Small terrestrial mammal and amphibian survey Boé region, Guinea-Bissau

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Introduction

Because of its isolated location the Boé region in the southeast of Guinea-Bissau has been left untouched by large scale human influences and development. The region has natural habitats for chimpanzees in West-Africa. The biodiversity in the area is high and Chimbo foundation is working on getting a protected status for the area.

Reports about presence and distribution of small terrestrial mammals and amphibians Guinea Bissau in general and in the Boé specifically are scarce (*Auliya et. al., 2012*). The *IUCN Red List database* (2013) sums up a total of at least 25 species of small mammals and 15 species of amphibians for Guinea-Bissau. According to *Mammals Worldwide* (2013) there could be many more species of mammals present in the area.

For amphibians, the largest online encyclopedia, *Amphibiaweb* (2013), speaks of at least 40 species that are possibly present in Guinea-Bissau. Therefore, species inventories and distribution surveys could reveal very valuable and new information about the presence of small terrestrial mammals and amphibians. There is a real chance to discover species that are new for the region or even new for science. And with this information the need for protecting the area could be very well emphasized.

In January 2013 a proposal was made by Silvavir forest consultants to Chimbo foundation to carry out a survey for small terrestrial mammals and amphibians. Initially capturing bats in mistnets was also part of the proposal but we decided that due to many diseases that bats cary in West Africa this was not safe enough to include in the survey.

The survey was granted and carried out during three weeks in October 2013 in the surroundings of Beli, the main village of the Boé region. With regard to the targets (see Chapter two) the surveys were handed over to and continued by volunteer biologists and students that came to Beli sequentially. In the initial monitoring set up of the proposal the research locations should have been surveyed for one calendar year.

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This report was created on behalf of the Chimbo Foundation by Silvavir Forest Consultants in Arnhem, The Netherlands. The field surveys took place around the village of Beli in the Boé area, Guinea-Bissau. Maps have been produced by Silvavir using GIS software and the preliminary studies of animal specimens were conducted at Naturalis Biodiversity Centre in Leiden, The Netherlands.

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Targets

This research project aims to support the purpose of conservation and reduction of poverty in the Boé region:

Nature conservation

Chimbo has set up a research station with the aim of researching and conserving the biodiversity in the Boé. Proper knowledge of the various habitats and current status and trends in biodiversity are essential. Therefore additional surveys and monitoring schemes need to be set up. Adequate financial resources, availability of research materials, researchers, a biodiversity database, structural collection of data, and local knowledge (training local people as assistants) are key to the set up of a broad ranged research station in which various species groups can be surveyed.

This survey is one with which a great deal of knowledge about local biodiversity and project management can be obtained. By continuing this survey with help of students, volunteers or staff the possibilities and feasibility of different research methods and species groups can be explored more extensively. The collected data could lead to define different conservation management strategies needed. Training of local people to become field assistants contributes to the local awareness and knowledge about the need for protection of the environment.

Eco tourism

There is global tourism growth and therefore perspective for the Boé. Chances of getting mainstream tourism to Guinea-Bissau are very slim and the political situation is too instable to offer the right perspective on the short term. Tourism in the Boé has high potential; however focus has to lie on specific low threshold groups like eco-volunteers and biologists.

Eco-volunteers contribute actively to international conservation. For them participation in a relatively easy monitoring survey could be one of the activities of their holiday to the Boé. Alternatively there are eco-volunteers that are specialized in species groups like mammals, bats, birds, reptiles and amphibians. For them it could be a challenge to come to the Boé to discover new species. Chimbo and Daridibó offer eco-volunteers the facilities and guidance for a unique experience in the Boé. With targeted marketing the mentioned eco-volunteers will be approached.

Eco-volunteers offer opportunities for economic development. Tourist will have to be fed and housed, providing work and clientele for shops, cooks and housekeepers. They will also need guidance and assistance from locally trained nature guides or field work assistance. Furthermore their contribution to the project will provide financial benefits to Chimbo that can be invested into the project.

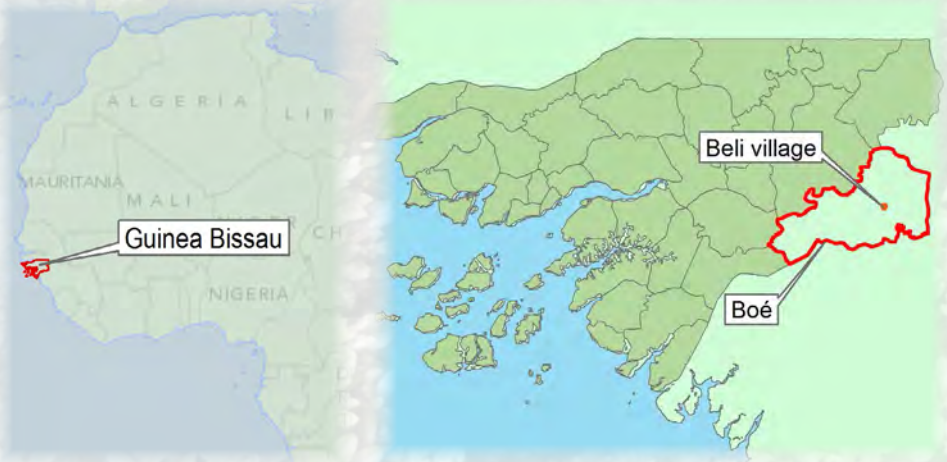
Poverty reduction
The chances for economic development in the Boé region are limited. The local population is largely illiterate and especially dependent on small scale agriculture on over-used farmlands. Chimbo and her local sister-organisation Daridibó are looking for alternative resources. Targets that are described above will help create employment for local inhabitants and increase sales in local shops.

Guinea-Bissau and Boé region

The Boé region is an area of about 3200 km² in the south-east of Guinea-Bissau. The accessibility of the region is limited by poor infrastructure and the 200m wide Rio-Corubal. Because the area is so isolated, it is relatively unaffected by human interference which creates favorable values for natural conservation.

The region is in the tropical savanna climate zone with daytime temperatures between 30ºC and 40ºC, during the night temperatures will drop between 10ºC and 23ºC. The dry season starts in November and lasts until May, during this time precipitation is very low, whilst the rainy season is extremely wet and accessibility is further limited by puddles and gulley's.

The region is the north-western spur of the Fouta Djallon highland region which consists mainly of massive plateaus and rolling savanna areas that are intersected by shallow river valleys. The savanna vegetation consist of high grassy vegetation in the wet season that disappears because of drought in the dry season. The savanna is interspersed with forest corridors. These gallery forests provide suitable habitat for amphibian and mammal species otherwise restricted to tropical rainforest elsewhere in West Africa (*Greenbaum & Carr, 2005*).



Survey location selection and description

Five locations were chosen for trapping with a spacing of about one km between them. The aim is to survey small terrestrial mammals and amphibians in representative natural habitats in different biotopes in the surrounding area of Beli village. Therefore two locations were selected in a savanna biotope, two were selected in a forest corridor and one site was located in an overgrown abandoned agricultural rice field. These sites were located at a distance close to the village so that logistics (research sites were reached by bicycle) could be planned responsibly.

South of Beli a sixth location was added later solely for amphibian pitfalls. No live traps were placed here. No data or description is available from it during wet season (*Cabuy, 2014*).

Location 1 (see photo below);
A savanna biotope, the area is covered with tall grassy vegetation in the wet season. The location is bordered by a small gallery forest on the south side, comprised of tall shrubs and some small trees. The soil consists of red clay, mixed with coarse gravel and large rocks. The infiltrating capacity of the soil is very low.

Coordinates in decimal degrees (WGS'84):
11,8612370 dd. -13,9371810 dd.

Location 2 (see photo below);
An abandoned agricultural field, used for dry rice production. The field is overgrown with low shrubs and tall bunches of grass. The soil consists of sand and organic materials, mixed with clay. The infiltrating capacity of the soil is reasonable.

Coordinates in decimal degrees (WGS'84):
11,8688910 dd. -13,9386090 dd.

Location 3 (see photo below);
A savanna biotope, the area is covered with tall grassy vegetation in the wet season. The location is bordered by a small gallery forest to the east, which is comprised of tall shrubs and some trees. On the west side the location is bordered by a small, slow flowing stream. The soil consists of red clay, mixed with coarse gravel and large rocks. The infiltrating capacity of the soil is very low.

Coordinates in decimal degrees (WGS'84):
11,8767270 dd. -13,9366700 dd.

Location 4 (see photo below);
A larger gallery forest in a savanna area. The area is covered by tall trees and shrubs. Halfway the transect, the forest is cut by a seam of very high grass. The soil consists of red clay and organic materials. The infiltrating capacity of the soil is reasonable.

Coordinates in decimal degrees (WGS'84):
11,8817920 dd. -13,9376400 dd.

Location 5 (see photo below);
A larger gallery forest amid the savanna area. The area is covered by tall trees and shrubs. Vegetation is very dense with a lot of thorny shrubs The soil consists of red clay and organic materials. The infiltrating capacity of the soil is reasonable.

Coordinates in decimal degrees (WGS'84):
11,8872000 dd. -13,9333500 dd.

Research methods

Amphibians

Many West African surveys show that pitfalls work well for trapping amphibians (*Santoni, 2000; Razetti & Msuya, 2002; Rödel & Bangoura 2004; Greenbaum & Carr, 2005; Leaché et. al., 2006; Kouamé et. al., 2007; Hillers & Rödel, 2007*). On the five selected locations pitfall traps were installed in combination with associated drift fences. The drift fences consist of a plastic fence that is about 40cm high. Along the fence buckets were dug in at a spacing of five meters. Small terrestrial animals will walk along the fence in order to get around the obstruction. When they encounter a bucket, they will fall in and will not be able to get out on their own (*Rödel et. al., 2005*).

Assembly

On a straight line, five 10 litre buckets were dug in at a spacing of five meters. To ensure drainage, the holes for the buckets were dug about 20 cm deeper than the bottom of the bucket. All buckets were covered with a lid in which a hole was cut in the middle, so that a three to four cm wide ring along the rim of the bucket remained when the lid was on. This ring prevents animals climbing back out from the inside along the side of the bucket once they are caught.

The round pieces of plastic that were cut from the lid were kept in order to close the buckets completely off when the traps were not in use. In order to be able to close the pitfalls, small crossbeams were attached to the cut-outs from the lids. This was done to make sure that the cut-outs wouldn't fall into the buckets.

The bottoms of the buckets were perforated to drain excess of rainwater. Furthermore, a medium sized rock was put in the bucket for shelter or refuge. For this project emptied sauce-buckets were used, which can easily be bought on the markets of Gabu and Bissau.

A wooden stake was placed right beside every bucket. In the space between the buckets three more stakes were evenly spaced. The stakes measure about 80 cm in length and have a diameter of about 10 cm. One end of the stake was cut into a point and was hammered about 30 centimetres into the ground. Stakes are made from local wood with a reasonable durability.

Agricultural plastic foil with a width of 50cm was fastened onto the stakes with staples using a tacker. It was installed in such a manner that the foil runs straight across the middle of the pitfall buckets. The foil is 40 cm in height, and a seam of 10 cm drapes over the ground, this seam is covered with soil so that animals cannot crawl underneath the drift fence. The foil was cut straight above the bucket-holes in order to create a gap in the fence that makes the bucket accessible from both sides. To make sure that animals would not get "stuck" in the corners between the fence and the stakes, these corners were also filled up with soil. Bucket-rims that were sticking out of the ground due to stony soils were filled up with dirt around the edges making the pitfalls readily accessible.

All pitfall traps were opened for trapping by removing the cut-outs from the lids of the pitfalls on Sunday afternoon. Every week 10 checks were being performed simultaneously with the checks of the Sherman and Heslinga live traps (see page 14). The traps were checked during daylight; every morning as soon after sunrise as possible and every afternoon as short before sunset as possible. In this way captured animals were not trapped longer than 12 hours. Nightly survey checks in these wild remote parts of Guinea-Bissau were considered unsafe. Traps were closed for the weekend by replacing the cut-outs from the lids on Friday mornings.

Captured animals were documented and photographed in the field and released on site. In the case a species was found that had not been trapped before, the specimen was taken along for further determination at the office in Beli. Various sources were consulted for species determination (*Schiøts, 1999; Rödel, 1996, Preez & Carruthers, 2009*). After determination, these animals were released at the same location on the next pitfall check. Animals that were un-identifiable with the use of the present literature were euthanized and put in 70% alcohol for further determination in the Netherlands. See chapter “Workprotocol Live traps and pitfall traps” on pages 20-21 for detailed protocol on trapped animals.

Below is a list with the characteristics that were documented per species:

Record ID	Description	Tympanum diameter	Upper-Eye horns
Species	Colour pattern	Eye diameter	Webbing formula
Location	Weight	Nose-Eye length	Genus
Date	Foot+Tarsus length	Nose-Snout length	Time of day
Catch number	Shank length (tibia)	Vocal sac / Gular flap	Weather
Record number	Thigh length	Skin / Warts	Trap number
State of catch	Snout-vent length	Paratoid glands	Trap type
Biotope	Head width	Tubercles	Other remarks

Mammals

To maximize trapping probability of the different species of small terrestrial mammals in the Boé, a combination of Sherman live traps and Heslinga live traps (see figures below) were used. The Heslinga traps are basically a remake by a Dutch company of the Longworth live trap, which has proven to be effective for more than 70 years. Both Longworth and Sherman live traps have been the international standard for small terrestrial mammal surveys (*Decher, 2004; 2007; Decher et. al., 2006; Nicolas & Colyn, 2006; Weber & Fahr, 2007; Anadu, 2008; Fichet-Calvet et. al., 2009; Hoffmann et. al., 2010; Manu 2011*). In addition to metal live traps, the pitfalls that were used primarily for the amphibian survey are known to catch shrews. For a description of methodology and use of pitfalls, see pages 10-13.

Sherman live trap

Heslinga live trap

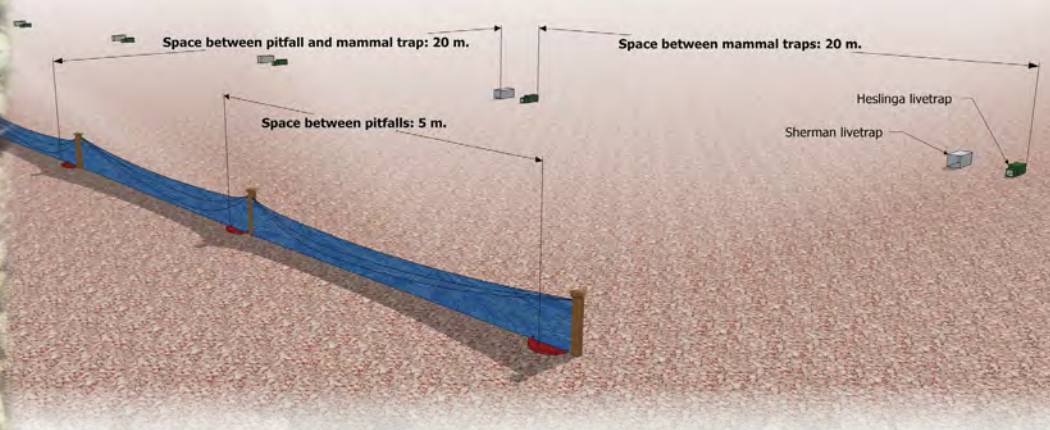
Research methods

The small terrestrial mammal survey in Beli was executed according to the Dutch standard IBN method for live trapping (*Bergers, 1997; Koelman, 2007*).

The metal live traps were filled with bait consisting of: 1. Apple, 2. A mixture of peanutbutter and flour or oats and 3. Dried fish.The traps were also filled with dried grassy vegetation that was gathered locally and used by caught animals as nesting material. Both bait and hay were replaced after every individual catch and refreshed for all traps at least every week. In practice all traps were re-baited every Monday morning.

Placement of the traps

The metal live traps were placed on each location about 20 meters parallel to the pitfall traps in a line with a pair of live traps every 20 metres. One pair of traps consists of one Heslinga live trap and one Sherman live trap. In total twenty individual traps were placed in ten pairs per location. Heslinga's were placed on the ground because they generally work well in catching the smaller lighter species like shrews or young terrestrial animals. Sherman live traps are bigger and were fixed on large horizontal limbs of trees with wire to catch arboreal mammals like dormice and small squirrels. All individual trap locations were marked with flag of white paper tape to indicate their location. The first and last pair was indicated with a double tape flag.



Checking traps
The trapping schedule runs ongoing from Sunday evening (setting traps active) to Friday morning (setting traps to safe). Every week 10 checks were being performed simultaneously with the checks of the pitfall traps. Time of checks were: First, at dawn, as shortly as possible after sunrise and Second, at dusk, as shortly as possible before sunset. The schedule makes sure that on average most animals remain inside the traps as short a period as possible. This minimizes stress and possible casualties amongst the trapped animals. Furthermore, the researchers will not have to go into the bush at night time in this remote part of Guinea-Bissau which reduces risks.

In the dry season outside air temperatures are very high. Therefore, from the beginning of February, traps were set to safe after the morning check and reactivated in the evenings (*van Montfort, 2014*).

Handling animals
Whenever an animal was caught in one of the traps it was being transferred to a large transparent plastic bag by putting the trap inside it and carefully opening and pulling out the contents of the trap. Once the animal was transferred to the plastic bag first the animal was positioned into the corner of the bag and then with its head into a small plastic tube. The tube was closed with cotton on one side so the animal is now contained inside the tube for species determination and measurements. This tubing method is less stressful for the animal and the researcher, and especially recommended for use by inexperienced persons. (*Hoffmann et. al., 2010*).

Data collection
If the species could not be determined in the field the animal was transported to a plastic container in which hay and bait was placed beforehand. The container was taken back to the office for further determination and measurements.

At the office the animal was transferred back to the tube via the handling bag. The animal was weighed, and length of body, tail, hind foot, front foot and ear were being measured. Whenever possible the life stage and gender was determined as well as whether an animal was pregnant or lactating. All data were documented in the datasheet '20151031_Mammalia_Amfibia_Datasheet_Mastersheet.xls' (Appendix I).

Every animal gets a unique code (a record id) for example: ML3131017001

A or M	A for Amphibia or M for Mammalia
L or P	L for live traps or P for Pitfall
Number 1-10	trapnumber
Date	format 131017 for 17th october 2013
Number 001-999	catchnumber of the day 001

By more experienced people the animals are best grasped by the skin in the neck using the method described by *Hoffmann et. al., 2010*. At least head, tail, ear and side view were clearly photographed. All pictures were organized and documented by changing their filenames to the animals' record id given to the individual as described on page 17. Fur on the base of the tail was clipped so that in possible future catches the animal could be recognized as a re-catch. Animals that were caught repeatedly in which the hair has grown back were clipped again.

An intensive effort was made to determine the species of the animal using the species identification table "20131106_IdentificationTable_SmallMammals_Boe.xls" (see Appendix II). In this table characteristics can be found of small terrestrial mammal species that are known to occur in Guinea-Bissau or neighboring countries according to different publications (*Happold & Happold, 2012; IUCN Red List database, 2014)*. Other sources were also consulted (*Booth, 1960; Rosevaer, 1965 ; Hutterer & Happold, 1983; de Visser et. al., 2001*)

Whenever a species was determined successfully it was kept inside a cage with adequate food and nesting material. On the next trap check the animal was released at the exact same spot where it was caught. However, correct identification and species assignment for African small mammals requires the collection and export of voucher specimens (*Nippon Koei UK, 2007*).

If determination of the species did not succeed it was collected as a voucher species for further analysis. If specimens are to be made permanently immune to decomposition it is necessary that liquid preservatives are introduced into the body as short as possible after the animal has been killed (*Etheridge, 1996*). The animal was euthanized and preserved by injecting formaldehyde into the body with a syringe. Afterwards the voucher species was submerged into ethyl alcohol in a closed container. A maximum of three voucher specimens per undetermined species were collected this way. Every individual specimen was stored in its own small plastic container and was clearly labeled with its record id and brought to the Netherlands for further analysis. All specimens collected are stored in the collection of Naturalis Biodiversity Centre as voucher specimens.

Risks and precautions

Other than the Dutch standard IBN method (*Bergers, 1997; Koelman 2007*) for checking life traps, traps were not checked during the dark hours of the night. Fieldwork was always conducted by at least two persons. Two local field guides were trained and acted as assistants to the researchers.

Small terrestrial mammals in Guinea-Bissau can carry zoonosis which can be transferred to humans are cause potential health hazards. It is essential that bites and scratches are avoided and contact with excretions is minimized. Safety gloves are to be worn at all times.

Work protocol live traps and pitfall traps

A. A new individual is caught:

- If a new individual is caught and the species can be determined in the field, measure, weigh and sex the animal in the field and mark mammals by clipping hair at the base of the tail.
- Fill in all the recorded data in: “20131201_Mammalia_Amfibia_Datasheet_Mastersheet.xls”
- Take photographs of all relevant characteristics of the species
- Name the photographs by editing the file name and turning them into record id of the specimen
- The animal can now be released at the spot

B. (presumably) new species is caught:

- Put the animal in a temporary cage
- Write down the unique record id of the animal on a temporary label on the cage
- Take the animal back to the office for measuring and recording
- Measure, weigh and sex the animal and fill in all fields on the “20131201_Mammalia_Amfibia_Datasheet_Mastersheet.xls”
- Take photographs of all relevant characteristics of the species
- Name the photographs by editing the file name and turning them into record id of the specimen
- Consult relevant literature and try to determine species:

B1. The species cannot be determined:

- o Euthanize the animal by injecting a small quantity (10-25 ml) formaldehyde into its abdomen. If the animal is large also inject its limbs after death.
- o Preserve the animal by putting it in a container, filled with in alcohol. It has to be completely submerged
- o Label the pot well with a permanent sticker with at least date, location and unique record id linking it to all the info on the master datasheet.

B2. The species can be determined:

- o If mammal mark the animal by clipping hair at the base of the tail
- o Put the animal back into the temporary cage and cover it with a cloth
- o At the next round of fieldwork take the animal to the original location
- o Always release the animal on the exact spot where it was caught

C. A re-catch of an already caught and marked individual:

- Check for any abnormalities and determine species
- Make sure the clippings are clear enough, possibly re-clip fur
- The animal can now be released at the spot

Results

Amphibians

A total of 75 individuals were trapped between 6th of October 2013 and the 10th of June 2014. When the survey was executed by Tom Cabuy the work protocol for amphibians was not for 100% followed and some additional capturing methods were introduced (*Cabuy, 2014*). Species determination was done with "140121_Ampfibiegids_met_sleutel.pdf" (see Appendix III) which was compiled from several sources (*Preez, 2009; Rödel, 1996; Santoni, 2007; Schiøtz, 1999*). Some pictures of observations in the area made by others were given to us. This resulted in one new species that was added to the results (*Phrynomantis microps*). The specimens can be subdivided in twenty different species which have all been given the status 'Least Concern' by the IUCN Red List Database (2013).

Afrixalus fulvovittatus

A medium-sized *Afrixalus* species (males 23–27 mm snout-vent length, females 25–28 mm) from the savanna and bushland areas. The dorsum is dark brown with three regular light stripes of equal width running lengthwise from head to vent. It is common in the northern half of Africa.

Amietophrynus xeros

A medium-sized toad with a wide, rounded snout. Males reach 52–85mm snout-vent length, females 55–88 mm. The back is cream or chocolate-brown with six pairs of symmetrical dark spots. They have reasonably well defined kidney-shaped paratoid glands above the tympanum. Warts are reasonably fine. This toads can inhabit very arid areas and is extremely abundant in Beli.

Arthroleptis poecilonotus

This small ranid like frog has a snout-vent length of 19-27mm, color varies from light-beige to copper red. Most specimens bear a dark hourglass shaped pattern on the dorsum. The toes have no webbing, males often have a elongated third finger. This species inhabits moist savannahs and gallery forests.

Bufo pentoni

A very robust toad without dorsal pattern. Has large paratoid glands and well developed tarsal tubercles. It has strong frontlegs and small hindlegs. Colour is olive green with small orange-red spots, skin is covered with small smooth warts. Males achieve 54–74 mm (snout-vent length), females 58–95 mm. This species is found mostly on sandy soils of riverbanks, semi-arid savannahs and cultivated lands.

Hyperolius occidentalis

A medium sized treefrog, measuring between 19 and 34 mm that inhabits the bushlands of Western Africa. It has a green dorsum which may have a darker hourglass pattern. Toes and thighs are reddish and this species has horizontal pupils. Toes and fingers have circummarginal disks.

Hoplobatrachus occipitalis

A large ranid (52-104mm snout-vent length) with severall broken ridges on the dorsum and a very slippery skin. Large protruding eyes at the topside of the head. Topside is olive green with dark spots, the belly is cream with dark spots. Full webbing on toes and fingers. The lower jaw contains fanglike projections. This frog is extremely abundant and inhabits riverbanks, ponds and road-puddles.

Kassina fusca

A ground dwelling treefrog species that reaches between 29 and 33 mm with a round hard nose and vertical pupils. It is the only Kassina species that has a brownish color. Dorsum has a spotted pattern that can link into an X shape in the shoulder region. Found in moist savannah regions and partly flooded meadows.

Leptopelis viridis

A medium sized treefrog that measures 33-48mm. It is light-brown with a smooth skin and yellowish eyes with vertical pupils. It has a clear visible tympanum. This species is a savannah dweller that prefers to climb.

Pseudhimenochirus merlini

A clawed frog that is water dependent and has webbings between all toes and fingers. It has a flat bodyshape and a dark black-brown color. The species is found in or near still or slow moving water as long as it is shaded. Snout-vent length is between 28 and 40 mm.

Ptychadena tournieri

A ranid with six or more unbroken dorsal ridges and a dark stripe from the snout that passes front legs. The tip of the snout is white and the base color is beige. Females reach about 43mm and males reach up to 35mm snout-vent length. Inhabits open savannahs and grassy areas.

Hyperolius concolor

A medium sized treefrog, measuring between 19 and 34mm that inhabits the bushlands of Western Africa. Color may vary from light green to brown. It is *very* similar to Hyperolius *occidentalis* which is smaller, has a shorter snout and a smaller gular flap. Horizontal pupils.

Photograph: Tom Cabuy

Hyperolius spatzi

Medium sized treefrog. The dorsum is beige-yellow and the individual has a broad head. The venter is white-yellow and the hidden parts of the hind legs are deep red colored. As with Hyperolius pupils are horizontal

Photograph: Tom Cabuy

Phrynobatrachus calcararus

Small frog (20mm), brown granular skin with black spots. The throat and venter are white with black dots. The tymnpanum is very small and almost indiscernible. This species has horizontal pupils.

Photograph: Tom Cabuy

Hildebrandtia ornata

Medium sized toad with a distinct Y-shaped pattern on the throat. A broad green vertebral band runs from the snout tip to the end of the body. The body is plump with comparable short hindlimbs and a large tympanum. It can reach up to 70 mm.

Photograph: Tom Cabuy

Ptychadena oxyrhynchus

A big ranid with a pointed snout and very long legs. Several short dorsal longitudinal ridges. The rather uniform basic color of these frogs is dark beige to olive. Numerous dark spots in the areas surrounding the dorsal ridges.

Photograph: Tom Cabuy

Ptychadena schubotzi

medium-sized ranid with long hind legs. Several rows of vaguely defined dorsal ridges, two of which stretch from the eyes to the center of the back where they gradually fade. Black spots on hindlegs and forearms.

Photograph: Tom Cabuy

Phrynomantis microps

Medium sized frog with a red back, flanks and extremities are black. It has a plump body with a blunt snout. The neck is very long which enables it to move the head from side to side. Snout to vent length; 36 to 62 mm.

Visual record, not found in pitfalls.
Photograph: Piet Wit

Table 1: The amphibian species captured during the survey.

Species	Species count
Afrixalus fulvovittatus	1
Amietophrynus xeros	6
Arthroleptis poecilonotus	7
Bufo pentoni	1
Hildebrandtia omata	2
Hoplobatrachus occipitalis	3
Hyperolius concolor	2
Hyperolius occidentalis	2
Hyperolius spatzi	4
Hyperolius spp.	2
Kassina fusca	12
Leptopelis viridis	10
Phrynobatrachus calcararus	1
Pixycephalus spp.	2
Pseudhymenochirus merlini	5
Ptychadena oxyrhynchus	5
Ptychadena schubotzi	3
Ptychadena spp.	4
Ptychadena tournieri	3

A total of 75 individuals were trapped which can be divided thirteen genera and in twenty different species. *Kassina fusca* and *Leptopelis viridis* were the two most abundant species that were trapped during this survey. The above table shows that in general not very many individuals were trapped or encountered. As most of this survey took place during the dry season a reason for this might be that species abundance and populations are smaller during this time of year.

Methodology and intensity of the amphibian survey has varied considerably over the course of the survey period and the exact number of survey days/hours are not well documented. Arboreal PVC tubes were used to attract tree frogs and were checked randomly whenever there was spare time and furthermore random visual encounters were also included (*Cabuy, 2014*). Therefore a representative species accumulation curve cannot be made. However, new species were still found towards the end of the survey period and this indicates that total species diversity has not been revealed by this survey.

Adding additional survey methods to the pitfall survey yielded considerably more results in terms of species numbers and abundance of trapped individuals but made the sequence of data unsuitable for monitoring analysis. For further information about trapped species composition per month and in different weather conditions and percentages of species and individuals per trapping method, see *Cabuy, 2014*.

Mammals

A total of 329 small terrestrial mammals were trapped on 96 survey days between 6th of October 2013 and the 27th of April 2014. These records consist of 135 individuals (194 re-captures) of which sixteen species could be identified. All have the status ‘‘Least Concern’ or have not yet been assessed by the IUCN Red List Database (2013). One species (*Xerus erythropus*) was observed but never caught in live traps. It was added to the results. Below is a resume taken from descriptions in Mammals of Africa (*Happold & Happold 2012)*. Also see “20131106_IdentificationTable_SmallMammals_Boe.xls”(Appendix II).

Crocidura variara

Large pale-coloured shrew. Dorsal pelage pale medium brown, with a mottled appearance. Ventral pelage medium reddish-brown or creamy-grey. Tail relatively long (ca. 70% of HB). Endemic to Africa.

Photograph: Amber Baele

Praomys rostratus

Small brown forest mouse, similar in colour to P. tuilbergi. Pelage dense and soft, ca. 10 mm on mid-back. Dorsal pelage reddish-brown to yellowish-brown in older animals; dark brown in younger ones. Ventral pelage nearly white in adult specimens; ventral hairs grey at base, white on terminal two-thirds. Hands and feet white. Some have a white patch or stripe just in front of penis. Tail very long (ca. 115-125% of HB), dark brown, with a few short hairs between the scales; unicoloured with irregular pale spots. Endemic to Africa.

Praomys daltoni

Small savannah mouse with pure white ventral pelage. Dorsal pelage variable in color; hairs grey at base, brown at tip. Ventral pelage pure white, clearly delineated from dorsal pelage on flanks and cheeks. Ears fairly large, oval-shaped. Eyes relatively small. Back of fore- and hind-feet white. Hindfeet rather short, with a short Digit 5 and a relatively long Digit 1. Tail long (ca. 110% of HB), with small scales arranged in rings. Endemic to Africa.

Photograph: Amber Baele

Praomys tullbergi

Small forest mouse with soft pelage. Colours of dorsal pelage reddish-brown; hairs grey at base, greyish-brown to rufous-brow n tips. Ventral pelage grey at base, white at tip. Tail with short sparse bristles. Chin, throat and chest whitish. Flead narrow and pointed, moderate to large eyes, large fleshy ears. Tail very long (ca. 140% of head and body), with short sparse bristles. Considerable variation in pelage color: dark grey in juveniles, greyish-brown in young adults and rufous-brown to reddish-brown in old individuals.

Photograph: Dorien van Montfort

Mastomys natalensis

Small, grey mouse. Dorsal pelage darkish-grey (young) to rusty-brownish (old adults). Ventral pelage dark grev; hairs with paler tip. Eyes dark and bulbous. Ears large, naked, rounded at tip. Fore- and hindfeet whitish.Tail long (ca. 100% of I IB), dark above and below. It is a common pioneer species after fire (Meester et al. 1979). Very lively, but generally not aggressive. Opportunistic omnivores. Endemic to Africa. Very widely distributed. One of the commonest species in savannah habitats, with densities of up to 1000/ha in disturbed areas.

Photograph: Amber Baele

Mastomys erythroleucus

Medium-sized reddish brown mouse. Dorsal pelage reddish-brown. Ventral pelage creamy. Colour of dorsal pelage more or less clearly delineated from ventral pelage. Fore- and hindfeet whitish. Tail long (ca. 89% of HB). Endemic to Africa. Very common.

Mastomys huberti

Medium-sized dark-grey mouse. Dorsal pelage darkish-grey (young), rusty-brownish (old adults) or blackish (in Senegal). Ventral pelage dark, hairs with greyish tip. Fore- and hindfeet whitish. Tail long (ca. 84% of HB).

Photograph: Dorien van Montfort

Lemniscomys linulus

Small grass mouse. Well-defined black mid-dorsal stripe. Many faint lateral stripes of very small pale spots. Ventral pelage pure white with buff line. Tail long (ca. 105-110% of HB).

Photograph: Dorien van Montfort

Lemniscomys striatus

Small grass mouse with black mid-dorsal stripe and lines of pale spots on back and flanks. Black mid-dorsal stripe; flanks with four lines of pale yellow lateral stripes.

Photograph: Dorien van Montfort

Lemniscomys zebra

Small grass mouse with pale lateral stripes along flanks; the only species (with L. barbarus) with unbroken lateral stripes (i.e. not broken into spots or streaks). Dorsal pelage yellowish-brown or brown. Black mid-dorsal stripe. Six or seven honey-yellow or cream unbroken lateral stripes on each flank. Ventral pelage white or cream. Head narrow and pointed, similar in color to dorsal pelage. Ears large and rounded, covered with short pale rufous hairs. Tail long (ca. 110% of HB). Forefoot has only three functional digits.

Photograph: Amber Baele

Grammomys macmillani

Small arboreal mouse with very long tail; the smallest species of the genus. Dorsal pelage olive-brown or grey. Flanks paler. Ventral pelage white or creamy-white. Bright rufous-brown on rump. Flanks paler. Small rusty subauricular tufts. Ventral pelage white or creamy-white Color of dorsal pelage clearly delineated from colour of flanks, usually by yellow or orange line. Limbs short. Tail very long (ca. 160% of HB), with short hairs, with slight pencil of longer hairs at tip. Endemic to Africa.

Photograph: Amber Baele

Uranomys ruddi

Small mouse with small limbs, short tail and stiffened hairs on back and rump. Pelage short and stiff. Dorsal pelage grey to grey-brown, speckled with pale brown and black; hairs dark grey with pale brown tip , or with pale brown terminal band and black tip. Color of flanks merges gradually to colour of ventral pelage. Head rather slim and pointed, with small eyes and small ears. Chin, throat, chest and limbs white. Limbs short. Tail short (ca. 60% of HB). Skin thin and fragile; many individuals have damaged ears, and tail is frequently shortened or completely absent.

Photograph: Dorien van Montfort

Rattus rattus

Large rat, with blackish-brown dorsal pelage and long scaly naked tail. Pelage coarse and dense, sleek, lying close to body. Dorsal pelage dark brown or blackish-brown, usually darker along mid-dorsal line. Many long dark guard hairs scattered throughout dorsal pelage. Ventral pelage varied. Ears naked. Tail very long (ca. 120% of HB), thin, with scales arranged in rings along length of tail and many short dark bristles. Introduced to sub-Saharan Africa by Arab and European ships, and subsequent dispersal within Africa mainly by river, rail and road transport.

Gerbilliscus guinea

Medium to large-sized robust rodent. Dorsal pelage grey-brown; hairs dark grey at base, brown to orange central zone, and usually with short black tip. Flanks and head paler; hairs mostly without black tip. Ventral pelage and inner sides of limbs white; antral color clearly delineated on lower Hanks. Chin, throat and nest white. Head rounded with moderately pointed nose. Large ears. Hindfeet white above, dark below; Forefeet entirely white. Tail relatively long (110-140% of HB), with marked pencil of darkish hairs : terminal end.

Photograph: Amber Baele

Graphiurus kelleni

Small dormouse. Dorsal pelage various shades of brown, beige or grey, sometimes with golden or reddish hue, with darkening of pelage towards the mid-line of the head and back in some individuals. Dorsal pelage silky, sleek in some populations, thick in others. Ventral pelage usually white or cream, lightly or moderately suffused with grey. Dorsal and ventral pelage colors clearly delineated. Head color usually matches that of dorsal pelage, sometimes paler towards muzzle. Eyes large; eye-mask conspicuous. Tail moderately long (ca. 82% of HB), tail hairs shorter at base and longer at tip.

Photograph: Amber Baele

Heliosciurus Gambianus

Medium-sized arboreal greyish-brown squirrel with long banded tail. Pelage short, slightly coarse. Dorsal pelage and flanks grizzled pale brown or buff, flecked with black; dorsal hairs with alternating black and buff bands.

Photograph: Dorien van Montfort

Xerus erythropus

Large terrestrial squirrel with coarse pelage. Dorsal pelage dark brown to pale cinnamon and sandy-yellow; hairs sandy colored at base, sometimes with black or brown tip.

Visual record from treetops in the village of Beli. No photograph available

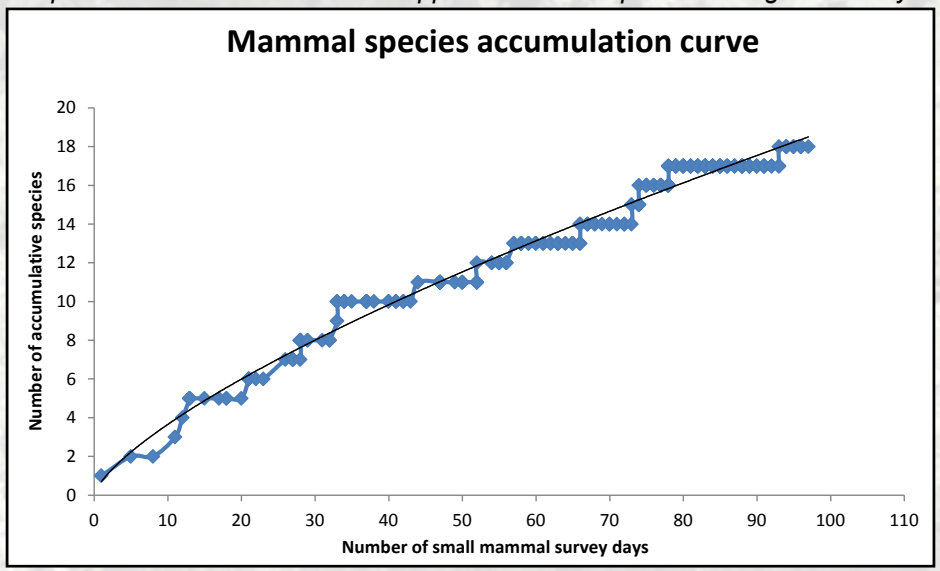
Table 2: The total of small mammals species captured during the survey.

Species	Species count
Crocidura	5
Crocidura variara / fuscomurina / jouvenatae	4
Gerbilliscus guineae	6
Grammomys macmillani	8
Graphiurus kelleni	4
Heliosciurus Gambianus	2
Lemniscomys linulus	46
Lemniscomys striatus	23
Lemniscomys zebra	5
Mastomys erythroleucus	3
Mastomys huberti	2
Mastomys natalensis	31
Praomys daltoni	44
Praomys rostratus	46
Praomys tullbergi	4
Rattus rattus	7
Uranomys Ruddi	4
Xerus erythropus	1

The total of 135 individuals that were trapped in this survey can be divided into eleven genera and sixteen species. The above table shows that *Lemniscomys spp.*, *Mastomys spp.* and *Praomys spp.* are the most abundant species that were trapped during this survey. *Graphiurus kelleni, Heliosciuris gambianus, Mastomys erythroleucus, Mastomys huberti and Proamys tullbergi* were trapped less than five times. This number is considered low regarding the number of survey days. Possibly these species are harder to trap because of their ecology or they are less abundant at the research locations.

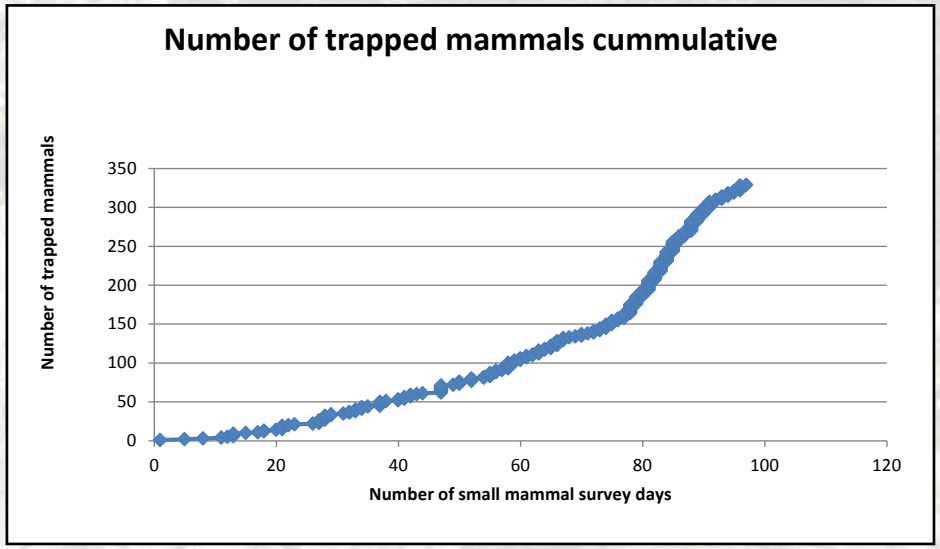
The shrews (*Crocidura spp.*) that were trapped could not all be identified with certainty to species level. Possibly some individuals that were caught might be *C. fuscomurina* or *C. jouvenatae* but most likely they concern *C. variara*. Variety in pelage color between the species, overlap in species specific characteristics and dealing with juveniles makes this process very difficult, if not impossible. None of these specimens or DNA samples were conserved or made it to the Netherlands. DNA analysis could give more clearity about the taxonomy of these individuals in future surveys but it is unclear whether there are DNA references of West African *Crocidura* available in Genetic databases.

Graph 1: Accumulation curve of trapped mammals species during the survey.



Species accumulation curves are a good way to determine whether a survey gives a complete overview of the species that are present within an area or if additional survey efforts need to be made to get the complete picture (*O'Brian et. al., 2002; Nippon Koei UK, 2007*). The above mammal species accumulation curve underpins the expectation of the presence of at least eight to ten new species that could not be identified during the timespan of this survey.

Graph 2: Cumulative number of trapped mammals during the survey



The abundancy of trapped individuals varies a lot over time (see Graph 2). In the dry season (survey days 1-80) numbers of captured individuals (0-7 ind.) are considerably lower than in the wet season. From late March onwards (> survey day 80) numbers of trapped animals rose to sometimes more than ten trapped individuals (1-13 ind.) on a single day.

Conclusions

Trapping of amphibians and small terrestrial mammals with use of live traps and pitfall traps is successful in the Boé with the described methods. The results in term of quantities are considered low at the end of the wet season but quantities of captured mammals increase towards the wet season.

A total of 75 individual amphibians were trapped which can be divided thirteen genera and in twenty different species. Compared to the 37 species that are expected to inhabit the area, one could say that 54% of these species was trapped. This is an indication that the area could possess a high species richness (*Cabuy, 2014*). Herpetological surveys in the neo/tropics have proven that it can take a lot of time and effort to record every species present in an area (*Duellman, 2005*).

A total of 329 small terrestrial mammals were trapped on 96 survey days between 6th of October 2013 and the 27th of April 2014. These records consist of 135 individuals (194 re-captures) out of which sixteen species could be identified. Considering that at least 25 species are to be expected, this indicates that more effort and continued research is needed to be able to get a full account of the species that are present in the Boé. The trend of the species accumulation curve further underpins this indication.

West African studies have shown that relatively small quantities of mammals are captured with live traps (*Anadu, 2008; Decher, Kilpatrick & Bahian, 2001*). It is known that numbers of small rodents fluctuate depending on the season and the time of year. This survey shows an increase in captured animals from late March onwards. Since this is only the beginning of the wet season in the Boé this might be an indication that numbers will rise even further in the wet season. Wet season is generally greener and foodsources like seeds, nuts and fruits are more abundant and therefore small rodent populations can be higher.

Difficulties in communication between Guinea-Bissau and Holland led to problems in the field. In the dry season outside air temperatures were very high which led to the death of animals that were captured in live traps during daytime. Therefore, from the beginning of February, traps were deactivated after the morning check and re-activated in the evening (*van Montfort, 2014*). This could have been solved with covering the traps by shelters keeping them in the shade and from overheating.

Difficulties in finding adequate numbers of volunteers due to an ebola outbreak in mid 2014 and problems with handling rodents caused the end of monitoring for mammals in April and for amphibians in June. This shows that continuation and defining time span of monitoring projects can be problematic.

This survey shows that great care should be taken when using a new type of live trap: Due to a lack of communication by the manufacturer of the Heslinga traps they were not set in the proper manner. Therefore animals were able to escape from the traps and capture success was influenced negatively. Only in March the problem was solved.

Occasionally live traps were disturbed and pushed over by other wild animals such mongooses influencing the trapping success. Also ants caused problems because bait would attract them causing small mammals to stay away or be eaten in the trap.

Recommendations

The used method to gather amphibians is very non-selective, pitfalltraps capture all small ground dwelling creatures which means that amphibians, as well as other animal species can be found in the traps. Among the species that were caught were spiders, centipedes, mantis, agamas, skinks, shrews and scorpions. Some of these are venomous and one should always check traps cautiously. In some weather conditions the rock that was placed in the pitfalls as a refuge, proved insufficient. Pitfalls can flood easily in heavy rain and sediment can clog the holes that should ensure drainage. Therefore it is advisable to use a floating object like polystyrene for refuge.

Another downside of the pitfalltrap is the fact that some amphibians might be able to jump out of the pitfall after falling in. Observations were made of amphibians climbing out of the pitfall traps (*Cabuy, 2014*). In future research lids should be modified to overcome this. In addition to the pitfalltraps one could use coverboards that function as hiding places for amphibians (*Grant et al. 1992*). The reason that this method is not used in this inventory is because of the risk of poisonous snakes that hide underneath these boards as well. One of the conditions for this inventory was the reproducibility of the fieldwork by relatively inexperienced trainees or eco-tourists, in which case snake-risks should be avoided where possible.

This project has taken place at the end of the rainy season. Based on vocal sounds of amphibians a distinct reduction in the abundance of amphibians was noticeable during this period. It is expected that most species could be captured during the rainy season. Assumptions are that during the dry season small terrestrial mammals cannot find adequate vegetation cover in Savannah habitat to provide enough food and cover against predators. They will most likely turn to the patches of gallery forests and use them as a refuge making densities in the dry season in these areas higher than in the wet season.

After completion of a full year of trapping a new report should be written including analysis of collected year round data. This will provide interesting records of species accumulation curve, variation in number of species and individuals per season, number of successful trappings in open and closed habitats, etc. However it is of the utmost importance that uniform methods and materials are used for collection of data. Only then sequences of data can be analyzed statistically.

It is very important to have side view photographs of the captured species in which the complete body including tail is visible. Not all animals were photographed well.

This survey has been a preliminary inventory and should be continued for at least one calendar year to get a grip on total abundancy of species that are present and to monitor other parameters like species quantities during the various seasons. Therefore it is recommended to fill in the gaps of the data by continuing this survey during the months that are not covered in this report. Earlier experience shows that visual encounters are a good way to survey amphibians (*Cabuy, 2014*). Fixed routes for walking transects should be added to trapping methods as an easy low threshold visual encounter method for assessing amphibian biodiversity.

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