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A comprehensive database of squirrel distribution and occurrence in South Asia

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A comprehensive database of squirrel distribution and occurrence in South Asia

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Abstract

Background

The Squirrels of South Asia (SOSA) database compiles comprehensive distribution and occurrence information on all squirrel species that occur in this region (34 species). These 34 squirrel species, including tree, flying and ground squirrels, represent 14% of global sciurid diversity. The database collates curated data from various sources such as museums, literature, primary fieldwork, citizen science, and social media platforms and covers the entire distributional ranges of the target species, including countries in Central Asia and Southeast Asia when required. The SOSA database enhances our understanding of squirrel distribution, population dynamics, and their conservation needs in South Asia by consolidating information. It aims to be a valuable resource for researchers, conservationists, and wildlife enthusiasts.

New information

As of March 2023, the database comprises over 40,000 records of 34 species in over 30 countries globally. Spending an average of 334 hours on each species, more than 20 data collectors put in over 10,000 hours to gather, curate, and build this database. The database has resulted in novel records of species occurrence in regions and countries that are poorly represented in currently available global data repositories. The current version which has been made public via GBIF comprises of 1187 records of all 34 species across multiple sources. This is a subset of the SOSA database.

Keywords

database, occurrence, social media, citizen science, museum records, squirrels, South Asia, Asia

Introduction

South Asia is home to several species of squirrels that occur across the Palearctic, Oriental and Indo-Malayan regions (Datta and Nandini 2014). Due to rising deforestation and urbanisation, South Asian forests, one of the most biologically diverse ecosystems on the planet, are being destroyed (Hasnat et al. 2018). The small mammals in this region are under severe threat from several factors, like habitat degradation and hunting for the illicit wildlife trade (Willcox 2020).

34 species of squirrels occur in the South Asian region, comprising 14% of the global diversity of squirrels (Whatton et al. 2012). Squirrels, like most other small mammals, have not been well studied in South Asia, which hampers our ability to prioritize endangered taxa and place them at the forefront of research on species declines (Koprowski and Nandini 2008, McKinney 1999). Squirrels can be broadly divided into three categories based on their diversity in lifestyle, habits, and morphology - tree squirrels, flying squirrels and ground squirrels. They play vital ecological functions like seed dispersal, pollination, and regulating plant growth (Lacher et al. 2019). They also serve as a significant prey base in the landscapes where they occur (Byholm et al. 2012). Squirrels are susceptible to environmental pressures, such as urbanisation, habitat modification, and climate change, and can serve as model study systems (Sol et al. 2013). The first step in understanding how species respond to such changes is to determine their geographic range by documenting where they occur.

Databases on species occurrence are crucial for understanding biodiversity dynamics because they provide a comprehensive record of when and where a species has been observed (Chapman 2005). This information aids in conservation efforts, helps identify areas of high biodiversity, and enables the study of species' responses to environmental changes (Jetz et al. 2019). Due to technical improvements and the emergence of online portals like the Global Biodiversity Information Facility (GBIF), which combine occurrence information from various datasets, the number and accessibility of data on species occurrences have significantly risen in recent years (Petersen et al. 2021). Managers of biodiversity and applied conservation practitioners use such data to understand species occurrence trends and update/infer species' IUCN statuses periodically (Bloom et al. 2017). For example, Species Distribution Models (SDMs) are frequently used to estimate how climate change affects species range shifts and to understand environmental limitations on range expansion and contraction (Jetz et al. 2019).

The rapid spread of internet connectivity and access to mobile technology enables the interested public to capture and share information and simultaneously allows researchers to serendipitously access large-scale secondary data in ways that were not possible a couple of decades ago (Pocock et al. 2017). The objective of creating the Squirrels of South Asia database is to compile comprehensive and up-to-date information on squirrel occurrence across South Asia by leveraging a diverse range of data sources, including traditional data, citizen science contributions and social media data. This database aims to serve as a valuable resource for researchers, conservationists and wildlife enthusiasts, providing a centralised platform to access, analyse and contribute to the understanding of squirrel species in Asia.

Sampling methods

Description:

Sampling description: Data Collection

We collected data from three major sources. Traditional data sources included museum data, information from the literature and primary field data. The second source of data included records from citizen science platforms (5 platforms), and the third source of data encompassed social media platforms (14 sources) (details in Table 1).

A pipeline was created for the data collection, and all volunteers (15) on the project were trained to follow this to maintain consistency in data collection. For all data records, irrespective of source, we noted essential information like species name, location, date/year of observation, and observer/author. Media data were examined/downloaded when available. In addition to this, all other relevant data associated with each record were noted (e.g. behaviour, ecological information, etc.). Details of how data records were collected within each source are listed below.

Traditional data

Museum data: Museum data was collected from the GBIF (<https://www.gbif.org/>) portal, which collated data from 40 museums across the world (Table 2). In addition to this, specimen data from the Bombay Natural History Society (BNHS) museum and the Zoological Survey of India (ZSI) were included. Specimen data from BNHS were included when data were collected as part of other projects in the research lab, and hence this is not a comprehensive list of their squirrel collections. Data on specimens in the ZSI collections were obtained through literature searches, detailed below. Sometimes, publications of ZSI included details of species occurrence through a listing of specimens collected during field expeditions. However, on other occasions, ZSI publications listed occurrence data in compilations and geographic summary reports, where specimens were not explicitly collected/listed. We include both sources as ZSI records.

Literature data:

A two-stage approach was used to find traditional sources that listed squirrel occurrence across the target region. The first stage included searching for species occurrence records on two online data engines, [Google Scholar](#) and Biodiversity Heritage Library, using species' scientific names only. Only current genera and species names were used for these searches. The Biodiversity Heritage Library ([BHL](#)) is a repository of old documents, books and natural history notes that are not always indexed by search engines like Google Scholar. BHL was specifically searched to add records from colonial expeditions from 1800 onwards. Google Scholar was used as the primary search engine as it has substantially higher coverage and indexing of academic literature than traditional search engines (Martín-Martín et al. 2018). When search hits were found on Google Scholar, a snowball search approach was used to locate the original references (Wohlin 2014). Only original references of species occurrence were used to build the database.

Two years into the building of the database, all curated location points were plotted on a map, and gap regions with no records were identified. For instance, large parts of Central Indian states like Madhya Pradesh, Chhattisgarh, Orissa and Jharkhand, etc., were lacking in records. However, we know from personal communications/experience that squirrels occur here. In such cases, a second search was performed on Google Scholar using a combination of search terms, including state names (old and new), district names, names of protected areas, and species common names to find more specific references from outside mainstream publication indexes. These were usually grey literature (occurrence information outside traditional literature) like survey reports or Forest Department documents. All of these were added to the database, and Suppl. material 1 has the details all the references examined species-wise.

Primary field data: Field survey data included occurrence records collected directly from the field by researchers within the lab (20 lab members) who have been trained to identify squirrel species by sight and call. Typically, the training includes examination and cross-validation of species identity using known photographs and calls and discussions during shared field observations.

Citizen Science data

Across all citizen science portals, searches were conducted using the scientific names of squirrel species. We did not use common names for searches, as all the citizen science portals identify data objects by their scientific names. iNaturalist (<https://www.inaturalist.org>) is a global online citizen science platform that crowdsources biodiversity information and organism occurrence using automated and curator-led species identification (Nugent 2018). The website allows search-based downloads of bulk records but does not automatically download media (calls, videos and images). The URL links of image files associated with each record were then used to import the images into our datasheets. The media records were verified for species identification during curation for records with calls and videos, but these files were not imported into our datasets. All records for a species were downloaded irrespective of the quality grade assigned by the curating protocol followed by iNaturalist. Project Noah (<https://www.projectnoah.org/>) is a global citizen science platform where naturalists and nature enthusiasts upload images of organisms. The squirrel records were

directly downloaded from the Project Squirrel mission page for this platform. The species of interest were later filtered out from the downloaded data, and the images were imported into our Airtable datasheets (a spreadsheet-database hybrid tool) using the image URL links. Two India-specific citizen science platforms were explored, given their popularity with Indian naturalists; the taxa-agnostic India Biodiversity Portal (<https://indiabiodiversity.org/>) and the mammal-specific Mammals of India (<https://www.mammalsofindia.org/>). India Biodiversity Portal is a repository of biodiversity information designed to collate information about the biodiversity of the Indian subcontinent (Vattakaven et al. 2016). Mammals of India is a peer-reviewed web-based repository of Indian mammals (Bayani et al. 2023). Squirrel records from the India Biodiversity Portal and Mammals of India platforms were downloaded from GBIF using species' scientific names.

Interested naturalists, students and researchers at or affiliated with IISER Tirupati were invited to join a campus-wide WhatsApp group dedicated to sharing information about squirrels in one's surroundings. Members post photographs, calls, videos and sighting locations (phone-based location within WhatsApp), and curators identify species and engage with group members on aspects of squirrel behaviour and ecology. This initiative is listed as a citizen science source rather than a social media source, as data is collected and curated on a specific project-linked platform.

Social media data

On all social media platforms (Table 1), species-wise searches were performed using common and scientific names for each species. Most users are not naturalists with comprehensive knowledge of biodiversity, and we used combinations of English common and local language names to extract records. For social media data, only search results with media files (images, audio, video) that allowed confirmation of species identity were included in the database. For all search results, the associated post data, including species identification given by the user, user name, date of posting, date of observation, and location information, were noted. In some instances where crucial information like location was missing, the observer was contacted for it, and the information was later noted down. Researchers manually entered each entry into the datasheets (17 people over two years, including volunteer interns).

Most platforms allowed media (images, audio, video) associated with posts to be downloaded directly (Facebook, Minden Pictures, India Nature Watch, Twitter, iStock, 500pix, Nature Picture Library, India Wilds and Wikimedia). In cases of platforms (e.g., Instagram and Pinterest) that did not allow direct downloads of images, we accessed the images stripped of metadata. An R script was used to download images with metadata from Flickr, which was uploaded manually to the Airtable datasheet. All images were then manually uploaded to the respective data record.

Quality control: Data Curation

All records, irrespective of their source, were curated for confirming species identification and determining location. Given low public awareness of squirrel species, we expected

high error rates with contributors' assignment of species identity. A key of species images and calls was used to maintain consistency across the curatorial team. To ensure verification of species identity, media (photographs, audio, and video data) were collected when possible or cross-checked on the source site. Each record was manually verified for species identity by one or two of four curators (more curators for less-familiar species). A curator manually eliminated duplicate records by comparing species-specific data across several sources. An internal history of deleted duplicate records was maintained. Subspecies level information in all records was collapsed to the species level. If only genus-level information were available, the record was discarded unless there were accompanying media to confirm species identification. Social media records/posts that did not have the required media to confirm species identity were discarded.

The location for each entry was also curated carefully, and the location was parsed into four spatial categories - specific location, broad area, state/province, and country. Specific location attributes to records where the exact location was mentioned are unique and have high spatial accuracy. The broad area is attributed to a larger place like a city or a town. The state/province refers to a larger administrative unit in which the broad area is located. The country is attributed to a major administrative unit in which the location occurs. For example, suppose a squirrel was recorded in the Victoria Memorial in Kolkata. In that case, the location details are as follows - specific location: Victoria Memorial, broad area: Kolkata, state/province: West Bengal, country: India. If the observer specified only a larger generalised area, like a range within a protected area, then we considered that as a broad area and not a specific location. A georeference was added when unavailable in the original post. All location data were imported into Google Sheets, and the map tool [Geocode by Awesome Table](#) was used to obtain latitude and longitude data for places. Curators often contacted observers on social media platforms to confirm details before an entry was finalised.

Database Structure

A combination of .csv files, Google Sheets, Google Drive and Airtable were used to collect and curate the records. Once the curation was complete, all data were migrated into a database following the Darwin Core Standard for data representation. Species taxonomy followed international nomenclature following the IUCN taxonomy, consistent with the GBIF Backbone Taxonomy (GBIF Secretariat 2011, International Union for Conservation of Nature 2022). Data will be uploaded to public platforms, specifically to GBIF, in batches over the coming years.

A preliminary version of the database with 1187 curated records (Swati et al. 2023) has been made public on the GBIF portal.

Geographic coverage

Description: For this database, we collected comprehensive occurrence records across the entire geographic ranges of the target species (Fig. 1). Species geographic range

maps from the IUCN Red List of Threatened Species ([IUCN, 2022](#)) were used to determine the final geographic ranges of species after consulting other sources (Datta and Nandini 2014, Whatton et al. 2012) to rule out conflicting range information. The geographic distribution of 16 species of squirrels found in South Asia extends into East and Southeast Asia, while the ranges of 12 species of squirrels are restricted to South Asia. 6 species of squirrels, including two species in Afghanistan, have ranges extending to Central Asia and the Palearctic. One species of palm squirrel (*Funambulus pennantii*) has been introduced to the Middle-east and Australia, well outside its native geographic range. When squirrel species in this database were found to occur in countries outside of South Asia (e.g. Central/East/Southeast Asia), their occurrence data were collected across all countries in their geographic ranges, including the introduced/invaded regions (for *F. pennantii*) (Csurhes 2016, Victor and Cuellar Soto 2020). Thus, this database is currently a comprehensive set of occurrence records for all South Asian squirrel species, even when the species found here are not restricted to this region alone.

Taxonomic coverage

Description: We created a list of 34 species of squirrels in South Asia by following the GBIF Backbone Taxonomy and using it as a guiding framework (GBIF Secretariat 2011). An earlier version of this database was created focusing only on species in India (Udayraj et al. 2022), but this was subsequently expanded to the current database.

Temporal coverage

Data range: 1766-1-01 - 2022-12-31.

Notes: The earliest records of the presence and occurrence of squirrel species with accurate geolocation information date back to the late 1700s. For this database, occurrence data were systematically collected for the period spanning over two centuries until May 2023. The time frames for traditional data are from 1766 to 2023; citizen science data from 1998 to 2023; and social media data from 2005 to 2023.

Collection data

Collection identifier:

Parent collection identifier:

Specimen preservation method:

Usage licence

Usage licence: Creative Commons Public Domain Waiver (CC-Zero)

Data resources

Data package title: IISERTPT Squirrels of South Asia Database - Version 1

Resource link: <https://doi.org/10.15468/mnqzjv>

Alternative identifiers: <https://www.gbif.org/dataset/f842ea5a-e38c-4be2-924d-c065b41215b0>

Number of data sets: 1

Data set name: Squirrels of South Asia Database - Version1

Description: The table contains details of the column labels and its description of the GBIF dataset

Column label	Column description
id	Globally inique id
basisOfRecord	The specific nature of the data record.
associatedReferences	A list (concatenated and separated) of identifiers (publication, bibliographic reference, global unique identifier, URI) of literature associated with the dwc:Occurrence.
occurrenceID	Globally unique identifier
recordNumber	An identifier given to the Occurrence at the time it was recorded.
year	The four-digit year in which the Event occurred, according to the Common Era Calendar.
month	The integer month in which the Event occurred.
day	The integer day of the month on which the Event occurred.
continent	The name of the continent in which the Location occurs.
country	The name of the country or major administrative unit in which the Location occurs.
countryCode	The standard code for the country in which the Location occurs.
stateProvince	The name of the next smaller administrative region than country (state, province, canton, department, region, etc.) in which the Location occurs.
locality	The specific description of the place.
decimalLatitude	The geographic latitude (in decimal degrees, using the spatial reference system given in geodeticDatum) of the geographic center of a Location.
decimalLongitude	The geographic longitude (in decimal degrees, using the spatial reference system given in geodeticDatum) of the geographic center of a Location.

coordinateUncertaintyInMeters	The horizontal distance (in meters) from the given decimalLatitude and decimalLongitude describing the smallest circle containing the whole of the Location.
geodeticDatum	The ellipsoid, geodetic datum, or spatial reference system (SRS) upon which the geographic coordinates given in dwc:decimalLatitude and dwc:decimalLongitude are based.
scientificName	The full scientific name, with authorship and date information if known.
kingdom	The full scientific name of the kingdom in which the taxon is classified.
phylum	The full scientific name of the phylum or division in which the taxon is classified.
class	The full scientific name of the class in which the taxon is classified.
order	The full scientific name of the order in which the taxon is classified.
family	The full scientific name of the family in which the taxon is classified.
genus	The full scientific name of the genus in which the taxon is classified.
specificEpithet	The name of the first or species epithet of the scientificName.
vernacularName	A common or vernacular name.
nomenclaturalCode	The nomenclatural code (or codes in the case of an ambireginal name) under which the scientificName is constructed.
taxonRank	The taxonomic rank of the most specific name in the scientificName.
dynamicProperties	A list of additional measurements, facts, characteristics, or assertions about the record. Meant to provide a mechanism for structured content. In this IUCN status

Additional information

Discussion

The use of social media platforms is increasing exponentially across India and South Asia, yet these still need to be explored as sources for harvesting biodiversity information. While studies are increasingly using social media and citizen science groups to harvest biodiversity data (Barman et al. 2022, O'Neill et al. 2023, Marcenò et al. 2021), our study is unique in a few respects.

Most studies typically collate data from taxon-specific, location-specific or event-specific groups on social media platforms like Facebook or citizen science portals like iNaturalist. Such groups typically have curators who perform the first line of filtering and identification. Our study not only gathers data across multiple platforms but employs naive searches to collate information across each platform/website. This implies that we redirect significant efforts towards data curation, as every point has to be validated by our internal team. Many

records are also verified by dialogue and direct engagement with observers. This amounts to many work hours towards building a highly accurate and reliable database. Time and effort spent towards obtaining data were variable across the 23 data sources explored, and database building up until March 2023 involved the efforts of four curators and 15 interns to collect over 40,000 records. The total time invested is upwards of 10,000 hours, with an average of 334 hours spent on each species.

We also propose to continue data collection from these sources over the next few years to add records till we reach saturation of records for species across their distribution ranges. For specific regions and species, we will invest in targeted efforts through workshops and citizen drives, as passive data collection might not be the ideal strategy. To date, we have launched a website to enable identification and education about squirrels in India (<https://squirrelsofindia.org>) and employ accompanying social media handles (<https://www.facebook.com/groups/412739976780858>, <https://www.instagram.com/squirrels.of.india/>) to encourage participation and dialogue. Versions of the database will be uploaded on public platforms, especially GBIF, on a regular basis.

We believe that building this database is a significant contribution to the field of mammalogy, particularly small mammal research in Asia. By consolidating and organising comprehensive information on squirrels inhabiting the South Asian region, this database offers numerous benefits in terms of scope and impact. In terms of scope, the database provides valuable data to researchers, conservationists and policymakers, aiding in a better understanding of the diversity and dynamics of the squirrel populations in this region (Cabrelli et al. 2014, Darrah et al. 2017, Pelletier et al. 2018). Additionally, this database goes beyond mere compilation of existing information. It also serves as a platform for data integration, enabling researchers to contribute new findings and update existing records through direct engagement. This approach fosters a continuous expansion of knowledge, allowing for the inclusion of new species discoveries, range extensions, and updated conservation assessments. Consequently, we propose that the database will become a tool that adapts to the evolving understanding of South Asian squirrel biodiversity.

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Author contributions

SU and RKM data compilation; SU training and supervising interns; SU and APS data curation; SD, SU and NR database design and building; SU, NR and RKM writing; NR, SU, SD, APS conception of the project.

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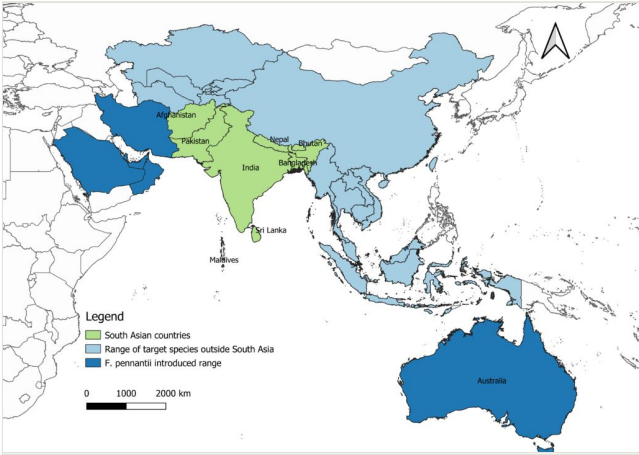


Figure 1.
Map showing countries from which South Asian squirrel occurrence records have been collected.

Table 1.
Details of the three major sources of occurrence data.

Traditional Data Sources	Citizen Science Data Sources	Social Media Data Sources
Museum data, Google search for literature, Biodiversity Heritage Library, Primary field data	iNaturalist, Mammals of India, India Biodiversity Portal, Project Noah	Instagram, Facebook, Twitter, YouTube, Flickr, 500px, Minden Pictures, Nature Picture Library, Alamy, iStock, India Nature Watch, Wikimedia, Pinterest, India Wilds

Table 2.

Species list and the museums from which specimen data has been included in the database. Species and genus names used were in accordance with the listing on the GBIF Backbone Taxonomy. Museum Codes (Institution codes) and Names were used in accordance with the Global Registry of Scientific Collections (GRSciColl) and the DarwinCore Archive data standard (legend below table).

Squirrel species	Museums
<i>Belomys pearsonii</i> (Gray, 1842)	AMNH, FMNH, BYU, MNHN, NHMUK, NSMT, SMF, USNM, Naturalis
<i>Biswamoyopterus biswasi</i> Saha, 1981	ZSIC
<i>Callosciurus erythraeus</i> (Pallas, 1779)	AMNH, ASNHC, BPBM, CAS, FMNH, KU, LACM, MACN, MCZ, MHNG, MNHN, MVZ, MZLU/LUND, NHMO/UiO, NHMUK, NML, NMR, NSMT, RBINS, ROM, SMF,UAM, UF, UMZM, USNM, UWBM, ZFMK, ZMH, YPM
<i>Callosciurus pygerythrus</i> (I. Geoffroy Saint-Hilaire, 1833)	AMNH, FMNH, LACM, MCZ, MNHN, NHMO/UiO, PSM, SMF,UMZM, USNM, YPM, ZFMK, ZMH
<i>Dremomys lokriah</i> (Hodgson, 1836)	AMNH, FMNH, KU, MCZ, MNHN, NHMUK, SMF, TCWC, UMZM, USNM, YPM, ZMH, Naturalis
<i>Dremomys pernyi</i> (Milne-Edwards, 1867)	AMNH, BYU, FMNH, KU, MCZ, MNHN, MVZ, NHMUK, SMF, TCWC, UMZM, USNM, ZFMK, Naturalis
<i>Dremomys rufigenis</i> (Blanford, 1878)	AMNH, FMNH, MCZ, MHNG, MNHN, MVZ, NHMUK, NSMT, RBINS, ROM, SMF, UMZM, USNM
<i>Eoglaucomys fimbriatus</i> (Gray, 1837)	nil
<i>Eupetaurus cinereus</i> Thomas, 1888	Naturalis
<i>Funambulus layardi</i> (Blyth, 1849)	MHNG, FMNH, NHMUK, USNM
<i>Funambulus obscurus</i> (Pelzeln & Kohl, 1886)	nil
<i>Funambulus (Funambulus) palmarum</i> (Linnaeus, 1766)	Naturalis, BNHS, ZSIC, NHMUK, AMNH
<i>Funambulus (Prasadsocius) pennantii</i> Wroughton, 1905	Naturalis, BNHS, ZSIC, AMNH
<i>Funambulus (Funambulus) sublineatus</i> (Waterhouse, 1838)	Naturalis, NHMUK
<i>Funambulus (Funambulus) tristriatus</i> (Waterhouse, 1837)	AMNH, FMNH, MCZ, MHNG, NHMO/UiO, NMBT, ROM, ZFMK, ZMH
<i>Hylopetes alboniger</i> (Hodgson, 1836)	Naturalis
<i>Hylopetes phayrei</i> (Blyth, 1859)	NSMT

<i>Marmota (Marmota) caudata</i> (Geoffroy, 1844)	ZMMU
<i>Marmota (Marmota) himalayana</i> (Hodgson, 1841)	ZSIC, Naturalis
<i>Petaurista petaurista albiventer</i> (Gray, 1834)	USNM
<i>Petaurista elegans</i> (Müller, 1840)	Naturalis, ZMA
<i>Petaurista magnificus</i> (Hodgson, 1836)	Naturalis
<i>Petaurista nobilis</i> (Gray, 1842)	nil
<i>Petaurista petaurista</i> (Pallas, 1766)	Naturalis, ZMA
<i>Petaurista philippensis</i> (Elliot, 1839)	Naturalis, ZMBN
<i>Petaurista mechukaensis</i> Choudhury, 2007	nil
<i>Petaurista mishmiensis</i> Choudhury, 2009	nil
<i>Petinomys fuscocapillus</i> (Jerdon, 1847)	nil
<i>Ratufa bicolor</i> (Sparrman, 1778)	Naturalis, ZMBN, RGM, LSUMZ
<i>Ratufa indica</i> (Erxleben, 1777)	ZMBN, Naturalis, ZMA
<i>Ratufa macroura</i> (Pennant, 1769)	nil
<i>Spermophilus fulvus</i> (Lichtenstein, 1823)	AMNH, KU, FMNH, MCZ, UMZM, ZFMK, RBINS, SMF, NHMUK, ISEZ-PAS, USNM, MVZ, MNHN
<i>Spermophilopsis leptodactylus</i> (Lichtenstein, 1823)	ROM, AMNH, KU, FMNH, MCZ, UMZM
<i>Tamias maclellandii</i> (Horsfield, 1840)	Naturalis, ZMA, KIZ

Legend: AMNH American Museum of Natural History; ASNHC Angelo State Natural History Collections; BNHS Bombay Natural History Society; BPBM Bernice Pauahi Bishop Museum; BYU Brigham Young University; BYU Brigham Young University (BYU) Life Science Museum; CAS California Academy of Sciences; FMNH Field Museum of Natural History; ISEZ-PAS Institute of Systematics and Evolution of Animals, Polish Academy of Sciences; KIZ Kunming Institute of Zoology, Chinese Academy of Sciences; KU University of Kansas, Biodiversity Institute and Natural History Museum; LACM Natural History Museum of Los Angeles County; LSUMZ Louisiana State University, Museum of Zoology; MACN Museo Argentino de Ciencias Naturales Bernardino Rivadavia; MCZ Harvard University, Museum of Comparative Zoology; MHNG Muséum d'Histoire Naturelle de la Ville de Genève; MNHN National Museum of Natural History, Paris, MVZ Museum of Vertebrate Zoology, University of California Berkeley, MZLU/LUND Lund University Biological Museum; Naturalis Naturalis Biodiversity Center; NHMO/UiO University of Oslo (UiO); NHMUK Natural History Museum, London; NMBT Natuurmuseum Brabant; NML World Museum, National Museums Liverpool; NMR Natural History Museum Rotterdam; NSMT National Science Museum, Tokyo; NSMT National Science Museum (Natural History); PSM Puget Sound Museum of Natural History, University of Puget Sound; RBINS Royal Belgian Institute of Natural Sciences; RGM Rijksmuseum van Geologie en Mineralogie (Naturalis); ROM Royal Ontario Museum; SMF Naturmuseum Senckenberg, Frankfurt; SNSB-SAPM SNSB-Staatssammlung für Anthropologie und Paläoanatomie

München; UAM University of Alaska Museum; UF Florida Museum of Natural History-Zoology, Paleontology & Paleobotany; UMZM University of Michigan Museum of Zoology; USNM Smithsonian Institution, National Museum of Natural History; ZSIC Zoological Survey of India

Supplementary material

Suppl. material 1: List of literature data from which occurrence data has been included in the database

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