

## Primary results of a bat survey in south-western Ethiopia, with a new Ethiopian record of *Kerivoula lanosa* (Chiroptera: Vespertilionidae)

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**ABSTRACT.** A short-term bat survey was conducted in spring, 2007, by the Joint Ethiopian-Russian Biological Expedition in the Mejangra Zone of the Gambela Peoples' National Regional State, south-western Ethiopia. The area studied was adjacent to the Godare forest massif, one of the most lowland forests of Ethiopia. About 100 individuals of fifteen bat species from ten genera and six families were captured. Together with species recorded in 2000, the total bat community in Godare forest includes at least 19 species. One of the most important records is the third capture of *Kerivoula lanosa* from Ethiopia; the two previous captures in Ethiopia were more than a hundred years ago. The capture of *Myotis bocagei* also was only the third record from the country. Individuals of *Rhinolophus* and *Miniopterus* belong to undetermined species.

**KEY WORDS:** Chiroptera, *Kerivoula*, *Miniopterus*, *Rhinolophus*, *Myotis*, Ethiopia, new records.

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## Предварительные результаты изучения рукокрылых на юго-западе Эфиопии и новая эфиопская находка *Kerivoula lanosa* (Chiroptera: Vespertilionidae)

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**РЕЗЮМЕ.** Непродолжительные исследования фауны рукокрылых в зоне Медженгр Демократической Национальной области Гамбела (юго-запад Эфиопии) были проведены весной 2007 г. в рамках работы совместной Российско-Эфиопской биологической экспедиции. Обследованная территория находится на границе лесного массива Годаре, одного из наиболее низинных лесов в Эфиопии (высота над уровнем моря около 1300 м). Было отловлено около ста особей пятнадцати видов рукокрылых из десяти родов шести семейств. Включая виды, отмеченные в 2000 г., в целом сообщество рукокрылых леса Годаре включает не менее 19 видов. Одна из наиболее значимых находок — третий случай поимки на территории Эфиопии украшенного гладконоса, *Kerivoula lanosa*; две предыдущие находки были сделаны более ста лет назад. Поимка *Myotis bocagei* так же представляет собой всего лишь третью находку вида на территории страны. Поиманные особи родов *Rhinolophus* и *Miniopterus* принадлежат к пока не установленным видам.

**КЛЮЧЕВЫЕ СЛОВА.** Рукокрылые, *Kerivoula*, *Miniopterus*, *Rhinolophus*, *Myotis*, Эфиопия, новые находки.

### Introduction

Even brief surveys of local bat faunas provide information about bat distribution, abundance and environmental preferences, forming the basis for further conservation activities (Fahr & Ebigbo, 2003; Decher & Fahr, 2007). They are especially important in the case of poorly investigated areas with specific natural conditions. The primary forests of south-western Ethiopia undeniably represent such an area, differing from all neighboring territories and the rest of Ethiopia.

The Godare forest massif is in the most eastern part of Gambela Province, bordering the remains of more

highland forests to the north and east and with savannahs in west. Bats of this forested area were very briefly surveyed for the first time in 2000 (Lavrenchenko *et al.*, 2004), when nine species were recorded. However, results of that survey suggested a more diverse bat community.

In spring 2007, a small mammal survey was conducted by the Ethiopian-Russian Joint Biological Expedition in the vicinity of Bishan Wak'a Lake (Meti area of the Mejangra zone, Gambela; N 7°17', E 35°16'; altitude 1350–1390 m ASL), on the border of Godare forest massif. About 100 individuals of bats were captured, representing at least fifteen species from 10 gen-

era and six families. Amongst them, an adult female of the woolly bat (*Kerivoula*) was captured, only the third record of the genus for Ethiopia and the first from the south-west of the country.

While there is some progress in the understanding of Asian *Kerivoula* (Francis *et al.*, 2007), the African branch of the genus remains poorly investigated. Infrequent captures and rarity of museum specimens inhibit both the investigation of taxonomic relationships between named forms and ecological research, obscuring environmental preferences of this or that species.

## Material and methods

The territory on which the investigations were conducted is situated about 23 km W from Tepi at relatively low elevations (1350–1390 m ASL). It was formerly part of an evergreen tropical forest massif known as Godare Forest. Now most of the study area is covered with coffee plantations (Tepi coffee farm) usually with canopy trees retained to provide shadow over the coffee crop. These plantations are divided by variable patches of pastures and primary and secondary growth. The largest water source in the area is Bishan Wak'a Lake — an almost round, flowing lake about 1.5 km in diameter, surrounded by a circle of primary forest.

All the bat research was restricted to that locality, from 31 March to 7 May. Bats were observed during the evening, usually between sunset and 21.30–22.00, several times also after midnight or in the morning hours up to sunrise. All the available biotopes were sampled, including variably disturbed primary forest, secondary growth, riverine biotopes, road, growth edges and coffee plantations. Observations were conducted visually with the help of electric lanterns, and acoustically by the use of narrow-band heterodyne ultrasound detector D100 (Petterson Elektronik AB, Sweden), and accompanied with the capture of selected individuals using the flap-trap (Borisenko, 1999). Some individuals were captured with the use of typical nylon mist-nets (size 7 x 2 m), set in bat foraging sites. Total trapping effort of this type of trap was relatively small, amounting to only 43 hours/net.

All the captured individuals were examined to determine sex, age and physiological condition. Selected specimens of all species captured were collected for further investigation, including of verification of their taxonomic position and status. Voucher specimens were fixed in alcohol (70% ethanol) or 4% formaldehyde, or prepared as a dry skin and skeleton. Extra bat individuals were released after the external examination in the same place in which they were captured. Voucher specimens were taken for the investigation to the Zoological Museum of Moscow State University. Acronyms of depositories of the processed collections are as follows: ZMMU — Zoological Museum of Moscow State University; ROM — Royal Ontario Museum, Toronto; MHNG — Natural History Museum of Geneva; ZIN — Zoological Institute of Russian Academy of Sciences, St. Petersburg.

For all but three voucher specimens DNA barcodes (sequences of the 5'-fragment of *cox-1* mitochondrial gene, up to 658 bp) were made as part of the Barcoding of life project [<http://barcodinglife.com>], forming basis for further molecular studies. A standard cocktail of primers acceptable for various mammalian species (Ivanova *et al.*, 2007) was used to get PCR-products of the 5'-fragment of *cox-1* (cytochrome c oxidase second subunit) mitochondrial gene (up to 658 bp). Analogous data from Kenyan bats were used for comparison. The Kimura 2 parameters model of the neighbour-joining method was accepted for grouping data. More detailed analysis of Ethiopian and Kenyan bat DNA barcodes is ongoing (Borisenko, in prep.).

## Results

Thirteen species of insectivorous bats, from five different families, and two species of fruit bats were found. Previously published records from Godare forest (Lavrenchenko *et al.*, 2004) include two more insectivorous bats and two fruit bats, making the overall bat diversity comparable to that of West African tropical forests (e.g., Fahr & Ebigbo, 2003).

### *Kerivoula lanosa*

The new record of the woolly bat should be the most important result of the given survey. A single adult female of *K. lanosa* was captured by the flap-trap on 30 April. Only two localities of woolly bats were previously known from Ethiopia: one in northern Ethiopia in the Simien mountains, and the second from the Great Rift Valley somewhere north of Lake Abaya (Largen *et al.*, 1974; Yalden *et al.*, 1996). Both records were made more than hundred years ago, and each was described as a distinct species, *K. eriophora* (Heuglin, 1877) and *K. harrisoni* Thomas, 1901, respectively. Our record was made at least 320 km west from the more southern previously published locality of the genus in Ethiopia (Fig. 1).

According to the latest checklist (Simmons, 2005) there are presumed to be seven African species of *Kerivoula*. Two of them, *K. phalaena* and *K. cuprosa*, were not documented for East Africa. Two species occur in Ethiopia. One of them, *K. eriophora*, is known only from type locality in northern Ethiopia and once was supposed to be a senior synonym for *K. africana* (Hayman & Hill, 1971); in his turn Kock (1984) concluded that *K. eriophora* cannot be conspecific with *K. africana* and belongs to “*lanosa*” species group. Based on the description and measurements of the only known *K. eriophora* specimen, Yalden *et al.* (1996) suggest that this form is conspecific with *K. lanosa* and a senior name for *K. l. harrisoni*. Nevertheless, the northern Ethiopian specimen is still usually treated as uncertain. *K. harrisoni* is now usually thought to be a subspecies of *K. lanosa* (Koopman, 1994; Simmons, 2005).

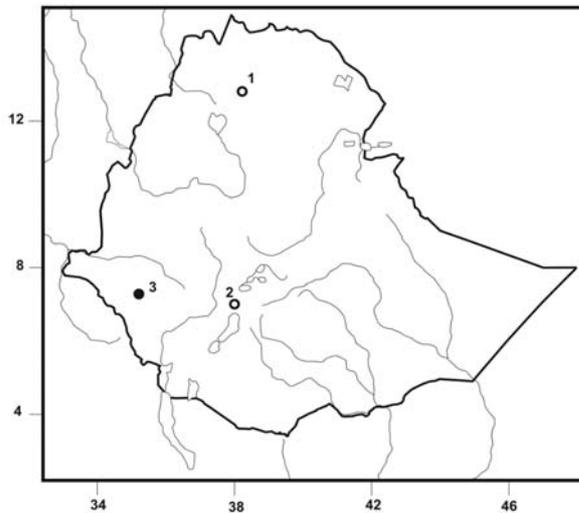


Figure 1. Localities of *Kerivoula* records in Ethiopia: 1 — type locality of *K. eriophora*; 2 — type locality of *K. harrisoni*; 3 — locality of our field work in Godare forest.

The following specimens were used as comparative material: *K. lanosa muscilla* — male and female from Cote d'Ivoire (types of *K. l. bellula*, MNHG-965.038, 965.039), female from Nigeria (ROM-86938); *K. l. harrisoni* — male from Kenya (ROM-48531); *K. argentata* — male from Kenya (ROM-36421); *K. smithi* — male from Kenya (ROM-48495); *K. phalaena* — male from Rwanda (ROM-59191).

Selected measurements of our specimen from Godare (ZMMU S-181514) are as follows: forearm: 32.7 mm, head and body length: 41 mm, tail length: 35.5 mm, hind foot: 6.4 mm, condylocanine length: 11.77 mm, mastoid width: 7.17 mm, upper tooth row: 5.30 mm, width between upper canines: 3.16 mm, lower tooth row: 5.68 mm. Externally this individual looks very similar to the specimen of *K. l. harrisoni* from Kenya, having relatively dark, brown dorsal fur frosted with long very pale-silver hair tips, dark brown ventral under fur and a well developed fringe of hair on the uropatagium. However our specimen has some minor difference. Its dorsal fur has shorter silver tips to the guard hairs; it also looks paler than in *K. l. harrisoni* because of presence of wide brown bands on the hairs. There is a visible difference in pigmentation of the ears: they well pigmented in the ROM specimen and colorless in our individual. West African specimens of *K. lanosa* seem to be somewhat smaller and paler than both Godare and Kenyan specimens. The specimen of *K. smithi* is similar in size but possesses almost no fur or fringe on tail membrane; its coloration on both back and belly looks darker because of distinctly shorter and more yellowish hair tips. *K. argentata* has larger proportions and is distinctly paler in color, almost white ventrally. Cranial proportions of the new specimen correspond well with all measured skulls of *K. lanosa* as well as with published measurements of Kenyan speci-

mens and of the *K. eriophora* co-type (Yalden *et al.*, 1996). We did not see any specimens of *K. africana*, but according to the literature this species is smaller and lacks the fringe on the tail membrane (Koopman, 1994; Yalden *et al.*, 1996). Thus we can assign the Godare woolly bat to *K. lanosa*, and it is to some extent intermediate between *K. l. harrisoni* and *K. l. muscilla*; its allocation to a definite geographic form needs investigation of additional material.

Our specimen was captured on the border between the coffee plantation and a small triangular patch of primary growth. At least one animal of the same species was observed in the same place two days later. In both cases animals were observed about one and half hours after sunset, flying slowly but extremely maneuverable over the coffee trees and under the large tree growing nearby, usually keeping very close (about 5–30 centimeters) to tree trunks and to canopies. The tendency to fly very close to obstacles or even between them makes woolly bats very hard to capture with the flap trap, the same habit gives them the ability to escape mist nets. This is one of the reasons why *Kerivoula* are so rare in scientific collections. African woolly bats and particularly *K. lanosa* are sometimes thought to be more characteristic of savannah woodlands (Taylor, 2000); however according to Grubb *et al.* (1998) and Fahr & Ebigo (2003), in West Africa this species seems to be more typical of forests. Our specimen came from relatively humid forest.

Observed specimens emitted very low intensity, frequency-modulated, echolocation calls, detected at about 100 kHz and over, which is similar to characteristics known for Asian woolly bats (Kingston *et al.*, 1999) and corresponds to the ecological niche of a leaf-gleaner or species foraging in highly cluttered space (Norberg, 1994).

### Other species

In the direct vicinity of Bishan Wak'a, fruit bats were represented by *Micropteropus pusillus* and *Rousettus aegyptiacus*. Both species seem to be common and abundant, being captured and observed many times during the field work. One specimen of *Epomophorus* sp. was observed but not captured; probably it was *E. gambianus*, which was previously recorded for Godare forest (Lavrenchenko *et al.*, 2004). The list of insectivorous bats includes, besides *Kerivoula*, *Nycteris hispidula*, *Rhinolophus* sp., *Triaenops persicus*, *Miniopterus* sp., *Myotis scotti*, *M. bocagei*, *M. welwitschii*, *Pipistrellus* cf. *aero*, *P. rusticus*, *Neoromicia guineensis*, *N. cf. nanus* and *Scotophilus dinganii*. Undetermined free-tailed bats from Molossidae family were detected by their echolocation calls. *Micropteropus pusillus*, *Triaenops persicus*, *Neoromicia* cf. *nanus*, *N. guineensis*, and *Scotophilus dinganii* were the most common and abundant amongst observed bats.

Most of the above listed species are already known for Gambela Province (Largen *et al.*, 1974) and even

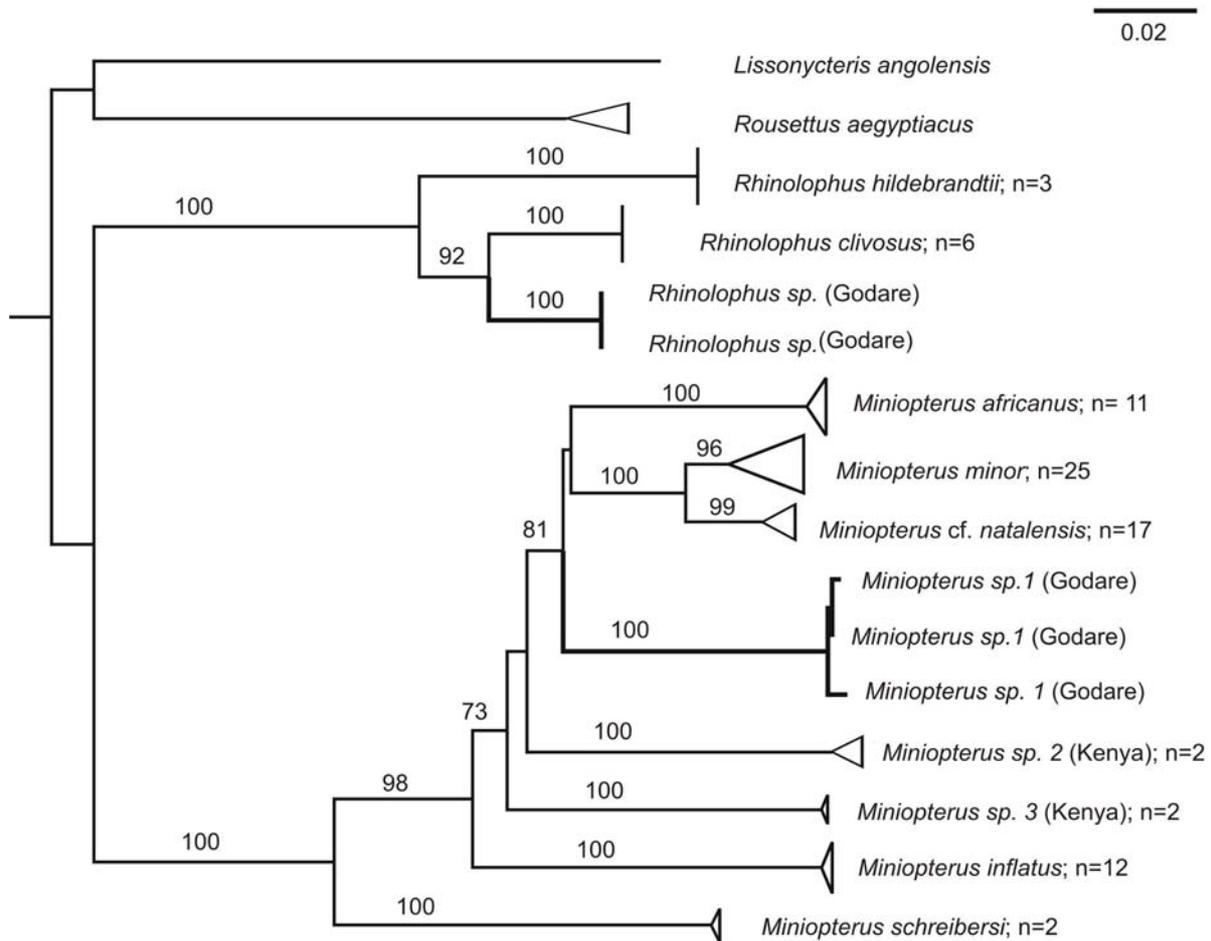


Figure 2. Kimura 2 parameter tree for East African *Miniopterus* and some *Rhinolophus*; fruit bats were taken as outgroup; bootstraps over 70% calculated from 1000 replicas are mentioned over appropriate branches.

for Godare forest (Lavrenchenko *et al.*, 2004). For the Ethiopian endemic *Myotis scotti* our record is new; however, there is a previous known locality less than 30 km eastward, on the Beko River in the vicinity of Tepi (Lavrenchenko *et al.*, 2004). Thus the record of major faunistic interest is *M. bocagei*. This species, not rare in the East Africa (Kingdon, 1974), has been previously found in Ethiopia only three times, in Addis-Ababa (Demeter & Topal, 1982), near Arba Minch and at Djala (Yalden *et al.*, 1996). During our observations, Bocage's mouse-eared bat was common on and nearby Bishan Wak'a Lake. Possibly its habit of hunting over water has led to it being under-recorded.

Both captured horseshoe bats demonstrate qualitative features, such as definitely hastate lancet, relatively narrow horseshoe not covering the whole muzzle, and lacking of the small upper premolars, which allocate them to *Rh. clivus* (Csorba *et al.*, 2003). However these individuals compared with reference material in the Royal Ontario Museum and Moscow Zoological Museum, look unlike other *Rh. clivus* from Ethiopia and Kenya, especially in coloration which is greatly

similar to that of *Rh. alcyone* from West Africa. According to the preliminary results of cox 1 gene analysis, these two specimens lie at a distance from Kenyan ones close to species level (average Kimura distance 4.77%, observed distance 4.57%; Fig. 2).

Three captured specimens of medium-size *Miniopterus* were compared with other African bent-winged bats in ZMMU and ROM collections. They demonstrate similarity with *M. minor* in fur structure and coloration, but resemble *M. natalensis* in external and cranial size. Average Kimura distances between newly found cox I haplotypes and the clade comprising *Miniopterus natalensis*, *M. minor*, and *M. africanus* from Kenya is 9.78% (observed distance 8.93%; Fig. 2).

## Discussion

Summarizing results of this survey and previous data, we can speak about the bat community containing at least 19 species. Insectivorous bats are represented, as it was already mentioned, by majority of known ecological forms: gleaners, trawlers and aerial hawkers

(e.g., Schnitzler & Kalko, 1998; Kruskop, 1999). Foliage gleaners are represented by *Kerivoula lanosa*, ground hovering gleaners by *Nycteris hispida*. Potentially gleaning behavior could be expected in *Myotis welwitschii*, however in our observations it seems to be a highly maneuverable aerial hawk. Amongst other members of this ecological group, *Neoromicia* cf. *nanus*, *N. guineensis* and probably *Rhinolophus* sp. exploit highly cluttered space between growths, while both true *Pipistrellus*, *Myotis scotti* and *Triaenops persicus* use edges of the growth, ecologically comparable to other typical pipistrelles, whiskered bats and large serotines respectively. One of the most interesting aspects is the foraging behavior of *N. cf. nanus*, which exploits the periphery of canopies and bushes, often seen flying close to vegetation. Maximum energy of the echolocation call of this species was at over 70 kHz, which does not correspond to published data on *N. nanus* (Taylor, 2000). *Scotophilus dingani*, *Miniopterus natalensis* and the undetermined free-tailed bat represent typical high-speed hawkers, exploiting uncluttered space. Finally, *Myotis bocagei* demonstrate foraging behavior almost identical to that of *M. daubentonii* and similar forms (Kalko & Schnitzler, 1989), of a typical trawler or water gleaner. Thus, in comparison to other palaeotropical bat communities, we were missing only two ecological forms, namely nectarivorous and carnivorous bats. In tropical Africa these types are represented by the fruit bat *Megaloglossus woermanni*; by giant slit-faced bat *Nycteris grandis* and probably *Cardioderma cor* (Norberg & Fenton, 1988) Taking into account the overall richness of this community, these elements could probably be found during further research.

In respect of environment type, revealed fauna mainly consist of species with variable biotopical preferences, living both in forests and open areas. According to Grubb *et al.* (1998) *Micropteropus pusillus* and *Neoromicia guineensis* are mainly inhabitants of savannah woodlands (and previously both species were known in Ethiopia from such habitats); while *Nycteris hispida* thought to be mainly forest species. *Neoromicia nanus*, treated as a savannah form by Taylor (2000), more probably inhabits a high variety of biotopes (Grubb *et al.*, 1998). In Godare according to our survey this species usually exploits more or less forest habitats. *Scotophilus dinganii* is thought to be a species of savannah woodlands (Taylor, 2000), but it actually forages in open patches. So it probably does not live in thick forests, and penetrates into forested areas on the heels of roads and agroecosystem. As was said, *Kerivoula lanosa* probably can exploit both forests and open woodlands, but in Godare it seems to be a real forest species. Finally, *Myotis bocagei*, according to Rosevear (1965), prefers moist forests; however in connection to its foraging behavior this species depends mainly on open water surface and less from the neighboring landscape.

We can suppose that savannah faunal elements may penetrate into forest massifs through clearings and roads

and thus depend on anthropogenous transformation of the landscape. Retaining more or less untouched patches, even small, of primary forest vegetation allowed the forest bat fauna to survive in the zone of coffee planting. However we did not observed foraging bats – either forest or eurytopic species – in places of continuous plantations with greatly destroyed forest cover.

As for outstanding taxonomic questions, the identities of *Rhinolophus* and *Miniopterus* remain problematic. Five species of *Miniopterus* usually thought to occur in East Africa (Simmons, 2005), however it is possible that there are still present some undescribed forms (Appleton *et al.*, 2004). Number of horseshoe bats known for East and North-East Africa is higher: about twelve species (Simmons, 2005). *Rhinolophus clivosus* itself represents a highly complex morphologically variable taxon (Cotterill, 2002; Csorba *et al.*, 2003) which actually may include more than one species. In any case both horseshoe bats and bent-wing bats are members of taxonomically problematic groups, and identification of the Godare specimens need further and more comprehensive investigation of comparative material and molecular data.

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