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Distribution of long-tailed marmot, *Marmota caudata* in the Badakhshan province of Afghanistan

Abdul Hallim Majidi¹, Loghman Maleki^{2,*}, Abdul Baser Qasimi³, Junaidullah Sabooryar¹, Abdul Ahmad Sangabi¹

¹ Department of Biology, Education Faculty, Badakhshan University, Fiazabad, Afghanistan

² Department of Biological Sciences, Faculty of Science, University of Kurdistan, Sanandaj, Iran

³ Department of geography, Education Faculty, Samangan University, Samangan, Afghanistan

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Abstract

The current survey was conducted on occurrence and distribution of long-tailed marmot, *Marmota caudata*, in Badakhshan Province, situated in the northeast of Afghanistan. *Marmota caudata* is one of the largest rodents in the cold desert habitats, and an important prey for endangered carnivores. Line transect method was used to collect specimens in the study area. A total of 761 individuals of long-tailed marmot, were observed in this region during 2020 and 2021. The presence of marmots was recorded by direct observation and their symptoms. The results indicate all individuals were occurring in the areas between the snow line and the timberline to near livestock grazing area. The maximum number of observations was in Arghanjkhah with 56 individuals (7.3% of all observations) and the lowest was in Kashim with 5 (0.6%). The highest population density per districts was in Arghanjkhah (11.2±2.5 per Km²) and the lowest was in Kashim (1±0.2 per Km²). Marmots were founded in all regions of Badakhshan with more abundance in eastern part of the province. This study was the first study on this species in the region and in Afghanistan.

Key words: Population density, Abundance, Arghanjkhah, Kashim, High-altitude mammals

INTRODUCTION

Of the recognized 15 species of marmots, six occur in Asia (Armitage, 2000). The long-tailed marmot, *Marmota caudata* (Geoffroy, 1844) or golden marmot possesses wide distribution in India, Tajikistan, Pakistan and China (Ahmed et al., 2016; Lu et al., 2016; Baseer-ud-Din et al., 2015). The distribution of this species has been assessed by the IUCN red list of Threatened Species in 2017 (Cassola, 2017). *Marmota caudata* has been widely spread in the North and East part of Afghanistan. So far, nothing is known about the distribution and abundance of the *M. caudata*, in the Badakhshan Province (BP) and other part of Afghanistan in details.

Badakhshan Province has relatively cold climate. The winters are characterized by cold temperatures (to -40° C), heavy snow and substantial amounts of precipitation (81–255 millimeter). The summers are warm (28–37.5° C) and dry (precipitation 24–100 millimeter). Despite a good vegetation in BP, continued pressures such as animal grazing, farming, deforestation and uprooting shrubs for fuel,

most of original natural vegetation region has been diminished (PDMC, 2013). In BP, long-tailed marmot inhabits a region between the upper forest border and snow line in the alpine.

Long-tailed Marmot is a large holarctic rodent adapted to cold climate (Nikol'skii & Ulak, 2007). This species forms an important part of the diet of some globally endangered species in Afghanistan such as the snow leopard, *Panther uncia* (Schreber, 1775), wolf, *Canis lupus* (Linnaeus, 1758), red fox, *Vulpes vulpes* (Linnaeus, 1758), golden eagle, *Aquila chrysaetos* (Linnaeus, 1758) and other associated carnivores in the top of food web (Ahmed et al., 2016).

Marmots live in the colonies in high-altitude mountains and are considered one of the highest altitude mammals in the world and important component of ecosystem because of their role in web chain (Aryal et al., 2015; Poudel et al., 2016). Long-tailed marmot is classified as a species of "least concern" under IUCN red list category (Sheikh & Molur, 2004). The long-tailed marmot is among the least studied species among marmots in the world and more apparently in the BP.

Habitat utilization in rodents is typically determined by vegetation and soil features (Řičánková et al., 2014). Marmots occupy habitats from small, alpine meadows to the wide range of steppe environments (Ahmed et al., 2016). The relationship between species existence and ecological features is vital for understanding of species distributions. Marmots, in the terms of the benefits associated with obtaining food and risk of predation often display two types of behaviors in response to avoidance of predation, vigilance and group formation. Humans and their livestock like dogs usually are as potential predators, therefore the effects of human distribution are similar to natural predation risks (Poudel et al., 2015). Marmots are commonly baited by domestic dogs for entertainment besides persecute as pests. Furthermore, marmots hunt for a local believe to their extraordinary medicinal properties and their fat (Zaman et al., 2019).

Recently, research on adaptation of marmots to high-altitude and their hibernation have been of great interest. Species of marmots hibernate in family groups during the cold period of the year. Hibernation burrows are usually deep with more than 10 m in some areas. Hibernation in animals is a seasonal state of metabolic suppression and dormancy characterized by a decrease in body temperature, metabolism, heart rate, and oxygen consumption. Marmots are confronted with severe hypoxic and cold stress during winter (Bai et al., 2019). Marmots usually hibernate for up to eight months of the year depending on species. Therefore, they are accessible to the predators for less than half of the year (Tytar et al., 2019).

Regional distribution of long-tailed marmot was not documented in Afghanistan. The aim of this study was to record of the distribution and population density of *M. caudata* in the Badakhshan Province of Afghanistan.

MATERIAL AND METHODS

Study area

The current study was conducted in the Badakhshan Province, situated in the northeast of Afghanistan between 35°26'46"N-69°57'40"E and 38°29' 27"N-74°53'39"E with the area of 43721 per Km² (Figure 1). The region is surrounded in the North by Tajikistan, Southern East by Pakistan and Kashmir, in the far end of Wakhan corridor by China and in the West and South by Takhar, Nuristan and Panjshir Provinces. High mountains and steep river valleys are the main geographical features of the province. Nearly 89.9% of the province is mountainous or semi mountainous terrain while 9.7% of the area is made up of flat or semi-flat lands.

METHOD

Line-transect method was used to collect data on distribution of the long-tailed Marmot, *M. caudata* in Badakhshan Province. A total of 56 transects (each district with 2 transects) between 3000–5500 m was taken During April 2020 to September 2021. Each transect was 300 m wide by 2 to 3 Km long (Ahmed, et al., 2016). Length of transects was adjusted according to the land of the regions corresponding with the

TABLE 1. The distribution of long-tailed marmot, *Marmota caudata* in each district of Badakhshan Province. Number of marmots and abundance and density in each district have been observed.

No	districts	Number of marmots observed	Abundance* (%)	Density (per Km ²) (Mean±SE)	Distance travelled (Km)
1	Arghanjkhan	56	7.3	11.2±2.5	87
2	Sheghnan	54	7	10.8±2.4	147
3	Wakhan	50	6.5	10±2.3	279
4	Kohistan	48	6.3	9.6±2.2	131
5	Raghistan	46	6	9.2±1.2	127
6	Kran & Manjin	44	5.7	8.8±1.5	189
7	Zibak	43	5.6	8.6±1.2	203
8	Darwaz bala	42	5.5	8.4±1.5	371
9	Ishkashim	36	4.7	7.2±1.2	138
10	Tagab	32	4.2	6.4±1.5	147
11	Kuf Ab	28	3.6	5.6±1.2	204
12	Warduj	28	3.6	5.6±1.2	61
13	Yamgan	28	3.6	5.6±1.2	121
14	Yaftalbala	26	3.4	5.2±1.5	29
15	Jurm	26	3.4	5.2±1.4	72
16	Yawan	22	2.8	4.4±1.2	98
17	Shohada	22	2.8	4.4±1.5	78
18	Khwahan	22	2.8	4.4±1.5	279
19	Shaki	18	2.3	3.6±1.3	437
20	Nasi	17	2.2	3.4±1.4	416
21	Maimi	14	1.8	2.8±1.2	360
22	Baharak	12	1.5	2.4±1.5	46
23	Yaftalsafla	12	1.5	2.4±1.3	35
24	Argo	9	1.1	1.8±0.4	32
25	Daraym	8	1	1.6±0.5	54
26	Tishkan	7	0.9	1.4±0.3	73
27	Shahri Buzurg	6	0.78	1.2±0.2	83
28	Kashim	5	0.6	1±0.2	105
Total	28	761	100		4,402

alpine zone (Ahmed et al., 2016; Baseer-ud-Din et al., 2015). Interview was carried out at least with six local residents to be confident of marmots observation (Aryal et al., 2015).

Each district was observed daily, in the morning between 07:00–11:00, and in the afternoon between 14:00–15:00 for two days. During the survey, a few local people helped to collect data and guide authors to the marmot habitats. Each transect was carefully checked for the presence of marmots. In some places, 43 burrows in an area with 200 m² were recorded. The new burrows were differing from old and inactive ones by the presence of fresh soil and runways. Presence of marmot were recorded by direct observation and their nests and feces (Figure 2).

The human distribution was divided into three types, low, medium, and high density. Human disturbance was considered as low when there was no evidence of human activity or livestock grazing; medium when the plots show only signs of grazing, and high when the plot contained evidence of intensive human activity.

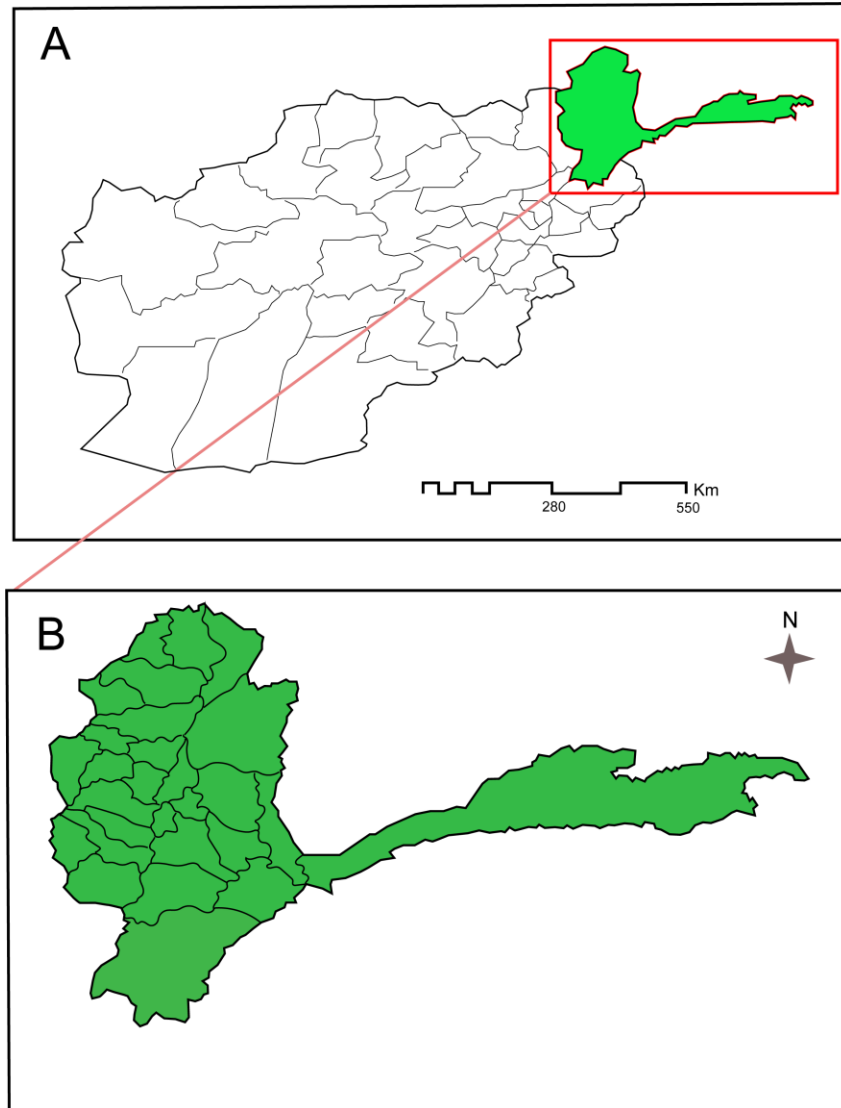


FIGURE 1. A: Map of Afghanistan; B: Badakhshan Province.

Statistical analysis was carried out using IBM SPSS statistics 24. At first, the normality of data was tested using Shapiro-Wilk test, then the significance differences were calculated by Kruskal-Wallis test. The p-value was considered at 0.05.

RESULTS

Data was collected from 28 districts of Badakhshan Province in 2020 and 2021. The Long-tailed marmot, has been distributed throughout the study area. A total of 761 individuals of *M. caudata* were observed in this region. The distribution of this species was varied in the study area (Table 1; Figure 2B, C). Distribution in each district was recorded separately. The maximum number of observations is related to the Arghanjkahh with 56 individuals (7.3% of all observations) and the lowest observation is in Kashim district with 5 (0.6%).

Mean density of the long-tailed marmot was highest in Arghanjkahh with 11.2 ± 2.5 per Km^2 , follow by Sheghnan, Wakhan and Kohistan (10.8 ± 2.4 , 10 ± 2.3 and 9.6 ± 2.2 , respectively). lowest density per districts was in Kashim, Shahri Buzurg and Tishkan (1 ± 0.2 , 1.2 ± 0.2 and 1.4 ± 0.3 , respectively) (Figure 3). Distribution of this species was significantly different between districts ($P < 0.05$). Maximum

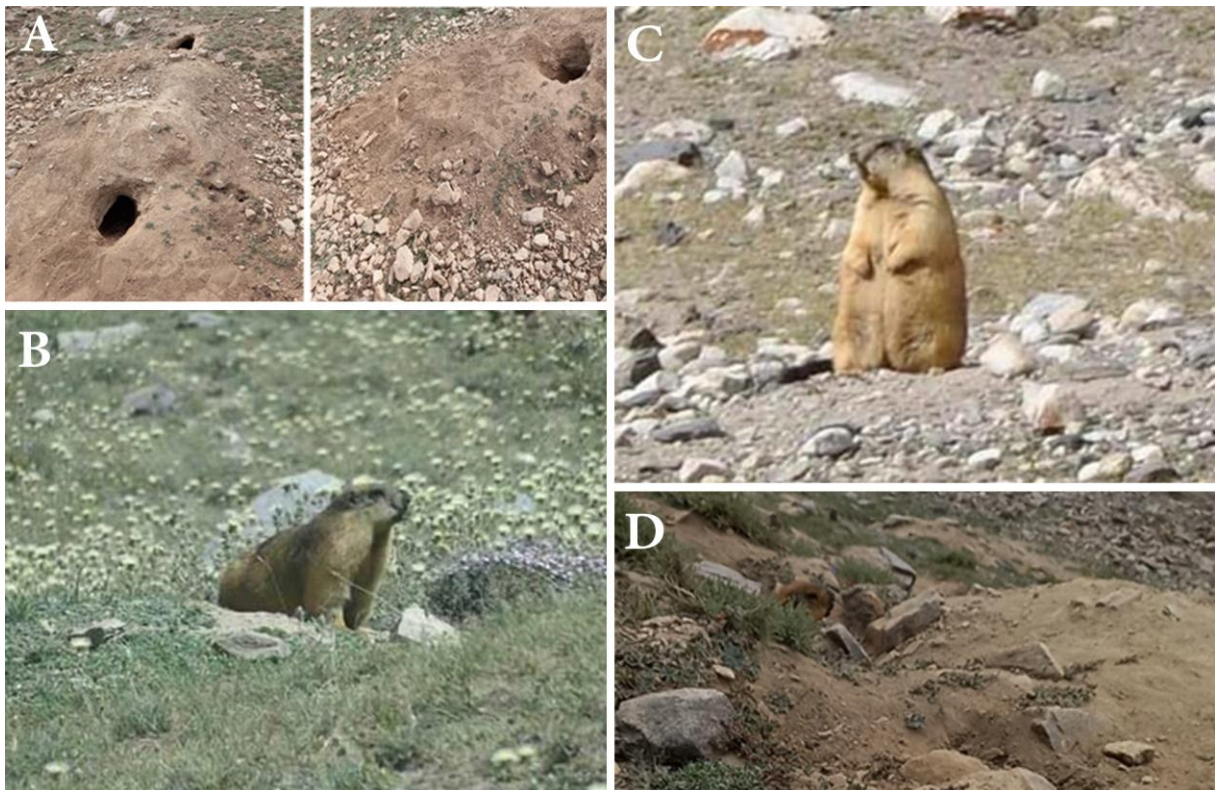


FIGURE 2. A: Burrows of the long-tailed marmot, *Marmota caudata*; B: *M. caudata* in grassland habitat; C: Giving alarm by *M. caudata*; D: A marmot coming out from the burrow.

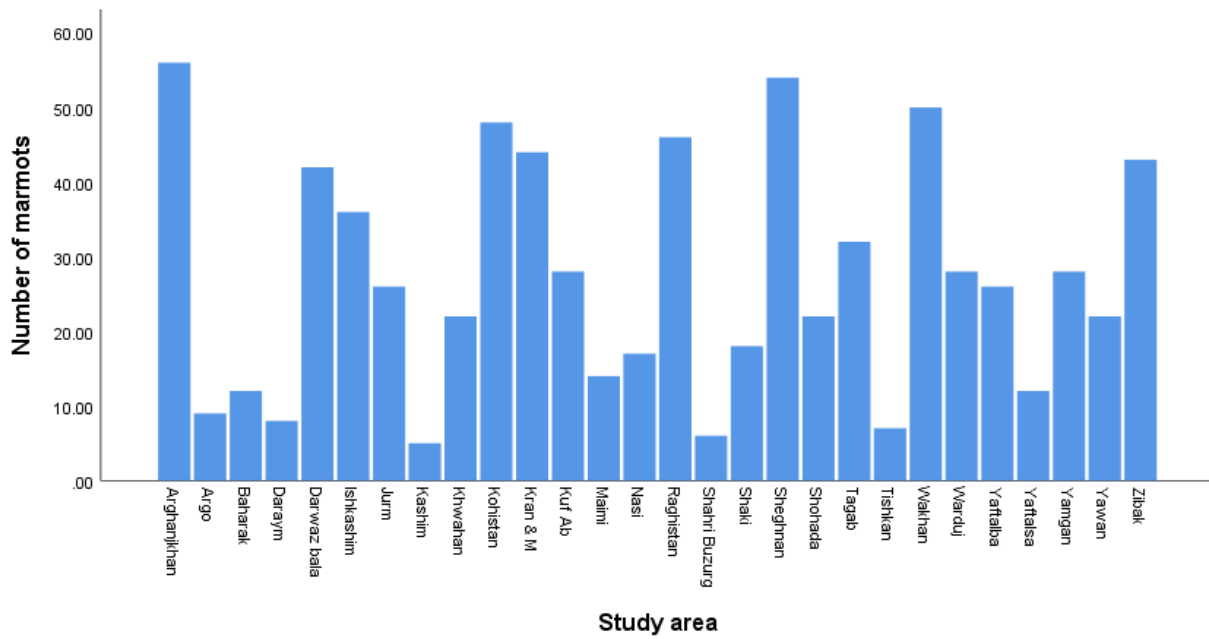


FIGURE 3. The number of the long-tailed marmot, *Marmota caudata* in each district of BP.

number of this marmot was observed between timberline and snowline. In this region, the populations of marmots were observed more in hilly areas followed by valleys and plateaus. The more abundance of marmots in districts like Arghanjkhah, Sheghnan, Wakhan and Kohistan was observed. These districts have vast grassland cover providing adequate food and shelter. grazing activities were observed around the marmot colonies.

DISCUSSION

The current survey was the first time to record distribution and abundance of the long-tailed marmot, *M. caudata* in Badakhshan Province and in all Afghanistan. Our results correspond with Ahmed et al. (2016) from India in which maximum abundance was at herbaceous, meadow, grassland and then in rocky area, respectively (Ahmed et al., 2016). Baseer-ud-Din et al. (2015) reported 551 individuals from Baboon, Bloar and other regions of Pakistan of long-tailed marmot. Chaudhary et al. (2017) recognized that a total of 110 individuals of *Marmota himalayana* (Hodgson, 1841) were observed in the surveyed stretches of Leh District with a maximum mean of encounter of 2.71. The occurrence and distribution of marmots in other regions in nearby was recorded (Nicol'skii & Ulak, 2006, 2007; Poudyal, 2011).

Distribution of this species was significantly different between districts ($P < 0.05$). In fact, there exist a tendency of decreasing abundance from East to West of Badakhshan. It related to having vast grassland, adequate food, type of suitable soil to excavate the burrow and lower human population in suitable habitat of Eastern part. Maximum number of this marmot was observed between timberline and snowline. Boero (2003) reported that elevation, sun-shine duration, sun exposure, slope, anthropic pressure, food resource, and soil composition impact on the marmot's distribution. According to Nicol'skii & Ulak, (2006), elevation is an important ecological factor for marmots and other mountain species, since most of the other factors depend on it, directly. The maximum number of marmots occurs between the snow line and the timberline with 3000 to 5000 m coinciding with subalpine and alpine mountain belts (Chaudhary et al., 2017). According to Řičánková et al. (2014), the vegetation type explained most of the variability of marmot density. Marmots usually prefer the grasslands as favorable habitat (Figure 2B). Accordingly, the fewer preferential coefficient was also found for the shrubs and clearly avoided the woodlands such as Kashim and Tishkan.

Marmots have often high level of stress during the summer time, due to presence of human and their livestock. They usually approach to the livestock and human disturbances, because they are diurnal and have a small home range, and a high dependency on burrows (Poudel et al., 2016). Nicol'skii and Ulak (2007) documented that burrows are large and deep, the depth of nest borrows in *M. himalayana* are usually 4–7 m, and they can dig their large burrows only in the regions where the ground is soft and sufficiently be deepened (Figure 2A). In addition, soil conditions and especially the depth of the soft soil layer influence the distribution and abundance of this animal (Barash, 1989).

The geographical distribution of burrows is affected by temperature. The marmots have adapted with lower temperature. Their desired temperature value is between 22–25° C, for normal activity (Lu et al., 2016). A lot of burrows are found near water sources such as streams, rivers, or ponds (Aryal et al., 2015). The same pattern of burrow distribution was observed in the current study.

Generally, we surmised that long-tailed marmot (*M. caudata*) was abundance in suitable areas of Badakhshan province. This is corresponded with the Eastern districts of the province. In addition to human and livestock, four aspects i.e., height, temperature, relief and feeding conditions affect the marmot distribution. The most of the marmot population was observed in Arghanjkhah and lowest in Kashim district. Marmot distributed in all regions and population density are differ in each district of Badakhshan province. Finally, it seems that *M. caudata* is more abundant in Badakhshan province of Afghanistan in comparison with other nearby regions because of tendency of decreasing population from East to West of Province. The same pattern may to be extended to all Afghanistan. Further studies need to reveal the pattern of distribution in another region of Afghanistan.

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