THESIS

Small Mammal Communities of the Darhad Valley, Mongolia

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Abstract

The Darhad Valley, Mongolia, is a sparsely populated area with abundant wildlife and numerous livestock, including: goats, yaks, horses, sheep, and Bactrian camels. Few studies completed in this location have placed an importance on obtaining baseline species data. To my knowledge, no data have been collected on small mammal diversity, density, and distribution. This study focused on live-trapping small mammals, with an emphasis on rodents in six locations throughout the Darhad Valley. We aimed to identify species currently present and develop protocols for future work. Captured rodents represented three families: Sciuridae, Cricetidae, and Muridae. Common species included striped dwarf hamsters (*Cricetulus barabensis*), Mongolian silver voles (*Alticola semicanus*), and Korean field mice (*Apodemus peninsulae*). Challenges encountered, which must be mitigated in future studies, included: curious humans, grazing animals, supply acquisition, locational information, and identification resources. Future studies should also emphasize community composition, range, and presence of ectoparasites, which could transfer zoonotic diseases.

Introduction

Mongolia is landlocked and situated between Russia and China. It is the 18th largest country in the world, at approximately 1,566,000 km^2. However, it is also the most sparsely populated country in the world. The population of Mongolia is just over 3 million, and approximately half of the population lives in the capital city of Ulaanbaatar (NSO, 2020). Additionally, about 80% of the land in Mongolia is grassland (Sternberg, 2008) and many Mongolians still practice a mobile pastoralist lifestyle (Ahearn, 2018).

In Mongolia, the primary domesticated animals are horses, yaks, sheep, goats, and camels. All of these animals are used for their meat and dairy. However, Cashmere goats and Bactrian camels are primarily raised as sources of wool, which provides significant income to herders (Fox, 2015). Because of the financial benefit gained by raising livestock, livestock numbers in Mongolia continue to grow and are now over 70 million (NSO, 2020). This number of livestock has the potential to transform landscapes,

including the soil nutrients present and the composition of plant communities (Augustine, 2003), which can influence other aspects of the ecosystem and community compositions as well.

To protect the natural landscapes of Mongolia from pastoralism and other factors, four types of protected areas were created by the Mongolian Parliament. These areas have varying levels of regulation, and include: Strictly Protected Areas (SPAs), National Conservation Parks, Nature Reserves, and Monuments. The strictest protections are in SPAs, which fall under the International Union for Conservation of Nature's (IUCN) Ia Strict Nature Reserve category. The SPAs include pristine areas, where only protected area managers and observational researchers are allowed. National Parks are the next most protected areas and are considered a category II protected area by IUCN. The least strict categories are Nature Reserves and Monuments and are considered by IUCN as a category III or IIII (Reading et al., 2015).

The Ulaan Taiga Protected Area (UTPA) complex is located in the Darhad Valley, Mongolia. This remote complex includes three areas: Horidol Saridag SPA, Tengis Shisged National Park, and Ulaan Taiga SPA. The UTPA is supervised by the Ulaan Taiga Specially Protected Areas Administration (UTSPAA). In the summer of 2018, Round River Conservation Studies (RRCS) joined with UTSPAA to implement a conservation study abroad experience for college students. The UTSPAA recognized the importance of small mammals to the Darhad Valley and in 2019 requested a small mammal survey be completed by RRCS during the study abroad program. According to UTSPAA, small mammals have been overlooked for larger more charismatic species during previous research conducted in the Darhad.

Of all mammal species, approximately 90%, or 4,875 species, are small mammals (Reeder & Wilson, 2005). Small mammals are defined as mammals weighing less than 5 kg at maturity (Merritt, 2010). Quantifying small mammal populations and densities is important to understanding ecosystem functions (Davidson et al., 2012), as well as zoonotic disease transfer risk and potential (Pulscher et al.,

2018). Therefore, obtaining information on small mammal communities and densities in the Darhad Valley is essential for a greater understanding of the ecosystem and for protecting public health from diseases like the plague, which is present in Mongolia.

The goal of this study was to use live trapping to identify which rodent species were present in multiple locations throughout the Darhad Valley. This study also aimed to create a protocol for future RRCS and UTSPAA studies that will use small mammal trapping. Another objective was to identifying challenges and possible solutions of trapping in this remote location and future directions for studies in the Darhad.

Methods

Study Sites & Trapping

All study sites were located within the Darhad Valley of Mongolia (Figure 1) and were approximately 1,700–2,000 m in elevation. Sherman live traps were used and were checked once in the morning (approximately 0700) per trap night. Traps were placed opportunistically in areas that appeared to be good habitat for rodents (e.g. near cover and food sources). The number of traps and bait used varied by location and are described in (Table 1).

The first site trapped was the Mungash Hashsa (MH), located approximately 1 km northwest of the Horidol Saridag SPA and the Mungash River. One trap night was completed at this location on 06/28/2019. The second site trapped was the Round River Base Camp (BC), located approximately 1 km north of the Horidol Saridag SPA and the Mungash River. Five trap nights were completed on 06/29/2019 - 07/01/2019 and 07/04/2019-07/05/2019. The third site trapped was the UTSPAA Hasha (UH) in Ulaan-Uul, one trap night was completed at this location on 07/03/2019. The fourth site trapped was at Battogtokh Hasha (BH) near Tsagaan Nuur, one trap night was completed at this location on 07/07/2019. The fifth site was Duuren Nuur (DN), one trap night was completed on 07/08/2019. The

final site was the junction of Uurjuul and Dartsag (UD), five trap nights were completed between 07/14/2019 - 07/19/2019.

Figure 1: Setting of the Darhad Valley in Northern Mongolia. All six trap sites were located near Horidol Saridag SPA shown in green.

Table 1: Description of the sites trapped, number of trap attempts, and bait used. All locations trapped were between 1,700 m – 2,000 m in elevation. Boortsog is a local fry bread.

Site Name	Site Code	Habitat	Trap Nights	Bait
Mungash Hasha	MH	Meadow	20	Peanut butter, oats, apples
Round River Base Camp	BC	Meadow	55	Peanut butter oats, apples, and boortsog
UTSPAA Hasha	UH	Semi-Rural	8	Peanut butter oats, apples, and boortsog
Battogtokh Hasha	BH	Steppe	8	Peanut butter and millet
Duuren Nuur	DN	Steppe	10	Peanut butter and millet
Junction of Uurjuul and Dartsag	UD	Dry Rocky Area	50	Peanuts, raisins, and boortsog

Data Collected

Animals were removed from the traps and transferred to a 1 gallon plastic bag for further data collection. Data collected on mammals at each trap site included: location, species, fate (new, recapture, dead), reproductive status, sex, weight, hind foot length (heel of foot to the longest digit, including claw), ear length (notch at base of ear cavity to tip of pinna, excluding hair), tail length (base of tail to last tail vertebrae), and gender (anus to genitals). All measurements were taken with calipers and recorded in millimeters. Weights were taken using a spring scale and recorded in grams. Multiple photos of each individual were obtained using a Google Pixel 2 camera phone. Each rodent was given a marking on its head and stomach with a Sharpie before release to determine if future captures were new or recaptures.

Data Analysis and Identification

A list of the recorded data was compiled using Microsoft Excel. Photo files were saved by date and individual photo identification numbers were assigned in the data sheet. The data were then saved on an external hard drive owned by RRCS. Photos and measurements were compared to *A Field Guide to the Mammals of Mongolia* (2014) to determine species. Data were then analyzed using Microsoft Excel to create a graph of the number of individuals captured by species, a graph of the percentage trapping success by location, and a table of average measurements of the species.

Protocol Creation

Protocols were created based on previous field experience with small mammals and industry accepted field methods prior to the field research in Mongolia. After research completion, modifications were made based on observations and field note data. After editing, the final protocol (Appendix A) was saved on an external hard drive owned by RRCS for future use.

Results

Overall, 23 unique individuals and nine recaptures were trapped during this study, for a total of 32 captures. The species identified consisted of Mongolian silver voles (*Alticola semicanus*), striped dwarf hamsters (*Cricetulus barabensis*), Korean field mice (*Apodemus peninsulae*), and a long-tailed ground squirrel (*Urocitellus undulatus*). Additionally, a few unidentified rodents were captured (Figure 2).

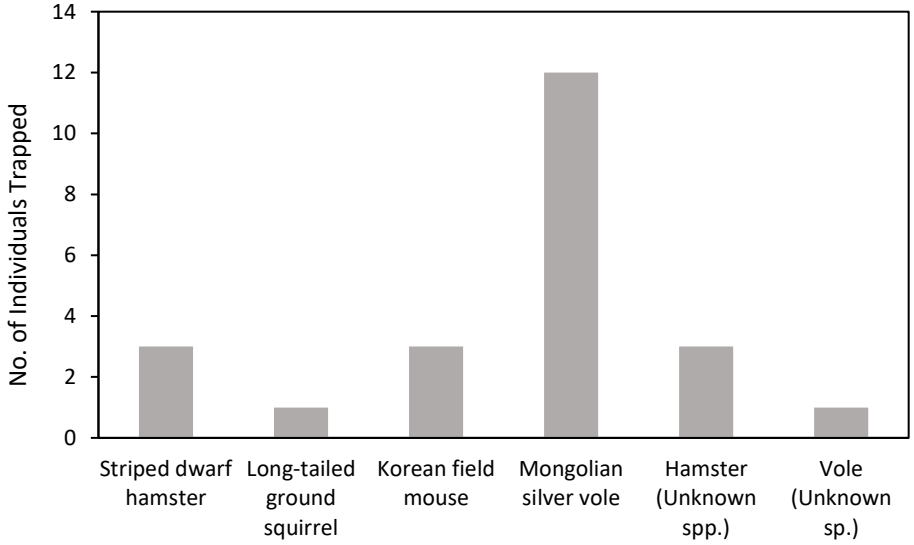

Figure 2: Number of individuals trapped by species at six locations in the Darhad Valley, Mongolia. There was a total of 23 unique individuals identified.

By location, UD had the greatest percentage of success (Figure 3). These captures included 12 Mongolian silver voles, 3 Korean field mice, and 4 unknown species. All of the species captured at BC were striped dwarf hamsters. The species captured at BH was a long-tailed ground squirrel. No species were captured at the MH, UH, or DN locations.

Species weight and measurements varied, but the averages fell within the expected weights and lengths for species identified, with the exception of the Korean field mice tail length (Batsaikhan et al.,

2014). However, one of the Korean field mice captured did have an injured tail, which may have caused the results to vary. Calculations on the long-tailed ground squirrel and unknown species were excluded due to small sample sizes (Table 2).

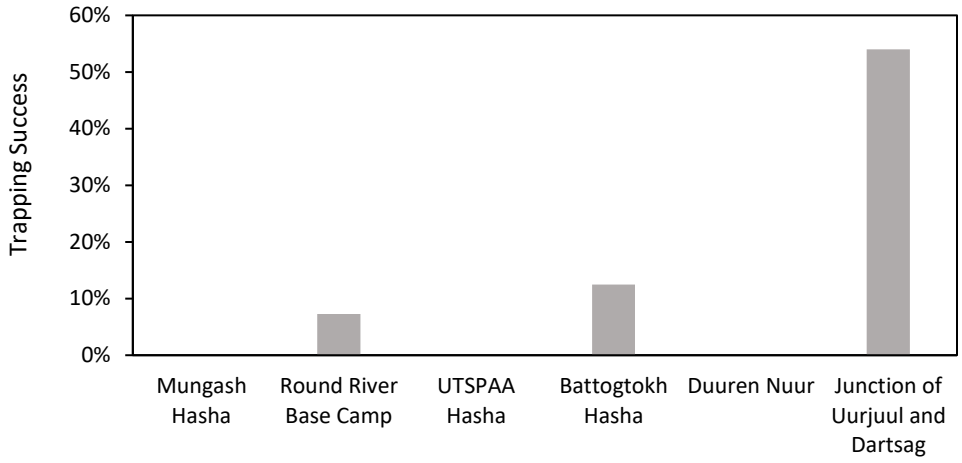

Figure 3: Percent of small mammal trapping success by location in the Darhad Valley. Trap nights varied by location: Mungash Hasha=1, RR Base Camp=5, UTSPAA Hasha=1, Battogtokh Hasha=1, Duuren Nuur=1, Junction of Uurjuul and Dartsag=5.

Table 2: Mean weights and lengths of the identified species with SD (Korean field mouse n=3, Mongolian silver vole n=12, striped dwarf hamster n=3). The long-tailed ground squirrel and unknown species were not included due to sample size (ground squirrel n=1).

Species Name	Avg Weight (g)	Avg Foot (mm)	Avg Ear (mm)	Avg Tail (mm)
Korean field mouse	34.33 ± 9.81	22.11 ± 2.01	11.17 ± 2.02	63.83 ± 29.75*
Mongolian silver vole	28.83 ± 8.74	19.33 ± 1.93	13.38 ± 2.65	19.46 ± 3.41
Striped dwarf hamster	25.00 ± 5.00	14.50 ± 1.80	9.33 ± 2.52	16.67 ±2.08

Discussion

The rodents captured during this study represented three families: Sciuridae, Cricetidae, and Muridae. The location where trapping success was greatest was UD. This may be due to the amount of time spent at this location, dryer conditions, and/or lack of livestock present compared to other locations. Many Mongolian silver voles were captured in this location, which may be due to the rocky outcrops that provided shelter to them.

Trapping in remote locations can present a variety of obstacles. The pastoralist lifestyle of the Darhad people and this study being the first of its kind in this location added compounding factors. Challenges encountered included: curious children discovering and removing traps from study sites, livestock grazing which reduced areas that traps could safely be set, limited supplies to restock trapping materials and bait, and limited resources for species identification and locational information. Species identification and locational data are crucial to continued studies in the Darhad. Use of GPS was not available for this study and *A Field Guide to the Mammals of Mongolia* (2014) book is out of print and difficult to obtain. There are no other known identification guides for mammals in Mongolia. Recommendations for future studies are outlined in Table 3.

Despite these challenges, valuable data were collected which will assist future researchers. Future studies should place an emphasis on density data and range identification of individuals, including elevational data. This would be useful in determining future range shifts and population changes due to climate change and other factors (Mestre et al., 2015). Several of the rodents captured also harbored ectoparasites such as fleas and ticks, and additional studies should be conducted to better inventory the species infected with ectoparasites and the types of ectoparasites present. This would help to determine the risk of zoonotic disease transfer, such as plague (*Yersinia pestis*), which can be detrimental to human health and is carried by ectoparasites (Galdan et al., 2010).

Table 3: Challenges encountered which must be mitigated in future studies.

Challenge	Description	Solution
Curious Humans	Children were especially interested in the traps and removed/broke some traps.	Inform the nearby community of the studies taking place or select locations further from humans.
Grazing Animals	Many grazing animals were present, which limited the locations we could trap without the potential of damaging traps.	Create enclosures which can protect the traps (PVC pipe or similar).
Resources	There are few shops in town with limited inventory. Also, baits like peanut butter and oats are not regularly sold in the Darhad Valley.	Bring in all resources from the city and reuse them as much as possible. Also, find local products which can substituted items (e.g. millet instead of oat).
Locational Information	At times it was difficult to determine what a location should be referred to as.	Obtain a GPS to mark trap locations when possible and continue to work with local partners to get more detailed locale data.
Identification	Many small rodents appear visually similar; therefore it is difficult to differentiate between species and Mongolian resources on identification are lacking.	Take photos of all aspects of the rodents (feet, tail, genitals, etc.). Obtain mammal guides from Russia if possible and China to assist in identification.

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APPENDIX A

Small Mammal Survey Protocol

By: Chyanne Smith

2020

Introduction

Of all mammal species, approximately 90 percent, or 4,875 species, are considered to be small mammals (Wilson and Reeder, 2005). Small mammals are defined as mammals weighing less than 5 kg at maturity (Merritt, 2010). Quantifying small mammal populations and densities is important to understanding ecosystem functions (Davidson et al., 2012), as well as zoonotic disease transfer and risks (Pulscher et al., 2018). The Ulaan Taiga Protected Area Administration (UTPAA), in Mongolia, has asked Round River Conservation Studies to conduct research in this area to better understand what small mammal species inhabit the valley. Many times, when research is conducted in this area, small mammals are overlooked for larger more charismatic animals. Currently, there is no baseline for the communities and densities of the small mammals present in the Darhad Valley.

Safety

Both the Hantavirus and plague are associated with small mammal populations around the world, including Asia. Therefore, care should be taken in the field while handling animals and equipment that comes into contact with them.

Hantavirus

Read the updated guidelines for protection of mammalogists and wildlife researchers from Hantavirus pulmonary syndrome (HPS) published by the American Society of Mammologists (Kelt et al., 2010).

Plague

The plague is caused by the bacterium *Yersinia pestis*. A study in Mongolia found that most plague cultures are from ectoparasites of mammals, mainly fleas. Additionally, a majority of the fleas carrying the plague were marmot fleas (Galdan et al., 2010).

Recommended gear

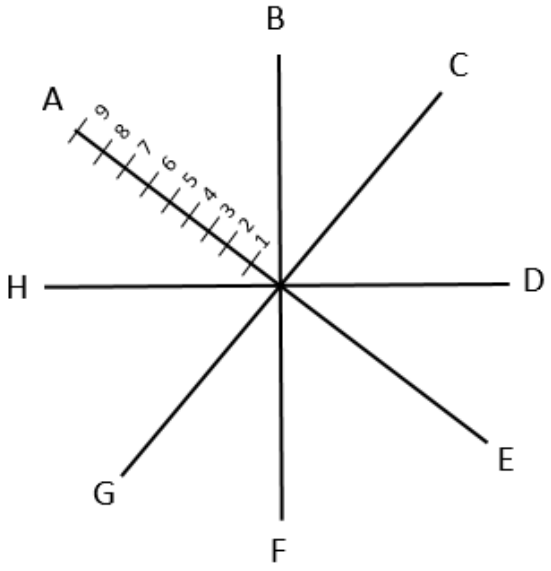
Researchers shall wear long sleeve shirts and pants in the field. Additionally, animals will only be handled by gloved individuals. A minimum of a latex glove will be worn, however, leather gloves may be worn for extra protection. For additional safety, protective eyewear can be worn.

Bites/Scratches

If researchers are bitten or scratched, affected areas will be washed thoroughly with soap and water and then disinfected with an alcohol-based sanitizer.

Trapping Grid (Optional)

1. Locate a central grid location, mark with a pin flag.
2. Use a measuring tape to create a 90 m long grid, with the center pin flag as the center point (each side from the center should be 45 m).
3. Every 5 m place a pin flag on the grid, starting at the center and working outward on each line. Each spoke from the center should have 9 flags (adjust the number depending on the number of total traps available).
4. Repeat the steps above, with a new line which will cross the center and the other line, making a t shape.
5. Repeat again two more times making an x over the t. Attempt to keep the grids as evenly spaces as possible.
6. Label each pin flag with the line name and location number (EX: A1 for line A and location 1). The center flag will serve as number 0 for all lines, so any trap in the center will be line name and location 0 (EX: A0).



Opportunistic Trapping

If a grid is not reasonable based upon the habitat, traps may be placed opportunistically. Look for adequate habitat for small mammals. This may include wood piles, ground burrows, rocky crevices, food storage, and more. Place the trap and mark with flagging tape nearby so you are able to locate the traps again. Give the trap location an identifying number for data collection.

Setting Traps

1. Inside of each trap, include a handful of bait and insulation (cotton batting or dry grass clippings). *Optional: If extreme weather, place a wax cardboard container (milk carton or juice box) around the trap for insulation.*
2. Set the trap by pressing down the door until it latches, only one side of the trap latches.

3. If using a grid, place one trap at each flagged location, starting from the center of each line. Take care that the trap does not trigger shut as you place it. Traps can be placed away from the pin flag if there appears to be good habitat, however, all traps should be within 1 m of their flagging. Use the same method for opportunistic.

Checking Traps and Removing Mammals

1. Go to each trap location individually.
2. Check to see if the trap door has been triggered shut.
3. If the door has not been triggered shut, shut the door and mark it on your sheet as empty.
4. If the door is triggered shut, hold the trap away from your face and cautiously open the door with a gloved hand until you can see if a small mammal has been trapped. Take care not to open the door too wide, so the mammal does not escape.
5. If there is a mammal, take an empty plastic bag (3 L) and weigh it (g) marking the weight on your data sheet. Next, place the bag around the outside of the trap with the door still closed.
6. Use your hand to open the door, through the bag, and give the trap a firm shake to move the mammal into the bag. **Take care to hold the door open the entire time you are shaking the trap, otherwise the door can shut and cause injury to the mammal. Also, make sure there is no gap between the bag and the trap.**

If you choose to move the traps to a central processing location, instead of processing at each location individually, make sure to return the mammals to an area near the habitat they were captured.

Data Collection

1. Once the mammal is in the clear plastic bag, quickly record the following information:

- Species information, using Appendix B or mammal guides
- Weight with the bag (g), using a spring scale (subtract the weight of the bag to get the mammals weight)
- Photos (optional, can take after scruffing)
- If this is a recapture or a first time captured individual

2. While the mammal is still in the plastic bag, place the mammal on a flat surface, and use your thumb and forefingers to grab the skin behind the neck and scruff the mammal. If done correctly, the mammal will have restricted head movement. Do not grab/hold the animal by its tail at any point, as it can cause damage to the vertebrae.
3. Once the mammal is secured, peel back the bag to reveal the ventral side of the mammal and record the following information:

- Sex - If ambiguous, sex can be determined by distance from anus to vaginal opening or penis, males have a greater distance.
- Reproductive status - can be determined by seminal plugs, distended abdomens, and milk in nipples or halos around nipples.
- Right hind foot measurement (mm) - heel of foot to the longest digit, including claw.
- Right ear measurement (mm) - notch at base of ear cavity to tip of pinna, excluding hair.
- Tail length (mm) - base of tail to last tail vertebrae, can gently bend the tail to find the base.
- Total length (mm) - last tail vertebrae to tip of nose. This may be difficult to measure while the animal is living. You can mark as N/A if living or attempt to use a fabric measuring tape.
- Any additional comments regarding the mammal - Presence of ticks, fleas, injuries, etc.

4. Once the data collection is complete, mark the mammal on the ventral side with a blue or purple sharpie, it is important to use an unnatural color. If you would like to identify individuals, you may wish to number them, otherwise, just place a large visible dot.

Animal Injury/Euthanasia

If animals are severely injured during trapping activities, they will be euthanized by anesthetic overdose using the following method:

1. Place the animal in a sealed plastic bag
2. Soak a cotton ball in 2 ml of isoflurane
3. Place the cotton ball in the sealed bag
4. Continue isoflurane exposure until one minute after breathing stops
5. Dispose of body in accordance with UTPAA guidelines

If isoflurane is not available, euthanize the animal in accordance to UTPAA guidelines.

Release and Clean Up

1. Once data collection is complete, place the mammal back in the bag, set on the ground with the bag open and wait for the mammal to exit.
2. Discard insulation and excess bait.
3. Clean the trap and plastic bags with a 1:10 bleach and water mix and dry in sunlight.

Hantavirus is inactivated by direct sunlight and a 10% bleach solution. Therefore, all equipment that comes in contact with rodents will be disinfected, by spraying with a 10% bleach solution and/or exposing to direct sunlight (Kelt et al., 2010). Any trash being discarded should also have bleach sprayed inside of the bag.

APPENDIX B

Species Guide to the Darhad Valley, Mongolia

By: Chyanne Smith

2020

Korean field mouse (*Apodemus peninsulae*)

Family: Muridae

AVERAGE MEASUREMENTS WITH STANDARD DEVIATION

Average weight (g): 34.33 ± 9.81

Average foot length (mm): 22.11 ± 2.01

Average ear length (mm): 11.17 ± 2.02

Average tail length (mm): 63.83 ± 29.75

Species Photo(s):

Long-tailed ground squirrel (*Urocitellus undulatus*)

Family: Sciuridae

AVERAGE MEASUREMENTS

Average weight (g): 280

Average foot length (mm): 31

Average ear length (mm): 11

Average tail length (mm): 80

Species Photo(s):

Mongolian silver vole (*Alticola semicanus*)

Family: Cricetidae

AVERAGE MEASUREMENTS WITH STANDARD DEVIATION

Average weight (g): 28.83 ± 8.74

Average foot length (mm): 19.33 ± 1.93

Average ear length (mm): 13.38 ± 2.65

Average tail length (mm): 19.46 ± 3.41

Species Photo(s):

Striped dwarf hamster (*Cricetulus barabensis*)

Family: Cricetidae

AVERAGE MEASUREMENTS WITH STANDARD DEVIATION

Average weight (g): 25.00 ± 5.00

Average foot length (mm): 14.50 ± 1.80

Average ear length (mm): 9.33 ± 2.52

Average tail length (mm): 16.67 ±2.08

Species Photo(s):

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