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African bats in the collection of the National Museum, Prague (Chiroptera). I. Bats from Zambia

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Abstract. A list of 139 specimens of bats belonging to 32 species of eight families originating from Zambia, housed in the collection of the National Museum, Prague, Czech Republic, is presented in a systematical review. The species lists are complemented by comments on distribution and morphometry data. The specimens represent 73 new records (species vs. locality) of bats from Zambia. The collection contains two species new for the Zambian fauna, *Afropipistrellus grandidieri* and *Neoromicia somalica*, and the bat fauna of Zambia now comprises 76 species in total. Two species, *Rhinolophus sakejiensis* and *Chaerephon bivittatus* are documented from Zambia for the second time, the former bat for the first time since the species description. The record localities of *Epomophorus labiatus*, *Rhinolophus mossambicus*, and *Neoromicia somalica* shift margins of the hitherto known distribution ranges of these bats. In *Epomophorus dobsonii*, *Nyctinomus aegyptiacus*, *Glauconycteris variegata*, *Pipistrellus rusticus*, *Scotophilus leucogaster*, and *S. viridis*, the collection specimens represent new peripheral records making their distribution range margins more precise. Molecular genetic analysis revealed new extents of distribution for particular mitochondrial lineages of otherwise common species in Zambia, *Hipposideros caffer*, *Nycteris thebaica*, and *Miniopterus natalensis* s.str.

Key words. National Museum, collection, catalogue, bats, distribution, Afrotropics, southern Africa, Northern Rhodesia.

INTRODUCTION

Zambia is a large country of south-central Africa, occupying 752,617 square kilometres of high plateaus, covered mainly by woodland savannas with large areas of wetlands and floodplains and small patches of dry broadleaf forests (Burgess et al. 2004). In comparison with the faunas of many other African countries, the bat fauna of Zambia is relatively well known. Already Ansell (1978) mentioned 62 species of bats from this country, and recently, at the time of immense taxonomic changes in the African mammal fauna, Monadjem et al. (2020a) reported the confirmed occurrence of 73 bat species from Zambia (Appendix 1).

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Bat specimens from Zambia are scattered throughout many collections; Monadjem et al. (2020a) reported almost 500 bat records from the country based on museum specimens. More than three quarters of these specimens (77.4%) are housed in four collections, viz. the Natural History Museum of Zimbabwe, Bulawayo, Zimbabwe; the Amathole Museum, King William's Town, South Africa; the Natural History Museum, London, UK; and the Livingstone Museum, Livingstone, Zambia; while the remaining specimens are reported to be spread across 13 collection institutions.

A small collection of bats from Zambia is also housed in the National Museum, Prague (NMP). The collection comprises mostly specimens gathered by the staff and students of the Department of Zoology, University of South Bohemia, České Budějovice, Czech Republic, during various research projects focused on the diversity of small mammal fauna of central Africa (see e.g., Bryja et al. 2012, 2014, 2018, McDonough et al. 2015, Mizerovská et al. 2019, etc.). The bats were collected relatively recently during several research trips to Zambia in the period 2009–2018 and have been transferred to the NMP collection in the last few years. The NMP series of Zambian bats contains 139 specimens belonging to 32 species of eight families. These bats originate from 29 localities covering the entire country (Fig. 1) and represent 73 records (species vs. locality), i.e. about 13% of the available country's amount of bat records. Thus, concerning the information potential, such a collection has a certain value. In this catalogue, we describe the NMP collection of Zambian bats in the context of the last and most comprehensive compendium of bats of Zambia and surrounding countries by Monadjem et al. (2020a).

We intend this contribution to be an initial part of a catalogue series of African bats housed in the NMP collection and an informal continuation of several geography-based catalogues of the NMP bat specimens, until now focused on the Palearctic fauna only (Gaisler 1956, Benda et al. 2008, 2011, 2018).

METHODS

The lists of specimens from the collection of the National Museum, Prague (NMP), are arranged in alphabetical order (according to the collection locality name) and then, in chronological order (according to collection date). The lists include, for each item, the following information: (1) indication of sex, (2) NMP collection ID, (3) preparation type (see Abbreviations below), (4) name of the locality (primarily listed by the name of the closest settlement or notable physical feature), (5) date of collection, and (6) collector name/s. For the names of the first level administrative divisions and geographic coordinates of the localities see gazetteer (Appendix 2; in alphabetical order). The lists of specimens of particular species are complemented by a list of references reporting the particular specimen/s or the finding/s, i.e., additional data concerning the specimens.

Basic biometric data taken from the NMP specimens are presented in Tables 1–10. The specimens were measured in a standard way with the use of mechanical calliper. Horizontal dental dimensions were taken on cingulum margins.

Molecular genetic examinations

The genomic DNA was extracted from alcohol-preserved tissue of the museum specimens using Geneaid Genomic DNA Mini Kit. We targeted the complete mitochondrial gene for cytochrome *b* (Cyt-*b*). When we were not able to obtain any sequence for this marker we targeted shorter parts of Cyt-*b* and completed the mitochondrial gene for NADH dehydrogenase subunit 1 (ND1). These markers were used frequently in previous studies dealing with African bats. The genes were amplified with the primers mtDNA-R3-F (TGGCATGAAAAATCACCGTTGT; Puechmaille et al. 2011) and CytB-H (CTTTTCTGGTTTACAAGACCAG; Weyeneth et al. 2008) for complete Cyt-*b*, F3.1-R (CGGTTGGGTTATTGGACCCA) and

R3.2-F (AGAATGAGTCTGAGGTGGCTTTT; Puechmaille et al. 2011), and Cytb1 (CCATCCAACAT-CTCAGCATGATGAAA) and Cytb2 (CCCTCAGAATGATATTTGTCCTCA; Kocher et al. 1989) for short Cyt-*b*, and ER65 (5'-CCTCGATGTTGGATCAGG-3') and ER66 (5'-GTATGGGCCCGATAGCTT-3; Dietz et al. 2016) for ND1. The PCR amplifications of complete Cyt-*b* were treated as in Uvizl et al. (2019), of shorter Cyt-*b* as in Puechmaille et al. (2011) and Šmíd et al. (2013), respectively, and of *ND1* as in Dietz et al. (2016). The PCR products were Sanger-sequenced from both sides using the PCR primers by Macrogen, Inc. (Amsterdam, the Netherlands).

Sequences were edited and aligned using the MAFFT plugin (Katoh & Standley 2013) in Geneious 11.0.5 (https://www.geneious.com), subsequently manually edited and trimmed using Gblocks (Castresana

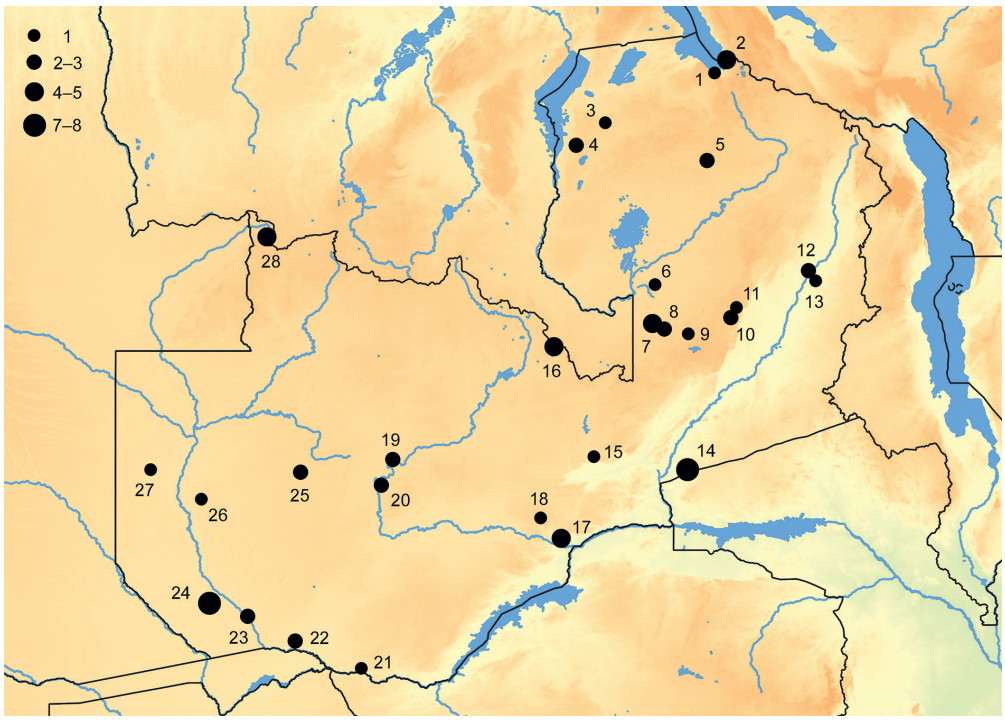

Fig. 1. Map of Zambia with the localities of recorded bat specimens housed in the collection of the National Museum, Prague, Czech Republic; the size of circle corresponds with the number of species collected (see legend in top left corner of the map). Localities: 1 – Kasakalawe, Lake Tanganyika Lodge, 2 – Kalambo Falls, 3 – Lumangwe Falls, 4 – Ntumbachushi Falls, 5 – Chishimba Falls, 6 – Bangweulu Game Reserve, Chikuni, 7 – Kasanka National Park, Luwombwa Camp, 8 – Kasanka National Park, Pontoon Camp & Fibwe Camp, 9 – Nsalu Cave, 10 – Mutinondo, Mayense Camp, 11 – Mutinondo, Kankonde Camp, 12 – North Luangwa National Park, Chifunda Camp, 13 – Chifunda, Old Luelo Ranger Post, 14 – Kacholola, 15 – Mkushi River Camp, 16 – Ndola Hill, 17 – Chisakila, Bwarenunka Cave, 18 – Lusaka, Lusaka East Forest Reserve, 19 – Kafue National Park, Lufupa River Camp, 20 – Kafue National Park, Chunga Camp, 21 – Livingstone, No Name Camp, 22 – Simungoma, Nulubeti village, 23 – Kabula Lodge, 24 – Sioma Bush Camp, 25 – Kaoma, Farmers Rendezvous Lodge, 26 – Newa, 27 – Liuwa Plain National Park, Lyangu Camp, 28 – Sakeji, Nchila Wildlife Reserve.

2000). Sequences of protein-coding markers were translated to amino acids to check for the presence of stop codons, which would indicate pseudogenes have been amplified. Basic Local Alignment Search Tool (BLAST; Altschul et al. 1990) was used to search for the most related sequences and therefore to identify the species of some samples that were difficult to identify by morphological examination. The GenBank Accession Numbers of the newly defined haplotypes are listed in Appendix 3, comparative haplotypes were extracted from the studies by Juste et al. (2013), Koubínová et al. (2013), Monadjem et al. (2013b, 2021), Goodman et al. (2015), Benda et al. (2016), Hutterer et al. (2019), and Moir et al. (2020).

Phylogenetic analyses of the obtained datasets were run maximum likelihood (ML). The appropriate nucleotide substitution model for each partition was selected based on the Bayesian information criterion (BIC) ModelFinder (Kalyaanamoorthy et al. 2017). We inferred the maximum-likelihood tree using the partition model in IQ-TREE (Nguyen et al. 2015). Searching for the best-scoring ML was performed by ultrafast bootstrap (UFBoot; Hoang et al. 2018) with 1,000 bootstrap and 1,000 topology replicates. To verify robustness of the ML tree, the branch supports were evaluated using SH-like approximate likelihood ratio test (SH-aLRT; Guindon et al. 2010) and a Bayesian-like transformation of aLRT (aBayes; Anisimova et al. 2011). SH-aLRT was performed with 1000 replications. aBayes branch support was used instead of Bayesian posterior probabilities because aBayes is more conservative, more robust to model violation and moreover exhibits the more confident resolution (Anisimova et al. 2011). The ML, SH-aLRT and aBayes analysis were run on IQtree web server (Trifinopoulos et al. 2016).

Abbreviations

Preparation type. A = alcohol specimen; – B = skin (balg); – S = skull; – Sk = skeleton.
Dimensions. **External**: G = weight; – LAt = forearm length. – **Cranial**: LCr = greatest length of skull (including praemaxilla); – LOc = occipitocanine length; – LCb = condylobasal length; – LCc = condylocanine length; – LaZ = zygomatic width; – LaI = width of interorbital constriction; – LaP = width of postorbital constriction; – LaInf = infraorbital width; – LaN = neurocranium width; – LaM = mastoidal width; – ANc = neurocranium height; – LBT = largest horizontal length of tympanic bulla; – CC = rostral width between labial margins of canines; – M^2M^2 = rostral width between labial margins of second upper molars; – M^3M^3 = rostral width between labial margins of third upper molars; – CM^2 = length of upper tooth-row between mesial margin of canine and distal margin of second molar; – CM^3 = length of upper tooth-row between mesial margin of canine and distal margin of third molar; – LMd = condylar length of mandible; – ACo = height of coronoid process; – CM_3 = length of lower tooth-row between mesial margin of canine and distal margin of third molar.
Collections. AMNH – American Museum of Natural History, New York, United States of America; – MHNG = Natural History Museum, Geneva, Switzerland; – NMP = National Museum (Natural History), Prague, Czech Republic; – ZMB = Natural History Museum, Berlin, Germany.
Others. leg. = legit [presented, bequeathed, sended]; – M = mean; – max., min. = dimension range margins; – SD = standard deviation.

ANNOTATED LIST OF SPECIMENS

Pteropodidae

Epomophorus crypturus Peters, 1852

Material (31 specimens). 1 ♂ (NMP 97595 [S+A]), Kabula Lodge, shrubland, 20 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera;
1 ♂, 1 ♀ (NMP 97692, 97693 [S+A]), Kacholola, riverine forest, 15 June 2010, leg. J. Šklíba, V. Mazoch & E. Knotková;
1 ♀ (NMP 97617 [S+A]), Kafue National Park, Chunga Camp, 28 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera;

2 ♂♂ (NMP 97615 [S+A], 97616 [A]), Kafue National Park, Lufupa River Camp, 26 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera;
1 ♂, 1 ♀ (NMP 97667, 97668 [S+A]), Kaoma, Farmers Rendezvous Lodge, small pool, 5 June 2010, leg. J. Šklíba, V. Mazoch & E. Knotková;
1 ♂, 4 ♀♀ (NMP 97559–97561, 97563 [S+A], 97562 [A]), Kasanka National Park, Luwombwa Camp, 27 November 2018, leg. P. Benda & J. Červený;
1 ♂, 1 ♀ (NMP 97629, 97630 [S+A]), Kasanka National Park, Pontoon Camp, riverine forest, 15 June 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera;
1 ♂, 1 ♀ (NMP 97671, 97672 [S+A]), Liuwa Plain National Park, Lyangu Camp, woodland, 8 June 2010, leg. J. Šklíba, V. Mazoch & E. Knotková;
1 ♀ (NMP 97662 [S+A]), Lumangwe Falls, chalet, 4 August 2009, leg. V. Mazoch & J. Zima;
1 ♀ (NMP 97666 [S+A]), Lusaka, Lusaka East Forest Reserve, miombo forest, 29 May 2010, leg. J. Šklíba & H. Patzenhauerová;
1 ♂ (NMP 97637 [S+A]), Mkushi River Camp, river bank, 4 July 2009, leg. V. Mazoch & J. Zima;
1 ♀ (NMP 97642 [S+A]), Mutinondo, Kankonde Camp, river bank, 9 July 2009, leg. V. Mazoch & J. Zima;
1 ♂, 1 ♀ (NMP 97622, 97623 [S+A]), Ndola Hill, 7 June 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera;

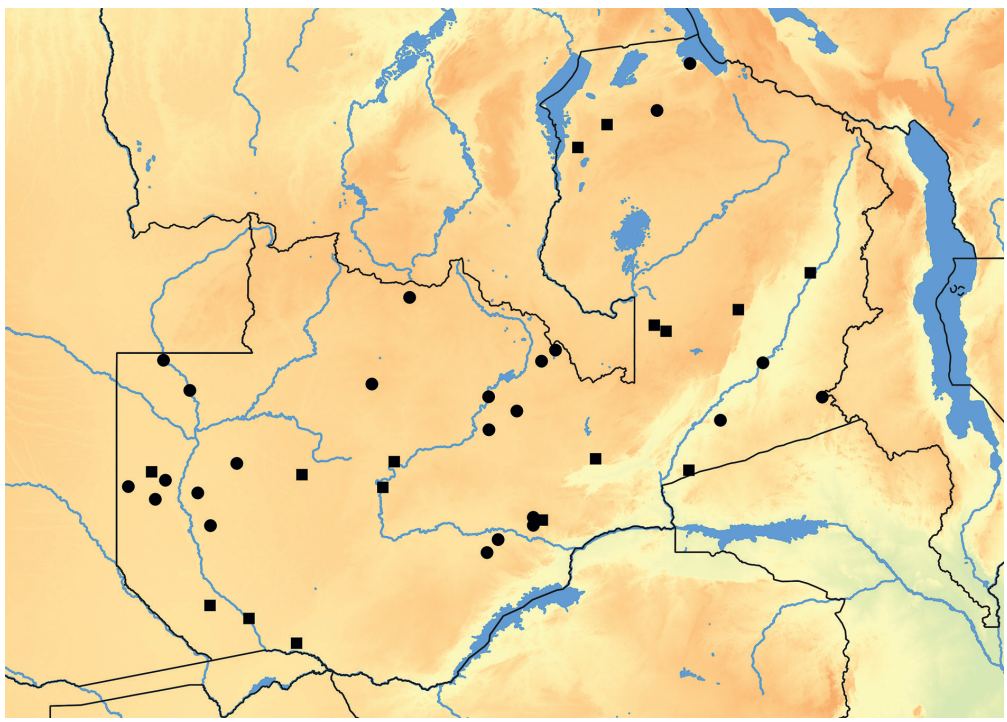

Fig. 2. Distribution of *Epomophorus crypturus* in Zambia based on museum specimens; circles – published data (Bergmans 1988, Monadjem et al. 2020a), squares – new data.

Table 1. Basic biometric data on the NMP specimens of *Epomophorus crypturus* from Zambia (only adult specimens are included). For abbreviations see Methods

dimension	males					females				
	n	**M**	min	max	SD	*n*	**M**	min	max	SD
G	*8*	**99.35**	90.0	105.0	4.593	*18*	**76.91**	52.0	88.0	8.278
LAt	*9*	**85.27**	83.2	87.6	1.575	*18*	**79.79**	72.8	86.3	2.976
LCr	*9*	**53.12**	45.75	55.56	2.964	*17*	**46.63**	40.76	53.06	2.503
LCb	*9*	**53.22**	45.28	55.75	3.167	*17*	**46.33**	40.35	53.13	2.673
LaZ	*9*	**26.43**	24.81	28.11	0.945	*17*	**24.55**	21.84	26.76	1.064
LaI	*9*	**8.65**	7.36	9.98	0.741	*17*	**7.64**	7.18	8.16	0.290
LaP	*9*	**10.17**	9.44	11.02	0.546	*17*	**9.71**	8.41	10.84	0.708
LaInf	*9*	**11.43**	10.27	12.36	0.662	*17*	**10.55**	9.45	11.92	0.566
LaN	*9*	**17.03**	16.56	18.13	0.607	*17*	**16.52**	15.61	17.61	0.555
LaM	*9*	**18.14**	17.34	19.08	0.570	*17*	**17.31**	16.23	18.63	0.620
ANc	*9*	**10.82**	10.41	11.62	0.349	*17*	**10.78**	10.22	11.71	0.440
LBT	*9*	**4.73**	4.46	4.98	0.192	*17*	**4.65**	4.18	5.12	0.238
CC	*9*	**9.85**	8.64	10.51	0.543	*17*	**9.25**	8.14	9.98	0.443
M^2M^2	*9*	**13.70**	12.54	14.42	0.558	*16*	**12.94**	11.32	14.17	0.661
CM^2	*9*	**17.86**	14.92	19.07	1.242	*16*	**15.80**	13.38	17.98	0.947
LMd	*9*	**42.42**	36.04	44.33	2.525	*17*	**36.73**	31.69	42.05	2.179
ACo	*9*	**16.28**	14.38	17.64	0.906	*17*	**14.17**	12.24	17.24	1.152
CM_3	*9*	**19.27**	16.35	20.21	1.193	*17*	**17.31**	14.85	19.76	0.995

1 ♀ (NMP 97643 [S+A]), North Luangwa National Park, Chifunda Camp, 12 July 2009, leg. V. Mazoch & J. Zima;
1 ♂ (NMP 97664 [S+A]), Ntumbachushi Falls, above road, 6 August 2009, leg. V. Mazoch & J. Zima;
3 ♂♂, 1 ♀ (NMP 97589 [S+A], 97590–97592 [A]), Simungoma, Nulubeti village, 19 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera;
1 ♂, 1 ♀ (NMP 97597, 97598 [S+A]), Sioma Bush Camp, 22 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera.

Epomophorus crypturus is an endemic of south-eastern Africa and the territory of Zambia represents a large segment of its distribution range (Bergmans 1988). Monadjem et al. (2020a) reported 25 confirmed record sites of this bat from Zambia and we added 15 new sites that well complement the distribution evidence across the country (Fig. 2); from the Lufupa Camp, this bat was reported also by Kearney et al. (2010). In the NMP collection, *E. crypturus* is the most numerous species of Zambian bats, it was recorded at 17 of 29 sampled localities, its specimens represent almost a quarter of the collection (22.3%). This bat is widespread in Zambia, it was collected from the whole territory of the country with the exceptions of the Chambeshi/Luapula river basin and the "Ikelenge Pedicle" of north-western Zambia (Fig. 2). The dimensions of the adult NMP specimens of *E. crypturus* from Zambia are shown in Table 1.

Epomophorus labiatus (Temminck, 1837)

Material (7). 2 ♀♀ (NMP 97659, 97660 [S+A]), Chishimba Falls, river bank, 25 July 2009, leg. V. Mazoch & J. Zima;

2 ♂♂, 1 ♀ (NMP 97655–97657 [S+A]), Kalambo Falls, camp above river, 18 July 2009, leg. V. Mazoch & J. Zima;
1 ♀ (NMP 97558 [S+A]; Fig. 3), Kasanka National Park, Luwombwa Camp, 27 November 2018, leg. P. Benda & J. Červený;
1 ♀ (NMP 97663 [S+A]), Ntumbachushi Falls, 6 August 2009, leg. V. Mazoch & J. Zima.

Epomophorus labiatus is distributed in the central and eastern parts of Africa and in southern Arabia (Happold 2013a). In Zambia, this species occurs only in the north-eastern section of the country and reaches there a segment of the south-western margin of its distribution range (Monadjem et al. 2020a). The NMP specimens of *E. labiatus* originate from four sites in Zambia, they fell roughly into the known range of distribution; from the Kalambo Falls this bat was reported already by Bergmans (1988), though as *E. minor* Dobson, 1880, a junior synonym of *E. labiatus* (Claessen & De Vree 1991, Bergmans & van Strien 2004). Two newly documented sites of occurrence of this bat, Luwombwa Camp in the Kasanka NP and Ntumbachushi Falls, demarcate newly the south-western margin of the species range (cf. Monadjem et al. 2020a; Fig. 4). A record of *E. labiatus* from the Kasanka NP was already marked by Happold (2013a), however, without reference to specimens and in a tentative version of map. Now, the occurrence of *E. labiatus* in this marginal part of the species range is confirmed and definitely represents a distribution extreme (Fig. 4).

The dimensions of the NMP specimens of *E. labiatus* from Zambia are shown in Table 2. The metric data conform to the characteristics of this species as defined by Bergmans & van Strien (2004).

Fig. 3. A female of *Epomophorus labiatus* (NMP 97558) netted at the Luwombwa Camp, Kasanka National Park, on 27 November 2018. All photos by J. Červený.

Table 2. Basic biometric data on the NMP specimens of *Epomophorus labiatus* and *E. wahlbergi* from Zambia. For abbreviations see Methods

dimension	*Epomophorus labiatus* males		*Epomophorus labiatus* females					*Epomophorus wahlbergi*
	NMP 97655	NMP 97656	*n*	**M**	min	max	SD	NMP 97583
G	45.0	50.0	*5*	**41.44**	37.2	45.0	3.297	91.0
LAt	66.3	65.6	*5*	**63.40**	62.1	65.0	1.405	80.3
LCr	39.66	39.38	*5*	**36.17**	33.86	37.98	1.674	44.97
LCb	38.86	38.84	*5*	**35.47**	33.03	36.94	1.628	44.76
LaZ	21.61	20.86	*5*	**19.93**	19.14	20.48	0.702	24.92
LaI	6.58	6.28	*5*	**6.20**	5.81	6.44	0.249	7.75
LaP	8.61	8.05	*5*	**8.78**	8.47	8.95	0.183	9.34
LaInf	9.57	9.03	*5*	**8.52**	8.21	8.74	0.232	11.32
LaN	13.90	13.63	*5*	**13.95**	13.16	14.42	0.542	16.13
LaM	14.43	14.74	*5*	**14.09**	13.54	14.53	0.490	17.12
ANc	10.38	9.77	*5*	**10.20**	9.83	10.51	0.279	10.38
LBT	3.98	3.69	*5*	**3.70**	3.55	3.89	0.127	4.64
CC	7.58	7.68	*5*	**6.83**	6.51	7.23	0.266	9.38
M^2M^2	11.44	10.74	*5*	**10.16**	9.81	10.38	0.223	–
CM^2	13.64	13.34	*5*	**12.12**	11.63	12.48	0.346	15.47
LMd	31.06	31.02	*5*	**28.08**	26.61	28.88	0.924	35.58
ACo	11.25	11.94	*5*	**10.86**	9.38	12.09	1.042	13.75
CM_3	14.84	14.37	*5*	**13.43**	12.55	14.21	0.637	17.38

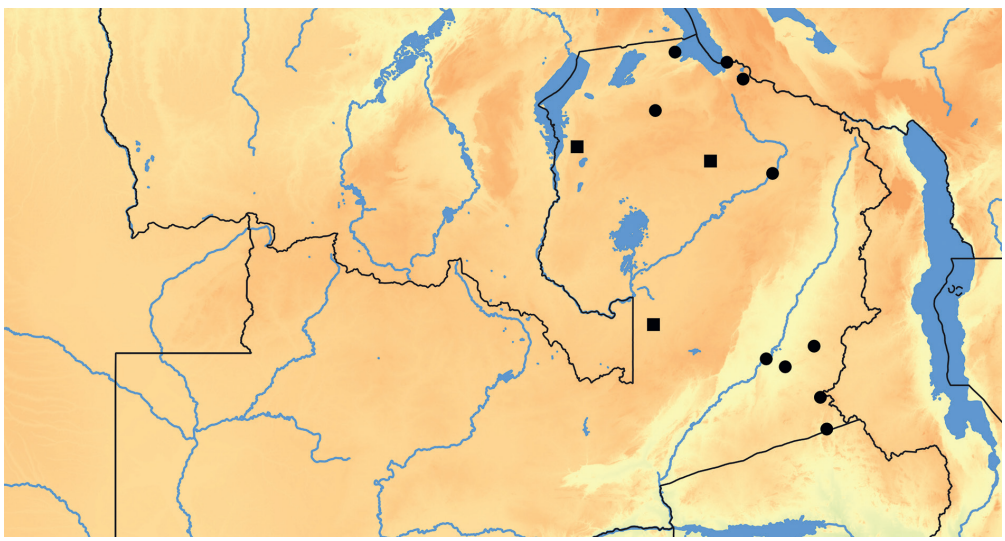

Fig. 4. Distribution of *Epomophorus labiatus* in Zambia based on museum specimens; circles – data published by Monadjem et al. (2020a), squares – new data.

Epomophorus wahlbergi (Sundewall, 1846)

Material (1). 1 ♀ (NMP 97583 [S+A]), Sakeji, Nchila Wildlife Reserve, 27 April 2009, leg. R. Šumbera, M. Lövy, H. Patzenhauerová & J. Šklíba.

Epomophorus wahlbergi is a widespread and common bat in the eastern and central parts of southern Africa (Bergmans 1988, Monadjem et al. 2020a), its rarity in the NMP collection from Zambia is thus rather surprising. A single specimen of *E. wahlbergi* was documented among almost fifty fruit bat specimens collected in Zambia. It was obtained from the area where it was documented already by Ansell (1978). The dimensions of the NMP specimen of *E. wahlbergi* are shown in Table 2.

Epomophorus dobsonii de Bocage, 1889

Material (8). 1 ♀ (NMP 97661 [S+A]), Chishimba Falls, river bank, 25 July 2009, leg. V. Mazoch & J. Zima;
1 ♂ (NMP 97691 [S+A]), Kacholola, riverine forest, 15 June 2010, leg. J. Šklíba, V. Mazoch & E. Knotková;
1 ♀ (NMP 97621 [S+A]), Ndola Hill, 7 June 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera;

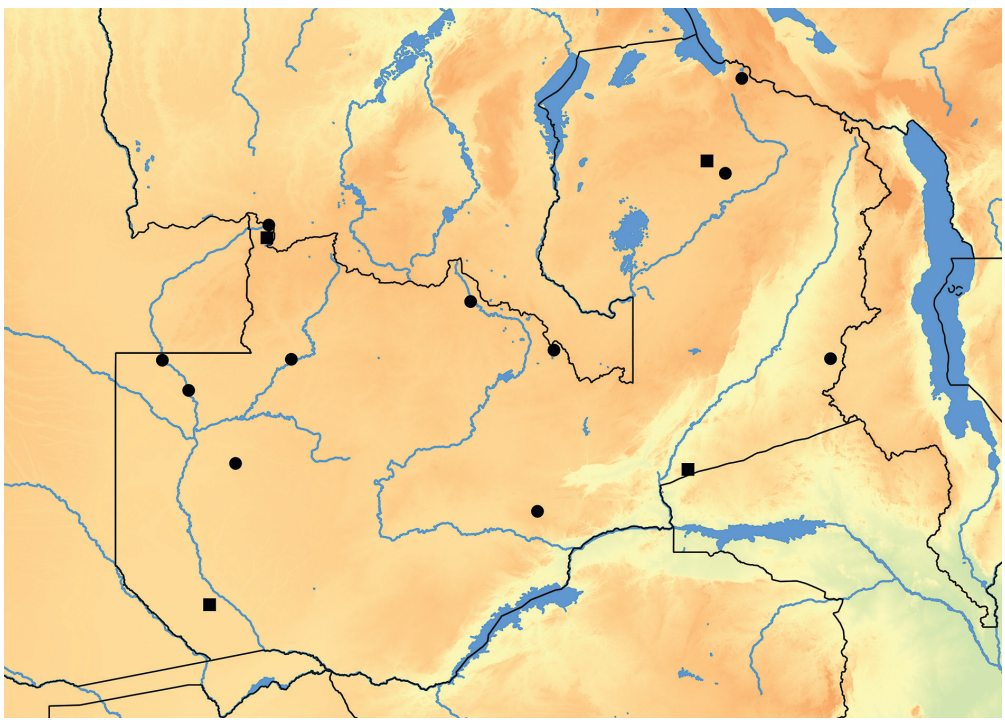

Fig. 5. Distribution of *Epomophorus dobsonii* in Zambia based on museum specimens; circles – published data (Bergmans 1989, Monadjem et al. 2020a), squares – new data.

Table 3. Basic biometric data on the NMP specimens of *Epomophorus dobsonii* from Zambia (only adult specimens are included). For abbreviations see Methods

dimension	males					females				
	n	**M**	min	max	SD	*n*	**M**	min	max	SD
G	*3*	**102.67**	88.0	112.0	12.858	*3*	**95.67**	90.0	104.0	7.371
LAt	*3*	**86.47**	82.0	90.7	4.355	*3*	**86.23**	83.4	90.3	3.612
LCr	*3*	**53.14**	50.13	55.03	2.637	*3*	**49.82**	47.38	53.29	3.088
LCb	*3*	**52.55**	48.88	54.61	3.186	*3*	**48.86**	46.98	51.93	2.679
LaZ	*3*	**26.28**	24.68	27.11	1.383	*3*	**24.78**	23.94	25.87	0.990
LaI	*3*	**7.29**	6.88	7.83	0.488	*3*	**6.90**	6.54	7.61	0.612
LaP	*3*	**10.51**	9.98	11.02	0.520	*3*	**10.47**	9.54	11.44	0.951
LaInf	*3*	**11.87**	11.16	12.34	0.626	*3*	**11.21**	10.71	11.58	0.449
LaN	*3*	**18.34**	18.04	18.64	0.300	*3*	**17.84**	17.29	18.48	0.599
LaM	*3*	**18.37**	18.05	18.78	0.374	*3*	**17.47**	16.84	18.38	0.809
ANc	*3*	**11.41**	11.21	11.64	0.217	*3*	**11.52**	10.86	12.33	0.746
LBT	*3*	**4.97**	4.83	5.08	0.129	*3*	**4.97**	4.51	5.24	0.400
CC	*3*	**10.34**	10.08	10.73	0.344	*3*	**10.18**	10.10	10.28	0.092
M^2M^2	*3*	**14.80**	13.75	15.56	0.938	*3*	**13.97**	13.83	14.14	0.158
CM^2	*3*	**15.92**	14.74	16.53	1.019	*3*	**14.48**	14.25	14.68	0.217
LMd	*3*	**41.62**	38.11	43.81	3.069	*3*	**39.00**	37.63	41.45	2.127
ACo	*3*	**13.67**	13.23	14.04	0.410	*3*	**13.31**	12.82	14.08	0.675
CM_3	*3*	**17.54**	16.21	18.48	1.184	*3*	**15.76**	13.73	17.18	1.806

2 ♀♀ (NMP 97578, 97584 [S+A]), Sakeji, Nchila Wildlife Reserve, 27 April 2009, leg. R. Šumbera, M. Lövy, H. Patzenhauerová & J. Šklíba;
2 ♂♂ (NMP 97585, 97586 [A]), Sakeji, Nchila Wildlife Reserve, 28 April 2009, leg. R. Šumbera, M. Lövy, H. Patzenhauerová & J. Šklíba;
1 ♂ (NMP 97606 [S+A]), Sioma Bush Camp, 23 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera.

The territory of Zambia represents a large part of the distribution range of *Epomophorus dobsonii* (Bergmans 1989). As a faunal element of central Africa, it reaches a part of the southern margin of its distribution in this country. Published records of *E. dobsonii* are available from all parts of Zambia, except the areas south of Lusaka. The NMP collection contributes to the distribution picture at the southern margin of the range of this bat (Fig. 5); the finding of a male specimen at the Sioma Bush Camp represents the second southernmost record and that from Kacholola the fifth southernmost record of this species (Bergmans 1989, Monadjem et al. 2020a). The dimensions of the NMP specimens of *E. dobsonii* from Zambia are shown in Table 3.

Rhinolophidae

Rhinolophus clivosus Cretzschmar, 1828

Material (2). 1 ♀ (NMP 97631 [S+A]), Kasanka National Park, Fibwe Camp, chalet, 16 June 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera;

1 ♂ (NMP 97665 [S+A]), Kasanka National Park, Fibwe Camp, chalet, 10 August 2009, leg. V. Mazoch & J. Zima.

Rhinolophus clivosus is a locally abundant species throughout southern Africa; however, in Zambia it is a rather rare species, only seven confirmed record sites were reported from the country (Monadjem et al. 2020a). The available records are spread over the whole country, the new locality of the NMP specimens from the Kasanka NP does not represent an important contribution to the distribution picture of this bat.

The dimensions of the NMP specimens of *R. clivosus* from Zambia are shown in Table 4. This bat is considered a polyphyletic species, although this matter has not yet been resolved definitely (see Csorba et al. 2003, Benda & Vallo 2012, Stoffberg et al. 2012, Bernard & Happold 2013, Benda et al. 2017, Demos et al. 2019a, Monadjem et al. 2020a, etc.). Three groups of populations being worthy of possible species status were suggested to occur within the distribution range of this bat, from the Middle East in the north and southern Africa in the south (Benda et al. 2017). These groups differ from each other in morphometric and molecular genetic traits (mtDNA) (Aellen 1939, Benda & Vallo 2012). The Zambian samples represent the large-sized morphotype that comprises the populations occurring between Uganda and South Africa, tentatively referred to *R.* (*clivosus*) *augur* Andersen, 1904 (LAt 49.2–57.4 mm, LCc 18.47–20.57 mm, CM^3 7.09–8.82 mm; Benda et al. 2017) that possesses a genetic lineage of its own (at least on the mitochondrial genome; Benda & Vallo 2012: 81, Fig. 6).

Table 4. Basic biometric data on the NMP specimens of Rhinolophidae and Hipposideridae from Zambia. For abbreviations see Methods

dimension	*Rhinolophus clivosus*		*Rhinolophus sakejiensis*	*Rhinolophus fumigatus*		*Rhinolophus mossambicus*		*Hipposideros caffer*			*Macronycteris vittata*
	97631	97665	97587	97641	97650	97612	97640	97570	97571	97572	97569
G	18.5	18.0	21.0	16.0	11.5	22.0	28.5	7.8	7.2	7.3	74.2
LAt	52.5	52.5	56.6	53.8	48.7	66.3	66.4	46.9	47.0	46.7	99.0
LCr	22.82	23.08	25.47	23.72	21.96	29.17	29.96	–	17.05	17.44	33.25
LCO	22.19	22.31	24.76	23.06	21.28	28.44	28.51	–	16.93	17.31	33.44
LCc	19.61	19.87	21.86	20.14	18.65	25.09	25.34	–	14.88	15.06	29.83
LaZ	11.62	11.82	13.39	11.77	11.09	14.23	14.27	–	9.18	9.28	17.18
LaI	2.62	2.52	3.18	2.62	2.13	2.89	2.66	–	2.54	2.32	3.11
LaInf	5.91	5.98	6.91	6.19	5.49	7.79	7.43	–	4.81	4.93	9.26
LaN	9.29	9.29	10.27	9.49	8.74	10.81	11.03	–	7.49	7.46	11.54
LaM	10.27	10.47	11.56	10.86	10.08	12.76	12.68	–	9.28	9.32	14.87
ANc	6.76	7.04	7.84	6.51	6.34	8.13	8.21	–	5.74	5.74	10.54
LBT	3.28	3.48	3.45	4.41	3.88	4.88	5.27	–	3.15	3.38	4.33
CC	6.29	6.37	7.60	6.44	5.86	7.79	7.96	–	3.93	4.16	8.85
M^3M^3	8.31	8.65	9.89	8.54	8.01	10.07	10.49	–	6.14	6.25	11.91
CM^3	8.17	8.48	9.61	8.43	7.75	10.32	10.12	–	5.95	6.15	11.96
LMd	14.69	14.93	17.13	15.41	14.14	19.41	19.33	–	10.48	10.73	22.48
ACo	3.62	3.74	4.68	4.09	3.28	4.98	4.94	–	2.47	2.54	7.43
CM_3	8.87	9.02	10.66	9.08	8.38	11.22	10.89	–	6.32	6.67	13.57

Rhinolophus sakejiensis Cotterill, 2002

Material (1). 1 ♂ (NMP 97587 [A]), Sakeji, Nchila Wildlife Reserve, 28 April 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera.

Rhinolophus sakejiensis is a rather enigmatic taxon, until recently known only from the type series. The type series composed of three male specimens was collected on 11 October 1990 and twelve years later formally described as a new species (Cotterill 2002). The NMP specimen reported here represents a fourth known specimen of *R. sakejiensis*, and is the first collected after the type series, i.e. after almost 20 years. The locality of collection of the NMP specimen of *R. sakejiensis* is the Nchila Wildlife Reserve, a site situated some 4 km WNW of the type locality marked in a map by Cotterill (2002: 167, Fig. 1). All known specimens of *R. sakejiensis* come from a limited area of the eastern part of "Ikelenge Pedicle" of north-western Zambia; so, the species remains known from only a small upland region north of the source of the Zambezi.

The dimensions of the NMP specimen of *R. sakejiensis* from Zambia are shown in Table 4. The correct identification of the species is indisputable, the dimensions of the bat conform to those mentioned by Cotterill (2002) for the type series, the structure of noseleaf of the NMP bat is identical to that figured by Cotterill (2002: 170, Fig. 2). In most of the dimensions that allow comparison (LCr 24.6–25.6 mm; LCc 21.7–22.3 mm; LaZ 12.9–13.5 mm; CM^3 9.4–9.7 mm), the NMP specimen falls within the respective ranges of the type series (Cotterill 2002: 169, Table 3); in three dimensions (LAt 52.5–55.2 mm; LaM 11.0–11.5 mm; M^3M^3 9.2–9.5 mm) the ranges of the type specimens lie slightly below the values of the NMP specimen. However, these differences are tiny and insignificant, regarding the small sample size of the type series.

Rhinolophus fumigatus Rüppell, 1842

Material (2). 1 ♂ (NMP 97650 [S+A]), Kalambo Falls, camp above river, 18 July 2009, leg. V. Mazoch & J. Zima;
1 ♂ (NMP 97641 [S+A]), Mutinondo, Mayense Camp, camp office, 8 July 2009, leg. V. Mazoch & J. Zima.

In southern Africa, the distribution of *Rhinolophus fumigatus* has two separate areas, the western patch in north-western Namibia and western Angola, and the eastern patch in Zimbabwe and Malawi, slightly exceeding to surrounding countries (Monadjem et al. 2020a). In Zambia, this bat is a rather rare faunal element; only six confirmed record sites are known from the eastern part of the country. The new localities of the NMP specimens of *R. fumigatus* originate from north-eastern Zambia and do not represent an important contribution to the distribution picture of this bat. The dimensions of the NMP specimens of *R. fumigatus* from Zambia are shown in Table 4.

Rhinolophus mossambicus Taylor, Stoffberg, Monadjem, Schoeman, Bayliss et Cotterill, 2012

Material (2). 1 ♀ (NMP 97612 [S+A]), Kafue National Park, Lufupa River Camp, 26 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera;
1 ♀ (NMP 97640 [S+A]), Mutinondo, Mayense Camp, camp office, 8 July 2009, leg. V. Mazoch & J. Zima.

Recently described *Rhinolophus mossambicus* is an endemic of the eastern parts of southern Africa (Taylor et al. 2012, Monadjem et al. 2020a). Its confirmed distribution range stretches from northern South Africa, through Mozambique and Zimbabwe to Malawi and Zambia. In the latter country, two distribution areas were documented, one in the lower Kafue river basin

and the other in the broader Luangwa river basin. Concerning the two new localities here presented, each falls into one of these range segments (Fig. 6). The record from the Lufupa River Camp marks a new geographical extreme at the north-western margin of the species distribution range in central Africa.

The dimensions of the NMP specimens of *R. mossambicus* from Zambia are shown in Table 4. In their description of the new species *R. mossambicus*, Taylor et al. (2012) gave very little information on the dimensions of this and other newly defined taxa. Only three of them could be compared, based on five specimens: forearm length (LAt 60–65 mm; mean [M] 62.8 mm), greatest length of skull (LCr 27–29 mm; M 28.1 mm), and condylocanine length (LCc 24–25 mm; M 24.4 mm). Monadjem et al. (2020a) added new data for LAt (59.5–66.0 mm; M 63.9 mm), based on an enlarged set of specimens (n=11). In all cases, the published ranges of dimensions are below the values of the data collected from the NMP specimens (see Table 4); the two bats from NMP are larger in body size than other examined specimens of *R. mossambicus*. These differences could be a consequence of cline shift in body size in this bat along the geographic (south-north) or climatic (south-east to north-west) gradient (observable also in other mammal species in Africa), or just of a difference in the method of measuring. In any case, this observation seems to be in a need of further examination.

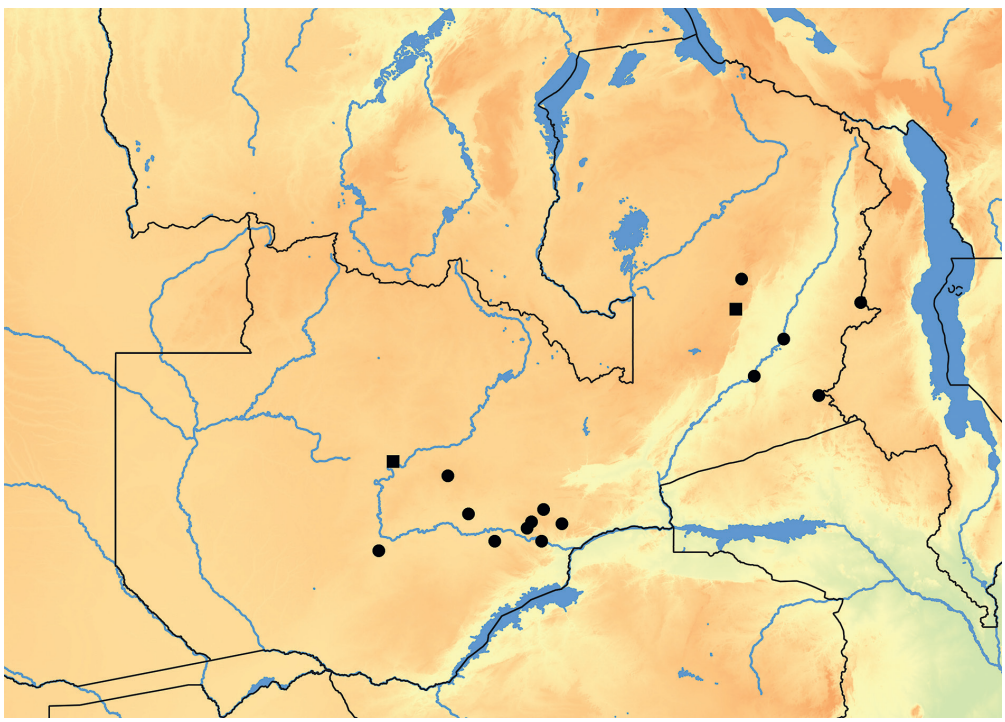

Fig. 6. Distribution of *Rhinolophus mossambicus* in Zambia based on museum specimens; circles – data published by Monadjem et al. (2020a), squares – new data.

Hipposideridae

***Hipposideros caffer* (Sundevall, 1846)**

Material (3). 3 ♀♀ (NMP 97571, 97572 [S+A], 97570 [A]), Chisakila, Bwarenunka Cave, 1 December 2018, leg. P. Benda & J. Červený.

Hipposideros caffer s.l. is a common bat in most of the savanna habitats of sub-Saharan Africa and it occurs also in south-western Arabia and western Maghreb (Spanjer Wright 2009). In southern Africa, it is distributed more abundantly mainly in the northern and eastern parts. It is also a common bat in Zambia, where 30 confirmed record localities are available according to Monadjem et al. (2020a). The here presented single record from the south-central part of Zambia does not represent an important contribution to the distribution picture of this bat; in the karst area at the Zambezi Escarpment south-east of Lusaka this bat has been documented repeatedly (Ansell 1978, Monadjem et al. 2020a).

The NMP specimens from Zambia belong to the A1 mitochondrial genetic lineage sensu Vallo et al. (2008), i.e. *H. caffer* s.str. However, their haplotypes create a sub-lineage of their own within this lineage (A1c; Fig. 7), which is rather deeply separated from the A1[a] sub-lineage from South Africa, Swaziland/Eswatini, and southern Mozambique, as originally defined by Vallo et al. (2008), and the A1b sub-lineage from northern Mozambique defined by Monadjem et al. (2013b). The bats of the new sub-lineage represent the first record of the population of A1 lineage from Zambia and the westernmost and the most inland record of this lineage, until now known to occur only in the rather low situated areas of south-eastern Africa along the Mozambique Channel; other extremes of its occurrence are known from northernmost Mozambique – the northernmost record from 12°11'S, 37°33'E and the easternmost from 12°52'S, 37°41'E (Monadjem et al. 2013b, 2020a). The A1 lineage of the *H. caffer* complex is now known from a triangular area stretching between southern Zambia, northern Mozambique and south-eastern South Africa (Mkuzi Reserve; Vallo et al. 2008). This geographical pattern suggests that the bats of the *caffer*-morphotype (sensu Koopman 1975) from this part of distribution range belong to the A1 lineage, since all genetically examined specimens of A1 lineage belong to this morphotype (Vallo et al. 2008, Monadjem et al. 2013b, 2020a; Table 4). This could also refer to the bats from north-western Mozambique, including the type specimen of *Phylorhina gracilis* Peters, 1852. This bat (ZMB 364) was collected at Tete (NW Mozambique; Peters 1852) and represents the *caffer*-morphotype (LAt 43.6 mm, LCc 15.39 mm, LaZ 9.14 mm, CM^3 6.02 mm; own data). This suggests that this name really represents a synonym of *Hipposideros caffer* as it is traditionally considered, based on biogeographic grounds (Allen 1939, Ellerman et al. 1953, Meester et al. 1986, Koopman 1993, Simmons 2005, Spanjer Wright 2009).

A colony of this species composed of ca. 1000 bats (adults and non-flying juveniles) was discovered in the Bwarenunka Cave near Chisakila on 1 December; all examined bats were lactating females. The dimensions of the NMP specimens of *H. caffer* from Zambia are shown in Table 4.

***Macronycteris vittata* (Peters, 1852)**

Material (1). 1 ♀ (NMP 67569 [S+A]), Chisakila, Bwarenunka Cave, 1 December 2018, leg. P. Benda & J. Červený.

The limits of the distribution range of *Macronycteris vittata* are still a subject of research; however, this bat is not rare in the central and north-eastern parts of southern Africa (Monadjem et

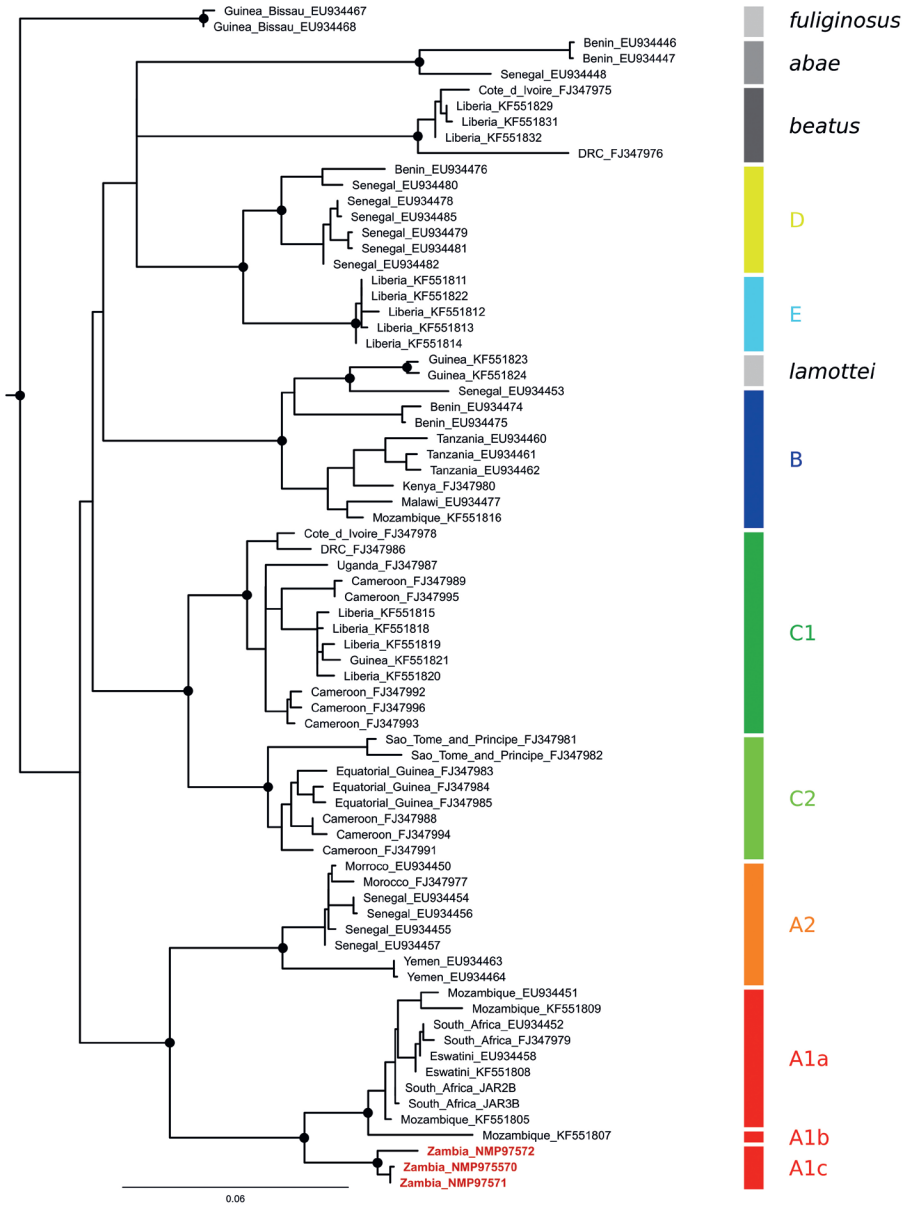

Fig. 7. Maximum likelihood tree of reconstructed phylogenetic relations of the *Hipposideros caffer* complex (cf. Vallo et al. 2008, Monadjem et al. 2013b) and *H. fuliginosus* (Temminck, 1853) as an outgroup, based on the cytochrome *b* sequences (the Zambian bats in red; the labeling of the lineages sensu Vallo et al. 2008). Black dots on the nodes denote that these nodes have high branch support (e.g., SH-aLRT ≥80%, aBayes ≥0.95, UFBoot ≥90%).

Fig. 8. A group of local boys hunting for *Macronycteris vittata* in the Bwarenunka Cave near Chisakila.

al. 2020a). In Zambia, nine confirmed record sites of *M. vittata* are available from central and southern parts of the country, including the karst area at the Zambezi Escarpment south-east of Lusaka (Ansell 1978, Monadjem et al. 2020a), where the single NMP specimen of this bat comes from.

A colony of this bat was discovered in the Bwarenunka Cave near Chisakila; the examined adult female did not show any signs of current reproduction. The colony is used as a food source by the local community, we found a group of boys from a village nearby that hunted these bats inside the cave (Fig. 8). The dimensions of the NMP specimen of *M. vittata* from Zambia are shown in Table 4.

Rhinonycteridae

Cloeotis percivali Thomas, 1901

Material (5). 4 ♂♂, 1 ♀ (NMP 97565–97568 [S+A], 97564 [A]), Chisakila, Bwarenunka Cave, 1 December 2018, leg. P. Benda & J. Červený.

Cloeotis percivali is an uncommon bat in southern Africa; in Zambia, its distribution is limited to the south-eastern part of the country, four record sites are available from a belt stretching between Lusaka and Chipata (Monadjem et al. 2020a). The new locality of the NMP specimens of *C. percivali* falls into this range and conforms with the current picture of the occurrence of this bat.

A colony of this species composed of ca. 100 bats (adults and non-flying juveniles) was discovered in the Bwarenunka Cave near Chisakila on 1 December (Fig. 9); the examined female was lactating. The dimensions of the NMP specimens of *C. percivali* from Zambia are shown in Table 5.

N y c t e r i d a e

Nycteris thebaica Geoffroy, 1813

Material (3). 2 ♂♂ (NMP 97613, 97614 [S+A]), Kafue National Park, Lufupa River Camp, 26 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera.
1 ♂ (NMP 97628 [S+A]), Kasanka National Park, Pontoon Camp, riverine forest, 15 June 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera;

Nycteris thebaica is a common bat throughout Africa except the rain forest zone and a large part of the Sahara; furthemore, it occurs also in the western and southern parts of the Middle East (Gray et al. 1999). In Zambia, this species ranks among the most common bats; it was collected from at least 34 localities (Monadjem et al. 2020a). The NMP specimens of *N. thebaica* originate from only two sites. This is rather surprising considering the common occurrence of this bat in Zambia. However, at least one of these localities lies in a region where this bat

Fig. 9. Colony of *Cloeotis percivali* (partly mixed with a colony of *Hipposideros caffer*) in the Bwarenunka Cave near Chisakila observed on 1 December 2018.

Table 5. Basic biometric data on the NMP specimens of *Cloeotis percivali*, *Nycteris thebaica*, and *Chaerephon pumilus* from Zambia. For abbreviations see Methods

dimension	*Cloeotis percivali*					*Nycteris thebaica*					*Chaerephon pumilus*				
	n	**M**	min	max	SD	*n*	**M**	min	max	SD	*n*	**M**	min	max	SD
G	*5*	**3.44**	3.1	3.9	0.344	*3*	**8.67**	8.0	9.0	0.577	*4*	**9.50**	6.0	11.0	2.380
LAt	*5*	**34.32**	33.8	35.0	0.536	*3*	**42.50**	42.5	42.5	0.000	*4*	**37.60**	37.3	38.0	0.294
LCr	*3*	**13.38**	13.14	13.82	0.379	*1*	**19.43**	–	–	–	*3*	**16.58**	15.83	17.13	0.673
LCO	*4*	**13.11**	12.88	13.32	0.209	*3*	**19.08**	18.83	19.31	0.240	–	–	–	–	–
LCb	–	–	–	–	–	–	–	–	–	–	*2*	**15.20**	14.66	15.73	0.757
LCc	*4*	**11.00**	10.93	11.04	0.051	*3*	**16.74**	16.58	16.92	0.170	–	–	–	–	–
LaZ	*4*	**7.17**	7.04	7.26	0.092	*3*	**10.87**	10.83	10.93	0.051	*3*	**10.30**	9.98	10.63	0.325
LaI	*4*	**1.44**	1.32	1.58	0.116	*3*	**4.75**	4.66	4.83	0.085	*3*	**3.72**	3.68	3.81	0.075
LaP	–	–	–	–	–	*3*	**4.59**	4.57	4.61	0.021	–	–	–	–	–
LaInf	*4*	**3.48**	3.38	3.61	0.099	*3*	**4.64**	4.62	4.68	0.032	*3*	**4.29**	4.21	4.41	0.108
LaN	*4*	**5.57**	5.25	5.88	0.321	*3*	**8.71**	8.63	8.87	0.139	*3*	**8.46**	8.36	8.59	0.117
LaM	*4*	**6.81**	6.71	6.93	0.109	*3*	**8.41**	8.28	8.53	0.125	*3*	**9.85**	9.81	9.92	0.064
ANc	*4*	**4.56**	4.35	4.71	0.165	*3*	**6.70**	6.58	6.86	0.143	*2*	**5.75**	5.61	5.89	0.198
LBT	*4*	**2.21**	1.84	2.47	0.280	*3*	**3.39**	3.35	3.42	0.035	*3*	**3.58**	3.44	3.73	0.145
CC	*4*	**2.89**	2.81	2.97	0.066	*3*	**4.63**	4.43	4.88	0.230	*3*	**4.36**	4.18	4.63	0.236
M^3M^3	*4*	**4.63**	4.48	4.74	0.111	*3*	**6.89**	6.72	6.98	0.150	*3*	**7.31**	6.84	7.61	0.412
CM^3	*4*	**4.03**	3.84	4.12	0.129	*3*	**6.40**	6.28	6.59	0.164	*3*	**6.24**	5.86	6.48	0.333
LMd	*4*	**7.49**	7.32	7.63	0.130	*3*	**11.99**	11.97	12.01	0.020	*3*	**10.90**	10.34	11.33	0.506
ACo	*4*	**1.46**	1.36	1.53	0.071	*3*	**3.57**	3.42	3.65	0.130	*3*	**2.91**	2.73	3.02	0.157
CM_3	*4*	**4.06**	3.91	4.16	0.114	*3*	**6.75**	6.68	6.84	0.081	*3*	**6.47**	6.15	6.76	0.307

has not been documented before, the Kasanka National Park (see Ansell 1978, Monadjem et al. 2020a).

According to the results of examination of the mitochondrial genome from the samples from both the above mentioned localities, the populations of *N. thebaica* from Zambia belong to the clade *thebaica* 4 sensu Demos et al. (2019b). Until now, this clade was known only from two regions in south-eastern Kenya (Kilifi and Kwale), while from the regions between Kenya and Zambia, other clades were detected (*thebaica* 2, *thebaica* 6; Demos et al. 2019b). The dimensions of the NMP specimens of *N. thebaica* from Zambia are shown in Table 5.

Molossidae

***Chaerephon pumilus* (Cretzschmar, 1830)**

Material (4). 1 ♂, 1 ♀ (NMP 97619, 97620 [S+A]), Kafue National Park, Chunga Camp, 28 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera;
1 ♂ (NMP 97673 [S+A]), Newa, 10 km E of Mongu, grassland at a river, 12 June 2010, leg. J. Šklíba, V. Mazoch & E. Knotková;
1 ♂ (NMP 97605 [A]), Sioma Bush Camp, 23 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera.

Bats traditionally assigned to *Chaerephon pumilus* are currently considered a complex composed of several species (Naidoo et al. 2016, Monadjem et al. 2020a). However, the phylogenetic relations within the complex as well as its taxonomic arrangement still remain to be resolved. If the complex really comprises more species, there is a high probability that the name *C. pumilus* is not applicable for the populations of southern and central Africa (Naidoo et al. 2016). The morphotype of *C. pumilus* s.l. represents one of the most common bat forms in the Afro-tropics except the southern Sahara and the arid regions of south-western Africa (Bouchard 1998). In Zambia, this bat is the most commonly recorded molossid (Ansell 1978, Monadjem et al. 2020a). The localities of four specimens of the NMP collection are situated in the western part of Zambia, where this bat has been previously collected most frequently (Monadjem et al. 2020a).

The dimensions of the NMP specimens of *C. pumilus* s.l. from Zambia are shown in Table 5. A genetic analysis of the mitochondrial ND1 gene showed these specimens to be in agreement by 98.3–99.7% with the haplotypes referred to *Chaerephon leucogaster* (Grandidier, 1869) from Madagascar (sensu Ammerman et al. 2012), i.e. to one of the possible separate species within the *Chaerephon pumilus* species complex (Naidoo et al. 2016).

Chaerephon bivittatus (von Heuglin, 1861)

Material (4). 3 ♂♂, 1 ♀ (NMP 97651–97654 [S+A]), Kalambo Falls, camp above river, 18 July 2009, leg. V. Mazoch & J. Zima.

Chaerephon bivittatus occurs in a long belt of savannas across the eastern part of Africa, stretching from Eritrea to Zimbabwe (Eger & Peterson 1979). Only one published record of this bat is available from Zambia, from Abercorn (= Mbala) in the north-eastern part of the country (Hayman & Harrison 1966, Monadjem et al. 2020a). The here presented second record of *C. bivittatus* from Zambia originates from an almost identical region as the first record; the Kalambo Falls are situated only some 30 km north-west of Mbala. The dimensions of the NMP specimens of this bat from Zambia are shown in Table 6.

Chaerephon nigeriae Thomas, 1913

Material (1). 1 ♀ (NMP 97670 [S+A]), Kaoma, Farmers Rendezvous Lodge, small pool, 5 June 2010, leg. J. Šklíba, V. Mazoch & E. Knotková.

Chaerephon nigeriae is a widely distributed savanna bat of sub-Saharan Africa (Willis et al. 2002). The region of south-central Africa, including Zambia, represents one of the distribution centres of this bat (Willis et al. 2002, Monadjem et al. 2020a). At least eight record localities are available from Zambia (Ansell 1978, Monadjem et al. 2020a); the highest concentration of records comes from the western part of the country, from where the NMP specimen also originates. The dimensions of the NMP specimen of *C. nigeriae* from Zambia are shown in Table 6.

Mops condylurus (Smith, 1833)

Material (5). 3 ♂♂, 2 ♀♀ (NMP 97632–97636 [S+A]), Bangweulu Game Reserve, Chikuni, swamp, 17 June 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera.

Mops condylurus ranks among the most common and widespread savanna bats of sub-Saharan Africa (Happold 2013b). However, with just seven confirmed records, this species is only the fourth most common molossid bat of Zambia (Monadjem et al. 2020a). The available record

Table 6. Basic biometric data on the NMP specimens of *Chaerephon bivittatus*, *C. nigeriae*, *Mops condylurus*, *Nyctinomus aegyptiacus*, and *Myotis welwitschii* (*Mw*) from Zambia. For abbreviations see Methods

dimension	*Chaerephon bivittatus*					*Chaerephon nigeriae*	*Mops condylurus*					*Nyctinomus aegyptiacus*		*Mw*
	n	**M**	min	max	SD	97670	*n*	**M**	min	max	SD	97638	97639	97579
G	*4*	**16.25**	14.0	17.0	1.500	16.0	*5*	**27.40**	23.0	36.0	5.177	17.0	17.0	13.0
LAt	*4*	**45.65**	44.4	46.3	0.850	46.0	*5*	**48.70**	46.8	50.0	1.447	46.6	45.7	57.0
LCr	*4*	**19.06**	18.88	19.38	0.238	18.98	*5*	**21.40**	20.34	22.68	0.991	18.78	19.06	19.62
LCb	*4*	**17.71**	17.45	18.14	0.302	17.98	*5*	**19.01**	18.48	19.58	0.484	18.08	18.68	18.72
LaZ	*4*	**11.54**	11.36	11.72	0.191	12.27	*5*	**13.49**	13.02	13.98	0.377	11.48	11.86	12.71
LaI	*4*	**3.85**	3.71	3.91	0.093	3.82	*5*	**4.53**	4.48	4.61	0.062	4.12	4.55	4.58
LaInf	*4*	**4.93**	4.58	5.21	0.263	4.74	*5*	**6.06**	5.52	6.53	0.360	4.47	4.43	5.38
LaN	*4*	**9.70**	9.36	9.84	0.228	10.41	*5*	**10.81**	10.42	11.18	0.296	9.48	9.84	9.31
LaM	*4*	**10.75**	10.54	10.88	0.147	11.12	*5*	**12.39**	12.13	12.87	0.280	10.88	11.13	9.81
ANc	*4*	**6.69**	6.57	6.85	0.130	6.58	*5*	**7.96**	7.39	9.17	0.741	5.66	5.74	6.57
LBT	*4*	**4.13**	3.87	4.42	0.234	4.11	*5*	**3.86**	3.67	4.04	0.171	4.41	4.34	3.44
CC	*4*	**5.25**	4.93	5.44	0.220	5.18	*5*	**6.47**	6.03	6.98	0.440	4.68	4.88	5.14
M^3M^3	*4*	**8.47**	8.38	8.61	0.101	8.68	*5*	**9.58**	9.21	9.83	0.269	7.88	8.08	8.09
CM^3	*4*	**7.31**	7.13	7.46	0.155	7.56	*5*	**8.00**	7.69	8.31	0.258	7.09	7.39	7.87
LMd	*4*	**12.89**	12.63	13.11	0.236	13.07	*5*	**14.51**	13.94	15.19	0.586	12.95	13.14	15.06
ACo	*4*	**3.28**	3.14	3.39	0.105	3.53	*5*	**4.01**	3.73	4.24	0.231	3.92	3.71	4.76
CM_3	*4*	**7.87**	7.61	8.03	0.195	8.05	*5*	**8.72**	8.38	9.04	0.270	7.71	7.93	8.47

sites of *M. condylurus* are spread over the whole territory of Zambia, and the NMP series thus does not contribute significantly to more precise understanding of its distribution. The dimensions of the NMP specimens of *M. condylurus* from Zambia are shown in Table 6.

Nyctinomus aegyptiacus Geoffroy, 1818

Material (2). 2 ♂♂ (NMP 97638, 97639 [S+A]), Nsalu Cave, 7 July 2009, leg. V. Mazoch & J. Zima.

Nyctinomus aegyptiacus was traditionally assigned to the genus *Tadarida* Rafinesque, 1814 (Freeman 1981, Koopman 1993, Simmons 2005, Monadjem et al. 2020a, etc.); however, the results of molecular genetic analyses by Lamb et al. (2011) and Ammerman et al. (2012) revealed this genus to be paraphyletic in respect to the relationships of *N. aegyptiacus* and the type species of this genus, *T. teniotis* (Rafinesque, 1814). Therefore, we classify the former species into a genus of its own, *Nyctinomus* Geoffroy, 1818, of which *N. aegyptiacus* is the type species (Geoffroy Saint-Hilaire 1818).

This bat is the most widely distributed molossid of the Old World; it occurs in the whole of non-forested parts of Africa, from South Africa to Egypt and Morocco, in southern Arabia, Iran, and broadly in the Indian subcontinent, from Afganistan to Bangladesh and Ceylon (Simmons 2005). In southern Africa, *N. aegyptiacus* is one of the most common and widespread bats in arid habitats; however, only three confirmed records are available from Zambia, namely from its southern part (Ansell 1978, Monadjem et al. 2020a). Thus, the NMP specimens from the

Nsalu Cave represent the northernmost record not only from Zambia, but from the eastern part of the region as well (see Monadjem et al. 2010, Curran et al. 2012).

Nyctinomus aegyptiacus is considered to be a complex composed of more than one species (Benda et al. 2012, Monadjem et al. 2020a). The dimensions of the NMP specimens of this bat from Zambia are shown in Table 6, they suggest these specimens to belong to the medium-sized morphotype of the complex, corresponding with the morphotype of *N. thomasi* (Wroughton, 1919), so far known from India and Arabia only (Benda et al. 2012).

Vespertilionidae

Myotis welwitschii (Gray, 1866)

Material (1). 1 ♂ (NMP 97579 [S+A]), Sakeji, Nchila Wildlife Reserve, 27 April 2009, leg. J. Šklíba, M. Lövy, H. Patzenhauerová & R. Šumbera.

Myotis welwitschii is a bat with patchy distribution in sub-Saharan Africa, it occurs almost exclusively in upland areas and was documented from all main mountain ranges and highland

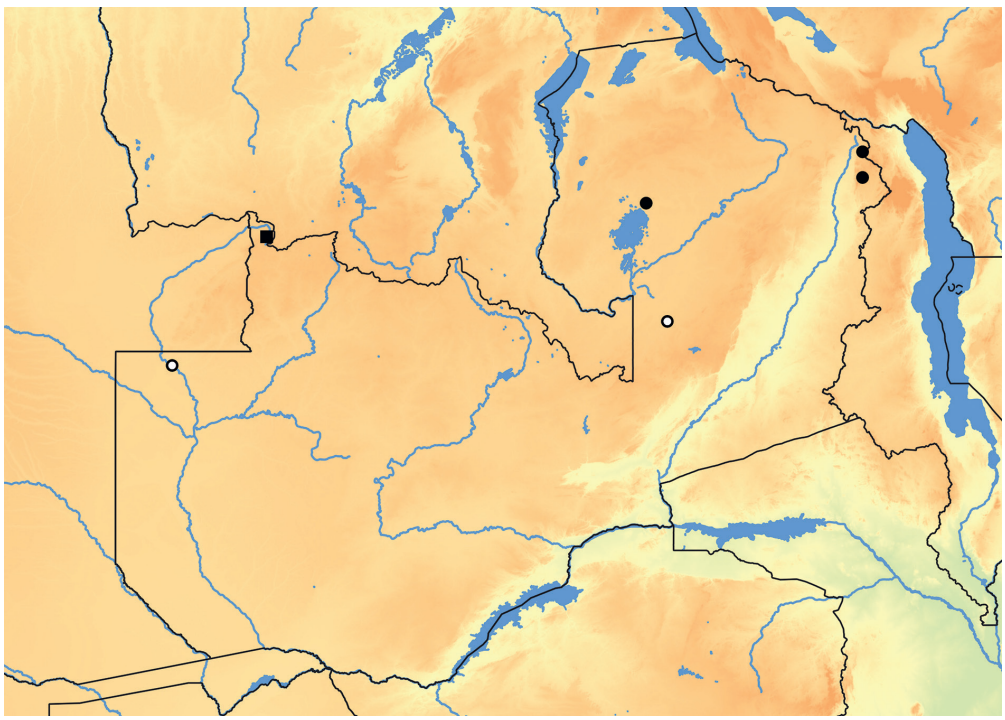

Fig. 10. Distribution of *Myotis welwitschii* in Zambia based on the data published by Fahr & Ebigbo (2003) and new data; closed circles – published localities of museum specimens, open circles – other published localities, square – locality of the NMP specimen.

plateaus of this region except for dry zones (Fahr & Ebigbo 2003, Sedláček et al. 2006). The new record from Zambia is in accordance with this pattern, the Nchila Wildlife Reserve near Sakeji is situated in an upland above 1400 m a. s. l. Fahr & Ebigbo (2003) mentioned five localities of *Myotis welwitschii* from Zambia. However, Monadjem et al. (2020a) considered only three of them as indisputable, being based on museum specimens, all situated in the north-eastern part of Zambia. The new finding here reported thus represents the first record from the western part of the country which is confirmed by a collected specimen (Fig. 10). The dimensions of the NMP specimen of *M. welwitschii* from Zambia are shown in Table 6.

***Glauconycteris variegata* (Tomes, 1861)**

Material (3). 1 ♂ (NMP 97669 [S+A]), Kaoma, Farmers Rendezvous Lodge, small pool, 5 June 2010, leg. J. Šklíba, V. Mazoch & E. Knotková;
2 ♂♂ (NMP 97602, 97603 [S+A]), Sioma Bush Camp, 23 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera.

Glauconycteris variegata is a bat widely distributed in the savanna zone of sub-Saharan Africa (Rambaldini 2010). In southern Africa, it occurs mainly in the central and eastern parts of the region and in all countries it ranks as an uncommon species (Monadjem et al. 2020a). Eight record localities are available from Zambia (Ansell 1978, Monadjem et al. 2020a), which is the largest number from any country of southern Africa (Monadjem et al. 2020a). However, with the exception of an eastern record from Chipata at the boder with Malawi, all localities are situated in a narrow belt of meridian arrangement, aproximately between 26°20'E and 27°55'E, across the central part of the country. This north-south stretching chain of sites also represents the western border of the distribution range of *G. variegata* in the central/northern part of southern Africa (Monadjem et al. 2020a). The NMP specimens of this bat come from western Zambia, the record from the Sioma Bush Camp shifts the margin of known distribution by ca. 320 km westwards. The dimensions of the NMP specimens of *G. variegata* from Zambia are shown in Table 7.

***Pipistrellus rusticus* (Tomes, 1861)**

Material (7). 1 ♀ (NMP 97626 [A]), Ndola Hill, 7 June 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera;
3 ♂♂ (NMP 97580, 97581 [S+A], 97582 [A]), Sakeji, Nchila Wildlife Reserve, 27 April 2009, leg. J. Šklíba, M. Lövy, H. Patzenhauerová & R. Šumbera;
1 ♀ (NMP 97588 [S+A]), Sakeji, Nchila Wildlife Reserve, 28 April 2009, leg. J. Šklíba, M. Lövy, H. Patzenhauerová & R. Šumbera;
2 ♂♂ (NMP 97593, 97594 [S+A]), Simungoma, Nulubeti village, 19 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera.

The distribution range of *Pipistrellus rusticus* comprises two separate patches in sub-Saharan Africa, one in the savanna belt stretching from Senegal to Ethiopia and Kenya, the other in southern Africa in a triangle of savannas, delimited by central Angola, central Malawi, northern Namibia, and Swaziland/Eswatini (Kearney 2013, Monadjem et al. 2020a). In Zambia, this bat is known from eight localities, all of which are situated only in the western part of the country (Ansell 1978, Monadjem et al. 2020a); the NMP specimens of *P. rusticus* also originate from three sites in this part of the country. However, the record from the Nchila Wildlife Reserve at Sakeji seems to define newly the northern margin of the southern African distribution range segment, to which the nominotypical subspecies of *P. rusticus* is

Table 7. Basic biometric data on the NMP specimens of *Glauconycteris variegata*, *Pipistrellus rusticus*, and *Afropipistrellus grandidieri (Ag)* from Zambia. For abbreviations see Methods

dimension	*Glauconycteris variegata*					*Pipistrellus rusticus*					*Ag*
	n	**M**	min	max	SD	*n*	**M**	min	max	SD	97557
G	*3*	**12.67**	12.0	14.0	1.155	*7*	**5.36**	5.0	6.0	0.476	10.7
LAt	*3*	**44.73**	43.8	45.7	0.950	*7*	**29.81**	27.4	31.1	1.678	38.2
LCr	*3*	**13.26**	13.21	13.29	0.044	*5*	**11.79**	11.32	12.13	0.345	14.58
LCb	*3*	**13.35**	13.24	13.48	0.121	*5*	**11.33**	10.64	11.71	0.431	14.42
LaZ	*3*	**10.71**	10.64	10.81	0.089	*3*	**7.98**	7.66	8.21	0.287	10.33
LaI	*3*	**4.54**	4.47	4.62	0.075	*5*	**3.44**	3.31	3.56	0.119	4.02
LaInf	*3*	**4.82**	4.75	4.89	0.070	*5*	**3.82**	3.75	4.02	0.114	4.95
LaN	*3*	**8.48**	8.42	8.54	0.060	*5*	**6.35**	6.12	6.61	0.180	6.98
LaM	*3*	**9.42**	9.39	9.45	0.031	*5*	**7.33**	7.04	7.57	0.230	8.58
ANc	*3*	**6.14**	6.07	6.23	0.081	*5*	**4.45**	4.24	4.59	0.132	5.79
LBT	*3*	**3.68**	3.53	3.78	0.131	*5*	**2.60**	2.35	2.77	0.176	3.22
CC	*3*	**4.96**	4.88	5.08	0.104	*5*	**4.07**	3.94	4.11	0.073	4.92
M^3M^3	*3*	**7.02**	6.88	7.21	0.171	*5*	**5.40**	5.21	5.67	0.186	6.58
CM^3	*3*	**4.94**	4.91	4.97	0.031	*5*	**4.24**	4.08	4.38	0.123	5.28
LMd	*3*	**10.05**	9.89	10.17	0.144	*5*	**8.73**	8.33	9.02	0.268	11.04
ACo	*3*	**3.31**	3.29	3.32	0.015	*5*	**2.65**	2.53	2.78	0.117	3.81
CM_3	*3*	**5.37**	5.33	5.41	0.040	*5*	**4.53**	4.41	4.64	0.101	5.68

referred (Ansell 1978, Kearney 2013). The dimensions of the NMP specimens of this bat from Zambia are shown in Table 7.

Afropipistrellus grandidieri (Dobson, 1876)

Material (1). 1 ♀ (NMP 97557 [S+A]; Fig. 11), Kasanka National Park, Luwombwa Camp, 27 November 2018, leg. P. Benda & J. Červený.

Throughout its range covering the central parts of Africa between Cameroon, southern Kenya, Angola and central Mozambique, *Afropipistrellus grandidieri* is a rare bat; Thorn et al. (2007) mentioned only 27 known specimens from 18 localities in this extensive area (they did not include six bats from four sites in the DR Congo reported by Hayman et al. 1966). From southern and central Africa, Monadjem et al. (2020a) list nine localities in four countries, but none from Zambia. Our finding of a female in the Kasanka NP thus represents the first record of *A. grandidieri* from Zambia.

The dimensions of the NMP specimen of *A. grandidieri* from Zambia are shown in Table 7. By its skull size (LCr 14.58 mm, CM^3 5.28 mm), the Zambian specimen corresponds well with the dimensions of the large-sized southern African subspecies *A. g. angolensis* (Hill, 1937), see Thorn et al. (2007: Table 1: LCr 14.1–14.7 mm, CM^3 4.9–5.4 mm). However, by the forearm length, this female specimen shows the largest value ever recorded (LAt 38.2 mm). As the largest specimen of this species, Thorn et al. (2007) reported a male from Angola (AMNH 85535, holotype of *Eptesicus capensis angolensis*) that showed LAt 37.0 mm. Nevertheless, an identical forearm length as in the Zambian female was found in a male from southern Malawi

Fig. 11. Portraits of *Afropipistrellus grandidieri* female (NMP 97557) netted at the Luwombwa Camp, Kasanka National Park, on 27 November 2018. It is the first individual of this bat recorded from Zambia.

(LAt 38.2 mm, LCr 14.58 mm, CM^3 5.33 mm; MHNG 1971.044 [S+A], Mt. Mulanje foothills, Tea Research Foundation Forest, 1 December 2007, leg. M. Curran & M. Kopp; own data, cf. Curran et al. 2012).

Based on an analysis of mitochondrial marker, Monadjem et al. (2021) suggested to include *A. grandidieri* into the genus *Nycticeinops* Hill et Harrison, 1987, until then considered a monotypic genus. However, since only the mtDNA was employed in the analysis and the genus *Nycticeinops* s.str. possesses a markedly distinct condition of several morphologic traits (usual for generic separation, namely the dentition or, in lesser extent, the baculum morphology) than other species suggested to be included to this taxon, we prefer to retain the latter genus in its traditional taxonomic structure in the sense by Hill & Harrison (1987). For *A. grandidieri*, formerly frequently referred to the genera *Eptesicus* Rafinseque, 1820 or *Pipistrellus* Kaup, 1829, we prefer to use the genus name *Afropipistrellus* Thorn, Kock et Cuisin, 2007 (originally a subgenus for *Pipistrellus grandidieri*), at least tentatively, until the positions of various mitochondrial lineages found within the group of pipistrelloid bats of Africa are elucidated by a profound analysis of various genetic markers, including the nuclear ones.

Afronycteris nana (Peters, 1852)

Material (6). 1 ♂, 1 ♀ (NMP 97686, 97687 [S+A]), Kacholola, riverine forest, 15 June 2010, leg. J. Šklíba, V. Mazoch & E. Knotková;
1 ♂ (NMP 97658 [A]), Kasakalawe, Lake Tanganyika Lodge, lake bank, 20 July 2009, leg. V. Mazoch & J. Zima;
1 ♂ (NMP 97611 [S+A]), Livingstone, No Name Camp, 24 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera;
1 ♂, 1 ♀ (NMP 97644, 97645 [S+A]), North Luangwa National Park, Chifunda Camp, 12 July 2009, leg. V. Mazoch & J. Zima.

References. Benda et al. (2016), Monadjem et al. (2021), Taylor et al. (2022).

Afronycteris nana is a bat inhabiting most of the savanna habitats of sub-Saharan Africa. In southern Africa it is distributed mostly in its eastern part; the territory of Zambia lies on the southern margin of the continuous African range (Happold 2013d, Monadjem et al. 2020a). Despite this, *A. nana* ranks among the most common and widespread bats of the country, Monadjem et al. (2020a) reported 25 confirmed record localities from Zambia. The new specimens come from four sites spread over the whole country, situated in its northern, southern, western and eastern parts. The dimensions of the NMP specimens of *A. nana* from Zambia are shown in Table 8.

Neoromicia capensis (Smith, 1829)

Material (9). 2 ♂♂ (NMP 97689, 97690 [S+A]), Kacholola, riverine forest, 15 June 2010, leg. J. Šklíba, V. Mazoch & E. Knotková;
1 ♂ (NMP 97618 [S+A]), Kafue National Park, Chunga Camp, 28 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera;
2 ♀♀ (NMP 97600, 97601 [S+A]), Sioma Bush Camp, 22 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera;
2 ♂♂, 2 ♀♀ (NMP 97607, 97609, 97610 [S+A], 97608 [A]), Sioma Bush Camp, 23 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera.

References. Benda et al. (2016), Monadjem et al. (2021), Taylor et al. (2022).

Neoromicia capensis is a common and perhaps the most widespread bat of southern Africa, although in Zambia it is less abundant compared to the more southward situated regions. According to the data by Monadjem et al. (2020a) and regarding the territories of particular countries,

Table 8. Basic biometric data on the NMP specimens of *Afronycteris nana*, *Neoromicia capensis*, *N. somalica* (*Ns*), and *Laephotis angolensis* (*La*) from Zambia. For abbreviations see Methods

dimension	*Afronycteris nana*					*Neoromicia capensis*					*Ns*	*La*
	n	**M**	min	max	SD	*n*	**M**	min	max	SD	97648	97599
G	*6*	**3.58**	3.0	4.0	0.492	*9*	**5.83**	5.0	7.0	0.750	4.0	5.0
LAt	*5*	**30.42**	28.9	33.5	1.862	*9*	**32.28**	31.0	33.1	0.646	30.6	36.0
LCr	*5*	**11.27**	10.98	11.63	0.252	*8*	**13.22**	12.65	13.62	0.344	11.88	14.03
LCb	*5*	**10.76**	10.42	11.22	0.330	*8*	**12.77**	12.21	13.08	0.296	11.47	13.43
LaZ	*5*	**7.21**	7.11	7.53	0.180	*7*	**8.77**	8.61	8.91	0.116	7.57	8.07
LaI	*5*	**3.15**	2.99	3.24	0.100	*8*	**3.39**	3.22	3.54	0.097	2.87	3.28
LaInf	*5*	**3.21**	2.98	3.44	0.200	*8*	**4.29**	4.11	4.64	0.162	3.48	3.93
LaN	*5*	**5.98**	5.79	6.13	0.130	*8*	**6.77**	6.56	6.93	0.122	6.76	6.94
LaM	*5*	**6.62**	6.33	6.83	0.190	*8*	**7.76**	7.58	8.13	0.181	6.76	7.73
ANc	*4*	**4.06**	3.91	4.25	0.148	*8*	**4.37**	4.15	4.51	0.123	4.34	4.43
LBT	*5*	**2.58**	2.51	2.68	0.076	*8*	**3.04**	2.53	3.34	0.257	2.88	3.35
CC	*5*	**3.34**	3.23	3.46	0.093	*8*	**4.25**	4.04	4.49	0.161	3.38	3.93
M^3M^3	*5*	**4.56**	4.38	4.66	0.109	*8*	**5.61**	5.43	5.73	0.108	4.94	5.42
CM^3	*5*	**3.81**	3.66	3.98	0.136	*8*	**4.71**	4.41	4.83	0.132	4.29	4.59
LMd	*5*	**7.82**	7.48	8.13	0.305	*8*	**9.50**	9.19	9.88	0.229	8.48	9.38
ACo	*5*	**2.31**	2.14	2.44	0.130	*8*	**3.21**	3.12	3.41	0.092	2.61	2.88
CM_3	*5*	**4.06**	3.87	4.25	0.166	*8*	**5.09**	4.74	5.26	0.170	4.41	4.96

N. capensis is three times more abundant in Botswana (with 41 record sites) and ten times more frequently recorded in Zimbabwe (92 sites), compared to the evidence from Zambia (18 sites). Nevertheless, in the NMP collection of Zambian bats, *N. capensis* is one of the most numerous bats, nine specimens were collected from three localities in southern Zambia. The dimensions of the NMP specimens of *N. capensis* from Zambia are shown in Table 8.

Neoromicia somalica (Thomas, 1901)

Material (1). 1 ♀ (NMP 97648 [S+A]), Chifunda, Old Luelo Ranger Post, 13 July 2009, leg. V. Mazoch & J. Zima.

The small bat of the genus *Neoromicia* collected at Old Luelo Ranger Post of Chifunda, in the upper Luangwa river basin, eastern Zambia, fits by its body size to the category of medium-sized brown-winged *Neoromicia* bats, traditionally affiliated to *N. somalica* s.l., a bat widely distributed in savannas of sub-Saharan Africa (cf. Peterson et al. 1995, Kearney et al. 2002, Lavrenchenko et al. 2004, Simmons 2005, Benda et al. 2011, 2016). However, several cryptic species were recognised within this morphotype, originally defined only by body and skull size within the genus limits, see the review by Benda et al. (2011). Based on molecular genetic analysis, Monadjem et al. (2021) restricted the distribution of *N. somalica* s.str. to East Africa, with confirmed records spread in a belt of savannas stretching from Somaliland via Kenya to central Tanzania.

The molecular genetic comparison clustered the Zambian specimen (NMP 97648) among the haplotypes of *N. somalica* s.str. sensu Monadjem et al. (2021); the position of this bat was close to the specimens from southern Kenya and central Tanzania, while the samples from western and central Kenya were slightly more distant (Fig. 12). The bat collected in Chifunda thus represents the first record of *N. somalica* from Zambia and from southern and central Africa as well (in the sense of Monadjem et al. 2020a). The closest confirmed locality of *N. somalica* is Maji Moto, Ruaha National Park, Tanzania (08°02'S, 34°30'E), ca. 475 km NNE of Chifunda. The new record from Zambia has thus extended the known distribution range of this species significantly southwards. The dimensions of the NMP specimen of *N. somalica* from Zambia are shown in Table 8.

Laephotis angolensis Monard, 1935

Material (1). 1 ♂ (NMP 97599 [S+A]), Sioma Bush Camp, 22 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera.

References. Benda et al. (2016), Monadjem et al. (2021), Taylor et al. (2022).

Although the NMP specimen from Zambia was originally identified as and referred to *Laephotis botswanae* Setzer, 1971 (Benda et al. 2016, Monadjem et al. 2021), here its determination is corrected to *L. angolensis*, in accordance with the conclusions by Taylor et al. (2022). Based on the results of a molecular genetic analysis, the latter authors suggested to consider these names as synonyms. This conclusion is supported by the morphological similarity of bats identified as these two species and difficulties to dinstinguish between them based on external or cranial characters (Kearney & Seamark 2005, Monadjem et al. 2020a, own data).

Of the genus *Laephotis* s.s., only *L. angolensis* was reported from Zambia till present (under *L. botswanae*, see Ansell 1978, Monadjem et al. 2020a) and this species is the most wide-

spread member of the genus in southern and central Africa. The four available Zambian record localities of *L. angolensis* come only from the western part of the country. The locality of the here presented record lies also in this section of the country, although it is the first finding of

Fig. 12. Maximum likelihood tree of reconstructed phylogenetic relations of African pipistrelloid bats (Vespertilioninae) based on the cytochrome *b* sequences (the Zambian bats in red). Black dots on the nodes denote that these nodes have high branch support (e.g., SH-aLRT ≥80%, aBayes ≥0.95, UFBoot ≥90%).

this bat from southern Zambia. The dimensions of the NMP specimen of *L. angolensis* from Zambia are shown in Table 8.

Nycticeinops schlieffenii (Peters, 1859)

Material (4). 1 ♂ (NMP 97596 [S+A]), Kabula Lodge, shrubland, 20 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera;
1 ♀ (NMP 97688 [S+A]), Kacholola, riverine forest, 15 June 2010, leg. J. Šklíba, V. Mazoch & E. Knotková;
2 ♀♀ (NMP 97555, 97556 [S+A]), Kasanka National Park, Luwombwa Camp, 27 November 2018, leg. P. Benda & J. Červený.

Nycticeinops schlieffenii is a bat broadly distributed in dry savannas and arid steppes of sub-Saharan Africa, from the southern Sahara to South Africa (Happold 2013c). In southern and central Africa, it is widespread over central and eastern parts of the region, although in Zambia it is less abundant compared to the more southern regions. According to the data by Monadjem et al. (2020a) and regarding the territories of particular countries, *N. schlieffenii* is almost twice more abundant in Botswana (with 11 record sites) and 13 times more frequently recorded in Zimbabwe (56 sites), compared to the evidence from Zambia (8 sites). The Zambian localities cover mainly areas of the central and northern parts of the country. In the NMP collection of Zambian bats, specimens of this species are available from three localities, including two in southern Zambia. The dimensions of the NMP specimens of *N. schlieffenii* from Zambia are shown in Table 9.

Scotoecus hirundo (de Winton, 1899)

Material (3). 1 ♂, 1 ♀ (NMP 97684, 97685 [S+A]), Kacholola, riverine forest, 15 June 2010, leg. J. Šklíba, V. Mazoch & E. Knotková;
1 ♀ (NMP 97627 [S+A]), Ndola Hill, 7 June 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera.

The taxonomy of the dark-winged species of the genus *Scotoecus* Thomas, 1901 remains unresolved, with existence of one to three species being suggested within this group (Koopman 1993, Simmons 2005). The analyses of geographic variation showed small-sized bats to occur in the savanna belt from Senegal to Ehiopia and Uganda, medium-sized bats in eastern Africa, and large-sized bats in southern Africa, plus marked sexual dimorphism where males are larger than females (Hill 1974, Robbins 1980, Taylor & van der Merwe 1998, Cotterill 2001, own data). These findings can indicate either an existence of more taxa within this group or a cline of increasing body size from north to south within one taxon. Hence, without an employment of molecular genetic methods in a broad geographical scale, this problem will perhaps remain unresolved for good. Therefore, we here temporarily assign the Zambian specimens under a broadly defined taxon *Scotoecus hirundo* s.l., sensu Hayman & Hill (1971), Koopman (1975, 1993), and Happold (2013e).

This form is a widespread but uncommon savanna bat of sub-Saharan Africa (Happold 2013e). Only a limited number of records of *S. hirundo* are available from southern Africa, with most numerous records from Mozambique and Zambia (Cotterill 2001, Monadjem et al. 2020a). In Zambia, the confirmed record localities are situated in the eastern, central, and western parts of the country (Monadjem et al. 2020a, under *S. hindei* / *S. albigula*), which includes the areas where the NMP specimens of this bat also come from (Ndola and Petauke regions). So, the

Table 9. Basic biometric data on the NMP specimens of *Nycticeinops schlieffenii*, *Scotoecus hirundo*, and *Scotophilus leucogaster* from Zambia. For abbreviations see Methods

dimension	*Nycticeinops schlieffenii*					*Scotoecus hirundo*					*Scotophilus leucogaster*	
	n	**M**	min	max	SD	*n*	**M**	min	max	SD	97646	97647
G	*4*	**6.20**	4.5	7.4	1.273	*3*	11.67	10.5	13.0	1.258	15.0	15.0
LAt	*4*	**31.55**	28.7	33.8	2.381	*3*	34.93	33.6	36.9	1.739	45.2	46.3
LCr	*3*	**12.53**	11.87	13.28	0.709	*3*	14.24	13.83	14.85	0.540	16.46	16.47
LCb	*3*	**12.19**	11.54	13.04	0.771	*3*	14.01	13.53	14.66	0.585	15.53	15.75
LaZ	*3*	**8.77**	8.29	9.19	0.452	*3*	10.95	10.62	11.41	0.411	12.37	12.16
LaI	*4*	**3.63**	3.54	3.69	0.070	*3*	4.53	4.36	4.62	0.150	4.44	4.56
LaInf	*4*	**4.14**	3.86	4.34	0.212	*3*	5.61	5.38	5.98	0.326	6.18	5.94
LaN	*4*	**6.52**	6.21	6.85	0.334	*3*	7.84	7.58	8.07	0.246	8.63	8.65
LaM	*4*	**7.20**	7.08	7.44	0.168	*3*	9.55	9.18	10.04	0.444	10.32	10.36
ANc	*3*	**4.52**	4.38	4.65	0.135	*3*	5.39	5.06	5.58	0.289	7.08	6.74
LBT	*4*	**2.82**	2.56	3.05	0.225	*3*	3.43	3.39	3.45	0.032	3.68	3.73
CC	*4*	**3.94**	3.54	4.17	0.276	*3*	5.39	5.21	5.74	0.303	5.96	5.75
M^3M^3	*4*	**5.59**	5.09	6.02	0.397	*3*	7.41	7.33	7.52	0.098	7.88	7.74
CM^3	*4*	**4.62**	4.37	4.83	0.219	*3*	5.81	5.54	6.13	0.299	5.96	5.75
LMd	*4*	**9.22**	8.52	9.71	0.540	*3*	11.27	10.88	11.81	0.484	11.87	12.38
ACo	*4*	**3.11**	2.79	3.45	0.270	*3*	3.52	3.38	3.75	0.203	4.89	5.04
CM_3	*4*	**4.94**	4.63	5.19	0.288	*3*	6.09	5.87	6.47	0.328	6.64	6.66

NMP bats do not represent an important contribution to the distribution picture of *S. hirundo* in Zambia. The dimensions of these specimens are shown in Table 9.

Scotophilus leucogaster (Cretzschmar, 1830)

Material (2). 2 ♂♂ (NMP 97646, 97647 [S+A]), North Luangwa National Park, Chifunda Camp, 12 July 2009, leg. V. Mazoch & J. Zima.

The distribution range of *Scotophilus leucogaster* comprises two separate patches in the Afrotropics, one in the savanna belt stretching from Mauritania to Yemen and Kenya, the other in the central part of southern Africa, between central Angola, central Zambia and southern Mozambique (Van Cakenberghe & Happold 2013). Monadjem et al. (2020a) reported only one confirmed record of this bat from Zambia, from Mfuwe near Kakumbi, in the South Luangwa National Park. The here presented specimens of *S. leucogaster* originate from a locality in the same region of the Luangwa river valley, some 150 km upstream along the river. Currently, this record represents the northernmost confirmed occurrence site in the southern distribution patch of the species in Africa; it is inhabited by the subspecies *S. l. damarensis* Thomas, 1906 (Vallo & Van Cakenberghe 2017). The dimensions of the NMP specimens of *S. leucogaster* from Zambia are shown in Table 9.

Scotophilus viridis (Peters, 1852)

Material (5). 2 ♂♂, 2 ♀♀ (NMP 97679–97682 [S+A]), Kacholola, riverine forest, 15 June 2010, leg. J. Šklíba, V. Mazoch & E. Knotková;

Table 10. Basic biometric data on the NMP specimens of *Scotophilus viridis*, *S. dinganii*, *Miniopterus natalensis* (*Mn*), and *M. mossambicus* from Zambia. For abbreviations see Methods

dimension	*Scotophilus viridis*					*Scotophilus dinganii*		*Mn*	*Miniopterus mossambicus*				
	n	**M**	min	max	SD	97624	97625	97649	*n*	**M**	min	max	SD
G	*5*	**18.30**	16.5	21.0	1.891	36.0	36.0	10.0	*11*	**9.23**	8.0	10.9	0.771
LAt	*5*	**48.38**	46.7	50.1	1.268	58.9	58.8	45.2	*11*	**44.48**	43.5	45.5	0.704
LCr	*5*	**17.51**	17.02	17.98	0.345	21.75	21.64	14.88	*10*	**14.99**	14.68	15.16	0.142
LCb	*5*	**16.54**	15.98	16.83	0.338	20.10	20.14	14.42	*10*	**14.45**	14.31	14.68	0.114
LaZ	*5*	**12.71**	12.49	12.98	0.190	15.01	15.06	8.44	*10*	**8.26**	8.11	8.48	0.142
LaI	*5*	**4.50**	4.32	4.68	0.162	5.13	5.18	3.68	*10*	**3.62**	3.51	3.78	0.109
LaInf	*5*	**6.19**	6.01	6.35	0.132	7.75	7.97	3.93	*10*	**3.73**	3.58	3.93	0.096
LaN	*5*	**8.89**	8.74	9.07	0.138	10.61	9.90	7.88	*10*	**7.71**	7.48	7.92	0.147
LaM	*5*	**10.83**	10.62	10.94	0.138	13.19	12.63	8.54	*10*	**8.37**	8.26	8.52	0.095
ANc	*5*	**7.03**	6.68	7.33	0.234	8.88	8.62	6.27	*10*	**6.08**	5.93	6.27	0.107
LBT	*5*	**3.73**	3.64	3.92	0.114	4.69	4.63	2.93	*10*	**2.97**	2.82	3.18	0.101
CC	*5*	**5.98**	5.87	6.11	0.086	7.74	7.48	4.38	*10*	**4.28**	3.98	4.44	0.126
M^3M^3	*5*	**8.26**	8.13	8.43	0.122	9.88	9.38	6.14	*10*	**6.14**	5.67	6.33	0.186
CM^3	*5*	**6.21**	6.11	6.28	0.073	7.29	7.54	5.66	*10*	**5.75**	5.67	5.93	0.078
LMd	*5*	**12.90**	12.71	13.06	0.159	15.59	16.06	10.34	*10*	**10.44**	10.32	10.66	0.128
ACo	*5*	**4.94**	4.68	5.16	0.189	6.53	6.14	2.63	*10*	**2.46**	2.28	2.61	0.096
CM_3	*5*	**6.96**	6.92	7.02	0.043	8.24	8.58	6.01	*10*	**6.09**	6.02	6.28	0.078

1 ♀ (NMP 97604 [S+A]), Sioma Bush Camp, 23 May 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera.

Scotophilus viridis s.str. is nearly endemic to southern Africa (Vallo & Van Cakenberghe 2017), it occurs mainly in the eastern part of the region and the north-western margin of its distribution range stretches through Zambia (Monadjem et al. 2020a). The NMP specimens of this bat come from southern Zambia, from the area of known distribution of *S. viridis*; however, the record from the Sioma Bush Camp creates a new marginal point of the species' western distribution border in south-western Zambia. The dimensions of the NMP specimens of *S. viridis* from Zambia are shown in Table 10.

Scotophilus dinganii (Smith, 1833)

Material (2). 1 ♂, 1 ♀ (NMP 97624, 97625 [S+A]), Ndola Hill, 7 June 2009, leg. J. Šklíba, M. Lövy, V. Mazoch & R. Šumbera.

Scotophilus dinganii is a bat distributed abundantly in southern and eastern Africa (Vallo & Van Cakenberghe 2017), in southern Africa it is the most widespread species of the genus (Monadjem et al. 2020a). This is also true for Zambia, where 13 confirmed sites of occurrence are known from all parts of the country (Ansell 1978, Monadjem et al. 2020a). The NMP specimens thus do not improve its distribution picture. The dimensions of the NMP specimens of *S. dinganii* from Zambia are shown in Table 10.

Miniopteridae

Miniopterus natalensis (Smith, 1833)

Material (1). 1 ♂ (NMP 97649 [S+A]), Kalambo Falls, camp above river, 18 July 2009, leg. V. Mazoch & J. Zima.

The distribution range of *Miniopterus natalensis* s.str. is only imperfectly defined; according to Monadjem et al. (2020a), this bat occurs mainly in savannas of the temperate zone of southern Africa. Confirmed records of *M. natalensis* s.str. come from the countries southwards and westwards of Zambia, while in Zambia, Mozambique and the DR Congo, this species still awaits confirmation of its occurrence. Thus, the here presented bat from the Kalambo Falls in northern Zambia represents the first specimen of *M. natalensis* s.str. confirmed by the molecular genetic methods from the country and one of the northernmost known records. The dimensions of the NMP specimen of this species from Zambia are shown in Table 10.

Miniopterus mossambicus Monadjem, Goodman, Stanley et Appleton, 2013

Material (11). 2 ♂♂, 3 ♀♀ (NMP 97574–97577 [S+A], 97573 [A]; Fig. 13), Chisakila, Bwarenunka Cave, 1 December 2018, leg. P. Benda & J. Červený;
3 ♂♂, 3 ♀♀ (NMP 97674–97678, 97683 [S+A]), Kacholola, riverine forest, 15 June 2010, leg. J. Šklíba, V. Mazoch & E. Knotková.

Fig. 13. A male of *Miniopterus mossambicus* collected from the Bwarenunka Cave near Chisakila on 1 December 2018.

The known distribution range of recently described *Miniopterus mossambicus* stretches discontinuously across the savanna belt of eastern and south-eastern Africa; it covers a triangular area in the eastern part of southern Africa (Monadjem et al. 2020a), and recently this bat has been discovered in central Tanzania and southern Kenya (Demos et al. 2020). Besides Mozambique that gave the name to the bat, the confirmed records of *M. mossambicus* from southern Africa are known only from southern Zambia. Two record sites are available from the latter country, the Leopards Hill Cave near Lusaka (15°36'S, 28°43'E; Miller-Butterworth et al. 2005, Monadjem et al. 2013a) and Old Mine at Missale (14°07'S, 32°52'E; Monadjem et al. 2013a, 2020b). The NMP specimens of *M. mossambicus* originate from southern Zambia, from the area geographically bordered by the previous two sites. This pattern suggests the distribution that follows the Zambezi watercourse from lowlands of Mozambique to the inland uplands of Zambia and Zimbabwe. A colony of this species composed of ca. 2000 bats of both sexes was discovered in the Bwarenunka Cave near Chisakila on 1 December; all examined females were in the lactation stage.

So, although *M. mossambicus* is a rare bat in collections (cf. Monadjem et al. 2020a), the new NMP samples do not contribute significantly to its distribution picture. However, the eleven NMP specimens identified with help of genetic analysis can be useful for the description of metric traits, until now defined based on a small number of samples of which only several were diagnosed genetically (Monadjem et al. 2013a, 2020b). The dimensions of the NMP specimens of *M. mossambicus* from Zambia are shown in Table 10. The values of the dimensions are slightly larger than those given by Monadjem et al. (2013a, 2020b), both external and cranial, of the latters, both lengths and widths (LAt 41.0–44.9 mm, mean [M] 43.9 mm; LCr 14.38–15.20 mm, M 14.71 mm; LaZ 7.85–8.40 mm, M 8.06 mm; CM^3 5.27–5.87 mm, M 5.52 mm; Monadjem et al. 2020a, b). These differences could indicate a cline shift in body and skull size in this bat along the geographic and/or climatic gradient from east to west, from warm lowlands to continental uplands.

CONCLUSIONS

The NMP collection contains 139 specimens of bats from Zambia belonging to 32 species of eight families (Table 11). These bats originate from 29 localities covering the whole territory of the country (Fig. 1), with a frequency 1–8 species per locality, on average 2.5 species and 4.8 specimens per locality. Particular species originate from 1–17 localities, together representing 73 records (species vs. locality), on average 2.3 records per species, and the species are represented by 1–31 specimens, on average 4.3 specimens per species. Most of the specimens belong to common species, which could be frequently found in other collections containing material from Zambia and the broader region of south-central Africa (Monadjem et al. 2020a). However, some of the species series have an undoubted value for zoological research. Generally, the collection as a whole contributes significantly to the description of both distribution and physical traits of the bat fauna of Zambia.

According to the review by Monadjem et al. (2020a), the bat fauna of Zambia is composed of 73 species (Appendix 1, Table 11; or 74 species, when *Miniopterus* cf. *natalensis* is included) belonging to ten families; of these, 29 species are housed in the NMP collection, making up 39.7% of the known fauna. The evaluation of the NMP collection brought confirmation of two more species for the Zambian fauna, *Afropipistrellus grandidieri* and *Neoromicia somalica*, plus confirmation of the occurrence of *Miniopterus natalensis* s.str. in the country based on

molecular genetic evidence. The bat fauna of Zambia now comprises 76 species in total, 42.1% of them are housed in the NMP collection. One species, *Neoromicia somalica*, is now confirmed as a new bat also for the whole region of southern and central Africa as defined geographically by Monadjem et al. (2020a).

Until now, *Rhinolophus sakejiensis* has been known only from the type series, composed of three bats collected in north-western Zambia in 1990; the NMP collection contains a new specimen of this bat, first documented after the species description. The NMP collection includes also four specimens of *Chaerephon bivittatus*, representing the second record of this bat from Zambia.

The record localities of the NMP specimens of *Epomophorus labiatus*, *Rhinolophus mossambicus*, and *Neoromicia somalica* changed the known distribution ranges of these bats as a whole, not only in Zambia. The genetic analysis revealed a new distribution extension of several mitochondrial lineages of the otherwise common species, like *Hipposideros caffer* (A1 lineage) and *Nycteris thebaica* (clade *thebaica* 4), to the territory of Zambia; the genetic analysis also confirmed the occurrence of *Miniopterus natalensis* s.str. in Zambia. In several species, the NMP specimens represent new marginal records, making the distribution ranges more precise, viz. *Epomophorus dobsonii*, *Nyctinomus aegyptiacus*, *Glauconycteris variegata*, *Pipistrellus rusticus*, *Scotophilus leucogaster*, and *S. viridis*.

In two species, *Rhinolophus mossambicus* and *Miniopterus mossambicus*, the basic morphometric comparison suggests an increase of body size along a gradient from south-eastern African lowlands towards central African uplands resembling a cline shift in metric traits according to Bergmann's rule (although not in the north-south direction). However, this brief observation needs further studies based on examinations of more extensive materials.

In summary, the small collection of bats from Zambia, created in a relatively short time between 2009 and 2018, represents a valuable series of specimens, providing an important addition to the knowledge of composition, distribution and morphometry of the bat fauna of the country.

Table 11. Composition of the bat fauna of Zambia according to Monadjem et al. (2020a) [M20] and the composition of the NMP bat collection from Zambia (record = species vs. locality); the new species for the Zambian fauna are typed in **bold**

family	species fauna M20	species NMP	specimens NMP	records NMP
Pteropodidae	11	4	47	27
Rhinolophidae	9	4	7	6
Hipposideridae	3	2	4	2
Rhinonycteridae	2	1	5	1
Megadermatidae	1	0	0	0
Emballonuridae	2	0	0	0
Nycteridae	6	1	3	2
Molossidae	13	5	16	7
Vespertilionidae	24	11+**2**	45	25
Miniopteridae	2	1+**1**	12	3
total	73	29+**3**	139	73

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We dedicate this catalogue to Professor Hynek Burda, a founder of the Czech mammalogical research in Zambia, on the occasion of his 70th birthday. Without his initial effort in the Zambian field, the small bat collection presented here would not have arisen.

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APPENDIX 1

Composition of the bat fauna of Zambia, as summarised by Monadjem et al. (2020a); in brackets are the numbers of records based on museum specimens

Pteropodidae: *Eidolon helvum* [11], *Rousettus aegyptiacus* [5], *Myonycteris angolensis* [2], *M. torquata* [1], *Epomophorus crypturus* [26], *E. labiatus* [11], *E. wahlbergi* [14], *E. dobsonii* [12], *Epomops franqueti* [1], *Micropteropus pusillus* [1], *Plerotes anchietae* [2];
Rhinolophidae: *Rhinolophus clivosus* [7], *R. sakejiensis* [1], *R. darlingi* [2], *R. fumigatus* [6], *R. mossambicus* [15], *R. rhodesiae* [4], *R. lobatus* [4], *R. simulator* [7], *R. blasii* [3];
Hipposideridae: *Hipposideros caffer* [30], *H. ruber* [4], *Macronycteris vittata* [9];
Rhinonycteridae: *Triaenops afer* [1], *Cloeotis percivali* [4];
Megadermatidae: *Lavia frons* [4];
Emballonuridae: *Taphozous perforatus* [1], *T. mauritianus* [11];
Nycteridae: *Nycteris thebaica* [34], *N. major* [1], *N. macrotis* [10], *N. grandis* [4], *N. woodi* [7], *N. hispida* [13];
Molossidae: *Chaerephon pumilus* [16], *C. major* [1], *C. chapini* [4], *C. ansorgei* [1], *C. bivittatus* [1], *C. nigeriae* [8], *Mops midas* [4], *M. condylurus* [7], *Mops niveiventer* [12], *Otomops martiensseni* [1], *Nyctinomus aegyptiacus* [3], *Tadarida fulminans* [2], *T. ventralis* [1];
Vespertilionidae: *Myotis tricolor* [1], *M. welwitschii* [3], *M. bocagii* [2], *Kerivoula lanosa* [3], *K. argentata* [7], *Eptesicus hottentotus* [2], *Glauconycteris variegata* [8], *Pipistrellus hesperidus* [7], *P. rusticus* [8], *Vansonia rueppellii* [5], *Afronycteris nana* [25], *Neoromicia zuluensis* [9], *N. capensis* [17], *N. stanleyi* [6], *N. anchietae* [11], *Laephotis angolensis* [4], *Pseudoromicia rendallii* [2], *Nycticeinops schlieffenii* [8], *Scotoecus hirundo* s.l. [7], *S. albofuscus* [1], *Mimetillus thomasi* [4], *Scotophilus leucogaster* [1], *S. viridis* [4], *S. dinganii* [13];
Miniopteridae: *Miniopterus inflatus* [1], *M. mossambicus* [1].

APPENDIX 2

Gazetteer (NM = number in the map in Fig. 1)

site	coordinates	altitude	NM
Bangweulu Game Reserve, Chikuni (Muchinga Prov.)	12°01'S, 30°13'E	1175	6
Bwarenunka Cave, Chisakila (Lusaka Prov.)	15°52'S, 28°42'E	502	17
Chifunda, Old Luelo Ranger Post (Eastern Prov.)	11°52'S, 32°33'E	566	13
Chifunda Camp, North Luangwa National Park (Muchinga Prov.)	11°52'S, 32°26'E	630	12
Chikuni, Bangweulu Game Reserve (Muchinga Prov.)	12°01'S, 30°13'E	1175	6
Chisakila, Bwarenunka Cave (Lusaka Prov.)	15°52'S, 28°42'E	502	17
Chishimba Falls (Northern Prov.)	10°06'S, 30°55'E	1320	5
Chunga Camp, Kafue National Park (Central Prov.)	15°03'S, 26°00'E	1128	20
Farmers Rendezvous Lodge, Kaoma (Western Prov.)	14°50'S, 24°49'E	1187	25
Fibwe Camp, Kasanka National Park (Central Prov.)	12°35'S, 30°15'E	1170	8
Kabula Lodge (Western Prov.)	17°02'S, 24°01'E	1012	23
Kacholola (Eastern Prov.)	14°46'S, 30°36'E	932	14
Kafue National Park, Chunga Camp (Central Prov.)	15°03'S, 26°00'E	1128	20
Kafue National Park, Lufupa River Camp (North-western Prov.)	14°37'S, 26°12'E	1085	19
Kalambo Falls (Northern Prov.)	08°36'S, 31°14'E	1220	2
Kankonde Camp, Mutinondo (Muchinga Prov.)	12°23'S, 31°19'E	1457	11
Kaoma, Farmers Rendezvous Lodge (Western Prov.)	14°50'S, 24°49'E	1187	25
Kasakalawe, Lake Tanganyika Lodge (Northern Prov.)	08°47'S, 31°05'E	739	1
Kasanka National Park, Fibwe Camp (Central Prov.)	12°35'S, 30°15'E	1170	8
Kasanka National Park, Luwombwa Camp (Central Prov.)	12°30'S, 30°08'E	1168	7
Kasanka National Park, Pontoon Camp (Central Prov.)	12°34'S, 30°14'E	1171	8
Liuwa Plain National Park, Lyangu Camp (Western Prov.)	14°47'S, 22°35'E	1036	27
Lake Tanganyika Lodge, Kasakalawe (Northern Prov.)	08°47'S, 31°05'E	739	1
Livingstone, No Name Camp (Southern Prov.)	17°49'S, 25°44'E	911	21
Lufupa River Camp, Kafue National Park (North-western Prov.)	14°37'S, 26°12'E	1085	19
Lumangwe Falls (Northern Prov.)	09°32'S, 29°23'E	1326	3
Lusaka, Lusaka East Forest Reserve (Lusaka Prov.)	15°27'S, 28°25'E	1281	18
Luwombwa Camp, Kasanka National Park (Central Prov.)	12°30'S, 30°08'E	1168	7
Lyangu Camp, Liuwa Plain National Park (Western Prov.)	14°47'S, 22°35'E	1036	27
Mayense Camp, Mutinondo (Muchinga Prov.)	12°27'S, 31°17'E	1457	10
Mkushi River Camp (Central Prov.)	14°35'S, 29°13'E	999	15
Mutinondo, Kankonde Camp (Muchinga Prov.)	12°23'S, 31°19'E	1457	11
Mutinondo, Mayense Camp (Muchinga Prov.)	12°27'S, 31°17'E	1457	10
Nchila Wildlife Reserve, Sakeji (North-western Prov.)	11°16'S, 24°19'E	1405	28
Ndola Hill (Copperbelt Prov.)	12°58'S, 28°36'E	1288	16
Newa, 10 km E of Mongu (Western Prov.)	15°15'S, 23°14'E	1065	26
No Name Camp, Livingstone (Southern Prov.)	17°49'S, 25°44'E	911	21
North Luangwa National Park, Chifunda Camp (Muchinga Prov.)	11°52'S, 32°26'E	630	12
Nsalu Cave (Central Prov.)	12°43'S, 30°41'E	1450	9
Ntumbachushi Falls (Luapula Prov.)	09°51'S, 28°57'E	1142	4
Nulubeti, Simungoma (Western Prov.)	17°26'S, 24°41'E	915	22
Old Luelo Ranger Post, Chifunda (Eastern Prov.)	11°52'S, 32°33'E	566	13
Pontoon Camp, Kasanka National Park (Central Prov.)	12°34'S, 30°14'E	1171	8
Sakeji, Nchila Wildlife Reserve (North-western Prov.)	11°16'S, 24°19'E	1405	28
Simungoma, Nulubeti village (Western Prov.)	17°26'S, 24°41'E	915	22
Sioma Bush Camp (Western Prov.)	16°45'S, 23°25'E	1001	24

APPENDIX 3

GenBank Accession Numbers of the NMP bats from Zambia

species	NMP voucher	haplotype (GenBank No.)
Afronycteris nana	NMP 97611	KX375181
Afronycteris nana	NMP 97644	KX375182
Afronycteris nana	NMP 97645	OQ111854
Afronycteris nana	NMP 97658	OQ111856
Afronycteris nana	NMP 97686	OQ111858
Afronycteris nana	NMP 97687	OQ111859
Glauconycteris variegata	NMP 97602	OQ111839
Glauconycteris variegata	NMP 97603	OQ111840
Hipposideros caffer	NMP 97570	OQ111836
Hipposideros caffer	NMP 97571	OQ111837
Hipposideros caffer	NMP 97572	OQ111838
Laephotis angolensis	NMP 97599	KX375172
Miniopterus mossambicus	NMP 97573	OQ224760
Miniopterus mossambicus	NMP 97574	OQ224759
Miniopterus mossambicus	NMP 97575	OQ224761
Miniopterus mossambicus	NMP 97577	OQ224758
Neoromicia capensis	NMP 97600	OQ111846
Neoromicia capensis	NMP 97601	OQ111847
Neoromicia capensis	NMP 97607	OQ111848
Neoromicia capensis	NMP 97608	OQ111848
Neoromicia capensis	NMP 97609	KX375175
Neoromicia capensis	NMP 97610	OQ111849
Neoromicia capensis	NMP 97618	OQ111851
Neoromicia capensis	NMP 97689	OQ111861
Neoromicia capensis	NMP 97690	OQ111861
Neoromicia somalica	NMP 97648	OQ111855
Nycteris thebaica	NMP 97614	OQ224757
Nycteris thebaica	NMP 97628	OQ224756
Nycticeinops schlieffenii	NMP 97688	OQ111860
Pipistrellus rusticus	NMP 97580	OQ111841
Pipistrellus rusticus	NMP 97581	OQ111842
Pipistrellus rusticus	NMP 97588	OQ111843
Pipistrellus rusticus	NMP 97593	OQ111844
Pipistrellus rusticus	NMP 97594	OQ111842
Pipistrellus rusticus	NMP 97626	OQ111843
Rhinolophus clivosus	NMP 97631	OQ224768
Rhinolophus clivosus	NMP 97665	OQ224767
Rhinolophus fumigatus	NMP 97641	OQ224763
Rhinolophus fumigatus	NMP 97650	OQ224765
Rhinolophus mossambicus	NMP 97612	OQ224764
Rhinolophus mossambicus	NMP 97640	OQ224766
Scotoecus hirundo	NMP 97627	OQ111852
Scotoecus hirundo	NMP 97684	OQ111857
Scotoecus hirundo	NMP 97685	OQ111857