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The Endemic Bale Monkey (Chlorocebus djamdjamensis): Distribution and Threat, A Review Paper

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Abstract
The Endemic bale monkey (*Chlorocebus djamdjamensis*) is a little-known primate species recorded as Vulnerable in the IUCN Red list. Bale monkeys are believed to be confined to bamboo forest habitats, specializing on the young leaves of highland bamboo (*Arundinaria alpina*). Bale monkeys found at Harenna Forest (BMNP), Kacha and Rira area at altitude 2800 masl, and at Odobullu Forest, in the bamboo forest 23km northwest of Dodolla, and Djam-Djam Mountains near "Abera" area, a region east of Lake Abaya at about 3000 masl, Hagere Selam regions (Southern Nations Nationalities Region, Sidamo) and recently recorded at Geremba mountain of Arbegona Wereda (Southern Nations Nationalities Region, Sidamo Zone). The species inhabit a wide range of habitat types including savannah, woodland forest, grassland and riverine forests and are generalists inhabiting different habitat types and feeding on different food sources. The range of this species is less than 20,000 km² with severe fragmentation and there is continuing decline due to ongoing habitat loss and degradation. Habitat destruction, agricultural land expansion, and human settlement are major threats of the species.
Keywords: Anthropogenic, Conservation, Habitat, Mammals, Threats

Introduction

Any vertebrate within the class Mammalia, distinguished from reptiles and bids by the possession of a neocrtex (a region of the brain), hair, three middle ear bones and mammalry glands is classified as a mammal (Vaughan *et al.,* 2012). Mammals are one of the most important components of biodiversity in the world. According to the most recent (3rd) edition of the standard taxonomic reference work, Mammal Species of the World (Wilson and Reeder, 2005), the class Mammalia comprises 5416 species. Of these 2277(42%) are rodents (Rodentia) and 1116 (20.6%) are bats (Chiroptera). The order Primates, with its 300 or more species, is the third most diverse order of mammals, after rodents (Rodentia) and bats (Chiroptera). Although there are some notable variations between some primate groups, they share several anatomic and functional characteristics reflective of their common ancestry. Primates, occupy a wide range of habitats even though they are a relatively small order. In addition, they occupied a wide diversity of ecological niches (Robbins and Hohmann, 2006). Ethiopia is also one of the countries with most diverse mammalian faunas in Africa (Yalden and Largen, 1992; Vreugdenhil *et al*., 2012) and harbors about 320 species of mammals including 36 endemics (Afework Bekele and Yalden, 2013). Different species and subspecies of primates occur in Ethiopia including bale monkey (*Cercopithecus djamdjamensis*), one of the endemic mammals of the country (Carpaneto and Gippoliti, 1994; Kingdon, 1997). This species was named after the Djam-Djam Mountains, a region found approximately 30 km west of Harenna Forest and east of Lake Abaya (Carpaneto and Gippoliti, 1994). The species restricted only to the Bale Mountains and Hagere Selam regions (Southern Nations Nationalities Region, Sidamo); bale monkey is threatened because of habitat destruction it inhabits (Hillman, 1986; IUCN, 2008).

Bale monkey (*Chlorocebus djamdjamensis*)

Taxonomy

The taxonomic position of Bale monkeys was in debate; Neumann first described Bale monkeys in 1902 as a species and named *Cercopithecus djamdjamensis*. Based on new records, Dandelot and Prévost (1972) re-described Bale monkeys and named *Cercopithecus aethiops djamdjamensis* as a distinct form of vervet/grivet complex. This taxonomy was also accepted by Carpaneto and Gippoliti (1994), Kingdon (1997) as they interbreed where the taxa have over-lapping ranges. Even though *Cercopithecus aethiops djamdjamensis* is classified as a subspecies under *Cercopithecus aethiops,* it is distinctive compared to its members (Kingdon, 1997). However, Groves (2005) categorized the subspecies of savannah monkeys in a single Genus *Chlorocebus* that contains the six-distinct species. Thus, based on this classification, the Bale monkey is now no longer part of the Genus *Cercopithecus* and classified as a distinct species as *Chlorocebus djamdjamensis* (Groves, 2005). As a result, the species is classified under Kingdom: Animalia, Phylum: Chordata, Class: Mammalia, Order: Primates, Family: Cercopithecidae, Sub-family: Cercopithecinea, Genus: Chlorocebus and Species: *Chlorocebus djamdjamensis* with various common names including Bale Monkey, Bale Mountains Grivet, Bale Mountains Vervet and Djam-djam.

Habitat and Ecology

Each mammal species has its own habitat use/preferences regard to vegetation type, terrain, living space and climate (Yalden and Largen, 1992; Vreugdenhil *et al*., 2012), for terrestrial mammals by far the most common habitat is the forest. Shrub-lands and grasslands are the next most favored habitats (IUCN, 2018). Notably rocky areas and caves are quite common habitat preferences too, most notably for bats. As IUCN Habitats Classification Scheme of 2018; the least favored habitats are those that are dry and arid. Ethiopia is a country rich in geographical diversity supporting diverse vegetation composition as a product of various factors such as climate, geology, and soil (Yalden and Largen, 1992); The diverse set of ecosystems ranging from humid forests and extensive wetlands to the desert; Alpine and mountainous vegetations that vary with coniferous and broadleaved forests, vast savannah, steppes and desserts are interrupted by lakes and intersected by permanent and seasonal rivers accompanied by gallery forests (Wolff, 1961) which are suitable habitats for large number of wild mammals. The country also consists of rugged mountains, flat-topped plateaus, deep gorges and river valleys.

A large percentage of the country consists of high plateaus and mountain ranges distinguished from all other World/African countries by the extent of its high ground; approximately 15% of Ethiopia lies above 2000 m a.s.l., and 2% is above 3000 m (Mesfin Wolde-Mariam, 1969; Nowotny and Pankova, 1981). For instance; 50.4% of land above 2000 m a.s.l., in the Afro-tropical Region (i.e. that part of the continent lying south of the Tropic of Cancer) is in Ethiopia, while 79.7% of land above 3000 m a.s.l., is in Ethiopia (Yalden, 1983), which are preferred habitats for very rare and endemic mammals. Vreugdenhil *et al*. (2003) also state that the species diversity in the cool mountains though, is much lower than in the hot moist lowlands, as in general, species diversity is highest in hot moist areas while rarity and endemicity are high at highland. *Chlorocebus* species inhabit a wide range of habitat types including savannah, woodland forest, grassland and riverine forests (Kingdon, 1997). Savannah monkeys are generalists inhabiting different habitat types and feeding on different food sources. They are opportunistic omnivores but fruits are the preferred items and most important.

They also consumed flowers, leaves, young shoots, bulbs, roots and grass seeds. In addition, they also feed on insects and other invertebrates and bird nestlings (Kingdon, 1997). As a genus, they are second to baboons in their ability to survive across a diverse range of ecological conditions and they appear to cope in most habitats (Kingdon, 1997). The ecology and behavior of other savannah monkeys have been relatively well studied. But still limited information is available for bale monkey. This species has specialized habitat requirements as it is found in the bamboo forest, Bale monkeys primarily inhabit bamboo forest and are described as bamboo forest habitat specialists with a high dietary specialization on young bamboo leaves, which account for 73% of their diet (Addisu Mekonnen *et al*., 2012). Given the general principal that the more specialized a primate's diet, the greater is its risk of extinction because of habitat loss and fragmentation, particularly destruction of bamboo forest. Interestingly, a very recent survey revealed that Bale monkeys continue to survive in the human dominated landscape where bamboo was eradicated several years ago (Addisu Mekonnen *et al*., 2012).

Distribution

The global distribution of overall mammalian species richness is concentrated in tropical regions throughout the world (Gaston, 2003; Lomolino *et al*., 2006). The highest concentrations being found in northern South America, East Africa, and Southeast Asia. In contrast, even though they are found overall continents, they are concentrated in relatively few regions containing many islands, peninsulas, or island-like habitats such as mountaintops (Gaston, 2003; Lomolino *et al*., 2006). In the Americas, there are relatively continuous concentrations in a large region extending from central Mexico to the northern and central Andes, and in the Atlantic forests of Brazil (Ceballos and Ehrlich, 2006). In Africa, restricted-range species are found commonly in the tropical lowlands of Cameroon in the west, in the inland and coastal forests of East Africa, on Madagascar and in the Ethiopian highlands (Ceballos and Ehrlich, 2006). As expected, the occurrence of centers of threatened species is concentrated in regions with high-impact human activities and it follows to a certain extent the patterns of species richness, threatened species are found throughout the world, with higher concentrations in tropical regions of the Western Hemisphere, Africa, and Asia (Gaston, 2003; Ceballos and Ehrlich, 2006; Lomolino *et al*., 2006).

The biogeography of the Ethiopia characterized by two features; the arid horn of Africa (Ogaden) and mosaic highland plateau (Young, 2012) and results extremely rich and distinctive flora and fauna. The country also has a diverse and contrasting from the desert of the Dankil Depression, the lowest dry land points on earth at 116 m below sea level to Ras Dashen Mountain at 4543 m above sea level (Yalden and Largen. 1992; Tefera Melaku. 2011). The altitudinal variation within the country produces a range of climate which affects every aspect of life in the country; plant and animal distributions; the concentrations are so interdependent on temperature zones, Rainfall and of the broad climatic zones which are largely determined by the altitudinal difference (Yalden and Largen, 1992; Young, 2012).

Chlorocebus species are the most widely distributed in Africa occurring from Senegal to Ethiopia and

southwards to South Africa (Kingdon, 1997; Groves, 2005). Vervet monkeys (*Chlorocebus pygerythrus)* are distributed in southern Ethiopia, Somalia to Zambia and southern part of Africa, tantalus monkey (*C. tantalus*) are found in the north central to western African countries and in Sudan and Kenya, green monkeys (*C. sabaeus*) are distributed in the west African countries. Grivet monkeys *(C. aethiops)* are distributed along the southeastern Sudan, north central Ethiopia and Eritrea. Malbrouck monkeys *(C. cynosuros)* are distributed from Democratic Republic of Congo to Namibia and Zambia (Kingdon, 1997; Groves, 2005). The distribution of bale monkeys is little-known with few known populations which are found in the Harenna Forest of the Bale Mountains National Park, Kacha (Butynski *et al*., 20008) and Rira area at altitude 2800 m asl (Carpanetoand Gippoliti, 1994; Kingdon, 1997), and Odobullu Forest (Anagaw Atickem, 2010). In addition, Bale monkeys were recorded in the bamboo forest 23 km northwest of Dodolla, and Djam-Djam Mountains near "Abera" area, a region east of Lake Abaya at about 3000 m asl (Carpaneto and Gippoliti, 1994; Butynski *et al*., 2008).

As Addisu Mekonin et al., 2012, bale monkeys are restricted only to the Bale Mountains and Hagere Selam regions (Southern Nations Nationalities Region, Sidamo). Additionally, Zerubabel Worku, 2018 confirmed the presence of isolated populations of bale monkey in Geremba mountain of Arbegona Wereda (Southern Nations Nationalities Region, Sidamo). The population status of other savannah monkeys is Lower Risk while the Bale monkey status was not determined (Kingdon, 1997; IUCN, 2008). However, Kingdon (1997) argued that Bale monkeys are an endangered species which inhabit areas where other unique species are similarly endangered. Currently, this species is Listed as Vulnerable as the range of this species is less than 20,000 km² with severe fragmentation and there is continuing decline due to ongoing habitat loss and degradation. The species occurs at low densities in bamboo forest, a very specialized and unusual habitat.

Conservation Challenges and Major Threats

A diverse habitat supports numerous species, while a dynamic habitat changes frequently through processes like vegetation succession, human activities, and environmental variations, thus influencing the species occurrence (MacKenzie *et al*., 2011). Changes in habitat affect species richness (Gurd *et al*., 2001), population, abundance and distribution (Best *et al*., 2001). The most direct threat to biodiversity comes from the destruction of the habitat on which it depends (Brian and Marine, 2016). Human interference has modified and fragmented important wildlife habitats, thus blocking key wildlife dispersal routes (pathways or corridors) and causing wild animals to be confined and sequestered in relatively well-protected areas. Mammals are the third most vulnerable group among vertebrates, with more than 30% of the species in one of the threatened categories according to the IUCN Red List (IUCN. 2016). A recent analysis shows that the conservation status of mammal species has declined between 1996 and 2008, and tropical species are among the most vulnerable (Hoffmann *et al*., 2010). Uncontrolled logging, illegal charcoal production, and fuel wood collection are some of the major causes of deforestation that directly influence the habitat.

The Global Gap Analysis by Conservation International on 2003 showed how Protected Areas around the world were not sufficient to meet conservation needs. In the face of global change and ensuing modifications of biodiversity patterns, research on species distribution and status is a prime focus in ecology and conservation (Austin, 2002; McMahon *et al.,* 2011). As Dirzo *et al*. (2009), anthropogenic impacts threaten the survival and abundance of mammals, the impact and high pressures on wild animals that resulted from an expansion of human settlement and agriculture. Furthermore, because of habitat destruction, some mammals, particularly predatory species of large size (e.g., mountain lions and leopards), will venture into urban areas, posing a risk to humans and to the animals themselves. The loss of these mammals can cause an entire series of trophic cascades and alter the ecosystem imbalance (Estes *et al.,* 2011). Globally, the main threats to non-flying terrestrial and arboreal mammals are habitat destruction, hunting, loss of critical resources, and illegal trade (Schipper *et al.,* 2008). Land conversion to agricultural ecosystems accounts for 80% of deforestation (Kissinger *et al.,* 2012; Gabrielle *et al.,* 2017), and is the leading driver of current rates of global biodiversity loss (Tscharntke *et al.,* 2005).

Ethiopia, one of the most densely populated countries in Africa with an estimated population of over 90 million people Population (UNECA, 2016). Pressures contribute significantly to environmental degradation in the country (Atickem Anagaw *et al.,* 2010). The forest cover of Ethiopia declined from 47% to only 3% for the past few decades due to ever increasing population and anthropogenic effect. Wildlife population in Ethiopia have diminished over the past century in diversity, density and distribution because of a loss of habitat, illegal hunting, land clearing for farming and land degradation due to overgrazing (Morgan, 1973; Yalden and Largen, 1992; Tefera Melaku, 2011). In Ethiopia, about 17.1% of the Ethiopian land is protected area (Amare Alemneh, 2015), this land that is now widely used for cultivation, grazing, and source of fuel wood and timber. According to Afework Bekele *et al*. (1988), during the 1970s, trophy hunting was conducted on a large scale in Ethiopia, though since then, increasing human populations, political instability, and encroachment on wildlife habitat have resulted in a 95% of the decrease in the area used for trophy hunting.

The most serious immediate threat to the survival of many primate species is habitat destruction for timber,

agricultural land, and human settlement (Isabirye-Basuta & Lwanga, 2008; IUCN, 2018). Habitat loss has forced many primate populations to live in small fragments isolated from one another by human dominated landscapes. Wieczkowski (2004) also states the major threat for primates is habitat destruction Habitat destruction reduces the forest size leading to the reduction of food sources (Muoria *et al*., 2003). The Bale monkey may be threatened because of habitat destruction it inhabits (IUCN, 2008). For instance, the Harenna forest that harbor a relatively high population Bale monkeys is increasingly utilized for the supply of construction material, fuel and charcoal for the increasing human population in Ethiopia. The habitat destruction of bamboo forest for local consumption and commercial purpose is a big threat for the Bale monkeys. Twinomugisha and Chapman (2006) found out that the harvesting of bamboo in the same area year after year affected the growth of bamboo resulting in poor yield and low coverage. Similarly, harvesting of bamboo in the Odobullu Forest decreases the quality and abundance of bamboo. Kingdon (1997) suggested that hybridization with the widespread and adaptable grivet monkey *(Chlorocebus aethiops*) and vervet monkey (*Chlorocebus pygerythrus)* due to forest clearance in lowland areas is a real threat facing the Bale monkey (*Chlorocebus djamdjamensis)*.

Conclusion

The Bale monkey (*Chlorocebus djamdjamensis*) is a little-known primate species endemic to the southern Ethiopia. Bale monkeys are believed to be confined to bamboo forest habitats in, specializing on the young leaves of highland bamboo (*Arundinaria alpina*) (Addisu Mekonnen *et al*., 2012: Butynski *et al*., 2008). The taxonomic position of Bale monkeys was in debate; Neumann first described Bale monkeys in 1902 as a species and named *Cercopithecus djamdjamensis*. The distribution of bale monkeys was little-known with few known populations at Harenna Forest (BMNP), Kacha and Rira area at altitude 2800 m asl (Carpaneto and Gippoliti, 1994; Kingdon, 1997), and also Odobullu Forest (Anagaw Atickem, 2010), in the bamboo forest 23 km northwest of Dodolla, and Djam-Djam Mountains near "Abera" area, a region east of Lake Abaya at about 3000 m asl (Carpaneto and Gippoliti, 1994; Butynski *et al*., 2008), Hagere Selam regions (Southern Nations Nationalities Region, Sidamo) and in Geremba mountain of Arbegona Wereda (Southern Nations Nationalities Region, Sidamo Zone) (Zerubabel Worku, 2018). *Chlorocebus* species inhabit a wide range of habitat types including savannah, woodland forest, grassland and riverine forests (Kingdon, 1997). Savannah monkeys are generalists inhabiting different habitat types and feeding on different food sources. Currently, this species is Listed as Vulnerable as the range of this species is less than 20,000 km² with severe fragmentation and there is continuing decline due to ongoing habitat loss and degradation. Habitat destruction, agricultural land expansion, and human settlement are major threats of the species.

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