International Journal of Zoology and Applied Biosciences **ISSN: 2455-9571**
Volume 5, Issue 2, pp: 68-78, 2020
https://doi.org/10.5281/zenodo.3755290
http://www.ijzab.com

Research Article

DIVERSITY, DISTRIBUTION, AND HABITAT OF HERPETOFAUNA AROUND GAMBELLA ZURIA DISTRICT, WEST ETHIOPIA

Abeje Kassie[1*] and Afework Bekele[2]

[1]Animal Biodiversity Directorate, Ethiopian Biodiversity Institute, Addis Ababa, Ethiopia
[2]Department of Zoological Sciences, College of Natural Sciences, Addis Ababa University, Addis Ababa, Ethiopia

Article History: Received 29th March 2020; Accepted 8th April 2020; Published xx April 2020

ABSTRACT

Herpetofauna is the least studied group of vertebrates in general in the world and in particular in Ethiopia. This study was carried out to describe the species composition, diversity, distribution and species richness of amphibians and reptiles in Gambella Zuria District, Gambella National Regional State, Western Ethiopia. The study was conducted in 2018. Pitfall traps along with drift fence and Visual encounter survey methods were used to capture the amphibians and reptiles for visual estimation. Herpetofauna was investigated in three habitat types such as wetland, agricultural land, and house and riverine forest. A total of 95 amphibian individuals categorized under nine species, belonging to six genera in six families were recorded. In addition to amphibians, a total number of 17 reptile species belonging to three orders, 11 different families, and 13 genera were recorded. Out of which, five species were snakes, 10 species of lizards, one species of Turtle and one species of Crocodile. *Ptychadena nilotica* was the most abundant amphibian species while *Agama finchi* was highest from reptile species in the study area. Tedia riverine forest (H=1.81; D=5.02) was the most amphibian species-rich and diverse among the four habitat types. Agricultural land and house had the lowest diversity index (H=0.64; D= 1.8) compared to other habitat types. Karmi riverine forest (H=2.03) was the most reptile species-rich and diverse among the four habitat types followed by Agricultural land and house (H=1.69). Jenena wetland had the lowest diversity index (H=1.09) compared to other habitat types. This study showed that Gambella Zuria District is rich in amphibian and reptile species. A further extended molecular study should be carried out to obtain detailed information on the abundance and population structure of herpetofauna for better understanding and develop conservation strategies in Gambella Zuria District riverine forests and wetland areas.

Keywords: Amphibia, Reptile, Distribution, Diversity, Gambella, Herpetofauna.

INTRODUCTION

Herpetofauna is a group of vertebrates that include amphibians and reptiles. Herpetofauna (herps) form an important component of our ecosystem by linking terrestrial with the aquatic ecosystem and the lower vertebrates with the higher vertebrates (Bickford *et al*., 2010). Due to their pokilothermic nature, they are more susceptible to seasonal variation than other vertebrates. Seasonal changes affect three major physiological functions of amphibia viz., water balance, thermo-regulation and hormonal regulation of reproduction (Donnelly & Crump, 1998). Although generally unseen or overlooked, ectothermic terrestrial vertebrates, amphibians, and reptiles are important components of ecosystems worldwide. They are notably abundant and species-rich in tropical areas where they play critical roles in food webs often linking terrestrial and aquatic ecosystems. Current distribution and ecology of both amphibians and reptiles closely reflect rainfall and temperature patterns, which will have significant impacts on amphibian and reptilian biodiversity (Bickford *et al*., 2010).

Herpetofauna in Ethiopia has received little attention from the scientific community, which explains the significantly lower number of species reported for Ethiopia compared to neighboring countries like Kenya. Currently, 75 species of amphibians and 242 reptiles are recognized in Ethiopia (Abeje Kassie, unpublished data), although the species list is not a definite one and a greater sampling

*Corresponding Author: Abeje Kassie, Animal Biodiversity Directorate, Ethiopian Biodiversity Institute, Addis Ababa, Ethiopia, Email: kassieabeje@gmail.com, Mobile: +251 913205773

effort is still required for many regions. Although Ethiopia has a wide diversity of ecosystems that may harbor a great diversity of species, many ecosystems remain unexplored. At the same time, most areas are facing a sustained loss of habitat and degradation through forest fragmentation, an increase of the agricultural frontier, and pollution. Gambella region is a poorly explored area that is facing anthropogenic pressures like deforestation, agricultural investment, and other habitat fragmentation. Although forest loss has occurred in the area, there are still reserves that could potentially serve as refugia for several organisms. This is of great importance especially for amphibians and reptiles, which are facing population declines worldwide. Therefore, the aim of this study is to analyze the herpetofauna species composition found at the Gambella Zuria District.

MATERIALS AND METHODS

Study site

The study area was Gambella Zuria District, part of the Anuak Zone, Gambella National Regional State. It is bounded by Abobo in the south, Itang in the west, and Oromia Region in the north and east. The administrative center of the District is Abol. The total surface area coverage of the District is 2,586 km^2. According to the information obtained from the District Agricultural Office, the total population of the Gambella Zuria District is 14,599 (male 7,591, female 7,008). The annual temperature of the District ranges from 27^{o}C to 40^{o}C, with an elevation in the range of 450 to 1,000 meters above sea level. The average annual rainfall ranges from 1,000 mm to 2,000 mm, and Baro is the main river. The area is lowland and it has many rivers and riverine forests. The area also harbors large areas of wetlands. The study area is stratified into three habitats from three Kebeles (Figure1). These are Tidia Riverine Forest (found in Abol Kebele), Karmi Riverine Forest (found in Karmi Kebele) and Jenina wetland (found in the Gambella town Kebele 04).

Sampling Design

The study area was stratified into three habitats: riverine forest, wetlands/swamps, and agricultural land. Six sampling sites (two sites for each habitat) were purposively chosen and established in selected study habitats for data collection.

Data Collection Methods

Data collection methods followed the standard methods proposed by Heyer *et al*., (2014) and (Howell, 2002). The methods included drift fence pitfall trap, active search, and visual survey.

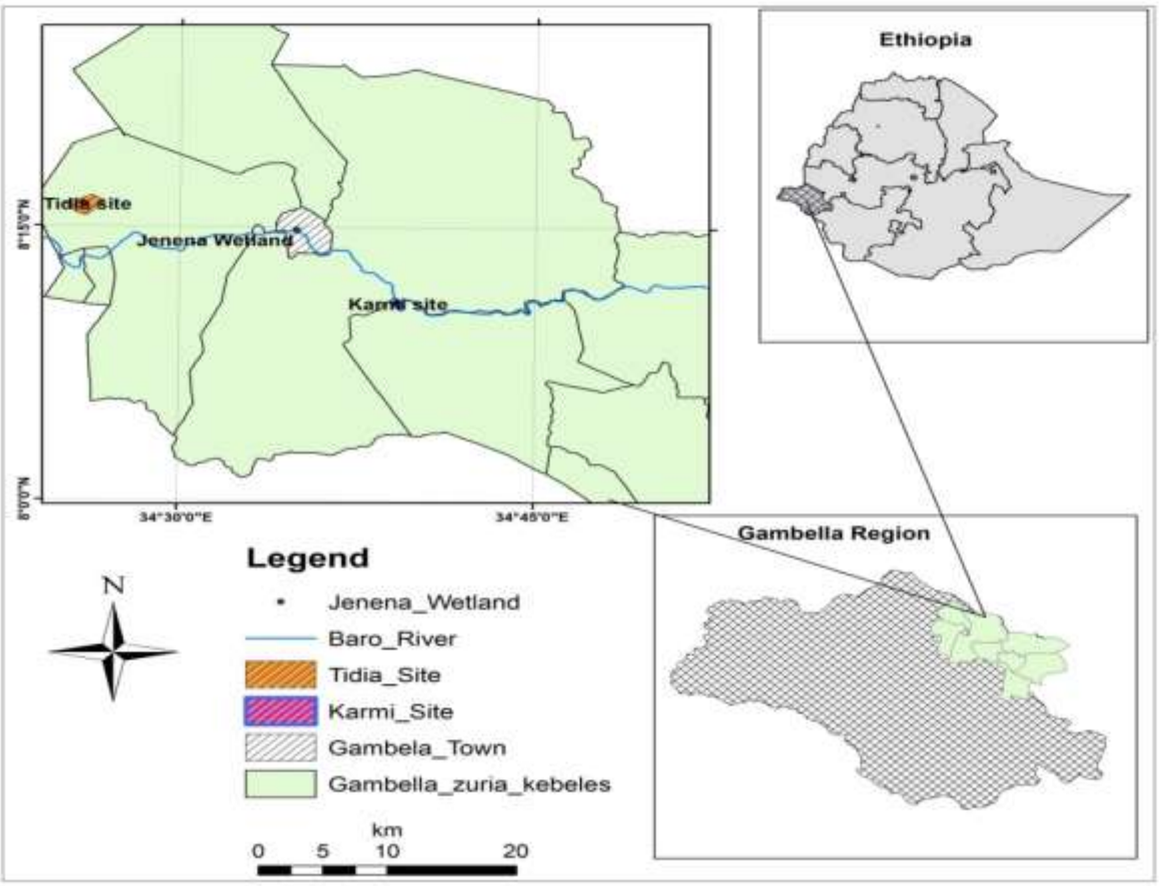

Figure 1. Map of the study area.

Drift Fence and Pitfall Trap

(Howell, 2002)was employed using a drift fence and pitfall trap (Figure 2) with 10 liters of the bucket (Howell, 2002) to collect amphibian and reptile species. The drift fence consisted of plastic sheeting, 60 cm in height and 55 m in length. This was constructed to intercept and redirect amphibians and reptiles moving on the ground into pitfall traps. Each transect line had ten buckets sunk into the ground with the rim level of the ground at 5 m interval along the drift fence. Three transect lines with drift and pitfall traps were constructed in eight data collection sites. The distance between the transect line was determined by the suitability of the area to herpetofauna. The drift fence and pitfall traps were checked twice a day early in the morning and late evening before sunset.

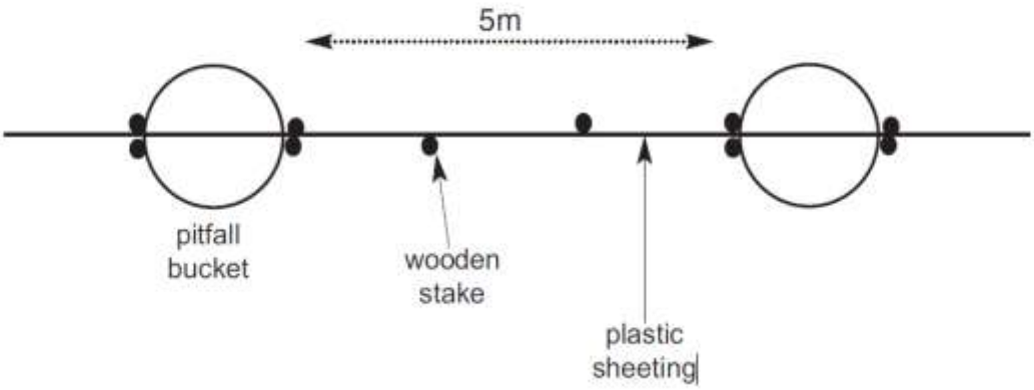

Figure 2. Sketch of the Drift Fence and Pitfall Trap Layout (Davies *et al*., 2002; Howell, 2004).

Active Searching and Visual Encounter Survey

An active search was undertaken randomly in sites away from the transect lines involving turning over logs, leaf litter, tree holes, rocks, and other potential hideout searching areas for amphibians and reptiles. Active search and visual surveys were undertaken day and night. Each site was searched in a group during the time interval between 6:00 and 7:00 a.m. for day time and 7:00 to 8:00 p.m. for night time. We had collected data for each individual of a species encountered during fieldwork. The locality, date, time, weather condition, habitat, microhabitat, the gender of each individual (when possible) was recorded in a field datasheet. We had also taken taxonomic note of individuals captured during the fieldwork and morphometric data of the individual gathered. Geographic coordinates for each survey site was determined in the field with a Garmin GPS 72 receiver. Coordinates were recorded as latitude and longitude in decimal degrees. During day time, we searched for reptiles along forest trails, forest edges and stream/river side's besides active search methods. Our aquatic search involved examining each type of aquatic habitat. We made incidental observations any time a species was located in an area that was not actively surveyed. We incorporated records of road kill individuals, and the individuals caught by fringe village peoples.

Species Identification and Voucher Specimen Preservation

Captured amphibians were placed in individual plastic bags with water for moisture. Some sighted and caught individuals were identified to the species level, and this was done using the keys and field guide books (Largen, 2001; Largen and Spawls, 2010; Spawls *et al*., 2018). After taking records, caught individuals were released 50 m away from the capture area to avoid recapture (Pickersgill *et al*., 2017). Nonetheless, individuals that could not be identified at the data collection sites were collected as voucher specimens and preserved in 97% ethanol. The voucher specimens were deposited at EBI Zoology Museum for permanent preservation.

Data Analysis

Data collected from the field through traps and an active search was used for statistical analysis of amphibians and reptiles.

Species Diversity

Shannon – Wiener Index of Diversity, (H′) was used to calculate diversity of species in various habitats

$$H' = -\sum_{i=0}^{s}(Pi \ln Pi)$$

Where H' is the index of species diversity, s is the number of amphibia, pi is the proportion of the total sample belonging to the i-th species and ln as a natural logarithm. Species richness was summed as the total number of species encountered. Simpson index was calculated to determine the dominance of species

$$\text{Simpson index: } D' = 1/\sum_{i=0}^{s} (Pi^2)$$

Abundance of Species

The relative abundance of amphibian species in various habitats was calculated as the ratio of the number of species found in each habitat and the total number of species recorded in all study habitats. The relative abundance of amphibian species was calculated as the ratio number of each species and the total number of all species recorded.

Distribution of Species and Similarity Estimates

The distribution of species recorded as the presence or absence of species in a particular habitat was analyzed using Cochran's Q test (Zar, 1996) SPSS version 20. Two-tailed probability results <0.05 was used to test the statistical significance (Zar, 1999). Herpetofauna community composition and turnover was compared among habitats using the Sorenson's Coefficient (CC) (Duellman, 1990), calculated as: CC=2C/S1+S2, where C is the number of species that the two habitats have in common, S1 is the total number of species found in habitat 1 and S2 is the total number of species found in habitat 2. Low similarity indicates high turnover as the index provides a range from 0 (no species in common among two areas) to 1 (totally identical set of species among two areas) (Watkins, 2006).

RESULTS AND METHODS

A total of nine amphibian species belonging to six different families and six genera were recorded in the study area (Table 1). All amphibian species were categorized under order Anura. In addition to amphibians, a total number of 17 reptile species belonging to three orders (order Squamata further divided into two suborders; Sauria and Serpents), 11 different families, and 13 genera were recorded. Out of which, five species were snakes, 10 species of lizards, one species of turtle and one species of crocodile (Table 2).

The Order Squamata (Sauria) is the most represented reptile in the study area, with five families and 10 species, followed by the order Squamata (Serpent), with four families and five species. The orders Crocodylia and Testudines are represented only with one species (Table 2).

Table 1. Amphibian recorded from the study areas.

Order	Family	Scientific name	IUCN RL Status	Coordinates	Altitude
	Hemisotidae	*Hemisus marmoratus*	LC	N 08^0 16' 14.62'' E034^0 25' 54.73''	436 m asl
	Dicroglossidae	*Hoplobatrachus occipitalis*	LC	N 08^0 14' 51.19'' E034^0 34' 56.68''	424 m asl
		Phrynobatrachus inexpectatus	DD	N 08^0 14' 51.19'' E034^0 34' 56.68''	424 m asl
	Phrynobatrachidae	*Phrynobatrachus natalensis*	LC	N 08^0 16' 14.62'' E034^0 25' 54.73''	436 m asl
Anura		*Phrynobatrachus spp.*	DD	N 08^0 16' 14.62'' E034^0 25' 54.73''	436 m asl
	Ptychadenidae	*Ptychadena anchietae*	LC	N 08^0 10' 52.53'' E034^0 39' 10.36''	428 m asl
		Ptychadena mascareniensis	LC	N 08^0 10' 52.53'' E034^0 39' 10.36''	436 m asl
	Pyxicephalidae	*Tomopterna cryptotis*	LC	N 08^0 10' 52.53'' E034^0 39' 10.36''	428 m asl
	Arthroleptidae	*Leptopelis bocagii*	LC	N 08^0 10' 52.53'' E034^0 39' 10.36''	428 m asl

Table 2. Reptiles recorded from the study areas.

Order	Family	Scientific name	IUCN RL Status	Coordinates	Altitude
	Agamidae	*Agama finchi*	LC	N 08^0 16' 14.62'' E034^{0}25' 54.73''	436 m asl
		Agama doriae	LC	N 08^0 10' 52.53'' E034^{0}39' 10.36''	428 m asl
Squamata (Sauria)		*Trachyle pisstriata*	LC	N 08^0 14' 51.19'' E034^{0}34' 56.68''	424 m asl
		Trachyle pisquinquetaeniata	LC	N 08^0 10' 52.53'' E034^{0}39' 10.36''	428 m asl
	Scincidae	*Mochlusafer*	LC	N 08^0 10' 52.53''	428 m asl

				E034^{0}39’ 10.36’’	
		Mochlus sundevalli	LC	N 08^{0} 10’ 52.53’’ E034^{0}39’ 10.36’’	428 m asl
	Gekkonidae	*Lygodactylus scorteccii*	LC	N 08^{0} 10’ 52.53’’ E034^{0}39’ 10.36’’	428 m asl
	Chamaeleonidae	*Chamaeleo laevigatus*	LC	N 08^{0} 16’ 14.62’’ E034^{0}25’ 54.73’’	436 m asl
	Varanidae	*Varanus niloticus*	LC	N 08^{0} 14’ 51.19’’ E034^{0}34’ 56.68’’	424 m asl
		Varanus exanthematicus	LC	N 08^{0} 10’ 52.53’’ E034^{0}39’ 10.36’’	428 m asl
	Boidae	*Python sebae*	LC	N 08^{0} 14’ 51.19’’ E034^{0}34’ 56.68’’	424 m asl
Squamata (Serpentes)	Colubridae	*Crotaphopel tisdegeni*	LC	N 08^{0} 16’ 14.62’’ E034^{0}25’ 54.73’’	436 m asl
		Natricitere solivacea	LC	N 08^{0} 16’ 14.62’’ E034^{0}25’ 54.73’’	436 m asl
	Viperidae	*Causus maculatus*	LC	N 08^{0} 10’ 52.53’’ E034^{0}39’ 10.36’’	428 m asl
	Typhlopidae	*Letheo bialargeni*	LC	N 08^{0} 14’ 51.19’’ E034^{0}34’ 56.68’’	424 m asl
Crocodylia	Crocodylidae	*Crocodylus niloticus*	LC	N 08^{0} 10’ 52.53’’ E034^{0}39’ 10.36’’	428 m asl
Testudines	Trionychidae	*Cyclanorbis elegans*	LC	N 08^{0} 10’ 52.53’’ E034^{0}39’ 10.36’’	428 m asl

Table 3. Abundance and habitat associations of Herpetofauna species from different habitat types at the study areas (number in bracket indicates the abundance of species) TDRR-Tidia Riverine Forest; KRF- Karmin Riverine Forest; JWL- Jenena Wetland; ALH- Agricultural land and house.

Species	Habitat and Species Abundance				
	TRF	ALH	KRF	JWL	Total
Amphibians					
Hemisus marmoratus	8(21.6)				8 (8.42)
Hoplobatrachus occipitalis	4(10.8)			2(7.40)	6 (6.32)
Phrynobatrachus inexpectatus			2(7.14)		2 (2.11)
Phrynobatrachus natalensis	10(27.0)		14(50.00)	2(7.40)	26 (27.37)
Phrynobatrachus spp.	2(5.4)				2 (2.11)
Ptychadena anchietae	5(13.5)	1(33.33)	8(28.57)	2(7.40)	16 (16.84)
Ptychadena niolotica	8(21.6)	2(66.66)	3(10.71)	19(70.30)	32 (33.68)
Tomopterna cryptotis			1(3.57)		1 (1.05)
Leptopelis bocagii				2(7.40)	2 (2.11)
Total	37	3	28	27	95
Reptiles					
Agama finchi	5(45.00)	7(38.38)	2(20.00)		14(33.33)
Agama doriae	2(18.00)	1(5.00)			3(7.14)
Trachylepis striata	1(9.00)	3(16.16)	1(10.00)		5(11.90)
Trachylepis quinquetaeniata		2(11.11)			2(4.76)
Mochlus afer		1(5.55)			1(2.38)
Mochlus sundevalli		1(5.55)			1(2.38)
Lygodactylus scorteccii		3(16.16)	2(20.00)		5(11.90)
Chamaeleo laevigatus	1(9.00)				1(2.38)
Varanus niloticus			1(10.00)	1(33.33)	2(4.76)
Varanus exanthematicus			1(10.00)		1(2.38)
Python sebae				1(33.33)	1(2.38)
Crotaphopeltis degeni	1(9.00)				1(2.38)

Natriciteres olivacea	1(9.00)				1(2.38)
Causus maculatus			1(10.00)		1(2.38)
Letheo bialargeni				1(33.33)	1(2.38)
Crocodylus niloticus			1(10.00)		1(2.38)
Cyclanorbis elegans			1(10.00)		1(2.38)
Total	11	18	10	3	42

A total of 95 individuals representing the order Anura, six families and nine species of (*Hemisus marmoratus, Hoplobatrachus occipitalis, Phrynobatrachus inexpectatus, Phrynobatrachus natalensis,* Phrynobatrachus spp., *Ptychadena anchietae, Ptychadena mascareniensis, Tomoptern acryptotis, Leptopelis bocagii*) were recorded (Figure 3). *Ptychadena nilotica* was the most abundant amphibian species from the study area, followed by *Phrynobatrachus natalensis* and *Tomopterna cryptotis* as the least abundant species recorded (Table 3). *Agama finchi* had the highest relative abundance value of 0.33(33.33%) followed by the *Trachylepis striata* and *Lygodactylus scorteccii* with a relative abundance of 0.12 (12%). Most of the reptile species observed in the study areas had the lowest relative abundance of 0.024 (2.4%) (Figure 4).

Pitfall traps along drift fences (Figure 2 and 5) captured 20 individuals belonging to three species and three families. Most (80%) of the species trapped by this method were *Phrynobatrachus natalensis,* 15% were *Ptychadena anchietae* and 5% *Hoplobatrachus occipitalis.*

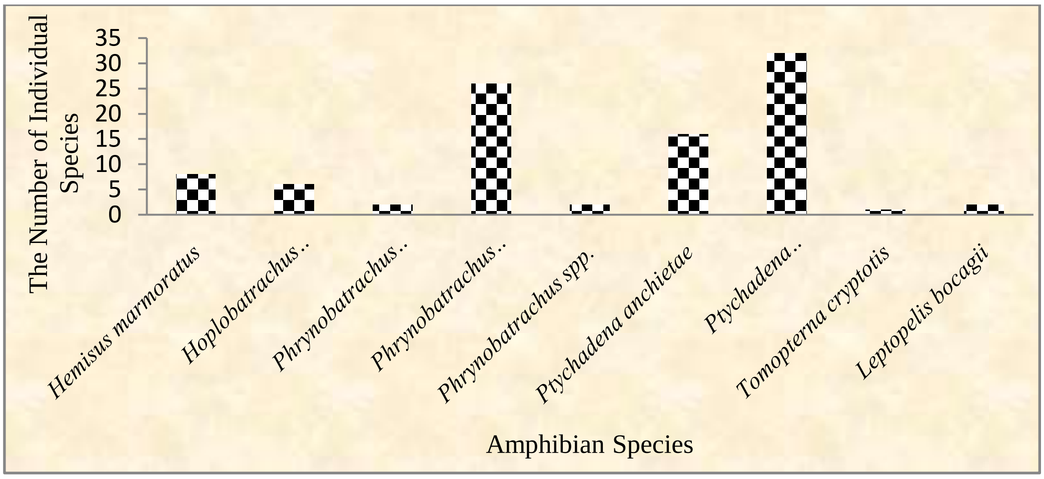

Figure 3. Number of Amphibians in each Species.

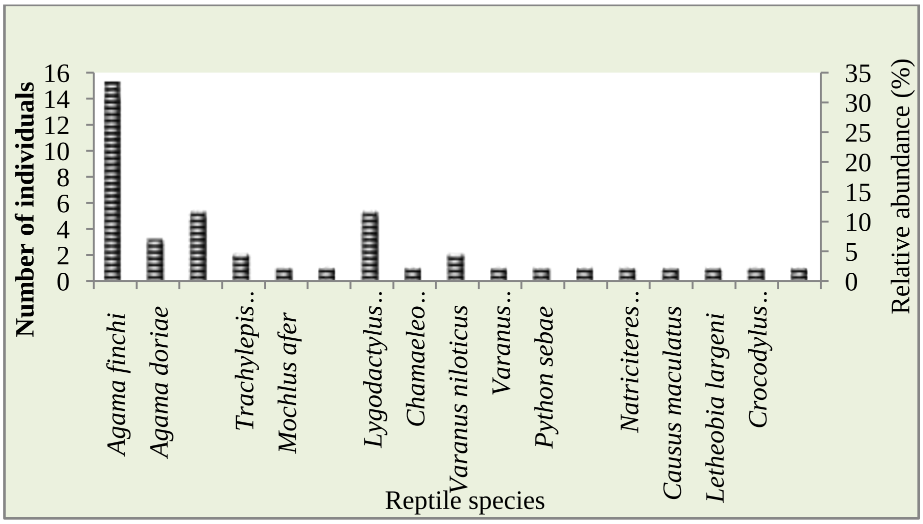

Figure 4. Composition and relative abundance of reptile species.

Figure 5. Drift Fence and Pitfall Trap.

The distribution of each species in selected habitats is shown in Table 3. The herpetofauna species number showed that no significant difference in preference within the four habitat types ($\chi 2 = 0 .213$, df = 9, p > 0.05). Of the nine amphibian species recorded, *Hemisus marmoratus* was recorded only in the Tedia riverine forest and *Phrynobatrachus inexpectatus* and *Tomopterna cryptotis* were recorded only in the Karmi riverine forest. *Ptychadena anchietae* and *Ptychadena nilotica* were distributed in all habitats. *Leptopelis bocagii*, is the only tree frog recorded only in the wetland site. *Phrynobatrachus natalensis* was recorded in all habitat types except in the agricultural land area. *Hoplobatrachus occipitalis* is a robust frog, was abundant in the river around the wetland area and Tedia riverine forest. *Phrynobatrachus natalensis* and *Ptychadena nilotica* are the most dominant species recorded from all habitats. From the total captured in all habitats, the greatest percentage (38.9%) of amphibian individuals was recorded in the Tedia riverine forest, followed by Karmi riverine forest (29.5%) and the least was recorded from agricultural land (3.2%). *Phrynobatrachus natalensis*, *Ptychadena anchietae*, and *Ptychadena nilotica* were amphibian species that were distributed in three habitats (Table 3). *Agama finchi* and *Trachylepis striata* were reptiles recorded from around agricultural land and home, Tedia and Karmi riverine forest. The Sorenson's coefficient similarity of the Tidia and Karmi riverine forest was 0.416 and this indicated that there is similarity (overlap of species between the two habitats) but not significant.

Of the 17 reptile species recorded, *Agama finchi* and *Trachylepis striata* were recorded in the three habitats. *Agama doriae, Lygodactylus scorteccii* and *Varanus niloticus* were recorded in two habitats. Other reptile species recorded in the study areas were observed only in one habitat. From the total captured in all habitats, the greatest percentage of reptile individuals was observed in the agricultural land and house (42.86%) and in Tedia riverine forest (26.19%), while only 7.14% were observed in Jenena wetland. The highest species richness of eight was observed in the Karmi riverine forest followed by Agricultural land and house that had a species richness of seven. Species richness of Tedia riverine forest was six and in Jenena wetland it was three. 42.86 % of all reptile species were observed at Karmi riverine forest followed by agricultural land and house that accounted for 26.19%. The number of reptile species was least at Jenena wetland (7.14%) (Table 3). Amphibian richness and diversity (as measured by the Shannon–Wiener and Simpson indices) were dependent on habitat types. Tedia riverine forest (H=1.81; D=5.02) was the most species-rich and diverse among the four habitat types (Table 2). Agricultural land and house had the lowest diversity index (H=0.64; D= 1.8) compared to other habitat types. Evenness was low (0.63) in the Jenena wetland while high at Tedia riverine forest (1.0).

Reptile richness and diversity were dependent on habitat type like amphibian species. Karmi riverine forest (H=2.03) was the most species-rich and diverse among the four habitat types followed by agricultural land and house (H=1.69). Jenena wetland had the lowest diversity index (H=1.09) compared to other habitat types. The equitability distribution of reptile species was almost similar (Table 5).

Table 4. Diversity index of amphibians among habitat types.

	Habitats			
	TRF	ALH	KRF	JWL
Species richness	6	2	5	5
Shannon – Wiener Index of Diversity	1.81	0.64	1.25	1.02
Species evenness	1	0.92	0.78	0.63
Simpson index	5.02	1.8	2.86	1.93

TRF-Tidia Riverine Forest; KRF- Karmi Riverine Forest; JWL-JenenaWetland; ALH- Agricultural land and house.

Table 5. Diversity index of reptiles among habitat types.

Diversity index	Habitats			
	TRF	**ALH**	**KRF**	**JWL**
Species richness	6	7	8	3
Shannon – Wiener Index of Diversity	1.54	1.69	2.03	1.09
Species evenness	0.86	0.87	0.98	0.99

According to the IUCN criteria, we evaluated 26 species of amphibians and reptiles recorded in the study area, of which 77.77 % of amphibians were considered least concern (LC) (seven species) and 22.22% Data Deficient (two species) (Table 1). *Phrynobatrachus inexpectatus* and Phrynobatrachus spp. is the amphibian species that are categorized under LC based on IUCN. Phrynobatrachus spp. is different from Phrynobatrachus species recorded from Ethiopia and it needs further molecular work for identification. Almost all reptile species are categorized under the least concern (LC). From the recorded amphibian species, only one species (*Phrynobatrachus inexpectatus)* was endemic to Ethiopia. *Letheobia largeni* (snake) is the only endemic reptile species identified from the study area. A 20-megapixel digital camera was used for photographing amphibian and reptile species sighted and captured in the field. Some pictures of amphibian and reptile species taken during the study period were given in figure 6 below

Phrynobatrachus natalensis

Ptychadena anchietae

Ptychadena nilotica

Hoplobatrachus occipitalis

Hemisus marmoratus

Agama finchi

Chamaeleo laevigatus

Trachylepis quinquetaeniata

Trachylepis striata

Lygodactylus scorteccii *Natriciteres olivacea* *Crotaphopeltis degeni*

Figure 6. Different species of Herpetofauna recorded from the study areas.

Ethiopia is one of the 25 mega biodiverse countries with diverse habitats including montane rain forest, afro-alpine and sub-afro-alpine, wetlands, aquatic ecosystems, grasslands, woodland, and semi-arid wooded savannah. About 75 amphibian and 242 reptile species (Abeje Kassie, unpublished document) have been recorded in the country. Of these species, 30 amphibians are endemic while 11 species are threatened with extinction (Iucn, 2013). About 19 reptile species are endemic to Ethiopia. In the Gambella region, there are about 32 snake species (Table 6). (Smith *et al*., 2017) reported that two Ptychadena species *Ptychadena baroensis* and *Ptychadena nuerensis* which are new for Ethiopia had been recorded. In line with this, the current study recorded 9 species of amphibians and 17 species of reptiles that dwell in different habitats of the study areas. Pitfall trapping success was not good compared to VES. Due to this reason, most of the amphibian species were recorded and captured in the study areas through VES. However, it was very essential to get the secretive species.

According to Channing and (Howell, 2002; Spawls *et al*., 2006), amphibian species *H. marmoratus*, *Ptychadena anchietae*, and *Ptychadena nilotica* prefer open woodland, grassland and savannah habitats and they can occur in very dry conditions. However, in the current study, we captured *H. marmoratus* at the shore of the river with the burrowing snakes, *Crotaphopeltis degeni* and *Natriciteres olivacea.* We observed six *Hoplobatrachus occipitalis* in the Tedia riverine forest and Jenena wetland near Baro River. Similarly, (Harper *et al*., 2010) suggested that the occurrence of *Hoplobatrachus occipitalis* in the riverine forest is due to the preference of moist habitat. Batrachiofauna (amphibian) of Ethiopia is dominated by endemics (40.0% of the total). The majority of which are demonstrably montane species known to occur only within the altitudinal range of 1500-4000 m. The high and geographically isolated Ethiopian plateau has evidently had a profound effect upon amphibian evolution; providing refugia for some genera. In the present study, we confirmed that the amphibian endemicity is low at the Gambella (our study area), its altitude ranging from 400 to 768 m asl compared to the highland of Ethiopia. In contrast, snakes (like other reptilian groups) do not fare well at high elevations and, in Ethiopia, by far the greatest number of species is found in the altitudinal range between 500-1000 m (Largen & Rasmussen, 1993). In line with this, in Gambella, which is a lowland region, there are about 32 species. In the current study, we recorded four species. At elevations above 1000 m the number of snake species in Ethiopia declines at a surprisingly constant rate, with lowland taxa becoming dominant (Largen & Rasmussen, 1993) (Figure 7).

According to the IUCN Red list, almost all herpetofauna species recorded from the study area were listed as least concern. However, from our field observation, the loss of habitat by agricultural expansion, and pollution is high which definitely affects the species survival.

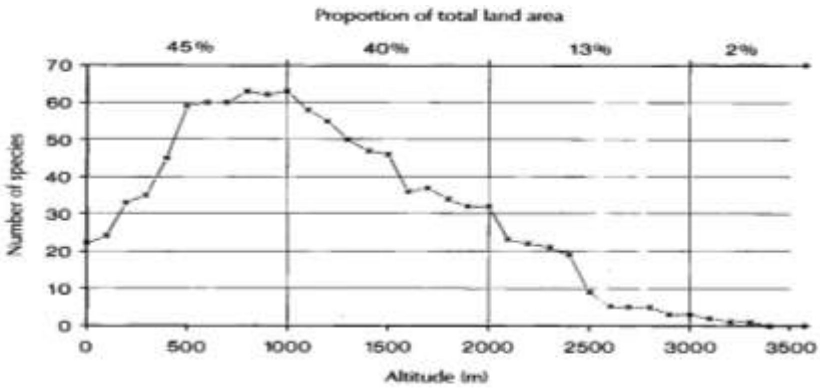

Figure 7. The Relationship in Ethiopia between altitude and number of snake species (Largen & Rasmussen, 1993).

Table 6. List of snake species recorded from Gambella Region, Western Ethiopia.

Order	Family	Scientific name
	Atractaspididae	*Atractaspis microlepidota*
	Boidae	*Python sebae* (Gmelin 1789)
	Colubridae	*Atractaspis microlepidots* (Gunther 1866)
		Atractaspis watsoni (Boulenger 1908)
		Crotaphopeltis degeni (Boulenger 1906)
		Crotaphopeltis hotamboeia
		Dispholidus typus (Smith 1829)
		Psammophis (Dromophis) lineatus (Dumeril and *Bibron 1854)*
		Psammophis sibilans
		Lamprophis fuliginosus (Boie 1827)
		Lycophidion capense (Smith 1831)
		Mehelya capensis (Smith 1847)
Squamata		*Meizodon regularis* (Fischer 1856)
(Serpent)		*Natriciteres olivacea* (Peters 1854)
		Philothamnus bequaerti (Schmidt 1923)
		Philothamnus heterolepidotus (Giinther 1863)
		Philothamnus irregularis (Leach 1819)
		Philothamnussemivariegstus (Smith 1847)
		Prosymna greigerti (Mocquard, 1906)
		Rhamphiophi srubropunctstus (Fischer 1884)
		Scaphiophisr affreyi
	Elapidae	*Elapsoides loveridgei* (Parker 1949)
		Naja haje
		Naja melanoleuca (Hallowell 1857)
	Lamprophiidae	*Gonionotophis savorgnani (Mocquard, 1877)*
	Leptotyphlopidae	*Leptotyphlops macrorhynchus* (Jan 1861)
		Leptotyphlops(Myriopholis) braccianii (Scortecci 1929)
	Typhlopidae	*Letheobia largeni* (Broadley and Wallach 2007)
	Viperidae	*Bitis arietans* (Merrem 1820)
		Causus maculatus (Hallowell 1842)
		Causus resimus (Peters 1862)
		Causus rhombeatus (Lichtenstein 1823)

CONCLUSION

This study provides a valuable overview of the diverse herpetofauna community of Gambella areas. Gambella consists of lowland forest and wetland grass and home of diverse herpetofauna species. This is the first study of amphibians and reptiles in the Gambella Zuria district. With very precise objectives, the present study provided the diversity and distribution of amphibians and reptiles in three Kebeles by stratifying into Tedia riverine forest, Jenena wetland, and Karmi riverine forest. Since amphibians play an important role in the ecosystem, loss of amphibian and reptile species is likely to affect other terrestrial vertebrates (birds and mammals) communities and their ecological roles in general. The study does not cover the entire area of Gambella Zuria district due to a lack of logistics, short time schedules, and inaccessibility. Therefore, a further comprehensive study should be taken to identify the diversity and abundance of all herpetofauna species found in the area. Even though the endemicity is low and according to IUCN Red list they are categorized under least concern, at present, they are found in terrible conditions. Besides this, the protection of wetlands is less than that of terrestrial ecosystems, owing to the fact that conservation efforts have been largely focused on large terrestrial mammals. This reveals that wetland ecosystems and wetland biodiversity are under great peril and urgent conservation measures should be taken. The identification of the herpetofauna was carried out by using field guides looking at their morphology. Hence, in the future study, there is an urgent need to use molecular techniques to analyze and understand the phylogenetic relationship with the highland species and to identify undescribed species collected from the study area.

ACKNOWLEDGMENTS

My deepest gratitude goes to my advisor Prof. Afework Bekele for his encouragement, advice, assistance and unreserved support in all aspects of this research work. His willingness to share his knowledge and experiences is greatly acknowledged. I thank Mr. Okumu, Environment and Climate Change expert in the Gambella region office, for his assistant in the fieldwork and language translation. I thank EBI for the willingness to provide field materials and financial support for my field trip.

REFERENCES

Bickford, D., Howard, S.D., Ng, D.J., & Sheridan, J.A. (2010). Impacts of climate change on the amphibians and reptiles of Southeast Asia. *Biodiversity and Conservation, 19*(4), 1043-1062.

Donnelly, M.A., & Crump, M.L. (1998). Potential effects of climate change on two neotropical amphibian assemblages. *Potential Impacts of Climate Change on Tropical Forest Ecosystems.* Kluwer Academic Publishers Group, pp. 401-421.

Duellman, W. (1990). Herpetofaunas in Neotropical rainforests: comparative composition, history, and resource use. In: Ed. A.H. Henry, *Four Neotropical rainforests.* Yale University Press, New Haven, Connecticut, pp. 455-505.

Harper, E.B., Measey, G.J., Patrick, D.A., Menegon, M., Vonesh, J.R., & Swilla, I. (2010). *Field guide to the amphibians of the Eastern Arc Mountains and Coastal Forests of Tanzania and Kenya.* Nairobi, Kenya: Camerapix Publishers International, pp. 114.

Heyer, R., Donnelly, M. A., Foster, M., & Mcdiarmid, R. (2014). *Measuring and monitoring biological diversity: standard methods for amphibians*. Smithsonian Institution Press, Washington, DC, pp. 1-364.

Howell, K. (2002). Amphibians and reptiles: the herptiles. In: *African forest Biodiversity, a field survey manual for vertebrates* (Ed. G. Davies), Earthwatch Europe Publisher, pp. 17-69.

Iucn, U. (2013). WWF. 1991. *Caring for the Earth: A Strategy For Sustainable Living,* Glands, Switerland, pp. 1-994.

Largen, M.J., & Rasmussen, J. B. (1993). Catalogue of the snakes of Ethiopia (Reptilia Serpentes), including identification keys. *Tropical Zoology*, *6*(2), 313-434.

Smith, M.L., Noonan, B. P., & Colston, T.J. (2017). The role of climatic and geological events in generating diversity in Ethiopian grass frogs (Genus: Ptychadena). *Royal Society Open Science*, *4*(8), DOI: 10.1098/rsos. 170021.

Spawls, S., Howell, K., & Drewes, R.C. (2006). *Pocket Guide to the Reptiles and Amphibians of East Africa*: Published by A & C Black, London, pp. 1-297.

Watkins, T. (2006). An introduction to cost benefit analysis. *San Jose State University Department of Economics* [database online]. San Jose, California,[cited January 26 Available from http://www. sjsu. edu/faculty/watkins/cba. htm.

Zar, J. (1996). Biostatistical Analysis–Prentice–Hall International. Inc., London, pp. 1-662.

Zar, J. (1999). Biostatistical analysis 4th ed. Prentice-Hall, New Jersey. pp. 1-663.