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Assessing Biodiversity Conservation of the Cricetidae Family in Afghanistan's Mountain Ecosystems

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Abstract

This study provides the first Afghanistan-led assessment of small mammal biodiversity within Afghanistan's critical mountain ecosystems, focusing on three Cricetidae species (*Microtus transcaspicus*, *Cricetulus migratorius*, and *Ellobius fuscocapillus*) identified across Bamyan and Kabul provinces. Specimens were analyzed using morphological, morphometric, and chromosomal methods. The findings reveal distinct taxonomic classifications among the three genera, underscoring the hidden diversity of Afghanistan's Cricetidae family. This work addresses a critical knowledge gap in a region where biodiversity loss is exacerbated by habitat fragmentation and limited conservation research. Species such as *Ellobius fuscocapillus*, a burrowing rodent, play essential ecological roles in soil nutrient cycling and plant community dynamics, highlighting their importance for maintaining ecosystem integrity. We emphasize the urgent need for habitat protection and community engagement to safeguard small mammals, which serve as vital bio indicators of ecosystem health in rapidly degrading mountain landscapes.

Keywords: Biodiversity, conservation, Cricetidae, Afghanistan, mountain ecosystems

بررسی حفاظت از تنوع حیاتی خانواده کریسیتیده در ایکوسیستم‌های کوهستانی افغانستان

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چکیده

این مطالعه اولین بررسی تنوع حیاتی پستانداران کوچک را در ایکوسیستم‌های کوهستانی افغانستان ارائه می‌دهد. که بر سه گونه حیاتی فامیل Cricetidae (*Microtus transcaspicus*، *Cricetulus migratorius* و *Ellobius fuscocapillus*) که در ولایت های بامیان و کابل شناسایی شده‌اند، تمرکز دارد. این نمونه‌ها با استفاده از روش‌های مورفولوژي، مورفومتری و کروموزومی مورد تجزیه و تحلیل قرار گرفتند. یافته‌ها، به اساس علم طبقه‌بندی سه جنس متمایزی را در بررسی نشان می‌دهد که بر تنوع پنهان فامیل Cricetidae در افغانستان تأکید دارد. این اثر به یک شکاف علمی حیاتی در منطقه‌ای می‌پردازد که در آن از بین رفتن تنوع بیولوژیکی به دلیل تخریب زیستگاه‌ها و تحقیقات محدود در زمینه حفاظت تشدید می‌شود. گونه‌هایی مانند *Ellobius fuscocapillus*، یک جونده حفار، نقش اساسی ایکولوژیکی را در دوران مواد غذایی خاک و پویایی جامعه نباتی ایفا می‌کنند و اهمیت آنها را برای حفظ یکپارچگی ایکوسیستم برجسته می‌سازد. ما بر نیاز فوری به حفاظت از زیستگاه‌ها و مشارکت جامعه برای حفاظت از پستانداران کوچک تأکید می‌کنیم، که به عنوان شاخص‌های حیاتی بیولوژیکی، سلامت ایکوسیستم در مناطق کوهستانی به سرعت در حال تخریب عمل می‌کنند.

واژه‌های کلیدی: تنوع حیاتی، حفاظت، Cricetidae، افغانستان، ایکوسیستم‌های کوهستانی

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Introduction

Rodents include two super families: Dipodoidea and Muroidea (Wilson & Reeder, 2005). Recently, Muroidea has been divided into six families: Platacanthomyidae, Spalacidae, Calomyscidae, Nesomyidae, Cricetidae, and Muridae (Musser & Carleton, 2005). Members of the superfamily Muroidea are found on all continents except Antarctica and on many oceanic islands.

The family Cricetidae Fischer, 1817 comprises 130 genera and 681 species, and according to recent classifications, it includes six subfamilies. Rodents in this family are medium to small in size. In terms of dental structure, they differ from the family Muridae (Musser & Carleton, 2005).

The family Cricetidae, comprising voles, hamsters, and lemmings, plays critical roles in maintaining ecosystem health through seed dispersal, soil aeration, and nutrient cycling (Davidson et al., 2012). These small mammals act as ecological engineers, shaping habitats that support biodiversity in fragile environments (Jones et al., 1994). Despite their importance, Cricetidae populations in Afghanistan remain poorly documented, reflecting broader gaps in conservation research within conflict-affected regions (Hanson et al., 2009).

Afghanistan's diverse landscapes, spanning arid deserts to alpine meadows, host unique yet understudied small-mammal communities. Species such as *Microtus transcaspicus*, *Cricetulus migratorius*, and *Ellobius fuscocapillus* are known from neighboring regions, yet their ecological roles and conservation status within Afghanistan are virtually unexamined (Habibi, 2003). This knowledge gap is alarming, as small mammals serve as bioindicators of environmental health and ecosystem integrity (Caro, 2010). For instance, burrowing rodents such as Ellobius fuscocapillus enhance soil structure and water retention, processes critical to sustainability in arid landscapes (Whitford & Kay, 1999).

Globally, habitat fragmentation and climate change threaten small mammals, with rodents representing over 30% of mammal species at risk of extinction (IUCN, 2023). In Afghanistan, decades of conflict have marginalized conservation efforts, leaving endemic species vulnerable to habitat degradation (Simms et al., 2011). Recent taxonomic studies

classify Cricetidae as a distinct family with 681 species, underscoring their ecological diversity (Burgin et al., 2018). However, Afghanistan's Cricetidae remain overlooked in regional conservation frameworks, despite their potential to inform adaptive management strategies in fragile ecosystems.

This study addresses these gaps by analyzing the biodiversity of Cricetidae in Afghanistan through morphological, morphometric, and chromosomal assessments of *Microtus transcaspicus, Cricetulus migratorius,* and *Ellobius fuscocapillus*. By establishing baseline data on these species, this research aims to support targeted conservation policies and habitat protection initiatives in a region where biodiversity loss is compounded by political instability.

Research Methodology

This study employed an integrative field-based and laboratory-based approach to document and characterize Cricetidae species in Afghanistan. Sampling was conducted across representative mountain and lowland habitats in Bamyan, Loar and Kabul provinces. Collected specimens were analyzed using three complementary methods: (i) field-based geographic and ecological recording, (ii) morphological and morphometric examination of external and cranial traits, and (iii) karyological analysis to assess chromosomal characteristics. These combined approaches were used to establish taxonomic identity and evaluate the conservation relevance of the recorded species.

Study Area and Sampling

For sampling this family, a total of 9 specimens were collected from two provinces, Bamyan and Kabul, and one specimens observed th logar province. with different geographical coordinates, using live traps and snap traps, nest excavation, and baits such as dry bread, apple, and cucumber, as well as searching among alfalfa and clover for collection (Table 1).

***Table 1**: Samples Caught at Each Location in Afghanistan*

SPECIES	NO	LOCALITY	ALTITUDE (METER)	LONGITUDE & LATITUDE
MICROTUS TRANSCASPICUS	1	Jai-E-Nikpai Bamyan	2650	34° 20′ 572″ N 67° 00′ 134″ E
CRICETULUS MIGRATORIUS	2	Dasht–E-Barchi	1870	34°30′ 17.83″ N 69°02′ 45.43″ E
ELLOBIUS FUSCOCAPILLUS	1	Chalghai Now Bamyan	3354	34° 21′ 709″ N 66° 57′ 699″ E
ELLOBIUS FUSCOCAPILLUS	1	Nowji Bamyan	3041	34°21′ 463″ N 67° 02′ 965″ E
ELLOBIUS FUSCOCAPILLUS	1	Sarzirgag Bamyan	3422	34° 22′ 28.44″ N 67° 04′ 09.92″ E
ELLOBIUS FUSCOCAPILLUS	1	Saritarkhgina Bamyan	3019	34° 21′ 50.52″ N 66° 55′ 00.56″ E
ELLOBIUS FUSCOCAPILLUS	1	Yakhak Bamyan	2765	34° 21′ 007″ N 66° 59′ 469″ E
ELLOBIUS FUSCOCAPILLUS	1	Sargiro Nargis Bamyan	3322	34° 21′ 54.00″ N 66° 56′ 36.86″ E
ELLOBIUS FUSCOCAPILLUS	1	pingoram Logar province	2093	33° 47′ 26″ N 68° 56′ 12″ E

Morphological and Morphometric Analysis

The study was conducted using rodent identification keys. Specimens were anesthetized with chloroform or ether, and all relevant information—such as the date and location of capture, weight and sex of the animal, tail length, head and body length, ear length, hind foot length, and the collector's name—was recorded under a unique serial number. Subsequently, karyological, morphometric, and morphological studies were performed. The animal's skin was also prepared in the laboratory using taxidermy. For the study of cranial morphometric traits, 34 morphometric characters across different species were measured and examined according to Darvish and Khosravi (2017) using a digital caliper with an accuracy of 0.01 mm. Specimens were euthanized humanely and preserved in 96% ethanol. Morphological identification was conducted using standardized keys for Palaearctic rodents (Wilson et al., 2017). Skull morphometrics were prioritized to minimize phenotypic plasticity effects, with 34 cranial measurements (e.g., condylobasal length, zygomatic

width) taken using a digital caliper (0.01 mm precision) (Darwish & Khosravi, 2017; Hammer et al., 2001).

Karyological Analysis

Chromosomal studies were conducted to evaluate genetic diversity, a critical factor in conservation planning (Frankham, 2010). For karyotyping, the bone marrow method was used, and CIP software was used to analyze chromosome arrangement (Schneider et al., 2012). For molecular studies, tissue samples were preserved in 96% pure ethanol for long-term stabilization. DNA was extracted from muscle tissue, and in some cases, from liver tissue.

Data Integration for Conservation

Morphometric and karyological data were cross-referenced with the IUCN Red List criteria (IUCN, 2023) to assess potential threats to identified species. Habitat preferences and anthropogenic pressures (e.g., agriculture, grazing) were documented to contextualize conservation risks.

Results

This study documents three members of the family Cricetidae in Afghanistan: *Cricetulus migratorius*, *Ellobius fuscocapillus*, and *Microtus transcaspicus*, recorded from Kabul (Barchi Plain), Punjab District, and Bamyan Province across an altitudinal range of 645m to 3,354 m.

Cricetulus migratorius (Gray Hamster)

The dorsal surface is bluish-gray in color, while the cheeks, throat, and belly are white. The boundary between the dorsal and ventral coloration is slightly distinct. The tail is relatively short and wholly covered with hair. The snout is short and compact, and the rounded ears are covered with hair on both sides. The cheeks have large pouches that are filled with food. The ears are large and, when bent forward, reach the eyes. The snout tip is relatively rounded. There are five pads on the forefoot and six pads on the hind foot. The tail is short, and the species has cheek pouches. The forelimbs are short, and the thumb is partially reduced, with only remnants remaining.

The third digit is the longest, while the second and fourth digits are nearly equal in length, and the fifth digit reaches only to the base of the

fourth digit. The nasal bones extend anteriorly beyond the base of the incisors. The interorbital region is as vast as the rostrum and lacks supraorbital ridges. The zygomatic arch is thin. The anterior palatal foramina are long, and the auditory bulla is relatively small. The upper incisors are yellow-orange on the anterior surface and extend downward and slightly inward; their anterior surface lacks grooves. The first molar of the lower jaw is anteriorly narrowed. The interorbital region is not strongly constricted; its width is approximately equal to the width of the rostrum, and the dorsal surface is flat and smooth, with no supraorbital ridges present. The zygomatic arches are thin and not widely flared laterally. The anterior orbital foramina are of moderate size and triangular, gradually narrowing toward the lower part. The anterior palatal fissures are relatively long and open, extending nearly to the anterior molar teeth. (Figure 1). Key adaptations include large cheek pouches for seed caching and specialized dentition (yellow-orange incisors) for herbivory. Morphometric analysis revealed a skull structure optimized for burrowing, with wide interorbital spacing and thin zygomatic arches (Table 2).

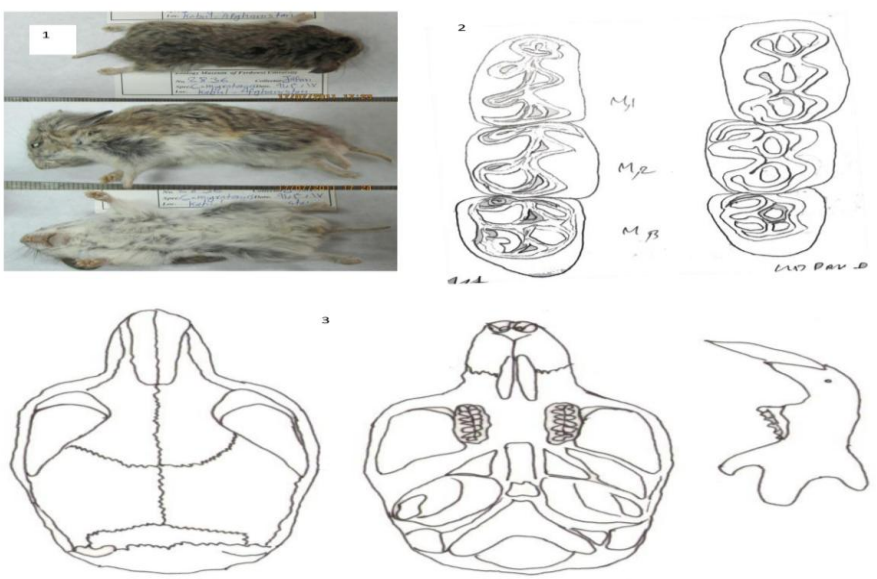

Figure 1: (1) Dorsal, lateral, and ventral views; (2) Right dental row — (a) upper jaw, (b) lower jaw; (3) Dorsal and ventral views of the skull and lower jaw in *Cricetulus migratorius* (image by the author)

Table 2. *Descriptive statistics (mean and standard deviation) of cranial, dental, and external traits of 2 specimens of Cricetulus migratorius from Kabul province*

Descriptive Statistics					
Cricetulus migratorius					
Characters	Number	Minimum	Maximum	Mean	Std. Deviation
LRA	2	4.170	4.250	4.21000	.056569
LRC	2	3.990	4.200	4.09500	.148492
LLD	2	4.460	5.020	4.74000	.395980
MEAL	2	7.590	8.940	8.26500	.954594
MARL	2	10.640	12.340	1.149001	1.202082
MANL	2	9.150	10.630	9.89000	1.046518
MAL	2	7.350	8.410	7.88000	.749533
HMCB	2	4.540	5.220	4.88000	.480833
HMAB	2	3.360	4.120	3.74000	.537401
HLD	2	2.140	2.650	2.39500	.360624
BAR	2	13.580	15.270	1.442501	1.195010
BAN	2	12.170	14.100	1.313501	1.364716
AAR	2	13.510	15.000	1.425501	1.053589
MH	2	5.090	6.620	5.85500	1.081873
URA	2	4.080	4.240	4.16000	.113137
URC	2	3.970	4.030	4.00000	.042426
UDL	2	7.230	8.810	8.02000	1.117229
NL	2	9.040	10.610	9.82500	1.110158
BWP1	2	4.590	4.760	4.67500	.120208
DB2M	2	10.820	11.430	1.112501	.431335
ZW	2	13.090	16.000	1.454501	2.057681
LANPF	2	4.8200	5.4000	5.110000	.4101219
NW	2	4.590	5.240	4.91500	.459619
IOW	2	4.310	4.340	4.32500	.021213
SH	2	9.460	9.610	9.53500	.106066
GLS	2	26.0200	29.2900	2.765501	2.3122392
CW	2	10.700	11.180	1.094001	.339411
CBL	2	22.660	25.920	2.429001	2.305168
BL	2	5.460	5.610	5.53500	.106066
BWP2	2	4.100	4.480	4.29000	.268701
AL	2	4.230	4.760	4.49500	.374767
ML	2	13.720	14.780	1.425001	.749533
UPM1L	2	1.686	1.745	1.71550	.041719
UPM1W	2	1.075	1.086	1.08050	.007778
UPM2L	2	1.212	1.291	1.25150	.055861
UPM2W	2	1.120	1.164	1.14200	.031113
UPM3L	2	.900	1.072	.98600	.121622
UPM3W	2	.903	1.034	.96850	.092631

LOM1L	2	1.502	1.642	1.57200	.098995
LOM1W	2	.907	1.218	1.06250	.219910
LOM2L	2	1.307	1.312	1.30950	.003536
LOM2W	2	1.043	1.101	1.07200	.041012
LOM3L	2	1.086	1.318	1.20200	.164049
LOM3W	2	.941	.985	.96300	.031113
H.B.L	2	87.000	97.000	9.200001	7.071068
T.L	2	25.000	27.000	2.600001	1.414214
F.L	2	16.000	17.000	1.650001	.707107
E.L	2	14.000	21.000	1.750001	4.949747

Ellobius (Afganomys) fuscocapillus

It has a cylindrical body and velvety fur. The dorsal fur is light brown with a grayish tint, darker on the head and neck, while the ventral surface is grayish to whitish. The tail is very short but visible. The ears and eyes are small and hidden within the fur. The upper incisors are long and white. The ear pinna is extremely short, to the extent that it is not visible among the fur. The forefeet have five digits. The first digit is very short, with its tip positioned posterior to the base of the second digit. The second and third digits are the longest, while the fourth digit is shorter than these two, and the fifth digit is very short, approximately equal in length to the first. The palm is completely naked and bears five pads.

The hind foot also has five digits. The first and fifth digits are approximately equal in length and are shorter than the other three. The third and fourth digits are the longest and are roughly equal in length, while the second digit is shorter than these two but longer than the first. The sole is naked and bears six pads, and the dorsal surface of the foot, like the tail, is more or less covered with fine, light-colored hairs. The claws are also short. In the skull, the rostrum is broad, and its width is approximately equal to that of the interorbital region. The nasal bones are short and do not reach the base of the incisors. The braincase is wide, with a convex dorsal surface that slopes posteriorly. The anterior palatal fissures are very poorly developed and short. The auditory bullae are somewhat flattened and posteriorly bear processes that extend laterally from both sides. In the upper jaw, the incisors are very long, extend forward, and are white in color. The first and second molars are approximately equal in length. On the first molar, three transverse ridges are formed that are connected in the

middle, and no closed triangles are formed on the occlusal surface of this tooth.

On the second molar, three cusps are present on the outer margin, while on the inner margin, the first and second cusps are not completely separated, with only a shallow groove between them. In contrast, the depression between the second and third cusps is very deep and large, and the middle outer cusp is triangular in shape.

The third molar is smaller than the second, and on both the inner and outer sides, two completely rounded cusps are present. The anterior outer cusp has a slight depression in the middle (Figure 2) (Table 3). This fossorial species displayed extreme adaptations to subterranean life. Its skull features a short nasal bone, convex cranium, and highly specialized molars for root/tuber consumption (Shenbrot et al., 2016)

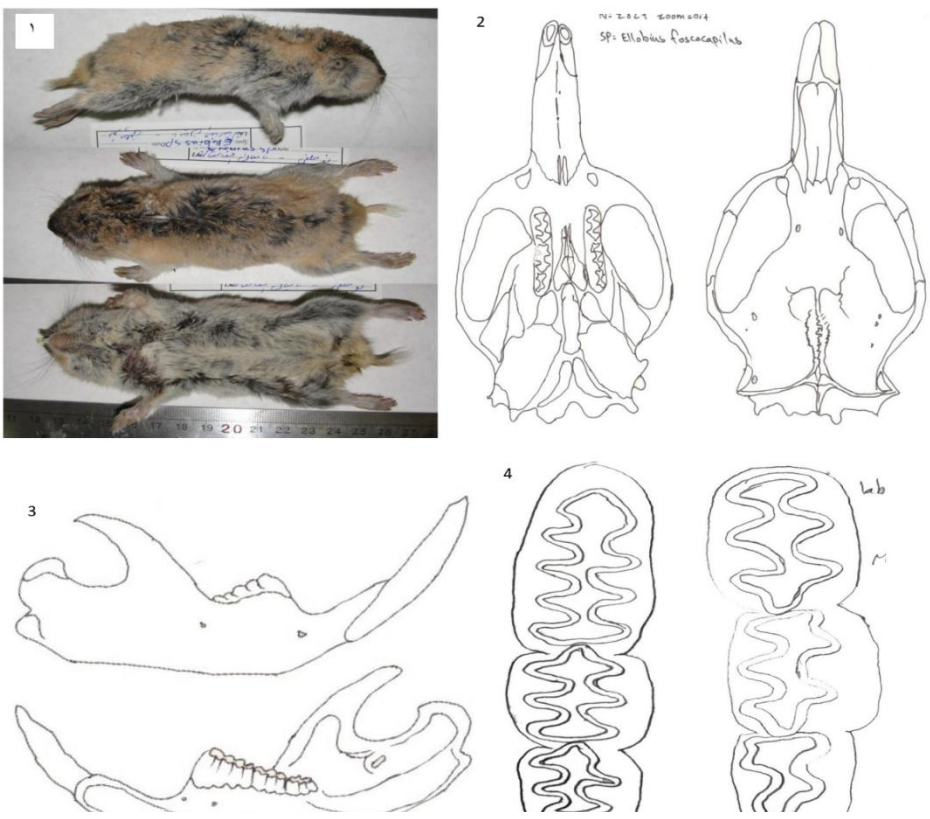

Figure 2: (1) Lateral, dorsal, and ventral views; (2) Ventral and dorsal views of the skull; (3) External and internal views of the lower jaw; (4) Right dental row (a) upper jaw, (b) lower jaw in *Ellobius fuscocapillus* (image by the author)

Table 3. *Descriptive statistics (mean and standard deviation) of cranial, dental, and external traits of 6 specimens of Ellobius fuscocapillus from Bamyan province, Afghanistan*

Ellobius fuscocapillus					
Descriptive Statistics					
CHARACTER	Number	Minimum	Maximum	Mean	Std. Deviation
LRA	6	8.270	9.600	8.73167	.471611
LRC	6	7.620	8.670	7.92667	.377977
LLD	6	6.330	7.780	6.99000	.668969
MEAL	6	17.500	20.910	1.84567e1	1.263529
MRI	6	17.190	20.770	1.87800e1	1.238095
MARL	6	18.560	22.110	1.97750e1	1.307804
MANL	6	17.780	22.520	1.90783e1	1.757731
MAL	6	16.160	20.170	1.74783e1	1.395699
HMCB	6	7.770	10.180	8.56500	.930994
HMAB	6	4.470	6.850	5.43500	.966597
HLD	6	3.170	4.580	3.58333	.500866
BAR	6	21.110	25.210	2.25733e1	1.547717
BAN	6	20.470	25.550	2.22500e1	1.801810
AAR	6	21.220	26.120	2.33450e1	2.186145
MH	6	6.260	9.260	6.99167	1.125903
URA	6	7.810	8.960	8.15333	.408787
URC	6	7.210	8.380	7.58500	.417217
UDL	5	12.050	13.560	1.27400e1	.575630
NL	5	8.140	9.580	9.00600	.556399
BWP1	6	6.190	6.880	6.55833	.246042
DB2M	6	16.750	19.070	1.75983e1	.831779
ZW	6	21.450	27.460	2.37983e1	1.974259
LANPF	5	2.0700	3.3900	2.674000e0	.4806558
NW	5	5.150	5.830	5.53800	.248133
IOW	5	5.780	6.600	6.20200	.322986
SH	6	11.770	14.380	1.25333e1	.932559
GLS	5	34.2500	37.7100	3.579600e1	1.6078339
CW	6	16.700	19.340	1.76483e1	.940158
CBL	5	5.890	32.080	2.51060e1	10.834195
BL	6	8.210	10.150	9.04667	.753198
BWP2	6	5.630	6.000	5.83833	.137611
AL	6	3.920	5.550	4.61700	.551803
ML	6	21.190	27.750	2.39033e1	2.249646
UPM1L	6	2.807	3.616	3.05450	.302699
UPM1W	6	1.566	1.959	1.66983	.146575
UPM2L	6	2.361	2.723	2.53367	.137843

UPM2W	6	1.019	1.637	1.35300	.216053
UPM3L	6	1.699	1.897	1.80567	.084861
UPM3W	6	1.193	1.331	1.25317	.058393
LOM1L	6	3.509	4.288	3.81017	.304168
LOM1W	6	1.319	1.748	1.46100	.172803
LOM2L	6	2.176	2.480	2.29950	.121717
LOM2W	6	1.301	1.594	1.41417	.115055
LOM3L	6	1.710	1.967	1.84300	.103634
LOM3W	6	.865	1.320	1.05317	.178848
H.B.L	6	100.000	165.000	1.25833e2	21.903577
T.L	6	14.000	20.000	1.70000e1	2.683282
F.L	6	22.000	25.000	2.40000e1	1.264911

***Microtus transcaspicus* (Transcaspian Vole)**

The dorsal surface of the body is chickpea-brown with a mixture of yellow, while the ventral surface is white with dark yellow patches. The ears are round, short, and inconspicuous and are hidden beneath the body fur, and the eyes are tiny. The soles of the feet are naked and hairless. In this species, the skull is somewhat larger than in other *Microtus* species and is relatively similar to *M. arvalis*. The interorbital distance is wide, and the braincase is relatively narrow. The third upper molar typically has four lingual triangles and three (in the typical condition) or four labial triangles. (Figure 3), This species' dental morphology (four lingual triangles on M3) distinguishes it from congeners.

Figure 3*: (1) Lateral, ventral, and dorsal views; (2) Right dental row (a) upper jaw, (b) lower jaw in* Microtus transcaspicus. *(Image by the author)*

Table4. *Descriptive statistics (mean and standard deviation) of cranial, dental, and external traits of 1 specimen of Microtus taranscaspicus from Bamyan province, Afghanistan.*

Descriptive Statistics		
Microtus taranscaspicus		
Character	N	Measurment
LRA	1	6.53
LRC	1	5.77
LLD	1	4.15
MEAL	1	10.58
MRI	1	11.78
MArL	1	13.7
MAnL	1	13.23
MAL	1	10.34
HMCB	1	5.35
HMAB	1	4.17
HLD	1	2.17
B	1	12.68
Bar	1	16
Ban	1	15.11
Aar	1	15.8
MH	1	8.26
URA	1	6.3
URC	1	5.89
UDL	1	8.66
NL	1	7.65
BWP 1	1	5.88
DB2M	1	12.65
ZW	1	15.86
LAnPF	1	5
NW	1	5.17
IOW	1	4.09
SH	1	9.52
GLS	1	27.88
CW	1	12.15
CBL	1	26.22
BL	1	8.39
BWP 2	1	5.77

AL	1	4.11
ML	1	16.06
UpM1L	1	2.325
UpM1W	1	1.148
UpM2L	1	1.688
UpM2W	1	0.95
UpM3L	1	1.865
UpM3W	1	0.949
LoM1L	1	3.115
LoM1W	1	0.897
LoM2L	1	1.456
LoM2W	1	0.845
LoM3L	1	1.574
LoM3W	1	0.828
B.L	1	123
T.L	1	45
F.L	1	7
E.L	1	10

Discussion

This study provides the first systematic, geographically verified record of three Cricetidae species in Afghanistan, revealing that the country's mountain and semi-arid landscapes support a more structured, ecologically specialized rodent fauna than previously documented. The main finding is the clear ecological and morphological differentiation among *Cricetulus migratorius*, *Ellobius fuscocapillus*, and *Microtus transcaspicus*, each occupying distinct habitats ranging from peri-urban plains to deep soils and alpine meadows. This spatial and functional separation suggests that Cricetidae rodents are key contributors to ecosystem stability across Afghanistan's highly heterogeneous environments.

The morphological patterns observed in this study reflect strong adaptation to local ecological conditions. The robust skull, wide interorbital region, and large cheek pouches of *C. migratorius* indicate specialization for seed storage and burrowing in dry, open habitats, supporting its role as a granivore and soil-disturbing species in agricultural landscapes. Similarly, the cylindrical body, reduced eyes and ears, and

compact skull of *E. fuscocapillus* reflect extreme adaptation to subterranean life, where mobility through dense soils and energy-efficient feeding on roots and tubers are critical for survival. In contrast, the lighter body form and distinctive molar pattern of *M. transcaspicus* are consistent with grazing and surface activity in high-altitude grasslands, where rapid reproduction and mobility are advantageous.

These findings are consistent with previous studies of Cricetidae ecology in Central and Southwest Asia, where *C. migratorius* is known to dominate semi-arid agroecosystems, *Ellobius* species act as ecosystem engineers in compact soils, and *Microtus* species function as keystone prey in alpine food webs (Davidson et al., 2012; Shenbrot et al., 2016; Burgin et al., 2018). However, unlike neighboring regions, Afghanistan has lacked verified distribution and morphological data, making this study the first to confirm these ecological roles within its national boundaries. The restriction of *E. fuscocapillus* to undisturbed soils in Punjab District and of *M. transcaspicus* to Bamyan's alpine meadows suggests a higher degree of habitat specificity than reported in some Central Asian populations, possibly reflecting Afghanistan's extreme topographic and climatic gradients.

The ecological interpretation of these findings highlights the importance of Cricetidae rodents as drivers of soil processes, vegetation dynamics, and trophic stability. Burrowing by *C. migratorius* and *E. fuscocapillus* enhances soil aeration, water infiltration, and nutrient cycling, reducing erosion and increasing plant productivity in fragile landscapes (Whitford & Kay, 1999; Alhajeri & Schenk, 2022). Meanwhile, *M. transcaspicus* supports predator populations in alpine ecosystems, helping maintain food-web balance (Burgin et al., 2018). The presence of these species therefore indicates the presence of functioning ecosystems, making them valuable bioindicators in Afghanistan's post-conflict environment (Ostrowski et al., 2021).

Despite its contributions, this study has limitations. The sample size was small, and karyological analyses were constrained by specimen availability and preservation quality, limiting the ability to detect fine-scale genetic variation. In addition, sampling was restricted to Bamyan, Kabul, and the Punjab District, leaving large areas of eastern and

northeastern Afghanistan unexplored. These constraints mean that the full distributional range and population connectivity of these species remain unresolved.

Future research should use non-invasive genetic tools, such as DNA barcoding, to examine population structure and dispersal across fragmented habitats (Frankham, 2010). Expanding surveys into remote and conflict-affected regions such as Nuristan, combined with remote-sensing-based habitat mapping, would allow identification of biodiversity hotspots and guide conservation planning under Afghanistan's ecological recovery framework (Ostrowski et al., 2021).

Conclusion

In this study, 9 specimens belonging to the family Cricetidae were obtained from altitudes of 645 to 3,354 meters above sea level in the two provinces of Bamyan and Kabul, representing the first systematic assessment of the Cricetidae family in Afghanistan and documenting three species (*Microtus transcaspicus*, *Cricetulus migratorius*, and *Ellobius fuscocapillus*). Before dissection, several external morphological traits of the specimens were measured with an accuracy of 1 mm using a ruler and caliper. These traits included head and body length, tail length, hind foot length, ear length, and weight. Additionally, the specimens were examined from different perspectives (dorsal, ventral, and lateral surfaces, and occasionally the soles of the feet due to pads and fur). The fur color on the dorsal, lateral, and ventral surfaces of the body, as well as on the dorsal and ventral surfaces of the tail, along with external morphological traits, cranial and dental morphometrics, karyotype, and molecular studies, was examined in some specimens. In this study, a limited number of specimens from the family were karyotyped as *Ellobius*, but some slides were poorly stained, and thus no photographs were taken. These species were identified, and their biosystematic studies, including chromosomal, morphological, and morphometric analyses, were conducted using rodent identification keys and tools such as a ruler, caliper, drawing mirror, and a Nikon Measuring Microscope MM-40. The data were analyzed with software including CIP, Excel, PAST, and SPSS. As a result, one specimen of *Microtus transcaspicus* was obtained from the village of Joy Nik Pay, two specimens of *Cricetulus migratorius* from the 20-Metre Road area of

Dasht-e Barchi, Kabul province, and six specimens of *Ellobius fuscocapillus* from various locations and altitudes in the Punjab District, Bamyan province. These specimens were identified as belonging to three genera and three subfamilies of Cricetidae. Distinct morphological and cranial characters confirmed clear taxonomic separation among the three genera. At the same time, habitat-specific distributions revealed strong ecological specialization, with *C. migratorius* associated with peri-urban and agricultural plains, *M. transcaspicus* restricted to alpine grasslands, and *E. fuscocapillus* confined to undisturbed montane soils. Karyological analyses further supported species-level differentiation and highlighted the genetic uniqueness of these populations within Afghanistan.

Collectively, these findings demonstrate that Afghanistan's mountain and semi-arid ecosystems support a previously undocumented diversity of small mammals that play key roles in soil turnover, vegetation dynamics, and food-web stability. By integrating morphological, morphometric, and chromosomal data, this study establishes the first scientific baseline for Cricetidae in the country and provides essential evidence for prioritizing habitat protection and biodiversity monitoring. These results are significant for Afghanistan, where climate change, land-use conversion, and prolonged socio-political instability continue to threaten fragile ecosystems and their biological integrity.

Recommendations

Small mammal conservation should be integrated into Afghanistan's biodiversity and disaster risk reduction strategies, emphasizing their role in soil health, climate resilience, and ecosystem recovery. Agroforestry and habitat-friendly farming practices that reward local communities can link conservation with livelihood security. Strengthening collaboration with IUCN, neighboring countries, and donor agencies is essential for habitat restoration and harmonized cross-border policies.

On the research side, priority actions include refining karyotyping protocols for subterranean species, expanding nationwide biodiversity surveys, and combining GIS/remote sensing with field studies to monitor habitat fragmentation. Establishing a national biodiversity database and building local capacity in taxonomy and conservation biology through

university partnerships will ensure long-term monitoring and conservation success.

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Author Contribution

Mohammad Hassan Jafari conducted the field sampling and performed the primary data collection and analysis. Narges Teimoory contributed to data interpretation, analytical refinement, and manuscript revision, including language editing and scientific clarity. Nazifullah Qurbani assisted with critical reviewing and editorial feedback on the manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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