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# An overview of the Mammal Collection of Instituto de Biología, Universidad Nacional Autónoma de México



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## Abstract

Colección Nacional de Mamíferos (CNMA) is an important Mexican mammalian collection that meets international standards of curatorial procedures and follows domestic and international regulations. It holds the largest number of museum mammalian specimens from México of any Mexican biological collection, and keeps representatives of nearly 90% of Mexican taxa. Skins, skulls, skeletons, fluid-preserved specimens, and frozen tissues are the main preservation types. Most taxonomic representatives are small mammals such as mice, bats, shrews, and lagomorphs from almost every major political division of México, and ecosystems of temperate and tropical affinity. CNMA holdings contain important voucher specimens such as extinct taxa, endemic species, and unique specimens. Taxonomic and geographic data for most specimens are available online and also in digital file format including images. CNMA specimens actively contribute to environmental education and teaching through routine activities of its faculty, staff, and students. CNMA is successfully contributing to the inventory of mammals from México.

**Keywords:** Curation, CNMA, UNAM, Colección Nacional de Mamíferos, Mexico, biodiversity

## Introduction

Colección Nacional de Mamíferos is one of the most important mammalian collections in México and Latin America, and dates from the mid-20th century (Figure 1; Cervantes, 2016). It is hosted by Instituto de Biología (IB) of Universidad Nacional Autónoma de México (UNAM) in Mexico City (Hortelano-Moncada et al., 2006), and its formal collection acronym has been CNMA since 2003 (Consejo Interno, 2003; Zambrano and Reynoso, 2003). The international standards of curation procedures of CNMA have been recognized by the Systematic Collections Committee of the American Society of Mammalogists (ASM), granting a Certificate of Accreditation to the CNMA in 1975, 1983, and 1995 (Figure 2). CNMA is included in a list of accredited collections in the Western Hemisphere that was compiled by the Systematic Collections

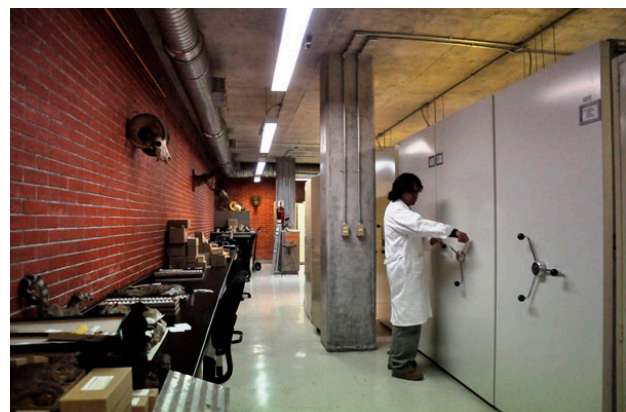


Figure 1. Panoramic view of the mammal collection (Colección Nacional de Mamíferos, CNMA) of Instituto de Biología, Universidad Nacional Autónoma de México, in Mexico City.



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Figure 2. Certificate of Accreditation granted to Colección Nacional de Mamíferos (CNMA) by the Systematic Collections Committee of the American Society of Mammalogists in 1975, 1983, and 1995.

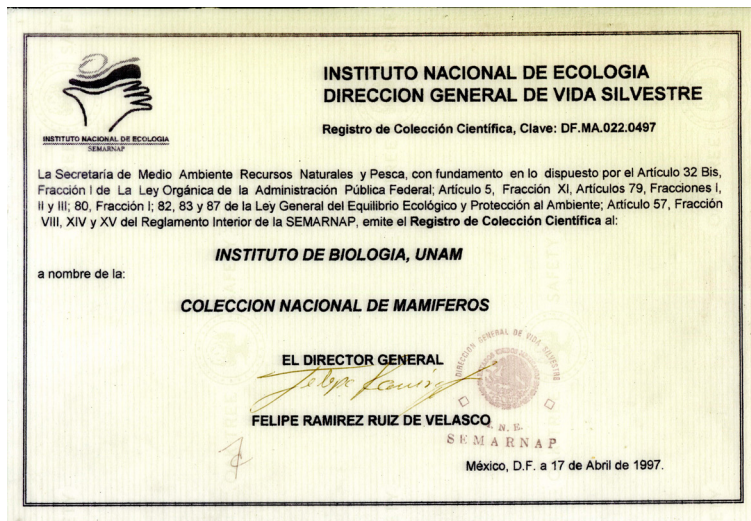


Figure 3. CNMA in the National Register of Scientific Collections issued by the environmental branch of the Mexican government (Secretaría del Medio Ambiente y Recursos Naturales).



Figure 4. Register of National Biological Collections of Instituto de Biología, Universidad Nacional Autónoma de México, including Colección Nacional de Mamíferos (CNMA), as a CITES site.

Committee (Hafner et al., 1997). In addition, faculty, staff and students at CNMA follow the guidelines of the ASM for the use of wild mammals in research and education (Sikes et al., 2016), mainly relating to vouchering of specimens and ancillary materials. CNMA policy agrees with ASM's that deposition of specimens in collections maximizes benefits from each catalogued specimen, ensures access to data by any user, and provides vouchers for individuals or species used in published research.

In addition, to comply with domestic regulations on collecting permits and biological collections of México, CNMA is formally entered in the National Register of Scientific Collections, compiled by the environmental branch of the Mexican government (Secretaría del Medio Ambiente y Recursos Naturales (SEMARNAT)) under the register number DF.MA.022.0497, issued on 17 April 1997 (Figure 3). As expected, many of the specimens of CNMA are on the international list of threatened and endangered species of the Convention on International Trade in Endangered Species (CITES), whose trade is closely regulated by national and international agencies. In order to export and import specimens for research purposes, CNMA needs a special certification from CITES. In México, such recognition is issued by SEMARNAT (local administrative authority of CITES), which accredited CNMA as CITES site no. MX-007, along with other national biological collections at Instituto de Biología (Figure 4).

### The Collection

CNMA holds nearly 48,000 catalogued museum specimens of mammals, which include representatives of all the mammalian orders reported for México (Table 1; Boisserie et al., 2005; Ramírez-Pulido et al., 2015; Guevara et al., 2015). Small mammals such as rodents and bats are the mammal groups with the highest number of species in México (together comprising 70.4% of the total of 550 Mexican mammal species, including land and marine forms; Ceballos and Arroyo-Cabrales, 2012). Unsurprisingly, they comprise the bulk (45,495 out of 47,295 specimens = 96.2%) of holdings at CNMA, along with carnivore, rabbit, and shrew specimens. Recent listings at CNMA indicated that nearly 90% of mammal species reported for México have representatives therein.

Preserved mammal specimens at CNMA include stuffed skins, tanned skins, skulls, complete skeletons, individual bones including bacula of mice, horns, antlers, tissues frozen at  $-75^{\circ}\text{C}$ , and fluid-preserved specimens. Other ancillary materials of CNMA include plaster casts of footprints, collected mostly in the field. The source of specimens that arrive at CNMA is mainly research projects, either from research groups at UNAM or other Mexican institutions. Moreover, Mexican environmental authorities commonly hand over mammal materials confiscated from smugglers, animal traffickers, illegal hunters, and illegal mammal souvenirs seized by customs. Zoos and other public or private facilities also donate dead mammals, their parts or products to CNMA.

Table 1. Collection records of Mexican mammals by Order, held by the mammalian collection (Colección Nacional de Mamíferos; CNMA) of Instituto de Biología of Universidad Nacional Autónoma de México.

Mammalian Order	Number of holdings	Common names	Species occurring in:	
			Mexico	Solely New World
Rodentia	24450	Mice, squirrels, gophers, porcupines	X	
Chiroptera	18268	Bats	X	
Carnivora	1087	Bears, foxes, racoons, otter, ocelot	X	
Lagomorpha	1064	Rabbits, hares, jackrabbits	X	
Eulipotyphla	966	Shrews, moles	X	
Cetartiodactyla	681	Jabalin, deer, bison, dolphins, whales	X	
Didelphimorphia	463	Opossums	X	X
Cingulata	67	Armadillos	X	X
Primates	26	Monkeys	X	
Pilosa	21	Anteaters, tamandua	X	X
Perissodactyla	15	Tapir	X	
Sirenia	14	Manatee	X	

As expected, native mammal species make up the majority of CNMA holdings. The earliest numbers in the collection catalogue correspond to Virginia Opossum (*Didelphis virginiana*) specimens (skin and skull) from México and the United States of America. These were collected, skinned, and stuffed in 1938 - 1945. The five Mexican political divisions or states with the highest number of collecting records (Table 2) are territories that are mostly represented by an interesting array of diverse ecosystems such as tropical rain forest, tropical dry forest, cloud forest, temperate forest, grassland, mangrove, and xeric shrublands. Therefore, holdings at CNMA are evidence of the rich biological diversity of Mexican mammals.

Moreover, CNMA holds specimens from several countries representing all world continents except for Antarctica (Table 3), although African specimens came solely from captive facilities. Other important holdings are specimens of the endangered Mexican Wolf (*Canis lupus baileyi*, CNMA-24555; Figure 5) the extinct Monk seal (*Monachus tropicalis*, CNMA-24563), and fluid-specimen individuals and skeletons of the critically endangered Vaquita Marina (*Phocoena sinus*, CNMA-19588, 19589). The Vaquita is a small and secretive porpoise, endemic to a small range in the northern Gulf of California, México. Similarly important holdings are two specimens of the recently catalogued Big Gopher (*Orthogeomys lanius*, CNMA-46463, 46483), microendemic to a small region in the mountains south and east of Pico de Orizaba in Veracruz. This fossorial rodent, unknown to science since the first two specimens were captured in 1904, was rediscovered in 2013 (Hafner et al., 2014); its conservation status has not ever been assessed,

although the Mexican government has listed it as threatened since 2010 (Herrera Flores, 2010).



Figure 5. Skull of Mexican wolf (*Canis lupus baileyi*, CNMA-24555), extirpated from Mexican grounds for nearly half a century.

In 1983, 26 type specimens belonging to 15 taxa were held in the collection (Urbano Vidales & Sánchez-Herrera, 1983). At present, 12 holotype specimens highlight the Type section, including taxa of rodents, bats, carnivores, and shrews (Table 4; Hortelano-Moncada et al., 2006). It is interesting to note that the first holotype specimen deposited at CNMA, in 1941, was the Peter's Climbing Rat (*Tylomys gymnurus*, CNMA-101), and at present it is still recognized at the subspecific level. The last holotype specimen catalogued at CNMA was the Delicate Deer Mouse (*Habromys delicatulus*; CNMA 22439), a monotypic species endemic to the cloud forest of the mountains of Central México (Carleton et al., 2002).

Table 2. Collection records of Mexican mammals by Mexican political divisions (states), held by the mammalian collection (Colección Nacional de Mamíferos; CNMA) of Instituto de Biología of Universidad Nacional Autónoma de México.

Number of state	State	Number of holdings	Number of state	State	Number of holdings
1	Oaxaca	4985	17	Nayarit	930
2	Guerrero	4203	18	Tamaulipas	740
3	Chiapas	3615	19	Guanajuato	624
4	Veracruz	3476	20	Campeche	597
5	Puebla	3311	21	Coahuila	583
6	Jalisco	2476	22	Sinaloa	570
7	Baja California Sur	2313	23	Yucatán	543
8	Morelos	1874	24	Zacatecas	518
9	Ciudad de México	1825	25	Tabasco	512
10	Estado de México	1581	26	Quintana Roo	497
11	Colima	1461	27	Tlaxcala	440
12	Durango	1386	28	Querétaro	387
13	San Luis Potosí	1248	29	Hidalgo	377
14	Sonora	1173	30	Chihuahua	364
15	Michoacán	982	31	Nuevo León	340
16	Baja California	969	32	Aguascalientes	131

Table 3. Collection records of Mexican mammals by country hold by the mammalian collection (Colección Nacional de Mamíferos; CNMA) of Instituto de Biología of Universidad Nacional Autónoma de México. (\*undetermined country)

Number of country	Country	Number of holdings	Number of country	Country	Number of holdings
1	Mexico	45917	19	Nicaragua	5
2	United States of America	681	20	French Guiana	5
3	Argentina	198	21	Guatemala	4
4	Colombia	105	22	Africa *	4
5	Trinidad & Tobago	93	23	Haiti	4
6	Costa Rica	72	24	Poland	3
7	Brazil	60	25	El Salvador	3
8	Belize	58	26	Czech Republic	2
9	Undetermined	48	27	Chile	2
10	Venezuela	48	28	Honduras	2
11	Panama	47	29	Sweden	2
12	Peru	35	30	Australia	1
13	Canada	34	31	Philippines	1
14	Rusia	32	32	France	1
15	Bolivia	23	33	Indonesia	1
16	Cuba	10	34	Iceland	1
17	Spain	8	35	Japan	1
18	China	5	36	Madagascar	1

Table 4. Holotype specimens hosted by the mammalian collection (Colección Nacional de Mamíferos; CNMA) of Instituto de Biología of Universidad Nacional Autónoma de México.

Type, catalogue number, gender, authority name and date	Present valid taxon name, authority name and date	Family and Order	Preservation type
Holotype, CNMA-101, ♀ <i>Tylomys gymnurus</i> Villa R., 1941	<i>Tylomys nudicaudus gymnurus</i> Villa, 1941	Muridae, Rodentia	Skin and skull
Holotype, CNMA-8516, ♀ <i>Tylomys nudicaudus villai</i> Schaldach, 1966	<i>Tylomys nudicaudus villai</i> Schaldach, 1966	Muridae, Rodentia	Skin and skull
Holotype, CNMA-22439, ♂ <i>Habromys delicatulus</i> Carleton, Sánchez y Urbano Vidales, 2002	<i>Habromys delicatulus</i> Carleton, Sánchez y Urbano Vidales, 2002	Muridae, Rodentia	Skin and skeleton
Holotype, CNMA-8496, ♀ <i>Orthogeomys grandis alvarezi</i> Schaldach, 1966	<i>Orthogeomys grandis alvarezi</i> Schaldach, 1966	Geomyidae, Rodentia	Skin and skull
Holotype, CNMA-221, ♂ <i>Orthogeomys grandis huixtlae</i> Villa R., 1944	<i>Orthogeomys grandis huixtlae</i> Villa R., 1944	Geomyidae, Rodentia	Skin and skull
Holotype, CNMA-12145, ♂ <i>Spilogale pygmaea intermedia</i> López-F. and Urbano V., 1979	<i>Spilogale pygmaea intermedia</i> López-F. and Urbano-V., 1981	Mephitidae, Carnivora	Skin and skeleton
Holotype, CNMA-212, ♀ <i>Potos flavus dugesii</i> Villa-Ramírez, 1944	<i>Potos flavus chiriquensis</i> J. A. Allen, 1904	Procyonidae, Carnivora	Skin and skull
Holotype, CNMA-8445, ♀ <i>Notiosorex phillipsii</i> Schaldach, 1966	<i>Cryptotis phillipsii</i> (Schaldach, 1966)	Soricidae, Eulipotyphla	Skin and skull
Holotype, CNMA-9246, ♂ <i>Nyctinomops depressus</i> Ward, 1891	<i>Nyctinomops macrotis</i> (Gray, 1839)	Molossidae, Chiroptera	Fluid-preserved
Holotype, CNMA-9243, ♂ <i>Vesperugo veraecrucis</i> Ward, 1891	<i>Perimyotis subflavus veraecrucis</i> (Ward, 1891)	Vespertilionidae, Chiroptera	Fluid-preserved
Holotype, CNMA-8594, ♂ <i>Rhogessa mira</i> La Val, 1973	<i>Rhogessa mira</i> La Val, 1973	Vespertilionidae, Chiroptera	Skin and skull
Holotype, CNMA-1738, ♀ <i>Cynomops malagai</i> Villa R., 1955	<i>Molossus rufus</i> É.-Geoffroy Saint Hilaire, 1805	Molossidae, Chiroptera	Skin and skull

### The Collection as a Resource

CNMA is frequently visited by researchers and students. They mostly request to examine mammalian specimens for morphology projects, cranial and dental variation, patterns of reproduction, sexual dimorphism, size and biomass variation, and hair colour and structure, among other topics. Requests to take pictures of skulls and obtain permanent loans of frozen tissues for molecular systematics are common. In addition, not only mammalogists but researchers of other vertebrate groups request the services of the resident dermestid colony to clean bones. Recently, requests for specimen information in database format have noticeably increased.

The information of CNMA scientific specimens is currently being uploaded into a database. The results have been highly useful for the curation of the specimens. The management of the CNMA database has become a helpful tool that significantly helps store, retrieve, and analyse information on the specimens as an important part of the internal curatorial work at CNMA. For example, CNMA keeps a record in its curatorial database of specimens recently collected in the field or received from different sources, samples being cleaned in the colony of dermestids, skins and skeletons in fumigation, bone material being washed, skins in the process of tanning, specimens being fixed in formaldehyde before being preserved in alcohol, stored frozen tissues, nomenclature and classification of species, cataloguing of specimens, georeferencing of localities (when not registered in the field), national and international loans and permits for collection, export and import, among others. All of these procedures have helped CNMA to obtain international recognition for its high standard of curatorial practice.

The specimen database of CNMA is already available free of charge online, through the institutional website (<https://datosabiertos.unam.mx/>). Currently, there are nearly 37,000 records available. Our records show that CNMA holdings are intensively consulted online, and feed numerous research projects dealing not only with the presence or absence of species data, but with complex analyses such as niche modelling, biogeographical inferences, and impact of climate change, that require large mammalian datasets. Curatorial records from CNMA are also uploaded into databases of international projects, organisations, and agencies that help make field data on biodiversity available online using web portals, such as the Global Biodiversity Information Facility (GBIF; <http://www.gbif.org/>) and The Mammal Networked Information System (MaNIS; <http://manisnet.org/>).

CNMA products also include an online collection of digitised files, named IREKANI, containing images of specimens and their associated taxonomic and geographical metadata (<http://unibio.unam.mx/irekani/>; Figure 6; Cervantes and Vargas-Cuenca, 2012; Cervantes 2016). This dataset provides users that live away from biological collections with access to images of mammalian museum specimens, needed to make decisions about taxonomic identification. Similarly, ecologists and botanists interested in identifying mammalian skin or bone remains found in the field rely on this image collection as a vital resource. Moreover, this web site is heavily consulted and used by students and instructors in mammalogy and wildlife courses, and by popular science publications to illustrate what mammals look like, where they occur, and how they are named. Many of the IREKANI files that CNMA holds also function as voucher information for camera trap records. Editors of scientific journals frequently ask CNMA to corroborate identifications of new or noteworthy mammalian records obtained through camera traps that have been reported in manuscripts submitted for publication.



Figure 6. Digital file number 11903 from image collection of Colección Nacional de Mamíferos, available online (<http://unibio.unam.mx/irekani/>). Highly distinctive S-shaped enamel pattern of third upper right molar of Allen's Woodrat (*Hodomys alleni*, adult ♀, CNMA-46965), a secretive cricetid rat endemic to the dry tropical forest of western México.

CNMA designed its own web page ([cnmaib.wordpress.com](http://cnmaib.wordpress.com)), which includes information on how to contact and find CNMA, forms to request academic visits, specimen and frozen tissue deposits and loans, and access to the dermestid colony service. The website also shows panoramic views and particular images of CNMA's facilities, provides taxonomic and geographic data on important specimens (Figure 7), and free PDF files of relevant publications on Mexican mammals, including research articles and books. Information on

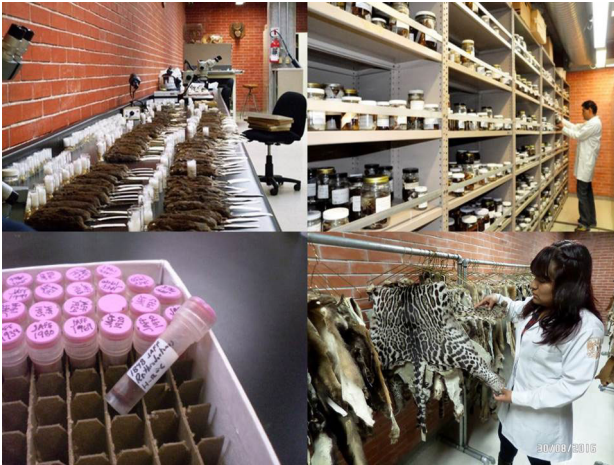


Figure 7. Images of the facilities at Colección Nacional de Mamíferos (CNMA) of Instituto de Biología of Universidad Nacional Autónoma de México.

faculty, staff, and students associated with CNMA is also made available therein.

CNMA is also an important facility that curators and staff utilise to teach mammalogy to students enrolled in undergraduate and postgraduate courses, give seminars and talks on curatorial matters, and participate in exhibitions and museographical activities and events outside campus (Cervantes et al., 2009). For instance, the teaching collection of CNMA is intensively used to support the laboratory section of the Mammalogy course taught in UNAM at undergraduate level. Regarding environmental education, students associated with CNMA also help organize events using mammal specimens to teach children and adults of local communities how mammals function in nature, and how human beings may coexist with mammals to live sustainably (Figure 8).

## Conclusion

In summary, CNMA has become an important and necessary source of information for those interested in the taxonomy and geographical distribution of Mexican mammals. Such information significantly contributes to the scientific knowledge of the diagnostic features of Mexican mammalian species and its biogeographical implications, and to the growth and enrichment of domestic and international databases on Mexican mammals, which are benefiting conservation efforts to sustainably manage this component of biodiversity. The main objectives of CNMA are maintaining and developing the national collection of Mexican mammals, and providing support to research, teaching, museography, and environmental education in México. At present, CNMA is moving ahead and has institutional support to continue its work (Cervantes, 2016).



Figure 8. Digital file number 12017 from image collection of Colección Nacional de Mamíferos, available online (<http://unibio.unam.mx/irekani/>). Comparative dorsal view of Mexican squirrel skins (top to bottom): Red-bellied Squirrel (*Sciurus aureogaster*; CNMA-6819), Ring-tailed Ground Squirrel (*Notocitellus annulatus*; CNMA-37243), Tropical Ground Squirrel (*N. adocetus*; CNMA-47466), and Southern Flying Squirrel (*Glaucomys volans*; CNMA-29).

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