Introduction

Andrew T. Smith and Xie Yan

China is a magnificent country and one of the most diverse on Earth. Its size ranks fourth among the world's nations (9,596,960 km^2), and it is home to over 1.3 billion people. The topography of China ranges from the highest elevation on Earth (Mt. Everest or Chomolungma; 8,850 m) to one of the lowest (Turpan Pendi; 154 m below sea level). Chinese environments include some of Earth's most extensive and driest deserts (the Taklimakan and Gobi) and its highest plateau (the Tibetan Plateau or "Roof of the World"). Habitats range from tropical to boreal forest, and from extensive grasslands to desert. This wide variety of habitats has contributed greatly to the richness of China's mammal fauna. Additionally, the geographic location of China, at the suture zone between the Palaearctic and Indo-Malayan biogeographic regions (Hoffmann 2001), further contributes to the country's mammal diversity. Overall, more than 10 percent of the world's species of mammal live in China (556/5,416; total count from Wilson and Reeder 2005). Twenty percent (109/556) of China's mammals are endemic, and one of these is among the most recognizable of the world's mammals, the Giant Panda. In their analysis of megadiversity countries, Mittermeier et al. (1997) consider China to have the third highest diversity of mammals among all countries (following Brazil and Indonesia).

China's Geography and Mammalian Biogeography

There have been many attempts to describe China's diverse landscape (reviewed in MacKinnon and Hicks 1996; MacKinnon et al. 1996; Xie et al. 2004a). Conventionally, China has been divided into three major physical geographic regions: the Tibetan (Qinghai-Xizang) Plateau, northwest arid China, and eastern monsoon China (map 4).

The Tibetan Plateau is one of the highest and most remote landscapes on Earth. The plateau averages between 3,000 and 5,000 m in elevation and encompasses roughly a quarter of China. The word "plateau" is a misnomer, as this area is crisscrossed by numerous impressive mountain chains, such as the Anyemaqin Shan, Bayan Har Shan, and Tanggula Shan, and many smaller spur ranges. Nevertheless, approximately 70 percent of the plateau is composed of alpine meadow or semisteppe vegetation. The Qaidam Basin, an interesting area of tectonic collapse, is found at the northern extreme of the plateau at an elevation of only 2,600 m (MacKinnon and Hicks 1996).

The arid northwest encompasses about 30 percent of China and represents an eastern extension of the great Eurasian deserts and grasslands. One of the world's most desolate deserts, the Taklimakan (translation: "those who go in do not come out alive") lies north of the Tibetan Plateau and the Kunlun range. The cooler Dzungarian Basin, China's second-largest desert, lies in the far northwest. Various smaller deserts extend to the east, increasingly interspersed with semidesert and temperate steppe grasslands. Finally, the rocky Gobi Desert occupies the northern part of China and extends into Mongolia. Two of Asia's major mountain ranges break up this barren expanse in the northwest: the Tian Shan and the Altai. One can stand below sea level in Turpan Pendi and clearly see the snow-capped top of Bogda Feng (in a spur of the Tian Shan) at 5,445 m (MacKinnon and Hicks 1996).

Eastern monsoon China comprises about 45 percent of the country but is home to roughly 95 percent of China's human population. This land is crossed by major rivers that originate on the Tibetan Plateau, most notably the Huang He (Yellow River) and the Yangtze. Almost all of the arable land has been converted to agriculture, and much of the original forest habitat has been destroyed. Most of this landscape is low in elevation and consists of broad alluvial valleys, coastal plains, and modest ancient mountain ranges. The south is seasonably humid, and the plains are punctuated by dramatic limestone pillars. The climate becomes increasingly temperate toward the north, with deciduous trees giving

way to expansive coniferous forests in the far northeast (MacKinnon and Hicks 1996).

These physical geographical regions, however, do not adequately define the major biogeographic divisions in China (maps 3, 4, and 5; Xie et al. 2004a). Biogeographically, China's flora and fauna have been affected by both historical factors (their derivation from two formerly isolated biogeographic realms—the Palaearctic and the Indo-Malayan) and their relative ability to colonize new habitats.

The southern boundary of the Palaearctic realm in China and adjacent countries was analyzed by Hoffmann (2001), particularly with regard to the distribution of mammals. He found extreme compression of the zone of overlap between the Palaearctic and Indo-Malayan realms along the southern boundary of western China, as this region is defined by high altitudinal relief. In contrast, in areas of low relief (such as in eastern central China), the zonation is determined more by latitude than altitude, and there is a broad latitudinal band of overlap between forms that originated from the Palaearctic and Indo-Malayan realms (Hoffmann 2001). In the south this zone extends from about 28° N on the coast to roughly 25° N in the area in northern Yunnan where the three great rivers (Yangtze, Mekong, Salween) lie in close proximity. The northern edge of this zone essentially follows the Yangtze River from the east coast to the area where the three great rivers come together (Hoffmann 2001). This description contrasts with previous opinions that the southern limit of the Palaearctic in China largely corresponds to the latitude of the Huang He in eastern China (about 30° N; Corbet 1978; Corbet and Hill 1992).

A sensitive and objective approach to understanding the zoogeography of Chinese mammals has been developed recently by Xie et al. (2004a). They defined 124 biogeographic units in China based on a comprehensive suite of factors (altitude, landform, climate, vegetation, hydrology, etc.) and then overlaid maps of 171 diagnostic mammal species on these units. A statistical analysis identified aggregations of biogeographic units based on mammal distributions, and this information was used to create cluster dendrograms. This analysis produced a classification of the boundaries dividing the mammal fauna at different spatial scales across China. A similar analysis was performed on 509 representative plant species.

The biogeographical divisions of mammals and plants in China determined by the methodology outlined above contrast significantly with the commonly used physical geographical regions for China (map 4). Additionally, there are distinctive differences between the biogeographical divisions using the plant and mammal data. Four major biogeographical divisions occur in China based on vegetation: northeast, southeast, southwest, and northwest. These in turn can be broken down into 8 subareas and 27 regions (table 1; maps 3 and 4). Compared with the physical geographical regions, the major divisions based on plants separate the arid northwest into a western and eastern section, and eastern monsoonal China into a northern and southern part. The southwest China biogeographical region for plants is basically similar to the Tibetan Plateau physical geographic region, although both the northern and southern boundaries of the biogeographical region are found farther south than the physical geographical region (table 1; map 4; Xie et al. 2004a).

There are three major biogeographical divisions for mammals (map 5; Xie et al. 2004a). As for plants, the mammals have distinctive western and eastern distributions in the arid northwest geographical region; the divisional boundary for mammals occurs farther west than that for plants (map 4). The mammals also separate eastern monsoonal China into northern and southern areas, and the boundary for mammals is further south than that for plants. In the large arc from northwest to southeast China, there is a single mammal biogeographical boundary compared with two for plants (map 4). Mammals in the interior drainage area on the Tibetan Plateau have northern affinities. The southeastern plateau region shows a continuous extension in faunal affinities to the southeast, maintaining a mammal fauna more similar to that of monsoonal southeastern China.

In northwest China the montane forests and grasslands of the Tian Shan and Altai mountains clearly are distinct from the surrounding

Table 1. China Biogeographic Divisions (from Xie et al. 2004a)

Area	Subareas	Regions
I. Northeast China	Ia. Nei Mongol steppe and northeast China plain	1. Greater Xing'an mountains
		2. Northeast China plain
		3. Nei Mongol arid and desert grassland
		4. Ordos Plateau arid and desert grassland
	Ib. Lesser Xing'an and Changbai mountains	5. East of Northeast China
	Ic. North China	6. North China
		7. Huangtu Plateau forest grassland and arid grassland
II. Southeast China	IIa. Central China	8. Huaibei Plain and plains of the middle and lower Yangtze River
		9. Qinling and Daba mountain mixed forest
		10. Sichuan Basin agriculture
	IIb. Highlands and plains in the south to Yangze River	11. Southeast China hills and basins evergreen broadleaf forest
		12. Yangtze River southern bank evergreen broadleaf forest
		13. Yunnan-Guizhou Plateau evergreen broadleaf forest.
	IIc. Coast and islands of South China	14. South to Nan Ling evergreen broadleaf forest
		15. South Yunnan tropical monsoon forest
		16. Hainan and Leizhou Peninsula tropical rainforest and monsoon forest
		17. Taiwan island evergreen broadleaf forest and monsoon forest
		18. South China Sea islands tropical rainforest
III. Southwest China	IIIa. Southeast and south of Tibetan Plateau	19. South Sichuan and Yunnan Plateau evergreen broadleaf forest
		20. East Tibet and West Sichuan incisive hill coniferous forest and alpine meadow
		21. Himalaya mountains
	IIIb. Central and northern Tibetan Plateau	22. Northeast Tibetan Plateau
		23. West and central Tibetan Plateau
IV. Northwest China		24. Alashan Plateau temperate desert
		25. East Tian Shan temperate desert
		26. North Xinjiang
		27. Tarim Basin and Kunlun mountains

arid landscape. The Altai (F3; map 5) shows clear ties to the fauna of Russia's boreal forest. As a result, Zhang and Zhou (1978) biogeographically linked the Altai with the Greater Xing'an mountains of northeast China. However, more than twice as many Altai mammals occur simultaneously in the Tian Shan mountains and the arid Dzungarian Basin as in the Greater Xing'an mountains (Xie et al. 2004a).

In northeast China there are distinct differences in vegetation between the Greater and Lesser Xing'an mountains (regions 1 and 5; map 3), whereas mammal distributions are similar between these ranges, and the area can be classified as a single region (region A; map 5).

Overall, the analysis of Xie et al. (2004a) demonstrates that the ability to colonize varies between plants and animals, producing

distinctive differences in the cluster analysis and the designation of major biogeographic areas in China. While plant distributions tend to be closely tied to prevailing environmental conditions, mammals generally exhibit broader geographic tolerance. Additionally, mammal distributions appear to be truncated by major rivers and mountain chains, whereas these do not appear to be as stringent barriers to plant distributions. Thus plant divisions appear to be more reliable than those of mammals as a general descriptor of China's biogeography (table 1; map 3).

History of Chinese Mammalogy, by Wang Sung

Pre–People's Republic of China

In ancient times knowledge about animals was primarily obtained from human activities, such as hunting and fishing. As early as the Shang dynasty (ca. 1500 BC), over 100 words existed for various kinds of birds (such as chickens), mammals (such as sheep, horses, cattle, and pigs), fish, and insects. By the Tang dynasty (AD 600–900), when culture and exploration in China were ascendant, knowledge of mammals was widespread (Schafer 1963).

During the most active time of natural history exploration (the mid–late 1800s and early 1900s), China's culture was more introspective. Most explorations in China at that time were conducted by scientists from Europe or North America (John Anderson, Roy Chapman Andrews, M. Berezovski, Douglas Carruthers, Père Armand David, George Forrest, Walter Granger, P. M. Heude, Pyotr Kozlov, Clifford Pope, G. Potanin, Nikolai Przewalski, Vsevolod Roborovski, Arthur de Carle Sowerby, Robert Swinhoe, and Walter Zappey to name a few; Allen 1938, 1940; Rayfield 1976). A quick look in this book at the names of scientific authorities for the majority of Chinese mammal species and subspecies bears witness to the prevalence of Western scientists in the initial determination of the Chinese mammal fauna. Indeed, most of the type specimens from these expeditions remain deposited in the major museums of the United States and Europe, a factor that hampers systematic mammalogy in China to this day.

Toward the end of this era (the 1920s and 1930s), some Chinese mammalogists became involved in the study of the Chinese fauna, including Shou Zhenhuang, Fu Tongsheng, Liu Chengzao, and Peng Hongshou. The publication of Glover Allen's *The Mammals of China and Mongolia* (1938, 1940) provided a benchmark capturing the results of these early investigations. Allen's treatise continues to inform, and it provided essential information used by the authors of this book.

Early People's Republic of China Period (1949–1966)

Chinese mammalogy began in earnest in the early 1950s, upon the founding of the PRC. The Chinese Academy of Sciences (CAS) was founded in late 1949 after the advent of the PRC, followed shortly by the establishment of the Institute of Zoology (IOZ) under the CAS in 1951. It was immediately recognized that mammalogy was a field that had received minimal attention in the past. To rectify this, Shou Zhenhuang, an experienced zoologist who had studied abroad throughout the 1930s and 1940s, was appointed to found the Mammalogical Research Division of the IOZ. As one of the leading zoologists in China, he had published the first scientific paper about Chinese ichthyology and was the author of *Birds of Hopei Province* (1936), the only ornithological monograph published before the PRC was founded. Shou recruited young students for the Mammal Division and established a mammal collection, beginning with materials from old institutions in Beijing and the former Heude Museum in Shanghai. He also developed the mammalogical portion of the institutional library (including important international journals, e.g., *Journal of Mammalogy, Zoological Record, Biological Abstracts, Proceedings of the Zoological Society of London, Annals and Magazine of Natural History,* as well as significant reference books, e.g., Allen's *Mammals of China and Mongolia* [1938, 1940], Miller's *Mammals of Western Europe* [1912], Ellerman and Morrison-Scott's *Checklist of Palaearctic and Indian Mammals* [1951]), despite the extreme difficulty in amassing foreign currency needed to purchase them.

Most important, Shou initiated field surveys and ecological research. A five-year plan, the

Mammalogical Faunal Survey, began in 1953 in northeastern China (Heilongjiang, Jilin, Liaoning, and eastern Nei Mongol), a minimally disturbed area that still contained large expanses of virgin forest. This survey covered much of the Lesser Xing'an mountains (1953), Greater Xing'an mountains (1954), Changbai Shan mountains (1955), and the Liaodong Peninsula, Songhuajiang-Liaohe Delta, and Sanjiang Plain (1956–57). Involved in the field survey team were the majority of the Mammal Division of IOZ/CAS, headed by Peng Hongshou (1953–57) together with Zhu Jing (1954), Yang Hefang (1953), Wang Sung (1954–56), Zhang Jie (1954), and Li Xueren (1954–56). While the main survey was being conducted in the northeast, other mammalian surveys began in other areas (southern Yunnan, Hainan, Guangxi, Sichuan, Xizang, Gansu, Qinghai, Guangxi), many of which remained productive until they were terminated during the Cultural Revolution.

As the IOZ's Mammal Division developed, it became the center of mammalogical research in China. A number of young colleagues from universities and institutions were sent to IOZ/CAS for further study under Shou's supervision, including Li Guiyuan (Sichuan Agricultural University), Yang Anfeng (Peking University), He Hong'en (from Hunan), Zhang Luanguang (Beijing Normal University), Chen Jun (Lanzhou University), Zheng Changlin (from Xining, Qinghai), Wu Delin (Kunming Institute of Zoology), and Xu Munong (Shandong Normal University). These young scientists eventually became some of the leading mammalogists in China.

In parallel additional zoological institutions were established, such as the Kunming Institute of Zoology (KIZ) in the late 1950s (headed by Pan Qinghua) and the Northwest Plateau Institute of Biology (NWPIB) in Xining in 1966 (headed by Xia Wuping), as well as some local institutions in Shaanxi, Xinjiang, and Guangdong. Research staff from these institutions and university teachers conducted a large number of field surveys and research projects in various regions. Thus, mammalian collections were further developed not only at the IOZ/CAS, but also in different locations throughout China.

Over 10,000 mammal specimens were collected during the Mammalogical Faunal Survey, and these constituted the first mammalian collection in China at IOZ/CAS. The final results of the five-year survey were compiled and published as *Report on Mammalian Survey in Northeastern China* (1958), now regarded as a milestone of early Chinese mammalogy. It was followed by publication of *The Economical Fauna—Mammalia* (1962) and *Illustrated Books of Animals—Mammalia* (1963). These are the earliest publications about the mammalian fauna written and compiled by Chinese mammalogists.

At this time it was difficult for Chinese mammalogists to catalog incoming specimens because nearly all the type specimens were housed in foreign collections, and most of the relevant literature was in either English or Russian. The language barrier was formidable for younger scientists. Although universities offered courses in Russian, no English courses would become available for another two decades.

The first international collaboration involving Chinese mammalogists also occurred during the 1950s. A Joint Survey on Agro-Biological Resources with the former East Germany was conducted in northeastern and northern China over a four-month period in 1956. Shou and Klaus Zimmerman (Museum für Naturkunde der Humboldt-Universitat in Berlin) were the coleaders of the zoological group (mammals and birds), and Wang Sung was the Chinese academic secretary for the joint survey team. Specimens were mainly sent to the Museum für Naturkunde, except for a small number that were deposited at the IOZ/CAS. The results of the mammalian survey were published in the 1960s in East Germany by Zimmermann.

A second international collaboration involved a special animal ecology course for graduates sponsored by the Northeast Normal University under a Sino-Soviet cooperative agreement on education in 1957–58. Fu Tongsheng, a famous zoologist in China who had formerly studied in France, was the head of the program. A. P. Kuziakin, a professor from Moscow Normal College, was invited to Changchun, Jilin, to develop the first team of Chinese graduate students majoring in animal ecology. Students from normal universities and colleges from each province were included to become broadly trained in vertebrate zoology, including mammalogy. This cohort became active instructors

and researchers upon returning to their own regions throughout China.

Throughout this period Chinese mammalogy was developing a distinctive personality above and beyond that of faunal surveys, collections, and systematic research. Studies on population dynamics of rodents that were initiated in Dailing (Lesser Xing'an mountain area) linked rodent pest control with prevention of deforestation of pine plantations following large-scale logging. This activity was led by Shou and carried out by Xia Wuping, who became a pioneer of mammalian ecology in China. Xia ultimately developed projects concerning rodent ecology and their control in the steppes of northern China, and he was later appointed as the deputy head of the Department of Animal Ecology of the IOZ, under Shou. This research direction was further linked with epidemiological research. Specifically, disease control and rodent control were carried out by the epidemiological sector from the central to local levels. Some epidemiologists became interested in mammalian taxonomy and published a number of survey results.

China also developed an expertise in captive breeding of mammals to harvest for fur and body parts for traditional Chinese medicine (TCM). This activity was initiated with captive breeding of fur-bearing mammals, most notably the Red Fox, upon the founding of the PRC. Because this specific project was not highly successful, external trade sectors of the government founded the Institute of Fur-bearing Animals in Zuojia, Jilin Province, in the late 1950s. This institute formed the prototype for fur-bearing mammal breeding centers in China. Following this, many deer-breeding centers were founded, sponsored by TCM communities and designed to meet the demands of the TCM market. This trend has continued and now includes facilities housing musk deer (since the late 1950s for the production of musk) and bears (since the 1980s for the production of bear bile), each providing a critical ingredient for TCM.

A Critical Period for China: 1966–1976

From 1966 to 1976 a massive political movement, the Cultural Revolution, brought Chinese mammalogy to a screeching halt. This movement prevented progress in every aspect of Chinese life—economic, industrial, agricultural, cultural, education, and scientific. All scientific research and all education in research institutions and universities were terminated. The publication of scientific journals and books was largely suspended for many years. During this period Chinese mammalogists became increasingly isolated from the international community, particularly with regard to systematic studies.

It was particularly disturbing that some activities just nearing completion were suddenly terminated, such as the manuscript for *A Synopsis of Chinese Mammals,* which included a species key, species accounts, and maps of all the mammals recorded from China at that time. This collective work, initiated and organized by Wang Sung, was never published. However, the manuscript was eventually printed and used as a teaching resource for the Wildlife Department of the North East Forestry College, and as the identification reference for the epidemiology sectors. We had this work translated into English, and its contents provided much of the data for this book.

Only a few fields of scientific research were given special permission to restart during the Cultural Revolution. One of these research programs was the compilation of the series *Fauna Sinica*—over 100 volumes, 9 of which would focus on mammals. As neither new field surveys nor specimen collection were allowed, and existing specimens required for the compilation of *Fauna Sinica* were far from sufficient, work on the mammal portion of this project was difficult. Nevertheless, the initiative of *Fauna Sinica* had a positive influence on Chinese science during this critical time, as it promoted the study of regional fauna and flora when the majority of other scientific programs had been stopped.

Current Developments: Late 1970s to the Present

For a long time, there had been very few contacts between China and the international science community. Between the 1950s and 1970s, for example, there were only a few joint projects between China and the former USSR and East Germany. In the late 1970s, however, a new era of international collaboration began with the Qinghai–Tibetan Plateau International

Symposium, sponsored by the CAS and held in Beijing. Conservationists and zoologists (S. Dillon Ripley, Smithsonian Institution; Peter Jackson, World Conservation Union (IUCN); Richard Mitchell, United States Fish and Wildlife Service, George Schaller, New York Zoological Society; and others) were invited to visit Beijing to attend the symposium. This momentous occasion allowed the first contact between Chinese and Western mammalogists since the new open policy was initiated. Attendees were permitted to visit CAS institutions, including the IOZ in Beijing, where they interacted with Chinese mammalogists, among them Wang Sung, Zhu Jing, and Gao Yaoting.

At almost the same time, a joint team from IUCN and Worldwide Fund For Nature (WWF), headed by Sir Peter Scott (WWF president and chair of IUCN's Species Survival Commission (SSC/IUCN) and accompanied by Lee Talbot (director general of IUCN) and Charles de Haes (director general of WWF), visited China. The State Council Environment Protection Bureau (EPB), headed by Li Chaobai and Qu Geping, hosted the delegation, and a team that included representatives from the CAS and the Ministry of Forestry met with the group. As a result of the visit, a memorandum of mutual understanding of cooperation between China and IUCN-WWF was signed by Scott and Qu Geping, deputy head of the EPB, including the following proposals: (1) China would send Zhang Shuzhong, another deputy head of the EPB, and Wang Sung from the CAS, as observers to the Convention on International Trade in Endangered Species of Wild Fauna and Flora, 2nd Convention of the Parties (CITES COP 2), held in Costa Rica; (2) China's National Conservation Strategy would be formulated under the coordination of the EPB, headed by Qu; and (3) the Wolong Panda Project would be initiated. The Panda Project was first bilateral cooperative project for wildlife research and conservation endorsed by the PRC and was initiated to protect one of China's most charismatic and endangered species, the Giant Panda. This project was ultimately funded by WWF and carried out by George Schaller, Hu Jinchu, Pan Wenshi, and Zhu Jing.

The new era of international communication and cooperation for Chinese mammalogy was solidified with the founding of the Mammalogical Society of China (MSC) in 1979. Zhou Mingzhen, a well-known paleontologist and director of the Institute of Vertebrate Palaeontology and Palaeo-anthropology at the CAS, was elected the founding president, and Xia Wuping, Huang Wenji, and Wang Sung were elected as vice presidents. The MSC sponsored publication of the journal *Acta Theriologica Sinica*, the first issue of which appeared in 1981. This journal became an important tool for communication and exchange between Chinese mammalogists and their international colleagues.

Another early activity undertaken by the MSC was to sponsor the first Chinese symposium on primatology, held in Kunming. This activity led to the establishment of a Primate Center in Kunming, and since then Kunming has become the focal point for primate research, conservation, and breeding programs in China.

The MSC began international institutional exchanges beginning with the Sino-Japanese Symposium on Mammalogy in 1983, held in Hefei, Anhui Province. This event, coordinated by Wang Sung and Kazuo Wada, was cosponsored by the Japanese Society of Mammalogy and attended by 17 mammalogists. During the symposium, a joint project on Tibetan macaques between Kyoto University and Anhui University was initiated. This project, under the leadership of Wada and Wang Qishan, was effectively carried out for several years on Huang Shan mountain, Anhui Province.

A larger gathering, the Asian-Pacific Symposium on Mammalogy, was held in Beijing in 1988. This symposium was jointly sponsored by the MSC and the American Society of Mammalogists (ASM), and cochaired by Wang Sung and Andrew Smith. Attending the symposium were over 200 participants from China and 184 participants from about 30 other countries. This was the first large-scale contact between Chinese and Western mammalogists and thus should be regarded as a landmark of international cooperation and communication in mammalogy. At the meeting Don Wilson, then president of the American Society of Mammalogists, presented Xia Wuping with honorary membership in the ASM. Wang Sung joined Xia Wuping as the only two Chinese mammalogists so honored, with his election to honorary

membership in 1998. Symposium participants visited the IOZ/CAS in Beijing, and, during extended pre- or postsymposium tours of China, they visited local institutions and their mammalian collections. This event greatly enhanced international contacts, communications, and cooperation.

China has now hosted several major international meetings relevant to mammalogy: the 19th International Congress on Primatology (2003) and the 19th International Congress of Zoology (2004) were held in Beijing. Interactions and cooperative research of Chinese mammalogists with international mammalogists is increasing as a result.

Specimens from 50 years of mammalian surveys are now housed throughout China in significant systematic collections. Three collections contain over 10,000 specimens: the Institute of Zoology, CAS, Beijing (early 1950s to present; approximately 25,000 specimens); Kunming Institute of Zoology, CAS, Kunming (late 1950s to present); and Northwest Plateau Institute of Biology, CAS, Xining, Qinghai (late 1950s to present). Small, more or less well-preserved mammalian collections of no more than 5,000 specimens are housed in the following regional institutions: Zoology Division, Guangdong Institute of Entomology, Guangzhou, Guangdong; Shaanxi Institute of Zoology, Xi'an, Shaanxi; Xinjiang Institute of Geography and Biology, CAS, Urumqi, Xinjiang; Shanghai Museum of Natural History, Shanghai (formerly the Heude Museum and Asiatic Society Natural History Museum); School of Life Science, Fudan University, Shanghai; Zhejiang University, Hangzhou, Zhejiang; Sichuan Epidemic Center, Chengdu, Sichuan; Xinjiang Epidemic Center, Urumqi, Xinjiang; Southwest Agriculture University, Ya'an, Sichuan; School of Wildlife Management, Northeast Forestry University, Harbin, Heilongjiang; Beijing Museum of Natural History, Beijing; Heilongjiang Museum of Natural History, Harbin, Heilongjiang. The majority of these institutions are no longer actively collecting specimens.

With the establishment of mammalogical collections in China, there has been increased activity in the naming of new species and subspecies, with type specimens remaining in China. Numerous provincial and regional guides along with specialized taxonomic treatments of the mammals of China have now been published. And for the first time major references of Chinese mammals have been made available: *The Distribution of Mammalian Species in China* (1997), coordinated by Zhang Yongzu and the CITES Management Authority of China; *The Mammalian of China* (1999), by Sheng Helin, Noriyuki Ohtaishi, and Lu Houji; *China Red Data Book of Endangered Animals: Mammalia* (1998), edited by Wang Sung; *A Dictionary of Mammalian Names: Latin, Chinese, English* (2001), edited by Wang Sung, Xie Yan, and Wang Jiajun; and *A Complete Checklist of Mammal Species and Subspecies in China: A Taxonomic and Geographic Reference* (2003), by Wang Yingxiang; and *China Species Red List* (2004), edited by Wang Sung and Xie Yan. We relied heavily on all of these sources for the production of this book.

In summary, the scientific study of mammals in China has a rather short history that began in the early 1950s. A major achievement during this half century was the identification of China's mammal fauna. Initially, communication with the international community was infrequent. Additionally, Chinese mammalogists faced difficulties at the beginning due to the unavailability of collections for study and a lack of comparative sources for systematic reviews. Recent developments have produced hope that more complete data on China's mammals may become available. Because of the current desire to conserve wildlife and biological diversity, studies in cell biology, molecular biology, genetics, population ecology, behavior, and conservation biology are increasing throughout China. Unfortunately, the increase in molecular research has resulted in a decline in traditional mammalogy research. Young students are more interested in laboratory research than in field work. As a result, there have been fewer additions to mammalian specimen collections in recent decades, and mammalian taxonomy is a low priority. Field biology as a whole in China is weak, and, except for some selected species, little is known about the natural history of most of China's mammals. The resulting scientific gap not only influences the development of an integrated biological science program in China, but also

seriously impacts biodiversity conservation. We hope that this book brings increased attention to mammalian systematics in China.

Mammalian Conservation

The mammals of China have been seriously threatened by a variety of anthropogenic causes. Few Chinese landscapes appear today as they occurred in the past; there has been an extreme loss of natural habitat, and natural habitats have increasingly become fragmented and isolated from one another. Chinese mammals have been harvested or poached heavily and unsustainably for food, products, and the pet trade. Native species have been subject to widespread poisoning campaigns. Additionally, the presence of alien invasive species, pollution, and litter has degraded many natural habitats. We fear that finding many Chinese mammals in the regions indicated on our distribution maps may not be possible today. One of our motivations for writing this guide is to attract attention to the Chinese mammal fauna so that effective conservation measures can be enacted.

The government of China understands the gravity of biodiversity loss. China is signatory to most major conservation conventions, such as the Convention on International Trade in Endangered Species (CITES; 1981), the Convention on Wetlands (Ramsar; 1992), the World Heritage Convention (1985), and the Convention on Biological Diversity (CBD; 1993). China has hosted a large number of major conservation workshops and congresses. The China Council for International Cooperation in Environment and Development (CCICED) has served as a model organization linking Chinese and international specialists in order to address issues of conservation and sustainable development. These efforts, however, often fall short in their implementation, resulting in ongoing threats to China's mammal diversity.

A first step in any conservation agenda is to recognize those species most in need of protection. We have listed the threatened species categorization for Chinese mammals using four separate criteria, in this order: China (national) Species Red List, China State Key Protected Animal List, CITES Appendix designation, and IUCN (global) Red List. We also present additional conservation information, when available, for each species. The instruments used for categorizing threatened species each have distinctive characteristics and notations, as given below.

IUCN Red List

The IUCN Red List presents the global status for a species using five independent quantitative criteria: (A) Population Reduction (measured as declines in population over time); (B) Geographic Range (extent of occurrence or area of occupancy); (C) Small Population and Decline; (D) Very Small, or Restricted Population; and (E) Quantitative Analysis. Within each of these main criteria are additional refined criteria (see IUCN 1994; 2001). Threatened species may qualify under any of these criteria for a listing as Critically Endangered (CR), Endangered (E), or Vulnerable (VU). Additionally, species can be listed as Near Threatened (NT), of Least Concern (LC), Extinct (EX), or Extinct in the Wild (EW). Some species cannot be listed because they are Data Deficient (DD). The above listing criteria and categories follow from IUCN (2001), an updated revision of the original quantitative Red List categories and criteria (IUCN 1994). There are small but significant differences in how these two listing procedures operate (for example, the 1994 category for Near Threatened is portrayed as Least Concern/near threatened; LC/nt). We do not present the stand-alone global IUCN category for Least Concern. We identify which criteria (ver 2.3 1994 or ver 3.1 2001) were followed for each assessment listed, as not all Chinese species have yet been assessed using the new criteria. The IUCN Red List is one of the most respected indicators of the threatened status of species (de Grammont and Cuarón 2006; Rodrigues et al. 2005).

China Species Red List

To complement the IUCN global Red Listing process, and to allow countries and regions to develop their own conservation priorities, IUCN undertook a process to develop a parallel mechanism for listing threatened species at national levels (Gardenfors 2001; Gardenfors et al. 2001; IUCN 2003). These quantitative criteria take into consideration the extent of a species'

range within a host country and other applications to tailor the IUCN Red Listing process to national levels. These criteria were followed in an ambitious effort to Red List all of China's mammals (Wang and Xie 2004). These evaluations include two additional categories: Regionally Extinct (RE), for those species that are now extinct in China although they exist elsewhere in the world; and Not Applicable (NA), for those species that are distributed at the margin of China and for which data are lacking (even though there may be sufficient data for a global assessment). All of China's mammals were assessed against these regional criteria (Wang and Xie 2004); the only species for which we do not present a China Species Red List category are those whose taxonomy has changed since the workshops were held to produce the China Species Red List.

China State Key Protected Animal List

Each Chinese mammal species is listed on the State Key Protected Animal List as a Category I or a Category II species. This national schedule of protected fauna is heavily skewed toward charismatic megafauna and is primarily composed of primates, carnivores, marine mammals, and ungulates. The representation on this list is not truly indicative of the overall threat across all taxa of mammals in China. The formulation of this list was initiated by the Chinese Endangered Species Scientific Commission and authorized by the Ministry of Forestry. Inclusion of species on the list was derived by consensus at an interactive workshop comprised of species specialists from throughout China. The State Key Protected Animal List was finalized soon after the People's Congress issued China's Wildlife Law in 1989.

Convention on International Trade in Endangered Species of Wild Fauna and Flora—CITES

Those species of mammal believed to be negatively affected by trade are listed in CITES appendixes. The Appendix I classification incorporates those mammals that would be threatened with extinction if traded. Trade in specimens of these species is permitted only in exceptional circumstances. Appendix II includes species not necessarily threatened with extinction, but for which trade must be controlled in order to avoid utilization incompatible with their survival (CITES 2006).

China's Protected Area System

Biodiversity conservation can take many forms, but one of the most recognizable is the establishment of nature reserves and protected areas, coupled with their effective management, to ensure that a decline in biodiversity does not occur. Thus, protected areas remain one of the best ways for governments to ensure biodiversity preservation, as well as serving as magnets for eco-tourists who desire to observe native species. Initially, few areas were protected, but the Chinese government has recently stepped up efforts to protect areas rich in biodiversity. Currently over 2,000 protected areas have been established in China, encompassing 14.4–18% of China's land area (see map 6); most of these were established after 1980, many after 1995 (Xie et al. 2004b). These sites are variously catalogued as nature reserves, scenic landscapes, historic sites, nonhunting zones, and forest parks. Over 10 different ministries or administrations are responsible for the management of these areas in mainland China (not including Taiwan and Hong Kong), including the State Forestry Administration, Ministry of Agriculture, Ministry of Water Conservation, Ministry of Construction, Ministry of Geology and Mineral Resources, Ministry of Land Resources, State Oceanic Administration, and State Environmental Protection Agency. Other protected areas are administered at the provincial, county, or township level. The decision to protect species-rich areas in China stems from the belief that these lands will help define the national culture, assist in economic development among rural people, and provide destinations for tourists. Their function is to promote the retention of natural capital, provide flood control, and preserve biodiversity. A full review of the Chinese protected area system is available in MacKinnon et al. (1996) and Xie et al. (2004b).

In spite of the positive strides made in protected-area management in China, more work needs to be done to ensure that these

lands will continue to support mammalian biodiversity. China's protected areas are mainly found in the sparsely populated west. Many protected areas in China are small and isolated, minimizing their effectiveness in the preservation of biodiversity. Often they are poorly managed and insufficiently funded; in some instances key programs have been initiated that are actually counterproductive to the preservation of biodiversity (such as poisoning native wildlife). Incursions and poaching by people living outside of protected areas jeopardize their success. Nevertheless, the protected-area system in China has great potential to protect mammalian biodiversity. With improved management, China's protected areas can become sites in which the study and viewing of mammals are enhanced.

How to Use This Book

We present available data on the systematics, distribution, and natural history of the 556 species of mammal found in China. The order of presentation follows the higher-level classification (from order to family to subfamily) as outlined in *Mammal Species of the World*, third edition (Wilson and Reeder 2005). Genera (within a family or subfamily) and species (within a genus) are alphabetized within a taxon. All taxa are identified by both their scientific and common names in English. Chinese names are given in both character and pinyin format. We have given a single English common name for each species, basically following the naming convention used in Wilson and Reeder (2005). Many species are known by more than one common name, but we believe that the application of a single name will, over time, eliminate confusion and enhance the ability of mammalogists to communicate.

We present brief descriptions at each level of classification, followed by a cascade of keys that can be used to discriminate forms within hierarchical levels. Information given for each species includes distinctive characteristics, distribution, natural history, comments (if any), conservation status, and any relevant references. The depth of treatment reflects the information available for each species.

Distinctive Characteristics

Standard specimen measurements are given for each species, when available. These include head and body length (HB); tail length (T); length of hind foot (HF); ear length (E); and greatest length of skull (GLS) (Fig. 1). Bat measurements include forearm length (FA) (Fig. 2), shoulder height (SH) is presented for most larger mammals. These measurements are given in mm, unless otherwise stated for large mammals. Body mass (Wt) is given when available. The dental formula for a species (or taxon) is presented as the upper canines (C), incisors (I), premolars (P), and molars (M)/lower canines (c), incisors (i), premolars (p), and molars (m), followed by the total number of teeth (e.g., 2.0.3.3/1.0.2.3 = 28). Individual teeth are noted as being uppers with capital letters or lowers with lowercase letters, each followed by the tooth number for that tooth type. For example, the third upper incisor = I3; and the second lower premolar = m2. In some rodent groups (fig. 3 and 4), and for some insectivores, we have used a slightly different notation (clarified when introduced in the text).

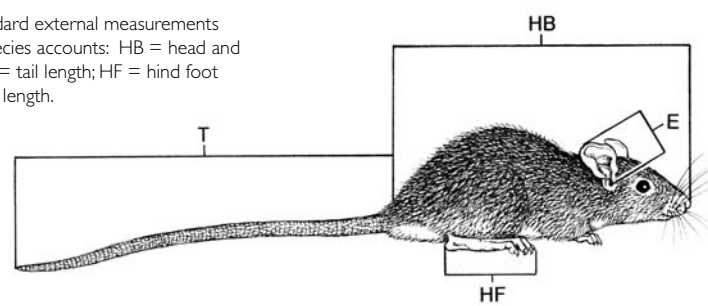

Figure 1. Standard external measurements used in the species accounts: HB = head and body length; T = tail length; HF = hind foot length; E = ear length.

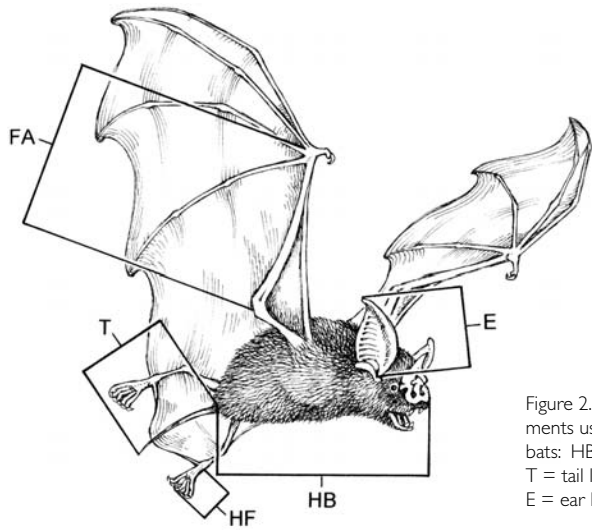

Figure 2. Standard external measurements used in the species accounts for bats: HB = head and body length; T = tail length; HF = hind foot length; E = ear length; FA = forearm length.

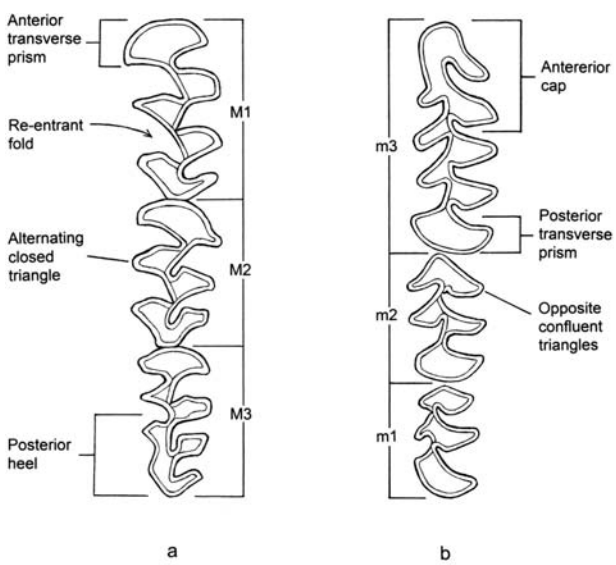

Figure 3. Molar occlusal patterns of a typical volelike rodent illustrating descriptive terms used in the text. Note that the molars of the upper toothrow (a) are numbered M1–M3 from anterior to posterior, whereas in the lower toothrow (b), the teeth are numbered m1–m3 from posterior to anterior.

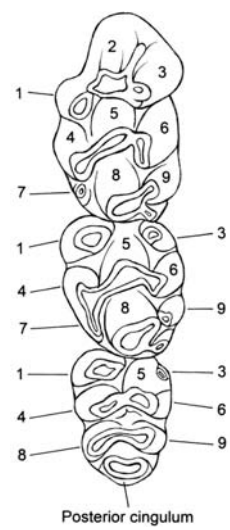

Figure 4. Upper molar toothrow (M1–M3) of a typical murid rodent illustrating Miller's (1912) cusp numbering scheme. The three rows of cusps on each tooth are numbered sequentially from the lingual to the labial side. Drawn from Musser (1981; fig. 1).

A description of the appearance of each species and its distinctive characteristics (including descriptions of skull features) follows. Plates, including drawings of 384 species (69 percent of Chinese mammals), accompany these descriptions. Our artist, Federico Gemma, examined specimens from the Institute of Biology, Chinese Academy of Sciences, Beijing, as well as the American Museum of Natural History, New York, and Smithsonian Institution, National Museum of Natural History, Washington, DC, to capture the color and nuances of each species; only a few drawings depict species that were not represented in these collections. He also visited the Beijing Zoo collection, which contains most of the large mammal species found in China. Additionally, authors made available to Gemma original photographs, other printed material, and Internet sources to assist with his depiction of species.

Distribution

A brief description of the distribution in China is given for each species, along with its range outside of China or the statement that the form is endemic to China. Often multiple subspecies are found in China, and we present these (in alphabetic order) along with a general description of the geographic range the subspecies occupies. The determination of subspecies for many species in China is problematic; in the interest of aiding further taxonomic inquiry, we incorporated subspecies, relying heavily on the treatments in Wilson and Reeder (2005) and Wang (2003), as well as original literature. In cases where there were discrepancies (and there were many of these), we issue cautionary comments.

Every species description is accompanied by a map of its distribution in China. In a few cases we present separate maps of the historical and contemporary distribution of a species; otherwise the maps depict the original range of the species in China before any potential recent contraction of the range due to anthropogenic factors (see Mammalian Conservation). Each map portrays the actual localities (dots) where a species has been found (or collected) in China. We present the maps in this manner, rather than as shaded range maps, for several reasons. First, the topography of China is so varied that any attempt to shade in a distributional range would inevitably be misleading of the area(s) the species actually inhabits. Second, dot maps, such as we present, give a gestalt for how well known or represented the species is in China; for example, common species are represented by hundreds of dots and tend to be very well understood, whereas those portrayed by only a few localities are generally poorly known.

The localities presented on maps were derived from data from the China Species Information Service. Data in CSIS were gathered using a variety of sources and recorded at the county level. The primary data included original locations from specimens housed at major mammal collections in China (Institute of Zoology, CAS) and the United States (American Museum of Natural History; National Museum of Natural History), as well as published locality records from Chinese scientific surveys, journal articles, and Chinese provincial and regional mammal guides (see References). All data added to CSIS were cross-referenced to their source, so that in verifying maps each author had available the data source for each locality. The original data entered for each map could have been corrupted for a number of reasons; including misidentification of specimens and out-of-date nomenclature. Thus, every map was reviewed carefully and frequent modifications were made (for example, moving a subspecies from one species to another to reflect current taxonomic understanding, which we could do with a single command because of the database structure within CSIS). We believe that these maps portray the distribution of all mammal species in China in the most accurate form possible at the present time, although some of these distributions may need further definition.

Natural History

While information on the natural history of many Chinese mammals is fragmentary, some species are among the most widely recognized on Earth. We focus on the habitat requirements, mode of life, diet, and reproduction for each species, drawing from a variety of sources.

Comments

Frequently it was necessary to explain variants or deviations in our systematic treatment. Some scientific names that are well established in the historical literature have been changed recently, and these are mentioned. Often there are differences of opinion regarding the taxonomy of a species—either with different subspecies or synonyms, or by combining or splitting the species in a manner different from that found in our treatment—and these cases have been documented.

Conservation Status

We list the conservation status as determined by the China Species Red List analysis, the category from the China State Key Protected Animal List, the appropriate CITES Appendix, and the IUCN global Red List analysis. Not all species have been categorized using all four of these criteria; we include only those that have been so evaluated. Details of each of these forms for assessing conservation status are found above.

References

Key references, if available, are listed for each species. We utilized a wide variety of sources in compiling most accounts, and general regional or national sources are normally not listed in the reference section for a particular species—instead, this section highlights primarily the recent journal literature available on the species. Our bibliography, however, is comprehensive and treats all sources consulted even if they are not directly referenced in the text. Importantly, these sources include Chinese regional and provincial guides to mammals. Throughout the text cited literature references take the form of (Wang 2004); no comma separates the author and the year of publication. Each scientific name is followed by the name of the author(s) and the year in which it was described. These references are not placed in parentheses if the genus and species are unchanged. However, a species originally named by its author in a genus different from the one in which it is currently placed has parentheses surrounding the author and date. A comma separates the author from the date of publication (such as Liang, 1877) when the citation refers to the naming authority for a taxon.

Additional Material

Appendixes review those marine mammals that are found off the coast of China but are not included as a part of the Chinese fauna (appendix I), those species whose distributional ranges appear very close to the Chinese border and may eventually be found in China (appendix II), and those mammal species that have been introduced into China (appendix III).

Acknowledgments

Financial assistance for this project was provided by the China Council for International Cooperation in Environment and Development, from funds made available by the governments of Norway and Sweden. We also received support from Arizona State University, Bethel College, the National Museum of Natural History (Smithsonian Institution), and the American Museum of Natural History. The assistance of staff in the Beijing office of the Biodiversity Working Group was invaluable, including Wu Lihui, Yin Songxia, Du Youmei, Du Youcai, Li Shengbiao, and Du Langhua. The administration and staff of the CAS Institute of Zoology mammal collection in Beijing were very helpful, and it is a pleasure to acknowledge their support. We benefited also from the mammal collections at the American Museum of Natural History, National Museum of Natural History (Smithsonian Institution), and the Chicago Field Museum (with thanks to Larry Heaney and Bruce Patterson). We appreciate the consultation and advice given by many of our colleagues, which greatly enriched our accounts: Alexei Abramov, William Bleisch, Thomas Geissmann, Colin Groves, Richard Harris, Mike Hoffmann, Charlotte Johnston, John Lamoreux, Richard Thorington, and Wang Yingxiang. William Bleisch and Richard Harris kindly reviewed selected color plates and range maps. We thank Erin Gibbon, Hayley Ivins, Mary Boise, and Scott Holtz for their assistance with the manuscript. Scott also manually cross-checked all the bibliographic citations against original sources, a time-consuming but crucial task. Brenda Flores assisted with the final formatting of many of the range maps. We are grateful to the following for their assistance in translating scientific research papers: Eileen

Westwig (Russian, French, and German); Margarita Uvaydov (Russian); and Julie Wozencraft, Chien Hsun Lai, Yu Xiang, Zhang Jingshuo, and Zhou Jiang (Chinese). We appreciate the talents of Patricia Wynne, who drew figures 1–4, and the unidentified Chinese artist(s) who drew figures 5–15 (these were composed during the Cultural Revolution when it was politically incorrect to bring attention to oneself by signing artwork). The ASU School of Life Sciences Visualization Center, in particular Jacob Sahertian, Allyson Moskovits, and Sabine Deviche, helped format the baseline map of China, prepared various black-and-white figures for publication, and assisted with the final preparation of the color maps. Larry Heaney and Harriet Smith kindly edited selected portions of the manuscript. Finally, we are indebted to the talented and supportive staff at Princeton University Press. Robert Kirk guided and encouraged our efforts, and the completed project is a direct result of his vision. We are also grateful for the meticulous attention that Terri O'Prey, Dimitri Karetnikov, and Anita O'Brien brought to this project.