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DIVERSITY AND ABUNDANCE OF AMPHIBIANS IN THREE WETLANDS(KOFFE, KITTO AND BOYE) AROUND JIMMA TOWN, SOUTH WEST ETHIOPIA

A THESIS SUBMITTED TO DEPARTMENT OF BIOLOGY, COLLEGE OF NATURAL SCIENCE, JIMMA UNIVERSITY FOR THE FULFILMENT OF THE REQUIREMENTS OF MASTERS DEGREE IN BIOLOGY (ECOLOGICAL AND SYSTEMATIC ZOOLOGY)

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DECLARATION

I, the undersigned, declare that this thesis is my original work and has not been presented in this Or other universities and all sources or materials used for this study have been fully acknowledged

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Acronyms and abbreviations

VES-Visual encounters surveys

AES-Acoustic Encounter surveys

IUCN-International Union for Conservation of Nature natural resources

SNNP-Southern Nations, Nationalities, and PeoplesRegion

FDRE-Federal Democratic Republic of Ethiopia

NMA-National Meteorology Agency

GPS-Global Positioning System

JU Jimma University

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Abstract

This study aimed to assess the diversity and abundance of amphibians in Kofe, Kito and Boye wetlands around Jimma town, south western Ethiopia. For the data collection transect line were established along the whole area of the three wetlands. Representative transects were randomly selected for actual survey. Visual encounter surveys (VES) and Acoustic Encounter surveys (AES) methods were used for the assessment of amphibian presence along accessible length of the established transect. Amphibians observed were handpicked and placed in Zip locked plastic bags and brought to zoology laboratory JimmaUniversity (JU) for identification using standard key largen and spawl was used for identification. Data was collected from March-September of 2018.Ten species of amphibians were recorded all distributed in sixgenus. Among these nine species were identified to the species level. One species was identified to genus level. The identified species werePtychadenaneumani, Ptychadenawadei,Ptychadenamascareniensis,Ptychadenaerlangeri, Hyperollusviridiflavus, Afrixalusenseticola, Xenopuslargeni,Buforegularis and Lepitopelisragazzi.Of the trapped 501 individuals, amphibians the most individuals (79) were of p. wadei and least (20) was of L.ragazzi.The study shows degradation of habitats especially Boye wetland, so as to minimize the problem creating awareness among people by employing appropriate communication strategies about their importance of wetlands.

Keywords:Abundance,amphibians,Boye,diversity, Ethiopia,Jimma, Kofe,Kito, wetland.

1. Introduction

1.1 Background

Amphibians are unique animals because; they spend their lives in water and on land and include frogs, toads, salamanders and caecilians. About 7528 amphibian species are known worldwide with varying density, of which Anura, Caudata, and Gymnophiona account for 88%, 9% and 3%, respectively (Frost, 2016). One hundred sixty one (161) species are known from East Africa and in Ethiopia, 63 species of amphibian are reported of which 25 species (40%) are endemic (Howell, 2002).This includes six endemic genera, namely *Sylvacaecilia* (Wake, 1987),*Altiphyrnoides* (Dubois, 1987), *Spinophyrnoides (*Dubois, 1987), *Ericabatrachus* (Largen,1991), *Balebreviceps* (Largen and Drewes 1989) and *Paracassina* (Peracca, 1907)Three amphibian species appear to be confined to low land forest in south- western Ethiopia. But the majorities of endemics are most clearly associated with montaneforest grass land or moor land in the altitudinal range 1800-4000m.(Largen,2001)

Amphibians are important indicator animals, because they are extremely sensitive to changes in their environment (Lambert, 1997). There are several ways in which amphibians serve to benefit the environment. They eat large numbers of insects, including many harmful ones This is particularly true of the common Square-marked Toad, *B,regularis,* which is often found around the house or garden. Tadpoles of some species feed primarily on mosquito larvae (Rose, 1927).Other study revealed that amphibians serve as food and medicine for humans (Mohneke*et al.,* 2011)Ethiopian amphibians are the least focused of all other major vertebrates in terms of economic and social contribution (Mengistu, *et al*., 2013).

Up to 1985, the number of recognized species of amphibians has increased by over 60% (Frost, 2016). However, more than 150 become extinct (McCallum, 2007 cited in Teme*et al.,* 2016). This shows extinction rate for amphibians is greater and their decline may cause other species to become threatened (Matthews, 2002). Different hypotheses are suggested for amphibian declines. Habitat destruction, fragmentation and invasive species are the greatest threats. Pollution affects about 19% of amphibian species, which is higher than those recorded for birds or mammals (Stuart, 2008). The permeability of amphibian skin makes them susceptible to chemicals in the environment. Infectious diseases are listed among the major threats to global

loss of amphibian diversity (Stuart, 2008). International Union for Conservation of Nature has identified 41% of amphibians are at risk of extinction (IUCN, 2016).

The lack of accurate information on amphibian distributions, particularly for tropical regions where diversity and rate of declines are proportional is often roadblock for effective ecosystem restoration, conservation and management (Warrenton, 2016).Therefore, information regarding species diversity is needed to determine habitat protection and restoration strategies. This study was aimed to obtain base line information on the currentdiversity and abundance of amphibians in Kofe, Kito and Boye wetlands around Jimma town.

1.2. Statement of the problem

Amphibian declines and extinctions are global and rapid: 32.5% of 5743 the described species are threatened, with at least 9, and perhaps 122, becoming extinct since1980 (Stuart, 2004). Species have disappeared across the entire taxonomic group and in nearly all regions of the planet (Stuart, 2004) Nearly a quarter of known amphibian species were deemed "data deficient" with respect to conservation status in the recent global assessment. Within breeding ponds, amphibians face a biotic stressors (e.g., wetland desiccation, chemical contaminants, habitat disturbance) and biotic stressors (e.g., invasive competitors, predators and human activity) (Blaustein and Kiesecker, 2002). They are also particularly sensitive to surrounding landscape composition because of annual breeding migrations (Semlitsch, 1998). Isolated breeding ponds imbedded in fragmented landscapes can become population sinks if dispersers experience high mortality (Rotherm*et al*2004).

Because of the nature of their delicate skin that is used for respiration, most amphibians dwell in moist habitats, such as swamps/bogs, streams, lake shores, and moist forests (Pough*et al*., 2003). Drying or decreased moisture of such habitats brings the fragmentation of micro-habitats and local extinction of amphibians. Atits extreme, this could lead to extinction of species that have narrow geographic distribution and specialized resource requirements (IBC, 2005).

Wetland resources in Ethiopia are not fully documented. They are currently threatened throughout Ethiopia (Birhan*et al*., 2015). However, many scholars inventory indicates that about 2% of the total land coverage in Ethiopia is wetland. Like other developing countries most of Ethiopian wetlands are under the risk of degradation and loss due to population growth, policy related issues, on site and off site management problems, cultivation of wetland due to fall of upland production, draining, farmers need to meet their household food requirements and occurrence of drought (Mekonnen andAticho, 2011). In Ethiopia, wetland management is not efficiently coordinated and lacks adequate policy support. Due to the absence of workable institutional arrangement and wetland management policy, sustainable management of wetland and capacity building are not strengthened. As a result the field suffers from shortage of skilled manpower which is capable of disseminating the concept of wise use of wetlands (Birhan*et al*., 2015). The wetlands located at the periphery of Jimma town, southwestern Ethiopia, have critical

roles in providing a range of ecological and socio-economic benefits, yet they are subject to increasing anthropogenic disturbances, notably through agriculture, settlement, intensive grazing and brick making(Desta and Mengistou,2009).Even though different study done on amphibian's abundance and diversity in different area; still now no known information on the diversity, abundance and status of amphibians in Kofe,Kito and Boye wetlands around Jimma town. Therefore the present study will be expected to answer the following research question:

What is the diversity of amphibian's in the study area?

What is the relative abundance of amphibians in the study area?

1.3. Objectives of the study

1.3.1 General objective

- The general objective of this study was to assess the diversity and relative abundance of amphibians in the three wetland areas surrounding Jimmatown.

1.3.2 Specific objective

- To identify the species diversity of amphibians in the three wetlands.
- To determine the abundance of amphibian species in the three wetlands.
- To compare the abundance of amphibians in the three wetlands in both dry and wet seasons.

1.4. Significance of the study

Lack of information about the diversity of species, their distribution and possible threats of Ethiopia herpetofaunashould become the major concern for ecologists. The present study investigates the current diversity and abundance of amphibians in Koffe, Kitto and Boye wetlands around Jimma town together with the Land use/ cover changes occurred in the wetlands. The study will contribute in filling the information gaps about amphibian diversity and abundance in south western highland wetlands. In addition this investigates the impact of human activity in the wetlands and hence, its biodiversity. The up to date information on the current status of the wetlands provide insight the concerning body to take appropriate management measures.

2. Literature Review

2.1. Features of amphibians

Amphibians are vertebrate animals with smooth skins. Except in a few species, their fingers and toes lack claws. These features and the absence of external scales readily distinguished them from either fishes or reptiles. Except for limbless caecilians all have paired limbs as adults. Eggs are laid in water where larvae called tadpoles develop until metamorphosis. Prior to metamorphosis, leg develop ready to take over locomotion as the tail is absorbed during transformation. The word “amphibian” meaning “double life”, refers to the mode of life amphibians have; usually they spend part of their lives in water and part on land (Stewart, 1967).

2.2. Amphibian taxonomy

The class amphibian has three orders (Uredela, Anura and gymnophiona). Urodela, also called caudate consists all tailed amphibians much resembling lizards uredelawith over 600 described species is the North American fauna and absent in Africa.The Anura(Salientia) are frogs and toads or the tail less forms their hind legs are large and modified for jumping. Approximately 4,500 species come under this category making Anura the largest order of the three.The Gymnophiona, Apoda (Caecilians) are highly specialized amphibians which resemble worms. Approximately 50 known species of caecilians together form the order Gymnophiona. These are the least-studied species in this group (https://animalsake.com/three-types-of-amphibians .accessed on july 1,2018). Gymnophionalackslimbs live under ground and have smooth skins with minute scales imbedded in the skin. (Oliver, 1965)

2.3 Importance of amphibians

The ecological importance of amphibians includes their association with both aquatic and terrestrial environments where matter and energy are circulated between aquatic and terrestrial habitats. Their movement cycles essential nutrients such as Phosphorus, Carbon and Nitrogen improving the overall health and resilience of the ecosystem. In many northern forests and vernal pools, amphibians account for a greater biomass than birds, mammals and reptiles combined. They are a central part of many food webs being both predators and prey and being amphibians provide many predators with a stable food and nutrient source. The large number of prey eaten daily by amphibians make them useful regulators of biomass in lower tropic levels contributing to ecosystem stability as well as biological control agents against pests such as mosquitoes biting flies and crop-damaging arthropods. Their thin skin and superficial vasculature make them sensitive to environmental pollutants thereby making them useful indicator species as well(Hocking *et al*., 2014, West,2018).

Amphibians serve as a food source for some human societies particularly in Southeast Asia. They are exploited as model organism in ecological, embryological, physiological and genetic research. Amines, alkaloids and polypeptides are found in skins of amphibians and have pharmacological importance. In human cultures, amphibians featured through ages in the form of poetry, songs or stories. Amphibians have been a good food source and few years ago India dominated in frog leg export (it is completely banned now) along with Southeast Asian countries. This has resulted in increased insect pest population. In addition they serve as models in medical research and medical applications such as tissue regeneration, biomimicry of pharmaceutically useful compounds such as analgesics and anti-viral drugs derived from skin secretions and direct socio-economic benefits and overall ecosystem values (Hocking*et al*., 2014).

2.4 The Status of Ethiopian Amphibians

Ethiopia has a diverse amphibian fauna occurring in various ecosystems, from savanna to alpine highlands. The Ethiopian Highlands are particularly important habitats as several endemic amphibian genera and species are restricted to these highly fragmented areas. Amphibian web (2015), reported the recordof66 species of amphibians are currently recorded from Ethiopia of which 41% are endemic (Evangelista *et al*., 2008) Largon and Spawl (2010) reported the recorded of 38 species of Amphibians from south west portion of the country. Although the Southwest of Ethiopia is known to harbor the last large tracts of natural forest and extensive wetlands few reports are available for the herpetofauna in general. For instance(De Beenouwer*et al*., 2015) reported 16 species of amphibians from Belete Gera forest, these auteurs also recorded 37. 5% species of amphibians from shake biosphere reserve. Recently (Habtam*et al*.2017) reported17amphibian species from few localities in Iluababora mountain forest. From the recordherpitofaunal list nearly 59% were endemic to Ethiopia. The large extent of the south western high land wetlands in the south western part of the country is little explored. The three wetland areas surrounding Jimma town (Kofe,Kitoand Boye) are typical highland wetland with significant extent of area when such survey was hardly conducted. Therefore, accurate information on species conservation and distribution is an essential first step to facilitate the delivery of conservation updates, recognize biodiversity hotspots and encourage habitat protection and restoration(Rovero*et al*., 2014)

Ethiopian endemics are represented across a wide range of taxa particularly in charismatic fauna such as birds and mammals (Yalden*et al*., 1996). There are currently 64 amphibian species recorded as occurring in Ethiopia. These belong mostly to the Order Anura, with a singleSpecies representing Caecilians (Apoda),and no representative of salamanders (Caudata).Two of the 15 families, five of the 24 genera, and 26 of the 64 species are endemic to Ethiopia (Mengistu, 2012).

As is the case for amphibians worldwide, the survival of these species faces threats from habitat degradation, climate change, and a pathogenic fungal disease. Several factors might explain our low level of knowledge on Ethiopian amphibians; these are associated to culture and belief, education and training, and economic value (Mengistu, *et al*., 2013).

2.5 Status of World's Wetland Ecosystem

By definition of the U.S. Fish and Wildlife Service, wetlands are those areas that exist between the upland and the aquatic Environments. For lack of detailed inventories fully known in major continent (eg South America, Africa and Russia).Wetlands continue to decline globally, both in area and in quality. As a result, the ecosystem services that wetlands provide to society are diminished (Gardner *et al*., 2015). The current distribution and extent of wetlands no longer coincides closely with that which previously existed; the conversion and loss of wetlands has seen major changes in the area and ecological condition of many wetlands (Junk *et al*., 2013).

The global estimates of wetland areas range from 560,000,000–970,000,000 ha (Finlayson andSpiers, 1999). However, the exact data about losses are not widely available. Large areas of wetlands have been destroyed in most countries. Wetland destruction is advanced in densely populated regions, such as Western Europe and parts of China, or in countries with shortages of water, such as Australia, and also in countries with powerful agro-industries, such as the USA. On the other hand, wetland restoration and man-made wetlands are becoming increasingly important. In the USA, during recent years, wetland restoration has increased the total area of wetlands. In China, 47 % of the wetlands are human-made (rice paddy plantations and fish ponds) (Junk *et al*., 2013).

2.6 Status of Ethiopian Wetland Ecosystem

Ethiopia has a wetland area of 22,600km^2.Wetland Ecosystem is under pressure emanating from conversion into agricultural land especially for rice production, over exploitation of wetland resources, deforestation, soil erosion and land degradation, siltation, settlement, climate change and pollution. FogeraandChefa wetlands in Amhara national regional state, for example, are highly affected by excessive use of swamps and flood plains for cultivation of rice and other horticultural crops. Moreover, Boye-Kito wetland located around the town of Jimma and Lake Chelelaka in Bishoftu town have shrunk due to expansion of agriculture and urbanization. To reverse this trend, efforts such as integrated watershed management, livelihood improvement, and family planning are being made in some national regional states such as Oromia, Amhara and SNNPR (FDRE, 2014).

Ethiopia having variable topography and altitudinal range, from 126m below sea level to 4,620m above sea level (a.s.l.), is a country endowed with rich wetland resources that include lakes, marshes, and swamps (YimerandMengistou, 2009).

With little inventory some scholars indicates that about 2% of the total land coverage in Ethiopia is wetland Ethiopia owns more than 58 different types of wetlands which provide enormous socio-economic and environmental values. Like other developing countries most of Ethiopian wetlands are under the risk of degradation and loss due to population growth, policy related issues, on site and off site management problems, cultivation of wetland due to fall of upland production, draining, farmers need to meet their household food requirements and occurrence of drought (MekonnenandAticho, 2011).

Despite all those and other indispensable values, these wetlands are under severe pressure and degradation. Due to improper extraction of uses and misconceptions forwarded to wetlands, the institutional health of the wetlands is continuously decreasing from time to time that in doubt their existence in the near future (Gebresllassie*et al*., 2014)As a result the wet for and health of the wetlands in the country are in a critical conditions. This largely impacted their ecosystem services and life support potential of this rich ecosystem. The problem becomes sever for the survival of the fauna and flora unique to the ecosystem the herpetofauna including institutional arrangement and wetland management policy, sustainable management of wetland and capacity building are not strengthened.(Birhan*et al*., 2015) As a result the wet for and health of the wetlands in the country are in a critical conditions.

2.7 Status of Boye,Kitto and Koffe wetlands of Jimma

The human impact in the three wetlands surrounding Jimma(Kito ,Kofe and Boye) is very high however disturbance value is greater for Boye and least Kofe(Desta*et al*., 2009) No long term studies for zoological resources of the three wetlands to show the trends, however, studies revealed as these are rich in micro and macro invertebrate diversity that may serve as a list forherpetofaunal communities of the area.

2.8 Wetland changes and impact on amphibians

Wetlands playa number of roles in the environment, principally water purification, flood control, carbon sink and shoreline stability. Wetlands are also considered the most biologically diverse of all ecosystems, serving as home to a wide range of plant and animal life including amphibians.For many amphibian species, loss and degradation of wetlands is a major threat. The major anthropogenic modifications to both wetlands themselves and adjacent lands include deforestation and (or) conversion to agricultural use, road construction, wetland drainage and in-filling, and urbanization. These changes in land use are often associated with fertilizer and herbicide application, wastewater runoff, and livestock waste. Such changes may result in reduction or degradation of habitat (Ross *et al*., 2000), increase mortality through road kill (Hels and Buchwald 2001), and destroy or degrade breeding habitat by modifying wetland hydrology (Euliss and Mushet, 1996) or increasing eutrophication (Crosbie and Chow-Fraser 1999). Adjacent land uses have a significant impact on amphibian species richness, abundance, and community composition, with the size and quality of adjacent habitat being at least as important as, if not more important than, the size and quality of the breeding habitat. Incompatible adjacent land uses can affect amphibian species richness and community composition out to 3000–4000 m from the wetland edge. Important correlates of amphibian species richness included road density, proportion wetland, wetland size, and water nitrogen levels (Houlahan and Findlay, 2003).

Small water bodies are linked to amphibian ontogeny and recruitment, since the eggs and larvae of most species are aquatic (Wells, 2007). Thus, ponds are important for many amphibian species reproduction, and for egg and larval development, as they are rich in nutrients and poor in predators (Williams et al., 2010). Ponds have high biodiversity, are key landscape elements, provide water management services, enable responses to climate change, and have aesthetic and recreational value (Céréghino*et al.*, 2014).

There is evidence that some biophysical factors can influence amphibian pond community structure and dynamics, namely hydrology, climate factors, pond area and depth, local habitat characteristics, altitude, predation, and species inter-annual turnover (Jeliazkov*et al*., 2014). However, there are few studies on temporal variation of amphibian pond communities, and most of them only address inter-annual variation. Pond area, hydrology, meteorology, predation,

habitat dynamics, and regional factors can affect species inter-annual turnover (Werner *et al*., 2007). Concerning intra-annual variation, there is some evidence that there is temporal segregation, that some species have two breeding periods, and that many species exhibit plasticity in the breeding and larval periods. Furthermore, temperature and rainfall can affect phenology (Both *et al.*, 2009).

Amphibian species richness would vary between habitats having different environmental characteristics. The hypothesis of spatial heterogeneity (Pianka, 1966 cited in Real *et al.,* 1993) states that the more heterogeneous and complex the physical environment, the more diverse and complex will be the communities that inhabit it. Disturbances of intermediate magnitude and frequency maintain the highest levels of species richness (Real *et al*., 1993).

3. The study area and methods

3.1 Description of the study areas and the study period

This study was conducted in three wetlands; Boye, Kito and Kofewetlandsbordering Jimma town south west Ethiopia. Boye is located in the Southeast between 07°38'-07°40' N latitude and 36°50'-36°54'E longitude; Kito wetland borders Jimma town to the southwest portion and located between 07°39'-07°41' N and 36°48'-36°50' E; while Kofe borders the southern part of the town and lies between 07°38'-07°39' N and 36°78'-36°50'E .The altitude of the study areas ranges from 1700-1900m a.s.l. The study areas receives rainfall from May to November and the dry season prevail from December to April with sporadic rain throughout.

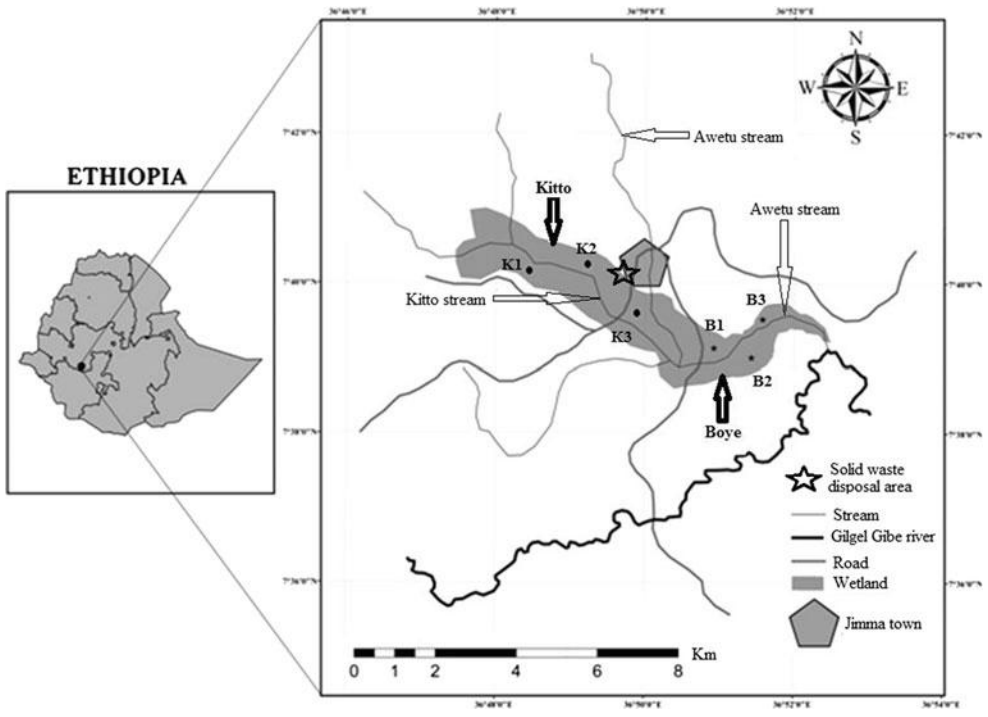


Figure 1 map showing study area

The annual rainfall of the last five years ranges from 2.025-9.116mm(NMA,2017).The area is characterized by warm climate with mean annual minimum and maximum temperature of16.1°C and 30.4°C respectively (NMA,2017).Average humidity of the area ranges between74.4 and 30.2% .The water source of Boyewetland is from AwetuRiver, whereas the source of water for Kito and Kofe wetlands is Kitoriver. The three wetlands are dominated by marshes and swamps with variable water level at different seasons. Boye is the largest341.64 ha) of the three wetlands, followed by Koffe (284.4 ha) and Kito is the smallest (258.32 ha).Topographically, the three wetlands are situated on a flat and surrounded by small hills.

The flat swampy grassland of the three wetlands is dominated by grass species including *Sporoboluspyramidus*and*Hyparrheniarufa.* The surrounding land and small hills are covered by Eucalyptus plantation (*Eucalyptus grandis*); some flowering and fruiting trees shrubs and herb species are also common. The study was carried out from March-September of 2018.

3.2. Methods

3.2.1. Preliminary survey

Preliminary survey was conducted for six days during thesedaysall accessible areas around each wetland were walked about GPS coordinates points were collected with certain interval demarcate the boundaries and to sketch map of each (Fig1) The study sites were also divided into grids, and then walking transects line were positioned using random sampling technique. Also observation of amphibians and habitats, obtaining local knowledge on their distribution and habitat type, major local uses of the wetlands, and

3.2.2 Visual encounter survey (VES) and Acoustic encounter survey (AES)

Fordata collection, the three wetlands were divided into transect lines. Accordingly the number of transect lines for Boye, Kito and Kofe were 12, 9 and 6respectively. Representative transects were randomly selected for actual survey. Visual encounter surveys (VES) and Acoustic Encounter surveys (AES) methods were used to assess amphibian along accessible length of the established transect. Amphibians observed were handpicked and placed in Zip locked plastic bag for their species identification. Data was collected when the most amphibians are active between 18:00 and 21:00 and between 05:00 and 06:00. Day time survey was also randomly conducted for some diurnal species. Location of each captured species was recorded for their use, mark on

their leg and release the sample after identification. From each species some are sampled to serve as a voucher specimen. Then the voucher specimens was tentatively identified to the species level, color notes was taken, labels were attached to specimens, preserved in 10% formalin and finally transferred to 70% ethanol. Preserved specimens were placed in JimmaUniversity Zoological laboratory for further researches. Through detailed investigation of their morphology, measurements of Snout-Vent Length and other body parts, such as head width, hind limb and other characteristics were taken and identified to the species level using Keyonlargon and Spawls (2014).All the external (coloration), toe characteristics was recorded. Hand staunch and headlight, plastic boots, zip lock plastic bag photographic camera, ruler and netwere used during the amphibians data collection.

3.2.3. Data Analysis

Shannon-Weiner (H′ = -Σ Pi ln Pi) diversity index was used to evaluate the amphibian diversity in each habitat Where, H'=Diversity index; Pi=the proportion of each species in the sample;lnpi=natural logarithm of this proportion. Species evenness among habitats in both wet and dry seasons were evaluated using Shannon-Wiener evenness index, Species Evenness = J/ Ln((s-1) / Ln(n)) Where, s = Number of Species Recorded n = Total Number of Individuals in the Sample J = Shannon wiener evenness Index. Species richness were quantified using Marglefs index (D) for species richness expressed as RI=(S-1)/lnN (Marglef,1968).Where S= total number of species ;N=Total number of individuals ;ln=natural logarithm .

By using Siegelstatically formula the significant different between dry and wet season of diversity index and evenness index was calculated by

$$\mathbf{C}=\sqrt{\frac{x^2}{N+x^2}}$$

Where, C= the value of relationship

N= grand total (the sum of all row totals)

x^2= (chi) is the summation of observed value minus expected value the whole square divided by expected value. According to Siegel and Spearman, two observations are said to have a perfect relationship if coefficient value is 1 (one). But if correlation value reads less than 0.5, there is weak correlation between the two observations.

4. Results

4.1. Species composition

The two season survey produced a total of 501 amphibians specimens distributed to ten species. The highest capture was from Kofe(199) followed by Kito(185) and the least from Boye (117) wetlands. The recorded species were from five families all under order anura. Among these family *ptychadena*has more species, while *xenopus* and*lepitopelis* hasthe least (Table 1)

Table 1. Amphibians recorded from the three wetlands, Jimma area

Family	Genus	Species	Number of individuals recorded for each species, in two season								
			Boye			Kitto			Koffe		
			Dry	Wet	Total	Dry	Wet	Total	Dry	Wet	Total
Ptychadenide	*Ptychadena*	*Ptychadenaneumani**	5	7	12	10	15	25	6	16	22
		*Ptychadenawadei**	4	10	14	8	20	28	10	27	37
		Ptychadenamascareniensis	6	8	14	9	14	23	8	10	18
		*Ptychadenaerlangeri**	5	8	13	4	10	14	8	19	27
Hyperoliidae	*Hyperolls*	*Hyperollusviridiflavus*	4	7	11	7	10	17	7	13	20
	Afrixalus	*Afrixalusenseticola**	**5**	**9**	**14**	**7**	**11**	**18**	**6**	**16**	**22**
Pipidae	*Xenopus*	*Xenopuslargeni**	**5**	**15**	**20**	**6**	**20**	**26**	**5**	**15**	**20**
Arthroldae	*Lepitopels*	*Lepitopelisragazzi**	**1**	**3**	**4**	**4**	**5**	**9**	**2**	**5**	**7**
Bufonidae	*Bufo*	*Buforegularis*	**2**	**4**	**6**	**3**	**5**	**8**	**2**	**5**	**7**
		Bufo species A	**4**	**5**	**9**	**7**	**10**	**17**	**7**	**12**	**19**
Total			**41**	**76**	**117**	**65**	**120**	**185**	**61**	**138**	**199**

*This symbol shows endemic species

Un identified species

All the recorded specimens were identified to the species level. However,one species from the genus *Bufo* were found difficult to identify the species with the resource we have. Therefore we temporarily named them as *B.speciesA.* Their detailed description is stated below

Bufo species A

This species was recorded from all wetlands in both seasons. In all nine individuals were recorded from Boye seventeen individual from Kito and nineteen individuals from Kofe. The specimen was grouped under genus *Bufo* because it has short limbs, thick glandular skins, horizontal pupil and mouth without teeth. Unlike the nearest species (*B.regularis*), this specimen has elongated snout and the presence of double strip on the rump area.

4.2 Amphibian species diversity and richness

During the present study the overall amphibian species was more diverse in Kofe (H= 2.25), followed by Kito(H=2.24)and the least in Boye (H= 2.21). The Shannon Weiner diversity index for the two seasons was H=2.4,2.2,2.19 for Kito, Boye and Koferespectively was recorded during the dry and H=2.23 (each for Boye and Kofe) and 2.2 for Kitoduring the wet season.

The evenness index for the recorded amphibian species was calculated for the three wetlands. Accordingly the overall species evenness was slightly higher for Kofe (J=4.23), followed by Kito(J= 4.11) and the least for Boye (J=3.47).

The result is that the correlation coefficient value C was 0.679. This shows us that there is perfect relationship between the two observations. This means that the relationship between dry and wet season are adequate. In other words, the relationship between dry and wet seasons is perfect. And the evenness index of dry and wet season has been determined. The result is that the correlation coefficient value C was 0.02235.This means that the evenness index of wet season does not adequately to the dry season. In other words, the relationship between dry and wet seasons does not adequately.

4.3 Abundance of amphibians in the thee wetlands

In Boye wetland the most abundant amphibian species was *X.largeni*,whichaccounts for 17% and the least abundant was *L.ragazzi* which accounts for 3.4%, In Kitto wetland the most abundant amphibian species was *P.wadei*,whichaccounts for 15% and the least abundant was *B.regularis* which accounts for 4.3% andInKofe wetland the most abundant amphibian species was *P.wadei*, which accounts for18.6% and the least abundant was*L.ragazzi* and *B.regularis* each accounts for 3.5% (Table 3)

Table 2. Abundance of amphibians in the three wetlands

			Number of species recorded in each wetland during wet and dry seasons					
Family	Genus	Species	Boye		Kito		Koffe	
Ptychadenide	*Ptychadena*	*P. neumani*	Dry	5	Dry	10	Dry	6
			Wet	7	Wet	15	Wet	16
			Total	12	Total	25	Total	22
			%	10.30	%	13.50	%	11.00
		P. wadei	Dry	4	Dry	8	Dry	10
			Wet	10	Wet	20	Wet	27
			Total	14	Total	28	Total	37
			%	12	%	15	%	18.60
		P. mascareniensis	Dry	6	Dry	9	Dry	8
			Wet	8	Wet	14	Wet	10
			Total	14	Tota	23	Total	18
			%	12	%	12.4	%	9
		P. erlangeri	Dry	5	Dry	7	Dry	8
			Wet	8	Wet	10	Wet	19
			Total	13	Total	17	Total	27
			%	11	%	9.2	%	13.4
Hyperoliidae	*Hyperollus*	*H. viridiflavus*	Dry	4	Dry	7	Dry	7
			Wet	7	Wet	10	Wet	13
			Total	11	Total	17	Total	20

			%	9.4	%	9.2	%	10
	Afrixalus	*A.enseticola*	Dry	5	Dry	7	Dry	6
			Wet	9	Wet	11	Wet	16
			Total	14	Total	18	Total	22
			%	17	%	9.7	%	11
Pipidae	*Xenopus*	*X. largeni*	Dry	5	Dry	6	Dry	5
			Wet	15	Wet	20	Wet	15
			Total	20	Total	26	Total	20
			%	17	%	14	%	10
Arthroldae	*Lepitopelis*	*L.ragazzi*	Dry	1	Dry	4	Dry	2
			Wet	3	Wet	5	Wet	5
			Total	4	Total	9	Total	7
			%	3.4	%	4.9	%	3.5
Bufonidae	*Bufo*	*B regularis*	Dry	2	Dry	3	Dry	2
			Wet	4	Wet	5	Wet	5
			Total	6	Total	8	Total	7
			%	5	%	4.3	%	3.5
		B. species A	Dry	4	Dry	7	Dry	7
			Wet	5	Wet	10	Wet	12
			Total	9	Total	17	Total	19
			%	7.7	%	9.2	%	9.6
Total			Dry	41	Dry	65	Dry	61
			Wet	76	Wet	120	Wet	138
			Total	117	Total	185	Total	199
			%	23	%	37	%	38

Discussion

The species *P.mascareniens*isrecorded from the three wetlands in both wet and dry seasons. .P.*mascareniensis* has white tympanum marking their dorsal skin fold has long there is no spiculs on their body. The dorsum is brown decorated with rows of darker spots and usually abroad vertebral band that is cream in colour.This species was earlier recorded in shoreline vegetation as well as flood pools near permanent low altitude waters near Soddotown and on shores of Lakes Ziway and Langano at altitudes(Mengistu, 2012).

The species*P.neumanni*recorded from the three wetlands in both wet and dry season. *P.neumanni*exhibit moderate sand-like, white tipped, Fine cone- shaped structures on the dorsal side of their body (sometimes including the top side of legs) and strictly on the lateral side of their body. This species was earlier recorded in such areas South high lands in Keffain GamoGofa (Mengistu, 2012).

The species *P.wadei*recorded from the three wetlands in both wet and dry season.*P.wadei*hasno tynpanum marking the mid ventral line is white and snout top marking is immaculate there is no spicules their dorsal skin fold is long. This species was erlier recorded inAbay River betweenLake Tana and the Tisiss at Falls, and we potentially expect it to occur across the mid-altitude plains forming the Lake TanaSub-basin in Gojam and Gondar provinces (EBEOO ˜ 6,000 km)in the northwestern highlands. (Mengistu, 2012)

The species *P.erlangeri*recorded from the three wetlands in both wet and dry season. *P.erlangeri* has no tympanum marking the mid ventral line has white the dorsal skin fold fragmented snout vent marking lined. This species was earlier recorded eastern shore of Lake Abaya at about 1300 m, a locality at the western hills of the southernmost segment of the Arsi-Bale massifs. The earlier distribution of this species has been thought to be patchy and distantly spaced (Mengistu, 2012).

The species*H.viridiflavus*recorded from the three wetlands in both wet and dry season. *H.viridiflavu*has green in color brown above often spotted but never strip. The snout is short.This species was earlier recorded in ethiopia (jimma) southern sudan ,Uganda ,Kenya andsouthern Smalia to Tanzania Ruwanda Burundi and eastern congoKeyonlargon and Spawls (2014)

The species*A.enseticola*recorded from the three wetlands in both wet and dry season. *A.enseticola*hasdark chocolate with vivid pattern of silvery white pigment, typically consisting of a broad dorso lateral stripe that extends over the upper eyelid to meet its neighbor in a triangle on top of snout. Head large and broader, hind limb long, finger webbed, and webbing of foot moderate This species was earlier recorded in Bonga ,Mizan Teferi Bale mountain national parkKeyonlargon and Spawls (2014)

The species*X.largeni* recorded fromthe three wetlands in both wet and dry season.*X. largeni*has smoothed skin clawed frogs dorsal color is dark their heads and bodies are depressed and flattened and they have small round eyes on the top of their head and hind limbs are flattened somewhat egg-shaped and streamlined bodies, and very slippery skin. This specieswas earlier recorded in such areas Dodola on the road to Asella Keyonlargon and Spawls (2014)

The species*L.ragazzi* recorded from the three wetlands in both wet and dry season. The tips of the digits are clearly expanded in to a well-defined adhesive discs. The dorsum is dark color the underside is white or cream.This species was earlier recorded insuch areas Arsi, Bale, Bore and ShewaKeyonlargon and Spawls (2014)

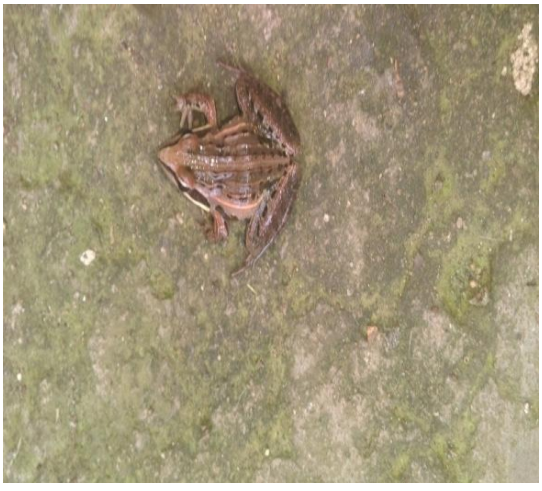
The species*B.regular*recorded from the three wetlands in both wet and dry season.The dorsum red brown and the underside of the body is whitish or cream. This species was earlier recorded in Lake Langano, Awassa.Keyonlargon and Spawls (2014)

Unidentified species Arecorded from the three wetlands in both wet and dry season.The specimen was grouped under genus Bufo because it has short limbs, thick glandular skins, horizontal pupil and mouth without teeth. Unlike the nearest species (B.regularis), this specimen has elongated snout and the presence of double strip on the rump area.

Then the voucher specimens was tentatively identified to the species level, color notes was taken, labels were attached to specimens, preserved in 10% formalin and finally transferred to 70% ethanol. Preserved specimens were placed in Jimma University Zoological laboratory for further researches. Through detailed investigation of their morphology, measurements of Snout-Vent Length and other body parts, such as head width, hind limb and other characteristics were taken and identified to the species level using Keyonlargon and Spawls (2014)

During this study the abundance of amphibians recorded vary among the wetlands more (199) in Kofe, followed by Kito (185) and the least (117) in Boye. The water chemistry, physicochemical and degree of pollution were reported high for Boye wetland due to intensive agriculture and disposal of wastes by the nearby community. The waste discharge from the town has directly caused the considerable reduction ofinvertebrates diversity (Ambelu*et al., 2013*) the variation may be the reported factors.

Photos of amphibians that recorded from the three Wet lands



FemaleAfrixalusenseticola

Female Ptychadenaneumanni

Female HyperoliusviridiflavusMale Ptychadenawadei

FemalePtychadenamascareniensisFemale Xenopuslargeni

Female Ptychadenaerlangeri*Female*Lepitopelisragazzi

Female Buforegolaris

Bufo species A

Amphibians searching during dry season

5. Conclusion

The finding of this study showed that existence of ten (10) species of amphibians, belonging to six (6) genus of these, nine species were identified species whereas the remaining one species*was*un identified species and the identified species are *P.neumani, P.wadei, P.mascareniesis, P.erlangeri, H.virdiflavus, A.enseticola, B.regularis, L.ragazis and X.largeni.*The total five hundred one (501) individuals of amphibians observed majority of the species, about seventy nine (79) individuals are *P.wadei* and the least recorded species are*L.ragazzi*.which accounts about twenty (20) individuals and among the three study wetland area majority of them about one hundred ninety nine (199) individuals consisting ten(10) different species were occurred in Koffe wetland, one hundred eighty five (185) individuals in Kito and one hundred seventeen were recorded from Boye wetland and all ten(10) species of amphibians were recorded from the three wetlands with variety of abundance. Distributions of the species were much more in wet season than in dry season.

6. Recommendation

Although the three wetlands supported several amphibian species in a quite good abundance, they have no conservation attentions from concerned bodies. The variety of land use patterns and anthropogenic alterations observed in and surrounding areas are major threats for the survival of the three wetlands and their fauna. As a precautionary measure a specific awareness program should be initiated to educate the people and resource users to protect them. In particular, the city municipality should give greater emphasis to control the pollution, create opportunities for designating as a protective area and utilized for recreation. More importantly, for the wetland to sustain their role in ecosystem function, specific management plan to these marvelous wetlands should also be a priority. Further follow up studies for a longer period will help to determine the ecology of amphibian species therein so as to determine their specific requirements.

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Appendix I

Average body measurement

Species	H W(mm)	S.V.L(mm)	H.L.l (mm)
p. neumanni	30.1	39	44
p. wadei	29.4	42	55
p. mascareniensis	32.6	45	59
P. erlangeri	28.2	46	49
H. virdiflavus	27.3	37	44
A.enseticila	34.3	40	54
X. largeni	33.2	44	52
L. raggazi	31.3	43	53
B. regularis	32.4	40	48
B. species.A	33.1	41	47

H.W (head width) S.V.L (snout vent length) H.L l (hind limb length)

KEY TO THE ANURA RECORDED FROM ETHIOPIA (Largen,2001)

1a. three inner toes bearing a hard, black claw; a row of stitch-like lateral line organs along each side of the body..... *Xenopus* 2

1b. Toes without claws; no lateral line organs 3

2a. Metatarsal tubercle bearing a conspicuous black claw; a prominent subocular tentacle..... *Xenopusclivii*

2b. No metatarsal tubercle; no subocular tentacle..... *Xenopuslargeni*

3a. Head small and very sharply pointed, the snout tip hardened for digging; a transverse groove across the head immediately behind the very small eyes; pupil vertical; limbs conspicuously short and powerful..... *Hemisus* 4

3b. Not having the above combination of characters..... 5

4a. Size smaller, snout-vent length of adult males 20-30 mm, of females 28-39 mm; metatarsal tubercle massively developed and strongly compressed, its length 62- 182% that of the free portion of toe V; ventrum whitish, immaculate apart from the gular region.....*Hemisus marmoratus*

4b. Size larger, snout-vent length of adult males 29-35 mm, of females 36-45 mm; metatarsal tubercle small and not conspicuously compressed, its length only 30- 46% that of toe V; ventrum yellowish, more or less extensively suffused with purplish-brown ..... *Hemisusmicroscaphus*

5a. Size moderate (snout-vent length up to 53 mm), form very robust; tympanum absent; foot conspicuously broad, unwebbed and with a much reduced fifth toe situated high on the side of the fourth; dorsum aposematic ally coloured with longitudinal bands of yellow and blackish-brown; known only from high altitude (3200 m) in the Bale Mountains ..... *Balebrevicepshillmani*

5b. Not having the above combination of characters 6

6a. Upper jaw toothless; pupil almost round; skin smooth, but with a pale and more or less distinctly raised urostylar gland on the posterior region of the back; digits with the terminal phalanx displaced from linear alignment by an intercalary cartilage, their tips dilated into broad, anteriorly truncate discs; toes without webbing; dorsum aposematicallycoloured with a vivid pattern of red or pink dorsolateral bands on a black background (Fig. 4); known only from southern Somalia and adjacent arid regions of Ethiopia ..... *Phrynomantissomalicus*

6b. Not having the above combination of characters..... 7

7a. Terminal phalanx of digits displaced from linear alignment by an intercalary cartilage; tips of digits often expanded into pronounced adhesive discs, each clearly delimited by a circummarginal groove 8

7b. Terminal phalanx of digits not displaced by an intercalary cartilage; tips of digits rarely expanded into well-defined discs with circummarginal grooves 25

8a. Hand with the digits arranged in two opposable pairs..... *Chiromantiskelleri*

8b.Hand with all digits set in the same plane..... 9

9a. Eye with a vertical pupil..... 12

9b. Eye with a horizontal or rounded pupil..... *Hyperolius* 10

10a. Size small, snout-vent length of adults 18-24 mm; snout elongated, acutely pointed and strongly projecting; no pronounced transverse fold across the throat of females and juveniles; not strongly dichromatic, the dorsum translucent green in life (straw-yellow in alcohol), with or without a pale dorsolateral stripe ....Hyperoliusnasutus

10b. Size small to moderate, snout-vent length of adults 23-35 mm; snout brief, broadly rounded to truncate, not strongly projecting; a pronounced transverse fold across the throat of females and juveniles; webbing of the foot rather extensive, always reaching beyond the subarticular tubercle of toe I; strongly dichromatic, phase J (juveniles and some males) brown above with longitudinal stripes that include at least a broad dark lateral band, phase F (adult females and remaining males) green or brown above often spotted but never striped .....*Hyperoliusviridiflavus*

10c. Size moderate to large, snout-vent length of adult males 29-33 mm, of females 33- 37 mm; snout rather long, obtusely pointed, somewhat projecting; no pronounced transverse fold across the throat of females and juveniles; webbing moderate, never reaching beyond the subarticulartubercle of toe I; not strongly dichromatic, the dorsum green, grey or brown in life and longitudinally striped 11

11a. Dorsum grey or brown; adults with a dark line above the canthus rostralis and a dark dorsolateral line extending from the posterior region of the upper eyelid towards the groin, juveniles with a pale dorsolateral stripe edged above and below by a dark line; ventrum immaculate; adult males with minute asperities on the dorsal surfaces .....*Hyperolius balfouri*

11b. Dorsum green to grey or brown; specimens of all ages with a dark line beneath the canthus rostralis and a broad lateral band of similar colour extending from the posterior margin of the eye towards the groin, both edged above by a more or less conspicuous pale stripe; ventrum sprinkled throughout with minute black chromatophores; adult males with no development of asperities on the dorsal surfaces .....*Hyperolius kivuensis*

12a. Dorsum usually prominently patterned with large, more or less rounded, sometimes confluent, dark blotches; vent directed ventrally and that of females with well-defined anal lobes; adult males with a heavily pigmented vocal sac which, when expanded, balloons on either side of the large gular flap..... 13

12b. Dorsum not prominently patterned with large rounded blotches; vent unspecialised; adult males lacking external modification of the throat or with a gular flap which allows the unpigmented vocal sac to expand without restriction……..17

13a. With or without a dark stripe or discrete row of blotches in the dorsal mid-line; chest and abdomen immaculate; tympanum visible; outer metatarsal tubercle small but distinct; gular flap of males longer than broad..... *Kassina* 14

13b. No dark stripe or discrete row of blotches in the dorsal mid-line; chest and abdomen usually patterned; tympanum usually hidden; outer metatarsal tubercle absent or very weak; gular flap of males with breadth equal to or greater than its length..... *Paracassina16*

14a. A large, dumb-bell or X-shaped blotch extending longitudinally from interorbital space to scapular region; tips of digits conspicuously flattened, transversely expanded and bearing distinct discs bounded by circummarginal grooves .....*Kassina maculifer*

14b. Interorbital-scapular region immaculate, or with a simple stripe or row of discrete blotches; tips of digits much less strongly expanded, with or without distinct discs bounded by circummarginal grooves 15

15a. Dorsum sometimes immaculate, more commonly with round to oval dark blotches randomly scattered or arranged in longitudinal rows, especially along the midline, but only rarely with an interrupted vertebral stripe or line of fused blotches; tips of digits tending to be flattened, somewhat transversely expanded and usually with detectable discs bounded by circummarginal grooves ..... *Kassinasomalica*

15b. Dorsum never immaculate, most commonly with an unbroken or weakly interrupted vertebral stripe, though this may occasionally be reduced to a row of separate blotches; tips of digits usually swollen, but not flattened or transversely expanded and lacking discs bounded by circummarginal grooves .....*Kassina senegalensis*

16a. Dark blotches on dorsum tending to be strongly defined, larger, fewer in number and more frequently coalescent; ventrum usually with discrete dark spots or blotches; groin bright yellow in life but often with no distinct pale patch delimited by darker pigment; known only from mountains to the east of the Ethiopian Rift Valley .....*Paracassinakounhiensis*

16b. Dark blotches on dorsum tending to be less strongly defined, smaller and more numerous; ventrum usually heavily marbled with dark pigment; a distinct pale patch (bright yellow in life) at the groin; known only from west of the Ethiopian Rift Valley .....*Paracassinaobscura*

17a. Size smaller, snout-vent length of adult males 20-29 mm, of females 23-30 mm; skin in both sexes with more or less conspicuous development of minute, sometimes melanised asperities; adult males with a prominent gular flap overlying the vocal sac..... *Afrixalus* 23

17b. Size larger, snout-vent length of adult males usually 26-56 mm, of females 38-63 mm; no development of asperities on the skin of either sex; adult males with the gular region unmodified externally, but having a pair of distinct pectoral glands.....*Leptopelis* 18

18a. Robust, terrestrial forms; digital discs small or absent; webbing of the foot reduced, leaving 1-11 - 2 phalanges free on toe V; inner metatarsal tubercle conspicuously enlarged, 6.3-9.1% of snout-vent length..... 22

18b. Gracile, arboreal forms; digital discs well developed; webbing of the foot more extensive, leaving only 1 - 3-1 phalanx free on toe V; inner metatarsal tubercle moderate, not more than 6.2% of snout-vent length 19

19a. Dorsum with three longitudinal dark stripes, the vertebral stripe and interorbital bar in continuity even when the rest of the pattern is disrupted, often more or less extensively suffused with brick-red pigment; known only from the Gughe Mountains in GemuGofa Province..... *Leptopelissusanae*

19b. Dorsum either immaculate or with a dark triangular mark on the back, the apex of which is not confluent with the interorbital bar; no suffusion of brick-red pigmen..... 20

20a. Onecolour phase only: dorsum brown with a dark triangle or V-shaped mark on the mid-back and conspicuous blue-green coloration at axilla and groin; known only from tropical deciduous forest in southwestern Ethiopia at altitudes of 1500- 2200..... *Leptopelisvannutellii*

20b. Two colour phases: dorsum brown with a dark triangle or V-shaped mark on the mid-back, or green and typically immaculate; rarely with any development of blue-green coloration at axilla and groin; not known to occur in the tropical deciduous forests of southwestern Ethiopia 21

21a. Size smaller, snout-vent length of adult males 26-34 mm, of females 38-43 mm; webbing of foot moderate, leaving 2 - 3-1 phalanx free on toe V; known only from montane grassland at 2000-2700 m in Gojjam Province. ..... *Leptopelisyaldeni*

21b. Size larger, snout-vent length of adult males 28-42 mm, of females 39-49 mm; webbing of foot more extensive, leaving only 1 - 3- 3 - 4 of a phalanx free on toe V; known only from montane forest at 1930-3100 m and not recorded from Gojjam Province ..... *Leptopelisragazzii*

22a. Dorsum almost invariably green; head moderate, its width 32-40% of snout-vent length; tympanum moderate, its horizontal diameter 35-51% that of the eye; known only from the Ethiopian mountains at altitudes of 1900-3900 m.....*Leptopelisgramineus*

22b. Dorsum of adults always brown (juveniles green); head large, its width 37-44% of snout-vent length; tympanum large, its horizontal diameter 45-64% that of the eye; recorded altitudinal range in Ethiopia 515-1900 m..... *Leptopelisbocagii*

23a. Dorsum usually green, sometimes with a dorsolateral dark line or row of spots but never prominently striped on the back; a distinct, yellowish and slightly swollen gland on the underside of the tarsus; known only from tropical deciduous forest in southwestern Ethiopia at altitudes of 820-1800 m ..... *Afrixalusclarkeorum*

23b. Dorsum never green and usually more or less prominently striped; no tarsal gland ……24

24a. Dorsal pattern typically consisting of a pale (often silvery-white) dorsolateral stripe that extends forward over the upper eyelid to meet its neighbour in a triangle on top of the snout (though these markings are occasionally much reduced or disrupted); subarticular tubercles of outer fingers partially divided or double; known only from grassland and forest at altitudes of 1700-2750 m ....*Afrixalus enseticola*

24b. Dorsal pattern consisting of four longitudinal dark bands that separate three pale stripes of similar width; subarticular tubercles of outer fingers single; lowland savanna ……..... *Afrixalusquadrivittatus*

25a. Skin thick, warty and often spinose; a large, elongate, more or less prominent parotid gland immediately behind each eye; upper jaw toothless 46

25b. Skin not usually conspicuously thick, warty or spinose; no parotid glands; upper jaw with teeth..... 26

26a. Inner metatarsal tubercle massive and strongly compressed for burrowing 27

26b. Inner metatarsal tubercle not exceptionally large or strongly compressed..... 28

27a. Dorsum almost or completely immaculate; tympanum very large, its maximum diameter about 68-108% that of the eye; adult males with paired vocal sacs, each capable of being expanded through a slit beneath the posterior margin of the lower jaw; known in Ethiopia only from the arid southeastern border region .....*Hildebrandtiamacrotympanum*

27b. Dorsum with a prominent pattern of dark spots, blotches or marbling; tympanum smaller, its maximum diameter about 40-66% that of the eye; adult males with a single, internal vocal sac and no gular slits; widespread in Ethiopia .....*Tomopternacryptotis*

28a. A small but conspicuous tubercle on the underside of the tarsus, about midway along its length, that is connected to the inner metatarsal tubercle by a more or less distinct tarsal ridge ..... *Phrynobatrachus* 29

28b. No such tarsal tubercle 31

29a. Size larger, snout-vent length of adult males 19-32 mm, of females 22-37 mm; toe IV with 2-3 phalanges free of significant webbing, broad web rarely falling short of and usually extending well beyond the distal subarticular tubercle on toes III and V; femoral glands absent .....*Phrynobatrachus natalensis*

29b. Size smaller, snout-vent length of adult males 13-20 mm, of females 15-23 mm; toe IV with 31 - 3-4 phalanges free of significant webbing, broad web always falling short of the distal subarticular tubercle on toes III and V; adult males with a more or less conspicuous femoral gland situated posteroventrally on the distal half of each thig…..... 30

30a. Size larger, snout-vent length of adult males 15-20 mm, of females 18-23 mm, broad web usually extending beyond the proximal subarticular tubercle on toes III and V, investing up to half the basal phalanx on the former and up to twothirds of this phalanx on the latter; adult males with extensive development of minute spinules on both dorsal and ventral surfaces of the body, but the throat not conspicuously darkened (bright yellow in life) and having no more than a pale grey cast in alcohol .....*Phrynobatrachus minutus*

30b. Size smaller, snout-vent length of adult males 13-16 mm, of females 15-17 mm; broad web not or scarcely extending beyond the proximal subarticular tubercle on toes III and V, investing at most only a quarter of the basal phalanx on these toes; adult males with little or no

development of spinules except occasionally on the chin, but the throat rather strongly suffused with dark pigment (probably not bright yellow in life).....*Phrynobatrachusinexpectatus*

31a. Size small, snout-vent length of adult males 19-22 mm, of females 23-27 mm; first finger conspicuously reduced; tips of digits dilated, each with a small adhesive disc ventrally and all but the first finger terminally bifid on the dorsal surface; adult males with a conspicuous, swollen, oval femoral gland on the underside of each thigh; chest and abdomen strongly patterned with vivid white spots on a dark background and similar spots at the groin brilliant yellow; known only from high altitude (2400-3200 m) in the Bale Mountains ..... *Ericabatrachusbaleensis*

31b. Not having the above combination of characters..... 32

32a. Size very small (snout-vent length of adults not exceeding 24 mm); tympanum hidden, its position occupied by a distinct longitudinal furrow; toes without webbing; chest and abdomen usually prominently patterned with grey to black spots or blotches (though in rare examples these may be almost imperceptible) ....*Cacosternum*boettgeri

32b. Not having the above combination of characters..... 33

33a. Size very large (snout-vent length of adults up to 155 mm); a transverse groove across the head immediately behind the eyes; all toes fully webbed 34

33b. Size generally smaller; no transverse groove in the occipital region; webbing leaving at least one phalanx free on the fourth toe 35

34a Tympanum clearly visible; adult males with external vocal sacs, each capable of being expanded through a slit beneath the posterior margin of the lower jaw.....*Euphlyctis occipitalis*

34b. Tympanum completely hidden beneath the skin (sometimes just visible in juveniles); adult males with no external vocal sacs or gularslits.....*Conrauabeccarii*

35a. Size rather large, snout-vent length of adult males 65-78 mm, of females 70-86 mm; webbing restricted, leaving 21 - 2-31 - 4 phalanges free on the fourth toe; back conspicuously ornamented by a pair of broad, pale dorsolateral bands, each extending from the upper eyelid to

near the hindlimb insertion (Fig. 8); adult males with external vocal sacs, each capable of being expanded through a slit beneath the posterior margin of the lower jaw.....*Hylaranagalamensis*

35b. Not having the above combination of characters..... 36

36a. Vomerine teeth not in contact with the margins of the internal nares; back with a pair of dorsolateral skin folds, extending from the upper eyelid at least to the sacral region, that are clearly more prominent and complete than any other ridges which may be present ; adult males with internal vocal sacs and no gular slits ..... *Ranaangolensis*

36b. Vomerine teeth (if present) in contact with the anterior margins of the internal nares; back typically with 4-5 pairs of conspicuous longitudinal skin folds, though these may be more or less extensively fragmented or even absent; dorsolateral skin folds (if present) not clearly more prominent and complete than any other ridges on the back; adult males with external vocal sacs, each capable of being expanded through a slit beneath the posterior margin of the lower jaw ....*Ptychadena* 37

37a. Webbing extensive, toe IV with 11 - 2-2 phalanges and toe V with 0-3 - 4 of a phalanx free of web 40

37b. Webbing moderate, toe IV with 2-31 - 4 phalanges and toe V with 1 - 4-11 - 2 phalanges free of web..... 41

37c. Webbing brief, toe IV with 21 - 2-31 - 2 phalanges and toe V with 11 - 4-21 - 2 phalanges free of web..... 38

38a. Five pairs of essentially complete skin folds on the back, the paravertebrals being replaced posteriorly by a pair of sacral folds; outer metatarsal tubercle present; posterior face of thigh more or less feebly patterned with dark streaks on a pale background .....*Ptychadena wadei*

38b. Skin folds on the back often more or less extensively and irregularly fragmented; outer metatarsal tubercle usually absent; posterior face of thigh invariably patterned with pale spots or mottling on a dark background 39

39a. Size larger, snout-vent length of adult males 35-47 mm, of females 40-54 mm; hindlimbs long, tibia 51-64% of snout-vent length; paravertebral skin folds extending anteriorly at least as far as the occiput and often reaching the interorbital or prefrontal region; gular slits of the male semi-inferior (ending posteriorly near the middle of the forelimb insertion) ..... *Ptychadenaerlangeri*

39b. Size smaller, snout-vent length of adult males 31-40 mm, of females 33-47 mm; hindlimbs moderate, tibia 43-62% of snout-vent length; paravertebral skin folds extending anteriorly at least as far as the occiput and often reaching the interorbital or prefrontal region; gular slits of the male inferior (ending posteriorly near the lower edge of the forelimb insertion) ..... *Ptychadenaneumanni*

39c. Size smallest, snout-vent length of adult males 24-27 mm, of females 25-30 mm; hindlimbs brief, tibia 40-50% of snout-vent length; paravertebral skin folds not extending anteriorly beyond the scapular region; gular slits of the male inferior ....*Ptychadena nana*

40a. Inner metatarsal tubercle no more than weakly compressed and of moderate size, in length about equal to its distance from the subarticular tubercle of the first toe; outer metatarsal tubercle usually absent, otherwise small and rounded; a more or less conspicuous pale triangle on the upper surface of the snout contrasting with the rest of the dorsum; dark markings on the back present or absent ....*Ptychadena anchietae*

40b. Inner metatarsal tubercle more obviously compressed and distinctly large, in length clearly greater than its distance from the subarticular tubercle of the first toe; outer metatarsal tubercle large and elongate; no conspicuous pale triangle on the upper surface of the snout contrasting with the rest of the dorsum; no dark markings on the back. ..... *Ptychadenatellinii*

41a. Four pairs of essentially complete longitudinal skin folds on the back, the paravertebral pair generally extending unbroken from occiput to supra-anal region..... 44

41b. Skin folds on the back more or less extensively and irregularly fragmented, the paravertebral folds never continuous from occiput to supra-anal region 42

42a. Size smaller, snout-vent length of adult males 36-39 mm, of females about 45 mm; a more or less conspicuous pale triangle on the upper surface of the snout; no pale vertebral or tibial lines; gular slits of the male inferior .... *Ptychadenaharenna*

42b. Size larger, snout-vent length of adult males 38-60 mm, of females 37-71 mm; no conspicuous pale triangle on the upper surface of the snout; pale vertebral and/or tibial lines often present; gular slits of the male semi-inferior 43

43a. Length of foot less than half snout-vent length; ventrum immaculate; a species of lowland savanna (perhaps confined in Ethiopia to the southwestern border regions).....*Ptychadena schillukorum*

43b. Length of foot greater than half snout-vent length; entire ventrum patterned by a reticulum of pale grey to dark brown pigment; a species of montane grassland and forest edge (recorded altitudinal range 2500-3100 m) ..... *Ptychadenacooperi*

44a. Toe IV with at least 3 phalanges free of web; a row of supernumerary tubercles often present beneath the fourth metatarsus; sole of foot uniformly pigmented; gular slits of the male inferior .....*Ptychadena porosissima*

44b. Toe IV with not more than 21 - 2 phalanges free of web; no supernumerary tubercles beneath the fourth metatarsus; sole of foot more or less conspicuously bicoloured (the webbing being paler than the underside of the toes); gular slits of the male superior (ending posteriorly above the upper edge of the forelimb insertion) or semi-inferior 45

45a. Size larger, snout-vent length of adult males 34-47 mm, of females 37-58 mm; posterior face of thigh with a bold longitudinal pattern of pale and dark stripes, the lowermost dark band not extending beneath the vent; dark crossbars on tibia interrupted mid-dorsally; gular slits of the male superior .....*Ptychadena mascareniensis*

45b. Size smaller, snout-vent length of adult males 27-40 mm, of females 31-43 mm; posterior face of thigh with a bold longitudinal pattern of pale and dark stripes, the lowermost dark band

continuous with its opposite neighbour beneath the vent; dark crossbars on tibia usually not interrupted mid-dorsally; gular slits of the male semi-inferior ..... *Ptychadenapumilio*

45c. Size smallest, snout-vent length of adult males 26-34 mm, of females 30-40 mm; posterior face of thigh with a comparatively delicate longitudinal pattern comprised of rows of small pale spots or fine beaded lines on a dark background; gular slits of the male superior ..... *Ptychadenafilwoha*

46a. Tympanum present, usually very conspicuous..... Bufo 48

46b. Tympanum absent; found only in montane habitats at altitudes of 1950-4000 m... ……47

47a. Size larger, snout-vent length of adult males up to 52.5 mm, of females up to 62 mm; tibia more than one-third of snout-vent length; dorsum usually with a dark Y- or X-shaped mark overlying the head and shoulder region; known only from the mountains of Arussi, Bale and Sidamo Provinces at altitudes of 1950-3520 m .. ..*Spinophrynoidesosgoodi*

47b. Size smaller, snout-vent length of adult males up to 21 mm, of females up to 31.5 mm; tibia less than one-third of snout-vent length; dorsum usually with three pale longitudinal stripes, one vertebral and two dorsolateral, often accentuated by dark margins; known only from the Bale Mountains at altitudes of 3200-4000 m ....*Altiphrynoidesmalcolmi*

48a. A pronounced longitudinal ridge on the inner ventrolateral margin of the tarsus …….... 50

48b. No such tarsal ridge (though there may be a row of partially fused warts in the same position) 49

49a. Digits short and stout, with at least some of the subarticular tubercles clearly double and numerous supernumerary tubercles; webbing of the foot often rather extensive, frequently leaving as little as 1 phalanx free on the fifth toe; a large and conspicuously swollen gland on the dorsal surface of the tibia; ventrum more or less heavily spotted with black; posterior face of thigh devoid of bright red pig ment even in life..... *Bufolughensis*

49b. Digits long and slender, the subarticular tubercles single and not accompanied by numerous supernumerary tubercles; webbing of the foot poorly developed, leaving about 2 phalanges free on the fifth toe; no large and conspicuously swollen gland on the dorsal surface of the tibia; chest

and abdomen immaculate or nearly so; posterior face of thigh prominently marked with bright red pigment (at least in life).....*Bufosteindachneri*

50a. Ventrum conspicuously smooth, especially on the throat and chest; tympanum unusually large, its horizontal diameter about 56-81% that of the eye, about 18- 26% of maximum head width; adult males with the gular region no more darkly pigmented than the rest of the ventrum; known in Ethiopia only from desert and semi-desert habitats in the eastern lowlands ..... *Bufododsoni*

50b. Not having the above combination of characters..... 51

51a. Size small, length from snout to tip of urostyle in adults not known to exceed 50 mm; tympanum unusually small, its horizontal diameter only 15-52% that of the eye and 7-15% of maximum head width; parotid glands low and often indistinct; known in Ethiopia only from desert and arid savanna habitats in the eastern lowlands.....*Bufoblanfordii*

51b. Not having the above combination of characters..... 52

52a. Posterior face of thigh (at least in life) usually conspicuously marked with bright red pigment; dorsum typically patterned with pairs of rich red-brown blotches, but obviously lacking such markings on the upper surface of the snout; tubercles on the underside of the forearm tending to be fused into a more or less continuous ridge; adult males with the gular region darkly pigmented; mating call a harsh croak or snore; known in Ethiopia only from the eastern and southern lowlands, at altitudes not exceeding 2000 m ..... *Bufogarmani*

52b. Posterior face of thigh (at least in life) usually conspicuously marked with bright red pigment; dorsum typically patterned with pairs of rather drab grey-brown blotches, including similar bilateral marks on the upper surface of the snout; tubercles on the underside of the forearm fused into a more or less continuous ridge; adult males with the gular region darkly pigmented; mating call a relatively pure unpulsed tone, somewhat resembling the hoot of a large owl; a lowland species, not recorded in Ethiopia at altitudes greater than 1500 m ..... *Bufoxeros*

52c. not having either of the above combinations of characters 53

53a. Dorsum with a strongly contrasting pattern of deep brown bilateral blotches, often highlighted by prominent pale margins; tubercles on the underside of the forearm typically fused into a more or less continuous ridge; adult males with the gular region no more darkly pigmented than the rest of the ventrum; a montane species, recorded in Ethiopia only within the altitudinal range 1500-3300 m ....*Bufo kerinyagae*

53b. Not having the above combination of characters..... 54

54a. Webbing extensive, leaving only 1-11 - 2 phalanges free on toe V and no more than 3 phalanges free of broad web on toe IV; parotid glands rather low and sometimes indistinct; vocal sac of males usually opening through a single (right or left) aperture in the floor of the mouth; posterior face of thigh generally with conspicuous pale blotches (yellow in life); back either unmarked or with a rather obscure pattern of bilaterally paired blotches, often paler than the background and tending to be orange in colour; known only from the northern sector of the Ethiopian Rift Valley ..... *Bufolanganoensis*

54b. Not having the above combination of characters 55

55a. Parotid glands flattened, lacking distinct margins and often further obscured by small granules or dark-tipped warts; size smaller, males maturing at a snouturostyle length of about 40 mm, females at about 50 mm ..... *Bufomaculatus*

55b. Parotid glands usually prominent, swollen and with distinct margins, typically porous rather than warty; size larger, males maturing at a snout-urostyle length of about 50 mm, females at about 60 mm (in Ethiopia adult males 49-85 mm, females 57-93 mm) 56

56a. Somatic chromosome number diploid (2n = 20); vocal sac of males opening into the buccal cavity through bilateral apertures in the floor of the mouth; scattered white spots sometimes present on the dorsum..... *Buforegularis*

56b. Somatic chromosome number tetraploid (4n = 40); vocal sac of males usually opening through a single (right or left) aperture in the floor of the mouth; no white spots on the dorsum.....
Bufoasmarae