

A further new species of vesper bat from Central Africa (Chiroptera: Vespertilionidae)

Další nový druh netopýra ze střední Afriky (Chiroptera: Vespertilionidae)

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received on 6 December 2019

Abstract. A new species of the vespertilionid bat genus *Parahypsugo* is described from Central Africa, increasing the number of species of the genus at least to five. The new taxon occurs in montane forests of Rwanda and eastern DR Congo and is larger than any other of the four known species. In skull measurements, it is the largest species of the genus.

Key words. *Parahypsugo*, new species, Rwanda, DR Congo, morphology, taxonomy.

INTRODUCTION

Vesper bats (Vespertilionidae) of the genus *Parahypsugo* have been revised by HUTTERER et al. (2019). The authors defined a new genus and species, *Parahypsugo happoldorum* Hutterer, Decher, Monadjem et Astrin, 2019, and placed three further species in the genus, while others were left unstudied. Here we define another new species of this genus which is even larger in cranial measurements than *P. happoldorum*, the largest species that was known so far.

The African genus *Parahypsugo* is similar to the Eurasian *Hypsugo*, but differs morphologically and genetically. The rhinarium is large and simply built (large and complex in *Hypsugo*), the epiblema is absent (small in *Hypsugo*), the free tail tip is very short (3–5 mm in *Hypsugo*), cranial pits are absent (present in *Hypsugo*), first upper incisor is bicuspid (unicuspid in *Hypsugo*), the colour of the ventral pelage is deep brown (gray in *Hypsugo*), and genetically the two genera fall into different groups (HUTTERER et al. 2019: 3, Fig. 1).

Our previous study dealt mainly with the West African populations. Here we describe another new species from Rwanda and DR Congo based on two specimens previously mentioned by HELLER et al. (1994), KERBIS PETERHANS et al. (2013), and others. The latter authors already questioned the status of the two specimens and considered them to represent a possibly new species.

MATERIALS AND METHODS

The examined specimens are preserved as skins and skulls in the Field Museum Chicago, USA (FMNH) and the Senckenberg Museum Frankfurt, Germany (SMF). Other specimens are stored in the Zoologisches Forschungsmuseum Alexander Koenig, Bonn, Germany (ZFMK), in the Durban Natural Science Museum,

Durban, South Africa (DM), in the Musée Royale de l'Afrique Centrale, Tervuren, Belgium (MRAC), and in the Harrison Zoological Museum, Sevenoaks, Great Britain (HZM). Taxonomy follows SIMMONS (2005), except where otherwise noted. The terminology of the skull follows LANZA et al. (2015).

Morphology

Skins and skulls were studied, measured, drawn, and photographed. Drawings were made with the help of a mirror attached to a Wild M5 binocular microscope.

The following standard external measurements were taken from field labels attached to the specimens: total body length, tail length, forearm length, hindfoot length (including claw), and ear length. Forearm length was taken with callipers to the closest 0.1 mm; all other measurements were taken at an accuracy of 1 mm. Body mass was taken from tags.

Nine cranial and four dental measurements were taken with callipers to the closest 0.01 mm following MONADJEM et al. (2013). Cranial measurements were: greatest skull length (GSKL), from the posterior-most point of the occipital to the anterior-most point of the incisors; condylo-incisive length (CIL), from the occipital condyles to the anterior-most point of the incisors; condylo-canine length (CCL), from the occipital condyles to the anterior-most point of the canines; greatest zygomatic breadth (ZYGO), taken as the greatest width across the zygomatic arches; greatest braincase width (GBW), lateral braincase width taken posteriorly above the zygomatic arches; greatest skull height (GSH), taken from the lowest point of the bullae to the highest point of the cranium; postorbital width (POB), narrowest dorsal width posterior to the postorbital at the constriction of the cranium; greatest mastoid breadth (MAST), greatest breadth of cranium at mastoid processes; and greatest mandible length (MAND), taken from the posterior-most point of the condyles to the anterior-most point of the incisors. Dental measurements included: width across the third molars (M3-M3), taken across the outer-most points of the alveoli of the third molars; complete upper canine-molar tooth row (C-M3), taken from the anterior-most point of the alveolus of the canine to the posterior-most point of the third molar; width across upper canines (C-C), taken across the outer-most points of the alveoli of the canines; and complete mandibular canine-molar tooth row (c-m3), taken from the anterior-most point of the alveolus of the canine to the posterior-most point of the third molar. Tooth abbreviations are as follows: C, canine; I, incisor; M, molar; P, premolar; with upper teeth presented in upper case and lower teeth in lower case. All craniodental measurements were taken by the first author.

Specimens examined

Type specimens

The holotype and paratype of *Pipistrellus eisentrauti* Hill, 1968 (ZFMK-MAM-1968.0005, 0006), the holotype and paratype of *Parahypsugo happoldorum* (ZFMK-MAM-2009.0029, 2008.0295) and the holotype of *Pipistrellus eisentrauti bellieri* De Vree, 1972 (MRAC 35686) were examined. For the holotype of *Pipistrellus crassulus* Thomas, 1904 (BMNH 1904.2.8.1), published measurements were taken from THOMAS (1904).

Comparative specimens

Parahypsugo crassulus (Thomas, 1904). – SMF 79.441 (Rwanda), SMF 79.442 (DR Congo, Kivu region, Centre de Recherche en Sciences Naturelles, 850 m a. s. l.); FMNH 165169, male (Uganda), FMNH 167775-776, male (Gabon), FMNH 108168, male (Sudan), FMNH 83599, male (Angola), FMNH 165170-171, male (Uganda), FMNH 152767, male (Kenya).

Parahypsugo eisentrauti (Hill, 1968). – ZFMK 1968.0005, holotype (Cameroon, Rumpi Hills); ZFMK 1968.0006, paratype (Cameroon, Mt. Kupe); ZFMK 1999.0676 (Cameroon, Mt. Nlonako).

Parahypsugo bellieri (De Vree, 1972). – Holotype, MRAC 35686, female, skin and skull (Côte d'Ivoire, Adiopodoumé; coll. F. DE VREE, 19 November 1969); ZFMK-MAM-2008.0299, female (Guinea, Simandou, Foko Confluence, 8 March 2008); ZFMK-MAM-2009.0030, male (Guinea, Simandou, Western Spur Valley, 12 December 2008). DM 12616, male (Liberia, East Nimba Nature Reserve, coll.

Ara MONADJEM, 22 December 2010, altitude 1,200 m a. s. l.); DM 13221, male (Liberia, East Nimba Nature Reserve, coll. A. M., 31 December 2011, altitude 900 m a. s. l.); DM 13222, male (Liberia, 10 km west of Mount Nimba, coll. A. M., 8 January 2012, altitude 420 m a. s. l.).

RESULTS

Family Vespertilionidae Gray, 1821

Parahypsugo Hutterer, Decher, Monadjem et Astrin, 2019

TYPE SPECIES. *Parahypsugo happoldorum* Hutterer, Decher, Monadjem et Astrin, 2019.

SPECIES INCLUDED. *Parahypsugo crassulus* (Thomas, 1904), *Parahypsugo eisentrauti* (Hill, 1968), *Parahypsugo bellieri* (De Vree, 1972), and *Parahypsugo macrocephalus* sp. nov.

DISTRIBUTION. Tropical Africa from Guinea in the west to Sudan and Somalia in the east, and south to Congo, DRC, Uganda, Rwanda and Kenya (PATTERSON & WEBALA 2012, BATES et al. 2013, MONADJEM et al. 2013, DECHER et al. 2016, VAN CAKENBERGHE et al. 2017). This genus is probably widely distributed in the rainforest zone of Africa.

Parahypsugo macrocephalus sp. nov.

Large Headed Pipistrelle

Hypsugo eisentrauti (Hill, 1968): VOLLETH & HELLER 1994: 13; HELLER et al. 1995: 2–3, Figs. 1, 5; VOLLETH et al. 2001: 33–34.

Hypsugo cf. *eisentrauti*: HUHNDORF & KALEME 2008: 24, Table 3.1; KERBIS PETERHANS et al. 2013: 189; VAN CAKENBERGHE et al. 2017: 92.

Pipistrellus eisentrauti Hill, 1968: THORN & KERBIS PETERHANS 2009: 53.

TYPE MATERIAL. **Holotype**: adult female, FMNH 195086 (MHH 845), skin, skull and postcranial skeleton, Kabogo Forest, 4 km SW Talama (04°59'S, 29°05'E), 1950 m a. s. l., DR Congo, 17 February 2007, leg.

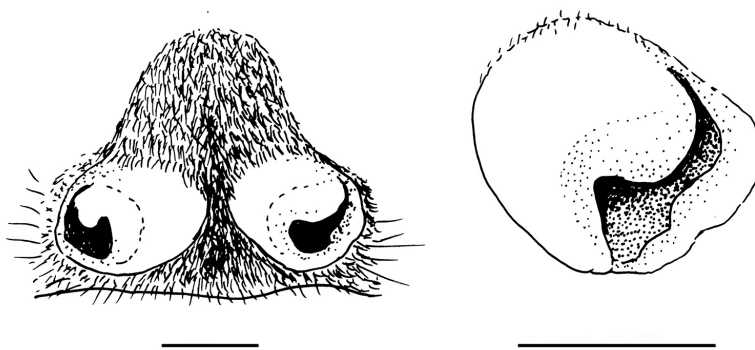


Fig. 1. Rhinarium of *Parahypsugo macrocephalus* sp. nov., holotype (FMNH 195086) in front view. Scale bars = 1 mm.

Obr. 1. Čenich netopýra velkohlavého (*Parahypsugo macrocephalus* sp. nov.), holotyp (FMNH 195086). Měřítko = 1 mm.

Table 1. External length measurements [mm] in the species of *Parahypsugo*
 Tab. 1. Vnější délkové rozměry [mm] u jednotlivých druhů rodu *Parahypsugo*

species druh	penis pyj	baculum bakulum	tragus kozlík	thumb palec	free tail tip volná špička ocasu	vouchers / source jedinci / zdroj
<i>Parahypsugo macrocephalus</i>	?	1.7	4.0–4.7	5.8–6.6	0.6–2.0	FMNH 195086, SMF 79.444; HELLER et al. (1994)
<i>Parahypsugo happoldorum</i>	6.4	4.4	4.0	7.2	1.2–1.9	holotype ZFMK-MAM-2009.0029, paratype 2008.0295, 2008.0296, 2009.032
<i>Parahypsugo eisentrauti</i>	4.0	1.4	3.8–5.2	4.7–6.4	0.5–1.5	ZFMK-MAM-1968.0005, 1968.0006, 1999.0676, HILL & HARRISON (1987)
<i>Parahypsugo bellieri</i>	10	1.8	3.8	5.7	1.0–1.2	ZFMK-MAM-2008.0299, 2009.0030
<i>Parahypsugo crassulus</i>	11	3.6–4.3	2.9–3.5	4	0.6–1.0	holotype (THOMAS 1904), HELLER et al. (1994), BATES et al. (2013), FMNH 165171, SMF 79441, 79442

C. KAHINDO. **Paratype:** adult male SMF 79.444, skin and skull, Cyangugu (02°29'S, 28°54'E), 2,500 m a. s. l., Nyungwe Forest Reserve, Rwanda, March 1990, leg. K.-G. HELLER and M. VOLLETH.

TYPE LOCALITY. Kabogo Forest, 4 km south-west of Talama (04°59'29"S, 29°04'49"E), 1950 m a. s. l., Democratic Republic of the Congo.

DIAGNOSIS. Largest species of the genus *Parahypsugo* with a total length of 82–93 mm, tail length 35 mm, forearm length 37.5–37.9 mm, hind foot length (with claws) 8.0–8.4 mm, ear length 9–12 mm, body mass 9.8–12.0 g. Free tail tip is 0.6–2.0 mm long. Thumb of medium length, 5.8–6.6 mm, tragus 4.0–4.7 mm. Greatest length of skull 15.11–15.32 mm, length of C-M3 5.51 mm.

ETYMOLOGY. Name derived from Greek, meaning large (μακρος, latinised to *macros*) headed (κεφαλή, latinised to *cephale*) bat.

DESCRIPTION AND COMPARISON. *Parahypsugo macrocephalus* sp. nov. is even larger than *P. happoldorum*, the largest species recognized so far. Total length in *P. macrocephalus* sp. nov. is 87.5 (82–93) mm, tail length 35 mm, forearm length 37.7 (37.5–37.9) mm, hind foot length 8.2 (8.0–8.4) mm, ear length 10.5 (9–12) mm, and body mass 10.9 (9.8–12.0) g (Table 3). In *P. happoldorum*, the total length is slightly larger but the tail length is smaller (Table 3).

The short free tail tip measures 0.6–2.0 mm, and is shorter than in most *Hypsugo* species (1.5–5.5 mm; HUTTERER et al. 2019). Both specimens from Rwanda and DR Congo are unicolored deep brown on the dorsal surface and slightly paler on the ventral surface. Dorsal hairs are 5 mm long. The wing membranes, the interfemoral membrane and the ears are as dark coloured as the dorsum.

P. macrocephalus sp. nov. has a broad and simply built rhinarium (Fig. 1), as found in the other species of the genus (HUTTERER et al. 2019: Fig. 2).

The ear length is 10.5 mm, and the tips of the ears are rounded. The tragus (Fig. 1) is 4.35 (4.0–4.7) mm long (Table 1) and represents 41.4% of the ear length (40% in *P. happoldorum*). The thumb of the holotype is 6.2 (5.8–6.6) mm long, and shorter than in *P. happoldorum* (Table 1, Fig. 2, A1). With 37.7 mm, the forearm of *P. macrocephalus* sp. nov. is larger than in all other species of the genus. It is rather long in *P. happoldorum* (34.6–36.5 mm), similar in *P. eisentrauti*, but significantly shorter in *P. bellieri* and *P. crassulus* (Table 2). Further measurements of wing bones can be found in KERBIS PETERHANS et al. (2013).

The baculum of the paratype specimen is very short (1.7 mm long; as described by HELLER et al. 1994: 2, Figs. 1–2), and similar in length to *P. eisentrauti* (1.4 mm) and *P. bellieri* (1.8 mm), but much shorter than those of *P. crassulus* and *P. happoldorum* (Table 1).

The cranium of *P. macrocephalus* sp. nov. is illustrated in Fig. 3. It is considerably broader in its front part than in *P. crassulus*, but also broader than in *P. happoldorum* (HUTTERER et al. 2019: 14, Fig. 12). A clear difference from the skulls of the hitherto known taxa is that in *P. macrocephalus* sp. nov., the narrowest point of the interorbital region is shifted towards the middle, while in the other species (HUTTERER et al. 2019: 14, Fig. 12) and in *P. crassulus* (Fig. 3) it is shifted towards the anterior-most part of the interorbital.

The new species is distinguished from the other four species by larger cranial and dental measurements, particularly in the greatest skull length and the upper and lower molar rows (Table 3). The dorsal profile is elevated. The rostrum is smooth and shows no traces of pits, like in the other species of the genus. The zygomatic arches are wide.

The first upper incisor has a second cusp, which is shorter than the first (Fig. 2, A4), and much heavier than that in *P. crassulus* (Fig. 2, B4). The second upper incisor is smaller, about

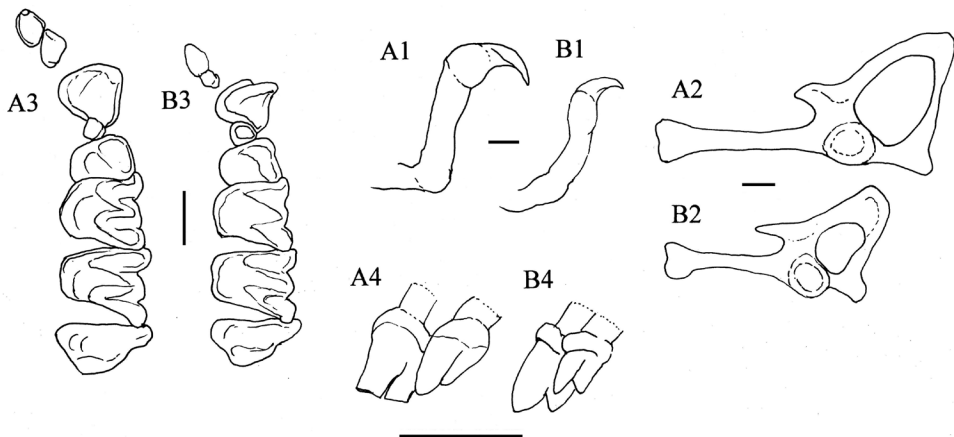


Fig. 2. Thumb (1), pelvis (2), left upper toothrow (3), and first two upper incisors in lateral view (4) of (A) *Parahypsugo macrocephalus* sp. nov., holotype (FMNH 195086) and (B) *Parahypsugo crassulus* (FMNH 165169). Scale bars = 1 mm.

Obr. 2. Palec (1), pánev (2), levá horní zubní řada (3) a první dva horní řezáky v bočním pohledu (4) u (A) netopýra velkohlavého (*Parahypsugo macrocephalus* sp. nov.), holotyp (FMNH 195086), a (B) netopýra obtlouštího (*Parahypsugo crassulus*) (FMNH 165169). Měřítka = 1 mm.

Table 2. External measurements of the body [mm] and body mass [g] of the species of *Parahypsugo*
 Tab. 2. Vnější tělesné rozměry [mm] a tělesná hmotnost [g] u jednotlivých druhů rodu *Parahypsugo*

species	sex	total length	tail length	forearm length	hindfoot length	ear length	body mass
druh	pohlaví	délka těla a ocasu	délka ocasu	délka předloktí	délka tlapky	délka ucha	hmotnost těla
<i>Parahypsugo macrocephalus</i> (n=2)	FM	87.5 (82–93)	35.0	37.7 (37.5–37.9)	8.2 (8.0–8.4)	10.5 (9.0–12.0)	10.9 (9.8–12.0)
<i>Parahypsugo happoldorum</i> (n=4–5)	FM	93.4 (90–97)	31.8 (28–37)	35.7 (34.6–36.5)	8.8 (8.0–10.0)	10.2 (9.0–12.0)	8.5 (7.3–9.5)
<i>Parahypsugo bellieri</i> (n=6)	FM	84.2 (78–89)	27.7 (26–29)	31.9 (30.3–33.3)	7.2 (6.0–8.0)	10.3 (7.0–12.0)	7.2 (5.2–10.0)
<i>Parahypsugo eisentrauti</i> (n=3)	FM	85.3 (84–88)	37.7 (36–40)	34.9 (34.3–35.5)	7.8 (7.0–9.0)	11.0 (9.0–13.0)	7.4 (7.0–8.3)
<i>Parahypsugo crassulus</i> (n=6)	FM	73.8 (66.5–80)	25.2 (20.5–32)	30.3 (28.0–32.0)	7.7 (6.0–11.0)	9.3 (8.0–11.0)	4.5 (4.0–5.4)

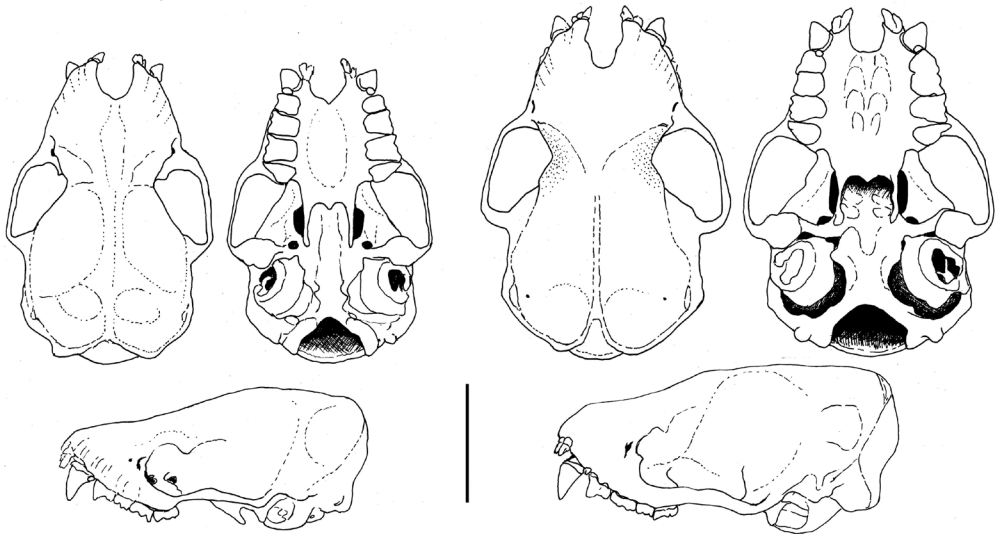


Fig. 3. Skull of *Parahypsugo crassulus* (FMNH 165169), left, and of the holotype (FMNH 195086) of *Parahypsugo macrocephalus* sp. nov., right; crania in dorsal, ventral, and lateral view. Scale bar = 5 mm.
 Obr. 3. Lebka netopýra obtlouštělého (*Parahypsugo crassulus*) (FMNH 165169), vlevo, a holotypového jedince (FMNH 195086) netopýra velkohlavého (*Parahypsugo macrocephalus* sp. nov., vpravo. Lebky ve hřbetním, břišním a bočním pohledu. Měřítko = 5 mm.

Table 3. Skull measurements [mm] of five species of *Parahypsugo*. Abbreviations as explained in the text
 Tab. 3. Rozměry lebky [mm] pěti druhů rodu *Parahypsugo*. Vysvětlení zkratk v textu

species, specimens / druh, jedinci	GSKL	CIL	CCL	ZYGO	GBW	GSH	POB	MAST	MAND	M3-M3	C-M3	C-C	c-m3
<i>Parahypsugo macrocephalus</i> sp. n.													
SMF 79.444	15.32	14.79	14.09	10.55	7.64	6.88	4.11	8.34	11.17	6.75	5.51	5.10	5.99
FMNH 195086	15.11	14.78	14.22	10.75	7.90	7.19	4.55	8.56	11.34	6.73	5.30	5.20	5.86
<i>Parahypsugo happoldorum</i> (n=5)													
mean	14.61	14.11	13.48	10.15	7.23	6.99	4.22	8.44	10.99	6.59	5.10	4.96	5.58
min	14.24	13.51	12.87	10.01	7.10	6.26	4.00	8.20	10.60	6.41	5.04	4.71	5.45
max	14.96	14.84	13.94	10.27	7.35	7.34	4.77	8.72	11.28	6.71	5.20	5.30	5.85
<i>Parahypsugo eisentrauti</i> (n=2-3)													
mean	14.30	13.51	12.87	9.58	7.25	6.70	4.17	7.82	10.48	6.44	5.11	4.43	5.57
min	14.03	13.26	12.52	9.56	7.18	6.59	4.09	7.75	10.30	6.40	5.04	4.17	5.40
max	14.46	13.79	13.17	9.60	7.29	6.81	4.29	7.92	10.67	6.49	5.17	4.58	5.71
<i>Parahypsugo bellieri</i> (n=6)													
mean	13.69	13.21	12.67	9.34	6.99	6.22	4.13	7.93	10.24	6.29	4.83	4.63	5.19
min	13.32	12.89	12.35	8.86	6.78	5.55	3.82	7.86	9.80	6.18	4.66	4.31	4.91
max	13.99	13.78	13.25	9.55	7.12	6.57	4.44	8.00	10.44	6.42	4.90	4.88	5.30
<i>Parahypsugo crassulus</i> (n=7-8)													
mean	13.00	12.64	12.26	8.83	6.88	5.76	3.93	7.71	9.54	5.68	4.66	4.32	4.87
min	12.70	12.34	12.07	8.22	6.70	5.51	3.59	7.47	9.18	5.40	4.54	4.08	4.78
max	13.55	13.17	12.66	9.42	7.09	6.01	4.37	7.99	9.91	6.02	4.82	4.57	5.09

a half to two third of the length of the first, and bears also a second cusp (Fig. 2, A4, B4). The first upper premolar (P1) is present (Fig. 2, A3), as in all species of the genus except for *P. hap-poldorum*. The upper molars and the second upper premolar (P2) are wider in the new species (Fig. 2, A3), but otherwise similar.

The pelvis of *P. macrocephalus* sp. nov. is longer (length 11.1 mm) than that of *P. crassulus* (7.9 mm), and also the shape is somewhat different (Fig. 2, A2, B2). The spine is short and broad in *P. macrocephalus* sp. nov., while it is long and narrow in *P. crassulus*.

KARYOTYPE. HELLER et al. (2001) reported (under *H. eisentrauti*) for specimen SMF 79.444 (our paratype) a karyotype of $2n=48$ and $FN=58$. For *H. crassulus*, they counted $2n=30$, $FN=56$.

DISCUSSION

In this paper we describe a further new species of bat and assign it to the genus *Parahypsugo* which is endemic to tropical Africa. As understood now, *Parahypsugo* comprises five to six morphologically similar species. Here we studied large-sized individuals previously reported or mentioned by VOLLETH & HELLER (1994), HELLER, VOLLETH & KOCK (1994), VOLLETH et al. (2001), HUHDORF & KALEME (2008), THORN & KERBIS PETERHANS (2009), KERBIS PETERHANS et al. (2013), and VAN CAKENBERGHE et al. (2017) from Rwanda and DR Congo. Other specimens reported from Somalia (VARTY & HILL 1988) and Kenya still remain to be studied.

The new study confirms that all currently recognized species of *Parahypsugo* are predominantly associated with undisturbed rainforest, although they may also be captured in edge and disturbed habitats. This suggests that continued persistence of blocks of undisturbed rainforest may be critical to the long-term conservation of all members of this genus. We repeat here our suggestion of an urgent re-appraisal of the conservation statuses of the *Parahypsugo* species. The unstudied population which occurs in southern Somalia (VARTY & HILL 1988) may provisionally be taken as a further taxon until its final study.

SOUHRN

Nový druh netopýra rodu *Parahypsugo* ze střední Afriky je zde poprvé definován a popsán; tím se zvyšuje počet druhů rodu na nejméně pět. Nový druh obývá horské pralesy Rwandy a východu Konžské demokratické republiky. Velikost těla je nový druh mnohem větší než ostatní čtyři známé druhy, v rozměrech lebky se jedná o vůbec největší druh rodu *Parahypsugo*.

A c k n o w l e d g e m e n t s

We are grateful to Irina RUF who allowed us to study specimens of bats in the Senckenberg Museum, and to the curators of the Harrison Museum, Durban Natural Science Museum, and the Musée Royale de l'Afrique Centrale for the permission to study comparative materials. The work of RH at the Field Museum was partly supported by a Barbara Brown grant provided in 2018.

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