05, 33.15 ●
DCHC?, Lengwe NP, -16.20, 34.78 (Happold *et al.* 1987)
TM41763, Liwonde NP, -15.03, 35.25 ●
DCHC?, Liwonde NP, -15.03, 35.25 (Happold *et al.* 1987)
BM?, Mulanje, -15.93, 35.62 (Van Cakenberghe & De Vree 1985)
DCHC?, Zomba Plateau, -15.33, 35.32 (Happold *et al.* 1987)

MOZAMBIQUE
IICT4800857, Gondola, -18.75, 33.25 (Lopes & Crawford-Cabral 1990)
DM8663, Gorongosa, E of, -18.56, 34.87 ●
IICT4800949, Manica, -18.93, 32.88 (Lopes & Crawford-Cabral 1990)
DM8662, Mepuze, -23.21, 32.50 ●
DM8665, Niassa GR, -12.87, 37.69 ●

ZAMBIA
?, Chingola?, -12.37, 27.62 (Ansell 1978)
?, Chisela Dambo, Mporokoso, -8.38, 29.75 (Ansell 1978)
NMZB11472, Kabompo Boma, -13.58, 24.20 ●
NMZB31743, Kalomo District, -17.12, 26.37 ●
NMZB7572, Mumbwa Caves, -14.75, 27.00 ●
NMZB30903, Nansai Farm, Choma, -16.62, 27.12 ●
NMZ3684, Ngwerere Cave, -15.30, 28.33
NMZB29868, Sakeji School, -11.12, 24.37 ●
?, Solwezi, -12.18, 26.42 (Ansell 1978)
BM66.5429, South Luangwa Valley, Mfuwe, -13.08, 31.78 (Ansell 1967)
NMZ3376, South Luangwa Valley, Mfuwe, -13.08, 31.78 (Ansell 1973)

ZIMBABWE
NMZB60552, Chewore-Zambezi R Confluence, -16.12, 29.75 ●
NMZB32281, Deka-Zambezi R Confluence, -18.00, 26.50 ●
NMZB84377, Hoya River Camp, Muzarabani, -16.25, 31.25 ●
NMZB62022, Kanjedza R, Matusadona, -16.87, 28.62 ●
NMZB54376, Matetsi SA, HQ, -18.50, 25.75 ●

major

ZAMBIA
IRSN?, Mweru Wantipa, Kangiri, -8.50, 29.73 (Van Cakenberghe & De Vree 1985)

nana

ANGOLA
?, Sombo, -8.63, 20.88 (Crawford-Cabral 1986)

DRC
RMCA?, Luluabourg (= Kananga), -5.88, 22.43 (Van Cakenberghe & De Vree 1985)

thebaica

ANGOLA
IICA1438, Baia Farta, -12.63, 13.16 ●
?, Bibala, -14.63, 13.38 (Crawford-Cabral 1986)
?, Capelongo, -14.88, 15.13 (Crawford-Cabral 1986)
IICA679, Capolopopo, -15.88, 12.88 ●
?, Catumbela, -12.38, 13.63 (Crawford-Cabral 1986)
?, Cazengo, -9.38, 14.88 (Crawford-Cabral 1986)
?, Curoca, -15.88, 12.13 (Crawford-Cabral 1986)
?, Gambos, -15.88, 14.13 (Crawford-Cabral 1986)
?, Hanha, -13.63, 14.38 (Crawford-Cabral 1986)
?, Hanha Estate, -12.38, 13.88 (Crawford-Cabral 1986)
?, Huila, -15.13, 13.63 (Crawford-Cabral 1986)
?, Humbe, -16.63, 14.88 (Crawford-Cabral 1986)
?, Luanda, -8.88, 13.38 (Crawford-Cabral 1986)
IICA7899, Naulila (Cunene), -17.13, 14.63 ●
?, Omupanda, -17.13, 15.88 (Crawford-Cabral 1986)
IICA496, Pedra Grande, Caraculo, -15.13, 12.63 ●
IICA2479, Quiteve, -16.13, 15.13 ●
?, Sangueve, -13.88, 15.88 (Crawford-Cabral 1986)
?, Serra de Seles, -11.38, 14.38 (Crawford-Cabral 1986)
IICA147, Tchivinguiro, -15.13, 13.38 ●

BOTSWANA
USNM00425271, Drotsky Caves, -20.12, 21.37
NMZB63316, Drotsky Caves, -20.12, 21.37 ●
NMZB64216, Francistown, -21.15, 27.50 ●
NMZB63338, Francistown-Nata, -21.00, 27.25 ●
TM6558, Goho Hills, -18.38, 24.13 ●
USNM00367675, Kaikai, 35 km SE, -20.13, 21.63
NMZB63325, Livingstone's cave, Molepolole, -24.25, 25.50 ●
NMZB63371, Maun, -19.98, 23.42 ●
USNM00479062, Maun, -19.98, 23.42
NMZB64235, Moremi GR, Khwai R, -19.15, 23.75 ●
NMZB64219, Ngoma, Chobe R, -17.90, 24.75 ●
NMZB64209, Nokaneng, 21 km N, -19.42, 22.27 ●
NMZB64222, Nthane, -21.25, 26.00 ●
NMZB64215, Savuti R, -18.62, 24.12 ●
USNM00425269, Sepopa, -18.62, 22.12
NMZB64233, Sepopa, -18.62, 22.12 ●
NMZB64229, Serowe, -22.37, 26.62 ●
NMZB63377, Shakawe, 15 km S, -18.50, 21.75 ●
USNM00518624, Xugana, -19.08, 23.10 (Archer 1975)

DRC
RMCA22890, Kakanda, -10.78, 26.60 (Hayman *et al.* 1966)
RMCA26234, Kapolowe, -11.05, 26.95 (Hayman *et al.* 1966)
RMCA23798, Kasenga road, km 67, -11.00, 28.15 (Hayman *et al.* 1966)
IRSN10812, Kaswabilenga, -8.80, 26.68 (Hayman *et al.* 1966)
IRSN10813, Kateke, -9.07, 26.72 (Hayman *et al.* 1966)
RMCA23797, Mukuen, -11.77, 27.45 (Hayman *et al.* 1966)
MHNG1046.36, Tantara, -11.03, 26.48 (Hayman *et al.* 1966)
IPNCV1436, Tumbwe (= Tembwe), -6.50, 29.48 (Hayman *et al.* 1966)

MALAWI
MMB?, Blantyre, -15.78, 35.00 (Happold *et al.* 1987)
MMB?, Chiwpina, near Chilwa, -15.32, 35.62 (Happold *et al.* 1987)
MMB?, Ekwendeni Station, -11.37, 33.88 (Happold *et al.* 1987)
MMB?, Fort Johnston (= Mangochi), -14.48, 35.27 (Happold *et al.* 1987)
MMB?, Karonga, -9.93, 33.93 (Happold *et al.* 1987)
DCHC?, Lengwe NP, -16.20, 34.78 (Happold *et al.* 1987)
MMB?, Limbe, -15.82, 35.05 (Happold *et al.* 1987)
MMB?, Mapera (= Maperera), -16.12, 34.88 (Happold *et al.* 1987)
MMB?, Mzuzu, -11.47, 34.07 (Happold *et al.* 1987)
MMB?, Zomba, -15.38, 35.32 (Happold *et al.* 1987)

MOZAMBIQUE
NMZB64244, Amamba, -20.00, 33.75 ●
DM8667, Caia Lodge, -17.85, 35.32 ●
IICT4800714, Chicualacuala, -22.63, 31.63 (Lopes & Crawford-Cabral 1990)
DM8668, Gorongosa, E of, -18.56, 34.87 ●
DM718, Inhaminga, -18.40, 35.00 ●
USNM00352013, Jangamo, -24.10, 35.30
USNM00365148, Massamba, 16 km E, -16.13, 33.63
USNM00352011, Massangena, -21.56, 32.96
NMZB63313, Mehave, Save R, -21.00, 34.75 ●
TM14683, Muchena, -15.63, 33.88 ●
?, Nalazi, -24.13, 33.38 (Smithers & Lobão Tello 1976)
?, Quelimane, -17.63, 36.88 (Smithers & Lobão Tello 1976)
NMZB63372, Save R Bridge, 30 km N, -21.63, 32.38 ●
USNM00365136, Tete, 3 km E, -16.27, 33.60
USNM00365150, Vila Gamito, 10 km N, -14.08, 33.02
TM14684, Vila Gamito, 10 km N, -14.13, 32.88 ●
USNM00365177, Vila Gouveia, -18.07, 33.18
NMZB63311, Zinave NP, 3 km SSW, -21.39, 33.89 ●
NMZB63308, Zinave NP, 3 km SSW, -21.39, 33.89 ●

NAMIBIA
SMM6695, Andara, Okavango, -18.13, 21.38 ●
SMM3504, Arnhem Cave, -22.70, 18.10 ●
TM16349, Arnhem Cave, -22.70, 18.10 ●
SMM12234, Beenbreck, -23.38, 17.88 ●
SMM13703, De Start 1014, Grootfontein District, -18.95, 19.15 ●
SMM10076, Diamond Area 1, -28.55, 16.42 ●
TM35972, Etosha NP, Halali, -19.13, 16.38 ●
SMM13620, Etosha NP, Halali, -19.13, 16.38 ●
SMM13619, Etosha NP, Okaukuejo, -19.13, 15.88 ●
SMM6465, Geiersberg, -22.13, 17.88 ●
TM6555, Gemsbok Pan, -20.38, 17.63 ●
USNM00342149, Gobabeb, Namib Desert, -23.55, 15.05
TM15165, Gobabeb, Namib Desert, -23.55, 15.05 ●
SMM11788, Gobabeb, Namib Desert, -23.55, 15.05 ●
KM1707, Gobabis, -22.45, 19.87 ●
LACM041617, Grootfontein, 40 km WNW, -19.38, 17.88 ●
SMM2682, Hoasas, -20.38, 16.63 ●
SMM6508, Kake, Okavango, -18.13, 21.63 ●
KM1677, Karibib, -21.97, 15.87 ●
KM1670, Katima Mulilo, -17.50, 24.33 ●
USNM00256930, Keetmanshoop, -26.58, 18.13
KM32585, Keetmanshoop, -26.58, 18.13 ●
TM32516, Keetmanshoop, 35 km SSW, -26.95, 17.93 ●

SMM13626, Namib-Naukluft NP, De Valle, -24.13, 16.13 ●
TM12347, Nampini, -17.63, 25.13 ●
SMM2688, Ohopoho, -18.13, 13.88 ●
TM3379, Okahandja, -21.98, 16.92 ●
SMM11499, Okakarara, -20.63, 17.63 ●
TM37645, Omaruru, 48 km NE, -21.30, 16.45 ●
TM1172, Ombalantu, -17.38, 14.88 ●
SMM10917, Ombonde, -19.55, 14.53 ●
KM1698, Ondangwa, -17.90, 15.98 ●
KM1685, Opuwo, N of, -17.33, 13.83 ●
TM32648, Oranjemund, -28.55, 16.42 ●
TM8298, Oshikanga, Ovamboland, -18.13, 15.63 ●
SMM3510, Otjikoko-Sud, -21.88, 16.88 ●
TM16343, Otjimbingwe, -22.38, 16.13 ●
DM16, Otjitundua, Kaokoveld, -18.62, 14.13 ●
SMM8076, Otjovasando, -19.38, 14.63 ●
KM28193, Outjo, W of, -20.13, 15.88 ●
SMM11319, Pipistrelle cave, Omaruru, -21.30, 16.45 ●
LACM056190, Rehoboth, 20 km NW, -22.67, 16.83 ●
SMM6731, Sinclair Mine, Luderitz, -25.63, 16.38 ●
SMM6427, Talana, -21.88, 18.13 ●
SMM2690, Uis, -21.13, 14.88 ●
TM16342, Usakos, NE, -21.38, 15.63 ●
KM1699, Uutapi, -17.53, 14.62 ●
TM8304, Warmbad, SW of, -28.88, 18.38 ●
SMM4333, Waterberg, -20.63, 17.63 ●
SMM13705, West End, Damaraland, -19.38, 14.38 ●
KM1675, Windhoek, -22.63, 17.13 ●
SMM6740, Windhoek, -22.63, 17.13 ●

SOUTH AFRICA

KM24646, Aberdeen, -32.36, 23.45 ●
KM32586, Albany District, -33.22, 26.77 ●
TM45422, Alldays, 32 km NE, -22.33, 29.37 ●
TM30125, Babanango District, -28.30, 31.02 ●
TM28028, Bitterfontein, 10 km NE, -30.95, 18.20 ●
TM23524, Blyde River Canyon NR, -24.58, 30.78 ●
KM1722, Clanwilliam, -32.12, 18.45 ●
TM20489, Derdepoort, 18 km SE, -24.75, 26.40 ●
TM23548, Derdepoort, 24 km S, -24.72, 26.28 ●
TM9987, Duiwelskloof, -23.70, 30.13 ●
TM36252, Dumisa Gold Mine, Umzinto, -30.27, 30.35 ●
DM7266, Durban, -29.85, 31.00 ●
DM1095, Durban, Bluff, -29.85, 31.00 ●
TM1033, Durban, Malvern, -29.78, 31.03 ●
DM7838, Durban, Westville, -29.83, 30.93 ●
TM19961, Ellisras, 10 km SE, -23.75, 27.83 ●
KM23619, Estcourt, -28.82, 29.53 ●
NMB2043, Fauresmith District, -29.88, 25.38 ●
TM41328, Figaro Mine, 11 km NE of Malelane, -25.45, 31.63 ●
MMK7129, Goegap NR, -29.65, 17.98 ●
KM1714, Gordonia, -28.57, 21.20 ●
USNM00424101, Graaff Reinet, 30 km SE, -32.45, 24.75
TM6654, Grahamstown, -33.32, 26.53 ●
NMZB59386, Grahamstown, 12 km NW, -33.12, 26.37 ●
TM40984, Gravelotte, -23.95, 30.60 ●
TM37873, Greater St. Lucia Wetlands Park, False Bay, -27.97, 32.37 ●
DM2429, Greater St. Lucia Wetlands Park, Mission Rocks, -28.28, 32.49 ●
MMK2752, Griekwastad, 25 km NNE, -28.63, 23.30 ●
TM8977, Grootvadersbosch, -33.88, 20.88 ●
TM1041, Hectorspruit, -25.43, 31.68 ●
TM24859, Hectorspruit, 10 km NE, -25.33, 31.83 ●
DM5074, Hella Hella GR, -29.90, 30.08 ●
TM40722, Hlabisa, -28.18, 31.95 ●
DM3277, Hluhluwe-Imfolozi Park, HQ, -28.07, 32.03 ●
DM7430, Illovo, -30.10, 30.83 ●
TM7122, Ingwavuma R, -29.13, 31.13 ●
TM31757, Itala NR, -27.52, 31.37 ●
NMB7577, Jagersfontein Commonage, -29.63, 25.38 ●
NMB1589, Jankempdorp, -27.88, 25.13 ●
DM7126, Jozini Dam, -27.41, 31.89 ●
MMK2718, Kalahari Gemsbok NP, Nossob, 17 km S, -25.57, 20.68 ●
TM15567, Kalahari Gemsbok NP, Twee Rivieren, -26.45, 20.52 ●
MMK2715, Kalahari Gemsbok NP, Twee Rivieren, 39 km NW, -26.13, 20.63 ●
MMK996, Kimberley, -28.63, 24.88 ●
KM7978, King William's Town, -32.87, 27.37 ●
DM5962, Kloof, -29.82, 30.83 ●
MMK2755, Koegelbeen Cave, -28.68, 23.37 ●
TM17504, Komatipoort, -25.43, 31.93 ●
KM19179, Komgha, -32.61, 27.66 ●
TM36637, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM36970, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM34191, Kruger NP, Levuvhu R, -22.43, 31.18 ●
TM39671, Kruger NP, Orpen, 14 km N, -24.35, 31.40 ●
TM13469, Kruger NP, Pretoriuskop, -25.17, 31.27 ●
TM12992, Kruger NP, Punda Milia, -22.77, 31.02 ●
TM29968, Kruger NP, Punda Milia, -22.77, 31.02 ●
TM2410, Kruger NP, Shingwedzi, -23.18, 31.23 ●
MMK2757, Kuruman, 29 km NW, -27.32, 23.18 ●
TM4826, Leydsdorp, -23.98, 30.52 ●
TM19815, Loskopdam NR, -25.42, 29.33 ●
KM31228, Lusikisiki, -31.28, 29.96 ●
TM38601, Manyaleti GR, Main Camp, -24.63, 31.47 ●
TM8890, Marico District, -24.88, 25.97 ●
TM24722, Marken, 20 km S, -23.83, 28.38 ●
MMK2750, Marydale, 31 km NE, -29.18, 22.30 ●
TM44200, Messina NR, -22.38, 30.07 ●
TM20313, Messina, 32 km E, -22.28, 30.28 ●
TM20393, Messina, 75 km W, -22.20, 29.38 ●
TM44497, Messina, 98 km E, -22.30, 30.87 ●
SAM ZM13543B, Mfongosi, -28.63, 30.88 ●
DM7522, Mkhuze GR, -27.58, 32.22 ●
DM4576, Mkhuze GR, Bube Hide, -27.63, 32.23 ●
TM35295, Mkhuze GR, Msinga Pan, -27.60, 32.20 ●
DM5589, Mooiplaas (SAPPI), -28.56, 31.15 ●
DM8351, Mooiplaas (SAPPI), -28.56, 31.15 ●
TM2542, Mooketsi, -23.67, 30.08 ●
TM34329, Mtubatuba, -28.37, 32.42 ●
DM114, Mtunzini, Twin Streams, -28.95, 31.77 ●
KM24657, Murraysburg, SW of, -32.31, 23.42 ●
TM7472, Mutale R, -22.50, 30.83 ●
DM3542, Nagle Dam, -29.58, 30.62 ●
DM4062, Nagle Dam, -29.58, 30.62 ●
KM1716, Namaqualand, -32.90, 18.23 ●
TM17036, Ndumu GR, -26.88, 32.27 ●
TM41423, Nysvlei NR, -24.48, 28.70 ●
MMK2768, Oviston NR, -30.63, 25.58 ●
MMK2760, Pamfret, 18 km W, -25.85, 23.35 ●
MMK1005, Papkuil, -28.38, 23.63 ●
TM44209, Percy Fyfe NR, -24.03, 29.13 ●
TM25531, Phalaborwa, 40 km N, -23.72, 31.08 ●
KM26069, Pietermaritzburg, E of, -29.60, 30.52 ●
TM13744, Pietermaritzburg, Town Bush, -29.55, 30.35 ●
KM28913, Piquetburg, -32.77, 18.72 ●
MMK2767, Pofadder, 42 km NE, -28.85, 19.70 ●
SAM ZM5444, Port St. Johns, -31.63, 29.55 ●
TM1028, Port St. Johns, -31.63, 29.55 ●
TM41559, Postberg NR, -33.12, 18.00 ●
MMK2735, Postmasburg, 21 km NNE, -28.17, 23.15 ●
MMK1425, Postmasburg, 24 km WSW, -28.42, 22.87 ●
MMK2732, Postmasburg, 25 km ENE, -28.20, 23.28 ●
MMK2717, Postmasburg, 6 km NE, -28.30, 23.12 ●
USNM00376753, Pretoria, -25.83, 28.13
TM46438, Pretoria, Hennops R, -25.83, 27.99 ●
TM1035, Pretoria, Muckleneuk, -25.73, 28.18 ●
TM27285, Prieska, 20 km SE, -29.83, 22.78 ●
MMK2743, Prieska, 23 km NNW, -29.47, 22.63 ●
MMK2731, Prieska, 4 km W, -29.63, 22.75 ●
KM29787, Prince Albert, -33.26, 22.00 ●
KM32597, Robertson, -33.92, 19.87 ●
TM46286, Roossenekal, -25.21, 29.97 ●
TM19629, Rustenburg, 18 km S, -25.82, 27.27 ●
TM40073, Shashe-Limpopo R Confluence, -22.22, 29.37 ●
DM7842, Shongweni Dam, -29.85, 30.72 ●
DM1104, Spioenkop NR, -29.67, 29.47 ●
TM40432, St. Lucia Village, -28.38, 32.42 ●
DM5314, Stainbank NR, -29.92, 30.93 ●
TM23307, Steilloop, 16 km W, -23.53, 28.42 ●
MMK7038, Tankwa Karoo NP, near, -32.38, 19.88 ●
USNM00468392, Thabazimbi, 20 km SE, -24.67, 27.37
TM1658, Thabazimbi, SE of, -24.88, 27.65 ●
KM32598, Uitenhage, -33.78, 25.47 ●
DM3975, Umlalazi NR, -28.96, 31.77 ●
DM5455, Umtamvuna Gorge NR, -31.06, 30.17 ●
DM5439, Vernon Crookes NR, -30.27, 30.60 ●
TM29800, Vernon Crookes NR, -30.27, 30.60 ●
TM40069, Verulam District, -29.60, 31.02 ●
KM4557, Victoria East, -32.78, 26.83 ●
TM41548, Warmbaths, -24.65, 28.03 ●
MMK2730, Warrenton, 47 km W, -28.13, 24.40 ●
TM19943, Waterpoort, 8 km E, -22.90, 29.70 ●
DM2367, Weenen NR, -28.85, 30.00 ●
SAM ZM37074, Worcester Division, -33.63, 19.38 ●
TM12560, Zebediela, -24.38, 29.38 ●

SWAZILAND

BM1975.515, Balegane, -26.05, 31.53
TM34328, Big Bend, -26.77, 31.90 ●
TM45318, Dinedor Ranch, -26.37, 31.57 ●

TM45300, Hlane NP, Sundwini, -26.25, 31.94 ●
TM45301, Hlane NP, Sundwini, -26.25, 31.94 ●
TM44890, Mlawula NR, -26.19, 32.01 ●
DM5816, Mlawula NR, -26.19, 32.01 ●
ZAMBIA
KM1669, Balovale (= Zambezi), -13.55, 23.12 ●
NMZ2973, Chief Chitanda, -14.63, 27.60 (Ansell 1973)
NMZB33480, Chikwa, Lundazi, -11.67, 32.78 ●
NMZB11546, Chikwa, Lundazi, -11.67, 32.78 ●
?, Chingola, -12.37, 27.62 (Ansell 1978)
NMZB20207, Fort Jameson (= Chipata), -13.62, 32.65 ●
KM1660, Fort Jameson (= Chipata), -13.62, 32.65 ●
NMZB11427, Kabompo Boma, -13.58, 24.20 ●
?, Kabompo, 50 km N, -12.92, 24.31 (Ansell 1978)
NMZB66983, Kafue NP, Ngoma, -15.88, 25.88 ●
?, Kalabo, -14.97, 22.68 (Ansell 1978)
NMZB31742, Kalomo R, -16.87, 26.62 ●
?, Kasama, -10.22, 31.17 (Ansell 1978)
NMZ3459, Kasama, N of, -9.13, 31.38 (Ansell 1986)
NMZB6947, Kasempa Boma, -13.47, 25.85 ●
KM17198, Kasempa, SE of, -13.98, 26.35 ●
NMZB11652, Lake Kariba, -16.88, 28.38 ●
NMZB11651, Lake Kariba, N shore, -16.63, 28.33 ●
?, Lake Tanganyika, -8.62, 30.62 (Ansell 1978)
UZMZ?, Leopard's Hill Cave, -15.55, 28.72 (Ansell 1969)
NMZ3524, Livingstone, -17.85, 25.87 (Ansell 1986)
NMZB63376, Luangwa Valley, -13.25, 31.50 ●
NMZB20136, Luangwa Valley, Mfuwe, -13.08, 31.78 ●
NMZB65176, Missale Old Mine, -14.12, 32.87 ●
?, Mongu, -15.15, 23.17 (Ansell 1978)
KM1662, Monze, -16.25, 27.50 ●
NMZ2974, Muckle Neuk, -16.63, 27.00 (Ansell 1973)
UZMZ?, Naleza, -15.45, 27.33 (Ansell 1969)
UZMZ?, Namantombwa Hill, -15.48, 27.30 (Ansell 1969)
NMZB31393, Nansai Farm, Choma, -16.62, 27.12 ●
?, Ndola, -12.97, 28.63 (Ansell 1978)
HNHM76.154.1, Ngwerere Cave, -15.30, 28.33 (Ansell 1986)
UZMZ?, Ngwerere Siding, -15.32, 28.32 (Ansell 1969)
NMZB29803, Sakeji School, -11.12, 24.37 ●
?, Solwezi, -12.18, 26.42 (Ansell 1978)
NMZ3476, Waterfall Farm, -15.63, 28.38 (Ansell 1986)
ZIMBABWE
NMZB32700, Beacon Hill, Mvuma, -19.25, 30.25 ●
NMZB84225, Bubye R, Chikwarakwara, -22.35, 31.10 ●
NMZB57047, Buffalo Bend, Chiredzi, -21.92, 31.48 ●
NMZB57078, Bulawayo, -20.12, 28.58 ●
NMZB57411, Chete, Eastern Section, -17.37, 27.62 ●
NMZB31133, Chinhoyi, Badze Cave, -17.17, 29.19 ●
NMZB57011, Chipingayi Bridge, Save Valley, -20.12, 32.37 ●
NMZB31672, Chiredzi, Lone Star Ranch, -21.12, 31.87 ●
USNM00425276, Chirinda Forest, -20.42, 32.72
TM34908, Chirisa Cave, -17.62, 28.37 ●
NMZB32924, Chishakwe Camp, 2 km E, -20.00, 32.00 ●
NMZB33007, Chishakwe Camp, 2 km E, -20.00, 32.00 ●
NMZB30559, Chisuma, Dibutibu R, -18.00, 26.00 ●
NMZB57064, Chizarira NP, Manzituba, -17.50, 27.75 ●
NMZB57052, Dam-Wall-G/S-Camp, -20.00, 30.50 ●
NMZB31963, Davimbi School, 5 km N, -18.12, 28.97 ●
NMZB33887, Deka-Zambezi R Confluence, -18.00, 26.50 ●
NMZB29674, Dibutibu R, Batoka, -17.94, 26.12 ●
NMZB57044, Eirene Farm, Marondera, -18.37, 31.62 ●
NMZB32351, Esigodini, Falcon College, -20.22, 28.92 ●
NMZB32385, Esigodini, Willow Park, -20.28, 28.83 ●
NMZB60612, Forest Hill, Lupane, -19.08, 27.83 ●
NMZB57243, Frog Mine, Mupfure R, -17.87, 29.87 ●
NMZB57162, Great Zimbabwe, -20.28, 30.93 ●
NMZB57234, Great Zimbabwe, -20.28, 30.93 ●
NMZB32072, Gwayi R Bridge, -18.62, 27.10 ●
TM34983, Gwayi R Bridge, -18.62, 27.10 ●
NMZB57112, Harare, -17.83, 31.07 ●
NMZB57056, Harare, 19 km NW, -17.50, 31.50 ●
NMZB57102, Haroni-Rusitu R Confluence, -20.03, 33.02 ●
NMZB60781, Hazeldene, Kwekwe, -18.75, 29.75 ●
NMZB57067, Hwange NP, Main Camp, -18.73, 26.95 ●
NMZB57088, Hwange NP, Shapi, -18.75, 27.00 ●
NMZB32778, Hwange NP, Umtshibi, -18.75, 27.00 ●
NMZB57620, Hwange Safari Lodge, -18.67, 26.92 ●
NMZB12718, Ingwe Mine, 22 km W of Filabusi, -20.62, 29.37 ●
TM34756, Inyanga NP, -18.28, 32.77 ●
NMZB80263, Katombora Rapids, -17.88, 25.33 ●
NMZB65242, Kwekwe Ranch, -18.93, 29.83 ●
NMZB8996, Lake Kariba, -16.88, 28.38 ●
NMZB57348, Lake Kariba, -16.88, 28.38 ●
NMZB63341, Lake Kariba Game Camp, -17.00, 28.00 ●
NMZB63529, Lake Kyle NP, -20.17, 30.92 ●
USNM00470244, Lake Kyle NP, -20.17, 30.92
NMZB65204, Lake McIlwaine, -17.90, 30.78 ●
NMZB30374, Mabura 2 Cave, Munyati R, -18.12, 29.37 ●
NMZB57029, Mana Pools NP, -15.80, 29.33 ●
NMZB33471, Marondera, -18.12, 31.62 ●
NMZB30482, Matobo Hills, Diana's Pool, -20.47, 28.87 ●
NMZB30483, Matobo Hills, Totololo R, -20.55, 28.83 ●
NMZB33362, Matobo NP, -20.37, 28.55 ●
NMZB57084, Matobo NP, Whitewaters Dam, -20.58, 28.47 ●
NMZB57007, Matusadona NP, Tashinga, -16.87, 28.37 ●
USNM00425277, Mount Selinda, -20.45, 32.67
NMZB57057, Munyati Bridge, -18.65, 29.77 ●
NMZB57136, Musemu Farm, Norton, -17.75, 30.75 ●
NMZB84387, Musengezi R, -16.25, 30.75 ●
NMZB57165, Mushandike NP, -20.13, 30.63 ●
NMZB19838, Mutare, -18.90, 32.62 ●
DM4622, Mutare, -19.08, 32.70 ●
NMZB33483, Mutare, Asbestos Mine, -18.92, 32.62 ●
NMZB33484, Mutare, Jeff Estate, -18.97, 32.62 ●
TM34700, Mutare, Old Mine, -19.08, 32.70 ●
NMZB57008, Mutare, Quaggas Hoek, -18.75, 32.50 ●
NMZB30569, Muzvezve Resettlement Scheme, -18.00, 29.25 ●
NMZB57259, Mzankwe Bridge, 3 km N, -17.75, 29.00 ●
NMZB57048, Netridge Farm, -20.12, 30.62 ●
NMZB61231, Nottingham Estates, Beitbridge, -22.12, 29.87 ●
NMZB56313, Nyamunyeche, Mvurwi, -16.77, 30.95 ●
NMZB32525, Nyashato Dam, -17.12, 32.12 ●
NMZB57026, Odzi, -18.95, 32.38 ●
NMZB25843, Porte Angwa Junction, -16.25, 30.00 ●
NMZB57086, Ramofu Cave, Runde, -20.00, 30.00 ●
NMZB57248, Rusape-Nyanga, -18.25, 32.25 ●
TM34676, Rusitu Forest, -20.03, 32.98 ●
NMZB57119, Sabi-Lundi (= Save-Runde) R Confluence, -21.28, 32.38 ●
NMZB57163, Sable Peak Farm, Concession, -17.30, 30.93 ●
NMZB65205, Saffron Walden, Farm, -17.87, 30.87 ●
NMZB17593, Save-Lunde R Confluence, Marhumbini, -21.28, 32.38 ●
NMZB57073, Sengwa Wildlife Research Station, -18.17, 28.22 ●
TM41614, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB57629, Shambayetu Farm, Beitbridge, -21.75, 29.50 ●
NMZB60780, Stratton Farm, Kwekwe, -18.75, 29.75 ●
NMZB32132, Victoria Falls, -17.85, 25.75 ●
NMZB57035, Vumba, -19.12, 32.87 ●
NMZB25835, Zambezi-Chewore R Confluence, -15.62, 29.87 ●

woodi

MALAWI
BM14.4.22.2, Chiromo, -16.53, 35.15 ●
MMB?, Nkhotakota, -12.93, 34.30 (Happold *et al.* 1987)
MOZAMBIQUE
USNM00365176, Chicoa, 20 km ESE, -15.70, 32.53 ●
SOUTH AFRICA
TM29898, Kruger NP, Pafuri, -22.45, 31.30 ●
TM20403, Messina, 75 km W, -22.20, 29.38 ●
ZAMBIA
FMNH11031, Chilanga, -15.55, 28.27 (Ansell 1967)
BM68123, Chinzombo, -13.10, 31.77 ●
TM38459, Chipangali, Chipata, -13.12, 32.87 ●
NMZB20137, Chipangali, Chipata, -13.12, 32.87 ●
NMZB20113, Fort Jameson (= Chipata), -13.62, 32.65 ●
NMZB20121, Fort Jameson (= Chipata), -13.62, 32.65 ●
KM11026, Lusaka, Mkwisi, -15.38, 28.35 ●
TM2543, Ndola, -12.97, 28.63 ●
HZM3.11408, Ngwerere Cave, -15.30, 28.33 (Ansell 1986)
ZIMBABWE
TM8579, Birchenough Bridge, -19.85, 32.33 ●
NMZB57418, Chete, Eastern Section, -17.37, 27.62 ●
HZM1.4128, Chipangayi, -18.30, 28.33 ●
NMZB58621, Chiredzi, 22 km E, -21.00, 31.75 ●
NMZB31585, Chiredzi, Lone Star Ranch, -21.12, 31.87 ●
NMZB33747, Ingwe Safari, Deka, -18.42, 26.31 ●
NMZB57211, Lake Kariba, -16.88, 28.38 ●
NMZB60543, Masingwa R, -16.37, 31.12 ●
NMZB82357, Matobo Hills, -20.50, 28.25 ●
NMZB30518, Mutanda, -19.12, 32.12 ●
NMZB31366, Ruya R, -16.50, 31.75 ●
NMZB60542, Sengwa Wildlife Research Station, -18.17, 28.22 ●
NMZB29667, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●

PTEROPODIDAE

Casinycteris

argynnis

DRC

RMCAa1.097-M-0412, Bena Mbala, -6.80, 23.78 (Bergmans 1990)
?, Kitwit, -5.08, 18.91 (Van Cakenberghe *et al.* 1999)
RMCA27430, Lukong, -5.80, 22.45 (Bergmans 1990)
RMCA?, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)
RMCA93.079-M-0092, Mbwambala, -5.05, 18.90 (Bergmans 1990)

Eidolon

helvum

ANGOLA

ZMB4239, Benguela, -12.63, 13.38 (Bergmans 1990)
?, Caconda, -13.63, 15.13 (Crawford-Cabral 1986)
FMNH81729, Camatabela, 30 km W, -8.38, 15.13 (Bergmans 1990)
ZMB5224, Chinchoxo, -5.13, 12.13 (Bergmans 1990)
MD3422, Dundo, -7.38, 20.88 (Hayman 1963)
?, Rio Cuilo, -5.88, 16.38 (Crawford-Cabral 1986)
IICT1900014, Santo Antonio do Zaire (= Soyo), -6.12, 12.35 (Lopes & Crawford-Cabral 1990)

DRC

RMCA?, Boma, -5.83, 13.05 (Schouteden 1947)
RMCA?, Dilolo, -10.48, 22.48 (Schouteden 1947)
RMCA?, Inkongo, -4.92, 23.25 (Schouteden 1947)
RMCA?, Kabambaie, -5.75, 20.82 (Schouteden 1947)
RMCA?, Katanga, -10.00, 27.50 (Schouteden 1947)
RMCA?, Kinda, -9.23, 25.07 (Schouteden 1947)
TM45594, Kitwit, -5.08, 18.91 ●
RMCA?, Leopoldville (= Kinshasa), -4.30, 15.30 (Schouteden 1947)
RMCA?, Luebo, -5.33, 21.55 (Schouteden 1947)
RMCA?, Luluabourg (= Kananga), -5.88, 22.43 (Schouteden 1947)
RMCA?, Lusanga Mwanza, -5.83, 13.05 (Schouteden 1947)
RMCA?, Tshikapa, -6.47, 20.80 (Schouteden 1947)
RMCA?, Zambi, -5.85, 12.87 (Schouteden 1947)

MALAWI

MMB?, Blantyre, -15.78, 35.00 (Happold *et al.* 1987)
ZMA21.694, Lisanthu, -13.00, 33.17 (Bergmans 1990)
BM97.10.1.17, Mount Malosa, -15.25, 35.32 (Bergmans 1990)
HZM?, Mugesse, Misuku, -9.62, 33.62 (Bergmans 1990)
BM96.10.28.5, Zomba, -15.38, 35.32 (Bergmans 1990)

MOZAMBIQUE

?, Bela Vista, near, -26.38, 32.63 (Smithers & Lobão Tello 1976)
NMZB63733, Chiniziwa District, -18.88, 35.13 ●
?, Manica, -18.93, 32.88 (Smithers & Lobão Tello 1976)
NMZB83936, Marromeu Town, -18.25, 35.94 ●
(pic), Zandamela, -24.77, 34.32 ●

NAMIBIA

ZMB90649, Anas-Sud, Bethanien, -26.48, 17.15 (Bergmans 1990)
SMM3505, Ariemsvlei, -28.13, 19.88 ●
SMM7488, Arnhem Cave, -22.70, 18.10 ●
SMM3515, Eliem 163, Maltahohe, -24.38, 17.63 ●
SMM15260, Etosha NP, Okaukuejo, -19.13, 15.88 ●
SMM6867, Gobabeb, Namib Desert, -23.55, 15.05 ●
SMM6848, Kleepfortella, -22.88, 17.88 ●
SMM6814, Maltahohe, -24.88, 17.00 ●
SMM2726, Outjo, SW of, -20.30, 15.83 ●
SMM9983, Sonnleiten 78, Windhoek, -22.38, 17.38 ●

SOUTH AFRICA

NMB1592, Bloemfontein, -29.13, 26.13 ●
TM39242, Bloemhoef District, -27.65, 25.60 ●
NMB1296, Hagesdam, Bloemfontein, -29.37, 25.78 ●
ROM78005, Hartswater, -27.88, 24.88 ●
SAM ZM37073, Hondeklipbaai, -30.38, 17.38 ●
NMB8514, Jacobsdal, -29.13, 25.13 ●
NMB1263, Marguard, -28.88, 27.38 ●
TM9419, Mazelsfontein, Douglas, -29.38, 23.88 ●
DM7356, Mtunzini, Twin Streams, -28.95, 31.77 ●
TM47601, Postmasburg, -28.90, 22.84 ●
TM44219, Potchefstroom District, -26.74, 27.48 ●
TM8947, Pretoria, Wildeharhoek, -25.73, 28.92 ●
NMB1237, Pretrusburg, -29.13, 25.38 ●
MMK1032, Rundle Olds, -29.38, 22.38 ●
MMK1028, Schutse Kama, Riet R, -29.03, 24.43 ●
NMB1262, Smithfield, -30.13, 26.63 ●
MMK6818, Taung, Todcaster, -27.88, 24.88 ●
NMB8515, Trompsburg, -30.13, 25.88 (J. Fahr pers. comm.)
SAM ZM8221, Tylden, -32.10, 27.07 ●
NMB3954, Vredefort Town, -27.13, 27.38 (J. Fahr pers. comm.)
NMB3954, Vredefort Town, -27.13, 27.38 ●
TM13056, Warden, -27.88, 28.88 ●

ZAMBIA

KM9292, Abercorn (= Mbala), -8.85, 31.38 ●
HZM?, Balovale (= Zambezi), -13.55, 23.67 (Bergmans 1990)
NMZB20213, Fort Jameson (= Chipata), -13.62, 32.65 ●
USNM00297469, Kafue, -15.77, 28.18 (Bergmans 1990)
KM9293, Kasama, -10.22, 31.17 ●
TM9871, Kasempa Boma, -13.47, 25.85 ●
NMZ3690, Lusaka, Munali, -15.38, 28.35 (Ansell 1974)
KM1556, Ndola, -12.97, 28.63 ●
NMZ3539, Nyika NP, -10.58, 33.65 (Bergmans 1990)
KM13489, Serenje, -13.38, 30.13 ●
NMZB7280, Sumbu, -8.52, 30.48 ●

ZIMBABWE

NMZB59732, Arcturus, -17.77, 31.30 ●
NMZB13103, Bulawayo, -20.12, 28.58 ●
NMZB59731, Carrick Creagh Farm, Harare, -17.72, 31.17 ●
NMZB62474, Goromonzi, -17.88, 31.38 ●
NMZB59727, Harare, 16 kms NE, -17.75, 31.02 ●
NMZB59728, Harare, Parkmeadowland, -17.72, 31.12 ●
NMZB59814, Matobo NP, -20.50, 28.25 ●
NMZB59738, Mutare, Feruka, -18.88, 32.63 ●
NMZB59729, Mutare, Gimboki, -19.02, 32.58 ●
NMZB59733, Mutare, Jeff Estate, -18.97, 32.62 ●
NMZB59737, Odzi, -18.95, 32.38 ●
NMZB59739, Umfuleni Farm, -17.88, 31.38 ●

Epomophorus

angolensis

ANGOLA

BM64.8.16.1, Benguela, -12.63, 13.38 (Bergmans 1988)
AMNH88071, Chitau, -11.38, 17.13 (Bergmans 1988)
IICA651, Fazenda Cacanda, -14.88, 13.13 ●
AMNH85520, Hanha, -13.63, 14.38 (Bergmans 1988)
FMNH83590, Huila, -15.13, 13.63 (Bergmans 1988)
?, Kuvangu Mission (= Cubango), -14.38, 16.38 (Crawford-Cabral 1986)
ZMB54932, Loanda (= Luanda), -8.88, 13.38 (Bergmans 1988)
IICA12, Luanda, -8.88, 13.38 ●
IICA319, Quipungo, -14.88, 14.63 ●
IICA2558, Quiteve, -16.13, 15.13 ●
IICA1274, Sa da Bandeira (= Lubango), -14.88, 13.38 ●
IICA121, Tchivinguiro, -15.13, 13.38 ●

NAMIBIA

TM16337, Epupa Falls, Cunene R, -17.13, 13.13 ●
M. Griffin, Ongwediva, -17.88, 15.88 ●
LACM058934, Opuwo, 70 km NW, -17.47, 13.03 ●
KM1563, Opuwo, N of, -17.33, 13.83 ●
SMM2717, Ruacana, -17.38, 14.38 ●
SMM8212, Sesfontein, -19.13, 13.88 ●
SMM6846, Swartbooisdrift, -17.33, 13.85 ●
TM11174, Swartbooisdrift, -17.33, 13.85 ●
KM1561, Uutapi, -17.53, 14.62 ●

anselli

MALAWI

NMMB 74ROM923, Karonga, -9.93, 33.93 (Bergmans & van Strien 2004)
ZMA21.693b, Lisanthu, -13.00, 33.17 (Bergmans & van Strien 2004)

crypturus

ANGOLA

BM63.1024, Lago Calundo, -11.72, 20.80 (Bergmans 1988)
CMNH40476, Luiana Camp, -17.63, 23.38 (Bergmans 1988)

BOTSWANA

NMZB63726, Chobe NP, Kasane, -17.80, 25.15 (Bergmans 1988)
NMZB54086, Four Rivers Camp, Okavango, -19.12, 23.12
NMZB80143, Kurunxaraga, Okavango, -19.67, 22.83
NMZB63727, Maun, -19.98, 23.42
NMZB63710, Moremi GR, Kwaai R, -19.15, 23.75 (Bergmans 1988)
NMZB80141, Pom Pom, Okavango, -19.50, 22.75
NMZB63721, Sepopa, -18.62, 22.12 (Bergmans 1988)
USNM00425249, Shakawe, -18.35, 21.87 (Bergmans 1988)
NMZB63713, Shorobe, -19.75, 23.50 (Bergmans 1988)
TM6556, Shorobe, NE of, -19.63, 23.63 ●
USNM518607, Xugana, -19.08, 23.10 (Bergmans 1988)

DRC

RMCA?, Elisabethville (= Lubumbashi), -11.68, 27.48 (Schouteden 1947)
MHNG1046.35, Kakontwe, -10.98, 26.63 (Hayman *et al.* 1966)
RMCA?, Kambove, -10.83, 26.65 (Schouteden 1947)

MALAWI

MMB?, Blantyre, -15.78, 35.00 (Happold *et al.* 1987)
MMB?, Chikwawa, -16.02, 34.78 (Happold *et al.* 1987)
BM22.12.17.3, Cholo (= Thyolo), -16.07, 35.15 (Bergmans 1988)
HZM4.2199, Karonga, -9.93, 33.93 (Bergmans 1988)
BM94.1.25.23, Likabula Mission, Mulanje, -15.95, 35.48 (Bergmans 1988)
AMNH161852, Likabula Mission, Mulanje, -15.95, 35.48 (Bergmans 1988)
MMB?, Liwonde, -15.05, 35.22 (Happold *et al.* 1987)
TM9156, Ncheu, -14.88, 34.63 ●
?, Ruo R, -16.10, 35.65 (Bergmans 1988)
DCHC?, Thondwe, -15.45, 35.25 (Happold *et al.* 1987)

MOZAMBIQUE
?, Beira, W of, -19.84, 34.63 (Smithers & Lobão Tello 1976)
?, Gorongosa, near, -18.50, 34.20 (Smithers & Lobão Tello 1976)
BM22.7.17.24, Lumbo, -15.13, 40.63 (Bergmans 1988)
USNM00365123, Mague (= Mphende), -15.82, 31.73
TM14714, Mague (= Mphende), -15.82, 31.73 ●
?, Manica, -18.93, 32.88 (Smithers & Lobão Tello 1976)
NMZB84003, Marromeu, Coutada 1, -18.25, 35.75 ●
DM8657, Meponda, Lake Niassa, -13.40, 34.87 ●
DM8629, Namapa, -13.49, 39.78 ●
DM8658, Niassa GR, Maputo Camp, -12.18, 37.55 ●
DM8632, Pemba, SW of, -13.01, 40.52 ●
DM8656, Ribaue, 40 km W, -14.97, 38.08 ●
?, Tete, 45 km N, -15.75, 33.50 (Bergmans 1988)
?, Tete, near, -16.25, 33.75 (Smithers & Lobão Tello 1976)
AMNH216400, Zinave, 45 km NW, -21.10, 33.50 (Bergmans 1988)
NAMIBIA
TM12341, Chobe R, -17.63, 25.13 ●
KM17147, Katima Mulilo, -17.50, 24.33 ●
TM11646, Kisikisi Lake, -17.63, 24.13 ●
TM17057, Kongola, -18.88, 23.38 ●
TM17108, Linyanti, -18.13, 24.13 ●
TM12343, Nampini, -17.63, 25.13 ●
SMM9909, Omega, -18.05, 22.18 ●
SOUTH AFRICA
TM17277, Acornhoek, -24.75, 31.42 ●
TM1061, Hectorspruit, -25.43, 31.68 ●
TM24832, Hectorspruit, 10 km NE, -25.33, 31.83 ●
TM7253, Klaserie-Olifants R confluence, -24.08, 31.23 ●
TM990, Komati R, Barberton, -25.88, 31.13 ●
TM1188, Komati R, Komatipoort, -25.63, 31.88 ●
TM29967, Kruger NP, Punda Milia, -22.77, 31.02 ●
TM12985, Kruger NP, Punda Milia, -22.77, 31.02 ●
TM29942, Kruger NP, Punda Milia, 5 km NW, -22.68, 30.95 ●
TM24660, Madimbo, 10 km W, -22.33, 30.97 ●
TM20340, Messina, 75 km W, -22.20, 29.38 ●
TM44061, Naboomspruit, -24.27, 28.72 ●
TM13951, Nelspruit, -25.47, 30.98 ●
TM17372, Pongola, -27.37, 31.60 ●
TM24034, Sabie Sands GR, -24.75, 31.43 ●
TM7474, Sibasa, Soutpansberg, -22.88, 30.38 ●
TM979, Tzaneen, -23.83, 30.17 ●
SWAZILAND
TM45553, Big Bend, -26.77, 31.90 ●
DM8035, Mlawula NR, -26.19, 32.01 ●
ZAMBIA
KM1565, Balovale (= Zambezi), -13.55, 23.12 ●
BM59.610, Chavuma area, -13.08, 22.68 (Bergmans 1988)
AMNH218964, Chilanga, -15.55, 28.27 (Bergmans 1988)
BM55.1061, Chilwa Island, -14.13, 27.63 (Bergmans 1988)
KM1569, Fort Jameson (= Chipata), -13.62, 32.65 ●
BM66.5415, Kalabo, -14.97, 22.68 (Bergmans 1988)
KM13488, Kasempa Boma, -13.47, 25.85 ●
?, Lake Tanganyika, -8.62, 30.62 (Ansell 1978)
AMNH115820, Limulunga, -15.15, 23.17 (Bergmans 1988)
KM9909, Luangwa Valley, Petauke, -14.05, 31.08 ●
AMNH168098, Luanshya, -13.13, 28.42 (Bergmans 1988)
BM66.5416, Lusaka, -15.42, 28.27 (Bergmans 1988)
BM66.5423, Machiya Ferry, -13.65, 27.63 (Bergmans 1988)
HZM42.7597, Magoye Research Station, -16.00, 27.62 (Bergmans 1988)
BM55.1055, Mazabuka, -15.83, 27.73 (Bergmans 1988)
KM1583, Mongu, -15.15, 23.17 ●
KM9286, Mporokoso, -9.37, 30.12 ●
NMZB33279, Ndanda Dambo, Mongu, 70 km NE, -14.75, 23.75 ●
HZM5.2229, Ndola, -12.97, 28.63 (Bergmans 1988)
?, Nyika NP, -10.58, 33.65 (Ansell 1978)
BM66.5418, Pwira Pan, -13.87, 27.87 (Bergmans 1988)
NMZB33281, Senenga, 50 km NE, -15.62, 23.37 ●
FMNH95208, Sihole, -15.32, 22.57 (Bergmans 1988)
FMNH95205, Sikongo, -15.00, 22.17 (Bergmans 1988)
BM55.1054, Solwezi, -12.18, 26.42 (Bergmans 1988)
BM66.5417, South Luangwa Valley, Mfuwe, -13.08, 31.78 (Bergmans 1988)
ZIMBABWE
NMZB33625, Benzie's Bridge, Shangani R, -18.81, 27.90 ●
NMZB55972, Bulawayo, -20.12, 28.58 ●
NMZB84099, Chikwarakwara, Pesu R Gorge, -22.28, 31.20 ●
NMZB84100, Chikwarakwara, Pesu R Gorge, -22.28, 31.20 ●
NMZB32407, Chinanga Dam, Maramba, -17.12, 32.87 ●
NMZB30585, Dwala Ranch, Bubiana, -21.12, 29.62 ●
USNM00368603, Harare, -17.83, 31.07
USNM00368604, Harare, Highlands, -17.80, 31.12
USNM00425265, Henderson Research Station, -17.62, 30.87
NMZB84366, Hoya River Camp, Muzarabani, -16.25, 31.25 ●
NMZB33734, Kabuba Camp, Manjolo, -18.28, 28.08 ●
NMZB33640, Lutope-Ngolangola R Confluence, -18.28, 28.08 ●
NMZB84492, Marivalle Ranch, -18.75, 29.75 ●
NMZB32813, Marondera, -18.12, 31.62 ●
NMZB31632, Matetsi SA, Tshope vlei, -18.62, 25.87 ●
NMZB31427, Matobo Hills, Lumane Valley, -20.58, 28.83 ●
NMZB30067, Matobo Hills, Mtshavezi Valley, -20.62, 28.62 ●
TM41876, Mazoe Estates, -17.38, 30.88 ●
NMZB84401, Musengezi R Confluence, -16.25, 30.75 ●
NMZB32668, Mzola Camp, -18.62, 27.37 ●
NMZB32409, Nyadiri R, -17.12, 32.12 ●
NMZB58073, Nyamunyeche, Mvurwi, -16.77, 30.95 ●
TM10754, Sabi-Lundi (= Save-Runde) R Confluence, -21.28, 32.38 ●
TM34892, Sengwa Wildlife Research Station, -18.17, 28.22 ●
NMZB31639, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB30817, Sentinel Ranch, Tongani R, -22.12, 29.62 ●
NMZB33737, Volunteer Farm, Zwikungwa, -18.91, 27.70 ●

grandis

ANGOLA
BM63.1025, Dundo, -7.38, 20.88 (Bergmans 1988)
FMNH66433, Dundo, -7.38, 20.88 (Bergmans 1988)
CONGO (BRAZZAVILLE)
ZMA15.535, Pointe Noire, -4.75, 11.90 (Bergmans 1988)

labiatus

DRC
RMCA?, Lukonzolwa, -8.75, 28.67 (Bergmans 1988)
MALAWI
CMNH409758, Cape Maclear, -13.97, 34.82 (Bergmans 1988)
TM41744, Chipita, -9.70, 33.25 ●
HZM9.1926, Karonga, -9.93, 33.93 (Bergmans 1988)
ZMA21.677, Kasungu NP, -13.05, 33.15 (Bergmans 1988)
ZMA21.678, Lingadzi R Valley, -13.48, 34.37 (Bergmans 1988)
ZMA21.680, Lisanthu, -13.00, 33.17 (Bergmans 1988)
TM41764, Liwonde NP, -15.03, 35.25 ●
MMB?, Monkey Bay, -14.07, 34.92 (Happold *et al*. 1987)
HZM35.14891, Nchalo, -16.27, 34.92 (Ansell 1985)
KM11773, Nkhotakota, -12.93, 34.30 ●
AMNH161853, Nkhotakota, -12.93, 34.30 (Bergmans 1988)
MOZAMBIQUE
DM8644, Meponda, Lake Niassa, -13.40, 34.87 ●
ZAMBIA
KM9288, Abercorn (= Mbala), -8.85, 31.38 ●
HZM1.1444, Abercorn (= Mbala), -8.85, 31.38 (Bergmans 1988)
KM9622, Chadiza, -14.15, 32.75 ●
NMZ2897, Fort Jameson (= Chipata), -13.62, 32.65 (Ansell 1973)
AMNH207412, Jumbe, -13.28, 32.07 (Bergmans 1988)
HZM?, Kalambo Falls, -8.58, 31.23 (Bergmans 1988)
KM9623, Kasama, E of, -10.33, 31.97 ●
KM9618, Kituta Bay, Lake Tanganyika, -8.50, 30.50 ●
NMZ2895, Lukusuzi NP, -12.97, 32.53 (Ansell 1973)
KM9289, Mporokoso, -9.37, 30.12 ●
BM66.5408, South Luangwa Valley, Mfuwe, -13.08, 31.78 (Bergmans 1988)
NMZ2952, Sumbu, -8.52, 30.48 (Ansell 1973)

wahlbergi

ANGOLA
?, Ambaca, -9.38, 15.38 (Crawford-Cabral 1986)
ZMB4240, Benguela, -12.63, 13.38 (Bergmans 1988)
IICA6574, Cabuta, -9.88, 14.88 ●
?, Caconda, -13.63, 15.13 (Crawford-Cabral 1986)
IICA1122, Campale (= Kapala), -10.63, 17.63 ●
HZM15.4236, Cassai, -10.63, 21.88 (Bergmans 1988)
ZMB4801, Chinchoxo, -5.13, 12.13 (Bergmans 1988)
AMNH85519, Chitau, -11.38, 17.13 (Bergmans 1988)
?, Cubicula, -9.38, 14.88 (Crawford-Cabral 1986)
IICT3159024, Dando, -11.13, 17.38 (Crawford-Cabral 1986)
IICA1394, Dando, -11.13, 17.38 ●
FMNH84051, Dundo, -7.38, 20.88 (Bergmans 1988)
FMNH81725, Duque de Braganca (= Calandula), -9.13, 15.88 (Bergmans 1988)
?, Luanda, -8.88, 13.38 (Crawford-Cabral 1986)
FMNH81606, Luhanda, -9.38, 17.13 (Bergmans 1988)
?, Malange (= Malanje), -9.63, 16.38 (Crawford-Cabral 1986)
IICA8484, Massano de Amorim, -12.38, 15.13 ●
IICA6825, Missongue, near Cuanza R, -10.38, 16.38 (Crawford-Cabral 1986) ●
FMNH83589, Monte Moco, -12.38, 15.13 (Bergmans 1988)
IICA1157, Mulundo, -11.38, 17.63 ●
IICA6711, Mussende, -10.63, 16.13 ●
?, Pungo Andongo, -9.63, 15.63 (Crawford-Cabral 1986)
IICA1312, Quimbango, -10.88, 17.63 ●
?, Quissange, -12.38, 14.13 (Crawford-Cabral 1986)
?, Rio Cuilo, -5.88, 16.38 (Crawford-Cabral 1986)
IICA2038, Sa da Bandeira (= Lubango), -14.88, 13.38 ●
?, Serra de Seles, -11.38, 14.38 (Crawford-Cabral 1986)

?, Uije (= Uige), -7.63, 15.13 (Crawford-Cabral 1986)
DRC
RMCA6539, Banana, -5.97, 12.45 (Hayman *et al.* 1966)
RMCA2484b, Boma, -5.83, 13.05 (Hayman *et al.* 1966)
RMCA4091, Congo da Lemba, -5.70, 13.67 (Hayman *et al.* 1966)
RMCA16209, Elisabethville (= Lubumbashi), -11.68, 27.47 (Hayman *et al.* 1966)
IRSN13108, Gandajika, -6.77, 23.97 (Hayman *et al.* 1966)
IRSN13329, Kabanga, -6.67, 23.67 (Hayman *et al.* 1966)
IRSN13280, Kanzenze, -10.48, 25.22 (Hayman *et al.* 1966)
RMCA7537, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)
RMCA6533, Moanda, -5.92, 12.40 (Hayman *et al.* 1966)
RMCA10515, Mulongo, -7.85, 27.02 (Hayman *et al.* 1966)
RMCA?, Tshikapa, -6.47, 20.80 (Schouteden 1947)
MALAWI
MMB?, Blantyre, -15.78, 35.00 (Happold *et al.* 1987)
MMB?, Chikwawa, -16.02, 34.78 (Happold *et al.* 1987)
MMB?, Karonga, -9.93, 33.93 (Happold *et al.* 1987)
TM41784, Likabula Mission, Mulanje, -15.95, 35.48 ●
MMB?, Mitsidi Hill (= Mzedi), -15.78, 35.10 (Happold *et al.* 1987)
KM11771, Mulanje, -15.93, 35.62 ●
DCHC?, Mzuzu, -11.47, 34.07 (Happold *et al.* 1987)
DCHC?, Thondwe, -15.45, 35.25 (Happold *et al.* 1987)
CMNH6375, Thyolo, -16.12, 35.08 (Bergmans 1988)
DCHC?, Viphya Plateau, -12.38, 33.70 (Happold *et al.* 1987)
MMB?, Zoa Estate, -16.23, 35.20 (Happold *et al.* 1987)
DCHC?, Zomba, -15.38, 35.32 (Happold *et al.* 1987)
MOZAMBIQUE
DM8631, Balama Coutada, -13.42, 38.04 ●
USNM00365135, Beira, 10 km N, -19.82, 34.87 (Bergmans 1988)
TM6208, Beira, near, -19.84, 34.88 ●
DM8652, Buzi R, -19.93, 33.83 ●
USNM00351989, Chimonzo, -24.92, 33.25 (Bergmans 1988)
DM42, Chimonzo, -24.92, 33.25 ●
DM8651, Chinizuia Forest, -18.98, 35.05 ●
?, Gorongosa, near, -18.50, 34.20 (Smithers & Lobão Tello 1976)
DM8628, Gurue, -15.46, 37.02 ●
DM43, Inhaca Island, -26.02, 32.97 ●
USNM00351978, Inhaca Island, -26.02, 32.97
USNM00352000, Jangamo, -24.10, 35.30 (Bergmans 1988)
?, Mague (= Mphende), -15.82, 31.73 (Smithers & Lobão Tello 1976)
TM47811, Maputo Special Reserve, -26.35, 32.93 ●
NMZB84005, Marromeu, Coutada 1, -18.25, 35.75 ●
USNM00351986, Massangena, -21.56, 32.96 (Bergmans 1988)
DM8627, Massangena, -21.56, 32.96 ●
USNM00351995, Massinga, -23.13, 35.38 (Bergmans 1988)
?, Mopeia, -17.90, 35.70 (Smithers & Lobão Tello 1976)
DM8650, Namapa, -13.49, 39.78 ●
USNM00352004, Panda, -24.05, 34.70 (Bergmans 1988)
?, Vila Gouveia, -18.07, 33.18 (Smithers & Lobão Tello 1976)
SOUTH AFRICA
KM32552, Albany District, -33.30, 26.52 ●
DM6913, Amanzimtoti, -30.05, 30.88 ●
TM1367, Barberton, -25.82, 31.12 ●
USNM00468324, Barberton, 20 km W, -25.78, 30.90
DM1, Beaumont Wattle Estate, -29.88, 30.57 ●
KM32572, Bedford, -32.65, 26.18 ●
DM4416, Bonamanzi GR, -28.10, 32.30 ●
TM25265, Duiwelskloof, 8 km E, -23.70, 30.27 ●
DM7239, Durban, -29.85, 31.00 ●
DM7234, Durban, Berea, -29.85, 31.00 ●
DM2187, Durban, Clairwood Park, -29.93, 30.97 ●
TM978, Durban, Malvern, -29.78, 31.03 ●
DM2196, Durban, Westville, -29.83, 30.93 ●
KM20537, East London, -33.15, 21.92 ●
DM5109, Emphisini NR, -30.21, 30.79 ●
DM2501, Emseleni NR, -28.68, 32.00 ●
KM20540, Encobo, -31.67, 27.98 ●
TM7447, Eshowe, -28.90, 31.47 ●
USNM00113455, Grahamstown, -33.32, 26.53
SAM ZM385, Grahamstown District, -33.13, 26.38 ●
DM2253, Greater St. Lucia Wetlands Park, False Bay, -27.97, 32.37 ●
TM23713, Haenertzburg, -24.02, 30.07 ●
DM5534, Harold Johnson NR, -29.21, 31.42 ●
TM1058, Hectorspruit, -25.43, 31.68 ●
DM6833, Hella Hella GR, -29.90, 30.08 ●
DM11, Hillary, -29.88, 30.93 ●
DM3278, Hluhluwe-Imfolozi Park, Mansiya, -28.08, 32.30 ●
TM34346, Howick, -29.50, 30.23 ●
TM31753, Itala NR, -27.52, 31.37 ●
KM1618, King William's Town, -32.87, 27.37 ●
SAM ZM37069, King William's Town, -32.87, 27.37 ●
DM6857, Kloof, -29.82, 30.83 ●
KM26318, Knysna, -34.03, 23.05 ●
TM40468, Kosi Bay NR, -26.96, 32.83 ●
KM31373, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM30540, Kruger NP, Levuvhu R, -22.43, 31.18 ●
TM29927, Kruger NP, Punda Milia, 5 km NW, -22.68, 30.95 ●
TM25752, Lake Sibaya, -27.35, 32.72 ●
TM25403, Loskopdam NR, -25.42, 29.33 ●
TM47130, Lydenburg, -25.11, 30.48 ●
TM14058, Malelane, -25.47, 31.52 ●
TM20341, Messina, 75 km W, -22.20, 29.38 ●
KM32574, Mqanduli, -31.97, 29.15 ●
TM40390, Mtubatuba, 6 km NE, -28.30, 32.22 ●
DM48, Mtunzini, Twin Streams, -28.95, 31.77 ●
TM35185, Ndumu NR, -26.88, 32.27 ●
TM3831, Nelspruit, -25.47, 30.98 ●
TM39131, Ngome Forest, -27.83, 31.42 ●
TM3027, Ntabanana, -28.60, 31.73 ●
TM34347, Oribi Gorge NR, -30.72, 30.27 ●
DM8793, Phinda GR, Bayete Camp, -27.78, 32.31 ●
DM5054, Pietermaritzburg, Montrose, -29.58, 30.34 ●
DM5691, Pietermaritzburg, Town Bush, -29.55, 30.35 ●
TM25603, Pilgrim's Rest, -24.13, 30.18 ●
DM7235, Pinetown, -29.82, 30.87 ●
TM17371, Pongola, -27.37, 31.60 ●
TM41180, Port Edward, -31.00, 30.17 ●
DM5052, Port Shepstone, -30.77, 30.40 ●
KM1596, Port St. Johns, -31.63, 29.55 ●
SAM ZM5545, Port St. Johns, -31.63, 29.55 ●
TM982, Port St. Johns, -31.63, 29.55 ●
TM29050, Pretoria, -25.80, 28.18 ●
TM41547, Pretoria, Brooklyn, -25.75, 28.14 ●
DM665, Sarnia, -29.83, 30.87 ●
TM38547, Scottburgh, -30.28, 30.75 ●
TM40101, Shashe-Limpopo R Confluence, -22.22, 29.37 ●
DM1097, St. Lucia Village, -28.38, 32.42 ●
DM3666, Stainbank NR, -29.92, 30.93 ●
TM1636, Steynsdorp, -26.15, 30.98 ●
TM980, Tzaneen, -23.83, 30.17 ●
TM27559, Tzaneen District, -23.98, 31.83 ●
DM3494, Umkomaas, -30.20, 30.80 ●
SAM ZM13351, Umtata, -31.60, 28.75 ●
KM1591, Victoria East, -32.78, 26.83 ●
TM4920, Weenen, -28.85, 30.08 ●
USNM00381537, White River, 17 km W, -25.30, 31.05
KM32549, Zwelitsha, -32.72, 27.29 ●
SWAZILAND
TM45554, Bar Circle Ranches, -26.68, 31.88 ●
TM45636, Dinedor Ranch, -26.37, 31.57 ●
TM45638, Franson Christian School, -27.18, 31.38 ●
TM25697, Mbabane, -26.28, 31.13 ●
DM52, Mlawula Estates (= Mlawula NR), -26.19, 32.01 ●
DM5847, Mlawula NR, -26.19, 32.01 ●
TM45640, Our Lady of Sorrows School, -27.27, 31.53 ●
TM47708, Rosecraft, -26.63, 31.29 ●
TM45639, Sandleni Primary School, -27.05, 31.42 ●
TM45704, St. Joseph's Mission, -26.23, 31.43 ●
BM1973.489, Tshaneni, -25.97, 31.72
TM45269, UNISWA, Kwaluseni campus, -26.48, 31.30 ●
ZAMBIA
NMZ?, Abercorn (= Mbala), -8.85, 31.38
?, Chavuma area, -13.08, 22.68 (Ansell 1978)
?, Fort Jameson (= Chipata), -13.62, 32.65 (Ansell 1978)
NMZB29854, Ikelenge, -11.23, 24.27 ●
ROM73960, Kanyale Stream, -10.97, 24.12 (Bergmans 1988)
?, Kasama, -10.22, 31.17 (Ansell 1978)
?, Kasempa Boma, -13.47, 25.85 (Ansell 1978)
?, Mongu, -15.15, 23.17 (Ansell 1978)
CAS15102, Naleza, -15.45, 27.33 (Bergmans 1988)
?, Ndola, -12.97, 28.63 (Ansell 1978)
?, Nyika NP, -10.58, 33.65 (Ansell 1978)
?, Pirwa Pan, -13.87, 27.87 (Ansell 1978)
NMZB30286, Sakeji School, -11.12, 24.37 ●
?, Solwezi, -12.18, 26.42 (Ansell 1978)
ZIMBABWE
NMZB84333, Bopoma River Camp, Chimanda, -16.50, 32.25 ●
TM38451, Chipinga, -20.17, 32.58 ●
USNM00425264, Chirinda Forest, -20.42, 32.72
NMZB84325, Chori Dam, Tokwa Ngarwe, -16.75, 32.50 ●
NMZB84326, Chori Dam, Tokwa Ngarwe, -16.75, 32.50 ●
NMZB31529, Haroni Forest, -20.00, 33.00 ●
NMZB32413, Nyadiri R, -17.12, 32.12 ●
NMZB32404, Nyagui R, 2 km N of Chenjerai confluence, -17.37, 31.62 ●
NMZB30048, Rusitu Forest, -20.03, 32.98 ●
TM34794, Rusitu Forest, -20.03, 32.98 ●
USNM00470238, Sabi-Lundi (= Save-Runde) R Confluence, -21.28, 32.38

DM55, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB29929, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●

Epomops

dobsoni

ANGOLA
?, Alto Chicapa, -10.88, 19.13 (Crawford-Cabral 1986)
BM8.2.12.2, Bailundo, -12.13, 15.88 (Bergmans 1989)
BM63.1013, Calunda, -12.13, 23.38 (Bergmans 1989)
AMNH88068, Chitau, -11.38, 17.13 (Bergmans 1989)
?, Galanga, -13.63, 14.38 (Crawford-Cabral 1986)
?, Hanha, -13.63, 14.38 (Crawford-Cabral 1986)
BM5.5.9.3, Kalonga (= Calonga), -12.13, 17.13 (Bergmans 1989)
FMNH84030, Monte Moco, -12.38, 15.13 (Bergmans 1989)
FMNH84022, Monte Soque, -12.38, 15.13 (Bergmans 1989)
BOTSWANA
NMZB63732, Chobe NP, Kasane, -17.80, 25.15
DRC
RMCA26267, Elisabethville (= Lubumbashi), -11.68, 27.48 (Hayman *et al.* 1966)
BM?, Kambove, -10.83, 26.65 (Hayman *et al.* 1966)
IRSN1811a, Kanzenze, -10.48, 25.22 (Hayman *et al.* 1966)
RMCA23945, Mwera, -11.32, 27.30 (Hayman *et al.* 1966)
MALAWI
ZMA21.689, Kasungu NP, -13.05, 33.15 (Bergmans 1989)
ZMA21.688, Lifupa, -13.08, 33.13 (Bergmans 1989)
ZMA21.692, Lisanthu, -13.00, 33.17 (Bergmans 1989)
BM34.6.4.1, Livingstonia, -10.60, 34.10 (Bergmans 1989)
ZAMBIA
HZM1.1953, Abercorn (= Mbala), -8.85, 31.38 (Bergmans 1989)
KM18128, Abercorn (= Mbala), -8.85, 31.38 ●
AMNH115821, Balovale (= Zambezi), -13.55, 23.12 (Bergmans 1989)
KM1564, Balovale (= Zambezi), -13.55, 23.12 ●
HZM6.2862, Chavuma area, -13.08, 22.68 (Bergmans 1989)
BM66.5473, Chipangali, Chipata, -13.12, 32.87 (Bergmans 1989)
HZM2.2801, Kabompo, NE of, -13.08, 24.62 (Bergmans 1989)
FMNH96267, Kafue R, -12.30, 27.30 (Bergmans 1989)
KM9683, Kasama, -10.22, 31.17 ●
NMZ2975, Lusaka, Munali, -15.38, 28.35 (Ansell, 1973)
NMZB33282, Ndanda School, Mongu, 70 km NE, -14.75, 23.75 ●
BM26.12.1.3, Ndola, -12.97, 28.63 (Bergmans 1989)
ROM73961, Sakeji Stream, -11.08, 24.33 (Bergmans 1989)
FMNH95213, South Lueti R, -16.63, 22.13 (Bergmans 1989)

franqueti

ANGOLA
FMNH81621, Canzele, -8.38, 15.13 (Bergmans 1989)
FMNH84021, Gabela, 30 km S, -11.13, 14.38 (Bergmans 1989)
ZMB10031, Malange (= Malanje), -9.63, 16.38 (Bergmans 1989)
IICA8020, Salazar (= N'Dalatando), Agronomic Station, -9.38, 14.88 ●
DRC
RMCA7640, Boma, -5.83, 13.05 (Hayman *et al.* 1966)
BM?, Inkongo, -4.92, 23.25 (Hayman *et al.* 1966)
RMCA26554, Katende Falls, -9.07, 26.72 (Hayman *et al.* 1966)
?, Kitwit, -5.08, 18.91 (Van Cakenberghe *et al.* 1999)
RMCA15383, Leopoldville (= Kinshasa), -4.30, 15.30 (Hayman *et al.* 1966)
RMCA6646, Luebo, -5.33, 21.55 (Hayman *et al.* 1966)
BM?, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)
ZAMBIA
BM52.1542, Abercorn (= Mbala), -8.85, 31.38 (Ansell 1978)

Hypsignathus

monstrosus

ANGOLA
FMNH66435, Dundo, -7.38, 20.88 (Bergmans 1989)
FMNH83588, Gabela, 30 km S, -11.13, 14.38 (Bergmans 1989)
IICA8076, Salazar (= N'Dalatando), Agronomic Station, -9.38, 14.88 ●
?, Uije (= Uige), -7.63, 15.13 (Crawford-Cabral 1986)
DRC
RMCA20397, Boltuma, -5.83, 13.05 (Hayman *et al.* 1966)
RMCA492, Congo da Lemba, -5.70, 13.67 (Hayman *et al.* 1966)
RMCA6530, Kisala, -4.77, 13.00 (Hayman *et al.* 1966)
TM45628, Kitwit, -5.08, 18.91 ●
TM45630, Kitwit, -5.08, 18.91 ●
TM45595, Kitwit, -5.08, 18.91 ●
RMCA6525, Luebo, -5.33, 21.55 (Hayman *et al.* 1966)
BM?, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)

Lissonycteris

angolensis

ANGOLA
IICA6618, Cabuta, -9.88, 14.88 ●
?, Cahata, -12.38, 14.88 (Crawford-Cabral 1986)
BM35.1.6.8, Congulu, -10.88, 14.38 (Bergmans 1997)
?, Pungo Andongo, -9.63, 15.63 (Crawford-Cabral 1986)
MLZA?, Quibula, -12.38, 14.63 (Bergmans 1997)
?, Uije (= Uige), -7.63, 15.13 (Crawford-Cabral 1986)
DRC
RMCA22504, Barafinda, -5.72, 14.47 (Hayman *et al.* 1966)
RMCA9904a, Kabalo, -6.03, 26.92 (Hayman *et al.* 1966)
RMCA27592, Kabolela, cave, -10.83, 26.65 (Hayman *et al.* 1966)
RMCA29219, Kakontwe, -10.98, 26.63 (Hayman *et al.* 1966)
RMCA13701, Kimbemba, -4.85, 14.10 (Hayman *et al.* 1966)
IRSN10662, Munoi, -8.75, 26.77 (Hayman *et al.* 1966)
IRSN10660, Pelenge, -8.67, 26.83 (Hayman *et al.* 1966)
RMCA13689, Thysville (= Banza-Ngungu), -5.27, 14.88 (Hayman *et al.* 1966)
ZAMBIA
NMZ3643, Sakeji headwaters, -11.38, 24.38 (Ansell 1974)
NMZB11555, Salujinga, -10.97, 24.12 (Ansell 1967)

goliath

MOZAMBIQUE
DM8654, Gurue, -15.46, 37.02 ●
NMZB84006, Marromeu, Coutada 1, -18.25, 35.75 ●
DM8653, Ribaue, 40 km W, -14.97, 38.08 ●
ZIMBABWE
NMZB31153, Chirinda Forest, Gungunyama, -20.00, 32.50 ●
NMZB59826, Gleneagles, Nyanga, -18.25, 32.75 ●
NMZB59796, Penhalonga, -18.87, 32.62 ●
NMZB30055, Rusitu Forest, -20.03, 32.98 ●

Megaloglossus

woermanni

ANGOLA
FMNH81604, Canzele, -8.38, 15.13 (Bergmans 1997)
MD12673, Dundo, -7.38, 20.88 (Crawford-Cabral 1986)
DRC
RMCA?, Banana, -5.97, 12.45 (Schouteden 1947)
?, Kitwit, -5.08, 18.91 (Van Cakenberghe *et al.* 1999)
RMCA33604, Luluabourg (= Kananga), -5.88, 22.43 (Bergmans 1997)

Micropteropus

intermedius

ANGOLA
BM62.2073, Dundo, -7.38, 20.88 (Bergmans 1989)
DRC
SMF2509, Banana, -5.97, 12.45 (Bergmans 1989)
RMCA32380, Luluabourg (= Kananga), -5.88, 22.43 (Bergmans 1989)
RMCA22661, Thysville (= Banza-Ngungu), -5.27, 14.88 (Bergmans 1989)

pusillus

ANGOLA
BM4.4.9.9, Canhoca, -9.13, 14.63 (Bergmans 1989)
NMBA5826, Catete, -9.13, 13.63 (Bergmans 1989)
ZMB4802, Chinchoxo, -5.13, 12.13 (Bergmans 1989)
IICT3159025, Dando, -11.13, 17.38 (Lopes & Crawford-Cabral 1990)
MD5031, Dundo, -7.38, 20.88 (Hayman 1963)
FMNH66449, Dundo, -7.38, 20.88 (Bergmans 1989)
?, Galanga, -13.63, 14.38 (Crawford-Cabral 1986)
?, Luanda, -8.88, 13.38 (Crawford-Cabral 1986)
ZMB5851, Malange (= Malanje), -9.63, 16.38 (Bergmans 1989)
?, Mucoso, -9.63, 14.38 (Crawford-Cabral 1986)
ZMB5221, Pungo Andongo, -9.63, 15.63 (Bergmans 1989)
DRC
RMCA2099a, Benza Masola, -5.20, 13.00 (Hayman *et al.* 1966)
RMCA1051, Boma, -5.83, 13.05 (Hayman *et al.* 1966)
RMCA408b, Congo da Lemba, -5.70, 13.67 (Hayman *et al.* 1966)
RMCA18148, Kabinda, -6.13, 24.50 (Hayman *et al.* 1966)
IRSN10679, Kaswabilenga, -8.80, 26.68 (Hayman *et al.* 1966)
?, Kitwit, -5.08, 18.91 (Van Cakenberghe *et al.* 1999)
RMCA1431, Leopoldville (= Kinshasa), -4.30, 15.30 (Hayman *et al.* 1966)
RMCA32381, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)
RMCA13947, Lusanga, -5.83, 13.05 (Hayman *et al.* 1966)
RMCA18160, Makengo, -4.75, 16.50 (Hayman *et al.* 1966)
RMCA?, Moanda, -5.92, 12.40 (Schouteden 1947)
RMCA6547, Thysville (= Banza-Ngungu), -5.27, 14.88 (Hayman *et al.* 1966)
RMCA12167, Vista, -5.85, 12.28 (Hayman *et al.* 1966)
RMCA? Yema, -5.73, 12.32 (Schouteden 1947)
RMCA149, Zambi, -5.85, 12.87 (Hayman *et al.* 1966)
ZAMBIA
NMZ3601, Jimbe Stream, -10.95, 24.08 (Ansell 1974)

Myonycteris

relicta

MOZAMBIQUE
DM8561, Chinizuia Forest, -18.98, 35.05 ●
ZIMBABWE
NMZB62472, Haroni-Rusitu R Confluence, -20.03, 33.02 ●

torquata
ANGOLA
BM66.1.20.4, Golungo, -9.13, 14.63 (Bergmans 1997)
DRC
RMCA33413, Luluabourg (= Kananga), -5.88, 22.43 (Bergmans 1997)
ZAMBIA
NMZB11556, Salujinga, -10.97, 24.12 (Bergmans 1997)
BM65.534, Salujinga, -10.97, 24.12 (Bergmans 1997)

Plerotes

anchietae
ANGOLA
CMNH6971, Chitau, -11.38, 17.13 (Bergmans 1989)
IICT3159026, Dando, -11.13, 17.38 (Bergmans 1989)
MLZA481a, Galanga, -13.63, 14.38 (Bergmans 1989)
IICA6735, Mussende, -10.63, 16.13 ●
DRC
IRSN10686, Lusinga, -8.88, 27.25 (Bergmans 1989)
IRSN10685, Lusinga, -8.88, 27.25 (Hayman *et al.* 1966)
RMCA26210, Panda, -10.98, 26.78 (Hayman *et al.* 1966)
MALAWI
SMF85745, Nyika NP, -10.75, 33.92 (Kock *et al.* 1998)
ZAMBIA
HZM1.3049, Abercorn (= Mbala), -8.85, 31.38 (Bergmans 1989)
BM63.45, Kasama, -10.22, 31.17 (Bergmans 1989)

Rousettus

aegyptiacus
ANGOLA
RMNH2535, Benguela, -12.63, 13.38 (Bergmans 1994)
RMNH81728, Canzele, -8.38, 15.13 (Bergmans 1994)
FMNH83592, Gabela, 30 km S, -11.13, 14.38 (Bergmans 1994)
AMNH85518, Hanha Estate, -12.38, 13.88 (Bergmans 1994)
IICA46, Luanda, -8.88, 13.38 ●
?, Necuto, -14.88, 12.63 (Crawford-Cabral 1986)
?, Pungo Andongo, -9.63, 15.63 (Crawford-Cabral 1986)
?, Qual do Sul R, -8.38, 15.13 (Crawford-Cabral 1986)
?, Quindumbo, -12.38, 14.88 (Crawford-Cabral 1986)
?, Uije (= Uige), -7.63, 15.13 (Crawford-Cabral 1986)
DRC
MHNG1046.32, Pempéré, -10.97, 26.78 (Hayman *et al.* 1966)
MALAWI
van Strien 198, Lengwe NP, -16.20, 34.78 (Bergmans 1994)
?, Likabula R, Mulanje, -15.92, 35.67 (Happold *et al.* 1987)
?, Mlolo, near Chiromo, -16.45, 35.17 (Happold *et al.* 1987)
KM11753, Mulanje, -15.93, 35.62 ●
?, Ngabu, -16.47, 34.90 (Happold *et al.* 1987)
MOZAMBIQUE
NMZB27455, Chemezi, -18.75, 33.00 ●
?, Espungabera, NW of, -20.13, 33.13 (Smtihers & Lobão Tello 1976)
DM8659, Gorongosa, E of, -18.56, 34.87 ●
DM8660, Gurue, -15.46, 37.02 ●
?, Inhambane, -23.90, 35.40 (Smtihers & Lobão Tello 1976)
?, Manica, -18.93, 32.88 (Smtihers & Lobão Tello 1976)
DM8661, Meponda, Lake Niassa, -13.40, 34.87 ●
DM8647, Ribaue, 40 km W, -14.97, 38.08 ●
SOUTH AFRICA
TM27562, Afcolaco, 19 km NE, -24.17, 30.25 ●
KM32579, Albany District, -33.30, 26.52 ●
KM20056, Alexandria, -33.50, 25.75 ●
KM32580, Bedford, -32.65, 26.18 ●
NMZB62006, Cape Town, Rondebosch, -34.00, 18.38 ●
TM12960, Chunies Poort, -24.13, 29.63 ●
DM7536, Durban, -29.85, 31.00 ●
TM34327, East London, -33.15, 21.92 ●
KM19090, East London, -33.15, 21.92 ●
DM4438, Greater St. Lucia Wetlands Park, Mission Rocks, -28.28, 32.49 ●
KM1603, Hankey, -33.82, 24.85 ●
KM23583, Hlabisa, -28.18, 31.95 ●
KM26320, Humansdorp, -33.98, 23.65 ●
DM5492, Jonkershoek NR, -33.96, 18.93 ●
KM1576, King William's Town, -32.87, 27.37 ●
TM984, Knysna, -34.03, 23.05 ●
SAM ZM10129, Knysna, -34.03, 23.05 ●
NMZB29633, Knysna, -34.03, 23.05 ●
KM26322, Knysna, -34.03, 23.05 ●
TM29859, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM30504, Kruger NP, Levuvhu R, -22.43, 31.18 ●
TM14055, Letsitele, -23.87, 30.38 ●
TM41656, Louis Trichardt, 16 km NW, -23.02, 29.77 ●
TM47090, Ngodwana, -25.70, 30.63 ●
TM13523, Skeleton Cave, Outshoorn, -33.67, 22.25 ●
KM1575, Stutterheim, -32.65, 27.53 ●
TM40992, Tzaneen, -23.83, 30.17 ●
DM5084, Umlalazi NR, -28.96, 31.77 ●
SAM ZM19451A, Wynberg Hill, -34.00, 18.38 ●
ZAMBIA
NMZB16529, Chilanga Cave, -15.55, 28.27 ●
CAS15101, Chipongwe Cave, -15.63, 28.23 (Bergmans 1994)
NMZB12246, Chipongwe Cave, -15.63, 28.23 ●
UZMZ?, Leopard's Hill Cave, -15.55, 28.72 (Ansell 1969)
NMZB11418, Lusaka, Mkwisi, -15.38, 28.35 ●
BM68.111, South Luangwa Valley, Mfuwe, -13.08, 31.78 (Bergmans 1994)
ZIMBABWE
NMZB84200, Bubye R, Chikwarakwara, -22.35, 31.10 ●
NMZB32402, Chinanga Dam, Maramba, -17.12, 32.87 ●
NMZB67001, Chinhoyi Caves, -17.37, 30.08 ●
NMZB32283, Deka-Zambezi R Confluence, -18.00, 26.50 ●
NMZB80371, Dorowa Mine, -19.00, 31.75 ●
DM3665, Great Zimbabwe, -20.28, 30.93 ●
TM34585, Great Zimbabwe, -20.28, 30.93 ●
NMZB31530, Haroni Forest, -20.00, 33.00 ●
NMZB6941, Honde-Mtarazi R confluence, -18.50, 32.75 ●
NMZB61988, Juliasdale, -18.42, 32.75 ●
NMZB33643, Lutope-Ngolangola R Confluence, -18.28, 28.08 ●
NMZB30475, Matobo Hills, Diana's Pool, -20.47, 28.87 ●
NMZB30685, Matobo Hills, Mtshavezi Valley, -20.62, 28.87 ●
NMZB83859, Morgenster Mission, -20.25, 30.75 ●
NMZB32399, Murehwa Caves, -17.62, 31.78 ●
NMZB27458, Mutare, -19.00, 32.50 ●
NMZB32403, Nyashato Dam, -17.12, 32.12 ●
TM34762, Rusitu Forest, -20.03, 32.98 ●
NMZB30056, Rusitu Forest, -20.03, 32.98 ●
NMZB30660, Tingwa R, Mavuradonha, -16.62, 30.87 ●

lanosus
MALAWI
ZMA24.573, Mugesse, Misuku, -9.62, 33.62 (Bergmans 1994)
?, Nkhata Bay, -11.60, 34.30 (Bergmans 1994)

RHINOLOPHIDAE

Rhinolophus

alcyone
DRC
HZM1.8022, Scierie Forest, -3.17, 25.77 ●

blasii
DRC
RMCA26280, Moba, -7.07, 29.75 (Hayman *et al.* 1966)
MALAWI
MMB?, Blantyre, -15.78, 35.00 (Happold *et al.* 1987)
MMB?, Dedza, -14.37, 34.33 (Happold *et al.* 1987)
MMB?, Lake Malombe, -14.63, 35.25 (Happold *et al.* 1987)
TM41789, Likabula Mission, Mulanje, -15.95, 35.48 ●
MMB?, Liwonde, -15.05, 35.22 (Happold *et al.* 1987)
MMB?, Liwonde NP, -15.03, 35.25 (Happold *et al.* 1987)
TM9163, Ncheu, -14.88, 34.63 ●
DCHC?, Nyika NP, -10.75, 33.92 (Happold *et al.* 1987)
DCHC?, Thondwe, -15.45, 35.25 (Happold *et al.* 1987)
DCHC?, Viphya Plateau, -12.38, 33.70 (Happold *et al.* 1987)
NMZ3229, Wilindi Forest, Misuku Hills, -9.70, 33.83 (Ansell 1974)
BM93.7.9.33, Zomba, -15.38, 35.32 ●
DCHC?, Zomba Plateau, -15.33, 35.32 (Happold *et al.* 1987)
MOZAMBIQUE
DM8480, Gurue, -15.46, 37.02 ●
?, Manica, -18.93, 32.88 (Smithers & Lobão Tello 1976)
DM10834, Mount Mabu, -16.30, 36.39 ●
NMZB62100, Zinave NP, 3 km SSW, -21.39, 33.89 ●
SOUTH AFRICA
TM31808, Itala NR, -27.52, 31.37 ●
TM37039, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM7062, Krugersdorp, -26.02, 27.73 ●
TM9470, Louws Creek, Barberton, -25.65, 31.30
TM4262, Makapans Cave, -24.15, 29.18 ●
TM30151, Ngubevu, -28.73, 30.63 ●
TM13961, Sandspruit, Thabazimbi, -24.62, 27.67 ●
TM12448, Skurweberg Cave, Pretoria, -25.80, 27.98 ●
TM12045, Sterkfontein, Krugersdorp, -26.02, 27.73
TM46645, Sudwala Caves, -25.37, 30.70 ●
SWAZILAND
DM7897, Lomati Gold Mine, -25.68, 31.30 ●
DM5919, Mlawula NR, -26.19, 32.01 ●
ZAMBIA
UZMZ285, Chipongwe Cave, -15.63, 28.23 (Ansell 1969)
?, Makutu Mountains, -10.42, 33.30 (Ansell 1978)
UZMZ215, Ngwerere Siding, -15.32, 28.32 (Ansell 1969)
ZIMBABWE
HZM9.3926, Chinhoyi, Orchard Cave, -17.37, 30.12 ●

NMZB62079, Chinhoyi, Orchard Cave, -17.37, 30.12 ●
NMZB57768, Colleen Bawn, -21.00, 29.00 ●
NMZB32282, Deka-Zambezi R Confluence, -18.00, 26.50 ●
NMZB30584, Dwala Ranch, Bubiana, -21.12, 29.62 ●
HZM3.3366, Filabusi, 14 km W, -20.55, 29.25 ●
TM34594, Great Zimbabwe, -20.28, 30.93 ●
NMZB62076, Great Zimbabwe, -20.28, 30.93 ●
NMZB32324, Hope Fountain Mission, -20.62, 28.62 ●
NMZB12701, Ingwe Mine, 22 km W of Filabusi, -20.62, 29.37 ●
NMZB60772, Kwekwe, -18.92, 29.80 ●
NMZB29895, Matobo Hills, Lumane Valley, -20.58, 28.83 ●
NMZB29989, Matobo Hills, Mtshavezi Valley, -20.62, 28.62 ●
NMZB30499, Matobo Hills, Totololo R, -20.55, 28.83 ●
NMZB29595, Matobo Hills, Totololo R, -20.55, 28.83 ●
NMZB57209, Matusadona NP, -16.87, 28.37 ●
NMZB30523, Mutanda, -19.12, 32.12 ●
NMZB62080, Nyanga NP, Mare Dam, -18.37, 32.87 ●

capensis

SOUTH AFRICA
KM31142, Bathurst, -33.58, 26.89 ●
SAM ZM14559, Bushman Cave, Montagu, -33.83, 20.17 ●
TM29066, De Hoop, NR, -34.43, 20.42 ●
SAM ZM35665, De Hoop, NR, -34.43, 20.42 ●
TM6653, Grahamstown District, -33.10, 26.83 ●
NMZB62005, Grahamstown, 12 km NW, -33.12, 26.37 ●
KM21166, Hankey, -33.82, 24.85 ●
KM23852, Humansdorp, -33.98, 23.65 ●
TM41471, Langebaan, -33.15, 18.08 ●
KM1786, Namaqualand, -30.25, 18.43 ●
KM28199, Namaqualand, -28.29, 16.97 ●
TM2273, Paarl District, -33.88, 19.05 ●
KM1824, Piquetburg, N of, -32.61, 18.78 ●
TM41560, Postberg NR, -33.12, 18.00 ●
TM8983, Riversdale, -34.02, 21.22 ●
TM2277, Saldanha Bay, -33.05, 17.97 ●
NMZB59388, Skoenmakerskop, -33.97, 25.60 ●
KM25630, Somerset East, -33.27, 25.68 ●
NMZB62158, Storms R Gorge, -34.00, 23.87 ●
TM40499, Stutterheim, 12 km W, -32.52, 27.25 ●
NMZB62159, Table Farm, Salerm, -33.37, 26.37 ●
TM40523, Tsitsikama NP, -34.02, 23.88 ●
TM2268, Van Rhynsdorp, 7 km SE, -31.78, 18.62 ●
DM5012, Van Rhynsdorp, 7 km SE, -31.78, 18.62 ●
KM1772, Van Rhynsdorp, NE of, -31.13, 18.18 ●
KM28938, Vredendal, -31.76, 18.23 ●
KM25504, Wodehouse, -31.33, 26.68 ●

clivosus

DRC
RMCA26256, Jadotville (= Likasi), -10.97, 26.78 (Hayman *et al.* 1966)
IRSN14513, Kakanda, -10.78, 26.60 (Hayman *et al.* 1966)
RMCA27538, Kambove, -10.83, 26.65 (Hayman *et al.* 1966)
RMCA7718, Kisantu, -5.13, 15.15 (Hayman *et al.* 1966)
RMCA22667, Lubudi cave, -9.93, 25.97 (Hayman *et al.* 1966)
RMCA28212, Pempéré, -10.97, 26.78 (Hayman *et al.* 1966)
LESOTHO
NMB8418, Butha-Butha, -28.88, 28.63 ●
NMB6891, Matelanong, -29.38, 29.13 ●
NMB8222, Mount Moorosi, Quithing, -30.18, 27.87 ●
NMB8300, Pallang, -29.88, 27.88 ●
NMB6863, Sehlabathebe NP, -29.87, 29.08 ●
MALAWI
DCHC?, Lengwe NP, -16.20, 34.78 (Happold *et al.* 1987)
TM41799, Likabula Mission, Mulanje, -15.95, 35.48 ●
DCHC?, Mzuzu, -11.47, 34.07 (Happold *et al.* 1987)
TM9164, Ncheu, -14.88, 34.63 ●
DCHC?, Nyika NP, -10.75, 33.92 (Happold *et al.* 1987)
MMB?, Zoa Estate, -16.23, 35.20 (Happold *et al.* 1987)
DCHC?, Zomba, -15.38, 35.32 (Happold *et al.* 1987)
MOZAMBIQUE
?, Espungabera, -20.50, 32.80 (Smithers & Lobão Tello 1976)
DM8570, Gurue, -15.46, 37.02 ●
?, Manica, -18.93, 32.88 (Smithers & Lobão Tello 1976)
DM10838, Mount Mabu, -16.37, 36.39 ●
DM10840, Mount Namuli, Manho Forest, -15.40, 37.04 ●
SOUTH AFRICA
TM44755, Abe Bailey NR, -26.31, 27.36 ●
DM6020, Albert Falls NR, -29.43, 30.38 ●
TM25838, Amsterdam, 2 km NE, -26.63, 30.63 ●
NMB7887, Arrarat, Sterkfontein Dam, -28.38, 28.88 ●
KM23624, Babanango, -28.38, 31.08 ●
TM36354, Babanango District, -28.30, 31.02 ●
TM3366, Barberton, -25.82, 31.12 ●
USNM00381559, Barberton, 3 km SW, -25.88, 31.13
KM25016, Barkley East, -31.08, 27.45 ●
KM21105, Bathurst, -33.58, 26.89 ●
TM2271, Berg River, -33.88, 19.13 ●
TM40301, Blyde River Canyon NR, -24.58, 30.78 ●
NMZB62118, Bredasdorp, -34.46, 20.40 ●
KM30468, Bredasdorp, NW of, -34.38, 19.81 ●
NMB5939, Butata, Zastron, -30.13, 26.88 ●
SAM ZM33493, Camps Bay, -33.97, 18.37 ●
KM1807, Clanwilliam, -32.12, 18.45 ●
NMB7389, Clarens, -28.38, 28.38 ●
MMK2805, Danielskuil, 10 km N, -28.10, 23.55 ●
SAM ZM35666, De Hoop, NR, -34.43, 20.42 ●
TM29071, De Hoop, NR, -34.43, 20.42 ●
TM30129, Dumisa Gold Mine, Umzinto, -30.27, 30.35 ●
DM6116, Dundee, 1 km E, -28.16, 30.26 ●
TM23420, Echo Caves, -24.56, 30.61 ●
DM4875, Eshowe, -28.90, 31.47 ●
NMB5900, Excelsior, -28.88, 27.38 ●
DM5083, Fairview Mine, Barberton, -25.72, 31.11 ●
DM5671, Ferncliff Cave, -29.53, 30.33 ●
TM41579, Ficksburg District, -28.77, 27.78 ●
NMB4129, Ficksburg District, -28.63, 27.88 ●
KM1735, Fort Beaufort, -32.78, 26.63 ●
DM2131, Garden Castle NR, -29.75, 29.22 ●
TM42096, Goegap NR, -29.65, 17.98 ●
NMB7905, Golden Gate, -28.38, 28.63 ●
MMK2790, Griekwastad, 25 km NNE, -28.63, 23.30 ●
TM28586, Groenval Wilderness Area, -32.72, 25.32 ●
TM8985, Grootvadersbosch, -33.88, 20.88 ●
TM23717, Haenertzburg, -24.02, 30.07 ●
DM6834, Hella Hella GR, -29.90, 30.08 ●
TM34155, Hester Malan NR, -29.65, 17.98 ●
TM12578, Howell Davies Cave, Zebediela, -24.38, 29.38 ●
KM23860, Humansdorp, -33.98, 23.65 ●
TM1019, Insusie Valley, -28.88, 31.05 ●
DM3271, Itala NR, -27.52, 31.37 ●
TM31759, Itala NR, -27.52, 31.37 ●
NMB7564, Jagersfontein Commonage, -29.63, 25.38 ●
TM1010, Johannesburg, -26.18, 28.07 ●
TM42473, Kaapse Hoop, -25.60, 30.78 ●
TM47104, Kafferskraal, -25.18, 30.15 ●
TM38092, Kamberg NR, -29.40, 29.68 ●
TM29732, Kammanassie, 8 km SE, -33.60, 22.55 ●
NMZB62194, King William's Town, -32.87, 27.37 ●
KM1737, King William's Town, -32.87, 27.37 ●
USNM00344269, King William's Town, 18 km NW, -32.72, 27.28
TM2269, Klaver, Van Rhynsdorp, -31.78, 18.62 ●
TM994, Knysna, -34.03, 23.05 ●
TM36060, Koegelbeen Cave, -28.68, 23.37 ●
MMK2777, Koegelbeen Cave, -28.68, 23.37 ●
NMB7502, Koegelbeen Cave, -28.68, 23.37 ●
TM42154, Koingaas, 16 km NW, -30.08, 17.18 ●
SAM ZM16185, Koster Caves, -25.80, 26.93 ●
TM4190, Koster Caves, -25.80, 26.93 ●
TM42008, Kruger NP, Levuvhu R, -22.43, 31.18 ●
KM6053, Krugersdorp, -26.02, 27.73 ●
TM1011, Krugersdorp, -26.02, 27.73 ●
TM35752, Kuruman, -27.45, 23.42 ●
USNM00381539, Kuruman, -27.45, 23.42 ●
MMK2776, Kuruman, -27.45, 23.42 ●
MMK2819, Kuruman, 44 km SSE, -27.83, 23.58 ●
NMB1664, Ladybrand, -29.13, 27.38 ●
TM2267, Lormarins, -33.88, 19.05 ●
KM26111, Lusikisiki, -31.28, 29.96 ●
TM1014, Makapans Cave, -24.15, 29.18 ●
USNM00381584, Malelane, 12 km SW, -25.53, 31.54
DM8376, Melmoth, -28.57, 31.32 ●
DM4782, Melmoth, -28.57, 31.32 ●
DM2134, Mkhuze GR, -27.60, 32.21 ●
KM30835, Montagu, -33.83, 20.17 ●
KM1743, Namaqualand, -30.25, 18.43 ●
DM5447, Ncandu, -27.88, 29.71 ●
TM39849, Ngome Forest, -27.83, 31.42 ●
KM26113, Ngqeleni, -31.83, 29.30 ●
KM23625, Nkandla, -28.67, 30.98 ●
TM25324, Ofcolaco, 13 km SW, -24.20, 30.28 ●
TM13742, Pietermaritzburg, Bishopstowe, -29.60, 30.55 ●
KM23643, Pietermaritzburg, E of, -29.60, 30.52 ●
KM28957, Piquetburg, -32.77, 18.72 ●
NMZB64266, Plettenberg Bay, -34.10, 23.38 ●
SAM ZM10132, Plettenberg Bay, -34.10, 23.38 ●
TM1018, Port St. Johns, -31.63, 29.55 ●
MMK2784, Postmasburg, 25 km ENE, -28.20, 23.22 ●
MMK2801, Postmasburg, 25 km ENE, -28.20, 23.28 ●
MMK2821, Postmasburg, 6 km NE, -28.30, 23.12 ●

NMB4991, Potchefstroom, -26.70, 27.08 ●
TM996, Potchefstroom, Wonderfontein, -26.32, 27.47 ●
TM1015, Pretoria, -25.72, 28.18 ●
MMK2785, Prieska, 23 km NNW, -29.47, 22.63 ●
NMB4321, Roodewal, Aliwal North, -30.38, 26.38 ●
TM33451, Saasveld Forest, -33.97, 22.52 ●
TM36579, Sandile's Cave, -32.72, 27.28 ●
TM12206, Skurweberg Cave, Pretoria, -25.80, 27.98 ●
KM25631, Somerset East, -33.27, 25.68 ●
DM1117, Songimvelo NR, -26.01, 30.92 ●
DM7227, Soutpansberg, -22.98, 29.88 ●
DM1051, Spioenkop NR, -29.67, 29.47 ●
MMK7043, Sprinkbok, near, -29.67, 17.82 ●
SAM ZM10306, Stellenbosch, -33.88, 18.88 ●
TM10019, Sterkfontein, Krugersdorp, -26.02, 27.73 ●
TM46481, Sterkspruit, -24.58, 30.62 ●
TM40507, Stutterheim, 12 km W, -32.52, 27.25 ●
TM41902, Sudwala Caves, -25.37, 30.70 ●
TM36093, Taung, 16 km SW, -27.62, 24.62
TM20427, The Downs, -24.13, 30.18 ●
DM5383, Uitkomst Cave, -25.96, 30.58 ●
TM20155, Uitkyk NR, -25.60, 31.12 ●
KM23872, Uniondale, -33.63, 23.16 ●
TM40201, Vaalwater, 30 km NE, -24.13, 28.13 ●
TM1016, Venterskroon, -26.88, 27.27 ●
NMB5889, Vredefort, N of, -26.88, 27.38 ●
MMK2786, Warrenton, 47 km W, -28.13, 24.40 ●
TM35986, Warrenton, 47 km W, -28.13, 24.40 ●
TM46402, Waterberg NR, -24.12, 28.39 ●
NMB7702, Waterval, Warden, -27.88, 29.13 ●
TM41472, West Coast NP, Langebaan, -33.15, 18.08 ●
TM12619, West Driefontein Caves, -26.13, 27.68 ●
DM19, Will Brook, Estcourt, -29.13, 29.88 ●
TM3389, Woodbush, -23.82, 29.90 ●
NMB5924, Woodcliff, Maclear, -30.88, 28.13 ●
NMB7501, Zastron Commons, -30.38, 27.13 ●
KM19607, Zwelitsha, -32.72, 27.29 ●

SWAZILAND
TM45534, Barites Mine, -26.22, 31.03 ●
TM1975, Horo, -25.77, 31.42 ●
DM7894, Lomati Gold Mine, -25.68, 31.30 ●
DM6228, Malolotja NR, -26.16, 31.11 ●
DM8037, Nottinghill Mine, -25.96, 31.17 ●
TM1977, Pigg's Peak, -25.97, 31.25 ●
DM8047, Piggs' Peak Mine, -25.95, 31.21 ●

ZAMBIA
KM9635, Chadiza, -14.15, 32.75 ●
KM9642, Fort Jameson (= Chipata), -13.62, 32.65 ●
NMZB29624, Ipombe Stream, -11.23, 24.27 ●
KM9633, Kasama, -10.22, 31.17 ●
KM1834, Livingstone, -17.85, 25.87 ●
KM9634, Luangwa Valley, Petauke, -14.05, 31.08 ●
?, Solwezi, -12.18, 26.42 (Ansell 1978)

ZIMBABWE
NMZB60705, Buchwa Iron Mine, -20.47, 30.15 ●
NMZB62201, Bulawayo, -20.12, 28.58 ●
DM21, Bulawayo, -20.17, 28.72 ●
NMZB58329, Chimanimani, Corner, -19.50, 32.75 ●
NMZB58352, Chirinda Forest, -20.42, 32.72 ●
NMZB84324, Chori Dam, Tokwa Ngarwe, -16.75, 32.50 ●
USNM00425286, Dunblaine. Martin Forest, -20.25, 32.75 ●
NMZB3453, Esigodini, -20.30, 28.93 ●
NMZB32335, Esigodini, Falcon College, -20.22, 28.92 ●
NMZB55636, Esigodini, Willow Park, -20.28, 28.83 ●
TM34593, Great Zimbabwe, -20.28, 30.93 ●
NMZB62196, Gwanda, -20.93, 29.02 ●
NMZB58371, Gweru, -19.42, 29.78 ●
NMZB58337, Harare, Cleveland Dam, -17.75, 31.00 ●
NMZB58338, Harare, Triumph Mine, -17.87, 30.87 ●
NMZB80196, Harare, Twentydales, -17.90, 31.17 ●
NMZB58575, Haroni-Rusitu R Confluence, -20.03, 33.02 ●
USNM00425282, Henderson Research Station, -17.62, 30.87 ●
NMZB32393, Hope Fountain Mission, -20.62, 28.62 ●
NMZB58348, Hwange NP, Main Camp, -18.73, 26.95 ●
NMZB12699, Ingwe Mine, 22 km W of Filabusi, -20.62, 29.37 ●
TM11404, Inyanga NP, -18.28, 32.77 ●
NMZB58335, Lake McIlwaine, -17.90, 30.78 ●
NMZB58360, Lannerhurst Mine, West Nicolson, -21.12, 29.37 ●
NMZB31807, Lucilia Port, Shurugwi, -19.62, 30.12 ●
NMZB33392, Marondera, -18.12, 31.62 ●
NMZB32183, Matabele Sheba Mine, Esigodini, -20.37, 28.87 ●
NMZB30679, Matobo Hills, Lumane Valley, -20.58, 28.83 ●
NMZB60452, Matobo Hills, Mtshelele Valley, -20.62, 28.62 ●
NMZB81542, Matobo Research Station, -20.25, 28.75 ●
NMZB82360, Matobo Research Station, -20.25, 28.75 ●
NMZB58356, Mutare, -18.90, 32.62 ●
NMZB58162, Mutare, Asbestos Mine, -18.92, 32.62 ●
NMZB58355, Mutare, Fern Valley, -19.12, 32.62 ●
TM34657, Mutare, Old Mine, -19.08, 32.70 ●
USNM00425285, Ngorima Reserve, -19.75, 32.33 ●
NMZB58321, Penhalonga, -18.87, 32.62 ●
NMZB58322, Penhalonga, -18.87, 32.62 ●
NMZB31862, Princess Farm, Shurugwi, -19.62, 29.92 ●
NMZB30059, Rusitu Forest, -20.03, 32.98 ●
TM34760, Rusitu Forest, -20.03, 32.98 ●
NMZB31684, Sengereri Hills, -17.62, 31.12 ●
NMZB9868, Shurugwi, -19.67, 30.02 ●
NMZB31813, Shurugwi, 2 km E, -19.62, 30.12 ●
NMZB58179, St.Carera Farm, -17.50, 31.00 ●
NMZB30089, Tingwa R, Mavuradonha, -16.62, 30.87 ●
NMZB58346, West Nicholson, 5 km W, -21.07, 29.37 ●
NMZB60990, Wolfshaw Pass, -19.70, 30.03 ●

darlingi

ANGOLA
?, Benguela, -12.63, 13.38 (Crawford-Cabral 1986)
SMM5463, Dolondolo, -13.88, 13.13 ●
SMM6415, Tchivinguiro, -15.13, 13.38 ●

BOTSWANA
NMZB64254, Francistown, 18 km S, -21.30, 27.50 ●
NMZB64253, Francistown, 32 km N, -20.90, 27.50 ●
?, Gaborone, -24.63, 25.88 (Smithers 1971)
NMZB32850, Makalamabedi Resource Area, -20.37, 23.87 ●
NMZB64252, Savuti R, -18.62, 24.12 ●

MALAWI
BM95.8.18.2, Fort Johnston (= Mangochi), -14.48, 35.27 (Happold *et al.* 1987)

MOZAMBIQUE
NMZB64264, Kanganatole, 8 km N, -18.38, 34.38 ●
?, Manica, -18.93, 32.88 (Smithers & Lobão Tello 1976)
?, Zumbo (= Zumbu), -15.70, 30.60 (Smithers & Lobão Tello 1976)

NAMIBIA
SMM12215, Arnhem Cave, -22.70, 18.10 ●
SMM1351, Aus, 22 km E, -26.88, 16.38 ●
SMM6812, Daan Viljoen NP, -22.63, 16.88 ●
SMM8092, Etosha NP, -19.38, 14.63 ●
BM35.1.6.17, Klein Windhoek ●
BM25.1.2.285, Karibib, -21.59, 15.51 ●
BM35.1.6.18, Otjosongombe, Waterberg, -20.29, 16.36 ●
TM12925, Gobabeb, 28 km upstream, -23.63, 15.13 ●
SMM7071, Gobabeb, Namib Desert, -23.55, 15.05 ●
LACM041608, Grootfontein, 40 km WNW, -19.38, 17.88 ●
TM8289, Kochina, Karas Mountain, -27.13, 18.88 ●
TM37615, Maltahohe, 70 km W, -24.90, 16.28 ●
SMM10148, Oberdorf, Bethanie, -26.13, 17.13 ●
SMM6780, Okongava, -22.13, 15.88 ●
MNKB3294, Otjimbingwe, -22.38, 16.13 ●
SMM7851, Outjo, SW of, -20.30, 15.83 ●
SMM2699, Sinclair Mine, Luderitz, -25.63, 16.63 ●
MG4007, Uris, -19.27, 17.52 ●
SMM4311, Waterberg, 416, -20.63, 17.38 ●
SMM6817, Windhoek, -22.63, 17.13 ●

SOUTH AFRICA
TM16977, Augrabies Falls NP, -28.60, 20.33 ●
TM40091, Blyde River Canyon NR, -24.58, 30.78 ●
MMK2912, Danielskuil, 10 km N, -28.10, 23.55 ●
TM23578, Derdepoort, 8 km S, -24.72, 26.28 ●
TM10017, Dongola Kop, Soutpansberg, -22.23, 29.68 ●
TM44525, Doorndraai Dam NR, -24.27, 28.72 ●
MMK7097, Gamsberg Inselberg, Aggeneys, -29.25, 18.92 ●
USNM00479221, Goodhouse, -28.90, 18.25
TM3994, Gravelotte, -23.95, 30.60 ●
MMK2900, Griekwastad, 25 km NNE, -28.63, 23.30 ●
TM40746, Grootkloof, Magaliesberg, -25.77, 27.17 ●
DM3273, Hluhluwe-Imfolozi Park, HQ, -28.07, 32.03 ●
MMK2810, Kakamas, 47 km NW, -28.45, 20.32 ●
MMK2926, Koegelbeen Cave, -28.68, 23.37 ●
MMK1434, Koegelbeen Cave, near, -28.63, 23.38 ●
TM36972, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM39657, Kruger NP, Nwanedzi, -24.45, 31.97 ●
TM13474, Kruger NP, Pretoriuskop, -25.17, 31.27 ●
TM39718, Kruger NP, Renosterkoppies, -25.13, 31.62 ●
TM13476, Kruger NP, Skukuza Koppies, -25.08, 31.60 ●
TM30047, Kruger NP, Stolznek, -25.38, 31.38 ●
TM39734, Kruger NP, Tshokwane, -24.78, 31.95 ●
USNM00381590, Malelane, 12 km SW, -25.53, 31.54
MMK2837, Marydale, 31 km NE, -29.18, 22.30 ●
TM20394, Messina, 75 km W, -22.20, 29.38 ●
DM4573, Mkhuze GR, Ghost Mountain, -27.62, 32.07 ●

DM7375, Mkhuze GR, Umpila Cave, -27.60, 32.30 ●
KM28202, Namaqualand, -28.29, 16.97 ●
TM25315, Ofcolaco, 13 km SW, -24.20, 30.28 ●
TM44208, Percy Fyfe NR, -24.03, 29.13 ●
TM41540, Phalaborwa, -24.37, 30.75 ●
DM6331, Phinda GR, -27.86, 32.27 ●
MMK2880, Postmasburg, 25 km ENE, -28.20, 23.28 ●
MMK2922, Postmasburg, 6 km NE, -28.30, 23.12 ●
TM2103, Pretoria, Baviaanspoort, -25.68, 28.37 ●
TM27206, Prieska, 20 km SE, -29.83, 22.78 ●
MMK2881, Prieska, 23 km NNW, -29.47, 22.63 ●
MMK2840, Prieska, 26 km NW, -29.45, 22.62 ●
MMK2864, Prieska, 4 km W, -29.63, 22.75 ●
MMK2877, Prieska, near, -29.63, 22.63 ●
TM45096, Shashe-Limpopo R Confluence, -22.22, 29.37 ●
MMK6955, Soetfontein Cave, -28.37, 23.05 ●
TM35878, Taung, 16 km SW, -27.62, 24.62 ●
TM20159, Uitkyk NR, -25.60, 31.12 ●
TM24784, Vaalwater, 32 km NW, -24.22, 27.87 ●
TM47095, Waterberg NR, -24.12, 28.39 ●
TM44605, Wonderkop NR, -23.22, 28.60 ●
SWAZILAND
DM8039, Maguga Dam, -26.13, 31.13 ●
DM5826, Mlawula NR, -26.19, 32.01 ●
TM47742, Mlawula NR, -26.19, 32.01 ●
ZAMBIA
KM9636, Fort Jameson (= Chipata), -13.62, 32.65 ●
BM66.5444, Nyika Plateau, -10.58, 33.65 ●
ZIMBABWE
NMZB60738, Buffalo Range, Chiredzi, -21.03, 31.53 ●
NMZB13104, Bulawayo, -20.12, 28.58 ●
NMZB58419, Chikupu Caves, Bindura, -17.38, 31.28 ●
NMZB58388, Chikwarakwara, Pesu R Gorge, -22.28, 31.20 ●
NMZB84092, Chikwarakwara, Pesu R Gorge, -22.28, 31.20 ●
NMZB31139, Chinhoyi, Badze Cave, -17.17, 29.19 ●
NMZB58420, Chinhoyi, Baruka Cave, -17.37, 30.08 ●
NMZB30079, Chivi, -20.30, 30.52 ●
NMZB60729, Cleveden Farm, Mangwe, -20.87, 28.12 ●
NMZB58383, Dete, -18.62, 26.85 ●
NMZB33677, Dick's Mine, Mutanda, -19.13, 32.13 ●
NMZB79465, Doddieburn Ranch, -21.40, 29.35 ●
NMZB30586, Dwala Ranch, Bubiana, -21.12, 29.62 ●
NMZB58408, Eirene Farm, Marondera, -18.37, 31.62 ●
NMZB80162, Esigodini, Willow Park, -20.28, 28.83 ●
NMZB60987, Farm 26, Kwekwe, -18.93, 29.82 ●
NMZB58413, Glenisla, Marondera, -18.18, 31.60 ●
TM34592, Great Zimbabwe, -20.28, 30.93 ●
USNM00470252, Great Zimbabwe, -20.28, 30.93
NMZB58396, Great Zimbabwe, -20.28, 30.93 ●
NMZB60768, Gumela Farm, Kezi, -20.62, 28.37 ●
NMZB58390, Harare, Atlantica Research Station, -17.75, 31.00 ●
NMZB62030, Harare, Borrowdale, -17.83, 31.07 ●
NMZB32223, Homestead Mine, Esigodini, -20.30, 28.93 ●
NMZB33383, Hope Fountain Mission, -20.62, 28.62 ●
NMZB58373, Hwange NP, Main Camp, -18.73, 26.95 ●
NMZB58374, Hwange NP, Ngamo Pan, -19.13, 27.47 ●
NMZB62048, Kanyemba, -15.65, 30.33 ●
NMZB32287, Kudu Asbestos Mine, Esigodini, -20.37, 29.12 ●
NMZB58407, Lake McIlwaine, -17.90, 30.78 ●
NMZB58375, Lannerhurst Mine, West Nicolson, -21.12, 29.37 ●
NMZB31733, Mabura 2 Cave, Munyati R, -18.12, 29.37 ●
NMZB60728, Mangwe, Vashu Farm, -20.87, 28.12 ●
NMZB58411, Marondera, Peterhouse School, -18.18, 31.62 ●
NMZB58428, Masvingo, 16 km W, -20.12, 30.87 ●
NMZB32186, Matabele Sheba Mine, Esigodini, -20.37, 28.87 ●
NMZB60734, Matobo Hills, Bale Hill Cave, -20.55, 28.48 ●
TM35022, Matobo Hills, Bale Hill Cave, -20.55, 28.48 ●
NMZB29891, Matobo Hills, Lumane Valley, -20.58, 28.83 ●
NMZB65240, Matobo NP, Gordon Park, -20.47, 28.53 ●
NMZB81515, Matobo Research Station, -20.25, 28.75 ●
TM41873, Mazowe, -17.06, 30.96 ●
BM4.12.1.3, Mazowe, -17.06, 30.96 ●
NMZB30485, Mberengwa Mountain, -20.62, 29.92 ●
NMZB83850, Morgenster Mission, -20.25, 30.75 ●
NMZB58432, Mushandike NP, -20.13, 30.63 ●
NMZB33393, Mutare, Asbestos Mine, -18.92, 32.62 ●
TM34661, Mutare, Old Mine, -19.08, 32.70 ●
NMZB58434, Netridge Farm, -20.12, 30.62 ●
NMZB56220, Nyamunyeche, Mvurwi, -16.77, 30.95 ●
NMZB84272, Nyandia Dam, -17.00, 32.00 ●
NMZB32565, Nyashato Dam, -17.12, 32.12 ●
BM49.441, Odzi, -18.95, 32.38 ●
NMZB31857, Princess Farm, Shurugwi, -19.62, 29.92 ●
NMZB32358, Radio Mine, Mzinyatini, -20.37, 28.87 ●
NMZB60731, Ramofu Cave, Runde, -20.00, 30.00 ●
NMZB32394, Red Hill Mine, Mzingwane, -20.37, 28.87 ●
TM34766, Rusitu Forest, -20.03, 32.98 ●
NMZB58389, Saffron Walden, Farm, -17.87, 30.87 ●
NMZB58423, Samalema Gorge, Mwenezi R, -21.87, 31.37 ●
NMZB31735, Sengereri Hills, -17.62, 31.12 ●
NMZB31655, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB31816, Shurugwi, 2 km E, -19.62, 30.12 ●
NMZB58181, St.Carera Farm, -17.50, 31.00 ●
NMZB30090, Tingwa R, Mavuradonha, -16.62, 30.87 ●
USNM00425283, Vumba NP, -19.00, 32.75
NMZB58386, West Nicholson, 5 km W, -21.07, 29.37 ●
NMZB58429, Ziwa Nyanga, -18.12, 32.87 ●

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MOZAMBIQUE
DM8560, Chinizuia Forest, -18.98, 35.05 ●

denti

ANGOLA
?, Ruacana Falls, -17.38, 14.13 (Crawford-Cabral 1986)
BOTSWANA
USNM00322855, Drotsky Caves, -20.12, 21.37
NMZB62082, Drotsky Caves, -20.12, 21.37 ●
NMZB64259, Kaikai, 35 km SE, -20.13, 21.63 ●
NMZB64260, Khuis, -26.67, 21.83 ●
NMZB64261, Tsodilo Hills, -18.87, 21.62 ●
NAMIBIA
SMM3507, Arnhem Cave, -22.70, 18.10 ●
SMM8116, Etosha NP, Okaukuejo, -19.13, 15.88 ●
SMM7082, Hoba 322, Grootfontein, -19.63, 17.88 ●
SMM7608, Namibi-Naukluft NP, -22.63, 15.63 ●
SMM1165, Ombalantu, -17.38, 14.88 ●
LACM058982, Opuwo, 70 km NW, -17.47, 13.03 ●
KM28198, Outjo, SW of, -20.30, 15.83 ●
LACM056202, Rehoboth, 20 km NW, -22.67, 16.83 ●
MG4013, Uris, -19.27, 17.52 ●
SOUTH AFRICA
NMB7640, Jagersfontein Commonage, -29.63, 25.38 ●
TM35990, Koegelbeen Cave, -28.68, 23.37 ●
MMK2947, Koegelbeen Cave, -28.68, 23.37 ●
NMB7517, Koegelbeen Cave, -28.68, 23.37 ●
MMK7068, Kuruman, 44 km SSE, -27.83, 23.58 ●
TM36080, Postmasburg, 6 km NE, -28.30, 23.12 ●
TM35977, Warrenton, 47 km W, -28.13, 24.40 ●
TM35974, Warrenton, 47 km W, -28.13, 24.40 ●
TM35975, Warrenton, 47 km W, -28.13, 24.40 ●
TM35976, Warrenton, 47 km W, -28.13, 24.40 ●

eloquens

DRC
RMCA387, Katanga prov (Hayman *et al.* 1966)

fumigatus

ANGOLA
?, Cahata, -12.38, 14.88 (Crawford-Cabral 1986)
?, Caluquembe, -13.88, 14.63 (Crawford-Cabral 1986)
?, Cassinga, -15.13, 16.13 (Crawford-Cabral 1986)
?, Chitau, -11.38, 17.13 (Crawford-Cabral 1986)
IICA8254, Cuchi, -14.63, 16.88 ●
?, Cuvelai, -15.63, 15.88 (Crawford-Cabral 1986)
SMM5464, Dolondolo, -13.88, 13.13 ●
IICA771, Hoque, -14.63, 13.88 ●
IICA1879, Huila, -15.13, 13.63 ●
?, Humbe, -16.63, 14.88 (Crawford-Cabral 1986)
IICA1916, Humpata, -15.13, 13.38 ●
NMZB62092, Kissama NP, -9.13, 13.38 ●
?, Maconjo, -15.13, 13.13 (Crawford-Cabral 1986)
?, Monte Verde, -12.13, 15.13 (Crawford-Cabral 1986)
?, Osi (= Osse), -14.63, 15.88 (Crawford-Cabral 1986)
?, Otjimpompenima, -15.13, 13.63 (Crawford-Cabral 1986)
?, Quibula, -12.38, 14.63 (Crawford-Cabral 1986)
?, Quimdumbe, -12.38, 14.88 (Crawford-Cabral 1986)
?, Quissange, -12.38, 14.13 (Crawford-Cabral 1986)
IICA8119, Sa da Bandeira (= Lubango), 20 km W, -14.88, 13.38 ●
SMM6418, Tchivinguiro, -15.13, 13.38 ●
DRC
RMCA20649, Banana-Boma road, -5.78, 12.52 (Hayman *et al.* 1966)
RMCA28169, Kakanda, -10.78, 26.60 (Hayman *et al.* 1966)
IRSN14489, Musosa, -9.00, 29.00 (Hayman *et al.* 1966)
RMCA27532, Mwandingusha, -10.75, 27.23 (Hayman *et al.* 1966)
MALAWI
BM22.12.17.10, Chiromo, -16.53, 35.15 ●
MMB?, Lunzu, -15.65, 35.02 (Happold *et al.* 1987)
KM11683, Mulanje, -15.93, 35.62 ●
DCHC?, Zomba, -15.38, 35.32 (Happold *et al.* 1987)
KM11681, Zomba Plateau, -15.33, 35.32 ●

MOZAMBIQUE
DM719, Dondo, -19.65, 34.65 ●
?, Mague (= Mphende), -15.82, 31.73 (Smithers & Lobão Tello 1976)
?, Manica, -18.93, 32.88 (Smithers & Lobão Tello 1976)
DM8568, Meponda, 10 km E, -13.35, 34.98 ●
DM8567, Niassa GR, Maputo Camp, -12.18, 37.55 ●
USNM00365204, Vila Gouveia, -18.07, 33.18 ●
NAMIBIA
SMM8108, Etosha NP, Namutoni, -18.80, 16.97 ●
SMM8106, Etosha NP, Ombika Gate, -19.38, 15.88 ●
SMM2683, Hoasas, -20.38, 16.63 ●
SMM7084, Hoba 322, Grootfontein, -19.63, 17.88 ●
KM1752, Karibib, -21.97, 15.87 ●
TM11862, Nasib, Tsumeb, -19.13, 17.63 ●
TM10979, Ohopoho, -18.13, 13.88 ●
TM3991, Okahandja, -21.98, 16.92 ●
SMM6781, Okongava, -22.13, 15.88 ●
TM37636, Omaruru, 48 km NE, -21.30, 16.45 ●
SMM6764, Ombalantu, -17.38, 14.88 ●
LACM058983, Opuwo, 70 km NW, -17.47, 13.03 ●
SMM6776, Otjikoko, -21.38, 16.38 ●
MNKB50073, Otjimbingwe, -22.38, 16.13 ●
MNKB3295, Otjimbingwe, -22.38, 16.13 ●
KM28206, Otjiwarongo, -20.46, 16.31 ●
SMM6816, Uis, -21.13, 14.88 ●
MG4009, Uris, -19.27, 17.52 ●
SMM4280, Waterberg, 416, -20.63, 17.38 ●
SOUTH AFRICA
TM39968, Blyde River Canyon NR, -24.58, 30.78 ●
TM36611, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM25530, Kruger NP, Levuvhu R, -22.43, 31.18 ●
ZAMBIA
NMZB20120, Chipangali, Chipata, -13.12, 32.87 ●
?, Chisela Dambo, Mporokoso, -8.38, 29.75 (Ansell 1978)
NMZB62107, Luangwa Valley, Lutembwe, -14.37, 30.37 ●
BM7.1.11.5, Luangwa Valley, Petauke, -14.05, 31.08 ●
NMZB64256, Mpomwa Hills, Chipata, -13.37, 32.37 ●
?, Mporokoso, -9.37, 30.12 (Ansell 1978)
ZIMBABWE
NMZB29682, Batoka Gorge, -17.94, 26.12 ●
DM5005, Bonda Mission, -18.25, 32.50 ●
NMZB60699, Buffalo Range, Chiredzi, -21.03, 31.53 ●
NMZB64784, Busi R, Manjolo, -18.12, 27.87 ●
NMZB58439, Chenahunga, Bumi R, -17.75, 28.25 ●
NMZB57422, Chete, Eastern Section, -17.37, 27.62 ●
NMZB60701, Chiredzi, Lone Star Ranch, -21.12, 31.87 ●
NMZB64785, Chizarira NP, Mchesu R, -17.75, 27.50 ●
NMZB58387, Gonarezhou NP, Chipinda Pools, -21.27, 31.90 ●
NMZB55659, Gonarezhou NP, Mabalauta, -21.93, 31.47 ●
NMZB57601, Hippo Valley, Kutanga Estates, -21.12, 31.87 ●
NMZB84380, Hoya River Camp, Muzarabani, -16.25, 31.25 ●
NMZB60670, Kandaha, -17.85, 25.75 ●
NMZB60671, Katombora Rapids, -17.88, 25.33 ●
NMZB60702, Lake Kariba, Gatshe Gatshe Bay, -16.87, 28.87 ●
NMZB30794, Matetsi SA, Westwood Lodge, -18.50, 25.75 ●
NMZB82440, Mavuradonha Wilderness Area, -16.25, 31.00 ●
NMZB60697, Mkota NR, -16.87, 32.87 ●
NMZB31135, Mutambaramwe Cave, -17.17, 29.19 ●
NMZB54161, Mutare, Asbestos Mine, -18.92, 32.62 ●
NMZB60703, No 2 Adit, Mutare, -18.75, 32.50 ●
NMZB84315, Nyadire River Camp, Pfungwe, -16.75, 32.25 ●
NMZB32595, Nyashato Dam, -17.12, 32.12 ●
NMZB60694, Penrose Farm, Mvurwi, -17.12, 30.87 ●
USNM00368605, Sabi-Lundi (= Save-Runde) R Confluence, -21.28, 32.38 ●
NMZB58385, Sandstone Fissure, -18.25, 28.50 ●
NMZB59660, Sengwa Wildlife Research Area, -18.17, 28.22 ●
TM34862, Sengwa Wildlife Research Area, -18.17, 28.22 ●
NMZB32964, Umkhondo Mine, -20.37, 32.12 ●
RMAC88011M28, Victoria Falls, -17.85, 25.75 ●

hildebrandtii

BOTSWANA
NMZB63466, Francistown, -21.15, 27.50 ●
DRC
RMAC23807, Baya Cave (Lubumbashi), -11.68, 27.48 ●
MHNG1046.1, Kaboyaboya, -9.93, 25.97 (Hayman *et al.* 1966)
RMCA22889, Kakanda, -10.78, 26.60 (Hayman *et al.* 1966)
RMCA22687, Kakontwe, -10.98, 26.63 (Hayman *et al.* 1966)
RMCA28318, Kalumbu cave, -10.85, 26.65 (Hayman *et al.* 1966)
RMCA27539, Kambove, -10.83, 26.65 (Hayman *et al.* 1966)
RMCA22062, Kando, -10.82, 26.12 (Hayman *et al.* 1966)
RMCA27292, Kiwakishi cave, -9.15, 27.07 (Hayman *et al.* 1966)
RMCA23810, Kyasala, -9.93, 25.97 (Hayman *et al.* 1966)
IRSN14447, Kyasala cave, -9.93, 25.97 (Hayman *et al.* 1966)
RMCA22662, Lubudi cave, -9.93, 25.97 (Hayman *et al.* 1966)
NMZ3396, Lufuko Stream, -7.67, 29.77 (Ansell 1974)
IRSN10851, Lusinga, -8.88, 27.25 (Hayman *et al.* 1966)
IRSN14432, Musosa, -9.00, 29.00 (Hayman *et al.* 1966)
RMCA27905, Pempere, -10.97, 26.78 (Hayman *et al.* 1966)
RMCA27531, Tantara, -11.03, 26.48 (Hayman *et al.* 1966)
IRSN14427, Tenke Mwela Panda, -10.50, 26.17 (Hayman *et al.* 1966)
MALAWI
BM95.8.18.1, Fort Johnston (= Mangochi), -14.48, 35.27 ●
DCHC?, Liwonde NP, -15.03, 35.25 (Happold *et al.* 1987)
NMZB62132, Mugesse, Misuku, -9.62, 33.62 ●
TM9165, Ncheu, -14.88, 34.63 ●
NMZ3231, Wilindi Forest, Misuku Hills, -9.70, 33.83 (Ansell 1974)
DCHC?, Zomba, -15.38, 35.32 (Happold *et al.* 1987)
MOZAMBIQUE
DM8579, Chinizuia Forest, -18.98, 35.05 ●
DM8580, Gorongosa, E of, -18.56, 34.87 ●
NMZB33577, Inhaminga, -18.40, 35.00 ●
USNM00365226, Mague (= Mphende), -15.82, 31.73
USNM00365208, Massamba, 16 km E, -16.13, 33.63
?, Massingir, W of, -23.88, 31.88 (Smithers & Lobão Tello 1976)
DM11485, Mount Inago, -15.13, 37.65 ●
TM14659, Muchena, -15.63, 33.88 ●
USNM00365227, Mungari, 5 km N, -17.15, 33.57
DM8577, Namapa, -13.49, 39.78 ●
DM8578, Niassa GR, Maputo Camp, -12.18, 37.55 ●
NMZB63469, Nyaboa Caves, -20.37, 33.62 ●
?, Pafuri, -22.38, 31.38 (Smithers & Lobão Tello 1976)
USNM00365207, Tete, 3 km E, -16.27, 33.60
USNM00365213, Vila Gamito, 10 km N, -14.08, 33.02
?, Vilanculos, N of, -21.63, 35.13 (Smithers & Lobão Tello 1976)
NMZB62123, Zinave NP, -21.37, 33.87 ●
NMZB62125, Zinave NP, 3 km SSW, -21.39, 33.89 ●
NMZB62124, Zinave NP, 3 km SSW, -21.39, 33.89 ●
SOUTH AFRICA
TM39967, Blyde River Canyon NR, -24.58, 30.78 ●
TM9983, Dongola Kop, Soutpansberg, -22.23, 29.68 ●
TM1748, Fairfield, Rustenburg, -24.58, 27.20 ●
TM31276, Klipfontein, Waterberg, -24.13, 28.30 ●
TM36475, Kruger NP, Levuvhu R, -22.43, 31.18 ●
TM29835, Kruger NP, Pafuri, -22.45, 31.30 ●
TM20339, Messina, 75 km W, -22.20, 29.38 ●
DM7886, Mountainland NR, -25.72, 31.27 ●
TM35447, Nwanedi, Messina, -22.63, 30.63 ●
TM45092, Rooiberg, -24.77, 27.73 ●
TM12617, Sandspruit, Thabazimbi, -24.62, 27.67 ●
TM45223, Shashe-Limpopo R Confluence, -22.22, 29.37 ●
TM41901, Sudwala Caves, -25.37, 30.70 ●
USNM00468402, Thabazimbi, 20 km SE, -24.67, 27.37
TM20428, The Downs, -24.13, 30.18 ●
ZAMBIA
NMZB62148, Bwana Mkubwa, -13.03, 28.68 ●
BM75.2137, Chilanga, -15.55, 28.27 ●
NMZB10422, Chingola, -12.37, 27.62 ●
BM68.998, Chipongwe Cave, -15.63, 28.23 ●
BM22.12.17.4, Chiromo, -16.53, 35.15 ●
KM9629, Fort Jameson (= Chipata), -13.62, 32.65 ●
NMZB9040, Kabompo Boma, -13.58, 24.20 ●
BM59.354, Kafue Gorge, -15.77, 28.35 ●
?, Lake Tanganyika, -8.62, 30.62 (Ansell 1978)
UZMZ?, Leopard's Hill Cave, -15.55, 28.72 (Ansell 1969)
NMZB62149, Luangwa Valley, -13.37, 31.62 ●
?, Luangwa Valley, -12.75, 32.08 (Ansell 1978)
KM9630, Lundazi, -12.30, 33.20 ●
KM9628, Lusaka, Mkwisi, -15.38, 28.35 ●
TM13534, Mazabuka, -15.83, 27.73 ●
BM10.8.17.2, Mpika, -11.85, 31.45 ●
KM9631, Mporokoso, -9.37, 30.12 ●
NMZB6950, Mumbwa Caves, -14.75, 27.00 ●
UZMZ?, Naleza, -15.45, 27.33 (Ansell 1969)
UZMZ?, Ngoma aerodrome, -15.97, 25.93 (Ansell 1969)
ZIMBABWE
NMZB58177, Alfalfa Ranch Lonely Mine, -19.37, 28.87 ●
NMZB33875, Barberton Ranch, -21.33, 29.62 ●
TM8576, Birchenough Bridge, -19.85, 32.33 ●
NMZB57560, Buffalo Range, Chiredzi, -21.03, 31.53 ●
NMZB8994, Bulawayo, Industrial Sites, -20.13, 28.58 ●
NMZB32263, Bushtick Mine, Esigodini, -20.22, 28.92 ●
NMZB64787, Busi R, Manjolo, -18.12, 27.87 ●
NMZB57432, Chete, Chifumbi Spring, -17.37, 27.62 ●
NMZB57433, Chete, Eastern Section, -17.37, 27.62 ●
NMZB57550, Chilo Cave, Lone Star Ranch, -21.12, 31.87 ●
NMZB57523, Chimanimani, Corner, -19.50, 32.75 ●
NMZB32537, Chinanga Dam, Maramba, -17.12, 32.87 ●

NMZB58248, Chinhoyi Caves, -17.37, 30.08 ●
NMZB57535, Chipingayi Bridge, Save Valley, -20.12, 32.37 ●
NMZB57518, Chiredzi, Lone Star Ranch, -21.12, 31.87 ●
NMZB33006, Chishakwe Camp, 2 km E, -20.00, 32.00 ●
NMZB30077, Chivi, -20.30, 30.52 ●
NMZB84323, Chori Dam, Tokwa Ngarwe, -16.75, 32.50 ●
NMZB57547, Cleveden Farm, Mangwe, -20.87, 28.12 ●
NMZB30556, Dibutibu R, Batoka, -17.94, 26.12 ●
NMZB57521, Eirene Farm, Marondera, -18.37, 31.62 ●
NMZB80243, Esigodini, -20.30, 28.93 ●
NMZB56336, Esigodini, Falcon College, -20.22, 28.92 ●
NMZB80150, Esigodini, Willow Park, -20.28, 28.83 ●
NMZB68255, Forest Hill, Lupane, -19.08, 27.83 ●
NMZB2781, Gowlay Block Lonely Mine, -19.62, 28.62 ●
NMZB57562, Great Zimbabwe, -20.28, 30.93 ●
NMZB57531, Great Zimbabwe, -20.28, 30.93 ●
SAM ZM3004, Harare, -17.83, 31.07 ●
NMZB57603, Harare, Atlantica Research Station, -17.75, 31.00 ●
NMZB58442, Harare, Borrowdale, -17.83, 31.07 ●
NMZB57528, Harare, Christon Bank, -17.83, 31.07 ●
NMZB57604, Harare, Thompark, -17.62, 31.12 ●
NMZB63163, Homestead Mine, Esigodini, -20.30, 28.93 ●
NMZB32314, Hope Fountain Mission, -20.62, 28.62 ●
NMZB57559, Hwange NP, Main Camp, -18.73, 26.95 ●
NMZB57540, Hwange NP, Ngamo Pan, -19.13, 27.47 ●
NMZB57558, Hwange NP, Ngamo Pan, -19.13, 27.47 ●
NMZB57541, Hwange NP, Shumba Pan, -18.80, 26.33 ●
NMZB57571, Ingezi River, -20.37, 29.87 ●
NMZB12690, Ingwe Mine, 22 km W of Filabusi, -20.62, 29.37 ●
NMZB58247, Inyati Farm, -17.00, 30.00 ●
NMZB57580, Karoi, -16.82, 29.68 ●
NMZB60684, Katombora Rapids, -17.88, 25.33 ●
NMZB58076, Lake McIlwaine, -17.90, 30.78 ●
NMZB58282, Lake McIlwaine, -17.90, 30.78 ●
NMZB57546, Lannerhurst Mine, West Nicolson, -21.12, 29.37 ●
NMZB33644, Lutope-Ngolangola R Confluence, -18.28, 28.08 ●
NMZB31715, Mabura 1 Cave, Ngondoma R, -18.37, 29.37 ●
NMZB30280, Mabura 2 Cave, Munyati R, -18.12, 29.37 ●
NMZB29802, Majorca Ranch, Kwekwe, -18.87, 29.62 ●
TM45053, Mana Pools NP, Mondo R, -16.25, 29.58 ●
NMZB58258, Mana Pools NP, Nyamepi, -15.80, 29.87 ●
NMZB25834, Manyambara, -17.00, 29.50 ●
NMZB62147, Marondera, -18.12, 31.62 ●
NMZB60449, Matobo Hills, -20.62, 28.62 ●
NMZB62009, Matobo Hills, -20.37, 28.37 ●
NMZB31429, Matobo Hills, Lumane Valley, -20.58, 28.83 ●
NMZB30084, Matobo Hills, Mtshavezi Valley, -20.62, 28.87 ●
NMZB30078, Matobo Hills, Shambanyama R, -20.67, 28.37 ●
NMZB59389, Matobo NP, Lower Outspan, -20.62, 28.62 ●
NMZB57517, Matobo NP, Whitewaters Dam, -20.58, 28.47 ●
NMZB81511, Matobo Research Station, -20.25, 28.75 ●
NMZB57602, Matusadona NP, Tashinga, -16.87, 28.37 ●
BM4.12.1.2, Mazoe, -17.38, 30.88 ●
NMZB32284, Mbalabala, -20.25, 29.00 ●
NMZB80244, Mbalabala, -20.25, 29.00 ●
NMZB58276, Mushandike NP, -20.13, 30.63 ●
NMZB57587, Mutare, -18.90, 32.62 ●
NMZB57520, Mutare, 15 km W, -18.90, 32.62 ●
NMZB54219, Mutare, Asbestos Mine, -18.92, 32.62 ●
NMZB19886, Mutare, Bulldog Mine, -18.75, 32.50 ●
USNM00382644, Mutare, Old Mine, -19.08, 32.70 ●
NMZB57568, Netridge Farm, -20.12, 30.62 ●
NMZB58295, Netridge Farm, -20.12, 30.62 ●
NMZB57561, Norah Valley Bromley, -17.87, 31.37 ●
NMZB58246, Nyajena, -21.12, 31.62 ●
NMZB32538, Nyashato Dam, -17.12, 32.12 ●
NMZB57585, Odzi, -18.95, 32.38 ●
NMZB57584, Penhalonga, -18.87, 32.62 ●
NMZB25840, Penrose Farm, Mvurwi, -17.12, 30.87 ●
NMZB31843, Princess Farm, Shurugwi, -19.62, 29.92 ●
NMZB30503, Quagga Mine, Mutanda, -18.95, 32.38 ●
NMZB32357, Radio Mine, Mzinyatini, -20.37, 28.87 ●
NMZB57519, Ramofu Cave, Runde, -20.00, 30.00 ●
NMZB32297, Red Hill Mine, Mzingwane, -20.37, 28.87 ●
NMZB60774, Rifle Range, Kwekwe, -18.92, 29.80 ●
NMZB84344, Ruya R, -16.50, 31.75 ●
NMZB58074, Samalema Gorge, Mwenezi R, -21.87, 31.37 ●
DM18, Selukwe, -19.67, 30.00 ●
NMZB57588, Sengereri Hills, -17.62, 31.12 ●
TM34846, Sengwa Wildlife Research Area, -18.17, 28.22 ●
NMZB30031, Sengwa Wildlife Research Area, -18.17, 28.22 ●
NMZB9908, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
TM41439, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB31817, Shurugwi, 2 km E, -19.62, 30.12 ●
NMZB58242, Viro Hill, Kachuta Mhangura, -16.37, 30.62 ●
NMZB57513, West Nicholson, 5 km W, -21.07, 29.37 ●
NMZB57522, West Nicholson, 5 km W, -21.07, 29.37 ●
NMZB31132, Zvarayi Cave, -17.16, 29.43 ●

landeri

ANGOLA
FMNM81638, Camabatela, 30 km W, -8.38, 15.13 (Crawford-Cabral 1986)
?, Hanha, -13.63, 14.38 (Crawford-Cabral 1986)
FMNM81615, Luhanda, -9.38, 17.13 (Crawford-Cabral 1986)
DRC
RMCA20746, Banana, -5.97, 12.45 (Hayman *et al.* 1966)
BM?, Banana-Boma road, -5.78, 12.52 (Hayman *et al.* 1966)
IRSN14505, Gandajika, -6.77, 23.97 (Hayman *et al.* 1966)
RMCA26722, Jadotville (= Likasi), -10.97, 26.78 (Hayman *et al.* 1966)
RMCA18149, Kabinda, -6.13, 24.50 (Hayman *et al.* 1966)
RMCA22380, Kakanda, -10.78, 26.60 (Hayman *et al.* 1966)
RMCA22650, Kakontwe, -10.98, 26.63 (Hayman *et al.* 1966)
RMCA28319, Kalumbu cave, -10.85, 26.65 (Hayman *et al.* 1966)
RMCA27540, Kambove, -10.83, 26.65 (Hayman *et al.* 1966)
RMCA22370, Kaniama, -7.47, 24.22 (Hayman *et al.* 1966)
RMCA?, Kasongo, -4.52, 26.58 (Hayman *et al.* 1966)
RMCA22127, Kikango, -6.62, 29.50 (Hayman *et al.* 1966)
RMCA23913, Kyasala cave, -9.93, 25.97 (Hayman *et al.* 1966)
RMCA26793, Lubudi cave, -9.93, 25.47 (Hayman *et al.* 1966)
BM?, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)
RMCA26783, Mulonga, -7.85, 27.02 (Hayman *et al.* 1966)
IRSN14495, Mulungwishi, -10.78, 26.63 (Hayman *et al.* 1966)
RMCA22724, Mwanakusu cave, -4.58, 27.13 (Hayman *et al.* 1966)
IRSN10740, Pelenge, -8.67, 26.83 (Hayman *et al.* 1966)
RMCA28213, Pempéré, -10.97, 26.78 (Hayman *et al.* 1966)
RMCA26806, Tantara, -11.03, 26.48 (Hayman *et al.* 1966)
MALAWI
MMB?, Chiromo, -16.53, 35.15 (Happold *et al.* 1987)
TM9162, Ncheu, -14.88, 34.63 ●
KM11684, Nkhotakota, -12.93, 34.30 ●
MOZAMBIQUE
DM8574, Chinizuia Forest, -18.98, 35.05 ●
USNM00365180, Massamba, 16 km E, -16.13, 33.63
USNM00352034, Massangena, -21.56, 32.96
?, Massingir, W of, -23.88, 31.88 (Smithers & Lobão Tello 1976)
DM8575, Pemba, SW of, -13.01, 40.52 ●
USNM00365178, Tete, 3 km E, -16.27, 33.60
USNM00365197, Vila Gamito, 10 km N, -14.08, 33.02
NMZB62096, Zinave NP, -21.37, 33.87 ●
NMZB62106, Zinave NP, 3 km SSW, -21.39, 33.89 ●
NMZB62099, Zinave NP, 3 km SSW, -21.39, 33.89 ●
NMZB62097, Zinave NP, 9 km SSW, -21.43, 33.93 ●
SOUTH AFRICA
TM36866, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM30554, Kruger NP, Shirombe Pan, -22.72, 31.38 ●
ZAMBIA
?, Chavuma area, -13.08, 22.68 (Ansell 1978)
KM9648, Fort Jameson (= Chipata), -13.62, 32.65 ●
NMZB20309, Luangwa NP, Nsefu, -12.87, 31.87 ●
NMZB20080, Missale Old Mine, -14.12, 32.87 ●
?, Mwinilunga, -11.80, 24.40 (Ansell 1978)
BM68.125, South Luangwa Valley, Mfuwe, -13.08, 31.78 (Ansell 1969)
ZIMBABWE
TM34909, Chirisa Cave, -17.62, 28.37 ●
NMZB59661, Chirisa Cave, -17.62, 28.37 ●
NMZB33382, Gonarezhou NP, Chipinda Pools, -21.27, 31.90 ●
NMZB62049, Kanyemba, -15.65, 30.33 ●
NMZB60739, Lake Kariba, -16.88, 28.38 ●
NMZB9564, Lake Kariba Game Camp, -17.00, 28.00 ●
NMZB60771, Lake Kariba, Mwenda, -17.12, 27.87 ●
NMZB58443, Lake Kyle NP, -20.17, 30.92 ●
NMZB31741, Mabura 2 Cave, Munyati R, -18.12, 29.37 ●
NMZB60740, MacDougall's Tunnel, Triangle, -21.12, 31.37 ●
NMZB60759, Mana Pools NP, Nyamepi, -15.80, 29.87 ●
NMZB81514, Matobo Research Station, -20.25, 28.75 ●
NMZB60719, Matusadona NP, Tashinga, -16.87, 28.37 ●
NMZB58431, Mushandike NP, -20.13, 30.63 ●
NMZB60718, Mutare, Asbestos Mine, -18.92, 32.62 ●
NMZB56219, Nyamunyeche, Mvurwi, -16.77, 30.95 ●
ROM87398, Sengwa Wildlife Research Area, -18.17, 28.22 ●
NMZB60765, Triangle, -21.12, 31.37 ●

maendeleo

MOZAMBIQUE
DM10839, Mount Namuli, Manho Forest, -15.40, 37.04 ●

sakejiensis

ZAMBIA
NMZB29153, Kamakanda, Ikelenge, -11.28, 24.35 ●

simulator

BOTSWANA
HZM15.5505, Livingstone’s cave, Molepolole, -24.25, 25.50 ●
MALAWI
DCHC?, Liwonde NP, -15.03, 35.25 (Happold *et al.* 1987)
BM14.6.13.2, Mulanje, -15.95, 35.48 ●
DCHC?, Zomba, -15.38, 35.32 (Happold *et al.* 1987)
MOZAMBIQUE
USNM00365193, Massamba, 16 km E, -16.13, 33.63
TM14653, Muchena, -15.63, 33.88 ●
DM8555, Niassa GR, -12.87, 37.69 ●
NMZB64257, Nyaboa Caves, -20.37, 33.62 ●
USNM00365198, Vila de Manica (= Manica), 10 km N, -18.83, 32.95
?, Zinave NP, -21.37, 33.87 (Smithers & Lobão Tello 1976)
SOUTH AFRICA
TM1983, Cinnabar, Barberton, -25.82, 31.02 ●
TM20478, Derdepoort, 18 km SE, -24.75, 26.40 ●
TM10024, Dongola Kop, Soutpansberg, -22.23, 29.68 ●
DM7836, Dumisa Gold Mine, Umzinto, -30.27, 30.35 ●
TM30123, Dumisa Gold Mine, Umzinto, -30.27, 30.35 ●
TM25854, Entabeni State Forest, -23.01, 30.26 ●
DM5078, Esperanza Tunnel, Umkomaas, -30.45, 30.64 ●
TM25459, Eston, -29.88, 30.38 ●
TM39775, Figaro Mine, 11 km NE of Malelane, -25.45, 31.63 ●
DM6890, Greater St. Lucia Wetlands Park, Mission Rocks, -28.28, 32.49 ●
TM1045, Hectorspruit, -25.43, 31.68 ●
DM3940, Hlabeni Forest, -29.95, 29.73 ●
TM44397, Hluhluwe-Imfolozi Park, Egodeni, -28.07, 32.03 ●
TM12581, Howell Davies Cave, Zebedelia, -24.38, 29.38 ●
TM27503, Howell Davies Cave, Zebediela, -24.38, 29.38 ●
DM6183, Jozini Dam Tunnel, -27.42, 32.07 ●
TM47620, Kaalrug, -25.62, 31.54 ●
TM8917, Kilgobin, Dargle, -29.47, 30.10 ●
TM1020, Klein Letaba, Zoutpansberg, -23.13, 30.32 ●
TM47102, Klipfontein, -25.49, 29.44 ●
TM38852, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM36476, Kruger NP, Levuvhu R, -22.43, 31.18 ●
TM34330, Lind Valley Game Ranch, -30.72, 30.27 ●
TM19834, Loskopdam NR, -25.42, 29.33 ●
TM2471, Louws Creek, Barberton, -25.65, 31.30 ●
TM47012, Machadodorp, -25.88, 30.30 ●
TM44489, Messina, 98 km E, -22.30, 30.87 ●
TM47621, Mpumalanga, -25.48, 31.61 ●
TM34658, Mutare, Old Mine, -19.08, 32.70 ●
KM23676, Nkandla, -28.67, 30.98 ●
KM23714, Nongoma, -28.20, 31.75 ●
TM24253, Phalaborwa, 13 km S, -24.05, 31.10 ●
TM25538, Phalaborwa, 40 km N, -23.72, 31.08 ●
DM6330, Phinda GR, -27.86, 32.27 ●
TM13735, Pietermaritzburg, Bishopstowe, -29.60, 30.55 ●
TM36207, Pietermaritzburg, Doornhoek Mine, -29.60, 30.55 ●
KM23706, Pietermaritzburg, E of, -29.60, 30.52 ●
TM23392, Potgietersrus (= Mokopane), 25 km ESE, -24.25, 29.13 ●
FMNH106025, Pretoria, -25.72, 28.18 ●
TM3937, Pretoria, Wonderboom, -25.63, 28.13 ●
TM45226, Pretoria, Zwartkop Cave, -25.85, 28.17 ●
DM594, Rustenburg, -25.67, 27.23 ●
DM4739, Sezela Tunnel, -30.42, 30.58 ●
DM3562, Shongweni Dam, -29.85, 30.72 ●
DM5746, Silverglen NR, -29.93, 30.88 ●
TM13447, Skurweberg Cave, Pretoria, -25.80, 27.98 ●
TM46647, Sudwala Caves, -25.37, 30.70 ●
TM45214, Thabazimbi, 24 km SW, -24.69, 27.21 ●
TM1648, Thabazimbi, Mooimijsiesfontein, -25.02, 27.62 ●
TM20157, Uitkyk NR, -25.60, 31.12 ●
DM5442, Vernon Crookes NR, -30.27, 30.60 ●
SWAZILAND
DM8435, Hlane NP, Sundwini, -26.25, 31.94 ●
TM1979, Horo, -25.77, 31.42 ●
DM7898, Kubuta, -26.88, 31.47 ●
DM7189, Malkerns, -26.57, 31.15 ●
DM5824, Mlawula NR, -26.19, 32.01 ●
TM1981, Wylesdale, -25.82, 31.29 ●
ZAMBIA
BM68.1001, Chipongwe Cave, -15.63, 28.23 (Ansell 1969)
BM69.1247, Kafue NP, Ngoma, -15.88, 25.88 (Ansell 1973)
BM66.5445, Kaungashi Stream, -13.83, 26.78 (Ansell 1967)
NMZB10316, Lusaka, -15.42, 28.27 ●
?, Mwinilunga, -11.80, 24.40 (Ansell 1978)
NMZ3448, Ngwerere Cave, -15.30, 28.33 (Ansell 1986)
BM68.1000, Ngwerere Siding, -15.32, 28.32 (Ansell 1969)
ZIMBABWE
NMZB31136, Chinhoyi, Badze Cave, -17.17, 29.19 ●
NMZB31138, Chinhoyi, Bashungwe Cave, -17.12, 29.12 ●
NMZB28790, Chinhoyi, Orchard Cave, -17.37, 30.12 ●
NMZB57757, Gem Farm, Beitbridge, -21.87, 29.62 ●
NMZB32827, Gweru, E of, -19.37, 30.12 ●
NMZB62029, Harare, Triumph Mine, -17.87, 30.87 ●
NMZB62058, Lake McIlwaine, -17.90, 30.78 ●
NMZB30336, Mabura 1 Cave, Ngondoma R, -18.37, 29.37 ●
NMZB33430, Mabura 2 Cave, Munyati R, -18.12, 29.37 ●
BM2.2.7.10, Mazoe, -17.38, 30.88 ●
NMZB62072, Musemu Farm, Norton, -17.75, 30.75 ●
NMZB30521, Mutanda, -19.12, 32.12 ●
DM4623, Mutare, -19.08, 32.70 ●
NMZB62040, Mutare, -18.90, 32.62 ●
NMZB33881, Mutare, Asbestos Mine, -18.92, 32.62 ●
DM3686, Mutare, Old Mine, -19.08, 32.70 ●
NMZB30568, Muzvezve NR, -18.00, 29.25 ●
NMZB62034, Penhalonga, -18.87, 32.62 ●
NMZB62033, Penhalonga, -18.87, 32.62 ●
NMZB62032, Penhalonga, -18.87, 32.62 ●
NMZB31854, Princess Farm, Shurugwi, -19.62, 29.92 ●
NMZB60973, Rifle Range, Kwekwe, -18.92, 29.80 ●
NMZB30807, Sentinel Ranch, Tongani R, -22.12, 29.62 ●
NMZB31810, Shurugwi, 2 km E, -19.62, 30.12 ●
NMZB31137, Zvarayi Cave, -17.16, 29.43 ●

swinnyi

DRC
RMCA?, Banana, -5.97, 12.45 (Hayman *et al.* 1966)
RMCA?, Baudouinville (= Moba), -7.05, 29.70 (Hayman *et al.* 1966)
MHNG1047.59, Kaboyaboya, -9.93, 25.97 (Hayman *et al.* 1966)
MHNG1046.45, Kakontwe, -10.98, 26.63 (Hayman *et al.* 1966)
MHNG1046.5, Kando, -10.82, 26.12 (Hayman *et al.* 1966)
MHNG1047.63, Kasoma, -9.42, 26.62 (Hayman *et al.* 1966)
MHNG1047.58, Kyamakonde, -9.93, 25.97 (Hayman *et al.* 1966)
MHNG1046.59, Kyantapo, -9.93, 25.97 (Hayman *et al.* 1966)
MHNG922.86, Kyasala, -9.93, 25.97 (Hayman *et al.* 1966)
MHNG1046.53, Lubudi cave, -9.93, 25.47 (Hayman *et al.* 1966)
MHNG1046.6, Mulonga, -7.85, 27.02 (Hayman *et al.* 1966)
IRSN14476, Mulungwishi, -10.78, 26.63 (Hayman *et al.* 1966)
MHNG1046.44, Pempéré, -10.97, 26.78 (Hayman *et al.* 1966)
IRSN14472, Salomoni cave, -10.98, 27.28 (Hayman *et al.* 1966)
MHNG1046.63, Tantara, -11.03, 26.48 (Hayman *et al.* 1966)
MOZAMBIQUE
USNM00365179, Massamba, 16 km E, -16.13, 33.63
DM11482, Mount Inago, -15.13, 37.65 ●
USNM00365202, Vila de Manica (= Manica), 10 km N, -18.83, 32.95 ●
USNM00365196, Vila Gamito, 10 km N, -14.08, 33.02
SOUTH AFRICA
DM7080, Hlabeni Forest, -29.95, 29.73 ●
DM3275, Hluhluwe-Imfolozi Park, Egodeni, -28.07, 32.03 ●
DM7084, Insizwe Mine, -30.80, 29.28 ●
KM1760, King William’s Town, -32.87, 27.37 ●
USNM00344268, King William’s Town, 18 km NW, -32.72, 27.28
TM36583, King William’s Town, 18 km NW, -32.72, 27.28 ●
TM36937, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM34210, Kruger NP, Levuvhu R, -22.43, 31.18 ●
TM36848, Ngome Forest, -27.83, 31.42 ●
TM1021, Ngqueleni District, -31.67, 29.03
TM47732, Pilgrim’s Rest, -24.98, 30.74 ●
TM47730, Pilgrim’s Rest, NE of, -24.89, 30.81 ●
SAM ZM12953A, Pirie Mission, -32.82, 27.23 ●
NMZB60555, Port St. Johns, -31.63, 29.55 ●
TM1023, Port St. Johns, -31.63, 29.55 ●
DM5456, Umtamvuna Gorge NR, -31.06, 30.17 ●
KM24299, Zwelitsha, -32.72, 27.29 ●
ZAMBIA
BM68.600, Chipongwe Cave, -15.63, 28.23 (Ansell 1969)
NMZB20079, Missale Old Mine, -14.12, 32.87 ●
NMZ3440, Ngwerere Cave, -15.30, 28.33 (Ansell 1986)
BM68.1396, Ngwerere Siding, -15.32, 28.32 (Ansell 1969)
ZIMBABWE
USNM00368608, Chinhoyi, Baruka Cave, -17.37, 30.08 ●
NMZB60556, Chinhoyi, Orchard Cave, -17.37, 30.12 ●
NMZB60730, Chiredzi, Lone Star Ranch, -21.12, 31.87 ●
NMZB64814, Chirisa Cave, -17.62, 28.37 ●
NMZB60557, Dichwe Forest, Chinoyi, -17.00, 30.18 ●
NMZB60562, Frog Mine, Mupfure R, -17.87, 29.87 ●
ROM64951, Great Zimbabwe, -20.28, 30.93 ●
NMZB58701, Hwange NP, Main Camp, -18.73, 26.95 ●
ROM65001, Masvingo, 30 km SE, -20.13, 31.13 ●
NMZB62090, Matusadona NP, Tashinga, -16.87, 28.37 ●
NMZB29665, Mberengwa Mountain, -20.62, 29.92 ●
HZM11.5485, Mutare, -18.90, 32.62 ●
NMZB60558, Mutare, -18.90, 32.50 ●
NMZB57223, Nyamunyeche, Mvurwi, -16.77, 30.95 ●
HZM12.7195, Sengwa Wildlife Research Area, -18.17, 28.22 ●

NMZB64811, Sengwa Wildlife Research Area, -18.17, 28.22 ●
NMZB30091, Tingwa R, Mavuradonha, -16.62, 30.87 ●
NMZB62091, Viro Hill, Kachuta Mhangura, -16.37, 30.62 ●

VESPERTILIONIDAE

Cistugo

lesueuri

LESOTHO
NMB7036, Lepaqoa, Pelaneng, -29.13, 28.38 ●
NMB8158, Mahlanapeng, Thaba-Tseka, -29.63, 28.63 ●
NMB7268, Marakabei, -29.62, 28.12 ●
NMB6887, Matelanong, -29.38, 29.13 ●
NMB8483, Moqotoane, Thaba-Tseka, -29.63, 28.88 ●
NMB8289, Pallang, -29.88, 27.88 ●
KM24805, Sehlabathebe NP, -29.87, 29.08 ●
NMB6696, Sehlabathebe NP, -29.87, 29.08 ●
SOUTH AFRICA
MMK2496, Algeria Forest Research Station, -32.40, 19.13 ●
TM35121, Algeria Forest Research Station, -32.40, 19.13 ●
NMB7847, Arrarat, Sterkfontein Dam, -28.38, 28.88 ●
KM2031, Bedford, SE, -32.88, 26.24 ●
DM88, Clarens, near, -28.52, 28.42 ●
NMB7902, Golden Gate, -28.38, 28.63 ●
DM7504, Kamberg Valley, -29.75, 29.36 ●
NMB? (JW142), Karoo NP, -32.33, 22.55 ●
TM29511, Karoo NP, -32.33, 22.55 ●
TM29310, Saasveld Forest, -33.97, 22.52 ●
NMB7700, Waterval, Warden, -27.88, 29.13 ●

seabrae

ANGOLA
BM1906.1.3.3, Mossamedes (= Namibe), -15.13, 12.13 (Crawford-Cabral 1986)
NAMIBIA
TM37541, Aus, 3 km W, -26.65, 16.22 ●
SMM11197, Aus, 3 km W, -26.65, 16.22 ●
SMM4392, Gorraris 99, Maltahohe, -24.88, 16.38 ●
TM37587, Maltahohe, 70 km W, -24.90, 16.28 ●
SMM11263, Maltahohe, Zwartmodder 101, -24.88, 16.38 ●
SMM10538, Namib-Naukluft NP, De Valle, -24.13, 16.13 ●
LACM059088, Orumpembe, -18.18, 12.52 ●
SMM9757, Skeleton Coast NP, -20.88, 13.63 ●
TM31277, Skeleton Coast NP, -20.88, 13.63 ●
SOUTH AFRICA
MMK7051, Augrabies Falls NP, -28.60, 20.33 ●
KM1889, Goodhouse, -28.90, 18.25 ●
TM47581, Khamkirri, -28.65, 20.43 ●
USNM00342632, Springbok, 10 km, -29.67, 17.87

Eptesicus

hottentotus

ANGOLA
IICA727, Capolopopo, -15.88, 12.88 ●
LESOTHO
NMB8342, Kofa, Qacha's Nek, -30.13, 28.38 ●
NMB8176, Mount Moorosi, Quithing, -30.18, 27.87 ●
MALAWI
BM22.12.17.39, Chiromo, -16.53, 35.15 ●
BM92.8.1.8, Mulanje, -15.95, 35.48 ●
BM92.8.1.9, Zomba, -15.38, 35.32 ●
MOZAMBIQUE
USNM00365430, Chiutu, -15.57, 33.28 (Smithers & Lobão Tello 1976)
NAMIBIA
SMM11154, Aus, 3 km W, -26.65, 16.22 ●
TM37539, Aus, 3 km W, -26.65, 16.22 ●
TM32695, Bethanie, -27.38, 17.38 ●
NMZB64056, Gobabeb, Namib Desert, -23.55, 15.05 ●
USNM00342153, Gobabeb, Namib Desert, -23.55, 15.05
TM27418, Kanaan, -25.87, 16.12 ●
TM32565, Keetmanshoop, 35 km SSW, -26.95, 17.93 ●
TM37588, Maltahohe, 70 km W, -24.90, 16.28 ●
SMM10544, Namib-Naukluft NP, De Valle, -24.13, 16.13 ●
LACM056268, Omaruru, 10 km SE, -21.44, 15.61 ●
LACM052698, Omaruru, 30 km NW, -20.97, 15.30 ●
TM9480, Ombu, Eronga Mountain, -21.67, 15.73 ●
SOUTH AFRICA
TM38411, Algeria Forest Research Station, -32.37, 19.05 ●
NMB7840, Arrarat, Sterkfontein Dam, -28.38, 28.88 ●
TM46916, Buffelskloof NR, -25.31, 30.50 ●
KM1985, Clanwilliam, -32.47, 18.98 ●
DM1887, Garden Castle NR, -29.75, 29.22 ●
TM31756, Itala NR, -27.52, 31.37 ●
TM40017, Krantzkloof NR, -29.77, 30.83 ●
TM34239, Kruger NP, Pafuri, -22.45, 31.30 ●
TM36780, Kruger NP, Punda Milia, 16 km NE, -22.68, 31.03 ●
MMK2497, Kuruman, -27.45, 23.42 ●
TM46877, Makapans Cave, -24.15, 29.18 ●
MMK2432, Marydale, 31 km NE, -29.18, 22.30 ●
KM1986, Namaqualand, -32.90, 18.23 ●
KM26035, Piquetburg, -32.77, 18.72 ●
TM41421, Shashe-Limpopo R Confluence, -22.22, 29.37 ●
SAM ZM37065, Table Mountain, -34.00, 18.38 ●
ZAMBIA
KM9661, Abercorn (= Mbala), -8.85, 31.38 ●
NMZB20242, Lundazi, -12.30, 33.20 ●
ZIMBABWE
NMZB58956, Banti, -19.25, 32.75 ●
NMZB57442, Chizarira NP, Mucheni Gorge, -17.50, 27.75 ●
NMZB80194, Crowborough Sewage Works, Harare, -17.87, 30.90 ●
NMZB58196, Esigodini, Falcon College, -20.22, 28.92 ●
NMZB58962, Harare, Thornpark, -17.62, 31.12 ●
NMZB58958, Marondera, -18.12, 31.62 ●
NMZB58959, Marondera, Peterhouse School, -18.18, 31.62 ●
NMZB30022, Matobo Hills, Lumane Valley, -20.58, 28.83 ●
NMZB32580, Nyadiri R, -17.12, 32.12 ●
NMZB56217, Nyamunyeche, Mvurwi, -16.77, 30.95 ●
NMZB32579, Nyashato Dam, -17.12, 32.12 ●
NMZB32279, Vumba, -19.12, 32.87 ●

Glauconycteris

argentata

ANGOLA
?, Dundo, -7.38, 20.88 (Crawford-Cabral 1986)
DRC
RMCA20751, Banana, -5.97, 12.45 (Hayman *et al.* 1966)
RMCA22723, Boma, -5.83, 13.05 (Hayman *et al.* 1966)
RMCA12060, Inkongo, -4.92, 23.25 (Hayman *et al.* 1966)
RMCA7570, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)
RMCA16213, Mukishi, -5.65, 21.05 (Hayman *et al.* 1966)
?, Netonna, -5.97, 12.45 (Hayman *et al.* 1966)
MALAWI
NMZB60645, Mugesse, Misuku, -9.62, 33.62 ●

beatrix

ANGOLA
FMNH81686, Camabatela, 30 km W, -8.38, 15.13 (Eger & Schlitter 2001)
DRC
RMCA97.021-M-0810, Kimbinga, -5.13, 19.05

variegata

ANGOLA
?, Dundo, -7.38, 20.88 (Crawford-Cabral 1986)
?, Lago Calundo, -11.72, 20.80 (Crawford-Cabral 1986)
?, Omupanda, -17.13, 15.88 (Crawford-Cabral 1986)
BOTSWANA
NMZB59225, Kurunxaraga, Okavango, -19.67, 22.83 ●
NMZB64053, Shakawe, 70 km SW, -18.55, 21.03 ●
USNM00518696, Xugana, -19.08, 23.10 (Archer 1975)
DRC
RMCA6566, Boma, -5.83, 13.05 (Hayman *et al.* 1966)
RMCA12662, Elisabethville (= Lubumbashi), -11.68, 27.48 (Hayman *et al.* 1966)
RMCA?, Funda Biabo, -9.83, 25.53 (Schouteden 1947)
RMCA16489, Moanda, -5.92, 12.40 (Hayman *et al.* 1966)
IPNC14517, Mpala, -10.48, 25.22 (Hayman *et al.* 1966)
MALAWI
?, Chiromo, -16.53, 35.15 (Happold *et al.* 1987)
BM?, Luchenza, -16.00, 35.30 (Happold *et al.* 1987)
MOZAMBIQUE
?, Beira, -19.84, 34.88 (Smithers & Lobão Tello 1976)
USNM00304844, Coguno, -24.55, 34.38
?, Inhambane, -23.90, 35.40 (Smithers & Lobão Tello 1976)
?, Maputo, W of, -25.88, 32.63 (Smithers & Lobão Tello 1976)
DM9374, Save R, -21.18, 34.75 ●
NAMIBIA
KM1946, Rundu, SE of, -18.10, 20.38 ●
SMM8162, Xnmakora, -18.38, 19.38 ●
SOUTH AFRICA
TM40416, Dukuduku Forest Station, -28.30, 32.22 ●
DM6861, Durban, -29.85, 31.00 ●
DM1023, Futululu, -28.42, 32.27 ●
KM25971, Hlabisa, -28.18, 31.95 ●
DM7037, Kosi Bay NR, -26.96, 32.83 ●
TM29899, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM6075, Manaba, -27.38, 32.38 ●
TM40164, St. Lucia Village, -28.38, 32.42 ●
ZAMBIA
NMZB20039, Fort Jameson (= Chipata), -13.62, 32.65 ●
NMZB64054, Kafue R, -13.40, 27.82 ●

?, Lochinvar NP, -15.88, 27.38 (Ansell 1974)
BM?, Lukanga Swamp, -14.38, 27.38 (Ansell 1957)
UZMZ?, Naleza, -15.45, 27.33 (Ansell 1969)
NMZB20322, Pirwa Pan, -13.87, 27.87 ●
NMZB22806, Pwira Pan, -13.87, 27.87 ●
NMZB32055, Volunteer Farm, Main Camp, -18.82, 27.63 ●
NMZ2630, Zimba, 19 km away, -17.13, 26.38 (Ansell 1973)
ZIMBABWE
NMZB60518, Chikwarakwara, -22.35, 31.10 ●
NMZB60517, Hwange NP, Main Camp, -18.73, 26.95 ●
TM45076, Kanyati Communal Land, -16.90, 28.88 ●
NMZB59227, Lake McIlwaine, -17.90, 30.78 ●
NMZB60522, Save-Lunde R Confluence, Marhumbini, -21.28, 32.38 ●
NMZB30064, Sengwa Wildlife Research Area, -18.17, 28.22 ●

Hypsugo

anchietae

ANGOLA
BM1906.1.3.1, Cahata, -12.38, 14.88 (Crawford-Cabral 1986)
BOTSWANA
NMZB54217, Four Rivers Camp, Okavango, -19.12, 23.12 ●
MOZAMBIQUE
NMZB83998, Marromeu, Coutada 1, -18.25, 35.75 ●
SOUTH AFRICA
DM5358, Emphisini NR, -30.21, 30.79 ●
DM2269, Greater St. Lucia Wetlands Park, False Bay, -27.97, 32.37 ●
DM5353, Harold Johnson NR, -29.21, 31.42 ●
DM5362, Hella Hella GR, -29.90, 30.08 ●
TM39768, Kruger NP, Skukuza, -24.98, 31.58 ●
DM8787, Phinda GR, Forest Lodge, -27.78, 32.34 ●
DM6885, Sobhengu Lodge, Nibela, -28.28, 32.42 ●
DM8500, Tembe Elephant Reserve, Muzi R, -26.97, 32.52 ●
SWAZILAND
TM47718, Hlane NP, Sundwini, -26.25, 31.94 ●
DM8508, Mbuluzi GR, -26.20, 31.98 ●
DM8422, Mlawula NR, -26.19, 32.01 ●
ZAMBIA
HZM1.11405, Balovale (= Zambezi), -13.55, 23.12 ●
NMZB9163, Chavuma area, -13.08, 22.68 ●
NMZB11703, Chilanga, -15.55, 28.27 ●
NMZB29855, Hillwood Farm, Ikelenge, -11.23, 24.30 ●
HZM4.2933, Kabompo Boma, -13.58, 24.20 ●
NMZB10047, Kabompo Boma, -13.58, 24.20 ●
BM69.1248, Kafue NP, Ngoma, -15.88, 25.88 (Ansell 1973)
HZM2.11406, Mwombezhi R, -12.22, 25.57 ●
NMZB33254, Ndanda Dambo, Mongu, 70 km NE, -14.75, 23.75 ●
NMZB33145, Ndanda School, Mongu, 70 km NE, -14.75, 23.75 ●
NMZB33146, Senenga, 50 km NE, -15.62, 23.37 ●
NMZB20246, Wusikili Bridge, Kitwe, -12.75, 28.00 ●
ZIMBABWE
NMZB33634, Benzie's Bridge, Shangani R, -18.81, 27.90 ●
NMZB32492, Chinanga Dam, Maramba, -17.12, 32.87 ●
NMZB32956, Chishakwe Camp, 2 km E, -20.00, 32.00 ●
NMZB32954, Chishakwe Camp, 2 km E, -20.00, 32.00 ●
NMZB30076, Chivi, -20.30, 30.52 ●
NMZB31183, Dwala Ranch, Bubiana, -21.12, 29.62 ●
NMZB58735, Gonarezhou NP, Chipinda Pools, -21.27, 31.90 ●
NMZB55655, Gonarezhou NP, Mabalauta, -21.93, 31.47 ●
NMZB58731, Gonarezhou NP, Mabalauta, -21.93, 31.47 ●
NMZB58716, Harare, Thornpark, -17.62, 31.12 ●
NMZB58732, Hippo Valley, Kutanga Estates, -21.12, 31.87 ●
NMZB58752, Hwange NP, Dete area, -18.50, 26.75 ●
NMZB58751, Hwange NP, Makalowa Pan, -19.00, 27.25 ●
NMZB82881, Mavuradonha Wilderness Area, -16.25, 31.00 ●
NMZB58725, Musengezi R, -16.25, 30.75 ●
NMZB32524, Nyagui R, 2 km N of Chenjerai confluence, -17.37, 31.62 ●
NMZB84270, Nyandia Dam, -17.00, 32.00 ●
NMZB32617, Nyashato Dam, -17.12, 32.12 ●
NMZB58846, Razi Chibi, -20.50, 30.50 ●
NMZB58734, Section 81, Triangle, -21.00, 31.50 ●
NMZB30032, Sengwa Wildlife Research Area, -18.17, 28.22 ●
NMZB30869, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB30870, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB31965, Volunteer Farm, Main Camp, -18.82, 27.63 ●

Kerivoula

argentata

DRC
IRSN14470, Kamatanda, -10.93, 26.83 (Hayman *et al.* 1966)
IRSN?, Kilwezi, -9.10, 26.70 (Hayman *et al.* 1966)
BM27.12.21.14, Luluabourg (= Kananga), -5.88, 22.43 ●
MALAWI
TM9172, Ncheu, -14.88, 34.63 ●
MOCAMBIQUE
TM1099, Matiwe, -17.63, 36.88 ●
MOZAMBIQUE
?, Manica, -18.93, 32.88 (Smithers & Lobão Tello 1976)
TM47810, Maputo Special Reserve, -26.35, 32.93 ●
?, Mopeia, -17.90, 35.70 (Smithers & Lobão Tello 1976)
DM9375, Save R, -21.18, 34.75 ●
NMZB63280, Zinave NP, -21.37, 33.87 ●
NAMIBIA
?, Otjoro (= Otyolo?), -17.88, 17.63
SOUTH AFRICA
AMNH81889, Durban, 50 km s, -30.22, 30.80 ●
TM3025, Hluhluwe-Imfolozi Park, Imfolozi, -28.32, 31.83 ●
TM29839, Kruger NP, Pafuri, -22.45, 31.30 ●
TM7124, Msinyini Pan, -28.38, 31.88 ●
KM23802, Ngwavuma, -27.27, 32.73 ●
FMNH152687, Uvongo Beach, -30.80, 30.40 ●
ZAMBIA
HZM2.3517, Abercorn (= Mbala), -8.85, 31.38 ●
KM1949, Balovale (= Zambezi), -13.55, 23.12 ●
KM1950, Fort Jameson (= Chipata), -13.62, 32.65 ●
NMZB30890, Kalomo R, -16.87, 26.62 ●
NMZ3689, Mundwiji Plain, -11.73, 24.72 (Ansell 1974)
BM46.524, Mwinilunga, -11.80, 24.40 ●
BM20.11.3.26, Ndola, -12.97, 28.63 ●
ZIMBABWE
NMZB60524, Great Zimbabwe, -20.28, 30.93 ●
NMZB60533, Harare, Merrywaters, -17.83, 31.07 ●
NMZB60532, Kanyemba, -15.65, 30.33 ●
NMZB60534, Matusadona NP, Tashinga, -16.87, 28.37 ●
NMZB60535, Mutare, Boys High School, -18.90, 32.50 ●
A.N. McWilliam collection, Siabuwa, -17.13, 28.13 ●

lanosa

ANGOLA
MHNFCP, Cazengo, -9.38, 14.88 (L. Souza pers. comm.)
BOTSWANA
NMZB64204, Sepopa, -18.62, 22.12 ●
USNM00425367, Sepopa, -18.62, 22.12
USNM00479534, Shakawe, -18.35, 21.87
NMZB63282, Shakawe, 15 km S, -18.50, 21.75 ●
DRC
RMCA5383a, Funda Biabo, -9.83, 25.53 (Hayman *et al.* 1966)
RMCA12006, Lukulu, -7.13, 28.13 (Hayman *et al.* 1966)
MALAWI
BM22.12.17.87, Thyolo, -16.12, 35.08 (Ansell & Dowsett 1988)
MOZAMBIQUE
?, Manica, -18.93, 32.88 (Smithers & Lobão Tello 1976)
DM9370, Save R, -21.18, 34.75 ●
NAMIBIA
SMM14546, Lianshulu, -18.00, 23.25 (M. Griffin, pers. comm.)
SOUTH AFRICA
KM32617, Bedford, -32.65, 26.18 ●
TM41664, Blyde River Canyon NR, -24.58, 30.78 ●
DM4282, Durban, -29.85, 31.00 ●
TM7126, Ingwavuma Bush, -27.13, 32.03 ●
KM32615, King William's Town, -32.87, 27.37 ●
NMZB63283, King William's Town, -32.87, 27.37 ●
KM32618, Knysna, -34.03, 23.05
TM1098, Knysna, -34.03, 23.05 ●
TM40465, Kosi Bay NR, -26.96, 32.83 ●
TM36960, Kruger NP, Pafuri, -22.45, 31.30 ●
NM1033, Mkhuze GR, Msinga Pan, -27.60, 32.20
TM8864, Njellele River (= Nzhelele R), -22.92, 30.37 ●
SAM ZM12949A, Pirie Mission, -32.82, 27.23 ●
KM1948, Pirie Mission, -32.82, 27.23
HZM1.4736, Port Elisabeth, King's Beach, -33.88, 25.25 ●
SWAZILAND
DM8428, Hlane NP, Sundwini, -26.25, 31.94 ●
DM7428, Mhlume, -26.10, 31.87 ●
ZAMBIA
NMZB22819, Fort Jameson (= Chipata), -13.62, 32.65 ●
KM9655, Kasama, -10.22, 31.17 ●
?, Ndola, -12.97, 28.63 (Ansell 1978)
ZIMBABWE
NMZB29664, Mberengwa Mountain, -20.62, 29.92 ●

Laephotis

angolensis

ANGOLA
AMNH87244, Dande (= Dando), 35 km E, -11.17, 17.17 (Kearney & Seamark 2005)
MHNC (Holotype), Tshiumbe (= Tyihumbwe) R, -11.03, 20.07 (Kearney & Seamark 2005)
DRC
BM57.435, Lubumbashi, 68 km E, -11.12, 28.13 (Kearney & Seamark 2005)
RMCA?, Mumene, -11.07, 28.13 (Hayman *et al.* 1966)

RMCA?, Musonge, -11.07, 28.13 (Hayman *et al.* 1966)

botswanae

ANGOLA

FMHM84120, Huila, -15.13, 13.63 (Kearney & Seamark 2005)

BOTSWANA

NMZB59310, Kurunxaraga, Okavango, -19.67, 22.83 ●
USNM00425349, Shakawe, 70 km SW, -18.55, 21.03
USNM00518678, Xugana, -19.08, 23.10 ●

DRC

BM57.438, Lubumbashi, 68 km E, -11.12, 28.13 (Kearney & Seamark 2005)
RMCA26.402, Lubumbashi, 68 km E, -11.12, 28.13 (Kearney & Seamark 2005)
SMF16869, Lubumbashi, 68 km E, -11.12, 28.13 (Kearney & Seamark 2005)

MALAWI

TM44544, Likabula Mission, Mulanje, -15.95, 35.48 ●
DCHC2992, Namadzi, Kapalasa Farm, -15.52, 35.18 (Kearney & Seamark 2005)
DCHC3040, Namadzi, Kapina Estates, -15.52, 35.18 (Kearney & Seamark 2005)
DCHC2937, Nkhotakota GR, -13.07, 33.93 (Kearney & Seamark 2005)
DCHC2855, Thondwe, -15.45, 35.25 (Kearney & Seamark 2005)
DCHC2673, Viphya Plateau, -12.38, 33.70 (Kearney & Seamark 2005)
DCHC2269, Zomba, -15.38, 35.32 (Kearney & Seamark 2005)
DCHC3012, Zomba Plateau, -15.33, 35.32 (Kearney & Seamark 2005)

NAMIBIA

SMM10678, Dose Pan, Okavango, -18.13, 20.88 ●
SMM13611, San Michelle, -17.88, 23.38 ●

SOUTH AFRICA

DM5351, Hella Hella GR, -29.90, 30.08 ●
TM38123, Kruger NP, Punda Milia, 16 km NE, -22.68, 31.03 ●
TM39796, Lapalala Wilderness Area, -23.85, 28.15 ●

ZAMBIA

NMZB9111, Kabompo Boma, -13.58, 24.20 ●
NMZB33067, Ndanda School, Mongu, 70 km NE, -14.75, 23.75 ●
HZM1.2533, Ndola, -12.97, 28.63 (Kearney & Seamark 2005)
BM55.1134, Solwezi, -12.18, 26.42 (Kearney & Seamark 2005)

ZIMBABWE

NMZB58131, Bem Tree Ranch, Kwekwe, -18.92, 30.83 ●
FMNH152728, Hwange NP, -18.75, 26.75 (Kearney & Seamark 2005)
NMZB29992, Matobo Hills, Lumane Valley, -20.58, 28.83 ●
TM34964, Sengwa Wildlife Research Area, -18.17, 28.22 ●
NMZB63201, Sengwa Wildlife Research Area, -18.17, 28.22 ●

cf. wintoni

LESOTHO

NMB6686, Sehlabathebe NP, -29.87, 29.08 ●

SOUTH AFRICA

NMB6379, Bethlehem, S of, -28.62, 28.37 ●

namibensis

NAMIBIA

TM37547, Aus, 3 km W, -26.65, 16.22 ●
USNM00342152, Gobabeb, Namib Desert, -23.55, 15.05
TM37586, Maltahohe, 70 km W, -24.90, 16.28 ●
SMM11302, Maltahohe, Zwartmodder 101, -24.88, 16.38 ●
TM33472, Tiras Mountain, -26.77, 16.25 ●

SOUTH AFRICA

TM28316, Algeria Forest Research Station, -32.37, 19.05 ●

Mimetillus

moloneyi

DRC

IRSN284, Landana= lower Congo, -5.23, 12.13 (Hayman *et al.* 1966)
IRSN14519, Zambi, -5.85, 12.87 (Hayman *et al.* 1966)

thomasi

ANGOLA

?, Cahata, -12.38, 14.88 (Crawford-Cabral 1986)
AMNH?, Chitau, -11.38, 17.13 (Crawford-Cabral 1986)
?, Kuvangu Mission (= Cubango), -14.38, 16.38 (Crawford-Cabral 1986)

DRC

RMCA16496, Elisabethville (= Lubumbashi), -11.68, 27.48 ●
RMCA?, Moero (= Lake Mweru), -9.00, 28.67 (Schouteden 1947)

MOZAMBIQUE

NMZB63199, Zinave NP, 3 km SSW, -21.39, 33.89 ●

ZAMBIA

KM1939, Balovale (= Zambezi), -13.55, 23.12 ●
AMNH115851, Balovale (= Zambezi), -13.55, 23.12 ●
LACM69905, Luangwa Valley, -12.75, 32.08 ●
BM20.11.3.28, Ndola, -12.97, 28.63 ●
NMZB63522, Pwira Pan, -13.87, 27.87 ●

Myotis

bocagii

ANGOLA

FMNH?, Camabatela, 30 km W, -8.38, 15.13 (Crawford-Cabral 1986)
Museu Bocage, Duque de Braganca (= Calandula), -9.13, 15.88 (Crawford-Cabral 1986)
FMNH?, Luanda, -8.88, 13.38 (Crawford-Cabral 1986)

DRC

RMCA422, Albertville (= Kalemie), -5.95, 29.17 (Hayman *et al.* 1966)
RMCA2102, Boma, -5.83, 13.05 (Hayman *et al.* 1966)
RMCA3434, Congo da Lemba, -5.70, 13.67 (Hayman *et al.* 1966)
RMCA12150, Elisabethville (= Lubumbashi), -11.68, 27.48 (Hayman *et al.* 1966)
RMCA26242, Kakonde, -7.87, 29.72 (Hayman *et al.* 1966)
BM?, Kakontwe, -10.98, 26.63 (Hayman *et al.* 1966)
RMCA26216, Kiswishi, -12.85, 29.20 (Hayman *et al.* 1966)
?, Kitwit, -5.08, 18.91 (Van Cakenberghe *et al.* 1999)
AMNH?, Leopoldville (= Kinshasa), -4.30, 15.30 (Allen 1917)
RMCA9987, Leverville (= Lusanga), -4.83, 18.72 (Hayman *et al.* 1966)
RMCA11131, Lukafu, -10.47, 27.53 (Hayman *et al.* 1966)
IRSN10807, Lusinga, -8.88, 27.25 (Hayman *et al.* 1966)
BM?, Moba, -7.07, 29.75 (Hayman *et al.* 1966)
RMCA18173, Moero, lake, region, -9.00, 28.67 (Hayman *et al.* 1966)
RMCA5441a, Pweto, -8.47, 28.87 (Hayman *et al.* 1966)
RMCA284, Zambi, -5.85, 12.87 (Hayman *et al.* 1966)

MALAWI

MMB?, Matope, -15.35, 34.95 (Happold *et al.* 1987)
KM11670, Nkhotakota, -12.93, 34.30 ●
DCHC?, Thondwe, -15.45, 35.25 (Happold *et al.* 1987)

MOZAMBIQUE

DM8558, Meponda, Lake Niassa, -13.40, 34.87 ●
?, Vila Gouveia, -18.07, 33.18 (Smithers & Lobão Tello 1976)

SOUTH AFRICA

DM10026, Kranzkloof NR, Durban, -29.77, 30.83 ●
TM34242, Kruger NP, Levuvhu R, -22.43, 31.18 ●
TM29843, Kruger NP, Pafuri, -22.45, 31.30 ●
TM30064, Kruger NP, Skukuza, -24.98, 31.58 ●
DM7528, Mkhuze GR, Umpila Cave, -27.60, 32.30 ●
TM42121, Tzaneen, 15 km W, -23.82, 30.02 ●

SWAZILAND

DM9520, Mlawula NR, -26.19, 32.01 ●

ZAMBIA

HZM3.2918, Chavuma area, -13.08, 22.68 ●
NMZB10177, Chavuma area, -13.08, 22.68 ●
NMZB9161, Chingi, Chavuma, -13.02, 22.73 ●

ZIMBABWE

ROM64875, Birchenough Bridge, -19.85, 32.33 ●
NMZB57886, Buffalo Range, Chiredzi, -21.03, 31.53 ●
NMZB80374, Dorowa Mine, -19.07, 31.77 ●
HZM6.4117, Haroni-Rusitu R Confluence, -20.03, 33.02 ●
NMZB59228, Lake McIlwaine, -17.90, 30.78 ●
NMZB84463, Marivalle Ranch, -18.75, 29.75 ●
NMZB32526, Nyagui R, 2 km N of Chenjerai confluence, -17.37, 31.62 ●
NMZB57512, Nyamunyeche, Mvurwi, -16.77, 30.95 ●
NMZB84235, Nyandia Dam, -17.00, 32.00 ●
NMZB32533, Nyashato Dam, -17.12, 32.12 ●
NMZB57885, Pungwe-Rwera R Confluence, -18.25, 33.00 ●

tricolor

DRC

MHNG1046.24, Kakontwe, -10.98, 26.63 (Hayman *et al.* 1966)
MHNG1046.97, Kyamakonde, -9.93, 25.97 (Hayman *et al.* 1966)
RMCA26792, Mulonga, cave, -9.93, 25.47 (Hayman *et al.* 1966)
RMCA16450, Thysville (= Banza-Ngungu), -5.27, 14.88 (Hayman *et al.* 1966)

LESOTHO

NMB8160, Mahlanapeng, Thaba-Tseka, -29.63, 28.63 ●
NMB7272, Marakabei, -29.62, 28.12 ●
NMB6909, Matelanong, -29.38, 29.13 ●
NMB8175, Mount Moorosi, Quithing, -30.18, 27.87 ●

MALAWI

HZM?, Karonga, -9.93, 33.93 (Happold *et al.* 1987)
DCHC?, Zomba, -15.38, 35.32 (Happold *et al.* 1987)

MOZAMBIQUE

DM8552, Gurue, -15.46, 37.02 ●
?, Manica, -18.93, 32.88 (Smithers & Lobão Tello 1976)
DM8778, Mount Chiperone, -16.51, 35.73 ●
DM10854, Mount Mabu, -16.30, 36.39 ●
DM6235, Mount Namuli, -15.38, 37.07 ●
?, Vila Gouveia, -18.07, 33.18 (Smithers & Lobão Tello 1976)

SOUTH AFRICA

NMB7841, Arrarat, Sterkfontein Dam, -28.38, 28.88 ●
TM33197, Babanango, -28.38, 31.08 ●
TM40300, Blyde River Canyon NR, -24.58, 30.78 ●
USNM00342643, Brits, -25.63, 27.88
KM30866, Bushman Cave, Montagu, -33.83, 20.17 ●
SAM ZM14564, Bushman Cave, Montagu, -33.83, 20.17 ●
NMB6994, Butata, Zastron, -30.13, 26.88 ●
MMK2494, De Hoop, NR, -34.43, 20.42 ●

SAM ZM35670, De Hoop, NR, -34.43, 20.42 ●
DM5339, Dlinza Forest, Eshowe, -28.91, 31.45 ●
TM36253, Dumisa Gold Mine, Umzinto, -30.27, 30.35 ●
DM7071, Durban, -29.85, 31.00 ●
KM24310, East London, -33.15, 21.92 ●
TM40845, Echo Caves, -24.56, 30.61 ●
NMB5529, Excelsior, -28.88, 27.38 ●
NMB7891, Golden Gate, -28.38, 28.63 ●
TM41690, Grootvadersbosch, -33.88, 20.88 ●
DM5895, Itala NR, -27.52, 31.37 ●
TM31814, Itala NR, -27.52, 31.37 ●
KM31982, King William's Town, -32.87, 27.37 ●
NMZB63130, King William's Town, -32.87, 27.37 ●
TM29856, Kruger NP, Pafuri, -22.45, 31.30 ●
TM7056, Krugersdorp, Uitkyk, -26.13, 27.63 ●
TM2481, Louws Creek, Barberton, -25.65, 31.30 ●
USNM00238099, Louws Creek, Barberton, -25.65, 31.30
TM4268, Makapans Cave, -24.15, 29.18 ●
DM7005, Pietermaritzburg, Queen Elizabeth Park, -29.57, 30.33 ●
KM23764, Pietermaritzburg, Town Bush, -29.55, 30.35 ●
USNM00292066, Pietermaritzburg, Town Bush, -29.55, 30.35
TM25418, Potgietersrus (= Mokopane), 16 km NE, -24.15, 29.18 ●
TM2440, Pretoria, Garsfontein, -25.88, 28.13 ●
TM6821, Pretoria, Irene, -25.87, 28.23 ●
TM25414, Sandspruit, Thabazimbi, -24.62, 27.67 ●
DM5665, Shongweni Dam, -29.85, 30.72 ●
TM25415, Skurweberg Cave, Pretoria, -25.80, 27.98 ●
KM26137, Umtata, -31.60, 28.75 ●
TM2091, Venterskroon, -26.88, 27.27 ●
TM28833, Vernon Crookes NR, -30.27, 30.60 ●
TM47617, Waterval-Boven, -25.87, 30.32 ●
SWAZILAND
DM7188, Kopola Cave, -26.36, 31.17 ●
TM47736, Mlawula NR, Siweni, -26.18, 32.05 ●
DM8040, Wylesdale, -25.82, 31.29 ●
ZAMBIA
AMNH?, Mwinilunga, SE of, -12.03, 24.96 (Ansell 1978)
ZIMBABWE
NMZB58156, Bulawayo, Hillside, -20.13, 28.58 ●
TM34606, Chirinda Forest, -20.42, 32.72 ●
NMZB31367, Crowborough Sewage Works, Harare, -17.87, 30.90 ●
NMZB56304, Esigodini, Falcon College, -20.22, 28.92 ●
NMZB33885, Mabura 1 Cave, Ngondoma R, -18.37, 29.37 ●
NMZB30678, Matobo Hills, Lumane Valley, -20.58, 28.83 ●
NMZB59656, Rusitu Forest, -20.03, 32.98 ●

welwitschii

ANGOLA
MD5476, Alto Chicapa, -10.88, 19.13 (Hayman 1963)
BM66.4.12.2, Pungo Andongo, -9.63, 15.63 (Crawford-Cabral 1986)
DRC
RMCA12661, Dilolo, -10.48, 22.48 (Fahr & Ebigbo 2003)
IRSNB15428, Elisabethville (= Lubumbashi), -11.68, 27.48 (Fahr & Ebigbo 2003)
IRSN10848, Lusinga, -8.88, 27.25 (Hayman *et al.* 1966)
MALAWI
BM22.12.17.76, Chiromo, -16.53, 35.15 (Fahr & Ebigbo 2003)
BM22.12.17.75, Cholo (= Thyolo), -16.07, 35.15 (Fahr & Ebigbo 2003)
DCHC?, Kasungu NP, -13.05, 33.15 (Happold *et al.* 1987)
NMZB57880, Livingstonia, -10.60, 34.10 ●
DCHC?, Liwonde NP, -15.03, 35.25 (Happold *et al.* 1987)
DCHC?, Namadzi, Kapalasa Farm, -15.52, 35.18 (Happold *et al.* 1987)
MOZAMBIQUE
?, Gaza, -24.00, 32.00 (Smithers & Lobão Tello 1976)
?, Vila de Manica (= Manica), -18.93, 32.88 (Smithers & Lobão Tello 1976)
SOUTH AFRICA
NMB1263, Bloemfontein, -29.13, 26.13 ●
TM17035, Boksburg, -26.23, 28.25 ●
DM954, Craigieburn, -30.20, 30.25 ●
TM963, Elandsklip, Belfast, -25.33, 30.17 ●
TM46638, Kanaan, Hazeyview, -25.07, 31.10 (Fahr & Ebigbo 2003)
(Skukuza), Kruger NP, Nwaswisake, -25.03, 31.53 (Fahr & Ebigbo 2003)
(Skukuza), Kruger NP, Punda Milia, 5 km NW, -22.68, 30.95 (Fahr & Ebigbo 2003)
TM42489, Kruger NP, Skukuza, -24.98, 31.58 ●
BM0.11.6.1, Lydenburg, 80 km ENE, -24.82, 30.18 (Fahr & Ebigbo 2003)
TM41034, Makapans Cave, -24.15, 29.18 ●
TM39421, Vaalwater, 30 km NE, -24.13, 28.13 ●
ZAMBIA
NMZ2573, Mafinga Mountains, -9.98, 33.30 (Fahr & Ebigbo 2003)
NMZ2572, Makutu Mountains, -10.42, 33.30 (Fahr & Ebigbo 2003)
SMF12145, Nsombo, -10.82, 29.95 (Fahr & Ebigbo 2003)
ZIMBABWE
NMZB80373, Dorowa Mine, -19.07, 31.77 ●
NMZB80464, Harare, 3rd Street, -17.83, 31.07 ●
NMZB57879, Harare, Baines Ave, -17.83, 31.07 ●
NMZB57881, Harare, Civic Centre, -17.83, 31.07 ●
HZM3.4131, Harare, Helenvale, -17.83, 31.07 (Fahr & Ebigbo 2003)
NMZB57883, Harare, Salisbury Street, -17.83, 31.07 ●
TM3977, Mount Silinda, -20.45, 32.67 ●
NMZB56442, Mutare, -18.98, 32.68 ●
HZM2.4100, Mutare, -18.97, 32.67 (Fahr & Ebigbo 2003)
NMZB57882, Vumba, -19.12, 32.87 ●

Neoromicia

capensis

ANGOLA
?, Chitau, -11.38, 17.13 (Crawford-Cabral 1986)
IICA1928, Humpata, -15.13, 13.38 ●
IICA7942, Naulila, 25 km E, -17.13, 14.88 ●
IICA756, Sa da Bandeira (= Lubango), -14.88, 13.38 ●
BOTSWANA
USNM00382656, Dikomo Di Kai, -24.87, 24.52
NMZB59213, First Pole Bridge, Okavango, -19.57, 22.88 ●
USNM00322919, Fort Rictfontein, 33 km SSE, -22.00, 21.25
NMZB54134, Four Rivers Camp, Okavango, -19.12, 23.12 ●
NMZB64157, Francistown, -21.15, 27.50 ●
NMZB32799, Ghanzi, -21.62, 21.62 ●
NMZB80205, Ghanzi, 45 km S, -22.10, 21.78 ●
NMZB80204, Gomoti R, -19.37, 23.37 ●
NMZB64156, Khuis, -26.67, 21.83 ●
USNM00425342, Khuis, -26.67, 21.83
NMZB64144, Khutse, -23.25, 24.25 ●
NMZB80206, Kwando R, -18.05, 23.13 ●
USNM00382651, Kwebe Hills, 26 km NW, -20.27, 22.87
USNM00382647, Letlaking, 17 km SE, -24.22, 25.17
USNM00367746, Mabeleapudi. Sehita, 60 km SW, -20.95, 22.52
NMZB80207, Makalamabedi Resource Area, -20.37, 23.87 ●
NMZB64143, Mopipi, -21.00, 24.75 ●
NMZB64076, Mumpswe Pan, -20.20, 25.87 ●
NMZB64149, Musu, -21.00, 25.75 ●
USNM00367748, Nata, -20.20, 26.18
NMZB64074, Nata, -20.20, 26.18 ●
NMZB64113, Nata R, -19.75, 26.75 ●
TM6549, Nekate, -20.00, 26.33 ●
USNM00425328, Nokaneng, 21 km N, -19.42, 22.27
NMZB64072, Nthane, -21.25, 26.00 ●
NMZB80200, Nunga, -18.75, 23.50 ●
NMZB80203, Nxai Pan, -19.75, 24.75 ●
NMZB80202, Pandamatenga, 130 km SW, -19.25, 24.75 ●
NMZB59209, Pom Pom, Okovango, -19.50, 22.75 ●
NMZB64115, Sehitwa, 16 km SW, -20.38, 22.63 ●
USNM00367737, Sehitwa, 16 km SW, -20.38, 22.63
USNM00382652, Sehitwa, 22 km W, -20.58, 22.53
NMZB64095, Sehitwa, 22 km W, -20.58, 22.53 ●
NMZB64133, Serowe, 40 km NW, -22.00, 26.29 ●
NMZB64123, Serowe, 40 km NW, -22.00, 26.29 ●
NMZB63996, Shakawe, 70 km SW, -18.55, 21.03 ●
USNM00425327, Shakawe, 70 km SW, -18.55, 21.03
NMZB64085, Sokwana, -18.00, 23.25 ●
NMZB64151, Sukwane, Botletle R, -20.75, 24.25 ●
USNM00382646, Tamafupi, 33 km N, -19.25, 26.00
NMZB64121, Tamafupi, 33 km N, -19.25, 26.00 ●
NMZB64075, Toromoja, -21.00, 24.50 ●
USNM00382650, Toten, -20.38, 22.95
NMZB64086, Tsane, -24.12, 21.87 ●
USNM00425338, Tsane, 32 km ENE, -24.00, 22.23
USNM00322933, Tsane. Camp 8, -24.12, 21.87
USNM00425341, Vloorskop, -25.92, 20.87
USNM00518647, Xugana, -19.08, 23.10 (Archer 1975)
DRC
BM?, Elisabethville (= Lubumbashi), -11.68, 27.48 (Hayman *et al.* 1966)
IRSN14507, Leopoldville (= Kinshasa), -4.30, 15.30 (Hayman *et al.* 1966)
RMCA7309, Luebo, -5.33, 21.55 (Hayman *et al.* 1966)
RMCA22126, Moba, -7.07, 29.75 (Hayman *et al.* 1966)
LESOTHO
NMB8654, Botsoela, Mafeteng, -29.83, 27.25 ●
NMB7270, Marakabei, -29.62, 28.12 ●
NMB8223, Mount Moorosi, Quithing, -30.18, 27.87 ●
MALAWI
DCHC?, Kasungu NP, -13.05, 33.15 (Happold *et al.* 1987)
DCHC?, Viphya Plateau, -12.38, 33.70 (Happold *et al.* 1987)
DCHC?, Zomba, -15.38, 35.32 (Happold *et al.* 1987)
MOZAMBIQUE
DM8533, Chinizuia Forest, -18.98, 35.05 ●
?, Espungabera, N of, -19.84, 32.88 (Smithers & Lobão Tello 1976)
NMZB63211, Javane, -21.25, 34.00 ●
?, Manica, -18.93, 32.88 (Smithers & Lobão Tello 1976)
USNM00365410, Mungari, 5 km N, -17.15, 33.57
?, Pafuri, -22.38, 31.38 (Smithers & Lobão Tello 1976)

?, Tete, S of, -17.13, 33.63 (Smithers & Lobão Tello 1976)
NMZB63210, Zinave NP, -21.37, 33.87 ●

NAMIBIA

NMZB64117, Bezarode Farm, Windhoek, -22.63, 17.13 ●
TM32657, Diamond Area 1, -28.55, 16.42 ●
SMM10078, Diamond Area 1, -28.55, 16.42 ●
SMM10617, Dose Pan, Okavango, -18.13, 20.88 ●
SMM12408, Eiseb R, -20.63, 20.63 ●
SMM12680, Etosha NP, Halali, -19.13, 16.38 ●
USNM00295193, Gam, -20.30, 20.58
KM2117, Gobabis, -22.45, 19.87 ●
LACM056259, Gobabis, 70 km NE, -21.26, 18.96 ●
KM8083, Grootfontein, -19.55, 18.07 ●
TM9477, Karochos, Outja, -20.37, 14.97 ●
TM32547, Keetmanshoop, 35 km SSW, -26.95, 17.93 ●
LACM041660, Koes, 89 km ENE, -26.27, 19.50 ●
TM8308, Liebig's Ranch, Windhoek, -22.63, 16.88 ●
KM2164, Muckwe, -18.12, 21.62 ●
LACM056234, Omaruru, 30 km NW, -20.97, 15.30 ●
SMM10924, Ombonde, -19.55, 14.53 ●
SMM9905, Omega, -18.05, 22.18 ●
LACM059104, Opuwo, 70 km NW, -17.47, 13.03 ●
LACM056244, Otjiwarongo, 60 km SE, -20.92, 16.87 ●
KM2148, Outjo, W of, -20.13, 15.88 ●
TM3381, Quickborn, Okahandja, -21.15, 17.08 ●
LACM059099, Rundu, 75 km S, -18.53, 20.83 ●
KM2168, Rundu, S of, -18.60, 19.70 ●
SMM13597, San Michelle, -17.88, 23.38 ●
DM40, Sandfontein, -22.32, 20.00 ●
LACM041673, Wilhelmstal, 47 km S, -22.33, 16.36 ●

SOUTH AFRICA

NMB5885, Aasvogelrand, Vredefort, -26.87, 27.37 ●
KM24659, Aberdeen, -32.36, 23.45 ●
KM2019, Albany District, -33.32, 26.37 ●
KM20064, Alexandria, -33.50, 25.75 ●
TM38413, Algeria Forest Research Station, -32.37, 19.05 ●
TM32294, Alldays, -22.68, 29.13 ●
NMB3721, Allermansdrift, Phillipolis, -30.63, 25.38 ●
TM11785, Alma, -29.63, 25.13 ●
NMB4061, Alpha, Ladybrand, -29.13, 27.63 ●
DM5449, Arden Estate, Howick, -29.50, 30.25 ●
NMB7843, Arrarat, Sterkfontein Dam, -28.38, 28.88 ●
NMB3137, Asem, Senekal, -28.38, 27.63 ●
MMK7053, Augrabies Falls NP, -28.60, 20.33 ●
DM5354, Badplaas, -25.96, 30.58 ●
TM23470, Barberspan NR, -26.63, 25.63 ●
KM25021, Barkley East, -31.08, 27.45 ●
DM4082, Beaufort West, 23 km N, -32.13, 22.55 ●
KM20188, Bedford, SE, -32.88, 26.24 ●
BM1902.4.3.1, Bethlehem, -28.23, 28.30 ●
NMB4918, Beubecula, Elliot, -31.38, 28.13 ●
USNM00344288, Bloemfontein, 21 km N, -28.93, 26.33
NMB1636, Bloemfontein, Dan Pienaar, -29.13, 26.13 ●
NMB4103, Bloemfontein, Glen, -28.88, 26.38 ●
KM26329, Bontebok NP, -34.07, 20.45 ●
USNM00342589, Brakfontein, 18 km N, -33.12, 23.45
KM30858, Bredasdorp, -34.46, 20.40 ●
NMB3777, Buitenhoop, Hertzogville, -28.13, 25.13 ●
NMB3018, Bultfontein, -28.38, 25.88 ●
KM12724, Calvinia, -31.54, 20.49 ●
DM1106, Chase Valley Heights, -29.55, 30.37 ●
TM20832, Christiana, 25 km NNE, -27.68, 25.23 ●
TM20832, Christiana, 25 km NNE, -27.68, 25.23 ●
KM2090, Clanwilliam, NE of, -32.07, 19.08 ●
DM5642, Clarens, -28.38, 28.38 ●
DM89, Clarens, near, -28.52, 28.42 ●
KM24499, De Aar, -30.73, 23.92 ●
SAM ZM7512, De Doorns, -33.38, 19.63 ●
NMZB63209, de Hoek, -32.25, 25.75 ●
USNM00342603, De Hoop, 24 km NNE, -38.38, 20.38
BM1902.9.1.2, Deelfontein, -30.87, 23.87 ●
NMB7849, Dennergeur, Boshof, -28.13, 25.13 ●
DM5355, Dlinza Forest, Eshowe, -28.91, 31.45 ●
NMB2915, Driehoek District, -29.63, 24.88 ●
NMB4560, Drumbo, Barkley East, -30.88, 27.63 ●
TM23803, Dullstroom, -25.38, 30.13 ●
DM7249, Durban, Bluff, -29.85, 31.00 ●
DM5881, Durban, Westriding, -29.78, 30.77 ●
DM5345, Durban Yellow Wood Park, -29.92, 30.93 ●
KM26123, Elliotdale (= Xhora), -32.23, 28.92 ●
USNM00342624, Ellisras, 8 km NE, -23.63, 27.82
NMB3747, Endrag, Bethulie, -30.63, 25.88 ●
NMB3291, Eureka, Steynsrus, -27.88, 27.63 ●
NMB5898, Excelsior, -28.88, 27.38 ●
NMB3661, Fauresmith District, -29.88, 25.38 ●
NMB6536, Ficksburg, -28.88, 27.88 ●
KM32638, Flagstaff, -30.90, 29.53 ●
NMB7752, Florisbad, Brandfort, -28.77, 26.08 ●
SAM ZM40796, Gamkapoort NR, -33.38, 21.88 ●
MMK7061, Ganyesa, -26.53, 24.12 ●
NMB4998, Gloria, Jamestown, -31.12, 26.87 ●
USNM00424102, Graaff Reinet, 30 km SE, -32.45, 24.75
USNM00344275, Graaff Reinet, 40 km N, -31.78, 24.82
USNM00344281, Grahamstown, 17 km SSW, -33.38, 26.20
TM23237, Groot Marico, 8 km SE, -25.63, 26.40 ●
NMB4989, Halstone, Barkley East, -30.63, 27.88 ●
NMB3148, Hangverwacht Vrede, -27.63, 29.13 ●
SAM ZM7522, Hanover, -31.13, 24.38 ●
NMB3584, Heeuhoek, Dewetsdorp, -29.38, 26.38 ●
NMB3171, Helena, Vredefort Basin, -26.88, 27.38 ●
DM6894, Hella Hella GR, -29.90, 30.08 ●
DM7018, Hillcrest, -29.77, 30.60 ●
DM5964, Hilton, -29.56, 30.30 ●
DM8055, Hluhluwe-Imfolozi Park, Hluhluwe, -28.11, 32.30 ●
KM24506, Hopetown, near, -29.81, 23.58 ●
KM24811, Humansdorp, -33.98, 23.65 ●
DM5368, Itala NR, -27.52, 31.37 ●
NMB7578, Jagersfontein Commonage, -29.63, 25.38 ●
TM35584, Kalahari Gemsbok NP, Marie se Gat, -25.63, 20.63 ●
MMK7070, Kalahari Gemsbok NP, Mata Mata, -25.75, 19.98 ●
USNM00451066, Kalahari-Gemsbok NP, Nossob, -26.43, 20.63
DM4457, Kamberg NR, -29.40, 29.68 ●
DM3868, Kamberg, Glengarry, -30.25, 29.60 ●
NMB11280, Kareeport, Phillipolis, -30.38, 25.13 ●
NMB? (JW138), Karoo NP, -32.33, 22.55 ●
TM29512, Karoo NP, -32.33, 22.55 ●
DM7192, Kersefontein Farm, Hopefield, -32.90, 18.33 ●
DM3932, Kimberley, -28.63, 24.88 ●
KM13280, King William's Town, -32.87, 27.37 ●
NMZB63519, King William's Town, -32.87, 27.37 ●
DM6370, Kloof, -29.82, 30.83 ●
DM7017, Kloof, -29.82, 30.83 ●
USNM00344273, Knoffelfontein, 22 km S, -29.90, 24.90
NMB7508, Koegelbeen Cave, -28.68, 23.37 ●
NMB8128, Kranskop, Zastron, -30.13, 27.38 ●
TM39569, Kruger NP, Letaba Bridge, -23.82, 31.58 ●
TM37833, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM30489, Kruger NP, Levuvhu R, -22.43, 31.18 ●
TM30032, Kruger NP, Malelane, -25.47, 31.50 ●
TM39602, Kruger NP, Olifants, -24.02, 31.65 ●
TM41158, Kruger NP, Orpen Gate, NW of, -24.45, 31.17 ●
TM30654, Kruger NP, Punda Milia, -22.77, 31.02 ●
TM37833, Kruger NP, Renosterkoppies, -25.13, 31.62 ●
TM30056, Kruger NP, Skukuza, -24.98, 31.58 ●
DM7082, Kuduskop, -32.98, 25.19 ●
BM1904.10.1.10, Kuruman, -27.45, 23.42 ●
MMK7065, Kuruman, 58 km S, -27.82, 23.58 ●
DM7426, KwaMakuta Township, -30.05, 30.88 ●
KM29437, Ladismith, -33.51, 21.10 ●
NMB4212, Lady Grey, -30.63, 27.13 ●
NMB1690, Ladybrand, -29.13, 27.38 ●
DM5648, Ladysmith, -28.23, 30.02 ●
KM2093, Lambert's Bay, -32.12, 18.45 ●
SAM ZM37046, Lambert's Bay, -32.12, 18.45 ●
NMB4162, Letsoana, Fourisburg, -28.63, 28.38 ●
DM1909, Loteni NR, 45 km N, -29.45, 29.53 ●
KM31229, Lusikisiki, -31.28, 29.96 ●
TM47008, Machadadorp, -25.88, 30.30 ●
NMB5127, Maniba, Dordrecht, -31.38, 26.88 ●
TM19594, Maria van Riebeeck NR, -25.88, 28.38 ●
DM4738, Merrivale, -29.50, 30.25 ●
DM5396, Messina NR, -22.38, 30.07 ●
TM44203, Messina NR, -22.38, 30.07 ●
SAM ZM13545B, Mfongosi, -28.63, 30.88 ●
NMB7802, Middelwater, Hoopstad, -27.62, 25.37 ●
NMB5834, Miltan, Maclear, -30.63, 28.38 ●
DM5380, Mkhuze GR, -27.62, 32.23 ●
USNM00342605, Modderfontein, 3 km N, -30.98, 23.80
DM87, Modderfontein, Malmesbury, -33.33, 18.50 ●
BM1898.4.4.8, Mogale City (= Krugersdorp), -26.10, 27.77 ●
MMK7062, Molopo NR, -25.97, 22.92 ●
NMB3815, Moscow, Heilbron, -27.13, 27.88 ●
DM7011, Mount Currie NR, -30.50, 29.39 ●
KM24514, Murraysburg, N of, -31.78, 23.58 ●
KM2086, Namaqualand, -30.25, 18.43 ●
DM7020, New Hanover School, -29.37, 30.62 ●
DM5873, Nottingham Road, Clifton School, -29.35, 30.00 ●
DM90, Nqutu, -28.22, 30.67 ●

MMK7036, Olifants R, Clanwilliam, -32.35, 18.95 ●
KM24560, Philipstown, -30.06, 24.67 ●
KM24569, Philipstown, -30.06, 24.67 ●
NMB1661, Phillipolis, -30.13, 24.88 ●
DM8788, Phinda GR, Mziki Pan, -27.70, 32.41 ●
DM3348, Pietermaritzburg, Queen Elizabeth Park, -29.57, 30.33 ●
KM30185, Piquetburg, -32.77, 18.72 ●
USNM00344283, Pirie Mission, -32.82, 27.23
KM19238, Port Elisabeth, King's Beach, -33.88, 25.25 ●
SAM ZM3433B, Potchefstroom, -26.70, 27.08 ●
TM23519, Potchefstroom, 24 km E, -26.67, 27.33 ●
TM23387, Potgietersrus (= Mokopane), 25 km ESE, -24.25, 29.13 ●
KM29798, Prince Albert, -33.26, 22.00 ●
NMB9231, Qwa-Qwa, -28.63, 28.63 ●
KM11100, Richmond, -31.03, 23.77 ●
NMB3264, Riebeeckstad, -27.88, 26.88 ●
TM20656, Rissik NR, -24.88, 28.45 ●
NMB3006, Roodepoort, Edenburg, -29.63, 25.88 ●
NMB4324, Roodewal, Aliwal North, -30.38, 26.38 ●
NMB4674, Rooipoort, Elliot, -31.38, 27.88 ●
DM2389, Royal Natal NP, -28.68, 28.98 ●
NMB12211, Sandveld NR, -27.88, 25.88 ●
NMB3381, Schurwepoort, -27.38, 27.63 ●
TM34864, Sengwa Wildlife Research Area, -18.17, 28.22 ●
DM4729, Skoenmakerskop, -33.97, 25.60 ●
NMB5815, Snowhill, Dordrecht, -31.63, 27.13 ●
NMB8758, Soutpansdrift, -29.63, 24.38 ●
DM1107, Spioenkop NR, -29.67, 29.47 ●
NMB3187, Spitskop, Boshof, -28.63, 25.38 ●
USNM00342627, Springbok, 14 km W, -29.67, 17.28
TM27935, Springbok, 28 km SSE, -29.88, 17.75 ●
TM25059, Standerton, 15 km E, -26.88, 29.38 ●
TM8970, Stilbaai, -34.37, 21.42 ●
KM24933, Stockenstrom, -32.50, 26.70 ●
KM8936, Stockenstrom, -32.50, 26.70 ●
KM7591, Stutterheim, -32.65, 27.53 ●
TM41686, Suikerbosrand NR, -26.53, 28.20 ●
DM6900, Suikerbosrand NR, -26.53, 28.20 ●
NMB2926, Tha Banchu, -29.13, 26.88 ●
NMB3556, Uitvlug, Vrede, -27.38, 29.38 ●
NMB1533, Uitzicht, Harrismith, -28.38, 28.88 ●
MMK2487, Upington, 100 km NNE, -28.18, 22.03 ●
KM2074, Upington, near, -28.38, 21.13 ●
SAM ZM17074, Upington, near, -28.38, 21.13 ●
KM2084, Van Rhynsdorp, NE of, -31.13, 18.18 ●
NMB2934, Ventersburg, -28.13, 27.13 ●
TM27752, Ventersdorp, 13 km W, -26.37, 26.53 ●
NMB5710, Venture, Aliwal North, -30.88, 26.63 ●
KM24571, Victoria West, -31.40, 23.12 ●
NMB8623, Vilfontein, Hanover, -31.13, 24.38 ●
TM24084, Vivo, 13 km W, -23.13, 29.13 ●
KM29017, Vredendal, -31.76, 18.23 ●
DM7195, Vrolijkheid NR, -33.90, 19.88 ●
NMB7701, Waterval, Warden, -27.88, 29.13 ●
DM2319, Weenen NR, -28.85, 30.00 ●
MMK2483, Williston, 45 km ENE, -31.27, 21.37 ●
NMB10563, Winburg, -28.88, 27.13 ●
NMB5927, Woodcliff, Maclear, -30.88, 28.13 ●
NMB5972, Zastron, -30.13, 26.88 ●

SWAZILAND

TM45646, Bethlehem Mission, -26.85, 30.93 ●
TM45649, Dwalile Primary School, -26.67, 30.80 ●
TM45641, Ekuphakameni High School, -26.80, 31.15 ●
DM8511, Hlane NP, Ndlovu, -26.26, 31.88 ●
DM8426, Hlane NP, Sundwini, -26.25, 31.94 ●
TM45707, Luyengo, -26.58, 31.20 ●
DM6231, Malolotja NR, -26.16, 31.11 ●
DM8049, Mlawula NR, -26.19, 32.01 ●
BM1989.0044, Mlilwane GR, -26.48, 31.18 ●
TM45642, Ngcoseni Primary School, -26.77, 31.07 ●
DM7173, Pine Valley, -26.27, 31.23 ●

ZAMBIA

KM9669, Abercorn (= Mbala), -8.85, 31.38 ●
KM2192, Balovale (= Zambezi), -13.55, 23.12 ●
NMZB10376, Chilanga, -15.55, 28.27 ●
NMZB29886, Hillwood Farm, Ikelenge, -11.23, 24.30 ●
KM9670, Isoka, -9.50, 32.75 ●
NMZB10371, Kabompo Boma, -13.58, 24.20 ●
KM9671, Kasama, -10.22, 31.17 ●
NMZ2758, Livingstone, -17.85, 25.87 (Ansell 1973)
UZMZ?, Lochinvar NP, -15.88, 27.38 (Ansell 1969)
NMZ2909, Mazabuka, -15.83, 27.73 (Ansell 1973)
NMZ2938, Mount Makulu, -15.57, 28.23 (Ansell 1973)
NMZ2732, Muckle Neuk, -16.63, 27.00 (Ansell 1973)
UZMZ?, Naleza, -15.45, 27.33 (Ansell 1969)
NMZB33275, Ndanda Dambo, Mongu, 70 km NE, -14.75, 23.75 ●
NMZB33171, Ndanda School, Mongu, 70 km NE, -14.75, 23.75 ●
NMZB33189, Senenga, 50 km NE, -15.62, 23.37 ●
FMNH95219, Sihole, -15.32, 22.57 (Ansell 1967)
BM66.5459, Sililo, -14.25, 22.50 (Ansell 1967)

ZIMBABWE

NMZB33629, Benzie's Bridge, Shangani R, -18.81, 27.90 ●
NMZB58874, Bonda Mission, -18.25, 32.50 ●
NMZB60674, Bridge, -17.75, 25.25 ●
NMZB58860, Buffalo Range, Chiredzi, -21.03, 31.53 ●
NMZB58931, Buffalo Range, Field Station, -20.75, 31.50 ●
NMZB57615, Bulawayo, -20.12, 28.58 ●
NMZB58896, Bulawayo, Heany, -20.00, 28.75 ●
NMZB58875, Bulawayo, Hillside, -20.13, 28.58 ●
NMZB9826, Bulawayo, Lakeside, -20.13, 28.58 ●
NMZB27182, Bulawayo, Sauerstown, -20.10, 28.62 ●
NMZB60673, Camp-Katembora, -17.75, 25.25 ●
NMZB57445, Chete, Eastern Section, -17.37, 27.62 ●
NMZB58903, Chikwarakwara, -22.35, 31.10 ●
NMZB60476, Chikwarakwara, -22.35, 31.10 ●
NMZB32494, Chinanga Dam, Maramba, -17.12, 32.87 ●
DM4691, Chingamwe Estates, Juliasdale, -18.47, 32.75 ●
NMZB58901, Chiredzi, Lone Star Ranch, -21.12, 31.87 ●
NMZB64825, Chirisa SA, Magurazino R, -17.62, 28.37 ●
NMZB32959, Chishakwe Camp, 3 km E, -20.00, 32.00 ●
NMZB30073, Chivi, -20.30, 30.52 ●
NMZB64827, Chizarira NP, Mchesu R, -17.75, 27.50 ●
NMZB58855, Chundayi, Borrowdale, -17.50, 31.00 ●
NMZB58915, Chundazi, Borrowdale, -17.75, 31.00 ●
NMZB80192, Crowborough Sewage Works, Harare, -17.87, 30.90 ●
NMZB58859, Darwendale, -17.75, 30.00 ●
NMZB79455, Doddieburn Ranch, -21.40, 29.35 ●
NMZB31193, Dwala Ranch, Bubiana, -21.12, 29.62 ●
NMZB58866, Eirene Farm, Marondera, -18.37, 31.62 ●
NMZB31750, Esigodini, Falcon College, -20.22, 28.92 ●
NMZB63157, Esigodini, The Homestead, -20.25, 28.75 ●
USNM00470254, Essexvale Ranch, -20.30, 28.93
NMZB60448, Forest Hill, Lupane, -19.08, 27.83 ●
DM116, Gokwe, -18.12, 28.97 ●
NMZB58862, Great Zimbabwe, -20.28, 30.93 ●
NMZB58932, Great Zimbabwe, -20.28, 30.93 ●
NMZB31378, Gutu Mission, -19.63, 31.17 ●
NMZB29985, Gwayi R Bridge, 2 km N, -18.63, 27.13 ●
NMZB58953, Gweru Teachers Training College, -19.25, 29.75 ●
USNM00368610, Harare, -17.83, 31.07
NMZB58886, Harare, Atlantica Research Station, -17.75, 31.00 ●
NMZB58849, Harare, Avondale, -17.83, 31.07 ●
NMZB58847, Harare, Haig Park, -17.83, 31.07 ●
NMZB30643, Harare, Highlands School, -17.80, 31.12 ●
NMZB58857, Harare, Kambuzuma, -17.83, 31.07 ●
NMZB58877, Harare, Rainham, -17.83, 31.07 ●
NMZB32784, Harare, Thompark, -17.62, 31.12 ●
NMZB58818, Harare, Thornpark, -17.62, 31.12 ●
NMZB80190, Harare, Twentydales, -17.90, 31.17 ●
NMZB58887, Harare, Union Avenue, -17.83, 31.07 ●
NMZB58845, Haroni Valley, -19.84, 33.00 ●
NMZB58865, Hippo Valley, Kutanga Estates, -21.12, 31.87 ●
NMZB58897, Hope Fountain Mission, -20.62, 28.62 ●
NMZB81868, Humani Ranch, -20.25, 32.25 ●
NMZB58910, Hwange NP, Dete area, -18.50, 26.75 ●
NMZB58911, Hwange NP, Inyantue, -18.50, 26.50 ●
NMZB12744, Hwange NP, Main Camp, -18.73, 26.95 ●
NMZB58902, Hwange NP, Main Camp, -18.73, 26.95 ●
NMZB58914, Hwange NP, Main Camp, -18.73, 26.95 ●
NMZB58904, Hwange NP, Makalowa Pan, -19.00, 27.25 ●
NMZB58907, Hwange NP, Mandundumela Pan, -19.00, 27.00 ●
NMZB58906, Hwange NP, Ngweshla Pan, -19.00, 27.00 ●
NMZB54112, Insuza Vlei, Gwaai Forest, -19.25, 28.00 ●
NMZB58895, Inwesi Ranch Syringa, -20.25, 28.00 ●
NMZB31426, Inyankuni, -20.25, 29.00 ●
NMZB60675, Katombora Rapids, -17.88, 25.33 ●
NMZB33755, Kwizizi R, Deka Valley, -18.43, 26.32 ●
NMZB58880, Lake McIlwaine, -17.90, 30.78 ●
NMZB58930, Lusulu Tsetse Station, Sebungwe, -18.12, 27.87 ●
NMZB33681, Lutope-Ngolangola R Confluence, -18.28, 28.08 ●
NMZB58898, Mangwe, Vashu Farm, -20.87, 28.12 ●
NMZB84437, Marivalle Ranch, -18.75, 29.75 ●
NMZB58869, Marondera, Peterhouse School, -18.18, 31.62 ●
NMZB31580, Matetsi SA, Tshope vlei, -18.62, 25.87 ●
NMZB33803, Matobo Hills, Amalinda Camp, -20.50, 28.25 ●
NMZB30020, Matobo Hills, Lumane Valley, -20.58, 28.83 ●
NMZB30684, Matobo Hills, Mtshavezi Valley, -20.62, 28.87 ●
NMZB29598, Matobo Hills, Totololo R, -20.55, 28.83 ●

NMZB68258, Matobo Research Station, -20.25, 28.75 ●
NMZB61149, Mill's Farm, Esigodini, -20.30, 28.75 ●
NMZB84505, Munyati R, -18.50, 29.75 ●
NMZB58882, Mutare, Fern Valley, -19.12, 32.62 ●
NMZB31916, Mvuma, -19.25, 30.50 ●
NMZB32654, Mzola Camp, -18.62, 27.37 ●
NMZB58871, Ngamo Gwaai Reserve, -19.00, 27.50 ●
NMZB58905, Ngamo Gwaai Reserve, -19.00, 27.50 ●
NMZB32501, Nyadiri R, -17.12, 32.12 ●
NMZB32491, Nyagui R, 2 km N of Chenjerai confluence, -17.37, 31.62 ●
NMZB3281, Nyamandhlovu, -19.75, 28.25 ●
NMZB58051, Nyamunyeche, Mvurwi, -16.77, 30.95 ●
NMZB32497, Nyashato Dam, -17.12, 32.12 ●
NMZB58856, Ruwa, Terendali Farm, -17.75, 31.00 ●
NMZB62073, Ruya R, -16.50, 31.75 ●
NMZB31363, Sabi-Lundi (= Save-Runde) R Confluence, -21.28, 32.38 ●
NMZB58924, Safari Farm, Marondera, -18.00, 31.50 ●
NMZB30037, Sengwa Wildlife Research Area, -18.17, 28.22 ●
DM3692, Sengwa Wildlife Research Area, -18.17, 28.22 ●
NMZB58934, Sengwa Wildlife Research Station, -18.17, 28.22 ●
NMZB29604, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB57627, Shambayetu Farm, Beitbridge, -21.75, 29.50 ●
NMZB33998, St James Mission, Nyamandlovu, -19.75, 28.00 ●
NMZB58884, Torre, Marondera, -18.25, 31.00 ●
NMZB58954, Triangle, Hospital, -21.00, 31.25 ●
NMZB58129, Umzingwane R, Beitbridge, -21.87, 29.62 ●
NMZB31967, Volunteer Farm, Main Camp, -18.82, 27.63 ●
NMZB33738, Volunteer Farm, Zwikungwa, -18.91, 27.70 ●
NMZB60682, Westwood Vlei, -17.75, 25.25 ●

cf. melckorum

BOTSWANA

NMZB59307, Kurunxaraga, Okavango, -19.67, 22.83 ●

MALAWI

DCHC?, Kasungu NP, -13.05, 33.15 (Happold *et al.* 1987)
DCHC?, Liwonde NP, -15.03, 35.25 (Happold *et al.* 1987)

SOUTH AFRICA

TM37943, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM34185, Kruger NP, Levuvhu R, -22.43, 31.18 ●

ZAMBIA

BM66.5461, Chipangali, Chipata, -13.12, 32.87 (Ansell 1967)
NMZB20019, Fort Jameson (= Chipata), -13.62, 32.65 ●
BM66.5460, Matebele Plain, -16.42, 23.13 (Ansell 1967)
NMZB20310, Mpomwa Hills, Chipata, -13.37, 32.37 ●
UZMZ66, Naleza, -15.45, 27.33 (Ansell 1969)

ZIMBABWE

NMZB30065, Gutu Mission, -19.63, 31.17 ●
NMZB33756, Kwizizi R, Deka Valley, -18.43, 26.32 ●
TM41860, Mana Pools NP, -15.80, 29.33 ●

nanus

ANGOLA

?, Alto Chicapa, -10.88, 19.13 (Crawford-Cabral 1986)
?, Benguela, -12.63, 13.38 (Crawford-Cabral 1986)
?, Caconda, -13.63, 15.13 (Crawford-Cabral 1986)
?, Capelongo, -14.88, 15.13 (Crawford-Cabral 1986)
IICA4990, Cariango, -10.63, 15.38 ●
IICA64, Catete road, -8.88, 13.13 ●
?, Chitau, -11.38, 17.13 (Crawford-Cabral 1986)
?, Congulu, -10.88, 14.38 (Crawford-Cabral 1986)
?, Dundo, -7.38, 20.88
?, Duque de Braganca (= Calandula), -9.13, 15.88 (Crawford-Cabral 1986)
?, Humbe, -16.63, 14.88 (Crawford-Cabral 1986)
?, Monte Verde, -12.13, 15.13 (Crawford-Cabral 1986)
?, Pungo Andongo, -9.63, 15.63 (Crawford-Cabral 1986)
IICA7998, Salazar (= N'Dalatando), Agronomic Station, -9.38, 14.88 ●
?, Salvador do Congo (= M'Banza Congo), -6.38, 14.13 (Crawford-Cabral 1986)

BOTSWANA

NMZB64002, Selinda Spillway, -18.62, 23.37 ●
USNM00425345, Sepopa, -18.62, 22.12
NMZB64001, Sepopa, -18.62, 22.12 ●
USNM00425344, Shakawe, -18.35, 21.87
NMZB64003, Shakawe, -18.35, 21.87 ●
USNM00425348, Shakawe, 70 km SW, -18.55, 21.03
USNM00518652, Xugana, -19.08, 23.10 (Archer 1975)

DRC

RMCA29302, Albertville (= Kalemie), -5.95, 29.17 (Hayman *et al.* 1966)
RMCA20526, Banana, -5.97, 12.45 (Hayman *et al.* 1966)
RMCA6644, Basongo, -4.38, 20.38 (Hayman *et al.* 1966)
RMCA28803, Bunkeya, -10.37, 27.02 (Hayman *et al.* 1966)
RMCA1544a, Congo da Lemba, -5.70, 13.67 (Hayman *et al.* 1966)
RMCA19076, Dilolo, -10.48, 22.50 (Hayman *et al.* 1966)
RMCA22456, Elisabethville (= Lubumbashi), -11.68, 27.48 (Hayman *et al.* 1966)
RMCA?, Funda Biabo, -9.83, 25.53 (Schouteden 1947)
RMCA?, Gombe, -6.67, 20.95 (Schouteden 1947)
RMCA27581, Jadotville (= Likasi), -10.97, 26.78 (Hayman *et al.* 1966)
RMCA21483, Kabongo, -7.33, 25.57 (Hayman *et al.* 1966)
RMCA22379, Kakanda, -10.78, 26.60 (Hayman *et al.* 1966)
RMCA26239, Kakonde, -7.87, 29.72 (Hayman *et al.* 1966)
RMCA26221, Kalulako, -11.70, 27.57 (Hayman *et al.* 1966)
RMCA27667, Kapanga, -8.37, 22.62 (Hayman *et al.* 1966)
RMCA26381, Kapaso, -11.67, 27.48 (Hayman *et al.* 1966)
RMCA26337, Kaponda, -11.77, 27.33 (Hayman *et al.* 1966)
RMCA26346, Karavia, -11.68, 27.48 (Hayman *et al.* 1966)
RMCA22440, Kasenga, -10.37, 28.60 (Hayman *et al.* 1966)
RMCA26335, Kasongo, -4.52, 26.58 (Hayman *et al.* 1966)
IRSN10709, Kateke, -9.07, 26.72 (Hayman *et al.* 1966)
IRSN10710, Kiamokoto, -9.17, 27.07 (Hayman *et al.* 1966)
RMCA23817, Kikanda, -11.55, 27.62 (Hayman *et al.* 1966)
RMCA5478, Kikwit, -5.22, 18.82 (Hayman *et al.* 1966)
RMCA26385, Kilobilobe, -11.70, 27.57 (Hayman *et al.* 1966)
RMCA14589, Kilwa, -9.25, 28.35 (Hayman *et al.* 1966)
RMCA29142, Kipopo, -11.57, 27.35 (Hayman *et al.* 1966)
RMCA3433, Kisantu, -5.13, 15.15 (Hayman *et al.* 1966)
RMCA26217, Kiswishi, -12.85, 29.20 (Hayman *et al.* 1966)
?, Kitwit, -5.08, 18.91 (Van Cakenberghe *et al.* 1999)
RMCA11737, Lovoi, -8.63, 24.80 (Hayman *et al.* 1966)
RMCA?, Luanza, -8.67, 28.70 (Schouteden 1947)
RMCA26330, Lubwa, -11.63, 27.47 (Hayman *et al.* 1966)
RMCA6609, Luebo, -5.33, 21.55 (Hayman *et al.* 1966)
RMCA11129, Lukafu, -10.47, 27.53 (Hayman *et al.* 1966)
RMCA25629, Lula, -7.42, 22.55 (Hayman *et al.* 1966)
RMCA1954c, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)
RMCA7334, Lusambo, -4.98, 23.43 (Hayman *et al.* 1966)
IRSN10805, Lusinga, -8.88, 27.25 (Hayman *et al.* 1966)
IRSN10808, Mabwe, -8.70, 26.48 (Hayman *et al.* 1966)
RMCA26333, Madimao, -11.67, 27.48 (Hayman *et al.* 1966)
RMCA13966, Matadi, -5.83, 13.53 (Hayman *et al.* 1966)
RMCA26382, Mimbulu, -11.72, 27.32 (Hayman *et al.* 1966)
IRSN14525, Mpala, -10.48, 25.22 (Hayman *et al.* 1966)
RMCA26394, Mukuta, -11.68, 27.48 (Hayman *et al.* 1966)
IPNCW530, Murambi, -8.75, 26.77 (Hayman *et al.* 1966)
IRSN14532, Musosa, -9.00, 29.00 (Hayman *et al.* 1966)
RMCA6611, Ngombe, -6.67, 20.95 (Hayman *et al.* 1966)
RMCA2821, Sakania, -12.73, 28.57 (Hayman *et al.* 1966)
RMCA26356, Shindaika, -11.65, 27.68 (Hayman *et al.* 1966)
RMCA25628, Tshibaka, -7.63, 23.05 (Hayman *et al.* 1966)
RMCA?, Tshikapa, -6.47, 20.80 (Schouteden 1947)
RMCA26371, Tshisangwe, -11.47, 27.65 (Hayman *et al.* 1966)

MALAWI

KM11705, Blantyre, -15.78, 35.00 ●
NMZB59246, Chipanzi, -14.25, 34.25 ●
NMZB59239, Ciwale Hill, N of Dezda, -14.30, 34.25 ●
DCHC?, Kasungu NP, -13.05, 33.15 (Happold *et al.* 1987)
DCHC?, Lengwe NP, -16.20, 34.78 (Happold *et al.* 1987)
DCHC?, Liwonde NP, -15.03, 35.25 (Happold *et al.* 1987)
KM11722, Mulanje, -15.93, 35.62 ●
DCHC?, Mzuzu, -11.47, 34.07 (Happold *et al.* 1987)
KM11744, Nkhotakota, -12.93, 34.30 ●
KM1904, Nsanje, -16.53, 35.15 ●
KM11731, Ntchisi, -13.37, 34.02 ●
MMB?, Ntonda, -15.30, 35.48 (Happold *et al.* 1987)
DCHC?, Thondwe, -15.45, 35.25 (Happold *et al.* 1987)
KM11728, Thyolo, -16.12, 35.08 ●
DCHC?, Viphya Plateau, -12.38, 33.70 (Happold *et al.* 1987)
MMB?, Zoa Estate, -16.23, 35.20 (Happold *et al.* 1987)
DCHC?, Zomba, -15.38, 35.32 (Happold *et al.* 1987)
DCHC?, Zomba Plateau, -15.33, 35.32 (Happold *et al.* 1987)
KM11708, Zomba Plateau, -15.33, 35.32 ●

MOZAMBIQUE

USNM00365399, Boane, -26.13, 32.38
NMZB64007, Changalane (= Estatuane), -26.30, 32.20 ●
USNM00352049, Chimonzo, -24.92, 33.25
?, Dindiza, -23.38, 33.38 (Smithers & Lobão Tello 1976)
?, Espungabera, -20.50, 32.80 (Smithers & Lobão Tello 1976)
NMZB63177, Estatuane, -26.37, 32.12 ●
USNM00365334, Furancungo, 40 km NNW, -14.53, 33.45
NMZB64012, Gorongosa Mountain, -18.42, 34.00 ●
DM8532, Gurue, -15.46, 37.02 ●
DM8478, Gurue, -15.46, 37.02 ●
KM23774, Inhaca Island, -26.02, 32.97 ●
USNM00352095, Jangamo, -24.10, 35.30
?, Kambulatsisi, -15.88, 34.38 (Smithers & Lobão Tello 1976)
DM9371, Magude-Mapulenguene, -24.94, 32.55 ●
DM9331, Magude-Mapulenguene, -24.94, 32.55 ●
DM34, Manica, near, -19.03, 32.97 ●
DM8531, Massangena, -21.56, 32.96 ●
USNM00352090, Massinga, -23.13, 35.38

DM8535, Meponda, Lake Niassa, -13.40, 34.87 ●
USNM00352065, Moamba, -25.60, 32.23
NMZB64000, Nampula, 32 km WSW, -15.62, 38.87 ●
DM8547, Niassa GR, -12.87, 37.69 ●
DM8541, Niassa GR, 23 km S of Kiboko, -12.62, 37.66 ●
DM8526, Niassa GR, Maputo Camp, -12.18, 37.55 ●
DM8538, Niassa GR, Nkuli Camp, -12.17, 38.24 ●
USNM00352105, Panda, -24.05, 34.70
?, Tete, -16.27, 33.58 (Smithers & Lobão Tello 1976)
USNM00365379, Vila de Manica (= Manica), 10 km N, -18.83, 32.95
NMZB64010, Vila Gouveia, -18.07, 33.18 ●
USNM00365350, Vila Gouveia, -18.07, 33.18
NMZB63134, Vila Gouveia, S of, -18.25, 33.00 ●
NMZB64009, Zavora, -24.50, 35.00 ●
?, Zinave NP, -21.37, 33.87 (Smithers & Lobão Tello 1976)
NAMIBIA
NMZB63155, Gobabeb, Namib Desert, -23.55, 15.05 ●
SMM14538, Mudumu NP, Horseshoe Bend, -18.88, 23.63 ●
SMM1126, Orongo Water Camp, -17.63, 15.38 ●
KM1902, Rundu, SE of, -18.10, 20.38 ●
SOUTH AFRICA
DM6151, Ballito, -29.53, 31.22 ●
DM5405, Bonamanzi GR, -28.10, 32.30 ●
DM7488, Durban, Bellair, -29.88, 30.95 ●
DM6916, Durban, Burman Bush, -29.85, 31.00 ●
DM5126, Durban, Forest Hills, -29.75, 30.83 ●
DM7422, Durban, Glenwood, -29.83, 31.00 ●
DM7019, Durban, Malvern, -29.78, 31.03 ●
DM6875, Durban, Queensburgh, -29.85, 30.90 ●
DM5365, Durban, Renishaw, -30.27, 30.75 ●
DM6117, Durban, Westville, -29.83, 30.93 ●
DM5931, Durban Yellow Wood Park, -29.92, 30.93 ●
DM5373, Emphisini NR, -30.21, 30.79 ●
DM4551, Entumeni, -28.83, 31.37 ●
DM5900, Itala NR, -27.52, 31.37 ●
DM5367, Jozini Dam Tunnel, -27.42, 32.07 ●
DM5550, Kloof, -29.82, 30.83 ●
DM1278, Krantzkloof NR, -29.77, 30.83 ●
TM36120, Kruger NP, Levuvhu R, -22.43, 31.18 ●
TM39621, Kruger NP, Satara, -24.40, 31.77 ●
TM39621, Kruger NP, Satara, 8 km E, -24.40, 31.83 ●
TM38317, Kruger NP, Shingwedzi, -23.18, 31.23 ●
TM42126, Kruger NP, Skukuza, -24.98, 31.58 ●
USNM00351378, Maputa, -27.00, 32.75
DM5371, Mkhuze GR, -27.62, 32.23 ●
DM103, Mtunzini, Twin Streams, -28.95, 31.77 ●
USNM00381649, Nelspruit, 5 km SE, -25.48, 30.98
BM1906.8.2.36, Nelspruit, Legogot, -25.22, 31.25 ●
DM1619, New Germany, -29.78, 30.88 ●
TM39136, Ngome Forest, -27.83, 31.42 ●
KM26146, Ngqeleni, -31.83, 29.30 ●
DM8795, Phinda GR, Bayete Camp, -27.78, 32.31 ●
DM8785, Phinda GR, Forest Lodge, -27.78, 32.34 ●
DM8783, Phinda GR, Mziki Pan, -27.70, 32.41 ●
DM2894, Pietermaritzburg, Queen Elizabeth Park, -29.57, 30.33 ●
SAM ZM5599, Port St. Johns, -31.63, 29.55 ●
KM1905, Port St. Johns, -31.63, 29.55 ●
TM1076, Port St. Johns, -31.63, 29.55 ●
DM5404, Scottburgh, -30.28, 30.75 ●
DM955, Shongweni Polo Club, -29.82, 30.72 ●
DM5869, Stainbank NR, -29.92, 30.93 ●
DM8499, Tembe Elephant GR, Pumphouse, -27.06, 32.45 ●
DM8498, Tembe Elephant Reserve, Muzi R, -26.97, 32.52 ●
DM6873, Tongaat, -29.58, 31.18 ●
DM8000, Umdloti, -29.70, 31.10 ●
DM37, Umkomaas, -30.20, 30.80 ●
DM6378, Umlalazi NR, -28.96, 31.77 ●
USNM00381651, White River, 17 km W, -25.30, 31.05
KM18933, Zululand, -26.88, 32.33 ●
SWAZILAND
NMB11560, Maguga Dam, -26.13, 31.13 ●
DM8041, Mlawula NR, -26.19, 32.01 ●
DM5880, Simunye, 10 km N, -26.13, 31.96 ●
DM5849, Simunye, 15 km N, -26.10, 31.87 ●
DM5977, UNISWA, Kwaluseni Campus, -26.48, 31.30 ●
ZAMBIA
?, Chilanga, -15.55, 28.27 (Ansell 1978)
NMZB10220, Chingi, Chavuma, -13.02, 22.73 ●
?, Chisela Dambo, Mporokoso, -8.38, 29.75 (Ansell 1978)
NMZB16527, Choma, -16.65, 27.02 ●
NMZB63170, Fort Jameson (= Chipata), -13.62, 32.65 ●
NMZB29816, Hillwood Farm, Ikelenge, -11.23, 24.30 ●
NMZB29884, Jimbe Stream, -10.95, 24.08 ●
NMZB8277, Kabompo Boma, -13.58, 24.20 ●
?, Kafue NP, -15.87, 25.87 (Ansell 1978)
NMZB22678, Kafue R, -14.08, 27.38 ●
?, Kanyale Stream, -10.97, 24.12
NMZB64020, Kawambwa, -9.28, 29.00 ●
?, Kipushi, -11.90, 27.36 (Ansell 1978)
FMNH95218, Luachi R, -14.83, 22.37
NMZ2730, Muckle Neuk, -16.63, 27.00
?, Mwombezhi R, -12.22, 25.57 (Ansell 1978)
UZMZ?, Naleza, -15.45, 27.33
NMZB33273, Ndanda Dambo, Mongu, 70 km NE, -14.75, 23.75 ●
?, Ndola, -12.97, 28.63 (Ansell 1978)
?, Nyika NP, -10.58, 33.65 (Ansell 1978)
NMZB30293, Sakeji School, -11.12, 24.37 ●
NMZB11457, Sakeji Stream, -11.08, 24.33 ●
UZMZ?, Samfya, -11.33, 29.53
NMZB12273, Samfya, -11.33, 29.53 ●
?, Solwezi, -12.18, 26.42 (Ansell 1978)
NMZ3378, South Luangwa Valley, Mfuwe, -13.08, 31.78
ZIMBABWE
NMZB84192, Bubye R, Chikwarakwara, -22.35, 31.10 ●
NMZB58723, Chesengu Valley, -19.75, 32.25 ●
NMZB84138, Chikwarakwara, Pesu R Gorge, -22.28, 31.20 ●
DM5366, Chingamwe Estates, Juliasdale, -18.47, 32.75 ●
NMZB57670, Chiredzi Research Station, -21.02, 31.57 ●
NMZB58714, Chiredzi, Lone Star Ranch, -21.12, 31.87 ●
NMZB63149, Chirinda, -20.25, 32.50 ●
TM34607, Chirinda Forest, -20.42, 32.72 ●
NMZB58747, Chirinda Forest, -20.42, 32.72 ●
USNM00425291, Chirinda Forest, -20.42, 32.72
NMZB58749, Chirinda Forest, Gungunyama, -20.00, 32.50 ●
NMZB64797, Chizarira NP, Mchesu R, -17.75, 27.50 ●
NMZB64800, Chizarira NP, Mucheni Gorge, -17.50, 27.75 ●
NMZB80372, Dorowa Mine, -19.07, 31.77 ●
NMZB58717, Frog Mine, Mupfure R, -17.87, 29.87 ●
NMZB58756, Gonarezhou NP, Chipinda Pools, -21.27, 31.90 ●
NMZB55653, Gonarezhou NP, Mabalauta, -21.93, 31.47 ●
NMZB58726, Haroni-Rusitu R Confluence, -20.03, 33.02 ●
NMZB58730, Hippo Valley, Kutanga Estates, -21.12, 31.87 ●
NMZB58761, Katombora Rapids, -17.88, 25.33 ●
NMZB58750, Limpopo R, -22.32, 30.67 ●
NMZB58763, Makurupini, -19.75, 33.00 ●
USNM00425324, Martin Forest Reserve, -20.25, 32.75
NMZB30687, Matobo Hills, Mtshavezi Valley, -20.62, 28.87 ●
NMZB82575, Mavuradonha Wilderness Area, -16.25, 31.00 ●
NMZB19888, Mutare, Toronto, -18.90, 32.50 ●
USNM00479478, Ngorima Reserve, -19.75, 32.33
NMZB58721, Penhalonga, -18.87, 32.62 ●
NMZB58738, Pungwe-Rwera R Confluence, -18.25, 33.00 ●
NMZB63166, Rungwe R, -18.25, 33.00 ●
TM34769, Rusitu Forest, -20.03, 32.98 ●
NMZB30536, Rusitu Forest, -20.03, 32.98 ●
TM34973, Sengwa Wildlife Research Area, -18.17, 28.22 ●
NMZB58762, Sengwa Wildlife Research Station, -18.17, 28.22 ●
DM73, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB29585, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB29609, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB30806, Sentinel Ranch, Tongani R, -22.12, 29.62 ●
NMZB30829, Sentinel Ranch, Tongani R, -22.12, 29.62 ●
NMZB57625, Shambayetu Farm, Beitbridge, -21.75, 29.50 ●
NMZB56270, Tuli Camp, -21.90, 29.22 ●

rendalli

BOTSWANA
NMZB59311, Kurunxaraga, Okavango, -19.67, 22.83 ●
USNM00425343, Nokaneng, 21 km N, -19.42, 22.27
USNM00518669, Xugana, -19.08, 23.10 (Archer 1975)
DRC
RMCA28666, Albertville (= Kalemie), -5.95, 29.17 (Hayman *et al.* 1966)
RMCA7571, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al.* 1966)
HZM1.8024, Mulongo, Lualaba R, -7.83, 26.97 (Gallagher & Harrison 1977)
MALAWI
?, Chiromo, -16.53, 35.15 (Happold *et al.* 1987)
MOZAMBIQUE
?, Mague (= Mphende), -15.82, 31.73 (Smithers & Lobão Tello 1976)
?, Mozambique Island, -15.13, 40.63 (Smithers & Lobão Tello 1976)
DM8666, Palmiera, -25.22, 32.83 ●
SOUTH AFRICA
DM5361, Bonamanzi GR, -28.10, 32.30 ●
ZAMBIA
NMZ3535, Lochinvar, -15.98, 27.25 (Ansell 1974)
BM68.1010, Naleza, -15.45, 27.33 (Ansell 1969)
ZIMBABWE
TM41858, Mana Pools NP, -15.80, 29.33 ●

tenuipinnis

ANGOLA
?, Cotete (= Catete), -9.13, 13.63 (Crawford-Cabral 1986)
?, Dundo, -7.38, 20.88 (Crawford-Cabral 1986)
DRC
RMCA21375, Banana, -5.97, 12.45 (Hayman *et al*. 1966)
RMCA21484, Kabongo, -7.33, 25.57 (Hayman *et al*. 1966)
IRSN7742, Kalenda, -7.05, 23.50 (Hayman *et al*. 1966)
RMCA7313, Kisantu, -5.13, 15.15 (Hayman *et al*. 1966)
?, Kitwit, -5.08, 18.91 (Van Cakenberghe *et al*. 1999)
RMCA17661, Leopoldville (= Kinshasa), -4.30, 15.30 (Hayman *et al*. 1966)
RMCA9987, Leverville (= Lusanga), -4.83, 18.72 (Hayman *et al*. 1966)
RMCA?, Luebo, -5.33, 21.55 (Schouteden 1947)
RMCA7569, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al*. 1966)
RMCA?, Mweka, -4.75, 21.53 (Schouteden 1947)
BM?, Sombe, -8.83, 26.03 (Hayman *et al*. 1966)
RMCA7255, Tshikapa, -6.47, 20.80 (Hayman *et al*. 1966)

zuluensis

ANGOLA
?, Caquindo, -15.38, 17.13 (Crawford-Cabral 1986)
?, Dundo, -7.38, 20.88 (Crawford-Cabral 1986)
?, Kuvangu Mission (= Cubango), -14.38, 16.38 (Crawford-Cabral 1986)
?, Mucoti, -14.13, 15.88 (Crawford-Cabral 1986)
IICT3157013, Nova Lisboa (= Huambo), -12.88, 15.63 (Crawford-Cabral 1986)
BOTSWANA
TM6553, Chobe, -18.60, 24.37 ●
NMZB64077, Gomoti R, -19.37, 23.37 ●
NMZB80197, Nunga, -18.75, 23.50 ●
NMZB64096, Tamafupi, 33 km N, -19.25, 26.00 ●
NMZB64097, Tsum Tsum, Okavango, -19.00, 23.00 ●
USNM00518655, Xugana, -19.08, 23.10 (Archer 1975)
MALAWI
HZM5.1544, Likwenu R, -15.13, 35.38 (Happold *et al*. 1987)
DCHC?, Liwonde NP, -15.03, 35.25 (Happold *et al*. 1987)
MOZAMBIQUE
DM8536, Chinizuia Forest, -18.98, 35.05 ●
NMZB84002, Marromeu, Coutada 1, -18.25, 35.75 ●
DM8479, Meponda, 6 km E, -13.36, 34.90 ●
DM8539, Niassa GR, 23 km S of Kiboko, -12.62, 37.66 ●
DM8542, Niassa GR, Maputo Camp, -12.18, 37.55 ●
NMZB63186, Zinave NP, -21.37, 33.87 ●
NAMIBIA
SMM7845, Etaneno 44, Otjiwarongo, -20.88, 16.38 ●
NMZB64064, Gobabeb, Namib Desert, -23.55, 15.05 ●
TM27593, Gobabeb, Namib Desert, -23.55, 15.05 ●
SMM12236, Lianshulu, -18.00, 23.25 ●
KM1996, Muckwe, -18.12, 21.62 ●
SMM10918, Ombonde, -19.55, 14.53 ●
KM2150, Opuwo, S of, -18.70, 13.92 ●
SMM8272, Otjihavera, -19.84, 13.88 ●
KM28210, Otjiwarongo, -20.46, 16.31 ●
KM28211, Outjo, NW of, -19.90, 15.18 ●
KM1994, Rundu, SE of, -18.10, 20.38 ●
TM8083, Rundu, SE of, -18.10, 20.38 ●
SMM13598, San Michelle, -17.88, 23.38 ●
SOUTH AFRICA
TM24087, Blouberg NR, -23.03, 29.12 ●
TM3024, Hluhluwe-Imfolozi Park, Imfolozi, -28.32, 31.83 ●
NMZB56066, Klipfontein, Waterberg, -24.13, 28.30 ●
TM39697, Kruger NP, Letaba-Olifants R, -23.98, 31.83 ●
TM36846, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM30534, Kruger NP, Levuvhu R, -22.43, 31.18 ●
TM36572, Kruger NP, Phalaborwa, 12 km E, -23.95, 31.12 ●
TM39684, Kruger NP, Roodewal, -24.13, 31.60 ●
TM30672, Kruger NP, Shoshanga windmill, -22.67, 30.98 ●
TM39760, Kruger NP, Skukuza, -24.98, 31.58 ●
TM6457, Leydsdorp, -23.98, 30.52 ●
DM5359, Messina NR, -22.38, 30.07 ●
TM41408, Messina, 75 km W, -22.20, 29.38 ●
TM35248, Mkhuze GR, Msinga Pan, -27.60, 32.20 ●
TM17293, Newington, 11 km N, -24.75, 31.42 ●
TM19372, Vaalwater, 30 km NE, -24.13, 28.13 ●
TM39792, Vaalwater, 65 km N, -23.85, 28.15 ●
SWAZILAND
TM47720, Hlane NP, Bhubesi, -26.18, 31.86 ●
TM47719, Hlane NP, Ebaleni, -26.26, 31.95 ●
DM8506, Hlane NP, Ndlovu, -26.26, 31.88 ●
DM8513, Mbuluzi GR, -26.20, 31.98 ●
ZAMBIA
NMZB11190, Chilanga, -15.55, 28.27 ●
HZM2.3296, Chingi, Chavuma, -13.02, 22.73 ●
HZM1.2328, Chizera, Kasempa, -13.13, 25.00 ●
?, Luangwa Valley, Mfuwe, -13.08, 31.78 (Ansell 1978)
HZM3.3449, Mweru Wantipa, Kangiri, -8.50, 29.73 ●
UZMZ505, Naleza, -15.45, 27.33 (Ansell 1969)
NMZB33271, Ndanda Dambo, Mongu, 70 km NE, -14.75, 23.75 ●
NMZB33245, Ndanda School, Mongu, 70 km NE, -14.75, 23.75 ●
?, Ndola, -12.97, 28.63 (Ansell 1978)
NMZB33162, Senenga, 50 km NE, -15.62, 23.37 ●
ZIMBABWE
NMZB33630, Benzie's Bridge, Shangani R, -18.81, 27.90 ●
NMZB84193, Bubye R, Chikwarakwara, -22.35, 31.10 ●
NMZB57448, Chete, Eastern Section, -17.37, 27.62 ●
NMZB32493, Chinanga Dam, Maramba, -17.12, 32.87 ●
NMZB32953, Chishakwe Camp, 3 km E, -20.00, 32.00 ●
NMZB33816, Chishakwe Ranch, -20.12, 32.12 ●
NMZB30075, Chivi, -20.30, 30.52 ●
NMZB64798, Chizarira NP, Mchesu R, -17.75, 27.50 ●
NMZB30571, Dwala Ranch, Bubiana, -21.12, 29.62 ●
NMZB81513, Esigodini, Falcon College, -20.22, 28.92 ●
NMZB58888, Frog Mine, Mupfure R, -17.87, 29.87 ●
NMZB31171, Gutu Mission, -19.63, 31.17 ●
NMZB29700, Gwayi R Bridge, -18.62, 27.10 ●
NMZB33732, Kabuba Camp, Manjolo, -18.28, 28.08 ●
NMZB30935, Mafungabusi Forest, -18.25, 28.75 ●
NMZB33002, Makonde Hill, Save Valley, -20.00, 32.00 ●
NMZB84490, Marivalle Ranch, -18.75, 29.75 ●
NMZB29993, Matobo Hills, Lumane Valley, -20.58, 28.83 ●
NMZB29596, Matobo Hills, Totololo R, -20.55, 28.83 ●
NMZB30489, Mberengwa Mountain, -20.62, 29.92 ●
NMZB32665, Mzola Camp, -18.62, 27.37 ●
NMZB59302, Nottingham Estates, Beitbridge, -22.12, 29.87 ●
NMZB32517, Nyagui R, 2 km N of Chenjerai confluence, -17.37, 31.62 ●
NMZB32499, Nyashato Dam, -17.12, 32.12 ●
NMZB31755, Princess Farm, Shurugwi, -19.62, 29.92 ●
NMZB30033, Sengwa Wildlife Research Area, -18.17, 28.22 ●
NMZB58943, Sengwa Wildlife Research Station, -18.17, 28.22 ●
NMZB58945, Sengwa Wildlife Research Station, -18.17, 28.22 ●
NMZB30865, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB30808, Sentinel Ranch, Tongani R, -22.12, 29.62 ●
NMZB32667, Shangani R, Mzola Camp, -18.62, 27.37 ●
NMZB59235, Victoria Falls, -17.85, 25.75 ●
NMZB31964, Volunteer Farm, Main Camp, -18.82, 27.63 ●

Nycticeinops

schlieffeni

ANGOLA
?, Ruacana Falls, -17.38, 14.13 (Crawford-Cabral 1986)
BOTSWANA
NMZB63198, Chobe NP, Kasane, -17.80, 25.15 ●
NMZB64035, Mopipi, -21.00, 24.75 ●
NMZB64028, Mumpswe Pan, -20.20, 25.87 ●
NMZB60500, Nata R, -19.75, 26.75 ●
NMZB64032, Nthane, -21.25, 26.00 ●
NMZB64034, Nunga, -18.75, 25.50 ●
NMZB59224, Pom Pom, Okavango, -19.50, 22.75 ●
USNM00425350, Shakawe, 70 km SW, -18.55, 21.03
TM6552, Tsotsaoga, -18.63, 24.38 ●
TM47494, Tuli Block, Nitani, -22.13, 29.13 ●
USNM00518646, Xugana, 17 km N, -18.90, 23.10 (Archer 1975)
DRC
BM?, Dikulwe, -10.75, 25.37 (Hayman *et al*. 1966)
IRSN10719, Kabenge, -9.17, 26.95 (Hayman *et al*. 1966)
IRSN10714, Kateke, -9.07, 26.72 (Hayman *et al*. 1966)
RMCA?, Lufira, -10.17, 27.45 (Schouteden 1947)
BM?, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al*. 1966)
IRSN10716, Mabwe, -8.70, 26.48 (Hayman *et al*. 1966)
IRSN10798, Masombwe, -9.08, 27.10 (Hayman *et al*. 1966)
?, Mpala, -6.72, 29.52 (Noack 1887)
IRSN10718, Munoi, -8.75, 26.77 (Hayman *et al*. 1966)
IRSN14514, Musosa, -9.00, 29.00 (Hayman *et al*. 1966)
MALAWI
DCHC?, Kasungu NP, -13.05, 33.15 (Happold *et al*. 1987)
DCHC?, Lengwe NP, -16.20, 34.78 (Happold *et al*. 1987)
DCHC?, Liwonde NP, -15.03, 35.25 (Happold *et al*. 1987)
MOZAMBIQUE
?, Beira, -19.84, 34.88 (Smithers & Lobão Tello 1976)
DM8495, Buzi R, -19.93, 33.83 ●
DM8487, Caia Lodge, -17.85, 35.32 ●
USNM00365402, Chicoa, 20 km ESE, -15.70, 32.53
USNM00365404, Chiutu, -15.57, 33.28
NMZB63192, Cruz Dabacua Setache, Zinave, -21.00, 33.50 ●
?, Inhambane, -23.90, 35.40 (Smithers & Lobão Tello 1976)
?, Inharrime, W of, -24.38, 34.63 (Smithers & Lobão Tello 1976)
USNM00365405, Mague (= Mphende), -15.82, 31.73
NMZB63197, Malucas, -21.75, 33.25 ●
?, Manica, -18.93, 32.88 (Smithers & Lobão Tello 1976)
DM8490, Massangena, -21.56, 32.96 ●

USNM00365406, Mungari, 5 km N, -17.15, 33.57
DM8486, Niassa GR, -12.87, 37.69 ●
DM8485, Niassa GR, Maputo Camp, -12.18, 37.55 ●
DM8489, Niassa GR, Nkuli Camp, -12.17, 38.24 ●
DM9377, Save R, -21.18, 34.75 ●
?, Save-Lunde R Confluence, Marhumbini, -21.28, 32.38 (Smithers & Lobão Tello 1976)
TM1089, Tete, -16.27, 33.58 ●
NMZB63194, Zinave NP, -21.37, 33.87 ●
NMZB63196, Zinave NP, 3 km SSW, -21.39, 33.89 ●
NMZB63195, Zinave NP, 9 km SSW, -21.43, 33.93 ●

NAMIBIA

SMM8099, Eindopaal, -19.38, 15.63 ●
KM1936, Katima Mulilo, -17.50, 24.33 ●
KM1935, Muckwe, -18.12, 21.62 ●
USNM00304843, Numkaub, -18.60, 19.68
SMM10925, Ombonde, -19.55, 14.53 ●
KM1916, Opuwo, -18.18, 13.83 ●
KM1927, Opuwo, E of, -18.20, 13.67 ●
KM1934, Opuwo, N of, -17.33, 13.83 ●
KM1937, Opuwo, N of, -17.33, 13.83 ●
KM1932, Opuwo, S of, -18.70, 13.92 ●
KM1925, Opuwo, SE of, -18.63, 14.15 ●
TM11255, Otavi, Kaoko, -18.30, 13.77 ●
KM28212, Outjo, NW of, -19.90, 15.18 ●
SMM13612, San Michelle, -17.88, 23.38 ●

SOUTH AFRICA

TM44206, Alldays, 32 km NE, -22.33, 29.37 ●
TM24598, Hans Merensky NR, -23.67, 30.68 ●
SAM ZM10114, Hectorspruit, -25.43, 31.68 ●
TM45506, Klaserie NR, -24.20, 31.15 ●
TM39576, Kruger NP, Letaba, 1 km SE, -23.85, 31.57 ●
TM39617, Kruger NP, Letaba, 8 km SE, -23.90, 31.57 ●
TM39692, Kruger NP, Letaba-Olifants R, -23.98, 31.83 ●
TM42001, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM30476, Kruger NP, Levuvhu R, -22.43, 31.18 ●
TM39787, Kruger NP, Malelane, -25.47, 31.50 ●
TM39656, Kruger NP, Nwanedzi, -24.45, 31.97 ●
TM39604, Kruger NP, Olifants, 7 km W, -24.02, 31.65 ●
TM30655, Kruger NP, Punda Milia, -22.77, 31.02 ●
TM29924, Kruger NP, Punda Milia, 5 km NW, -22.68, 30.95 ●
TM39686, Kruger NP, Roodewal, -24.13, 31.60 ●
TM30678, Kruger NP, Shoshanga windmill, -22.67, 30.98 ●
TM30071, Kruger NP, Skukuza, -24.98, 31.58 ●
TM39700, Kruger NP, Skukuza, -24.98, 31.58 ●
TM39724, Kruger NP, Skukuza, 15 km S, -25.13, 31.62 ●
TM30555, Kruger NP, Stangene Dam, -22.80, 31.28 ●
TM41300, Langjan NR, -22.83, 29.20 ●
TM26672, Maasstroom, 1 km SSE, -22.75, 28.47 ●
TM44206, Messina NR, -22.38, 30.07 ●
DM5401, Mkhuze GR, -27.62, 32.23 ●
TM35321, Mkhuze GR, Msinga Pan, -27.60, 32.20 ●
TM35208, Ndumu GR, -26.88, 32.27 ●
TM24940, Sabie Sands GR, -24.75, 31.43 ●

SWAZILAND

DM8424, Hlane NP, Ndlovu, -26.26, 31.88 ●
TM44897, Mlawula NR, -26.19, 32.01 ●
DM5846, Mlawula NR, -26.19, 32.01 ●

ZAMBIA

KM1913, Balovale (= Zambezi), -13.55, 23.12 ●
?, Chisela Dambo, Mporokoso, -8.38, 29.75 (Ansell 1978)
NMZB10369, Kabompo Boma, -13.58, 24.20 ●
NMZB64052, Kafue NP, Chunga, -15.13, 25.88 ●
KM9662, Luangwa Valley, Petauke, -14.05, 31.08 ●
HZM25.11536, Lundazi, -12.30, 33.20
?, Muozi (= Mwoji) R, -12.38, 24.38 (Ansell 1978)
NMZB33492, South Luangwa Valley, Mfuwe, -13.08, 31.78 ●

ZIMBABWE

NMZB33894, Bulawayo, Fortune's Gate, -20.12, 28.58 ●
NMZB57452, Chete, Eastern Section, -17.37, 27.62 ●
NMZB60475, Chikwarakwara, -22.35, 31.10 ●
NMZB84095, Chikwarakwara, Pesu R Gorge, -22.28, 31.20 ●
NMZB32506, Chinanga Dam, Maramba, -17.12, 32.87 ●
NMZB60502, Chiredzi Research Station, -21.02, 31.57 ●
NMZB58813, Chiredzi, Lone Star Ranch, -21.12, 31.87 ●
NMZB60523, Chiredzi, Lone Star Ranch, -21.12, 31.87 ●
NMZB32938, Chishakwe Camp, 2 km E, -20.00, 32.00 ●
NMZB30558, Chisuma, Dibutibu R, -18.00, 26.00 ●
NMZB60509, Chitowe Camp, Runde R, -21.25, 32.25 ●
NMZB57451, Chizarira NP, Mucheni Gorge, -17.50, 27.75 ●
NMZB84321, Chori Dam, Tokwa Ngarwe, -16.75, 32.50 ●
NMZB30619, Dwala Ranch, Bubiana, -21.12, 29.62 ●
NMZB55652, Gonarezhou NP, Mabalauta, -21.93, 31.47 ●
NMZB55654, Gonarezhou NP, Mabalauta, -21.93, 31.47 ●
NMZB61968, Gonarezhou NP, Nyabungwe Camp, -21.25, 32.00 ●
NMZB60485, Guluene, -21.37, 31.87 ●
NMZB5331, Gwaai Reserve, Nata R, -19.75, 26.75 ●
NMZB60494, Hippo Valley, Kutanga Estates, -21.12, 31.87 ●
NMZB81867, Humani Ranch, -20.25, 32.25 ●
NMZB33766, Ingwe Safari, Deka, -18.42, 26.31 ●
NMZB60477, Kanyemba, -15.65, 30.33 ●
NMZB60689, Katombora Rapids, -17.88, 25.33 ●
NMZB33757, Kwizizi R, Deka Valley, -18.43, 26.32 ●
NMZB31325, Lake Kariba, Gatshe Gatshe Bay, -16.87, 28.87 ●
NMZB60496, Limpopo R, -22.32, 30.67 ●
NMZB60516, MacDougall's Tunnel, Triangle, -21.12, 31.37 ●
NMZB60488, Malimasi, Gokwe, -18.00, 28.75 ●
NMZB60492, Malugwe Pan, -21.62, 31.87 ●
NMZB60501, Mana Pools NP, -15.80, 29.33 ●
NMZB67367, Matetsi SA, HQ, -18.50, 25.75 ●
NMZB31582, Matetsi SA, Tshope vlei, -18.62, 25.87 ●
NMZB58466, Matusadona NP, Nyanumi R, -16.87, 28.37 ●
NMZB60484, Matusadona NP, Tashinga, -16.87, 28.37 ●
NMZB60497, Mazoe R, Mkota, -16.70, 32.78 ●
NMZB60480, Mutare Museum, -18.90, 32.50 ●
NMZB29758, Muzarabani, Arda Office, -16.37, 30.12 ●
NMZB32622, Mzola Camp, -18.62, 27.37 ●
NMZB59301, Nottingham Estates, Beitbridge, -22.12, 29.87 ●
NMZB84280, Nyadire River Camp, Pfungwe, -16.75, 32.25 ●
NMZB32504, Nyagui R, 2 km N of Chenjerai confluence, -17.37, 31.62 ●
NMZB32844, Nyamandhlovu, -19.75, 28.25 ●
NMZB84245, Nyandia Dam, -17.00, 32.00 ●
NMZB32507, Nyashato Dam, -17.12, 32.12 ●
NMZB60498, Ruenya R, Chikwizo, -17.25, 32.75 ●
TM10753, Sabi-Lundi (= Save-Runde) R Confluence, -21.28, 32.38 ●
NMZB32975, Save Valley, Makonde Hill, -20.00, 32.00 ●
NMZB60503, Sengwa Wildlife Research Area, -18.17, 28.22 ●
TM34863, Sengwa Wildlife Research Area, -18.17, 28.22 ●
DM3691, Sengwa Wildlife Research Station, -18.17, 28.22 ●
NMZB30668, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB9889, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB30832, Sentinel Ranch, Tongani R, -22.12, 29.62 ●
NMZB57624, Shambayetu Farm, Beitbridge, -21.75, 29.50 ●
NMZB60479, Tshakabika, -18.50, 26.25 ●
NMZB83880, Tuli Safari Area, -21.75, 29.00 ●
NMZB60495, Urungu R, Lomagundi, -16.00, 30.25 ●
NMZB59236, Victoria Falls, -17.85, 25.75 ●
NMZB54146, Victoria Falls, Zambezi Camp, -17.92, 25.83 ●
NMZB30775, Westwood Lodge, -17.75, 25.25 ●
NMZB31377, Zambezi R, Chirundu, -16.75, 28.75 ●

Pipistrellus

grandidieri

ANGOLA

AMNH?, Chitau, -11.38, 17.13 (Crawford-Cabral 1986)
AMNH85535, Chitau, -11.38, 17.13 (Thorn *et al.* 2007)
MNHN?, Galanga, -13.63, 14.38 (Crawford-Cabral 1986)
Museu Bocage, Galanga, -13.63, 14.38 (Crawford-Cabral 1986)
MNHN1900-536, Galanga, -13.63, 14.38 (Thorn *et al.* 2007)

DRC

RMCA8872, Elisabethville (= Lubumbashi), -11.68, 27.48 (Hayman *et al.* 1966)
RMCA6560, Kisantu, -5.13, 15.15 (Hayman *et al.* 1966)
IRSN10707, Lusinga, -8.88, 27.25 (Hayman *et al.* 1966)

MALAWI

TM41805, Likabula Mission, -15.95, 35.40 (Thorn *et al.* 2007)

hesperidus

BOTSWANA

NMZB63998, Four Rivers Camp, Okavango, -19.12, 23.12 ●

MALAWI

DCHC?, Nyika NP, -10.75, 33.92 (Happold *et al.* 1987)
NMZ3230, Wilindi Forest, Misuku Hills, -9.70, 33.83 (Ansell 1974)
DCHC?, Zomba Plateau, -15.33, 35.32 (Happold *et al.* 1987)

MOZAMBIQUE

?, Espungabera, -20.50, 32.80 (Smithers & Lobão Tello 1976)
DM8477, Gurue, -15.46, 37.02 ●
?, Maputo, W of, -25.88, 32.63 (Smithers & Lobão Tello 1976)

SOUTH AFRICA

DM7834, Amanzimtoti, -30.05, 30.88 ●
TM1990, Barberton, -25.82, 31.12 ●
KM2025, Bedford, SE, -32.88, 26.24 ●
DM7201, Cowies Hill, -29.83, 30.88 ●
NMB7852, Dennergeur, Boshof, -28.13, 25.13 ●
DM5352, Dlinza Forest, Eshowe, -28.91, 31.45 ●
TM40406, Dukuduku Forest, -28.38, 32.36 ●
DM7015, Durban, -29.85, 31.00 ●
DM5382, Durban, North Park NR, -29.87, 30.75 ●
DM5384, Durban, Pigeon Valley Park, -29.85, 30.98 ●

DM6010, Durban, Queensburgh, -29.85, 30.90 ●
DM5378, Durban, Rossburgh, -29.83, 30.88 ●
DM7073, Durban, Thomas More School, -29.78, 30.85 ●
DM5388, Durban Yellow Wood Park, -29.92, 30.93 ●
DM6793, Greater St. Lucia Wetlands Park, Iphiva Camp, -28.35, 32.43 ●
DM6895, Greater St. Lucia Wetlands Park, Iphiva Camp, -28.35, 32.43 ●
DM5369, Harold Johnson NR, -29.21, 31.42 ●
TM38493, Harrismith, -28.62, 29.02 ●
DM6150, Hillary, -29.88, 30.93 ●
TM44399, Hluhluwe-Imfolozi Park, Hluhluwe, -28.11, 32.30 ●
TM40455, Kosi Bay NR, -26.96, 32.83 ●
DM5876, Krantzkloof NR, -29.77, 30.83 ●
TM41658, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM47654, Loskopdam NR, -25.42, 29.33 ●
TM45357, Louis Trichardt, 16 km NW, -23.02, 29.77 ●
DM7143, Mount Edgecombe, -29.70, 31.07 ●
DM5872, Mtunzini, Twin Streams, -28.95, 31.77 ●
TM35207, Ndumu GR, -26.88, 32.27 ●
TM39134, Ngome Forest, -27.83, 31.42 ●
TM1073, Ngqeleni, -31.83, 29.30 ●
DM7839, Nkandla Forest Reserve, -28.72, 31.12 ●
DM8782, Phinda GR, Bayete Camp, -27.78, 32.31 ●
DM7144, Pinetown, -29.82, 30.87 ●
KM26140, Port St. Johns, -31.63, 29.55 ●
DM8013, Sodwana Bay Estuary, -27.54, 32.68 ●
DM5868, Stainbank NR, -29.92, 30.93 ●
TM1085, Tzaneen, -23.83, 30.17 ●
TM30126, Umlalazi NR, -28.96, 31.77 ●
KM26141, Willowvale, -32.30, 28.83 ●

SWAZILAND

TM45708, Luyengo, -26.58, 31.20 ●
DM8509, Malolotja NR, -26.16, 31.11 ●
TM47724, Malolotja NR, -26.16, 31.11 ●
DM8427, Mlawula NR, -26.19, 32.01 ●
TM47737, Mlawula NR, -26.19, 32.01 ●

ZAMBIA

?, Abercorn (= Mbala), -8.85, 31.38 (Ansell 1978)
NMZB11296, Chilanga, -15.55, 28.27 ●
NMZB9016, Kabompo Boma, -13.58, 24.20 ●
?, Kabompo, 50 km N, -12.92, 24.31 (Ansell 1978)
NMZB10231, Kasempa, S of, -14.08, 25.88 ●
NMZB33147, Ndanda School, Mongu, 70 km NE, -14.75, 23.75 ●
NMZB6931, Solwezi, -12.18, 26.42 ●

ZIMBABWE

NMZB60472, Banti, -19.25, 32.75 ●
TM34839, Bindura, 10 km SSW, -17.38, 31.28 ●
NMZB68268, Bulawayo, Hillside, -20.13, 28.58 ●
TM34634, Chirinda Forest, -20.42, 32.72 ●
NMZB31174, Dwala Ranch, Bubiana, -21.12, 29.62 ●
NMZB58719, Frog Mine, Mupfure R, -17.87, 29.87 ●
DM115, Gokwe, -18.12, 28.97 ●
NMZB60468, Harare, Atlantica Research Station, -17.75, 31.00 ●
TM11403, Inyanga NP, -18.28, 32.77 ●
NMZB58891, Lake McIlwaine, -17.90, 30.78 ●
NMZB84506, Munyati R, -18.50, 29.75 ●
NMZB59650, Rusitu Forest, -20.03, 32.98 ●
TM34767, Rusitu Forest, -20.03, 32.98 ●
NMZB30036, Sengwa Wildlife Research Area, -18.17, 28.22 ●
NMZB31667, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●

nanulus

DRC

AMNH49323, Mosenge - Bandundu, -4.39, 18.58 (Van Cakenberghe & Seamark 2008)

rueppelli

ANGOLA

?, Duque de Braganca (= Calandula), -9.13, 15.88 (Crawford-Cabral 1986)
?, Kuvangu Mission (= Cubango), -14.38, 16.38 (Crawford-Cabral 1986)

BOTSWANA

NMZB54103, Four Rivers Camp, Okavango, -19.12, 23.12 ●
TM6547, Maun, -19.98, 23.42 ●
NMZB59221, Pom Pom, Okavango, -19.50, 22.75 ●
USNM00518641, Xugana, -19.08, 23.10 (Archer 1975)
USNM00518640, Xugana, 11 km W, -19.08, 22.98 (Archer 1975)

DRC

RMCA29300, Albertville (= Kalemie), -5.95, 29.17 (Hayman *et al*. 1966)
RMCA27586, Jadotville (= Likasi), -10.97, 26.78 (Hayman *et al*. 1966)
BM?, Leopoldville (= Kinshasa), -4.30, 15.30 (Hayman *et al*. 1966)
RMCA12693, Moanda, -5.92, 12.40 (Hayman *et al*. 1966)
RMCA22125, Moba, -7.07, 29.75 (Hayman *et al*. 1966)
RMCA11549, Mweka, -4.75, 21.53 (Hayman *et al*. 1966)

MALAWI

MMB?, Chiromo, -16.53, 35.15 (Happold *et al*. 1987)
DCHC?, Liwonde NP, -15.03, 35.25 (Happold *et al*. 1987)
MMB?, Matope, -15.35, 34.95 (Happold *et al*. 1987)
DCHC?, Viphya Plateau, -12.38, 33.70 (Happold *et al*. 1987)
DCHC?, Zomba, -15.38, 35.32 (Happold *et al*. 1987)
DCHC?, Zomba Plateau, -15.33, 35.32 (Happold *et al*. 1987)

NAMIBIA

SMM2701, Andorosa Falls, -17.38, 13.88 ●

SOUTH AFRICA

MMK7047, Augrabies Falls NP, -28.60, 20.33 ●
TM36791, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM36122, Kruger NP, Levuvhu R, -22.43, 31.18 ●

ZAMBIA

KM1963, Balovale (= Zambezi), -13.55, 23.12 ●
NMZB10342, Kabompo Boma, -13.58, 24.20 ●
NMZB22680, Kafue R, -14.08, 27.38 ●
NMZB22757, Lochinvar NP, -15.88, 27.38 ●
LACM069912, Luangwa Valley, -12.75, 32.08 ●

ZIMBABWE

NMZB57441, Chete, Eastern Section, -17.37, 27.62 ●
NMZB60463, Chikwarakwara, -22.35, 31.10 ●
NMZB60464, Chikwarakwara, Pesu R Gorge, -22.28, 31.20 ●
NMZB64795, Chizarira NP, Mchesu R, -17.75, 27.50 ●
NMZB59317, Crowborough Sewage Works, Harare, -17.87, 30.90 ●
NMZB60462, Harare, Atlantica Research Station, -17.75, 31.00 ●
NMZB60676, Katombora Rapids, -17.88, 25.33 ●
NMZB60679, Kazangula, -17.83, 25.27 ●
NMZB60461, Lake McIlwaine, -17.90, 30.78 ●
NMZB60465, Marlborough Sewage Works, Harare, -17.75, 31.10 ●
NMZB60467, Marondera, Peterhouse School, -18.18, 31.62 ●
NMZB77683, Matusadona NP, Tashinga, -16.87, 28.37 ●
NMZB84269, Nyandia Dam, -17.00, 32.00 ●
NMZB64796, Sengwa Wildlife Research Area, -18.17, 28.22 ●
NMZB31995, Volunteer Farm, Main Dam, -18.82, 27.63 ●

rusticus

BOTSWANA

NMZB59214, First Pole Bridge, Okovango, -19.57, 22.88 ●
NMZB54104, Four Rivers Camp, Okavango, -19.12, 23.12 ●
NMZB63995, Francistown, 32 km N, -20.90, 27.50 ●
NMZB64152, Nata R, -19.75, 26.75 ●
USNM00518645, Nokaneng, 21 km N, -19.42, 22.27
NMZB80198, Nunga, -18.75, 23.50 ●
NMZB80201, Pandamatenga, 140 km SW, -19.25, 24.75 ●
NMZB59207, Pom Pom, Okavango, -19.50, 22.75 ●
HZM6.4042, Tamafupi, 33 km N, -19.25, 26.00 ●
USNM00575922, Xugana, -19.08, 23.10 (Archer 1975)

MALAWI

KM1903, Nsanje, -16.53, 35.15 ●
DCHC?, Thondwe, -15.45, 35.25 (Happold *et al*. 1987)
DCHC?, Viphya Plateau, -12.38, 33.70 (Happold *et al*. 1987)
DCHC?, Zomba, -15.38, 35.32 (Happold *et al*. 1987)
DCHC?, Zomba Plateau, -15.33, 35.32 (Happold *et al*. 1987)

NAMIBIA

KM1896, Rundu, S of, -18.60, 19.70 ●
KM1891, Tsumkwe, NW of, -19.27, 19.38 ●

SOUTH AFRICA

NMZB56074, Klipfontein, Waterberg, -24.13, 28.30 ●
TM36440, Kruger NP, Levuvhu R, -22.43, 31.18 ●
DM5865, Messina NR, -22.38, 30.07 ●
BM1906.8.2.34, Nelspruit, Legogot, -25.22, 31.25 ●
TM20649, Rissik NR, -24.88, 28.45 ●
KM31378, Soutpansberg, -22.98, 29.88 ●
TM39813, Vaalwater, 30 km NE, -24.13, 28.13 ●

ZAMBIA

KM1901, Balovale (= Zambezi), -13.55, 23.12 ●
NMZ2803, Lochinvar, -15.98, 27.25
HZM8.11411, Lochinvar Ranch, -15.87, 27.12 ●
HZM2.3283, Manyinga R, Kabompo, -13.17, 24.18 ●
NMZ2736, Muckle Neuk, -16.63, 27.00 (Ansell 1973)
UZMZ547, Naleza, -15.45, 27.33 (Ansell 1969)
NMZB33192, Ndanda Dambo, Mongu, 70 km NE, -14.75, 23.75 ●
NMZB33199, Senenga, 50 km NE, -15.62, 23.37 ●

ZIMBABWE

NMZB33631, Benzie's Bridge, Shangani R, -18.81, 27.90 ●
NMZB57614, Bulawayo, -20.12, 28.58 ●
NMZB84078, Chamatema Dam, Chikwarakwara, -22.35, 31.10 ●
NMZB57450, Chete, Eastern Section, -17.37, 27.62 ●
NMZB84137, Chikwarakwara, Pesu R Gorge, -22.28, 31.20 ●
NMZB31177, Dwala Ranch, Bubiana, -21.12, 29.62 ●
NMZB58812, Groenko Farm, Melsetter, -19.70, 32.85 ●
NMZB54111, Insuza Vlei, Gwaai Forest, -19.25, 28.00 ●
NMZB84464, Marivalle Ranch, -18.75, 29.75 ●
NMZB59652, Matobo Hills, Bale Hill Cave, -20.55, 28.48 ●
NMZB63212, Safari Farm, Marondera, -18.00, 31.50 ●
NMZB30039, Sengwa Wildlife Research Area, -18.17, 28.22 ●
NMZB58939, Sengwa Wildlife Research Station, -18.17, 28.22 ●
NMZB30663, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●

NMZB30823, Sentinel Ranch, Tongani R, -22.12, 29.62 ●
NMZB83867, Tuli Safari Area, -21.75, 29.00 ●
NMZB31966, Volunteer Farm, Main Camp, -18.82, 27.63 ●
NMZB60680, Westwood Lodge, -17.75, 25.25 ●

Scotoecus

albofuscus

DRC
RMCA22412, Baudouinville (= Moba), -7.05, 29.70 (Hayman *et al*. 1966)
MALAWI
BM17.2.1.1, Chiromo, -16.53, 35.15 (Cotterill 2001d) ●
MOZAMBIQUE
NMZB63200, Cruz Dabacua Setache, Zinave, -21.00, 33.50 (Cotterill 2001d) ●
SOUTH AFRICA
DM6931, Durban Yellow Wood Park, -29.92, 30.93 ●
DM4885, St. Lucia Village, -28.38, 32.42 ●
ZAMBIA
TM48306, Lusaka, -15.42, 28.27 ●

hindei/albigula

ANGOLA
?, Cunene R, -14.88, 15.13 (Crawford-Cabral 1986)
BM63.1042, Lago Calundo, -11.72, 20.80 (Cotterill 2001d) ●
DRC
RMCA22192, Kapolowe, -11.05, 26.95 (Hayman *et al*. 1966)
MALAWI
DCHC?, Kasungu NP, -13.05, 33.15 (Happold *et al*. 1987)
TM41785, Likabula Mission, Mulanje, -15.95, 35.48 ●
BM87.1139, Liwonde NP, -15.03, 35.25 (Cotterill 2001d) ●
BM87.1142, Thondwe, -15.45, 35.25 (Cotterill 2001d) ●
DCHC?, Zomba, -15.38, 35.32 (Happold *et al*. 1987)
MOZAMBIQUE
NMZB63247, Cruz Dabacua Setache, Zinave, -21.00, 33.50 (Cotterill 2001d) ●
DM9372, Gorongosa NP, Envirotrade, -18.98, 34.18 ●
DM9376, Magude-Mapulenguene, -24.94, 32.55 ●
NMZB63249, Malucas, -21.75, 33.25 (Cotterill 2001d) ●
DM8554, Massangena, -21.56, 32.96 ●
DM8553, Ribaue, 40 km W, -14.97, 38.08 ●
ZAMBIA
KM1982, Fort Jameson (= Chipata), -13.62, 32.65 ●
?, Kitwe, 10 km SE, -12.88, 28.38 (Ansell 1978)
LACM69965, Luangwa Valley, -12.75, 32.08 (Cotterill 2001d) ●
NMZB63220, Luangwa Valley, Mfuwe, -13.08, 31.78 (Cotterill 2001d) ●
NMZ3377, Luangwa Valley, Mfuwe, -13.08, 31.78 (Ansell 1973)
BM7.1.11.6, Luangwa Valley, Petauke, -14.05, 31.08 (Cotterill 2001d) ●
?, Nanzhila R, Kafue Flats, -15.88, 26.13 (Ansell 1978)
NMZB33059, Ndanda School, Mongu, 70 km NE, -14.75, 23.75 (Cotterill 2001d) ●

Scotophilus

dinganii

ANGOLA
?, Alto Chicapa, -10.88, 19.13 (Crawford-Cabral 1986)
?, Camabatela, 30 km W, -8.38, 15.13 (Crawford-Cabral 1986)
?, Dundo, -7.38, 20.88 (Crawford-Cabral 1986)
?, Huila, -15.13, 13.63 (Crawford-Cabral 1986)
?, Humbe, -16.63, 14.88 (Crawford-Cabral 1986)
?, Uije (= Uige), -7.63, 15.13 (Crawford-Cabral 1986)
BOTSWANA
USNM00382684, Dikomo Di Kai, -24.87, 24.52
NMZB59220, First Pole Bridge, Okovango, -19.57, 22.88 ●
NMZB64163, Francistown, -21.15, 27.50 ●
NMZB64162, Francistown, 32 km N, -20.90, 27.50 ●
NMZB64161, Gomoti R, -19.37, 23.37 ●
USNM00382658, Letlaking, 17 km SE, -24.22, 25.17
NMZB64188, Masetsi Bridge, -20.50, 26.50 ●
USNM00367754, Maun, -19.98, 23.42
USNM00367761, Sehitwa, 16 km SW, -20.38, 22.63
NMZB64158, Serowe, 40 km NW, -22.00, 26.29 ●
USNM00425351, Shakawe, 70 km SW, -18.55, 21.03
NMZB64197, Shakawe, 70 km SW, -18.55, 21.03 ●
USNM00382685, Tamafupi, 33 km N, -19.25, 26.00
NMZB64160, Tsigara, -20.33, 25.83 ●
NMZB54143, Tsum Tsum, Okavango, -19.00, 23.00 ●
USNM00518680, Xugana, -19.08, 23.10 (Archer 1975)
DRC
IRSN9069, Albertville (= Kalemie), -5.95, 29.17 (Hayman *et al*. 1966)
RMCA20748, Banana, -5.97, 12.45 (Hayman *et al*. 1966)
RMCA26321, Boma, -5.83, 13.05 (Hayman *et al*. 1966)
RMCA9179, Elisabethville (= Lubumbashi), -11.68, 27.48 (Hayman *et al*. 1966)
RMCA16232, Funda Biabo, -9.83, 25.53 (Hayman *et al*. 1966)
RMCA27585, Jadotville (= Likasi), -10.97, 26.78 (Hayman *et al*. 1966)
RMCA16249, Kabalo, -6.03, 26.92 (Hayman *et al*. 1966)
RMCA16252, Kadia, -8.27, 26.58 (Hayman *et al*. 1966)
IRSN7792, Kalenda, -7.05, 23.50 (Hayman *et al*. 1966)
RMCA26323, Kipopo, -11.57, 27.35 (Hayman *et al*. 1966)
RMCA22458, Kipushi, -11.77, 27.25 (Hayman *et al*. 1966)
RMCA6564, Kisantu, -5.13, 15.15 (Hayman *et al*. 1966)
?, Kitwit, -5.08, 18.91 (Van Cakenberghe *et al*. 1999)
RMCA7110, Luluabourg (= Kananga), -5.88, 22.43 (Hayman *et al*. 1966)
MALAWI
MMB?, Blantyre, -15.78, 35.00 (Happold *et al*. 1987)
MMB?, Chididi, -16.90, 35.17 (Happold *et al*. 1987)
DCHC?, Kamuzu Academy, -13.03, 33.67 (Happold *et al*. 1987)
DCHC?, Kasungu NP, -13.05, 33.15 (Happold *et al*. 1987)
DCHC?, Liwonde NP, -15.03, 35.25 (Happold *et al*. 1987)
MMB?, Mikolongwe, -15.85, 35.22 (Happold *et al*. 1987)
DCHC?, Viphya Plateau, -12.38, 33.70 (Happold *et al*. 1987)
MMB?, Zoa Estate, -16.23, 35.20 (Happold *et al*. 1987)
DCHC?, Zomba, -15.38, 35.32 (Happold *et al*. 1987)
DCHC?, Zomba Plateau, -15.33, 35.32 (Happold *et al*. 1987)
MOZAMBIQUE
?, Beira, -19.84, 34.88 (Smithers & Lobão Tello 1976)
USNM00365435, Chiutu, -15.57, 33.28
NMZB63269, Cruz Dabacua Setache, Zinave, -21.00, 33.50 ●
?, Gorongosa Mountain, -18.42, 34.00 (Smithers & Lobão Tello 1976)
DM8467, Gurue, -15.46, 37.02 ●
?, Inhambane, -23.90, 35.40 (Smithers & Lobão Tello 1976)
?, Inharrime, W of, -24.38, 34.63 (Smithers & Lobão Tello 1976)
NMZB63268, Malucas, -21.75, 33.25 ●
?, Manica, -18.93, 32.88 (Smithers & Lobão Tello 1976)
TM47809, Maputo Special Reserve, -26.35, 32.93 ●
?, Maputo, W of, -25.88, 32.63 (Smithers & Lobão Tello 1976)
DM8465, Massangena, -21.56, 32.96 ●
DM8468, Niassa GR, Nkuli Camp, -12.17, 38.24 ●
NMZB63255, Ressano Garcia, 10 km SSE, -25.37, 32.05 ●
DM8469, Ribaue, 40 km W, -14.97, 38.08 ●
?, Tete, -16.27, 33.58 (Smithers & Lobão Tello 1976)
?, Tete, S of, -16.63, 33.38 (Smithers & Lobão Tello 1976)
NMZB63254, Zinave NP, 3 km SSW, -21.39, 33.89 ●
NMZB63267, Zinave NP, 3 km SSW, -21.39, 33.89 ●
NAMIBIA
SMM2703, Daan Viljoen NP, -22.63, 16.88 ●
SMM8068, Eindopaal, -19.38, 15.63 ●
SMM12383, Eiseb R, -20.63, 20.63 ●
SMM7847, Etaneno 44, Otjiwarongo, -20.88, 16.38 ●
USNM00448331, Gam Waterhole, -20.42, 20.97
KM2392, Gobabis, -22.45, 19.87 ●
SMM6802, Karakuwisa, -18.88, 19.63 ●
KM31812, Omaruru, -21.28, 16.00 ●
SMM9902, Omega, -18.05, 22.18 ●
SMM6822, Omuramba, -17.88, 20.38 ●
SMM1124, Orongo Water Camp, -17.63, 15.38 ●
KM28216, Otjiwarongo, -20.46, 16.31 ●
KM28222, Outjo, SW of, -20.30, 15.83 ●
SMM9892, Popa Falls, -18.13, 21.63 ●
KM2401, Rundu, E of, -17.93, 20.48 ●
SMM1903, Tsotana, 18 km W, -19.13, 20.63 ●
SMM9984, Windhoek, NE of, -22.38, 17.38 ●
SOUTH AFRICA
KM2406, Albany District, -33.32, 26.39 ●
DM5909, Albert Falls NR, -29.43, 30.38 ●
DM6366, Amanzimtoti, -30.05, 30.88 ●
KM2403, Bedford, SE, -32.88, 26.24 ●
TM1929, Buffelsdraai, Brits, -25.12, 27.67 ●
USNM00468414, Buffelshoek, 22 km SE, -24.67, 27.37
TM20467, Derdepoort, 18 km SE, -24.75, 26.40 ●
DM5338, Dlinza Forest, Eshowe, -28.91, 31.45 ●
KM23779, Dumisa Gold Mine, Umzinto, -30.27, 30.35 ●
DM7063, Durban, -29.85, 31.00 ●
DM3971, Durban North, -29.83, 31.00 ●
DM4957, Durban, Bluff, -29.85, 31.00 ●
DM2464, Durban, Glenwood, -29.83, 31.00 ●
TM1094, Durban, Malvern, -29.78, 31.03 ●
DM1853, Durban, Westville, -29.83, 30.93 ●
DM5081, Emphisini NR, -30.21, 30.79 ●
TM7379, Eshowe, -28.90, 31.47 ●
DM1062, Greater St. Lucia Wetlands Park, Cape Vidal, -28.13, 32.55 ●
TM40434, Greater St. Lucia Wetlands Park, Charter's Creek, -28.20, 32.42 ●
DM2266, Greater St. Lucia Wetlands Park, False Bay, -27.97, 32.38 ●
TM23283, Groot Marico, 8 km SE, -25.63, 26.40 ●
TM24554, Hans Merensky NR, -23.67, 30.68 ●
TM19682, Hartebeestpoort Dam, -25.75, 27.85 ●
TM24872, Hectorspruit, 10 km NE, -25.33, 31.83 ●
DM3349, Hillcrest, -29.77, 30.60 ●
DM5088, Hilton, -29.56, 30.30 ●
TM40340, Hluhluwe-Imfolozi Park, Mansiya, -28.08, 32.30

DM1974, Howick, -29.50, 30.23 ●
DM5776, Inanda Dam, -29.68, 30.93 ●
TM12799, Irene, -25.87, 28.23 ●
DM6000, Itala NR, -27.52, 31.37 ●
TM31772, Itala NR, -27.52, 31.37 ●
KM2410, King William's Town, -32.87, 27.37 ●
SAM ZM19147, King William's Town, -32.87, 27.37 ●
DM7053, Kloof, -29.82, 30.83 ●
DM5874, Krantzkloof NR, -29.77, 30.83 ●
TM36537, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM30487, Kruger NP, Levuvhu R, -22.43, 31.18 ●
TM30572, Kruger NP, Mahembane, -22.65, 31.03 ●
TM30017, Kruger NP, Malelane, -25.47, 31.50 ●
TM36562, Kruger NP, Phalaborwa, 12 km E, -23.95, 31.12 ●
TM30591, Kruger NP, Punda Milia, -22.77, 31.02 ●
TM30562, Kruger NP, Stangene Dam, -22.80, 31.28 ●
TM1485, Leydsdorp, -23.98, 30.52 ●
TM2477, Louws Creek, Barberton, -25.65, 31.30 ●
KM31242, Lusikisiki, -31.28, 29.96 ●
DM5947, Midmar Training Centre, -29.53, 30.21 ●
TM35274, Mkhuze GR, Msinga Pan, -27.60, 32.20 ●
TM2870, Mooketsi, -23.67, 30.08 ●
TM19906, Naboomspruit, 3 km SE, -24.60, 28.77 ●
TM17294, Newington, 10 km N, -24.75, 31.42 ●
KM26150, Ngqeleni, -31.83, 29.30 ●
TM13726, Onderstepoort, -25.62, 28.20 ●
TM34345, Oribi Gorge NR, -30.72, 30.27 ●
KM23778, Pietermaritzburg, E of, -29.60, 30.52 ●
DM1840, Pietermaritzburg, Queen Elizabeth Park, -29.57, 30.33 ●
DM5335, Pietermaritzburg, Queen Elizabeth Park, -29.57, 30.33 ●
TM25461, Pietermaritzburg, Town Bush, -29.55, 30.35 ●
TM2871, Pietersburg (= Polokwane), -23.93, 29.48 ●
DM3675, Pinetown, -29.82, 30.87 ●
DM1163, Port Edward, 6 km W, -31.07, 30.17 ●
SAM ZM6853, Port St. Johns, -31.63, 29.55 ●
NMB5244, Pretoria, -25.83, 28.13 ●
TM1494, Pretoria, -25.72, 28.18 ●
DM6240, Pretoria, Hennops R, -25.83, 27.99 ●
USNM00342639, Rustenberg, 3 km E, -25.82, 31.27
DM5336, Sanbonani, -25.03, 31.16 ●
DM109, Scottburgh, -30.28, 30.75 ●
DM1626, Shepstone Reserve, -29.87, 30.98 ●
DM6889, Sobhengu Lodge, Nibela, -28.28, 32.42 ●
DM3681, Stainbank NR, -29.92, 30.93 ●
TM23326, Steilloop, 16 km W, -23.53, 28.42 ●
DM8501, Tembe Elephant GR, Pumphouse, -27.06, 32.45 ●
TM2055, Thabazimbi, 20 km SE, -24.67, 27.37 ●
TM7087, Tzaneen, -23.83, 30.17 ●
DM4453, Umhlanga Rocks, -29.73, 31.08 ●
TM7783, Umhlatusi R, -29.88, 31.00 ●
DM1637, Umhloti, -29.63, 31.08 ●
DM2448, Umkomaas, -30.20, 30.80 ●
TM34150, Vernon Crookes NR, -30.27, 30.60 ●
TM20690, Warmbaths, 8 km E, -24.88, 28.45 ●
DM611, Waterpoort, -22.90, 29.62 ●
SWAZILAND
TM45706, Edwaleni, -26.55, 31.27 ●
DM7186, Malkerns, -26.57, 31.15 ●
DM7900, Mlawula NR, -26.19, 32.01 ●
DM8033, Mlawula NR, -26.19, 32.01 ●
ZAMBIA
?, Abercorn (= Mbala), -8.85, 31.38 (Ansell 1978)
KM9659, Chadiza, -14.15, 32.75 ●
NMZB30018, Chingola, Mushishima Farm, -12.62, 27.87 ●
KM2390, Fort Jameson (= Chipata), -13.62, 32.65 ●
NMZB64167, Fort Jameson (= Chipata), -13.62, 32.65 ●
NMZB29805, Hillwood Farm, Ikelenge, -11.23, 24.30 ●
NMZB33886, Hillwood Farm, Ikelenge, -11.23, 24.30 ●
NMZB29838, Kalene Mission, -11.17, 24.18 ●
?, Kasama, -10.22, 31.17 (Ansell 1978)
UZMZ021, Lochinvar Ranch, -15.87, 27.12
KM9658, Luangwa Valley, Petauke, -14.05, 31.08 ●
NMZB33301, Ndanda School, Mongu, 70 km NE, -14.75, 23.75 ●
AMNH218900, Ngoma, -15.90, 25.95
UZMZ452, Samfya, -11.33, 29.53
NMZB33300, Senenga, 50 km NE, -15.62, 23.37 ●
ZIMBABWE
NMZB59108, Banket, -17.25, 30.25 ●
NMZB33637, Benzie's Bridge, Shangani R, -18.81, 27.90 ●
NMZB84332, Bopoma River Camp, Chimanda, -16.50, 32.25 ●
NMZB84208, Bubye R, Chikwarakwara, -22.35, 31.10 ●
NMZB56311, Bulawayo, -20.12, 28.58 ●
NMZB59191, Bulawayo, Gwabalanda, -20.00, 28.25 ●
NMZB32131, Bulawayo, Hillside, -20.13, 28.58 ●
NMZB59009, Carrick Creagh Farm, Harare, -17.72, 31.17 ●
NMZB57430, Chete, Chifumbi Spring, -17.37, 27.62 ●
NMZB59164, Chibero, -18.00, 30.50 ●
NMZB59090, Chikwarakwara, -22.35, 31.10 ●
NMZB84097, Chikwarakwara, Pesu R Gorge, -22.28, 31.20 ●
NMZB60515, Chiredzi Research Station, -21.02, 31.57 ●
NMZB32921, Chishakwe Camp, 2 km E, -20.00, 32.00 ●
NMZB84320, Chori Dam, Tokwa Ngarwe, -16.75, 32.50 ●
NMZB33598, Concession, -17.25, 30.75 ●
NMZB59105, Cotter Marondera, -18.10, 31.57 ●
NMZB58963, Darwendale, -17.75, 30.00 ●
NMZB32902, Deka-Zambezi R Confluence, -18.00, 26.50 ●
NMZB79470, Doddieburn Ranch, -21.40, 29.35 ●
NMZB32857, Douglasdale, -20.00, 28.50 ●
NMZB30591, Dwala Ranch, Bubiana, -21.12, 29.62 ●
NMZB63258, Eirene Farm, Marondera, -18.37, 31.62 ●
NMZB56353, Esigodini, Falcon College, -20.22, 28.92 ●
NMZB59118, Essexvale Ranch, -20.30, 28.93 ●
NMZB59074, Gonarezhou NP, Chipinda Pools, -21.27, 31.90 ●
NMZB55663, Gonarezhou NP, Mabalauta, -21.93, 31.47 ●
NMZB59014, Great Zimbabwe, -20.28, 30.93 ●
NMZB59038, Great Zimbabwe, -20.28, 30.93 ●
NMZB30718, Gutu Mission, -19.63, 31.17 ●
NMZB58967, Harare, -17.83, 31.07 ●
NMZB58965, Harare, Borrowdale, -17.83, 31.07 ●
NMZB32706, Harare, Christon Bank, -17.83, 31.07 ●
NMZB31693, Harare, Cleveland Dam, -17.75, 31.00 ●
NMZB59029, Harare, Greystone Park, -17.83, 31.07 ●
NMZB58966, High School Marondera, -18.00, 31.50 ●
NMZB58976, Hippo Valley, Kutanga Estates, -21.12, 31.87 ●
NMZB63164, Homestead Mine, Esigodini, -20.30, 28.93 ●
NMZB59003, Hwange NP, Kapami, -18.75, 26.50 ●
NMZB59126, Hwange NP, Main Camp, -18.73, 26.95 ●
NMZB59004, Hwange NP, Makalowa Pan, -19.00, 27.25 ●
NMZB59081, Hwange NP, Makalowa Pan, -19.00, 27.25 ●
NMZB59083, Hwange NP, Mandundumela Pan, -19.00, 27.00 ●
NMZB59008, Hwange NP, Ngamo Pan, -19.13, 27.47 ●
NMZB59082, Hwange NP, Ngweshla Pan, -19.00, 27.00 ●
NMZB54140, Insuza Vlei, Gwaai Forest, -19.25, 28.00 ●
NMZB33730, Kabuba Camp, Manjolo, -18.28, 28.08 ●
NMZB61975, Kanjedza R, Matusadona, -16.87, 28.62 ●
NMZB59107, Karoi, -16.82, 29.68 ●
NMZB60686, Katombora Rapids, -17.88, 25.33 ●
NMZB59163, Lake McIlwaine, -17.90, 30.78 ●
NMZB29801, Majorca Ranch, Kwekwe, -18.87, 29.62 ●
NMZB32967, Makonde Hill, Save Valley, -20.00, 32.00 ●
NMZB59085, Mangwe, Vashu Farm, -20.87, 28.12 ●
NMZB57638, Manyeringa Farm, Guruve, -16.50, 30.50 ●
NMZB84484, Marivalle Ranch, -18.75, 29.75 ●
NMZB59045, Marondera, Peterhouse School, -18.18, 31.62 ●
NMZB59000, Matema Camp, -20.00, 30.50 ●
NMZB30680, Matobo Hills, Lumane Valley, -20.58, 28.83 ●
NMZB59125, Matobo NP, -20.50, 28.25 ●
NMZB59087, Matobo NP, Maleme Dam, -20.50, 28.50 ●
NMZB59077, Matobo NP, Whitewaters Dam, -20.58, 28.47 ●
NMZB68256, Matobo Research Station, -20.25, 28.75 ●
NMZB59174, Mushandike NP, -20.13, 30.63 ●
NMZB27481, Mutare, -18.90, 32.62 ●
NMZB58969, Mutare, Fairbridge Park, -18.90, 32.62 ●
NMZB58997, Mutare, Jeff Estate, -18.97, 32.62 ●
NMZB82351, Mvuma, -19.25, 30.50 ●
NMZB32644, Mzola Camp, -18.62, 27.37 ●
NMZB58978, Ngamo Gwaai Reserve, -19.00, 27.50 ●
NMZB59517, Nottingham Estates, Beitbridge, -22.12, 29.87 ●
NMZB84281, Nyadire River Camp, Pfungwe, -16.75, 32.25 ●
NMZB32424, Nyadiri R, -17.12, 32.12 ●
NMZB32418, Nyagui R, 2 km N of Chenjerai confluence, -17.37, 31.62 ●
NMZB59145, Nyajena, -21.12, 31.62 ●
NMZB57755, Nyamunyeche, Mvurwi, -16.77, 30.95 ●
NMZB84261, Nyandia Dam, -17.00, 32.00 ●
NMZB32419, Nyashato Dam, -17.12, 32.12 ●
NMZB59215, Plumtree School, -20.25, 27.75 ●
NMZB84345, Ruya R, -16.50, 31.75 ●
NMZB59285, Sengwa Wildlife Research Area, -18.17, 28.22 ●
DM61, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB9877, Sentinel Ranch, Limpopo R, -22.15, 29.47 ●
NMZB30830, Sentinel Ranch, Tongani R, -22.12, 29.62 ●
NMZB32651, Shangani R, Mzola Camp, -18.62, 27.37 ●
NMZB59047, Torre, Marondera, -18.25, 31.00 ●
NMZB59148, Triangle Game Park, -21.00, 31.50 ●
NMZB59143, Triangle, near, -21.00, 31.50 ●
NMZB59106, Tupton, Marondera, -18.00, 31.50 ●
NMZB32697, Victoria Falls, -17.85, 25.75 ●
NMZB60685, Victoria Falls, Lodge 18, -17.85, 25.50 ●

NMZB32010, Volunteer Farm, Main Dam, -18.82, 27.63 ●
NMZB33735, Volunteer Farm, Zwikungwa, -18.91, 27.70 ●

leucogaster

ANGOLA
IICT3157011, Silva Porto (= Kuito), -12.38, 16.88 (Crawford-Cabral 1986)

BOTSWANA
NMZB59217, First Pole Bridge, Okovango, -19.57, 22.88 ●
NMZB64184, Gomoti R, -19.37, 23.37 ●
NMZB64192, Maun, -19.98, 23.42 ●
NMZB63216, Moremi GR, Khwai R, -19.15, 23.75 ●
NMZB64173, Mumpswe Pan, -20.20, 25.87 ●
NMZB64183, Nata R, -19.75, 26.75 ●
NMZB59218, Pom Pom, Okovango, -19.50, 22.75 ●
USNM00367755, Sehitwa, 16 km SW, -20.38, 22.63
NMZB64200, Sehitwa, 16 km SW, -20.38, 22.63 ●
NMZB64193, Sehitwa, 22 km W, -20.58, 22.53 ●
USNM00425356, Shakawe, 70 km SW, -18.55, 21.03
NMZB63263, Shakawe, 70 km SW, -18.55, 21.03 ●
NMZB64202, Shakawe, 70 km SW, -18.55, 21.03 ●
NMZB64178, Toromoja, -21.00, 24.50 ●
NMZB63214, Tsum Tsum, Okavango, -19.00, 23.00 ●
USNM00518679, Xugana, 17 km N, -18.90, 23.10 (Archer 1975)

MOZAMBIQUE
TM14703, Mague (= Mphende), -15.82, 31.73 ●
DM8576, Mepuze, -23.21, 32.50 ●

NAMIBIA
USNM00448337, Dose Pan, Okavango, -18.13, 20.88
SMM10704, Dose Pan, Okavango, -18.13, 20.88 ●
LACM056274, Gobabis, 70 km NE, -21.26, 18.96 ●
LACM056359, Grootfontein, 25 km SE, -19.50, 18.20 ●
USNM00448339, Kaudom GR, -18.47, 20.92
LACM056282, Omaruru, 10 km SE, -21.44, 15.61 ●
LACM056285, Omaruru, 30 km NW, -20.97, 15.30 ●
LACM059084, Opuwo, 70 km NW, -17.47, 13.03 ●
LACM059018, Rundu, 75 km SE, -18.53, 20.83 ●
KM2365, Rundu, SE of, -18.10, 20.38 ●

SOUTH AFRICA
TM39571, Kruger NP, Letaba Bridge, -23.82, 31.58 ●
KM31379, Kruger NP, Levuvhu Bridge, -22.42, 31.18 ●
TM30603, Kruger NP, Pafuri, -22.45, 31.30 ●
TM39677, Kruger NP, Roodewal, -24.13, 31.60 ●
TM30488, Kruger NP, Shoshanga windmill, -22.67, 30.98 ●

ZAMBIA
NMZB63221, Luangwa Valley, Mfuwe, -13.08, 31.78 ●

ZIMBABWE
NMZB57428, Chete, Chifumbi Spring, -17.37, 27.62 ●
NMZB57607, Chete, Kabaya Bay, -17.37, 27.62 ●
NMZB64788, Chirisa SA, Magurazino R, -17.62, 28.37 ●
NMZB32937, Chishakwe Camp, 3 km E, -20.00, 32.00 ●
NMZB81857, Humani Ranch, -20.25, 32.25 ●
NMZB59265, Hwange NP, Gomo Pan, -19.50, 26.50 ●
NMZB33765, Ingwe Safari, Deka, -18.42, 26.31 ●
NMZB61973, Kanjedza R, Matusadona, -16.87, 28.62 ●
TM45070, Kanyati, -16.88, 29.91 ●
NMZB60651, Katombora Rapids, -17.88, 25.33 ●
NMZB60656, Kazangula, -17.83, 25.27 ●
NMZB30699, Lake Kariba, Gatshe Gatshe Bay, -16.87, 28.87 ●
NMZB77682, Matusadona NP, Tashinga, -16.87, 28.37 ●
NMZB84409, Plumtree School, -20.25, 27.75 ●
DM3690, Sengwa Wildlife Research Area, -18.17, 28.22 ●
NMZB59272, Sengwa Wildlife Research Area, -18.17, 28.22 ●
NMZB32021, Shangani Bridge, Lubimbi, -18.62, 27.37 ●
NMZB31744, St James Mission, Nyamandlovu, -19.75, 28.00 ●
NMZB60663, Westwood Vlei, -17.75, 25.25 ●
TM34902, Sengwa Wildlife Research Area, -18.17, 28.22 ●
TM45059, Mana Pools NP, -15.80, 29.33 ●
TM45070, Kanyati, -16.88, 29.91 ●

nigrita

DRC
RMCA22948, Albertville (= Kalemie), -5.95, 29.17 (Hayman *et al.* 1966)

MALAWI
BM22.12.17.53, Chiromo, -16.53, 35.15 ●
BM22.12.17.55a, Mtondo, -16.28, 35.07 ●

MOZAMBIQUE
NHMUK 18767, Zinave NP, -21.37, 33.87 (Dalquest 1965, Smithers & Lobão Tello 1976)

SOUTH AFRICA
TM47626, Komatipoort, Ngwenya Lodge, -25.37, 31.86 ●
?, Malelane, -25.37, 31.86 ●

ZIMBABWE
BM47.7, Odzi, -18.95, 32.38 (Cotterill 1996a) ●

viridis

ANGOLA
?, Dundo, -7.38, 20.88 (Crawford-Cabral 1986)

MALAWI
DCHC?, Lengwe NP, -16.20, 34.78 (Happold *et al.* 1987)
DCHC?, Liwonde NP, -15.03, 35.25 (Happold *et al.* 1987)

MOZAMBIQUE
DM8473, Chinizuia Forest, -18.98, 35.05 ●
USNM00365436, Chiutu, -15.57, 33.28
SAM ZM37067, Coquno (= Coguno?), -24.27, 34.67 ●
NMZB63248, Cruz Dabacua Setache, Zinave, -21.00, 33.50 ●
NMZB63275, Malucas, -21.75, 33.25 ●
DM59, Mapinhane, -22.32, 35.05 ●
DM8471, Massangena, -21.56, 32.96 ●
DM8584, Niassa GR, -12.87, 37.69 ●
DM8585, Niassa GR, 23 km S of Kiboko, -12.62, 37.66 ●
DM8583, Niassa GR, Nkuli Camp, -12.17, 38.24 ●
NMZB63219, Pamzila, -21.25, 33.25 ●
NMZB63279, Ressano Garcia, 10 km SSE, -25.37, 32.05 ●
DM9373, Save R, -21.18, 34.75 ●
TM1092, Zimbita, Beira, -19.84, 34.88 ●
NMZB63223, Zinave NP, -21.37, 33.87 ●

SOUTH AFRICA
TM40354, Dukuduku Forest, -28.38, 32.36 ●
DM1022, Futululu, -28.42, 32.27 ●
TM41049, Greater St. Lucia Wetlands Park, Eastern Shores, -28.27, 32.48 ●
TM24555, Hans Merensky NR, -23.67, 30.68 ●
KM21098, Hlabisa, -28.18, 31.95 ●
DM3276, Hluhluwe-Imfolozi Park, Egodeni, -28.07, 32.03 ●
DM8053, Hluhluwe-Imfolozi Park, Mansiya, -28.08, 32.30 ●
TM34540, Kruger NP, Crocodile Bridge, -25.33, 31.87 ●
TM42087, Kruger NP, Skukuza, -24.98, 31.58 ●
TM13206, Middelburg, -25.87, 29.38 ●
TM35250, Mkhuze GR, Malibali Pan, -27.60, 32.20 ●
DM7513, Mkhuze GR, Mantuma, -27.59, 32.22 ●
TM35218, Ndumu GR, -26.88, 32.27 ●
DM8794, Phinda GR, Bayete Camp, -27.78, 32.31 ●
DM8786, Phinda GR, Mziki Pan, -27.70, 32.41 ●
DM1045, St. Lucia Village, -28.38, 32.42 ●
DM8488, Tembe Elephant GR, Pumphouse, -27.06, 32.45 ●
KM25972, Ubombo, -27.55, 32.67 ●

SWAZILAND
DM8432, Hlane NP, Ebaleni, -26.26, 31.94 ●
TM47745, Mlawula NR, Siweni, -26.18, 32.05 ●

ZAMBIA
NMZB20220, Luangwa Valley, Mfuwe, -13.08, 31.78 ●
NMZB33121, Ndanda School, Mongu, 70 km NE, -14.75, 23.75 ●
NMZB63213, Pwira Pan, -13.87, 27.87 ●
NMZB33129, Senenga, 50 km NE, -15.62, 23.37 ●

ZIMBABWE
NMZB84209, Bubye R, Chikwarakwara, -22.35, 31.10 ●
NMZB59269, Buffalo Range, Chiredzi, -21.03, 31.53 ●
NMZB30774, Chizarira NP, HQ, -17.50, 27.75 ●
NMZB59266, Fishans, Lower Runde R, -21.25, 32.25 ●
NMZB61976, Gonarezhou NP, Chipinda Pools, -21.27, 31.90 ●
NMZB31674, Gutu Mission, -19.63, 31.17 ●
NMZB32972, Makonde Hill, Save Valley, -20.00, 32.00 ●
TM45055, Mana Pools NP, Mondo R, -16.25, 29.58 ●
NMZB84393, Musengezi R, -16.25, 30.75 ●
NMZB56444, Mutare, Fairbridge Park, -18.90, 32.62 ●
NMZB32623, Mzola Camp, -18.62, 27.37 ●
NMZB59267, Ngamo Gwaai Reserve, -19.00, 27.50 ●
NMZB59268, Sabi-Lundi (= Save-Runde) R Confluence, -21.28, 32.38 ●
NMZB58681, Zambezi Valley, -15.75, 29.50 ●

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GLOSSARY

Aerial feeding: refers to bats that catch their insect prey on the wing.

Allopatric: geographically isolated distribution pattern of two closely related species (or populations) caused by dispersal (peripatry) or habitat vicariance (dichopatry).

Amplitude: refers to the intensity of a sound, as measured in decibels from a fixed distance (10 cm) from the bat's mouth.

Aspect ratio: the square of the wingspan, divided by the wing area. Bats with wide, short, and rounded wings have a low aspect ratio while bats with narrow, pointed wings have a high aspect ratio.

Ambient temperature: outside, environmental temperature, also termed 'room temperature'.

Anti-tragal lobe: lobe at the base of the tragus.

Bat detector: electronic device that converts the ultrasonic echolocation calls of bats into an audible signal.

Bat house: wooden structure designed for accommodating colonies of bats.

Binaural: both ears used to localise sounds.

Biodiversity: the total diversity of life at different structural and functional levels.

Biome: a major vegetation type.

Calcar: a bony spur projecting from the ankle of certain bats, e.g. the Nycteridae, and supporting the edge of the tail membrane.

Calcareous: of or containing calcium carbonate or another calcium salt.

Carnivorous: meat-eating; carnivorous species of bats feed on fish, frogs, rodents and other bats.

Cavernicolous: inhabiting caverns or caves.

Chiroptera: literally meaning 'hand-wing', the name given to the mammalian order of bats.

Cingulum, pl. -la: narrow shelf at base of tooth.

Classification (biological): system of arranging organisms into groups in a hierarchical arrangement (e.g. species, genera, families, orders, classes and kingdoms), based on similarity and evolutionary relatedness.

Clutter: refers to more closed habitats within the vegetation canopy, where free movement of bats is hindered.

Constant frequency (CF): refers to bat calls in which most of the sound is concentrated in a very narrow frequency band. Typical of the Rhinolophidae and Hipposideridae.

Coronoid process: the ascending arm at the posterior end of the mandible.

Cratons: the stable ancient cores of continents, usually made up of granitic rocks and greenstone belts.

Decibel: unit of amplitude or intensity of sound.

Delayed embryonic implantation: situation whereby fertilisation follows mating, usually just prior to winter, but the resulting blastocyst fails to implant immediately in the uterus, being delayed over the winter period until the onset of spring, where after implantation and normal embryonic growth continues.

Diastema: gap between the canine and premolar teeth.

Distal: farthest from point of attachment to body of an appendage.

Dolomite: a sedimentary carbonate rock composed of calcium magnesium carbonate.

Dominant frequency: that frequency within the range of a bat's echolocation call where the signal is the strongest (i.e. highest amplitude or intensity). Usually corresponds with the constant frequency portion of CF calls, or the lower 'hook' of the backwards-'J' shape of some FM calls.

Doppler-shift: a phenomenon whereby sound produced by a moving obstacle appears to drop in frequency (pitch) as the object passes an observer (e.g. the effect you hear as a car whizzes by).

Draculin: a pharmaceutical drug produced commercially from the blood of the common vampire bat *(Desmodus rotundus)* to alleviate blood clots in heart attack patients.

Duty-cycle: the echolocation calls of bats can be classified as high duty-cycle or low duty-cycle. In high duty-cycle echolocation, individual calls are of longer duration than the inter-call intervals (the signal is switched 'on' most of the time), while the reverse is true for low duty-cycle calls.

Duvenhage virus: name given to a lyssavirus ('rabies-like virus') described after its discovery following the death of Mr Duvenhage from a bite from an apparently infected bat.

East African Rift: an active continental rift zone in eastern Africa that appears to be a developing divergent tectonic plate boundary. The rift is a narrow zone in which the African Plate is in the process of splitting into two new tectonic plates.

Echolocation: the ability of bats and other animals to orient themselves and locate obstacles and their prey using echoes from sounds emitted typically from the mouth or nostrils.

Edaphic: produced or influenced by the soil.

Endorheic: referring to a closed lake, which retains water and allows no outflow to other bodies of water.

Exorheic: referring to drainage from an open lake (e.g. through rivers).

Epeirogenic: relating to the formation and alteration of continents by the (especially vertical) movement of the earth's crust.

Forearm: that part of the arm between the wrist and elbow. Length of the forearm is a commonly used measurement of size in bats.

Frequency: the 'pitch' of a sound (high or low), determined by the number of wavelengths per second, measured in Hertz (1 Hz = 1 cycle per second).

Frequency division: refers to bat detectors which transform the entire spectrum of sound by producing one pulse per predetermined number of incoming pulses, say 8 or 10, thus lowering the frequency into the audible range.

Frequency-modulated (FM): refers to bat calls which have a non-zero bandwidth, usually sweeping from high to lower frequencies.

Fulvous: reddish-yellow; dull yellowish brown, tawny.

Gestation: the time period from fertilisation to birth of young.

Gleaning: the ability of bats to obtain or snatch stationary prey from surfaces such as branches and the ground.

Graben: elongated block of rock that has been lowered by faulting relative to the surrounding blocks.

Greenstone: metamorphic rocks composed of minerals with a distinctly greenish colour, usually a product of the metamorphism of basalt.

Greenstone belt: large linear mass of greenstone, a characteristic feature of the geology of ancient cratons.

Harmonics: the different frequencies of complex sounds are not randomly ordered, but follow a precise sequence of related frequencies. The lowest, or first harmonic, is usually termed the fundamental; further harmonics are exact multiples of the fundamental, i.e. x2, x3, x4 etc.

Harp trap: harp-shaped device for trapping bats, originally designed by D. G. Constantine and modified by M. D. Tuttle. Two metal rectangular frames strung with fine fishing line are suspended close together with the lines offset, above a catch bag. Bats negotiating the first bank of strands collide with the second bank and slide downwards into the catch bag, which has smooth sides to prevent the bats from escaping. The modern commercially available harp trap is based on the design by Tidemann and Woodside (1978).

Heterodyne: with a heterodyne detector, the bat's ultrasound is converted into an electronic signal and compared with a variable internal signal, so that we listen to the (audible) difference between these two signals.

Hibernaculum: winter hibernating site.

Hibernation: process whereby the body metabolism is shut down to a basic level in response to winter cooling, thus allowing body temperature to fall to that of the environment, or to just above freezing in sub-zero temperatures.

Histoplasmosis: a lung disease, sometimes fatal, which is caused by inhaling spores of the fungus *Histoplasma capsulatum*, living in moist bird or bat guano.

Insectivorous: feeding on insects.

Interfemoral membrane: the part of the bat's membrane enclosed by the tail and two hind legs.

IUCN: acronym for the International Union for the Conservation of Nature.

Kilohertz (kHz): unit for measuring frequency.

Labial: on the outer (cheek) side of the teeth.

Lagos virus: a rabies-like virus first isolated from fruit bats in the vicinity of Lagos, Nigeria.

Lek, pl. leks: an area which the males of certain species use solely for communal breeding displays and to which the females come to mate; such a gathering or display.

Lindane: an organochloride, otherwise known as gamma HCH, one of the commonest ingredients of pesticide fluids applied to timber, which has been shown to be highly toxic to bats and people.

Linnaean hierarchy: hierarchical system of names used to classify all living organisms, from kingdom down to the categories of the species and subspecies.

Lithological: dealing with rocks.

Lyssavirus: a group of viruses related to rabies.

Manoeuvrability: ability of bats to fly in confined or cluttered spaces without stalling or colliding with obstacles.

Maternity colony: colony of bats in which females give birth to and rear their young until they are capable of flying and feeding themselves.

Megachiroptera (megabats): term designating the suborder of bats comprising Old World fruit-eating bats, possessing large eyes, and two claws on the wing. Recent molecular findings refute this name.

Mental: situated on the chin (mentum).

Mesic: of a habitat, containing a moderate amount of moisture.

Methyl bromide: a highly toxic gaseous fumigant, widely used in conjunction with a tent to eradicate insect pests, and in particular wood borer.

Microchiroptera (microbats): term designating the suborder of bats comprising all the insect-eating bats, blood and animal-feeders, and New World fruit-eaters, possessing small eyes and a single claw on the wing. Recent molecular findings refute this name.

Migration: regular movement from one locality to another, usually prompted by seasonal climate changes. In bats, hibernators migrate from warm to cooler caves in winter, while non-hibernating migrators move to warmer climates in winter.

Mistnet: fine net suspended between two poles and used to trap birds and bats.

Monaural: a single ear used to localise sound.

Monoestrus: having a single oestrus period per year.

Noseleaf: specialised flaps which surround the nostrils of certain families of bats, and which function to improve the directional ability of their echolocation calls.

Palatal emargination: dent in the anterior margin of the palate.

Palatal foramina: small vertical canal through bone of palate for transmission of nerve fibres or blood vessels.

Phytochorion, pl. -ia: a geographic area with a relatively uniform composition of plant species.

Polygyny: a mating system in which one male may mate with two or more females concurrently.

Polyoestrus: having more than one oestrus period per year.

Proximal: closest to point of attachment to body of an appendage.

Rabies: fatal disease in humans which is spread by transmission of the virus through the bite of an infected animal.

Rift valley: valley of regional extent formed by the collapse of a fault-bounded central zone.

Rufous: reddish-brown; rust-coloured.

Rupicolous: inhabiting rocks or rocky outcrops.

Species richness: the number of species listed per unit area.

Speleology: the science of cave exploration and research.

Sperm storage: process whereby, after mating occurs in autumn, viable spermatozoa are stored and nourished in the female's uterus or oviducts throughout the hibernation period until spring.

Sympatric: populations (or species) with overlapping distributions, in contrast to the geographically isolated distributions of allopatric species.

Thermolability: tendency of animals to show a remarkable degree of tolerance for fluctuation in their body temperature.

Time expansion detector: digitally provides the equivalent to recording sound on a high speed tape recorder, and then playing it back at a lower speed.

Torpor: the ability of bats and other mammals to drop their body temperature in response to cooling and/or reduced food availability.

Tragus: specialised flap in the ear of most microbats, not found in other mammals.

Transponder: minute transmitters that can be implanted under an animal's skin, and which must subsequently be detected at close range using a specialised scanner.

Tympanate: of moths, referring to the presence of hearing organs termed tympani.

Ultrasound: above the frequency threshold of human hearing, usually taken as approximately 20 kHz.

Wavelength: the measurement of the distance between the troughs (or crests) of two successive sound waves; the shorter the wavelength, the higher the frequency.

Wing loading: an index of flight ability, defined as the bat's body weight carried in flight, divided by its wing area. Bats with low wing loading can fly at slower speeds without stalling.

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