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Population Estimate, Group Size and Age Structure of the Gelada Baboon (*Theropithecus Gelada*) around Debre-Libanos, Northwest Shewa Zone, Ethiopia

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Abstract- Most of the gelada baboon's population which is endemic to Ethiopia exists on the gorges and mountain cliffs of the country including Debre-Libanos. The objective of the study was to estimate the total gelada baboons, and determine their group size and age structure. This was investigated based on direct field observation method from August 2012 to March 2013. The study area was divided into seven counting blocks (Shinkurt Mikael, Chagel, Amanuel, Abba Dinkona, Wusha Gedel, Tekle Haimanot, and Set Debre). Data were analyzed using descriptive statistics. Chi-square test was used to compare the sex and age ration, and their distribution among the counting blocks. The population size of gelada baboons was determined from direct total count. The average number of gelada baboons counted was 1608. Of these, adult males comprised 162, adult females 576, sub-adult males 121, sub-adult females 231, young 307 and infants 212. There was a significant difference among the different age groups of the total individuals counted in the study area ($\chi 2=1002.657$, $df=5$, $p<0.05$).

Keywords: *gelada baboon, population estimate, group size, debre-libanos.*

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Population Estimate, Group Size and Age Structure of the Gelada Baboon (*Theropithecus Gelada*) around Debre-Libanos, Northwest Shewa Zone, Ethiopia

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Abstract- Most of the gelada baboon's population which is endemic to Ethiopia exists on the gorges and mountain cliffs of the country including Debre-Libanos. The objective of the study was to estimate the total gelada baboons, and determine their group size and age structure. This was investigated based on direct field observation method from August 2012 to March 2013. The study area was divided into seven counting blocks (Shinkurt Mikael, Chagel, Amanuel, Abba Dinkona, Wusha Gedel, Tekle Haimanot, and Set Debre). Data were analyzed using descriptive statistics. Chi-square test was used to compare the sex and age ration, and their distribution among the counting blocks. The population size of gelada baboons was determined from direct total count. The average number of gelada baboons counted was 1608. Of these, adult males comprised 162, adult females 576, sub-adult males 121, sub-adult females 231, young 307 and infants 212. There was a significant difference among the different age groups of the total individuals counted in the study area ($\chi 2=1002.657$, df=5, $p<0.05$). There was unequal sex ratio in the individual count. The highest range of group size was recorded during the wet season (5-187 individuals) with the mean group size of 28.21; while the dry season, the range of group size was smaller (3-120 individuals) with the mean group size of 18.4

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I. Introduction

East Africa is rich in biodiversity and abundance of large mammals (Kutilek, 1979). The extensive tropical and subtropical savanna biome provides the homeland for the variety of mammals. One of the reasons that made the African fauna so interesting and spectacular is the high degree of endemism (Hirst, 1975).

Ethiopia is internationally recognized as one of the most important conservation spots because of a great diversity of its natural ecosystem and biogeographically isolated highlands that support high species endemicity. Topography ranging from 110 meters below sea level at Kobar Sink of Afar depression to a peak of 4620 meters above sea level at Ras Dashen Mountain contributes for the availability of the large diversity of ecological conditions. The existence of diverse and varied species of wildlife reflects the diversity in climate, vegetation and terrain. The highland regions, although possess fewer species than lowland parts of the country, have large number of endemic species, particularly birds, mammals and amphibians (Yalden, 1983; Kingdon, 1997). The wide range of habitats in Ethiopia, from arid desert, open grassy steppe, and semi-arid savannas to highland forests and Afro-alpine moorlands have a great positive impact on the country's biodiversity richness (Hillman, 1993).

Due to increase in human population at an alarming rate, the natural resources and ecosystems of Ethiopia have been altered. The large areas of Ethiopian lowland and highlands are changed into agricultural and pastoral lands. The vegetation is overused for fuel wood, construction, timber production and other purposes. As a result, wildlife resources of the country are now largely restricted to a few protected areas and inaccessible areas (Hillman, 1993). Most of the gelada baboon population occurs on the Ethiopian plateau, gorges and mountain cliffs which are inaccessible but with low intervention of humans. Their number is estimated around 50,000 to 60,000 individuals and the number is declining (Dunbar, 1998). The highest density of gelada baboons, and the only place where they are officially protected, occurs in the Simien Mountains National Park, especially in Sankaber and Gich areas of the Park (Beehner *et al*., 2008). However, small populations of gelada baboons also occur in Menz (Guassa), Debresina, Wollo, and Debre-Libanos. An additional isolated population is located in the south of the Rift Valley in Arsi Province (Mori and Belay, 1990; Oates, 1996).

Even though, the existence of gelada baboon population was recorded in the northwest Shewa zone of Oromia Regional State, no research has been conducted on the population status, group size and structure of gelada baboon and other relevant issues about the species in the area. The intension of this

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research was to fill this gap and provide relevant information for local and regional administration and other conservation organizations.

II. Methodology

a) Study area

The present investigation was conducted at Debre-Libanos area, which is located in the central highlands of Ethiopia. Its geographical coordinates are 9° 43' 0" North, and 38° 52' 0" East. Debre-Libanos is found in the Oromia Regional State, within the Northwest Shewa zonal administration (Fig. 1). It is located at 104 km away from the capital city, Addis Ababa in the northwest direction, 16 km away from the zone capital (Fiche). Debre-Libanos community conservation area is designed to conserve and manage biodiversity and wildlife. The area is also a home for a variety of wild animals including spotted hyena, anubis baboon, warthog, vervet monkey, columbus monkey, gelada baboon, different species of birds and others. It characterized by heterogeneous landscape, flora, fauna and habitat types. The area has extremely steep escarpments leading up to a strip of plateau. It is found in the altitude ranges between 2150 to 2650 meters above sea level.

It has bi-modal rainfall pattern ranging from 800 mm to 1200 mm with five months of rain (May-September). The dry season is from December to March. The annual average maximum and minimum temperature of the study area is 23^{0}c and 15^{0}c, respectively.

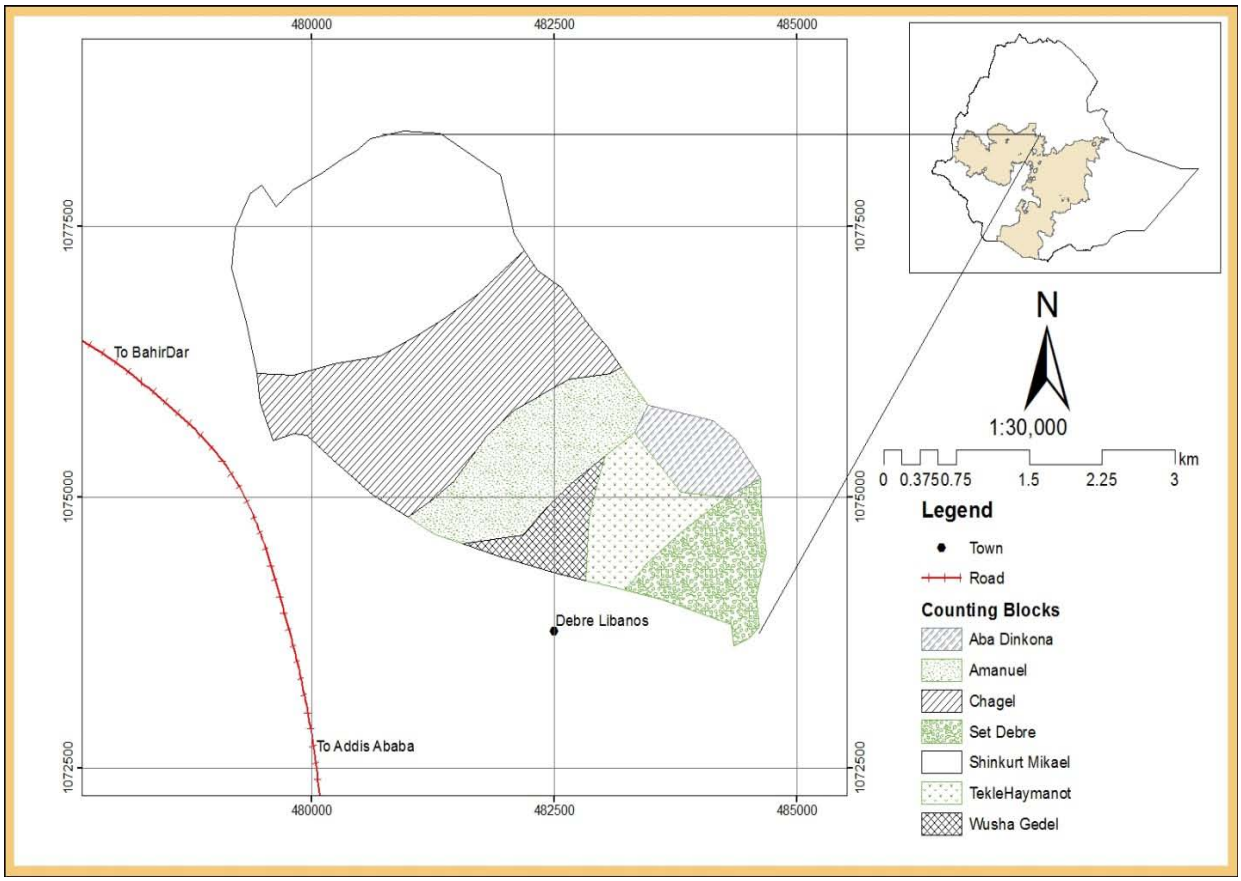

Figure 1: Map of the study area

b) Materials and methods

The present study was conducted from August 2012 to March 2013 to cover both wet and dry seasons. Quantitative and qualitative data were collected during the wet and dry seasons on the population estimate, and group size of the gelada baboon around Debre-Libanos area.

A preliminary survey was conducted in the study area in the first week of August 2012. During this period, the distribution of gelada baboon in the study area was assessed and the classification of vegetation type was carried out. The survey revealed that the vegetation cover and topography of the area was not homogenous. For the purpose of total counting of gelada baboons, the entire study area was divided into seven blocks; these are Shinkurt Mikael, Chagel, Amanuel, Aba Dinkona, Wusha Gedel, Tekle Haimanot, and Set Debre. Division of the entire area was based on artificial boundaries like roads and bridges, and natural boundaries such as small hills and vegetation

composition of the area. 'Blocks' in this context refer to small areas with natural and artificial boundaries that can easily be identified on the map as well as on the ground. The distance and expanse of the consecutive counting blocks vary depending on the natural boundaries and the topography of the area.

Total counting of gelada baboon population based on direct observation and silent detection was carried out to estimate the number of gelada baboons, and determine their group size and structure. Direct observational technique is most appropriate and effective for medium to large sized animals that live in relatively open habitats (Norton-Griffths, 1978; Caughly and Sinclair, 1994; Sutherland, 1996). Due to the mountainous nature of the area, almost all observations have been made on foot. A total of three counts were carried out in each of the wet and dry seasons in all the blocks. Each count was carried out simultaneously with the help of local people of the area.

Information was provided for data collectors on how to identify and categorize gelada baboons into adult males, adult females, sub-adult males, sub-adult females, young and infants. Adult males were defined as males with visible manes and overall size about twice that of the adult females. Sub-adult males were males similar in size to adult females with initial development of manes. Adult and sub-adult females were identified based on body size. All other individuals considered as young and infant are based on their body size (Beehner *et al*., 2008). Because of the smaller size of young and infants, identification of sex was difficult from a distance. During total counting of the gelada baboons, their sex and age composition were also recorded. Age and sex determination were carried out based on body size, presence or absence of mane, and by looking at their genital organs, following Mori *et al* (19990), and Kingdon (1997).

During each total count, the total number of individuals encountered in a group was recorded on a prepared data sheet before further subdividing into respective age and sex categories. When the distance between them was less than 50 meters, the animals were considered as the same group, following Lewis and Wilson (1979), Befekadu Refera and Afework Bekele (2004).

c) Data analysis

The data were pooled together, and SPSS software for Windows Evaluation Version 20 was used for statistical analysis using descriptive statistics and chi-square test. Statistical tests used were two-tailed with 95% confidence intervals. Chi-square test was used to compare between the sex ratio of gelada baboon, and their distribution among the counting blocks between wet and dry seasons.

d) Results

The total count of gelada baboon individuals in the study area for both wet and dry seasons is given in Tables 1 and 2. The average number of gelada baboons observed in the entire study area was 1608 individuals. The total number of gelada baboon counted was 1642 during the wet season, and 1573 during the dry season. There was no significant difference between the dry and wet seasons count ($\chi 2 = 1.481$, df=1, $p>0.05$).

Table 1: Number of gelada baboon counted in each counting blocks during the wet season (AM, adult male; AF, adult female; SAM, sub-adult male; SAF, sub-adult female)

Blocks	AM	AF	SAM	SAF	Young	Infants	Total	Percent
Abba Dinkona	5	27	7	14	15	13	81	4.9
Amanuel	10	41	15	18	20	23	127	7.7
Chagel	21	90	31	44	63	39	288	17.5
Set Debre	52	153	23	62	80	56	426	25.9
Shinkurt Mikael	62	207	23	56	85	51	484	29.5
Tekle Haimanot	7	30	6	16	18	11	88	5.4
Wusha Gedel	12	39	15	25	30	27	148	9.0
Total	169	587	120	235	311	220	1642	

In the total population of gelada baboons counted in the study area, adult females comprised the largest proportion. Next to adult females, the largest proportion was young individuals.

During the wet season, the total population was composed of 10.29% adult males, 35.75% adult females, 7.31% sub-adult males, 14.31% sub-adult females, 18.94% young and 13.39% infants. There was a significant difference among the age groups of the population counted during the wet season of the study period ($\chi 2=506.146$, df=5, $p<0.05$).

During the wet season, the number of adult females was higher than adult males, and showed significant difference ($\chi 2= 231.116$, df=1, $p<0.05$). There was also significance difference between sub-adult males and sub-adult females ($\chi 2=37.254$, df=1,

p< 0.05). Comparison of young individuals with infants showed a significant difference ($\chi2=15.595$, df=1, p<0.05). Out of the total individuals counted during the wet season, 29.5% was from Shinkut Mikael.

Table 2: Total count of gelada baboon during the dry season across blocks (AM, adult male; AF, adult female; SAM, sub-adult male; SAF, sub-adult female)

Blocks	AM	AF	SAM	SAF	Young	Infants	Total	Percent
Abba Dinkona	6	29	8	16	18	13	90	5.7
Amanuel	8	36	12	18	16	14	104	6.6
Chagel	15	72	29	37	48	32	233	14.8
Set Debre	54	161	29	68	90	62	464	29.5
Shinkurt Mikael	57	201	23	54	85	49	469	29.8
Tekle Haimanot	5	29	6	10	15	7	72	4.6
Wusha Gedel	9	38	14	24	30	26	141	9.0
Total	154	566	121	227	302	203	1573	

During the dry season, a total of 1573 gelada baboons were counted. Out of these, there were 9.8% adult males, 35.98% adult females, 7.69% sub-adult males, 14.43% sub-adult females, 19.20% young and 12.91% infants. Adult females were higher in number when compared to other groups. The number of adult females was significantly higher than adult males during the dry season ($\chi2=235.756$, df=1, p<0.05).

During the dry season, there was a significant difference between sub-adult male and sub-adult female ($\chi2=32.287$, df=1, p<0.05); and young and infants ($\chi2=19.408$, df=1, p<0.05). Based on counting blocks of the study area, the largest count during the dry season, 29.8% was from Shinkut Mikael.

Among the counting blocks, the highest population was recorded from Shinkurt Mikael counting block both during wet and dry seasons, 484 and 469 individuals, respectively. The smallest number of gelada baboon was recorded from Abba Dinkona (81 individuals) during wet season, and Tekle Haimanot (72 individuals) counting block during the dry season. Out the total gelada baboon individuals counted during both the wet and dry seasons, 29.55% was from Shinkurt Mikeal, 16.10% from Chagel, 7.15% from Amanuel, 5.3% from Abba Dinkona, 8.95% from Wusha Gedel, 5% from Tekle Haimanot and 27.65% from Set Debre (Figure 2).

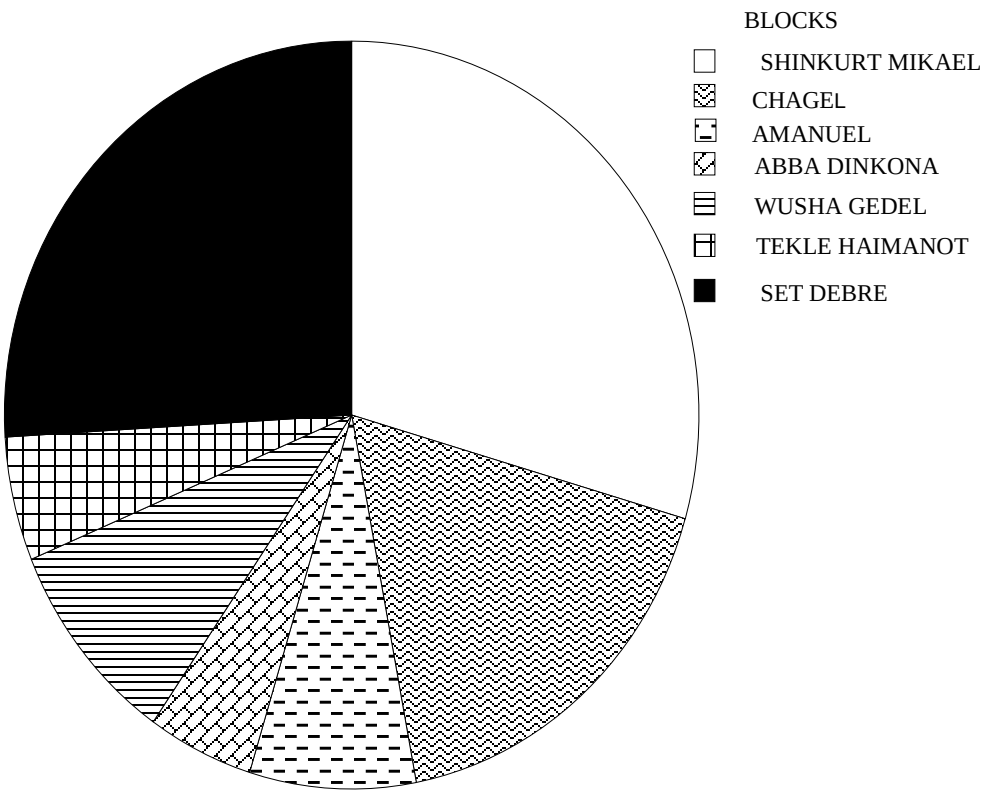

Figure 2: Percentage count of individuals during wet and dry seasons

The age structure and sex ratio showed 10% adult males, 35.8% adult females, 7.5% sub-adult males, 14.5% sub-adult females, 19.0% young and 13.1% infants. There was a significant difference among the different age groups of the total individuals counted in the study area ($\chi 2=1002.657$, df=5, $p<0.05$). The age and sex ratio given in Table 3 shows the ratio of adult male to adult female 1:3.47 (during the wet season) and 1:3.68 (during the dry season). The ratio of sub-adult male to adult female is 1:4.89 (during the wet season) and 1:4.68 (during the dry season). The ratio of adult males to sub-adult females was (1:1.47 during the dry season and 1:1.39 during the wet season). The ratio of young to adult male was (1:1.96 during the dry season and 1:1.84 during the wet season) and to adult female was (1:1.89 during the wet season and 1:1.87 during the dry season).The ratio of infants to adult females was (1:2.79 during the dry season and 1:2.67 during the wet season) and to adult male was (1: 1.32 during the dry season and 1:1.3 during the wet season).

Table 3: Age and sex categories during wet and dry seasons

Sex	Wet season	Dry season	Mean	Percent
Adult male	169	154	161.5	10.0
Adult female	587	566	576.5	35.8
Sub-adult male	120	121	120.5	7.5
Sub-adult female	235	227	231	14.4
Young	311	302	306.5	19.0
Infant	220	203	211.5	13.1
Total	1642	1573	1607.5	

The group size of gelada baboons ranged from 5 to 187 individuals during the wet season. Group size differed within the wet and dry seasons. The highest range of group size was recorded during the wet season (5-187) with the mean group size of 28.21. During the dry season, the range of group size ranged from 3 to 120 with the mean group size of 18.4. Large group sizes of gelada baboons (up to 187) were aggregated during the wet season, while during the dry season, they split into smaller number of groups over wider areas. The density of gelada baboons in the entire study area ($84.3km^2$) during the wet season was 19.49 individuals/km^2 and 18.67 individuals/km^2 during the dry season. Their density was higher during the wet season than the dry season.

III. Discussion

In the present study, the total number of individual gelada baboons counted in the study area was 1642 and 1573 during the wet and dry seasons, respectively. The insignificant variation in the number of gelada baboons may be due to the migration of gelada baboons to adjacent areas to get better feeding site and reduce the effect of food scarcity. This result is similar with the finding of Hailu Beyene, 2010. According to Zewdu Kifle, Gurja Belay and Afework Bekele (*2013*), the population estimate of gelada baboons in Wenchit valley area was around 1525 individuals that was more or less closer to the total population counted around Debre-Libanos. The number of gelada baboons varied among the counting blocks during the wet and dry seasons. This variation of gelada baboons among counting blocks may due to human disturbance, food availability, and variation in the size of counting blocks. Yonatan Ayalew (2009) also obtained similar variation of gelada baboon among counting blocks.

The present study showed that the population composition of gelada baboons consisted of unequal sex and age ratio. There was significant difference in age group and sex ratio between wet and dry seasons of the study period. It was also happened in the work of Yonatan, 2009 and Mussa Adem, 2009. The number of adult females was significantly greater than adult males. Adult male to adult female ratio was similar with report of Beehner et.al., (2008) and Habtamu Asfafaw and C. Subramanian (2013) where an adult sex ratio of 1:3.40 was recorded. The possible reasons for an unequal sex ratio may be due to an increased predation pressure on males, and the emigration of subordinate males to less favourable habitats (Estes, 1974).

There was a large group size during the wet season of the study period, and this decreased during the dry season. The same group size variation in the wet and dry seasons was observed in the study of Mussa Adem (2009). The aggregation of large group of gelada baboon population during the wet season in a limited area may be due to lack of space and presence of ample food in their living habitat. During the wet season, the local people farmed the area and chased gelada baboons to protect their crops, restricting gelada baboon population to the cliffy parts of the study area. Increment of human population causes high demand of land for farming, livestock grazing, settlement and other purposes to fulfill the basic daily requirement of people, and it results to restriction of animals into small areas (Siex and Struhsaker, 1999). But, during the dry season, they were distributed in different habitat types of the study area. This distribution in wider area might be to avoid the unpalatable foods and due to shortage of foraging access resulting the reduction of group size during the dry season. Gelada baboons migrate to different areas adjacent to the study site as food and

water can be limited at the edges of the cliff during the dry season. Iwamoto (1993) revealed that due to the shortage of food resources, baboons move greater distance in search of their food during the dry season. The Distribution of gelada baboon population is based on the availability of food availability and quality, and distance from human (Wallace, 2006).

IV. Conclusion and Recommendation

Most of the gelada baboon's population exists on the gorges and mountain cliffs of Ethiopia. The present study provided relevant information on gelada population and group size, and age structure in Debre-Libanos area. The average number of gelada baboons counted was 1608. There was a significant difference among the different age groups of the total individuals counted. Unequal sex and age ratio among the individual count was recorded. The highest range of group size was recorded during the wet season with the mean group size of 28.21.

The following points are suggested to reduce the problems and conserve the population of gelada baboon properly:

- Develop sense of ownership among the local community through awareness creation
- Set clear demarcation of conservation area for better conservation of gelada baboons
- Prior to this study, no comprehensive gelada baboon census of the area has been carried out. So, gelada baboon population censuses should be carried out in the future at specific duration to determine the population trends at Debre-Libanos.

Conflict of interests

The authors did not declare any conflict of interest.

V. Acknowledgement

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