



Assessment of small and medium sized mammals (Soricomorpha, Lagomorpha, Rodentia, Procavidae) in the Kafa Biosphere Reserve

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1 HIGHLIGHTS

- The African pigmy mouse (*Mus (Nannomys) mahomet*), the Ethiopian hare (*Lepus cf. fagani*) and the Ethiopian meadow rat (*Stenocephalemys albipes*) are endemic to Ethiopia (the latter also occurs in neighbouring Eritrea).
- The forms of the East African root rat (*Tachyoryctes splendens* s.l.), Brush furred mouse (*Lophuromys flavopunctatus* s.l.), African Marsh rat (*Dasymys cf. incomtus*) and Ethiopian Vlei rat (*Otomys cf. typus*) encountered in this study could be endemic to Ethiopia, but this needs to be corroborated by genetic studies.
- The observed form of the Gambian sun squirrel (*Heliosciurus gambianus cf. kaffensis*) could also be an endemic subspecies or even species.
- On the basis of the current study it is not possible to judge, if a certain species is threatened or not.
- The wetlands surrounding the Gojeb river and adjacent habitats seem to be more species diverse than the other plots studied.
- The African clawless otter (*Aonyx capensis*) may be considered a flagship species. The species could be a good indicator for the status of conservation of rivers and other natural / semi natural water bodies.
- Small mammals are sensitive to overgrazing and pollution from insecticides and herbicides as well as to intensification of agriculture in general. Regulations concerning future human land use should be implemented and controlled in order to protect their natural environment.
- Sewages, especially for villages in the wetlands and near streams, should be constructed and maintained, to prevent habitats from pollution from different sources.

2 INTRODUCTION

The geographical position, range of altitude, rainfall pattern and soil variability of Ethiopia have resulted in an immense ecological diversity and huge wealth of biological resources (Kassa & Bekele 2008). Ethiopia is also notable for containing 50% the Afrotropical region's land above 2.000 m asl (Yalden 1983). Further, factors promoting this development have been repeated glaciations and tectonic events. In Eastern Africa, rodents account for 28% of the total mammalian fauna (Kingdon 1989). The insectivore fauna, particularly of shrews, is also most diverse having 140 species (Hutterer & Yalden 1990).

Ethiopia's fauna and flora is characterized by many species endemic to the country. Besides, there are many unknown species that have not been identified until now. The real wealth of species in this country has not yet been fully assessed, due to a lack of studies for many regions. For the Kafa region of southwestern Ethiopia there are only very few studies providing reliable data on small mammals (summarized in Berhan 2008).

Most small mammal species are only rarely observed, but their role in ecosystems is very important. On the one hand, they produce a lot of biomass compared to other vertebrates of the same size classes. They are the base of food chains for small and medium sized carnivores, and birds of prey such as raptors and owls. They are responsible, to a certain degree, for the dispersal of plant species by selective feeding, spreading of seeds, and the concentration of nutrition by using latrines. They also promote ventilation and bioturbation of soil and drainage after rainfall. On the other hand, they are important vectors for diseases and can become pests in agricultural cultures.

The diversity of small mammals depends on the habitat type (Glennon & Porter, 2007; Garratt et al., 2012), where habitats with higher floral diversity and ground cover support more diversity compared to habitats with lower floral diversity and ground cover (Mulungu et al., 2008; Pearson et al., 2001). Hence, small mammal assessment is an important component of biodiversity assessment of an ecosystem because they are indicators of habitat conditions.

The current assessment of small mammals in the Kafa BR was carried out between 03/12/2014 and 12/12/2014, during the dry season in different types of habitats and altitudinal ranges. We expected different species compositions in different kinds of habitats (different types of forests, arable land, moister and drier stands). A comparison to other studies on small geographical areas (e.g. Habtamu & Bekele 2008, Kassa & Bekele 2008, Yonas et al. 2014) is not possible because of the short study period that resulted in an incomplete species list for each sampling site in contrast to long-term studies elsewhere. However, it is possible for us to compare the results from the different study sites we sampled during our field work to one another.

As the assessment took place in the dry season, the densities of small mammals was less compared to the wet and the early dry seasons, because most small mammal populations rise in the latter seasons following reproduction during the wet season, when food availability is larger (e.g. Delany 1986). Here it has to be mentioned that, a few days before our study started there was extraordinarily heavy precipitation in the study area, resulting in the flooding of lower areas, especially near rivers.

3 MATERIALS AND METHODS

3.1 Study area

Not all sampling sites of the biodiversity assessment have been studied concerning their small mammal fauna. Trapping was done in the surroundings of the bamboo forest and the northern areas

of arable land bordering small forest stands (1 BA). Another sampling site was the montane coffee forest (Ufa forest – 4 AW) and the riverine vegetation at the Gumi river. An area sampled intensively was the Gojeb wetland and its surroundings (8 GO-wet, 9 GO-riv). The last place investigated was the area of the NABU guesthouse in Bonga (11 KDA GH).

3.2 Sampling methods

Small mammals were sampled by snap traps of mouse and rat size and Sherman LFA live traps (7.5 x 9.0 x 23.0 cm, HB Sherman Trap Inc., Tallahassee, USA) baited with peanut butter mixed with canned fish. Sampling was done in two to three lines per locality and in each line the three types of traps were set by alternating one after the other in lines of up to 400 m length. The use of a variety of traps was in accordance with the suggestion that trap type and trap size can determine the types of small mammals captured (Thompson & Macauley, 1987; Slade et al., 1993; Lee, 1997). One trapping line holds 50-75 traps (depending up on the habitat condition), each five meters apart. Trapping was conducted mostly in edge habitats representing denser natural habitats and cultivated / disturbed fields. Traps were set before dusk (between 17:00 -18:00 hrs.) and inspected early in the morning (7:00 - 8:00 hrs.) to prevent captures from ant damage.

3.3 Data analysis

The standard external morphological measurements (body mass, head-body, tail, hind foot, and ear lengths) of each caught specimen were recorded and reproductive status of the hosts determined (see table 1) before skinning and the carcasses were preserved in alcohol for later skin and skulls / skeleton study. Samples of spleen and kidney were taken and preserved in 96 % ethanol for genetic analysis, and blood samples were collected on calibrated, pre-punched filter paper (LDA 22, Ploufragan, France) for later serological and/or molecular screening of RNA viruses.

Following the national regulations of the Ethiopian Biodiversity Institute (EBI), samples were properly prepared and exported to Germany, with the main objective to further identify the species and complete the species list. We have obtained the genetic data of three of the small mammals and the analysis of the rest of the specimens, with one exception, will be done in collaboration with Dr. J. Bryja in Brno (Institute of Vertebrate Biology, Czech Republic). A tissue sample of a hare (genus *Lepus*) found as a road kill in the Gojeb wetland (N8, GO-wet) will be analyzed in collaboration with Dr. F. Suchentrunk (Research Institute of Wildlife Ecology, University of Veterinary Medicine Vienna, Austria), an internationally acknowledged hare specialist, who is already working in Ethiopia.

Skulls and skeletons will be cleaned by larvae of *Dermestes* beetles, to prevent damage of delicate structures that might occur through faster but rougher cleaning methods, so as much information as possible can be gained from the material (the procedure still in progress).

Additional material obtained from local people, road kills and observations / photos are included in the analysis.

Excepting *Crociodura*, *Dasymys* and *Otomys* we provide preliminary identification results only based on morphological data in this report, as the genetic analysis requires more time. We were supported by R. Hutterer, the retired former head of the mammal collections in the Zoologisches Forschungsinstitut and Museum Alexander Koenig (ZFMK), Bonn during the first steps of species determination, who also provided us with new and rare literature. First results based on DNA-sequencing concerning *Crociodura*, *Dasymys* and *Otomys* were provided by J. Bryja (Institute of Vertebrate Biology, Academy of Sciences of the Czech Republic, Brno). The taxonomy follows Wilson & Reeder (2005) and Happold (2013) except where there are more recent studies with more differentiated results applicable to our material.

4 RESULTS AND DISCUSSION

4.1 Records

Taxonomic status and ecological requirements of the species recorded during the short-time survey are described below. We have also included information on reproductive status and parasite loads whenever available.

4.1.1 Soricomorpha

African Giant Shrew (*Crocidura olivieri*)

One shrew species was collected in the Gojeb wetland (N8, GO-wet) with three individuals, at all other sampling sites no shrews could be obtained. It represents a dark brown color morph of the widespread African Giant Shrew which occurs in almost all regions of sub-Saharan Africa and the upper Nile valley (Egypt), except in the very South of the continent. The species was formerly known under the name *C. flavescens*, a name today restricted to a smaller species occurring in South Africa (Churchfield & Hutterer 2013). It is also possible that this shrew is the species described as *C. fulvastra* in the species list of the faunal diversity study of the Kafa Afromontane Coffee Forest by Berhan (2008). Previously the population of the study area was described under the name *C. olivieri hansruppi* by Hutterer (1980), who studied six animals from four different places in the Kafa region, because of their unusual coloration compared to other samples of the species from Ethiopia and their long and densely haired tails. Biochemical studies have shown that *C. olivieri* is a highly variable species (Maddalena 1990) and the known colour morphs do not represent subspecies or even species (Churchfield & Hutterer 2013). One out of two females had active mammae (10/12/2014), it also was infected by Cestodes. The testes of the male specimen were inactive.



Fig. 1 Distribution of *C. olivieri* in Africa (Source: IUCN Red List of threatened Species 2014)



Fig. 2 Specimens of male *Crocidura olivieri* from Ethiopia (left: Gojeb wetland, 11/12/2014, and right: the more widespread savannah colour morph from Bahir Dar, Lake Tana, 07/04/2011) (photo: H. Meinig)

4.1.2 Lagomorpha

Ethiopian hare (*Lepus cf. fagani*)

Hares were frequently observed in open habitats in the study area. According to the maps provided by IUCN, *Lepus fagani* is the only species that occurs in the area. F. Suchentrunk (hare specialist, University of Vienna) suggested that the Ethiopian Highland Hare (*Lepus starcki*) could also occur (pers. communication), but *L. fagani* is the more probable species.

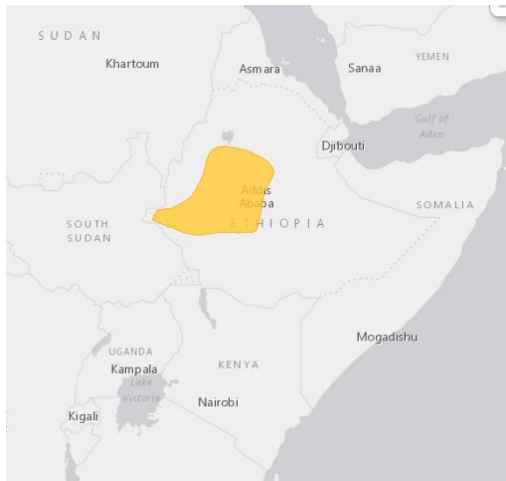


Fig. 3: Distribution of the Ethiopian endemic *Lepus fagani* (Source: IUCN Red List of threatened Species 2014)

The taxonomic status of the three hare species occurring in Ethiopia (in addition to the two endemic species mentioned above, the more widespread Abyssinian Hare *L. habessinicus* also occurs in Ethiopia) is not yet resolved. There seem to be bidirectional ancestral and actual introgressions in zones of sympatric occurrences (Tolesa et al. 2013).

Tissue samples and a piece of fur of a hare found as road-kill were collected in the Gojeb wetland 11/12/2014. The tissue sample will be analysed in collaboration with Dr. F. Suchentrunk as part of a running project on Ethiopian hares.

4.1.3 Rodentia

Gambian Sun Squirrel (*Heliosciurus gambianus* cf. *kaffensis*)

In the faunal diversity study by Berhan (2008), no representative of this arboreal squirrel genus is mentioned. The only squirrel known to this author is *Xerus rutilus*, a ground squirrel. The Gambian Sun Squirrel is widespread in sub-Saharan Africa (fig 4). This species is typically associated with savannah woodland. Populations have also been observed in riparian forest and in savannah areas. It is generally absent from closed forest habitats. This species is commonly found in agricultural areas. *Heliosciurus gambianus* probably represents a complex of several similar species. Further studies are needed to clarify the taxonomic status of populations / subspecies currently allocated to this species

(see Grubb & Ecué 2008). As the species was described based on specimens from West Africa (Gambia) it is very probable that Ethiopian animals represent a different species.



Fig. 4: Distribution of *Heliosciurus gambianus* in Africa (Source: IUCN Red List of threatened Species 2014).

For the individuals observed in the study area the subspecies name *kaffensis* seems to be applicable. They differ from other populations known in and outside Ethiopia in pelage coloration, especially the reddish coloration on the border between back and belly (own observation) (fig 5 – 7). For further taxonomic precisions at least a tissue sample would be needed for DNA analysis. It seems possible that the animals of the biosphere belong to an endemic species. At the moment only the occurrence of the endemic subspecies *H. g. kaffensis* can be confirmed.

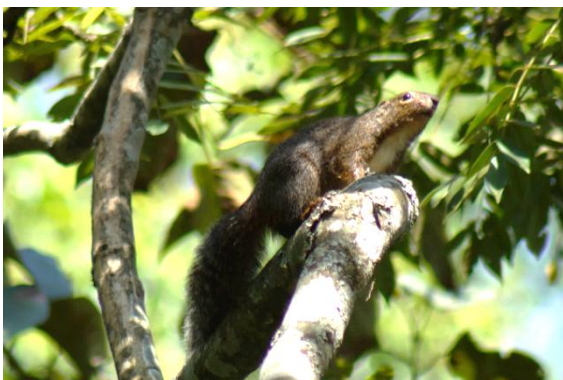


Fig. 5: *Heliosciurus gambianus cf. kaffensis* (photo: T. Kirschey 8/12/2014)

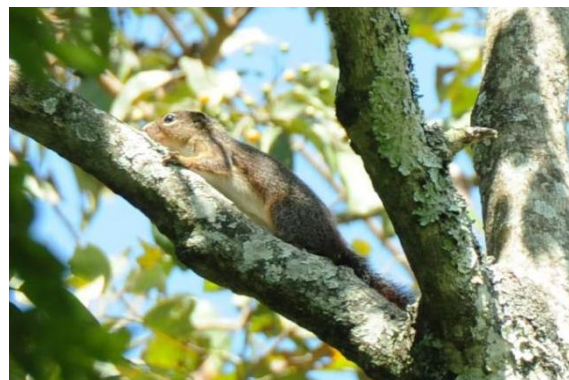


Fig. 6: *Heliosciurus gambianus cf. kaffensis* from S' Gind Aba (07°27'13.3''N, 37°11'040.0''E) (photo A. & K. Schell 11/12/2014)



Fig. 7: Coloration of *Heliosciurus gambianus* ssp. from Lake Awassa (29/03/2010) (photo H. Meinig)

East African root-rat (*Tachyoryctes splendens* s.l.)

The taxonomy of this subterranean rat is still not clear. Provisionally, eleven species of this complex (*Tachyoryctes*) confined to higher altitudes of East African montane grasslands are recognized at the moment (e.g. Kingdon 1997, Musser & Carleton 2005). According to these references populations occurring in Bonga biosphere have to be recognized as *T. splendens* s.l.. According to a new study based on genetic and cytogenetic characteristics (Lavrenchenko et al. 2014), at least four species are lumped under the name *T. splendens* alone in Ethiopia. Animals from the Bonga region belong to members of the so called “Northern clade”, named by the authors on the base of eight specimens collected from the surroundings of the village Masha, 100 km northwest of Bonga. Geographic limits of these form are not known yet. Subterranean mammal species occurring in grasslands often are endangered by intensification of agriculture, as recently shown by Csorba et al. (2015) for a European species-complex of blind mole-rats (Genus *Spalax* and *Nannospalax*), a closely related group to *Tachyoryctes* of the family Spalacidae with very similar ecological requirements. The replacement of extensive livestock farming and pasture-farming with intensive monocultures leads to a decline, fragmentation and, in many cases, to the final disappearance of grasslands. As a result root-rats, today sometimes regarded as a pest, will become endangered. The species feeds on grass and dicotyledonous plants (Yalden 1975 for *T. macrocephalus*), so a decline in plant species richness of grasslands can also be assumed to harm populations of root-rats. As long as the species limits in the *Tachyoryctes*-group are not clear and the geographical distribution and limits of the taxa have not been investigated properly, it is difficult to judge if a form is endangered or not.

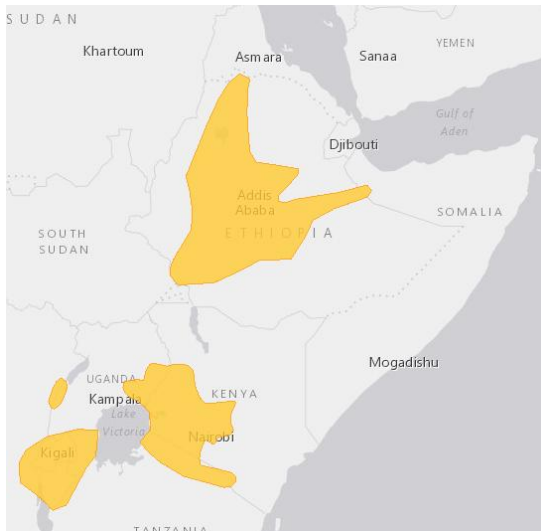


Fig. 8: Geographic range of *Tachyoryctes splendens* s.l. (Source: IUCN Red List of threatened Species 2014)

Typical mounds of the species were observed in the area around the NABU-Guest House in Bonga (N 11, KDA GH) and in open grasslands bordering the bamboo forest (N 1, BA). The species is hunted as a pest by local people because it consumes cultivated plants, particularly the staple enset or false banana (*Ensete ventricosum*), widely cultivated as a food plant in the area. Three individuals (two males, one female, fig: 9) were obtained from local people around the bamboo forest, caught using snares (Fig. 10) set in the running paths of this species. *T. splendens* occasionally goes aboveground to feed on the surface during the night. None of the three individuals was sexually active.



Fig. 9: *Tachyoryctes splendens* s.l. from the bamboo forest 06/12/2014 (photo H. Meinig)



Fig. 10: Snare for catching *Tachyoryctes*, bamboo camp 06/12/2014 (photo H. Meinig)

Brush-furred mouse (*Lophuromys flavopunctatus* s.l.)

Lophuromys according to a study by Lavrenchenko et al. (2007) is the rodent genus with the most endemic species in Ethiopia: nine in total. Among them there are species that can easily be recognized by the ratio of head and body / tail lengths, like *L. brevicaudatus* in the Bale Mountains. (see Fig. 12). Other species are more difficult to recognize.



Fig. 11: Distribution of *Lophuromys flavopunctatus* s.l. in Africa (Source: IUCN Red List of threatened Species 2014)



Fig. 12: Comparison of body proportions of Ethiopian *Lophuromys*. Left: female *L. flavopunctatus* s.l. from Bamboo-Camp 06/12/2014, right: male *L. brevicaudatus* from Wahoro village, Bale Mts. 04/04/2010 (photo H. Meinig)

On the basis of morphological data (preliminary to the results of the DNA analyses), all *Lophuromys* caught in our survey are regarded as *L. flavomaculatus* s.l. Members of this species mostly feed on insects (ants are preferred). The specimens were caught in different localities near the bamboo forest (N 1, BA), in the montane forests near Decha (N 4, AW) and in the Gojeb wetland (N 8, Go-wet). None of the four females caught was sexually active. Two of the five males captured had scrotal, active testes. Two individuals were infected by parasites (one ♂ with Nematodes, one ♀ with Cestodes).

Ethiopian Vlei rat (*Otomys* cf. *typus*)

The Vlei rat is supposed to be a species-complex consisting at least of six species (Taylor et al. 2008). In Ethiopia this species is recorded in montane areas of the highlands (1,900 to 4,100 m asl)

(Taylor et al. 2008). The species inhabits mesic grassland, montane grasslands and alpine heaths. The species is known to occur in grasslands and heaths of the highlands of Ethiopia, Kenya, Malawi, Tanzania and Uganda upwards from 1800 m asl (Taylor et al. 2008). The current determination of the three *Otomys* specimens collected near the Bamboo camp (2) and in the Gojeb wetland (1) is

preliminary based on DNA analysis. Maybe, the specimens collected represent the taxon *Otomys fortior*, a name used for specimens collected in the Charada Forest (Prov. Kaffa) and near Jimma (Taylor et al. 2011). The species-complex as a whole is evaluated as “least concern” by IUCN, all though it is supposed to be decreasing (Taylor et al. 2008). When there are several species hidden under the name *O. typus*, species limits and the area covered by each of them should be investigated properly, to decide if there are species more threatened than others and eventually to develop strategies to protect endangered forms. One of the males from the Bamboo camp was subadult, the other sexually inactive. The female from the Gojeb wetland was carrying one embryo close to birth (crown length: 48 mm).



Fig. 13: Geographic range of *Otomys cf. typus* (Source: IUCN Red List of threatened Species 2014)



Fig. 14: *Otomys cf. typus* from the Sanetti Plateau, Bale Mts. 14/04/2010 (photo H. Meinig)

Ethiopian meadow rat (*Stenocephalemys albipes*)

The genus *Stenocephalemys* is almost endemic to Ethiopia, the only species also occurring outside Ethiopia in neighbouring Eritrea being *Stenocephalemys albipes* (Fig. 16). At the moment four species of this genus, related to the other African genus of Muridae, like *Mastomys*, *Praomys* and *Myomyscus*, are recognized (Musser & Carleton 2005). *Stenocephalemys albipes* was the most abundant species in the study area. Of the 51 terrestrial mammals collected, 20 are *S. albipes*. The species was caught at all sites except on the banks of the Gumi river, where no animals entered the traps, and the area around the NABU Guest House. Except for one, all male individuals captured in the Gojeb wetland (n=10) had active testes. Of the 10 females captured two were pregnant, one showed active mammae and two had not been sexually active before. The remaining were adult but showed no signs of sexual activity when they were caught. Many individuals showed scars on their ears, indicating intraspecific aggression because of high densities. Two individuals were infected by Cestodes, one male from the Gojeb wetland was infected by a larva of a warble fly under its headskin (Genus: *Oestromyia*).



Fig. 15: *Stenocephalemys albipes* from the Bale Mts. near Dodola 09/04/2010 (photo H. Meinig)

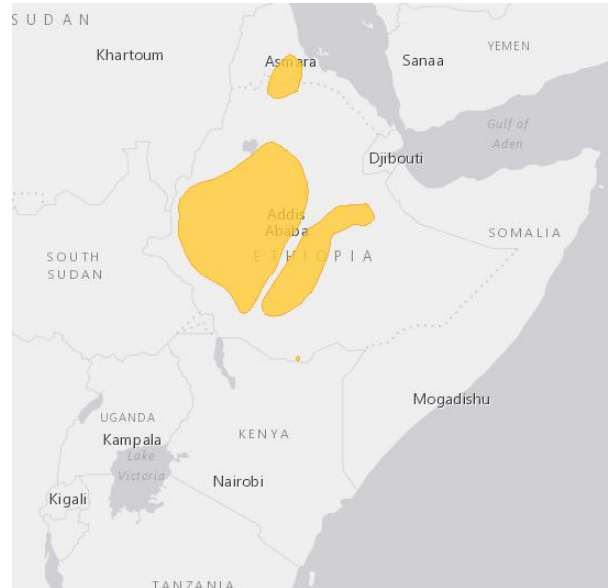


Fig. 16: Geographic range of *Stenocephalemys albipes* (Source: IUCN Red List of threatened Species 2014).

African pygmy mouse (*Mus (Nannomys) mahomet*)

Mice of the subgenus *Nannomys* are widespread throughout Africa. According to the recent study by Bryja et al. (2014) eight different forms of the subgenus occur in Ethiopia six, of which are endemic to the country. Among these is *Mus mahomet* (fig 17), which is restricted to the Ethiopian Plateau and not conspecific with pigmy mice from Kenya and Uganda as supposed earlier (e.g. Musser & Carleton 2005). In this study material from Bonga and Jimma was included (fig 18); hence the determination of the animals caught during our study is supported by genetic data from the same area. Twelve individuals were trapped in our study (1 in NABU Guest House, 5 in Bamboo camp, 6 in Gojeb wetland). Ten of these were females, four of them were pregnant, one with embryos close to birth (Gojeb wetland 10/12/2014) with a crown length of 18,2 mm. This might be the species mentioned by Berhan (2008) under the name of *M. triton*.



Fig. 17: *Mus mahomet* from the Bamboo camp 05/12/2014 (photo H. Meinig)

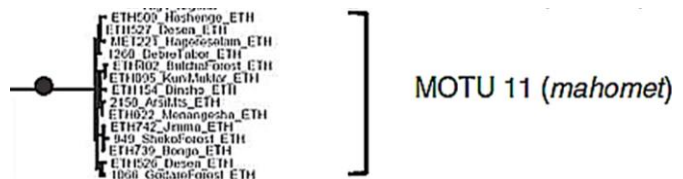


Fig. 18: Section of samples identified as *M. mahomet* from the phylogeny of the *Nannomys*-group by Bryja et al. (2014) among others presenting material from the study area (Bonga, Jimma)

African Marsh Rat (*Dasymys cf. incomtus*)

The genus *Dasymys* is widespread throughout sub-Saharan Africa and follows a savannah distribution (Mullin et al. 2005). Its natural habitats are moist savannah, seasonally wet or flooded lowland grassland, and swamps. One individual of this species, a subadult (M3 is just breaking through in the lower as well as in the upper jaw) female, was trapped in the Gojeb wetland (11/12/2014). We were unable to identify the specimen morphologically even to the genus level in the field, but preliminary DNA analysis indicated the specimens identity. The animal has a very dense soft fur, a relatively long tail (longer than in *Arvicanthis* and shorter than in *Stenocephalemys*), very hairy ears and black sole markings (Fig. 19). Further confirmatory determination will follow, using genetic analysis combined with a skull and the teeth investigation. Mullin et al. (2005) reported that two chromosomal forms of *Dasymys* (*Dasymys cf. incomtus*: $2n = 40$, $NF = 44$ from Bale Mountains and $2n=38$, $NF=44$ from Hareenna Forest) and one distinct morphological form (*D. griseifrons* known only from lakes Tana and Jigga) occur in Ethiopia. According to the authors all of them distinctly differ from the nominate *incomtus* material from South Africa.

In Southern Africa the populations of *Dasymys* have been decreasing since the 1960s because of desiccation and destruction of wetlands (Mugo et al. 1995). The Ethiopian populations can also be regarded as sensitive to these factors.



Fig. 19: *Dasymys cf. incomtus* from the Gojeb wetland 11/12/2014 (photo H. Meinig)



Fig. 20: Body proportions of *Stenocephalemys albipes* (above) and *Dasymys cf. incomtus* (below) (photo H. Meinig)



Fig. 21: Characteristic black sole markings of *Dasymys cf. incomtus* from the Gojeb wetland 11/12/2014 (photo H. Meinig)

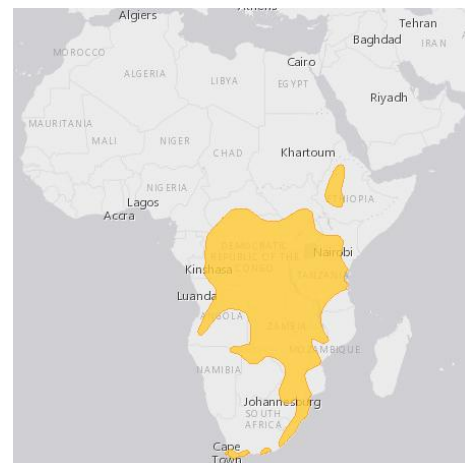


Fig. 22: Geographic range of *Dasymys cf. incomtus* (Source: IUCN Red List of threatened Species 2014).

4.1.4 Procaviidae

Yellow-spotted hyrax (*Heterohyrax brucei*)

A latrine typical for hyraxes was found in an old tree near the Bamboo camp (07°14'36''N, 36°27'27''E) by T. Kirschev and V. Clausnitzer 05/12/2014 (fig 23). As Rock hyraxes (genus *Procavia*) are usually restricted to areas with rocks and there are no rocks in the surrounding of the finding place, the latrine was supposed to be used by Yellow-spotted bush hyrax (fig. 24). The determination was confirmed by DNA analysis of scats by A. and K. Schell. The species, widespread in eastern Africa, is known to occur in our study area (Berhan 2008). Within *H. brucei*, there are about 25 recognized subspecies and Ethiopia is known as a type locality for three of these subspecies, *H. b. brucei*, *H. b. princeps* and *H. b. rudolfi* (Barry & Hoeck 2013).



Fig. 23: Yellow spotted hyrax from Waliso Negash (photo H. Meinig)

4.2 Evaluation of the results of the short-time study

The study area with the highest number of species trapped (6) was the border of arable land and forest stands in the Gojeb wetland, around the bridge south of the camp site. It was the only place where shrews were caught. Shrews prefer moister habitats because of the higher densities of insects as food compared to drier habitats. In this place one subadult female African Marsh Rat was also caught. Signs of the occurrence of the root rat (typical mounds were missing in that area, maybe because the ground water level there is too high for the building of deep burrows).

The Ethiopian Vlei rat also is bound to moister habitats; it was only trapped in the riverine habitats near the bamboo camp and the wetlands at Gojeb river. There were no successful trapping on the banks of Gumi river, though 25 traps were set in dense vegetation in a distance of 20 – 50 m from the embankment, a place in which trapping success would have been expected. Maybe the flooding after the heavy rainfalls during the weeks before the study began had resulted in temporarily free in the areas of small mammals. In higher altitudes in the forest the Brush-furred mouse and Ethiopian meadow rat were recorded.

In most places specimens of the Brush-furred mouse, Ethiopian meadow rat and African pigmy mouse were caught. This seems to be the regular species composition in the landscape of the biosphere reserve. The root rat also proved to be a common species in the area. It was encountered in 4 out of 9 trapping sites. In the area around the NABU guesthouse it was the only small mammal species beside of the African pigmy mouse to be caught (one animal in 30 traps, a further animal having been caught in a pitfall trap for insects).

Trapping sites were between 1.287 m asl (Gumi river) and 2.593 m asl (Bamboo Camp). A change in species composition in East African small mammals occurs at altitudes above 3.000 m asl (compare Clausnitzer & Kityo 2001). A different species composition with more high altitude specialists can therefore be expected in the biosphere in areas south and southeast of Bolla in an altitude above 3.000 m asl.

The list of species is shorter than expected, long-term studies would have yielded more species (e.g. further shrew species, Multimammate rats (*Mastomys*) or Zebra mice (*Lemniscomys*)).

5 CONCLUSIONS AND RECOMMENDATIONS FOR CONSERVATION AND MONITORING

The short-term study on small and medium sized mammals during the dry season yielded only the first of the results required to fully understand the species composition in different habitat types. The greatest problems are caused by the not yet solved difficulties of systematics and taxonomy in Ethiopian mammals. In the future, long-term studies during other seasons should be carried out to understand ecology of the species and their requirements and to gather more material to solve the taxonomic problems. These studies should be carried out during consecutive years in the same plots, as many species of small mammals show cyclic population increases and decreases during intervals of three to four years. There might be important species in some habitat types that could not be detected during our study because their densities were too low to be detected during our stay.

Except in some very rare occasions (e.g. Giant root rat *Tachyoryctes macrocephalus* in Bale National Park) small mammals surely will not fit the role of flagship species for a certain area, because they are normally more or less invisible. Furthermore, many people consider rodents as pest animals. However, they should be kept in mind during monitoring, as they play an important role in ecosystems. Small mammals are sensitive to overgrazing and pollution from insecticides and herbicides as well as to the intensification of agriculture in general. Where they are missing, many species depending on them as food will decline or switch to other endangered species like Abyssinian Longclaw (*Macronyx flavicollis*) or plover species (*Vanellus*) as food.

Dasymys cf. incomtus may be affected by the desiccation and destruction of wetlands as well as pollution of streams and ponds by detergents and pesticides.

To overcome problems caused by the intensification of land use, regulations should be implemented and controlled, regarding which kind of land use is allowed to which extent and what methods and means have to be used in certain areas. Especially for villages in the wetlands and near streams sewages should be constructed and maintained, to prevent water-bound habitats from destruction by pollution from fertilizers, detergents, and pesticides.

The African clawless otter (*Aonyx capensis*) would fit the role of a flagship species. Due to their endearing appearance, Otters are very popular in Europe and the United States and could become an attraction in the wetlands and river areas. Otters were observed regularly during three consecutive evenings in the Gojeb river. The species seems to occur also in other parts of the biosphere as pictures taken by B. Walter from 2009 near Bonga show (fig. 25 and 26). Otters are sensitive to water pollution and the destruction of dense vegetation structures on the banks of rivers and ponds, so they are a good indicator for environmental health.



Fig. 24: Clawless otter near Bonga 2009 (photo B. Walter))



Fig. 25: Clawless otter near Bonga 2009 (photo B. Walter)

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8 ANNEX

Table 1: Small and medium sized mammal species recorded during the Biodiversity Assessment in Kafa Biosphere Reserve, their preferred habitat types, distribution type, and IUCN Red List Category

No.	Scientific Name	Family	English name	Habitat/ Forest Type	Study sites	Distribution	IUCN Threat Status	CITES Appendix	Endemism
At 39, At 41, At 55	<i>Crocidura olivieri</i>	Soricidae	African Giant shrew	wetland	5 AG	widespread	LC	-	-
No no., skin, tissue sample	<i>Lepus cf. fagani</i>	Leporidae	Ethiopian Hare	wetland	5 AG	Western Ethiopia	DD	-	Ethiopia
No no., observations	<i>Heliosciurus gambianus cf. kaffensis</i>	Sciuridae	Gambian Sun Squirrel	Savannah with trees and bushes		Prov. Kaffa	LC	-	subspecies: western Ethiopia
At 6, At 25, At 26	<i>Tachyoryctes splendens</i> s.l., "northern clade"	Spalacidae	East African Root-Rat	Bamboo forest, arable land, garden	1 BA, 11 KDA GH	as <i>Tachyoryctes splendens</i> s.l. widespread	LC	-	maybe endemic species
At 8, At 10, At 15, At 16, At 19, At 23, At 31, At 37, At 42,	<i>Lophuromys flavopunctatus</i> s.l.	Muridae	Brush-furred mouse	Bamboo forest, arable land, riverine habitats, wetland	1 BA, 4 AW, 8 GO-wet, 9 GO-riv	widespread	LC	-	maybe endemic species
At 21, At 24, At 48	<i>Otomys cf. typus</i>	Muridae	Ethiopian Vlei Rat	Bamboo forest, wetland	1 BA, 8 GO-wet	Ethiopia + Eritrea	LC	-	Ethiopia + Eritrea
At 7, At 13, At 14, At 18, At 20, At 27, At 28, At 29, At 30, At 34, At 35, At 36, At 43, At 44, At 49, At 50, At 51, At 52, At 53, At 54	<i>Stenocephalemys albipes</i>	Muridae	Ethiopian meadow rat	Bamboo forest, montane forest, wetland	1 BA, 4 AW, 8 GO-wet, 9 GO-riv	Ethiopia + Eritrea	LC	-	Ethiopia + Eritrea

No.	Scientific Name	Family	English name	Habitat/ Forest Type	Study sites	Distribution	IUCN Threat Status	CITES Appendix	Endemism
At 1, At 9, At 11, At 12, At 17, At 22, At 32, At 33, At 38, At 45, At 46, At 47	<i>Mus (Nannomys) mahomet</i>	Muridae	African pigmy mouse	Bamboo forest, arable land, wetland	1 BA, 11 KDA GH	Ethiopia	LC	-	Ethiopia
At 40	<i>Dasymys cf. incomptus</i>	Muridae	African Marsh Rat	wetland	8 GO-wet	widespread	LC	-	maybe endemic species
No no. observation	<i>Heterohyrax brucei</i>	Procaevidae	Yellow spotted hyrax	Bamboo forest	1 BA	widespread	LC	-	-

Table 2: Species at sample sites recorded during the Biodiversity Assessment in Kafa Biosphere Reserve (only rodents and shrews)

Species / sample site	<i>Crocidura olivieri</i>	<i>Tachyoryctes splendens</i> s.l.	<i>Lophuromys flavomaculatus</i> s.l.	<i>Otomys cf. typus</i>	<i>Stenocephalemys albipes</i>	<i>Mus (Nannomys) mahomet</i>	<i>Dasymys incomptus</i> s.l.	Number of species
Bamboo forest, camp site north of road		+	+		+	+		4
Bamboo forest, camp site south of road		+	+	+	+	+		5
Bamboo forest, arable land / forest edges 3 km north of camp site		+	+		+	+		4
Ufa montane forest			+		+			2
Gumi river floodplain								-
Wetland, 8 GO-wet			+		+	+		3
Gimbo river, 9 GO-riv			+		+	+		3
Border arable land / forest south of campsite in wetland Gimbo river	+		+	+	+	+	+	6
Area of NABU guesthouse Bonga 11 KDA GH		+				+		2

Table 3: Morphological data of registered species at Kafa.

Genus	Species	Date	Field-No	Locality	Gazeteer	Sex	HB	T	HF	Ear	Weight	Remarks
<i>Mus (Nannomys)</i>	<i>mahomet</i>	04.12.2014	At 1	NABU Guesthouse, Bonga, 1.756 m ü NN	07°15'01``N, 36°15'15``E	♀	73,5	53	14	12		
<i>Tachyoryctes</i>	<i>cf. splendens</i>	05.12.2014	At 6	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14'25``N, 36°27'08``E	♀	238	82	32	16	405	lactating
<i>Stenocephalemys</i>	<i>albipes</i>	05.12.2014	At 7	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14'25``N, 36°27'08``E	♀	130	146	28,7	20,7	62	n.p.
<i>Lophuromys</i>	<i>flavopunctatus</i> (s.l.)	04.12.2014	At 8	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14'25``N, 36°27'08``E	♂	124	74	21	19,5	49	testes abdominal
<i>Mus (Nannomys)</i>	<i>mahomet</i>	04.12.2014	At 9	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14'25``N, 36°27'08``E	♀	60	45	13,2	10,5	4	juvenile
<i>Lophuromys</i>	<i>flavopunctatus</i> (s.l.)	04.12.2014	At 10	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14'25``N, 36°27'08``E	♀	125		22	20,5	55	
<i>Mus (Nannomys)</i>	<i>mahomet</i>	04.12.2014	At 11	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14'25``N, 36°27'08``E	♀	68	53	14	11,2	12	
<i>Mus (Nannomys)</i>	<i>mahomet</i>	04.12.2014	At 12	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14'25``N, 36°27'08``E	♀	86	52	14	11	15	
<i>Stenocephalemys</i>	<i>albipes</i>	04.12.2014	At 13	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14'25``N, 36°27'08``E	♀	140	176	28	21,8	65	lactating, Cestodes
<i>Stenocephalemys</i>	<i>albipes</i>	04.12.2014	At 14	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14'25``N, 36°27'08``E	♀	131,5	173,5	27	20,8	66	gravid 6/7
<i>Lophuromys</i>	<i>flavopunctatus</i> (s.l.)	04.12.2014	At 15	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14'25``N, 36°27'08``E	♀	122,5	75,5	20	16	48	not reproductive
<i>Lophuromys</i>	<i>flavopunctatus</i> (s.l.)	04.12.2014	At 16	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14'25``N, 36°27'08``E	♂	124,5	72,5	21	17	49	testes abdominal

Genus	Species	Date	Field-No	Locality	Gazeteer	Sex	HB	T	HF	Ear	Weight	Remarks
<i>Mus (Nannomys)</i>	<i>mahomet</i>	04.12.2014	At 17	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14`25``N, 36°27`08``E	♀	76	52	12,8	10		
<i>Stenocephalemys</i>	<i>albipes</i>	04.12.2014	At 18	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14`25``N, 36°27`08``E	♀	136	157	27,8	22,2	67	testes active 17 X 10 mm
<i>Lophuromys</i>	<i>flavopunctatus (s.l.)</i>	04.12.2014	At 19	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14`25``N, 36°27`08``E	♀	130		22,2	17,3	49	
<i>Stenocephalemys</i>	<i>albipes</i>	04.12.2014	At 20	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14`25``N, 36°27`08``E	♀	127	160	28,7	22,4	48	
<i>Otomys</i>	<i>cf. typus</i>	04.12.2014	At 21	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14`25``N, 36°27`08``E	♂	146	91	29	12,6	69	subadult
<i>Mus (Nannomys)</i>	<i>cf. mahomet</i>	04.12.2014	At 22	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14`25``N, 36°27`08``E	♀	68	51	15	10,9	12	
<i>Lophuromys</i>	<i>flavopunctatus (s.l.)</i>	06.12.2014	At 23	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14`25``N, 36°27`08``E	♀	118	70	12	18,3	45	
<i>Otomys</i>	<i>cf. typus</i>	06.12.2014	At 24	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14`25``N, 36°27`08``E	♂	154	78	27			
<i>Tachyoryctes</i>	<i>splendens</i>	06.12.2014	At 25	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14`25``N, 36°27`08``E	♂	254	78	34	15	420	
<i>Tachyoryctes</i>	<i>splendens</i>	06.12.2014	At 26	Bamboo Camp SW` Bolla, near Bonga, 2.593 m üNN	07°14`25``N, 36°27`08``E	♂	237	70	34,5	11,5	363	
<i>Stenocephalemys</i>	<i>albipes</i>	08.12.2014	At 27	Ufa Forest SE` Chi`ri, S`Bonga, 1.448 m üNN	07°05`34``N, 36°13`27``E	♀	89	103	22	18	24	
<i>Stenocephalemys</i>	<i>albipes</i>	08.12.2014	At 28	Ufa Forest SE` Chi`ri, S`Bonga, 1.448 m üNN	07°05`34``N, 36°13`27``E	♂	131	176	27	22	76	testes active 15 X 9,5 mm
<i>Stenocephalemys</i>	<i>albipes</i>	08.12.2014	At 29	Ufa Forest SE` Chi`ri, S`Bonga, 1.448 m üNN	07°05`34``N, 36°13`27``E	♂	137	177	27	22,8	82	testes active 15,8 X 10 mm

Genus	Species	Date	Field-No	Locality	Gazeteer	Sex	HB	T	HF	Ear	Weight	Remarks
<i>Stenocephalemys</i>	<i>albipes</i>	08.12.2014	At 30	Ufa Forest SE´ Chi´ri, S´Bonga, 1.448 m üNN	07°05´34``N, 36°13´27``E	♂	138	184	27		84	testes active 14 X 10 mm
<i>Lophuromys</i>	<i>flavopunctatus</i> (s.l.)	08.12.2014	At 31	Ufa Forest SE´ Chi´ri, S´Bonga, 1.448 m üNN	07°05´34``N, 36°13´27``E	♂	135	91	22	19	22	testes active 11,5 X 9 mm
<i>Mus (Nannomys)</i>	<i>mahomet</i>	10.12.2014	At 32	Gojeb Wetland, Meda Abo, Gewata, NW´ Bonga, 1531 m üNN	07°33´50``N, 36°03´06``E	♀	79	47		12,5	10	gravid 3/3
<i>Mus (Nannomys)</i>	<i>mahomet</i>	10.12.2014	At 33	Gojeb Wetland, Meda Abo, Gewata, NW´ Bonga, 1531 m üNN	07°33´50``N, 36°03´06``E	♀	83,5	51,5	13	12,7		gravid 3, CR- length 18,2 mm
<i>Stenocephalemys</i>	<i>albipes</i>	10.12.2014	At 34	Gojeb Wetland, Meda Abo, Gewata, NW´ Bonga, 1531 m üNN	07°33´50``N, 36°03´06``E	♀	133	180	27		50	lactating
<i>Stenocephalemys</i>	<i>albipes</i>	10.12.2014	At 35	Gojeb Wetland, Meda Abo, Gewata, NW´ Bonga, 1531 m üNN	07°33´50``N, 36°03´06``E	♂	124		27	22	44	testes active 15 X 8 mm
<i>Stenocephalemys</i>	<i>albipes</i>	10.12.2014	At 36	Gojeb Wetland, Meda Abo, Gewata, NW´ Bonga, 1531 m üNN	07°33´50``N, 36°03´06``E	♂	123	154	28	22,5	42	testes active 16,5 X 9 mm
<i>Lophuromys</i>	<i>flavopunctatus</i> (s.l.)	10.12.2014	At 37	Gojeb Wetland, Meda Abo, Gewata, NW´ Bonga, 1531 m üNN	07°33´50``N, 36°03´06``E	♂	143	80	23	18,7	46	testes active 17 X 10,5 mm, Nematodes
<i>Mus (Nannomys)</i>	<i>mahomet</i>	10.12.2014	At 38	Gojeb Wetland, Meda Abo, Gewata, NW´ Bonga, 1531 m üNN	07°33´50``N, 36°03´06``E	♀	79		14	11,5	8	gravid 3/3
<i>Crocidura</i>	<i>olivieri</i>	10.12.2014	At 39	Gojeb Wetland, Meda Abo, Gewata, NW´ Bonga, 1531 m üNN	07°33´50``N, 36°03´06``E	♀	119	86	20	12,3	20	lactating, Cestodes
<i>Dasymys</i>	<i>cf. incomtus</i>	11.12.2014	At 40	Gojeb Wetland, Meda Abo, Gewata, NW´ Bonga, 1531 m üNN	07°33´50``N, 36°03´06``E	♀	112	106	27	19,2	50	subadult, n.p., stomach contains only vegetables, no insects

Genus	Species	Date	Field-No	Locality	Gazeteer	Sex	HB	T	HF	Ear	Weight	Remarks
<i>Crocidura</i>	<i>olivieri</i>	11.12.2014	At 41	Gojeb Wetland, Meda Abo, Gewata, NW' Bonga, 1531 m üNN	07°33'50"N, 36°03'06"E	♂	131	86	20	13	32	
<i>Lophuromys</i>	<i>flavopunctatus</i> (s.l.)	11.12.2014	At 42	Gojeb Wetland, Meda Abo, Gewata, NW' Bonga, 1531 m üNN	07°33'50"N, 36°03'06"E	♂		76	22	19,2	66	
<i>Stenocephalemys</i>	<i>albipes</i>	11.12.2014	At 43	Gojeb Wetland, Meda Abo, Gewata, NW' Bonga, 1531 m üNN	07°33'50"N, 36°03'06"E	♂	129	174	27	22	74	testes active
<i>Stenocephalemys</i>	<i>albipes</i>	11.12.2014	At 44	Gojeb Wetland, Meda Abo, Gewata, NW' Bonga, 1531 m üNN	07°33'50"N, 36°03'06"E	♂	130	171	28	21,5	76	testes active
<i>Mus (Nannomys)</i>	<i>mahomet</i>	11.12.2014	At 45	Gojeb Wetland, Meda Abo, Gewata, NW' Bonga, 1531 m üNN	07°33'50"N, 36°03'06"E	♀	88,5	53	14	11	8	
<i>Mus (Nannomys)</i>	<i>mahomet</i>	11.12.2014	At 46	Gojeb Wetland, Meda Abo, Gewata, NW' Bonga, 1531 m üNN	07°33'50"N, 36°03'06"E	♂	72,5	47,5	14	12	7,5	
<i>Mus (Nannomys)</i>	<i>mahomet</i>	11.12.2014	At 47	Gojeb Wetland, Meda Abo, Gewata, NW' Bonga, 1531 m üNN	07°33'50"N, 36°03'06"E	♂	76		14,5	11,3		
<i>Otomys</i>	<i>cf. typus</i>	11.12.2014	At 48	Gojeb Wetland, Meda Abo, Gewata, NW' Bonga, 1531 m üNN	07°33'50"N, 36°03'06"E	♀	158		29	20,5		mammae active, gravid 1/0
<i>Stenocephalemys</i>	<i>albipes</i>	11.12.2014	At 49	Gojeb Wetland, Meda Abo, Gewata, NW' Bonga, 1531 m üNN	07°33'50"N, 36°03'06"E	♀	120	156	25,5	20,5		
<i>Stenocephalemys</i>	<i>albipes</i>	11.12.2014	At 50	Gojeb Wetland, Meda Abo, Gewata, NW' Bonga, 1531 m üNN	07°33'50"N, 36°03'06"E	♂	141	170	30,5	24,3		testes active
<i>Stenocephalemys</i>	<i>albipes</i>	11.12.2014	At 51	Gojeb Wetland, Meda Abo, Gewata, NW' Bonga, 1531 m üNN	07°33'50"N, 36°03'06"E	♀	123	156	26,3			
<i>Stenocephalemys</i>	<i>albipes</i>	11.12.2014	At 52	Gojeb Wetland, Meda Abo, Gewata, NW' Bonga, 1531 m üNN	07°33'50"N, 36°03'06"E	♀	133	171	27	22,2		
<i>Stenocephalemys</i>	<i>albipes</i>	11.12.2014	At 53	Gojeb Wetland, Meda Abo, Gewata, NW' Bonga, 1531 m üNN	07°33'50"N, 36°03'06"E	♀	132	174	27,2	24,2		

Genus	Species	Date	Field-No	Locality	Gazeteer	Sex	HB	T	HF	Ear	Weight	Remarks
<i>Stenocephalemys</i>	<i>albipes</i>	11.12.2014	At 54	Gojeb Wetland, Meda Abo, Gewata, NW´ Bonga, 1531 m üNN	07°33´50``N, 36°03´06``E	♂	132		27	23,3		parasited by a fly larva (warble fly) under the headskin, Oestromyia
<i>Crocidura</i>	<i>olivieri</i>	11.12.2014	At 55	Gojeb Wetland, Meda Abo, Gewata, NW´ Bonga, 1531 m üNN	07°33´50``N, 36°03´06``E	♀	128	94	21	10,5	34	
<i>Lepus</i>	<i>cf. fagani</i>	11.12.2014	no no.	Gojeb Wetland, Meda Abo, Gewata, NW´ Bonga, 1531 m üNN	07°33´50``N, 36°03´06``E							roadkill, only peace of fur
<i>Mus (Nannomys)</i>	<i>mahomet</i>	12.12.2014	no no.	NABU Guesthouse, Bonga, 1.756 m ü NN	07°15´01``N, 36°15´15``E	♂						

♂ - male; ♀ - female, HB – head and body, T – Tail, Hf – hind foot, Measurements except in Weight in millimetres, Weight in grams