

Bats of the Nacala blue holes

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Ara, Acacio and Delson at the Blue Grotto, Janga community, east of Nacala

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Background

Coastal forests of tropical eastern Africa are rich in bat species (Cockle *et al.* 1998). One species, *Taphozous hildegardeae*, is entirely restricted to coral caves within this region. *Taphozous hildegardeae* is listed as Endangered by the IUCN RedList due to the fact that its entire global population is restricted to about a dozen known coral caves in coastal Kenya and southern Tanzania. Several other bat species inhabit these coral caves, including *Rousettus aegyptiacus*, *Miniopterus minor*, *Coleura afra*, *Macronycteris vittatus*, *Hipposideros sp.*, and *Triaenops afra*.

The bats of the coastal zone of northern Mozambique have been poorly documented (Monadjem *et al.* 2010, 2020b). To the best of our knowledge, only a single (multi-night) survey has been conducted in the region between Quelimane in the south and Palma in the north, at Mozambique Island. A total of six bat species were captured here (Monadjem & Goodman, unpublished data). A single night of bat catching at Pemba yielded three species of bats (Monadjem, unpublished data). A total of seven species of bats are represented at these two sites. This is all that we currently know about the bats of coastal Mozambique, north of the Zambezi River.

The aim of this survey was to document the bat species occurring in the blue holes, to the east of Nacala port, in the Janga I and Janga II communities. This region is heavily populated by subsistence farmers growing a variety of crops including cassava, maize, beans, melons and bananas. To the east of the mashambas is a band of fossilized coral that runs in the north-south direction, on which farming is not possible. As a result, this area supports natural vegetation consisting of a stunted coastal forest, with open patches.

Methods

Between the 19th and 24th of April, we visited the Janga community in search of bats. We started by visiting all the known blue holes in the region, with a local guide. A map of our study site is presented in Figure 1, and the accompanying site descriptions appear in Table 1.

We searched each blue hole for possible bat roost sites. We also searched other sites for caves and holes. Where we found bats in a cave or hole, we either employed mist nets or a hand net to capture the bats. We also set up mist nets in suitable locations for capturing bats. And finally, we deployed a bat detector (Anabat Walkabout), to record the calls of free-flying bats in and around the vicinity of the blue holes.

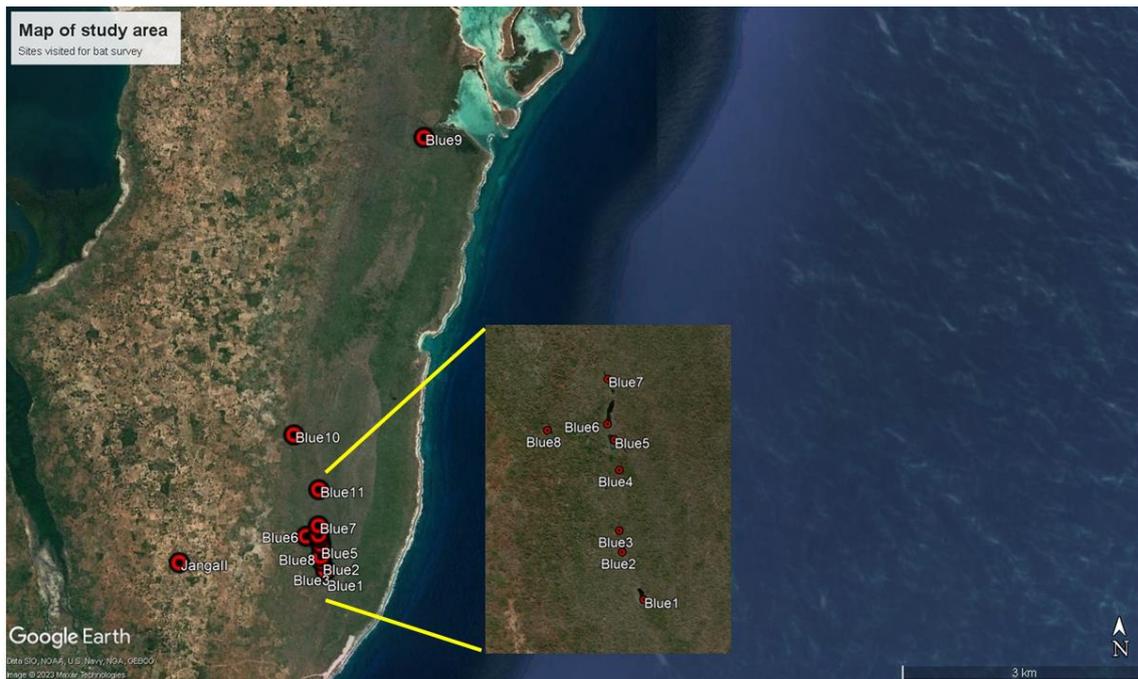


Figure 1. Map of study area, showing the eleven blue holes visited for the bat survey, and the netting site at Janga II Village. The echolocation calls recorded of bats emerging from their roost was at Blue3.

Captured bats were identified, sexed, aged, measured, and photographed. Where possible, echolocation calls were also recorded (this only being possible for bats using high-duty cycle echolocation calls, such as *Rhinolophus* species). Voucher specimens were taken of all species, except for the larger fruit bats, where we only took a genetic sample (a tiny piece of the wing membrane).

Table 1. A list of all sites that were searched for bats, including blue holes and places where we deployed mist nets. Coordinates and elevation are presented for each site, as are any observations regarding bats roosting in them.

Name	Description and original name	Latitude	Longitude	Elevation (m)	Bats detected
Blue1	Blue Grotto	-14.59886	40.81262	13	A roost of <i>Epomophorus crypturus</i> with ca. 20-30 individuals, and a small roost of 5 <i>Nycteris thebaica</i> .
Blue2	Crystal Cave	-14.59789	40.81217	18	None
Blue3	Blue Heaven	-14.59745	40.81211	16	<i>Rhinolophus mossambicus</i> , <i>R. lobatus</i> , <i>R. rhodesiae</i> , <i>Triaenops afer</i> were recorded emerging from this cave at sunset. A small number (maybe 10-20) of a large fruit bat (possibly <i>Epomophorus crypturus</i>) were also seen emerging.
Blue4	Skinny Blue	-14.59621	40.81211	6	None
Blue5	Green Island	-14.59559	40.81200	5	None
Blue6	Long Island	-14.59527	40.81186	21	None
Blue7	Bat Cave	-14.59435	40.81187	9	A roost of <i>Nycteris thebaica</i> with ca. 50-100 individuals.
Blue8	Jump Hole	-14.59540	40.81060	5	None
Blue9	Brown Hole	-14.55510	40.82282	15	None
Blue10	Unrecorded blue hole	-14.58515	40.80933	61	A massive roost of <i>Rousettus aegyptiacus</i> , numbering between 1,000 and 10,000 individuals.
Blue11	Sangoma Hole	-14.59069	40.81191	8	Small roost of <i>Nycteris thebaica</i> with ca. 5-10 individuals.
Janga II	In village, near home of Eduardo Movira	-14.59801	40.79755	65	<i>Epomophorus crypturus</i> , <i>Rousettus aegyptiacus</i> , <i>Rhinolophus mossambicus</i> , <i>Miniopterus cf mossambicus</i> .

The identification of bats is not a simple matter, and field identifications are generally not considered reliable. Final (confirmed) identifications will have to wait until the specimens have been properly examined (including skulls and teeth), and the specimens have been genetically sequenced. For bats with only echolocation calls, we are unable to provide confirmed identifications.

Results

A total of five species of bats were captured during this survey (Table 2). A further five species were recorded by their echolocation calls only. This brings the total to 10 species from general area of the blue holes. Of these 10 species, all except one (*Mops pumilus*) are obligatory cave-dwelling bats, suggesting that they are roosting in or around these blue holes. Of these, just one is Near Threatened, the rest are Least Concern or have not yet been assessed by the IUCN.

Table 2. List of all bat species recorded in the Janga region, including the mode of identification (either captured or recorded by echolocation call), and IUCN conservation status (2023). We captured five species. Species with “cf” still need to have their identifications confirmed.

Family	Genus	Species	Mode	Threat status (IUCN)
Pteropodidae	<i>Epomophorus</i>	<i>crypturus</i>	Captured	Least Concern
Pteropodidae	<i>Rousettus</i>	<i>aegyptiacus</i>	Captured	Least Concern
Rhinolophidae	<i>Rhinolophus</i>	<i>mossambicus</i>	Captured	Least Concern
Rhinolophidae	<i>Rhinolophus</i>	<i>lobatus</i>	Echolocation	Not listed
Rhinolophidae	<i>Rhinolophus</i>	<i>rhodesiae</i>	Echolocation	Not listed
Rhinolophidae	<i>Rhinolophus</i>	<i>deckenii</i>	Echolocation	Near Threatened
Rhinonycteridae	<i>Triaenops</i>	<i>afer</i>	Echolocation	Least Concern
Nycteridae	<i>Nycteris</i>	<i>thebaica</i>	Captured	Least Concern
Miniopteridae	<i>Miniopterus</i>	<i>cf mossambicus</i>	Captured	Not listed
Molossidae	<i>Mops</i>	<i>pumilus</i>	Echolocation	Least Concern

Annotated checklist

We present each species recorded during this survey in this annotated checklist; the list is in taxonomic order. For each species, we present a photograph of the bat (if it was captured), and, where possible, we also include an echolocation call. We only include photographs and echolocation calls of bats that we actually captured in this survey (i.e. none of the photographs or sonograms were recorded from elsewhere in the country). All of the photographs were taken by Ara Monadjem and are copyrighted to him.

Order: Chiroptera

Family: Pteropodidae

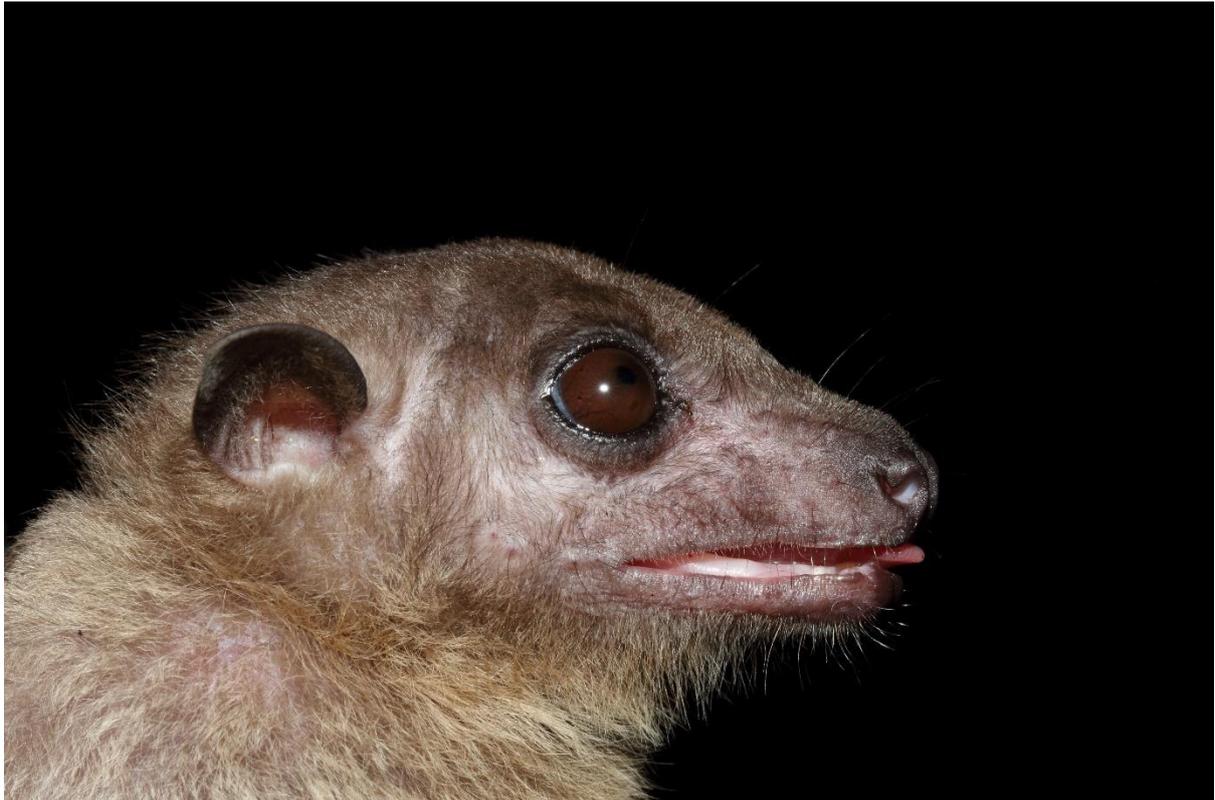
Epomophorus crypturus

This species was seen at several localities and was captured in Janga II. It was also seen roosting in one of the blue holes (Blue1 in Figure 1 and Table 1), and it was probably the fruit bat that was seen emerging from Blue3 in the evening (but it was too dark to be certain). This fruit bat is widespread in the savanna zone of southern Africa.



Rousettus aegyptiacus

A massive roost numbering thousands of individuals was recorded at Blue10. Five individuals were also captured at Janga Village. This fruit bat always roosts communally in large colonies and is widespread in tropical and subtropical Africa (as well as in the Middle East).



Family: Rhinolophidae

Rhinolophus mossambicus

The calls of multiple individuals were recorded emerging from Blue3, echolocating at 37kHz, which refers to this species. Three individuals were also captured in Janga Village. This species roosts in medium-sized colonies in caves. This species was only described recently (Taylor *et al.* 2012). It occurs widely in Mozambique and neighbouring countries.



Rhinolophus lobatus

The calls of multiple individuals were recorded emerging from Blue3, echolocating at 105kHz, which probably refers to this species. This species roosts in small or medium-sized colonies in caves. It occurs widely in the eastern parts of southern Africa and in east Africa (Taylor *et al.* 2018).

Rhinolophus rhodesiae

The calls of multiple individuals were recorded emerging from Blue3, echolocating at 100kHz, which probably refers to this species. This species roosts in small colonies in caves. It occurs widely in the eastern parts of southern Africa (Taylor *et al.* 2018).

Rhinolophus deckenii

The calls of several individuals were recorded echolocating at 72-73kHz, which probably refers to this species (although it is not possible to exclude *Triaenops afer*, which also calls at this frequency, with males calling at a higher frequency - see below). The recordings we have of this species are relatively poor, so it is not possible to be 100% sure of this identification. This species roosts in small colonies

in caves, but their roosts were not found during this survey. Restricted to coastal forests of Mozambique, Tanzania, and Kenya.

Family: Rhinonycteridae

Triadenops afer

Several echolocation calls were recorded near Blue3 at a frequency of 82kHz and of short duration, which possibly refers to this species. Several other species call at around this frequency, so without having captured a specimen, it is not possible to be sure of this identification. It roosts in caves.

Widespread in the eastern regions of southern and east Africa.

Nycteridae

Nycteris thebaica

This species was captured or observed roosting at three blue holes (Blue1, Blue7, and Blue12). In the study area, it was observed roosting in small colonies of between 5 and 50 individuals in caves or overhangs, usually near water. Its echolocation call was recorded at Blue7 and Blue12. Widespread in Africa.



Molossidae

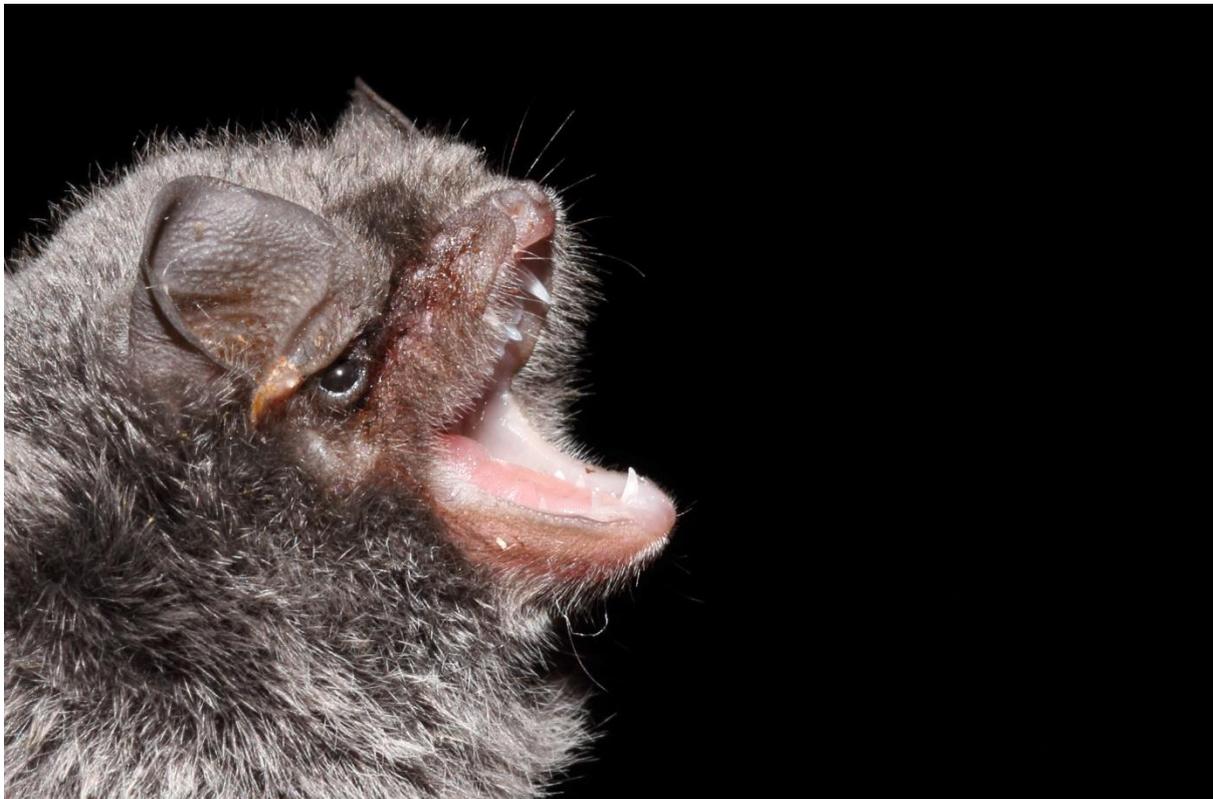
Mops pumilus

This species was only recorded flying over-head. It probably roosts in the roof of houses in the Janga Village. Widespread and abundant species across Africa.

Miniopteridae

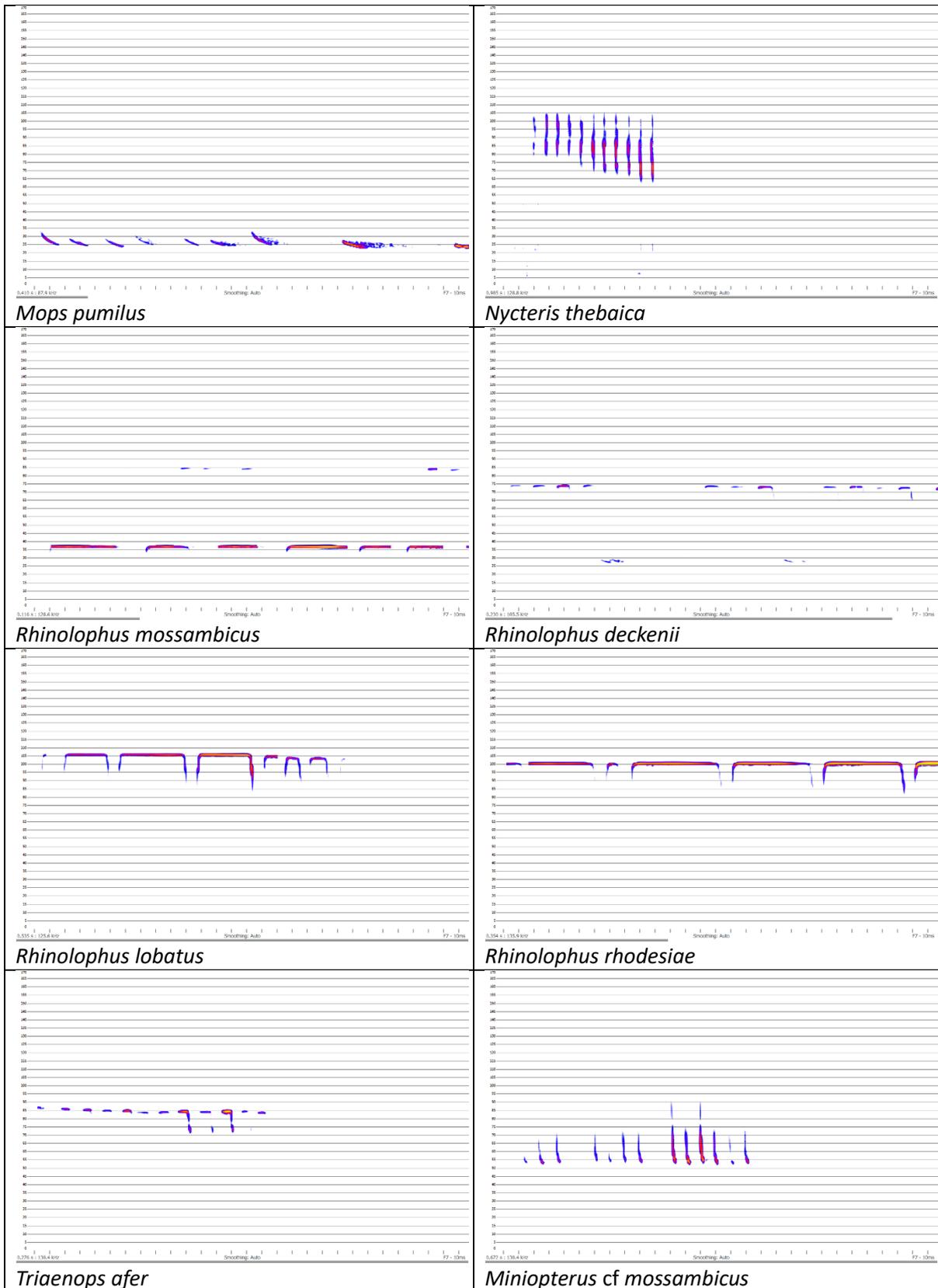
Miniopterus cf mossambicus

Two individuals of this species were captured in Janga Village. This species was also recorded flying overhead near Blue2, suggesting that it may be roosting there. The identity of this species is not yet resolved. The specimens need to have their skulls examined and the tissue needs to be sequenced. This genus is rather problematic at present, and two new species of *Miniopterus* have been described from Mozambique in the past decade (Monadjem *et al.* 2013, 2020a). These two specimens probably belong to the species *M. mossambicus*, but this needs to still be verified. It roosts in caves, and the echolocation calls of several individuals were recorded near Blue3 (calling at around 55kHz). Its distribution is restricted to Mozambique and neighbouring countries to the north and west (Monadjem *et al.* 2013; Demos *et al.* 2020).



Echolocation calls

The following sonograms show the echolocation calls of the species recorded in this survey (names of the species are presented below each sonogram).



Conclusions and recommendations

This survey has yielded a surprising number of bat species dwelling in the coastal coral caves associated with the blue holes in the Janga region, east of Nacala. Although the survey was brief, we recorded 10 species of bats, of which nine are obligate cave-dwelling bats, that cannot survive without some form of dark cavern for roosting in during the day. The only non-cave species was *Mops pumilus*, that can easily travel 10km in one direction from its roost (usually roofs of houses) to foraging grounds (Noer *et al.* 2012). We did not locate any roosting sites of this species in the Janga community (although it is very possible that we overlooked such a roost), but it will definitely be roosting in houses in Nacala, roughly 10km to the west of the study area.

Of the remaining nine species, we observed two fruit bat species roosting in caves associated with the blue holes. One of these, *Rousettus aegyptiaca*, is well known for roosting in very large aggregations – the roost we found here may have supported 10,000 individuals. The ecosystem services provided by this colony, in terms of seed dispersal of forest trees must be considerable.

This leaves us with seven species of insectivorous bats roosting in caves associated with the blue holes in Janga. Four of these are species of *Rhinolophus*, and one each of *Triaenops*, *Miniopterus* and *Nycteris*. One of these species, *R. deckenii* is listed as Near Threatened. However, all 10 species recorded in this survey are widespread and/or relatively abundant species. We did not find all the bat roosting sites, and we could not enter Blue3 where several species of bats were seen (and recorded acoustically) emerging from it. Further surveys for bats may add a few species, but it is unlikely that the Endangered and highly restricted *Taphozous hildegardeae* occurs in this system.

One recommendation is to extend the surveys to the area to the north (Figure 2) that, based on Google Earth images, appears to have coral caves, some of which may be suitable for roosting bats.



Figure 2. Further sites worth searching for coral caves with potentially large bat roosting colonies.

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Appendix – photos and description of bat roosts

Blue1. This blue hole is also known as Blue Grotto, and has crystal clear water, which enters a small cave on the northern side. This cave is used by about 20 individuals of the fruit bat *Epomophorus crypturus* as a day roost. There are a number of smaller caverns on the eastern side, one of which was occupied by five *Nycteris thebaica*.



Blue3. This is known as Blue Heaven, and we were unable to get down into it without climbing gear. We didn't take a photo either. However, we observed one large fruit bat species emerging from this cave (maybe 10-20 individuals), which probably refer to *Epomophorus crypturus*. We also made echolocation recordings of four species emerging from this cave, including *Rhinolophus mossambicus*, *R. lobatus*, *R. rhodesiae*, and *Triaenops afer*.

Blue7. This was a cave situated between Owl Grotto and Bat Cave blue holes and had a medium-sized colony (50-100 individuals) of *Nycteris thebaica* roosting in it.



Blue10. This was a previously unrecorded blue hole, occupied by a massive colony of *Rousettus aegyptiacus*. We estimated the number of individuals to be between 1,000 and 10,000, but it may have been even larger than this.



Blue11. This is the Sangoma hole. A small colony of around five *Nycteris thebaica* were roosting here. The entrance was very narrow and difficult to enter.

