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New data on bats from Dire Dawa region, eastern Ethiopia, with the first record of *Rhinopoma microphyllum* in the country

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Abstract. A small collection of bats composed of six species from Dire Dawa area, eastern Ethiopia, is presented. Besides three species previously known in the region, *Rousettus aegyptiacus*, *Epomophorus minimus* and *Chaerephon pumilus*, three bats were newly documented from the area, *Rhinopoma microphyllum*, *R. cystops* and *Scotophilus leucogaster*. *R. microphyllum* is here reported for the first time in Ethiopia. From molecular genetic comparisons Ethiopian *R. cystops* belongs to the Arabian subspecies lineage *R. c. arabium*, previously unknown from the African continent, raising interesting biogeographic questions.

Key-words. Bats, Afro-tropics, Horn of Africa.

Introduction

Global change is threatening biodiversity of the whole planet, including small mammals. At the same time biodiversity inventories of all biodiversity hotspots have yet to be completed. Thanks to the development of integrative taxonomy, the combination of molecular genetic and morphologic evidences of inventoried species leads to more precise knowledge of diversity, including cryptic species, as well as better appreciation of the biogeographic affinities of particular populations. This remains particularly valid for the mammals of the Horn of Africa including bats (see e.g. Hulva et al. 2007, Benda et al. 2015, 2016, Lanza et al. 2015, Bray and Benda 2016, Kruskop et al. 2016, Vallo et al. 2019, etc.).

Dire Dawa is a town and a federal state of the same name situated in the eastern part of Ethiopia, on the northern slope of the Chercher Mountains (Fig. 1). This range is the easternmost extension of the Ethiopian Highlands and although it extends at several places up to an altitude of 3000 m a. s. l., the Dire Dawa area is situated roughly at 1100–1400 m a. s. l. It lies in the transition between the zones of the dry evergreen Afromontane forests of the high parts of the Chercher Mountains and the dry *Acacia* scrublands of the arid Afar lowlands (Friis et al. 2011). From this eastern part of Ethiopia, only a small number of bat records is available. Moreover, these were collected around fifty years ago, or even earlier (see Largen et al. 1974), and only few records were made recently in the broader region (Table 1; Lavrenchenko et al. 2004, 2010). On the other hand, the diversity of bats in Ethiopia is relatively well studied; the list of bats of the country comprises at least 80 species (Lavrenchenko et al. 2004, 2010, Kruskop et al. 2016, Vallo et al. 2019) with at least two endemics, *Myotis scotti* Thomas, 1927 and *Plecotus balensis* Kruskop et Lavrenchenko, 2000 (Lavrenchenko and Afework Bekele 2017). However, most of bat records in Ethiopia were made in the western part of the country, as shown by the reviews by Largen et al. (1974), Yalden et al. (1996), and Lavrenchenko et al. (2004). Here, we bring new morphological and molecular data on bats from the Dire Dawa area, a corner of Ethiopia that has been, and continues to be, neglected and

understudied by bat researchers. This inventory will allow us to provide some biogeographic conclusions about the bats of this region.

Material and Methods

We conducted field work in the Dire Dawa area between 17th and 29th of November of 2017. Bat sampling was carried out in caves, bush and scrub forest, horticultural crops farmland, warehouses and close to human dwellings and pond and streams. Four to six mist-nets (9 m x 2 m, 12 m x 6 m and 8 m x 3 m) were set between the time period of 18:45 h and 22:00 h and checked at an interval of 15-20 minutes. Bats were sampled at several sites (Dire Dawa, Toni Farm, Enkuftu Cave, Goda Buticha Cave, Lege Hare river or stream and different ponds in Genda Gebere farm) using either erected or mobile mistnets. Visual observations and acoustic recordings were also conducted in situ at dusk and at night during trappings with the aid of torches. Daytime roosting site inspection was also conducted. The captured bats were carefully removed from the mistnet, placed in individual cotton bags, identified and measured. From each species, whenever captured representative sub-adults or adults individuals from both sexes were euthanised following ethic rules for morphometric analysis whereas the remaining were released on site after species identification and measurements have been taken. Muscle-tissue samples and non-lethal 3 mm wing biopsy samples were taken from the euthanized and the released specimens, respectively, and placed in 95% ethanol for molecular analyzes. Standard external dimensions (head and body length, tail length, forearm length, ear length) were taken with an accuracy to 1.0 mm, and 0.01 mm for skull dimensions (5–6 dimensions, see below). Skulls were extracted from only a part of the specimens and were deposited in the reference collection of the National Museum of Ethiopia (Addis Ababa).

The ethanol-preserved tissue samples from both collected *Rhinopoma* specimens were used for a molecular genetic comparison. The DNA was extracted from the samples using the NucleoSpin Tissue Core kit (Macherey-Nagel, Hoerd, France). The Cytb gene was amplified using PCR primers L14723 (CCAATGACATGAAAAATCATCGTT), and H15915 (TCTCCATTTCTGGTTTACAAGAC; Ducroz et al. 2001). The PCR consisted of a first denaturation at 94 C for 3 min, followed by 35 cycles (30 s at 94°C, 40 s at 52 C and 90 s at 72°C), and a final extension for 5 min at 72 C. The double-stranded PCR products were purified and sequenced at the Eurofins genomics laboratory (France).

For the phylogenetic reconstruction we used a Bayesian analysis because it has several advantages over other methods of phylogenetic inference, including easy interpretation of results, the ability to incorporate prior information and some computational advantages (see Larget and Simon 1999). We included in our analysis our two sequences from Ethiopia and all reference sequences previously used by Benda et al. (2012a; see Appendix). The new and reference sequences were 1140 bp long. In the GenBank database numerous other sequences are available, but they are much shorter (317–402 bp). These short segments were not included in our analysis except for five sequences coming from areas not represented in the above dataset (Hulva et al. 2007, Levin et al. 2008, Memish et al. 2013; see Appendix). Bayesian analysis was conducted using MrBayes v. 3.2.5 (Ronquist and Huelsenbeck 2003), with two runs and four chains (three hot and one cold), each of 20,000,000 generations, with trees sampled every 100 generations. Stationarity was assessed by examining the average SD of split frequencies and the potential scale reduction factor. After a visual inspection, the first 25% of iterations were excluded as burn-in time and the resulting trees were combined in a majority rule consensus tree to obtain posterior probabilities. The most appropriate model of sequence evolution was assessed using the Akaike information criterion (Akaike 1973) test as implemented in MrModeltest v.3.7 (Posada and Crandall 2001) using MrMTgui (available from <http://genedrift.org/software/mrmtgui.html>). The GTR + I + G models were retained. To root our tree, we included a sequence of *Asellia tridens* (GenBank JF439010).

Annotated list of species

Roussettus aegyptiacus (Geoffroy, 1810) – Egyptian rousette

MATERIAL. 1 ♂ ad (DDW26), Dire Dawa, Enkuftu Cave, 09°35'N, 41°52'E, 1258 m a. s. l., captured 24/11/2017.

One male of the Egyptian rousette was caught at the Enkuftu Cave within the Dire Dawa town. A huge colony of this bat was observed roosting during day time in this cave. This locality, together with Harar from where this bat was reported by Hayman and Hill (1971), constitutes the north-eastern limit of the known species range in sub-Saharan Africa (Bergmans 1994). The new record also represents the northernmost record of *R. aegyptiacus* from Ethiopia, since the known distribution of this bat in the country has been confined to the territory south of the 9°20'N (in the western part of the country, the northernmost locality is the Geda Gilinde Cave at 9°12'N; Stříbná et al. 2019). The region of Dire Dawa probably also constitutes the northernmost area of the species occurrence in the eastern part of Africa, i.e. nominally assigned to be inhabited by *R. a. leachii* (Smith, 1829), see Bergmans (1994). The only east-African finding originating from an area more to the north, Addi Sciaddi [= Addisc Addi; 15°40'N, 38°37'E] in Eritrea (Sordelli 1902), was doubted by Bergmans (1994), although it was accepted by Senna (1905), Largen et al. (1974) and Happold (2013a). Without doubt, Dire Dawa area represents an extreme and outlying distributional occurrence spot of *R. aegyptiacus* in tropical Africa.

Dimensions of the collected specimen are as follows: weight 110 g, head and body length 140 mm, forearm length 90 mm, ear length 22 mm, largest skull length 42.67 mm, condylobasal length 40.48 mm, zygomatic width 25.97 mm, neurocranium width 17.88 mm, neurocranium height 13.46 mm, length of upper tooth-row 16.03 mm. These data fall into the middle of the ranges of *R. a. leachii* from eastern Africa (n=72; Bergmans 1994), while some of them exceed the upper limits of the ranges of *R. a. arabicus* Anderson, 1902 from the southern part of the Middle East (n=58; Benda et al. 2012b). The latter subspecies was suggested to occur in eastern Ethiopia (Harar) by Hayman and Hill (1971) and Largen et al. (1974). However, our record supports the view by Bergmans (1994), who considered the presence of small-sized *R. a. arabicus* in eastern Ethiopia as improbable and all the populations of this bat from the eastern part of sub-Saharan Africa referred solely to large-sized *R. a. leachii*.

***Epomophorus minimus* Claessen et De Vree, 1991 – Least epauletted fruit bat**

MATERIAL. 1 ♀ ad (DDW03), Dire Dawa, Fasika hotel garden, 09°36'N, 41°51'E, 1188 m a. s. l., 19/11/2017. – 1 ♀ ad (DDW18), Dire Dawa, Toni Farm (Dire Dawa University), 09°37'N, 41°50'E, 1156 m a. s. l., 19/11/2017.

Two females of the least epauletted fruit bat were caught at two sites within the Dire Dawa town. According to data by Claessen and De Vree (1991), the records from Dire Dawa area only slightly shift the known limits of the distribution range of this species to the north-east. In the surrounding areas of the eastern edge of the Chercher Mountains, *E. minimus* represents a regularly encountered fruit bat species; specimens were collected in the areas some 50–80 km south-east of Dire Dawa, at Harar, Error Valley, and Babilie (Claessen and De Vree 1991, Lavrenchenko et al. 2010); Bahadu, the type locality of *E. minimus*, lies only some 145 km WNW of Dire Dawa.

External dimensions of the specimens collected in Dire Dawa are as follows (DDW03/DDW18): weight 36/38 g, head and body length 95/109 mm, forearm length 60/65 mm, ear length 16/19 mm; skull dimensions (DDW03): largest skull length 31.12 mm, condylobasal length 29.86 mm, zygomatic width 17.98 mm, neurocranium width 12.96 mm, neurocranium height 9.81 mm, length of upper tooth-row 10.89 mm. The species identification based on the craniodental data comparison conforms to those given by Claessen and De Vree (1991: 219); the result of discriminant function counted from three cranial measurements is 47.5. In *E. minimus* this value should be below 116, while higher values indicate *E. labiatus* (Temminck, 1837), which, however, is not known to occur in eastern Ethiopia or in Somalia (Claessen and De Vree 1991, Lanza et al. 2015).

***Rhinopoma microphyllum* (Brünnich, 1782) – Greater mouse-tailed bat**

MATERIAL. 1 ♀ ad (DDW22), Goda Buticha Cave, 9 km S of Hurso (23 km WSW of Dire Dawa), 09°33'N, 41°38'E, 1382 m a. s. l., 23/11/2017.

An adult female of the greater mouse-tailed bat was found inside the Goda Buticha Cave. The surroundings of the cave are composed of dry scrubland with rocky cliffs, and a small village with some cultivations is found near the cave. The environment thus corresponds well with the known ecological requirements of this bat (see, e.g. Schlitter and Qumsiyeh

1996). This finding represents the first record of *R. microphyllum* in Ethiopia and also a range extension of the south-eastern limit of the known distribution of the species in Africa (Van Cakenberge and De Vree 1994, Schlitter and Qumsiyeh 1996, Aulagnier 2013b). This bat is known from Sudan and Djibouti, but not Somalia (Koopman 1975, Pearch et al. 2001, Lanza et al. 2015). In Sudan, it was recorded southernmost in southern Kordofan (Jebel Talao, 2 km NE of Kaduqli, 11°02'N; Kock 1969) and thus, the Ethiopian locality is the southernmost extension of this species' range in eastern Africa. The new Ethiopian record also originates from the highest altitude locality of *R. microphyllum* in Africa, since in other African range countries this bat occurs rather in lowlands or in the Atlas Mountains of Morocco up to 1100 m a. s. l. (cf. Aulagnier and Destre 1985). On the other hand, the Ethiopian locality is still not the highest site of the whole range of this bat, since in the Middle East it has been recorded up to 1775 m a. s. l. (Benda et al. 2012a).

Measurements of the collected specimen are as follows: weight 20 g, head and body length 79 mm, tail length 57 mm, forearm length 69 mm, ear length 17 mm, tragus length 7 mm, largest skull length 19.90 mm, condylocanine length 17.76 mm, zygomatic width 11.72 mm, neurocranium width 8.47 mm, neurocranium height 6.87 mm, length of upper tooth-row 7.11 mm. The species identification of *R. microphyllum* was based on the above values showing large body size of the specimen as well as its relatively short tail, much shorter than the forearm (cf. Hill 1977, Van Cakenberge and De Vree 1994). The comparison of the measurements of the bat from Dire Dawa with those of other African samples of *R. microphyllum* (Kock 1969, Koopman 1975, Hill 1977, Koch-Weser 1984, Van Cakenberge and De Vree 1994, Pearch et al. 2001) show the medium-sized body of the Ethiopian specimen, comparable with bats from Egypt, Sudan and Morocco, rather smaller than bats from the Sahel, but much larger than a bat from the geographically closest population from Djibouti (210 km away), which was referred to the small-sized west-Arabian form *R. m. asirensis* Nader et Kock, 1983 by Pearch et al. (2001). Similarly, the results of the molecular genetic analysis positioned the Ethiopian sample of *R. microphyllum* among the samples from North Africa, Middle East and India (Fig. 2). Although the Iranian samples created a separate cluster (posterior probability 0.98), the node grouping all other specimens was not supported (posterior probability 0.53). In this analysis, a sample from south-western Saudi Arabia, from near Bishah, a site located 340 km from the type locality of *R. m. asirensis* (Al Jowa, 17°00'N, 43°3'E; Nader and Kock 1983), also clustered with bats from the broad area from Morocco to India. Although no type locality samples were included in this genetic comparison, the results still suggest that *R. microphyllum*, as a species, constitutes one morphometrically diverse but phylogenetically homogenous taxon (Schlitter and Qumsiyeh 1996, Hulva et al. 2007, Levin et al. 2008), rather than a series of more separated taxa (Hill 1977, Van Cakenberge and De Vree 1994). Hence, the results of morphometric and molecular genetic analyses, though based on the examination of a single bat, together placed the newly discovered Ethiopian population within the species limits of *R. microphyllum*.

***Rhinopoma cystops* Thomas, 1903 – Lesser mouse-tailed bat**

MATERIAL. 1 ♀ sad (DDW23), Goda Buticha Cave, 9 km S of Hurso (23 km WSW of Dire Dawa), 09°33'N, 41°38'E, 1382 m a. s. l., 23/11/2017.

A subadult female of the lesser mouse-tailed bat was caught inside the Goda Buticha Cave in the same place as *R. microphyllum*. External measurements of the collected specimen are as follows: weight 10 g, head and body length 67 mm, tail length 69 mm, forearm length 56 mm, ear length 17 mm, tragus length 6 mm; skull is not available for examination. According to the body size (forearm length) and the relative long tail (longer than forearm), this specimen represents the lesser mouse-tailed bat, *R. cystops* (sensu Hulva et al. 2007). This species identification was confirmed also by molecular genetic analysis (Fig. 2).

Although *R. cystops* belongs to widespread bat species in the arid zone of the northern part of Africa (Van Cakenberge and De Vree 1994, Aulagnier 2013a), in Ethiopia this bat was documented only from few sites in a limited region of the upper part of the Awash valley at Metahara (Hill and Morris 1971, Largen et al. 1974, Demeter 1982, Benda et al. 2017). The new record from the Dire Dawa area significantly enlarges the known range of this bat species in Ethiopia and eastern Africa generally. It falls close to the delimitation line of the south-eastern limits of the African species range, continuing eastward to northern Somalia (Van Cakenberge and De Vree 1994, Lanza et al. 2015). The new east-Ethiopian record represents also the highest African altitude recorded, since the other Ethiopian findings come from sites situated

around 1000 m a. s. l. (Hill and Morris 1971, Largen et al. 1974) and the altitude maximum known from the Algerian Sahara approaches 1200 m a. s. l. only (cf. Kowalski and Rzebik-Kowalska 1991).

The size of the Dire Dawa specimen of *R. cystops* conforms to the size of the known Ethiopian bats, in which the forearm length (FA) was reported in the range of 52.9–56.6 mm (mean 55.0 mm, n=13; Hill and Morris 1971) and 54.5–57.8 mm (mean 56.4 mm, n=3; Benda et al. 2017), respectively. The Ethiopian samples are in size very similar to the southern Arabian samples of *R. cystops* (FA 50.5–58.9 mm, mean 54.9 mm, n=52; Benda et al. 2017), but significantly differ from the large-sized bats from Somalia (FA 59.7–67.0 mm, mean 62.9 mm, n=12; Benda et al. 2017). The results of molecular genetic comparison (Fig. 2) clustered the Dire Dawa specimen with the sequences of *R. cystops* from the Middle East (Yemen, Socotra, Jordan, Syria), creating a sister lineage to the sequences from North Africa (Egypt, Libya). The genetic similarities thus are in accordance with the morphometric findings (see also Benda et al. 2017).

Hulva et al. (2007) referred the two lineages of *R. cystops* to two subspecies, African *R. c. cystops* and Middle Eastern *R. c. arabium* Thomas, 1913 and the Red Sea was regarded as a border between these lineages/subspecies. However, while the Ethiopian sample belongs to the Middle Eastern lineage by our analysis, perhaps all species' populations of the Horn of Africa belong rather to *R. c. arabium* than to the nominotypical form. An alternative explanation of this result could be a mosaic-like border between the lineages, when a certain percentage of individuals of one of the bordering population bears haplotypes of the opposite populations, similarly, as it was already found in *Rousettus aegyptiacus* and/or *Asellia tridens* (Geoffroy, 1813) in the identical geographical arrangement across the Red Sea (see Benda et al. 2012b, Bray and Benda 2016).

***Chaerephon pumilus* (Cretzschmar, 1830) – Little free-tailed bat**

MATERIAL. 1 ♀ juv (DDW04), Dire Dawa, at the Lega Hare River, 09°36'N, 41°53'E, 1212 m a. s. l., 18/11/2017. – 1 ♂ ad (DDW17), Dire Dawa, Toni Farm (Dire Dawa University), 09°37'N, 41°50'E, 1148 m a. s. l., 21/11/2017.

Two specimens of the little free-tailed bat were collected in agricultural areas adjacent to Dire Dawa town. This species belongs to one of the most common bats in various savannah zones of Africa (Happold 2013b); with the exceptions of true deserts and true forests, it is distributed widely across Ethiopia (Largen et al. 1974). *C. pumilus* was also repeatedly recorded in broader region of the eastern Chercher Mountains, viz. Haramaya, Babile, Errer valley, Harar (Largen et al. 1974, Demeter and Topál 1982, Lavrenchenko et al. 2010). Measurements of the specimens collected at Dire Dawa are as follows (DDW04/DDW17): weight 9.0/10.2 g, head and body length 87/70 mm, tail length 27/36 mm, forearm length 39/40 mm, ear length 17/15 mm, largest skull length 16.25/17.35 mm, condylobasal length 15.18/16.29 mm, zygomatic width 10.18/10.47 mm, neurocranium width 8.05/8.15 mm, neurocranium height 5.41/6.19 mm, length of upper tooth-row 6.31/6.51 mm. These values conform to the measurement ranges known for the species (see, e.g. Lavrenchenko et al. 2004, Happold 2013b).

***Scotophilus leucogaster* (Cretzschmar, 1830) – White-bellied house bat**

MATERIAL. 1 ♀ ad (DDW05), Dire Dawa, at the Lega Hare River, 09°36'N, 41°53'E, 1212 m a. s. l., 18/11/2017.

A female of the white-bellied house bat was caught in an agricultural area adjacent to Dire Dawa town. This species is rare in Ethiopia, verified records are available only from the western part of the country (Largen et al. 1974, Robbins et al. 1985). In the eastern part of the Chercher Mountains, including Dire Dawa area, only the larger and brighter species *S. colias* Thomas, 1904 has been reported (Robbins et al. 1985, sensu Vallo et al. 2011). However, the identification of the newly recorded Dire Dawa bat as *S. leucogaster* is clear from its rather small body and skull size fitting to the genetically identified samples by Vallo et al. (2019). Measurements of this specimen are as follows: weight 18 g, head and body length 83 mm, tail length 55 mm, forearm length 50 mm, ear length 16 mm, tragus length 9 mm, largest skull length 18.82 mm, condylobasal length 17.44 mm, zygomatic width 13.36 mm, neurocranium width 9.31 mm, neurocranium height 7.68 mm, length of upper tooth-row 6.52 mm.

Although this new record significantly enlarges the distribution range of *S. leucogaster* in Ethiopia, the extent of the whole species range is not really affected; this bat is known to occur in the whole savannah belt of northern part of Africa and south-western Arabia, including most of the countries surrounding Ethiopia, like Sudan, South Sudan, Chad, Central African Republic, Kenya, Somalia or Yemen (Robbins et al. 1985, Vallo et al. 2011, Lanza et al. 2015).

Considering the measurement values given (forearm length 48.6 mm, upper tooth-row length 6.7 mm) and pale colouration description, the *Scotophilus* specimen collected by Lavrenchenko et al. (2010) in the Babile Elephant Sanctuary, some 80–90 km south-east of Dire Dawa, and reported as *S. cf. dinganii* (Smith, 1833), could belong to *S. leucogaster*. Such a record there could be regarded as more possible in light of our finding from Dire Dawa. However, the detailed skull examination and/or genetic comparison is necessary to solve the identification of the concerned bat.

Conclusions

In the Dire Dawa area, we documented the occurrence of six bat species belonging to four families and three of these species as completely new records in the broader region of the eastern Chercher Mountains, one as a new species for Ethiopia as well. The recorded bat species represent three various types concerning their biogeographic affinities. *Epomophorus minimus*, *Chaerephon pumilus*, and *Scotophilus leucogaster* are true Afro-tropical elements whose distribution is confined solely to savannahs of sub-Saharan Africa and (in the cases of the two latter species) to the south-western corner of the Arabian Peninsula. On the other hand, *Rhinopoma microphyllum* and *R. cystops* are inhabitants of the Saharo-Sindian arid region, and their distributions are centred to deserts of the Palaearctic-Afro-tropical transition. *Rousettus aegyptiacus* belongs to a rare biogeographic type, being distributed broadly in the Afro-tropics, but also in the southern Palaearctic. The easternmost extent of the Chercher Mountains, including the Dire Dawa area, is a region of mixing of these two-main biogeographic elements, the Afro-tropical savannah bats and the Saharo-Sindian dry scrubland bats. While *Epomophorus minimus* finds in the Chercher Mountains the north-eastern limit of its whole distribution range, both *Rhinopoma* species find there the southern limits of their distributions in Africa.

After all, such a mixing is apparent from the whole bat faunal list of the region, now comprising 24 species, and besides Dire Dawa area, also covering Harar and Babile areas in the east, and the central Chercher Mts. in the west (Table 1). Naturally, the prevailing majority of documented species (17) represent Afro-tropical bats. Five species are representatives of mixed biogeographic affinities – they are elements occurring in both the southern Palaearctic and Afro-topical savannahs, viz. *Rousettus aegyptiacus*, *Rhinolophus clivosus*, *R. blasii*, *Taphozous perforatus* and *Nycteris thebaica*. The two newly documented *Rhinopoma* species remain the only Saharo-Sindian species of the eastern Chercher Mountains region.

To be concluded, in this contribution we extended the geographical distribution of three species towards the east of Ethiopia and provided new data on their altitudinal ranges. We again confirmed eastern Ethiopia as a biogeographical crossroad between the Afro-tropical and Palaearctic regions at various scales.

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Table 1. Composition of the bat faunas in several areas of the eastern edges of the Chercher Mountains (contemporary nomenclature used) and species diversity per field work.

| Dire Dawa area, this study | Dire Dawa area, Largen et al. (1974), Robbins et al. (1985) | Harar area, Largen et al. (1974), Robbins et al. (1985) | Central Chercher Mts., Lavrenchenko et al. (2004) | Babile Sanctuary, Lavrenchenko et al. (2010) |
|--------------------------------|---|---|---|---|
| <i>Rousettus aegyptiacus</i> | | <i>Rousettus aegyptiacus</i> | <i>Rousettus aegyptiacus</i> | |
| <i>Epomophorus minimus</i> | | <i>Epomophorus minimus</i> | | <i>Epomophorus minimus</i> |
| <i>Rhinopoma microphyllum</i> | | | | |
| <i>Rhinopoma cystops</i> | | | | |
| | | | | <i>Rhinolophus fumigatus</i> |
| | | <i>Rhinolophus clivosus</i> | | |
| | <i>Rhinolophus blasii</i> | <i>Rhinolophus blasii</i> | | |
| | <i>Hipposideros tephrus</i> | <i>Hipposideros tephrus</i> | | <i>Hipposideros tephrus</i> |
| | <i>Hipposideros megalotis</i> | <i>Hipposideros megalotis</i> | | |
| | <i>Triaenops afer</i> | | | |
| | | | | <i>Lavia frons</i> |
| | <i>Taphozous perforatus</i> | <i>Taphozous perforatus</i> | | |
| | <i>Nycteris thebaica</i> | <i>Nycteris thebaica</i> | | <i>Nycteris thebaica</i> |
| <i>Chaerephon pumilus</i> | <i>Chaerephon pumilus</i> | <i>Chaerephon pumilus</i> | | <i>Chaerephon pumilus</i> |
| | | <i>Chaerephon bivittatus</i> | | |
| | | | <i>Pipistrellus hesperidus</i> | |
| | | | <i>Pipistrellus aero</i> | |
| | <i>Neoromicia somalica</i> | <i>Neoromicia somalica</i> | | |
| | | | | <i>Neoromicia zuluensis</i> |
| | | <i>Neoromicia nana</i> | | |
| <i>Scotophilus leucogaster</i> | | | | <i>Scotophilus sp.</i> |
| | <i>Scotophilus colias</i> | <i>Scotophilus colias</i> | | |
| | | <i>Miniopterus africanus</i> | | |
| | | <i>Miniopterus arenarius</i> | | |
| 6 | 9 | 15 | 3 | 8 |



Figure 1. Localisation of the Dire Dawa Federal State (black area) in the map of Ethiopia (Er – Eritrea, Dj – Djibouti, Ug – Uganda). Note the position of Dire Dawa between the Afar lowlands in the north (covered by the dry savannah) and the Chercher Mountains in the south and south-west (covered by the evergreen Afromontane forest).

Appendix

List of sequences used in the molecular genetic comparison of the genus *Rhinopoma* (Fig. 1)

| code tree | seqLength | GenBank | species | geographic origin | reference |
|-----------|-----------|----------|--------------------------------|--------------------------------|--------------------|
| EGY2 | 1,140 bp | KF874527 | <i>Rhinopoma cystops</i> | Egypt, Luxor, Karnak | Benda et al. 2012a |
| EGY1 | 1,140 bp | KF874526 | <i>Rhinopoma cystops</i> | Egypt, Luxor, Valley of Kings | Benda et al. 2012a |
| JOR2 | 1,140 bp | KF874528 | <i>Rhinopoma cystops</i> | Jordan, Wadi Shu'ayb | Benda et al. 2012a |
| LIB1 | 402 bp | DQ337491 | <i>Rhinopoma cystops</i> | Libya, Al Jaghub | Hulva et al. 2007 |
| SOC1 | 1,140 bp | KF874532 | <i>Rhinopoma cystops</i> | Yemen, Socotra I., Wadi Darho | Benda et al. 2012a |
| SYR1 | 1,140 bp | KF874529 | <i>Rhinopoma cystops</i> | Syria, Qala'at Nimrod | Benda et al. 2012a |
| YEM2 | 1,140 bp | KF874531 | <i>Rhinopoma cystops</i> | Yemen, Am Rija | Benda et al. 2012a |
| YEM3 | 1,140 bp | KF874530 | <i>Rhinopoma cystops</i> | Yemen, Ma'arib | Benda et al. 2012a |
| DDW23 | 1,140 bp | MK894587 | <i>Rhinopoma cystops</i> | Ethiopia, Goda Buticha Cave | this study |
| YEM1 | 1,140 bp | KF874537 | <i>Rhinopoma hadramauticum</i> | Yemen, Ash Shahr | Benda et al. 2012a |
| IND1 | 1,140 bp | KF874522 | <i>Rhinopoma hardwickii</i> | India, Rajasthan, Gola-Ka-Baas | Benda et al. 2012a |
| IRN11 | 1,140 bp | KF874523 | <i>Rhinopoma hardwickii</i> | Iran, Sarkan | Benda et al. 2012a |
| IRN12 | 1,140 bp | KF874524 | <i>Rhinopoma hardwickii</i> | Iran, Sarkan | Benda et al. 2012a |
| IRN13 | 1,140 bp | KF874525 | <i>Rhinopoma hardwickii</i> | Iran, Mormori | Benda et al. 2012a |
| IRN2 | 1,140 bp | KF874536 | <i>Rhinopoma microphyllum</i> | Iran, Bishapur | Benda et al. 2012a |
| IRN1 | 1,140 bp | KF874535 | <i>Rhinopoma microphyllum</i> | Iran, Manian | Benda et al. 2012a |
| IRN3 | 1,140 bp | KF874534 | <i>Rhinopoma microphyllum</i> | Iran, Mormori | Benda et al. 2012a |
| JOR1 | 1,140 bp | KF874533 | <i>Rhinopoma microphyllum</i> | Jordan, Tabaqat Fahl | Benda et al. 2012a |
| IND2 | 402 bp | AM931061 | <i>Rhinopoma microphyllum</i> | India, New Delhi | Levin et al. 2008 |
| ISR1 | 402 bp | AM931063 | <i>Rhinopoma microphyllum</i> | Israel, Hula Valley | Levin et al. 2008 |
| MOR1 | 402 bp | AM931062 | <i>Rhinopoma microphyllum</i> | Morocco, Agadir-id-Aisha | Levin et al. 2008 |
| SAU1 | 317 bp | KF498641 | <i>Rhinopoma microphyllum</i> | Saudi Arabia, Old Najiah | Memish et al. 2013 |
| DDW22 | 1,140 bp | MK894586 | <i>Rhinopoma microphyllum</i> | Ethiopia, Goda Buticha Cave | this study |
| IRN4 | 1,140 bp | KF874544 | <i>Rhinopoma muscatellum</i> | Iran, Bishapur | Benda et al. 2012a |
| IRN5 | 1,140 bp | KF874545 | <i>Rhinopoma muscatellum</i> | Iran, Bishapur | Benda et al. 2012a |
| IRN9 | 1,140 bp | KF874546 | <i>Rhinopoma muscatellum</i> | Iran, Hormoz I. | Benda et al. 2012a |
| IRN6 | 1,140 bp | KF874541 | <i>Rhinopoma muscatellum</i> | Iran, Mach Gur | Benda et al. 2012a |
| IRN10 | 1,140 bp | KF874547 | <i>Rhinopoma muscatellum</i> | Iran, Pir Sohrab | Benda et al. 2012a |
| IRN7 | 1,140 bp | KF874542 | <i>Rhinopoma muscatellum</i> | Iran, Sarkan | Benda et al. 2012a |
| IRN8 | 1,140 bp | KF874543 | <i>Rhinopoma muscatellum</i> | Iran, Sarkan | Benda et al. 2012a |
| OMA2 | 1,140 bp | KF874540 | <i>Rhinopoma muscatellum</i> | Oman, Al Aqar | Benda et al. 2012a |
| OMA1 | 1,140 bp | KF874539 | <i>Rhinopoma muscatellum</i> | Oman, Al Qarbi Ash Sharqiyah | Benda et al. 2012a |
| OMA3 | 1,140 bp | KF874538 | <i>Rhinopoma muscatellum</i> | Oman, Muqal | Benda et al. 2012a |