

Brian Lander and Katherine Brunson

WILD MAMMALS OF ANCIENT NORTH CHINA

Abstract

Human activity has eliminated many of the natural lowland ecosystems of the Middle and Lower Yellow River Valley, and has modified the rest, making it difficult to understand what species are native to the region. As a step towards the reconstruction of these lost environments, this paper employs zooarchaeological and other evidence to identify the native mammals of the region. We provide basic ecological information about these animals and discuss controversial or difficult cases in more depth. Our goal is not only to study China's environmental history, but also to make clear that conventional understandings of species ranges are based on the distributions of animals in the modern period, when many had already been eliminated from large areas by human activity.

Keywords

Animals, early China, extinction, megafauna, zooarchaeology

INTRODUCTION

The lowlands of North China have been so thoroughly transformed by humans that it is difficult to imagine that a few brief millennia ago they were home to herds of buffalo, aurochs, and wild horses, solitary animals like rhinoceros and tigers, and a host of smaller mammals. The only wild mammals one is likely to encounter in the region now are hares, hedgehogs, and bats. While it is well known that the main reason for the disappearance of wild animals was the spread of humans and their agricultural ecosystems,¹ we know little about the natural distribution of many animals in China, and the process whereby they were extirpated.

The first step in understanding how humans have transformed the environment of mainland East Asia is to understand what it was like before humans took over. This paper seeks to contribute to the reconstruction of the vanished ecosystems of the

email: brian_lander@brown.edu; katherine_brunson@brown.edu

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¹Mark Elvin, *The Retreat of the Elephants: An Environmental History of China* (New Haven: Yale University Press, 2004), 9–18; Robert B. Marks, *China: An Environmental History*, 2nd ed. (Lanham, Md.: Rowman & Littlefield, 2017).

middle and lower Yellow River Valley by providing an overview of their native mammals.² We choose mammals because people are more familiar with mammals than with most other forms of life, so describing them can help us envision these long-lost landscapes. Also, all of the largest animals in the region were mammals. Given this goal, this paper will focus on the mammals themselves, not on what role they played in human society and culture, though of course most of our evidence is related to human activity.³

The basic premise of this research is that the main factor in transforming North China's flora and fauna over the past 10,000 years has been human activity, especially the spread of agricultural societies.⁴ While scholars have often taken the presence of certain animals in ancient North China to indicate a much warmer climate,⁵ in fact climatic fluctuations have been minor enough in this period that they could not have substantially altered which fauna can inhabit the region.⁶ Thus any animals that inhabited the Yellow River Valley during the Holocene would still be there if they had not been displaced by people, and can be considered its native fauna.⁷ This realization is not only relevant to China: accepted views of "natural" species distributions across the world are largely based on the field work of modern biologists, and thus reflect a world that had already

²Our study region consists of Shaanxi, Shanxi, Henan, Shandong, and Hebei provinces, plus the Wei River basin in Gansu, and Beijing. While southern Shaanxi and Henan are not in the Yellow River Basin, the few sites from these regions did not include any species that were not common in sites further north, except for the giant panda and elephant remains at Xiawanggang, discussed below.

³On how people in early China thought about animals, and their relationship with them, see Roel Sterckx, *The Animal and the Daemon in Early China* (Albany: State University of New York Press, 2002); Guo Fu 郭鄂, Li Yuese 李約瑟 (Joseph Needham), and Cheng Qingtai 成慶泰, *Zhongguo gudai dongwuxue shi* 中國古代動物學史 (Beijing: Kexue, 1999); John S. Major, "Animals and Animal Metaphors in the Huainanzi," *Asia Major* 21.1 (2008): 133–51; Roel Sterckx, "Attitudes towards Wildlife and the Hunt in Pre-Buddhist China," in *Wildlife in Asia: Cultural Perspectives*, ed. John Knight (London: Routledge Curzon, 2004), 15–35.

⁴For a global archaeological synthesis of these issues, see Nicole L. Boivin et al., "Ecological Consequences of Human Niche Construction: Examining Long-Term Anthropogenic Shaping of Global Species Distributions," *Proceedings of the National Academy of Sciences* 113.23 (2016): 6388–96.

⁵E.g., Kwang-chih Chang, *The Archaeology of Ancient China*, 4th ed. (New Haven: Yale University Press, 1986), 79.

⁶The Holocene megathermal, the warmest period of the past 10,000 years (c. 9000–4000 years ago), was about 1.5 degrees warmer, and precipitation was about 200 mm higher than at present in North China. Vegetation zones shifted northwards by around 200–300 km, so that Xi'an's climate was similar to that of modern Nanyang, Henan. Cold-intolerant plants and animals would have moved slightly northwards, including forests moving into areas that had been too arid. But the change was far too small to have any great effect on which mammals inhabited the Yellow River Valley. Hou-Yuan Lu et al., "Phytoliths as Quantitative Indicators for the Reconstruction of Past Environmental Conditions in China II: Palaeoenvironmental Reconstruction in the Loess Plateau," *Quaternary Science Reviews* 26.5–6 (2007): 759–72; Yanjun Cai et al., "The Variation of Summer Monsoon Precipitation in Central China since the Last Deglaciation," *Earth and Planetary Science Letters* 291.1–4 (2010): 21–31; Songbing Zou et al., "Holocene Natural Rhythms of Vegetation and Present Potential Ecology in the Western Chinese Loess Plateau," *Quaternary International* 194.1–2 (2009): 55–67.

⁷The idea of a "native species" shares the same etymological and intellectual roots as the idea of "natural," which has a long and complex history: Raymond Williams, "Ideas of Nature," in *Culture and Materialism* (London: Verso, 2005), 67–85. Here we use "nature" and "wild" to refer to species and environments not created by or dependent on humans.

been transformed by human activity.⁸ Ancient Eurasian civilizations were often located in well-watered valleys that had different ecologies from more arid or mountainous areas, and these ecosystems were replaced by farmland long before any modern biologists could study them. As these civilizations expanded they often transformed wider environments, having a particularly severe impact on larger animals.⁹

The Yellow River lowlands are one of the most extreme cases of this phenomenon, having been densely populated for three millennia. The region has a temperate climate, with annual precipitation ranging from around 500 mm per year in the semiarid west to over 800 mm in the North China plain, though the amount of precipitation varies considerably from year to year. Much of the region was dominated by temperate deciduous forests somewhat similar in their overall composition to those of Eastern North America, but more diverse. There were extensive wetlands in the plains and valleys, which expanded during summer monsoons and shrank in the winter. In the more arid west, the Wei River Valley contained mixed steppe and forest, with grasses and shrubs in dryer areas, and forests in better watered areas. Situated between arid Inner Asia, the northern taiga, and warm subtropical forests, the region was home to species from all of these habitats.

METHODOLOGY

Texts and cultural artefacts provide valuable clues as to the animals of ancient China, but are rather unreliable for identifying most species. While large and distinctive animals like elephants and tigers are unmistakable, most others can easily be confused. And early Chinese authors were not especially interested in mammalian taxonomy.¹⁰ Apart from a few large and distinctive animals, the only way we can be sure of the identification of a species in an ancient text is if it is a unique animal with a specific habitat or diet, such as the description of *ta* 獭 in the *Shuowen jiezi*: “Like a small dog. Lives in water. Eats fish.”¹¹ This and other passages make clear that this is an otter,¹² but most other textual references to small animals are impossible to identify with any accuracy. Moreover, some species may already have been rare by the time the first extant texts were written around 1200 BCE.

⁸Jennifer J. Crees and Samuel T. Turvey, “What Constitutes a ‘Native’ Species? Insights from the Quaternary Faunal Record,” *Biological Conservation* 186 (2015): 143–48; Samuel T. Turvey, ed., *Holocene Extinctions* (Oxford: Oxford University Press, 2009).

⁹The only Old World civilizations whose long-lost ecosystems have been studied in any depth are those of Europe and the Mediterranean, e.g. Kenneth F. Kitchell, *Animals in the Ancient World from A to Z* (New York: Routledge, 2014); A.T. Grove and Oliver Rackham, *The Nature of Mediterranean Europe: An Ecological History* (New Haven: Yale University Press, 2001); Wilhelmina Jashemski and Frederick Meyer, *The Natural History of Pompeii* (Cambridge: Cambridge University Press, 2002); László Bartosiewicz, “A Lion’s Share of Attention: Archaeozoology and the Historical Record,” *Acta Archaeologica Academiae Scientiarum Hungaricae* 60.1 (2009), 275–89; Ella Tsahar et al., “Distribution and Extinction of Ungulates during the Holocene of the Southern Levant,” *PLOS ONE* 4.4 (2009), e5316.

¹⁰Sterckx, *The Animal and the Daemon in Early China*, esp. 15–44.

¹¹如小狗也。水居；食魚。Ping Wang and Kehe Zang, *Shuowen jiezi xinding 說文解字新訂* (Beijing: Zhonghua, 2002). For other otter references, see John S. Major et al., trans., *The Huainanzi: A Guide to the Theory and Practice of Government in Early Han China* (New York: Columbia University Press, 2010), 182.

¹²Major, “Animals and Animal Metaphors in the Huainanzi,” 146.

We encounter similar problems with animals depicted in artefacts like bronze vessels and jades, namely that the animals they depict are either distinctive animals like buffalo or elephants, or impossible to distinguish with any certainty. It is often hard to tell whether they are real animals at all. For example, Chinese archaeologists tend to identify many animals in ancient artworks as “dragons,” though they are equally likely to depict lizards, salamanders, or alligators. Therefore, texts and artworks are not particularly helpful for studying the distribution of animals in ancient times, though they are certainly important sources for later periods. One of our goals in writing this paper is to help scholars of early texts and artefacts interpret ambiguous depictions of animals by making clear which animals ancient authors may have been aware of.

Because of the limitations of texts and artefacts, our most important evidence comes from zooarchaeology and zoology. Zooarchaeology is the study of faunal remains discovered at archaeological sites. Zooarchaeologists use faunal data to understand the roles of animals in human subsistence and economy, to analyze the ways that animals were used in ancient ritual, symbolic, and social contexts, and to reconstruct past environments. Many factors affect what kinds of animal bones are found in archaeological sites, most notably the preferences of hunters for certain types of animals, the conditions of preservation, and the methods archaeologists use to recover animal remains.¹³ The latter factor is significant in China because most archaeologists there do not employ sieves to sift through the dirt for smaller remains, and thus find few small animal bones.¹⁴ Sample size is also significant: the more bones are analyzed, the greater chance that rare animals will be found.¹⁵ Although zooarchaeological assemblages are subject to these cultural and taphonomic biases, they are still the best source of information about what types of animals lived at a certain time and place, and are thus a fundamental tool for understanding ancient species distribution. Our analysis is based on zooarchaeological data that we have compiled from archaeological reports from over 100 sites dating from the Neolithic through Zhou dynasty.¹⁶

Despite its importance, China’s zooarchaeological record presents some difficulties for reconstructing ancient fauna. One of these is that archaeologists of the historical period in China (roughly after 1200 BCE) usually focus on tombs, palaces, and cities, not on rural villages, so the animal bones they find are mostly domestic animals placed in tombs. Given that human populations and environmental impact increased during this period, our lack of a representative collection of wild faunal remains from the past three millennia makes it impossible to use current zooarchaeological data to

¹³R. Lee Lyman, *Vertebrate Taphonomy* (Cambridge: Cambridge University Press, 2004); Charles Reed, “Osteo-Archaeology,” in *Science in Archaeology*, by Eric Higgs and Don Brothwell (New York: Thames and Hudson, 1963), 2014–16.

¹⁴The use, and size, of screen mesh has a significant effect on the types of animal remains uncovered during excavations: Irvy Quitmyer, “What Kind of Data Are in the Back Dirt? An Experiment on the Influence of Screen Size on Optimal Data Recovery,” *Archaeofauna* 13 (2004), 109–29; Brian Schaffer and Julia Sanchez, “Comparison of 1/8”- and 1/4”-Mesh Recovery of Controlled Samples of Small-to-Medium-Sized Mammals,” *American Antiquity* 59 (1994): 525–30.

¹⁵Donald K. Grayson, “The Effects of Sample Size on Some Derived Measures of Vertebrate Faunal Analysis,” *Journal of Archaeological Science* 8 (1981): 77–88; R. Lee Lyman, *Quantitative Paleozoology* (Cambridge: Cambridge University Press, 2008), 196.

¹⁶For data, see online appendices.

trace when species disappeared. Another issue is that zooarchaeologists working in China have tended to assume that animals found in Neolithic (c. 7000–2000 BCE) sites are species that still exist. With the exception of water buffalo, very little attention has been paid to the possibility that excavated remains belong to extinct species. Given the complete elimination of lowland ecosystems, it is quite likely that some species that were endemic to the lowlands of North China are now extinct.

In addition to zooarchaeology, we depend on the work of modern zoologists. The single most important book for this study is the *Guide to the Mammals of China*, which includes species descriptions and maps of the distribution of fauna as revealed by field research since the mid-nineteenth century.¹⁷ We use these maps very conscious of what they depict. By the mid-nineteenth century almost one hundred million people inhabited North China, and natural lowland habitats of the Yellow River Valley had been completely replaced with farms and towns. Moreover, the North China plain had already been densely populated for over 2000 years. Given this situation, animals whose habitat was restricted to lowlands were long gone, and the ones that remained were those that could survive in hilly and mountainous areas that could not be farmed. Therefore, modern species distribution maps depict fragmented and impoverished populations, not the natural range of the species. Despite this, the human population and its impact on the environment have increased dramatically since the early twentieth century, so these maps are essential for helping us reconstruct earlier distributions. In addition to the maps, we have also relied on the *Guide to the Mammals* for descriptions of the size, habitat, and behaviour of the animals mentioned in the text, and will not cite it for each one.¹⁸

Since the goal of this paper is simply to provide a description of the region's mammals, we have tried to divide them by common sense groupings rather than the conventional taxonomic order. We will discuss them in this order: deer; bovids, horses, and pigs; rhinoceros and elephants; primates; small mammals; and carnivores. Following the main text we provide a list of all species we consider native to the region and a table listing the mammals identified at archaeological sites in the region.

DEER

We will begin with deer because they were very important to human societies and are thus well represented in the archaeological record. People not only ate deer, but also used their bones, antlers, hides, and other materials to make tools and clothing. Unlike camels, horses, and bovids (such as cattle, goats, sheep, and buffalo), deer cannot survive on low-quality plants like grasses, but require highly digestible, nutrient-rich food such as new plant growth, leaves, twigs, bark, mosses, ferns, and lichens.¹⁹ In

¹⁷Andrew T. Smith and Yan Xie, eds., *A Guide to the Mammals of China* (Princeton: Princeton University Press, 2008).

¹⁸Another useful work has been Michael Hutchins et al., eds., *Grzimek's Animal Life Encyclopedia*, 2nd ed. (Farmington Hills: Gale Group, 2003).

¹⁹This section on deer is primarily based on Valerius Geist, *Deer of the World: Their Evolution, Behaviour, and Ecology* (Mechanicsburg: Stackpole, 1998); Michael Hutchins et al., eds., *Grzimek's Animal Life Encyclopedia Vol. 15: Mammals IV*, 2nd ed. (Farmington Hills: Gale Group, 2003), 335–98.

regions whose natural vegetation is dense forest, deer find high quality forage in disturbed environments, including the openings created for farming. So farmers who left fields to grow wild for several years between plantings created ideal deer habitat. In other parts of the world, such as North America, people intentionally burned land to create deer habitat.²⁰ It is quite likely that societies in North China maintained a similar kind of symbiotic ecological relationship with deer even after domesticated animals became their primary source of meat.

Most of North China's deer wander widely in search of food, but two kinds of small deer maintain small territories which they guard with sharp elongated upper canines. Musk deer (*Moschus* sp.) and Reeves's muntjac (*Muntiacus reevesi*, a.k.a. barking deer) are dog-sized (c. 6–20 kg) nocturnal deer that live in forests and eat a variety of plants. Musk deer are among the most common deer in the zooarchaeological record, but there are several species in China, and it is unclear which one(s) would have been common in lowland North China.²¹ People in China have long valued the scent glands on the bellies of male musk deer for their supposed medicinal properties, and have hunted them nearly to extinction for it.²² Although not particularly common in the archaeological record, muntjacs obviously made an impression on Bronze Age people, who depicted them on bronze ritual vessels.²³ Tufted deer (*Elaphodus cephalophus*, 15–28 kg) are close relatives, or perhaps another species, of muntjac.

Deer of the genus *Cervus*, which include sika deer (*C. nippon*, 60–150 kg) and red deer (*C. elaphus*, 120–400 kg, known in North America as wapiti or elk) can eat rougher vegetation than most other deer, which allows them to be more flexible in habitat, though they prefer mixed forest and meadows.²⁴ Both divide into male and female herds for much of the year. Red deer inhabit more open alpine or northern landscapes, while sika deer are better adapted to warmer climates. Because of this, sika seem to have been the most common deer in the lowlands, and the most important to humans, so much so that the standard term for deer in Chinese, *lu* 鹿, was often used to refer to sika deer.²⁵ While there were once different geographically distinct populations of sika deer, habitat loss and centuries of deer farming has destroyed these natural

²⁰E.g., John L. Riley, *The Once and Future Great Lakes Country: An Ecological History* (Montreal & Kingston: McGill-Queens University Press, 2013), 14–19.

²¹The forest musk deer (*Moschus berezovskii*) now lives only in high mountains and Siberian musk deer (*M. moschiferus*) is found only in the far north of the region. The remains found in the lowlands may belong to either of these, or perhaps to an extinct lowland species.

²²The earliest record we can find of people valuing the musk comes from the “Discourse on Nourishing the Body” (*Yang shen lun* 養生論) of Ji Kang 嵇康 (223–62 CE): [https://zh.wikisource.org/zh-hant/養生論_\(嵇康\)](https://zh.wikisource.org/zh-hant/養生論_(嵇康)).

²³The head and pedicles (rounded furry horns from which small antlers grow on males) on some bronze vessels seem to depict a muntjac, while the rest of the animal contains fantastical elements, like wings. E.g., Zhongguo shehuikexueyuan kaogu yanjiusuo, *Zhangjiapo Xi Zhou mudi* 張家坡西周墓地 (Beijing: Dabaike quanshu, 1999), 161–63; Gao Gong 高功, “Long xing cheng cang, lu ming zhou ye—Shigushan Xi Zhou mudi chutu qingtongqi shangxi (er) 龍行陳倉，鹿鳴周野—石鼓山西周墓地出土青銅器賞析 (二),” *Shoucangjie* 4 (2015).

²⁴Geist, *Deer of the World*, 84–85.

²⁵Paul W. Kroll, *A Student's Dictionary of Classical and Medieval Chinese* (Leiden: Brill, 2015; Pleco edition). The same is true of Japanese, in which this character is pronounced “sika,” hence the English name.

populations, though northern sika remain larger than southern ones.²⁶ Sambar deer (*Rusa unicornis*, 185–260 kg), which are related to the *Cervus* genus, were identified at several sites in North China. If these identifications are correct, then Sambar once ranged from western India to Shandong.²⁷

Like sika and red deer, Siberian roe deer (*Capreolus pygargus*, 28–60 kg) prefer a mixture of open land and dense forest so that they can feed in the open but hide from predators in dense vegetation. Roe deer mostly remain solitary, though they can form herds. As suggested by their name, they are northern deer and North China is the southern limit of their range.

Two species of deer specialized in wetlands and floodplain habitats, namely elaphure (*Elaphurus davidianus*, 135–220 kg) and water deer (*Hydropotes inermis*, 15 kg). It is not surprising that these species have disappeared from the region, since wetlands make excellent farmland. Elaphure live in herds and are well adapted to wetland living. They were extirpated from China during the twentieth century, but fortunately survived because some had been sent to Europe.²⁸ Unusually, the males grow their antlers in the winter and shed them in December–January. This is the opposite of most other deer species and probably reflects the fact their lifestyles are “closely bound to the pulses of flooding in the valleys of the huge rivers of China.”²⁹

Water deer live alone or in small groups, and are very good swimmers. Although the presence of water deer in Neolithic North China has been taken as evidence of a warmer climate, they once ranged across the lowlands of east China into the subarctic climate of the northeast. They are currently found only in the Yangzi Valley and Korea, having been eliminated from the area in between.³⁰

Deer bones were identified at most Neolithic and Bronze Age sites.³¹ Sika deer are by far the most commonly identified wild taxon in all time periods, having been identified at about 64% of all sites shown in Table 1, followed by water deer (36%), roe deer (28%), elaphures (26%), musk deer (22%), and red deer (17%). Deer bones identified as chital (*Axis* sp.), which are now found only in South Asia, and white-lipped deer (*Cervus albirostris*), which inhabit the Tibetan Plateau, may be misidentifications.

BOVIDS, HORSES, AND PIGS

Wild animals have disappeared from lowland North China not only because their habitat has been converted to farmland, but also because they have been replaced by their domesticated relatives, which prefer the same habitats. Domesticated sheep, goats, cattle, horses, and water buffalo all thrive in the same environments as their wild counterparts. With the exception of pigs, zooarchaeologists working on Holocene China are only beginning to go beyond domestication and think about the history of wild populations.

²⁶Geist, *Deer of the World*, 90–94.

²⁷Hutchins et al., *Grzimek's Animal Life Encyclopedia* Vol. 15; *Mammals* 4, 367.

²⁸Edward H. Schafer, “Cultural History of the Elaphure,” *Sinologia* 4 (1956): 250–74.

²⁹Geist, *Deer of the World*, 102.

³⁰Smith and Xie, *Guide to the Mammals of China*, 467; Noriyuki Ohtaishi and Yaoting Gao, “A Review of the Distribution of All Species of Deer (Tragulidae, Moschidae and Cervidae) in China,” *Mammalian Review* 20.2/3 (1990): 125–44.

³¹112 of 121 sites, about 93%.

We know that aurochs (wild cattle) and wild water buffalo went extinct, and that Przewalski's horse survived only in captivity, but we know very little about how their populations declined and then disappeared. And because of the morphological similarities between wild and domestic species, it is often impossible for zooarchaeologists to tell their remains apart.

Wild boar (*Sus scrofa*) are still common across Eurasia, in habitats ranging from temperate to tropical. They are often a nuisance in both rural and urban environments in China, which demonstrates their ability to survive even in highly anthropogenic landscapes. Their domestication probably began when their versatile omnivorous diet led them to venture into human settlements to feed on crops or waste.³² Pigs were domesticated from wild boar by about 6000 BCE in at least three locations, namely the Yellow River Valley, the Yangzi River Valley, and Manchuria.³³ They have been identified at almost every site in North China from the Early Neolithic through the Bronze Age, but because they were domesticated locally and could always interbreed with wild boar zooarchaeologists often find it difficult to distinguish wild and domesticated pigs.³⁴ Zooarchaeologists do so by studying tooth size and morphology,³⁵ bone stable isotopes,³⁶ tooth formation pathologies,³⁷ changes in the frequency of pig bones in an assemblage, and slaughter patterns.³⁸ It is often impossible to identify individual bones as domestic or wild, but we can be sure that wild boar were present in low numbers at many sites where only domestic pigs have been identified in archaeological reports.

Horses excavated at several Neolithic sites in the Wei River basin are presumably Przewalski's horse (*Equus caballus przewalskii*, 200–350 kg), which would have found good grazing land in the basin's mix of grassland and forest.³⁹ Domesticated

³²For a detailed discussion of pig ecology and the nature of pig domestication, see Umberto Albarella et al., eds, *Pigs and Humans: 10,000 Years of Interaction* (Oxford: Oxford University Press, 2007).

³³Luo Yunbing 羅運兵, *Zhongguo gudai zhu lei xunhua, siyang yu yishixing shiyong* 中國古代豬類馴化飼養與儀式性使用 (Beijing: Kexue chubanshe, 2012).

³⁴Photographs taken in the early twentieth century reveal that some domesticated pigs still looked quite wild: Robert Sterling Clark and Arthur de Carle Sowerby, *Shen-Kan: The Account of the Clark Expedition in North China 1908–9* (London: T. Fisher Unwin, 1912), 137.

³⁵Jing Yuan and Rowan K. Flad, "Pig Domestication in Ancient China," *Antiquity* 76.293 (2002): 724–32; Thomas Cucchi et al., "Early Neolithic Pig Domestication at Jiahu, Henan Province, China: Clues from Molar Shape Analyses Using Geometric Morphometric Approaches," *Journal of Archaeological Science* 38.1 (2011): 11–22; Hua Wang et al., "Morphometric Analysis of *Sus* Remains from Neolithic Sites in the Wei River Valley, China, with Implications for Domestication," *International Journal of Osteoarchaeology* 25.6 (2015): 877–89.

³⁶Loukas Barton et al., "Agricultural Origins and the Isotopic Identity of Domestication in Northern China," *Proceedings of the National Academy of Sciences* 106.14 (2009): 5523–28.

³⁷Hua Wang et al., "Pig Domestication and Husbandry Practices in the Middle Neolithic of the Wei River Valley, Northwest China: Evidence from Linear Enamel Hypoplasia," *Journal of Archaeological Science* 39.12 (2012): 3662–70; Anne Pike-Tay et al., "Combining Odontochronology, Tooth Wear Assessment, and Linear Enamel Hypoplasia (LEH) Recording to Assess Pig Domestication in Neolithic Henan, China," *International Journal of Osteoarchaeology* 26.1 (2014), 68–77.

³⁸Yuan and Flad, "Pig Domestication in Ancient China"; Jing Yuan, "The Origins and Development of Animal Domestication in China," *Journal of Chinese Archaeology* 8 (2008): 1–7; Luo, *Zhongguo gudai zhu lei xunhua*.

³⁹Incidentally, another perissodactyl that may have inhabited the region is the tapir, which was found at Anyang, and seems also to be represented in ancient bronzes. However, Donald Harper argues that the tapir

horses arrived from Inner Asia in the second millennium BCE,⁴⁰ and zooarchaeologists tend to identify horses excavated after that date as domestic, so it is unclear when and how wild horses were eliminated from North China. The Yellow River Valley may have been the southern limit of the wild horse's range.⁴¹

Aurochs (*Bos primigenius*, c. 300–800 kg) were the large and powerful wild progenitors of domestic cattle.⁴² Like horses, they once inhabited a variety of habitats across Eurasia, but were gradually driven out by people who used their domesticated relatives to exploit their habitat. Genetic and zooarchaeological evidence indicates that domesticated cattle were brought to China from Central and Western Asia, and were not domesticated from native East Asian aurochs populations.⁴³ Because zooarchaeologists have often mistaken aurochs for domesticated cattle, and because wild aurochs could presumably have hybridized with domestic cattle, we know very little about the extinction of aurochs in China.⁴⁴ The latest clear identification of their remains dates to around 2000 BCE, but it is quite possible that many remains identified as belonging to domestic cattle actually belonged to aurochs, so it will require considerable research to explain when and where China's aurochs went extinct.

While they were once thought to be the wild ancestors of domesticated water buffalo, it is now clear that the wild water buffalo of North China (*Bubalus mephistopheles*) were in fact driven to extinction, and the domesticated water buffalo of South China were later introduced from South Asia.⁴⁵ The large sizes of their bones suggest that they were

bones excavated at Anyang date to the Pleistocene, that the bronze vessels do not depict tapirs, and that there were no tapirs in China in historical times. Pierre Teilhard de Chardin and Chung Chien Young, *On the Mammalian Remains from the Archaeological Site of Anyang* (Nanking: Geological Survey of China, 1936); Donald J. Harper, "The Cultural History of the Giant Panda (*Ailuropoda melanoleuca*) in Early China," *Early China* 35 (2013): 186–204.

⁴⁰Katheryn M. Linduff, "A Walk on the Wild Side: Late Shang Appropriation of Horses in China," in *Pre-historic Steppe Adaptation and the Horse*, ed. Martha Levine, Colin Renfrew, and Katie Boyle (Cambridge: McDonald Institute for Archaeological Research, 2003), 139–62; Rowan Flad, Jing Yuan, and Shuicheng Li, "Zooarchaeological Evidence for Animal Domestication in Northwest China," in *Late Quaternary Climate Change and Human Adaptation in Arid China*, ed. David Madsen, Fa-Hu Chen, and Xing Gao (Amsterdam: Elsevier, 2007), 194.

⁴¹Wen Huanran 文煥然, ed., *Zhongguo lishi shiqi zhiwu yu dongwu bianqian yanjiu* 中國歷史時期植物與動物變遷研究 (Chongqing: Chongqing chubanshe, 1995), 234–47.

⁴²Cis van Vuure, *Retracing the Aurochs: History, Morphology and Ecology of an Extinct Wild Ox* (Sofia: Pensoft, 2005), 213–59.

⁴³Lu Peng, Katherine Brunson, Yuan Jing and Li Zhipeng, "Zooarchaeological and Genetic Evidence for the Origins of Domestic Cattle in Ancient China," *Asian Perspectives* 56.1 (2017): 92–120.

⁴⁴Aurochs bones have been identified at the Longshan site of Zhoujiazhuang in Shanxi Province dating to 2140–1745 cal BCE. Since the mtDNA haplogroups of both domestic cattle and wild aurochs were identified at that site, we know that both animals lived in the area at the time, and may have interbred: Katherine Brunson et al., "New Insights into the Origins of Oracle Bone Divination: Ancient DNA from Late Neolithic Chinese Bovines," *Journal of Archaeological Science* 74 (2016): 35–44.

⁴⁵Recent zooarchaeological studies on water buffalo (*Bubalus* sp.) remains from China and South Asia have disproven the traditional view that water buffalo were first domesticated in Neolithic China. The results from several recent genetic studies of modern domesticated buffalo (*Bubalus bubalis*) are not consistent with each other, placing the original center of buffalo's domestication in South Asia, Southeast Asia, or China. Dongya Yang and colleagues analyzed DNA from water buffalo remains dated to 8000–3600 cal BP from Neolithic sites in North China. The phylogenetic analysis indicated that the ancient water buffalos were an extinct species, not the direct ancestor of modern domesticated water buffalo. Liu Li 劉莉, Yang Dongya 楊東亞, and

even larger than the domesticated species (*Bubalus bubalis*, 700–1200 kg⁴⁶). Like the Indian wild water buffalo, China's wild water buffalo probably also preferred wet lowlands and lived in herds.⁴⁷ They were among the largest animals in the region, so if they were anywhere near as violent as African buffalo, they would have been a dangerous and thus prestigious animal to hunt, which may be why they were commonly depicted on ritual bronze vessels.⁴⁸

It is unknown when water buffalo died out. They have been excavated at several Neolithic and Bronze Age sites, and with the latest dated specimens being those from the late second millennium at Anyang. But they were still commonly depicted on bronze vessels after that time, and historical accounts indicate that they were later hunted by Zhou elites. For example, the *Book of Odes* states: “We lead all the attendants, in order to please the king. We draw our bows and grasp our arrows. We shoot a small boar and kill a big buffalo (*si* 兕).”⁴⁹ The second-century CE glossary *Shuowen jiezi* defined *si* 兕 as “like a wild cow, but blue-black.”⁵⁰ This description seems to refer to water buffalo, and also suggests that its author was aware of aurochs (wild cow), so perhaps these animals, or at least a memory of them, survived long after our latest archaeological dates.

In addition to large horses and bovines, North China was also home to several small bovids that were occasionally hunted by ancient humans. One of these was the gazelle. *Gazella* species have been excavated from Neolithic sites in the Wei River basin, particularly in Shaanxi and Gansu provinces at sites closer to dry steppe habitats. These animals are probably the goitered gazelle (*Gazella subgutterosa*, 29–42 kg), which live in small groups and roam widely to find food.⁵¹ While goitered gazelle may have been eliminated from the Yellow River lowlands when they were colonized for farming, they probably remained in the Loess Plateau much longer. Now they only survive in arid Inner Asia, the driest part of their former range.

While all wild lowland bovids were eliminated, those living in high mountains have often managed to hang on. Mountain-dwelling caprids like Chinese serow (*Capricornis milneedwardsii*, 85–140 kg), takin (*Budorcas taxicolor*, 250–600 kg), and several

Chen Xingcan 陳星燦, “Zhongguo jiyang shuiniu qiuyuan chutan” 中國家養水牛起源初探, *Kaogu xuebao* 2 (2006), 141–76; Dongya Yang et al., “Wild or Domesticated: DNA Analysis of Ancient Water Buffalo Remains from North China,” *Journal of Archaeological Science* 35:10 (2008): 2778–85.

⁴⁶Ronald M. Nowak, *Walker's Mammals of the World* (Baltimore: The Johns Hopkins University Press, 1999).

⁴⁷Li Liu and Xingcan Chen, *The Archaeology of China: From the Late Paleolithic to the Early Bronze Age* (Cambridge: Cambridge University Press, 2012), 108–11; Michael Hutchins et al., eds., *Grzimek's Animal Life Encyclopedia Vol. 16: Mammals V*, 2nd ed. (Farmington Hills: Gale Group, 2003), 20–21.

⁴⁸E.g., Wen Fong, ed., *The Great Bronze Age of China* (New York: Metropolitan Museum of Art, 1980), 230.

⁴⁹悉率左右,以燕天子。既張我弓,既挾我矢,發彼小豨,殪此大兕。“Ji ri” 吉日, Mao ode # 180. We have changed Karlgren's translation of *si* 兕 from “rhinoceros” to “buffalo” in accordance with Jean A. Lefeuvre, “Rhinceros and Wild Buffaloes North of the Yellow River at the End of the Shang Dynasty: Some Remarks on the Graph 兕 and the Character 兕,” *Monumenta Serica* 39 (1990): 131–57; Carl W. Bishop, “Rhinceros and Wild Ox in Ancient China,” *The China Journal* 18.6 (1933): 322–30; Bernhard Karlgren, *The Book of Odes* (Stockholm: Museum of Far Eastern Antiquities, 1950), 124.

⁵⁰如野牛而青。 *Hanyu da zidian* 漢語大字典 (Wuhan: Hubei ci shu; Sichuan ci shu, 1986), 270.

⁵¹Two other species of gazelle inhabit similar ecologies, and may have lived in the Guanzhong basin: Mongolian gazelle (*Procapra gutturosa*, 25–45 kg) and Przewalski's gazelle (*Procapra przewalskii*, 17–32 kg).

species of goral (*Naemorhedus* sp., 20–40 kg), still inhabit the Qinling Mountains. The bones of these wild species are morphologically similar to those of domesticated bovids, which makes it difficult to accurately identify fragmentary specimens, and limits our ability to comment on the former ranges of these animals. Unidentified medium-sized bovid bones found at Neolithic sites may belong to any of these species.

RHINOCEROS AND ELEPHANTS

In the modern world, elephants and rhinoceros are found only in the tropics, so we think of them as warm-weather animals, but woolly mammoths and rhinoceros inhabited extremely cold regions during the last glaciation. The natural range of the Sumatran rhinoceros (*Dicerorhinus sumatrensis*, 800 kg) in fact extends all the way from Indonesia to North China, while the Asian elephant (*Elephas maximus*, 2700–4100 kg) once lived from Mesopotamia to the Yangzi Valley, but is probably not native to the Yellow River region.

The few remaining Sumatran rhinoceros inhabit dense tropical forest in Indonesia, browsing on trees and shrubs in dense undergrowth in valleys.⁵² They frequently wallow in mud, which sticks to their body because of their coat of stiff hairs. They are the smallest extant rhinoceros, current populations not exceeding 800 kg and 150 cm high at the shoulder, but these are a small remnant population at the very edge of their range, and cannot be taken as representative of how the species once was. The fact that the few remaining populations live in forested mountains probably reflects the destruction of their other habitat, not that they prefer such environments. They are the only furry rhinoceros left in the world, and are related to the extinct ice age woolly rhinoceros, so it should not be surprising that they lived so far north during the mid-Holocene.⁵³ Rhinoceros remains were found at various sites,⁵⁴ which indicates that the natural habitat of the rhinoceros extended across much of the Yellow River Valley and that they were present there from the Early Neolithic through at least the Zhou period. People used rhinoceros hides for armor in the mid-first millennium BCE, after which they are not mentioned in the region again.⁵⁵

There is no doubt that Asian elephants lived in the Yangzi Valley,⁵⁶ but neither of the Holocene Yellow River sites where elephant bones have been found are clear evidence of elephants living in the region. Only one small bone was found at Dadiwan, which may

⁵²Hutchins et al., *Grzimek's Animal Life Encyclopedia* Vol. 15, 249–57.

⁵³Ludovic Orlando et al., “Ancient DNA Analysis Reveals Woolly Rhino Evolutionary Relationships,” *Molecular Phylogenetics and Evolution* 28.3 (2003): 485–99; Hutchins et al., *Grzimek's Animal Life Encyclopedia* Vol. 16, 249.

⁵⁴Bones identified as rhinoceros or Sumatran rhinoceros were identified at Early and Middle Neolithic Dadiwan (Gansu), Middle Neolithic Guantaoyuan and Zijing (Shaanxi), Middle Neolithic Xiawanggang (Henan), Bronze Age Erlitou (Henan), and Bronze Age Anyang (Henan).

⁵⁵E.g., Yang Bojun 楊伯峻, *Chunqiu Zuo zhuan zhu* 春秋左傳注 (Beijing: Zhonghua shuju, 1990), 192, 654 (Zhuang 13, Xuan 3).

⁵⁶For a mostly reliable, if dated, account of the history of elephants in China, see Wen, *Zhongguo lishi shiqi zhiwu yu dongwu*, 185–219.

have come from elsewhere,⁵⁷ while the elephants found at Anyang may well have been captives in the collection of the Shang kings.⁵⁸ Wen Huanran's map depicting elephants north of Beijing, which was later used by Mark Elvin, is based on 50,000-year-old elephant remains.⁵⁹ The most likely scenario is that elephants were quite common in the Yangzi Valley and that the southern edge of the Yellow River Valley was the northern limit of their range. However, it is rather dangerous to hunt elephants, so the lack of their remains in Neolithic sites cannot be taken as evidence for their absence. Elephants were often depicted in bronze vessels and other artworks, but they are impressive enough that this cannot be taken as evidence that they were local.

Although there is little record of animal extirpations in ancient Chinese texts, the following passage from Han Feizi (d. 233 BCE) suggests that the disappearance of elephants did make an impression: "People rarely see living elephants, but if they obtain the bones of a dead elephant, they can imagine a living elephant based on their form. Because of this, everything people use to form an idea or mental image is called 'elephant.'"⁶⁰ This is still the meaning of *xiang* 象 in Chinese.

PRIMATES

There are three types of primates in the region: rhesus macaque, golden snub-nosed monkey, and humans, all three of which are highly social. Like other "leaf monkeys" (Colobinae), golden snub-nosed monkeys (*Rhinopithecus roxellana*, 8–15 kg) have complex, multichambered stomachs that allow them to digest relatively coarse plant material; they eat leaves, lichens, bark, buds, and fruit. This and their thick fur allow them to live in relatively cold mountain forests. Snub-nosed monkeys were far more widely distributed in the recent past than they are now, but there are still a few populations in the Qinling Mountains.⁶¹

Rhesus macaques (*Macaca mulatta*, 5–10 kg) live in matriarchal groups with dozens of members. They are good swimmers and climbers, and can eat a wide variety of foods

⁵⁷Gansu sheng wenwu kaogu yanjiusuo, *Qin'an Dadiwan: xinshiqi shidai yizhi fajue baogao* 秦安大地灣: 新石器時代遺址發掘報告 (Beijing: Wenwu, 2006), 873. The northernmost site with clear evidence of wild elephants is Middle Neolithic period Xiaawanggang, Henan, which is on the traditional border between North and South China.

⁵⁸There is some evidence for tamed elephants in the Shang-Zhou period: Hubei Sheng bowuguan, *Li yue Zhongguo: Hubei Sheng bowuguan guancang Shang Zhou qingtongqi tezhan* 禮樂中國: 湖北省博物館館藏商周青銅器特展 (Wuhan: Hubei renmin chubanshe, 2014), 132; Magnus Fiskesjö, "Rising From Blood-Stained Fields: Royal Hunting and State Formation in Shang China," *Bulletin of the Museum of Far Eastern Antiquities* 73 (2001): 86–98; John Knoblock and Jeffrey Riegel, *The Annals of Lü Buwei: A Complete Translation and Study* (Stanford: Stanford University Press, 2000), 5.151.

⁵⁹Samuel T. Turvey et al., "Holocene Survival of Late Pleistocene Megafauna in China: A Critical Review of the Evidence," *Quaternary Science Reviews* 76 (2013): 160; Wen, *Zhongguo lishi shiqi zhiwu yu dongwu*, 210; Elvin, *The Retreat of the Elephants*, 10. Although Wen and Elvin did not know the dates of the elephant tooth, the presence of woolly rhinoceros bones should have made clear that the Holocene date in the original publication was unreliable. It should be noted that this does not undermine Elvin's description of elephants disappearing as agricultural civilization spread southward.

⁶⁰人希見生象也，而得死象之骨，案其圖以想其生也，故諸人之所以意想者皆謂之象也。Wang Xian-qian 王先謙, *Han Feizi jijie* 韓非子集解 (Beijing: Zhonghua shuju, 1998), 20.148.

⁶¹Baoguo Li, Ruliang Pan, and Charles E. Oxnard, "Extinction of Snub-Nosed Monkeys in China During the Past 400 Years," *International Journal of Primatology* 23.6 (2002): 1227–44.

(mostly plants), so they can inhabit a wide variety of environments. Rhesus macaques seem to have been quite common in ancient North China,⁶² and there are still a few populations there.⁶³ Given how well macaques have adapted to life in other parts of Asia with dense human populations, their extirpation from most of North China suggests how extreme the human impact on the region has been.

Humans (*Homo sapiens*) are even more adaptable than macaques, being able to employ symbolic communication like art and language for exchanging and expressing ideas, and for organizing ourselves into complex groups. While pre-agricultural human groups rarely lived in year-round groupings of more than a few hundred, the ability to produce food from domesticated plants and animals has allowed for population increase and the formation of increasingly large social organizations. This has given us an unprecedented ability to transform the environment, to the detriment of most other species of mammals. There were at least 40,000,000 humans recorded in North China by the census of 2 CE, and there are over 400,000,000 now.⁶⁴

SMALL MAMMALS

Although we tend to find big animals more striking, small ones are more numerous and diverse, and they often play important ecological roles as predators, prey, and as spreaders of seeds. Unlike any larger wild animals, some small mammals have benefitted from the expansion of human society.⁶⁵ For example, Amur hedgehog (*Erinaceus amurensis*), Chinese white-bellied rat (*Niviventer confucianus*), striped field mouse (*Apodemus agrarius*), and greater long-tailed hamster (*Tscherskia triton*) have adapted to the expansion of farmland and are commonly found in rural North China.⁶⁶ Tolai hares (*Lepus tolai*) are quite common in North China, presumably because they find plenty to eat in the agricultural landscape. Bats like the common serotine (*Eptesicus serotinus*) and Japanese pipistrelle (*Pipistrellus abramus*) have flourished by learning to roost in buildings.⁶⁷ Like house sparrows and pigeons, some small mammals became fully specialized in living off human communities, most notably the brown and Oriental house rats (*Rattus norvegicus* and *R. tanezumi*).

While a few species benefitted from the expansion of farmland, the majority lost out, especially those native to wetlands (such as reed voles [*Microtis fortis*]) and the vast forests that once covered the lowlands of East China. The forests surrounding Neolithic

⁶²Their remains have been identified at Early Neolithic Cishan (Hebei), Middle Neolithic Dadiwan and Xishanping (Gansu), Beishouling (Shaanxi), and Huangpo, Xiawanggang, and Xipo (Henan), and late Shang period Huixian Beicun (Shaanxi) and Anyang (Henan).

⁶³Zhang Yongzu et al., "Extinction of Rhesus Monkeys (*Macaca mulatta*) in Xinglung, North China," *International Journal of Primatology* 10.4 (1989):375–81.

⁶⁴Hans Bielenstein, "The Census in China during the Period 2–742 AD," *Bulletin of the Museum of Far Eastern Antiquities* 26 (1947), 125–63.

⁶⁵Larger animals have been disproportionately extinguished globally over the Holocene: Samuel T. Turvey and Susanne A. Fritz, "The Ghosts of Mammals Past: Biological and Geographical Patterns of Global Mammalian Extinction across the Holocene," *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 366.1577 (2011): 2564–76. This seems to reflect the fact that it is easier for smaller animals to adapt to environmental change.

⁶⁶The term *shu* 鼠 was used in early texts to refer to various small rodents.

⁶⁷Smith and Xie, *Guide to the Mammals of China*, 358–63.

settlements were surely full of tree squirrels collecting acorns and chattering at unwelcome visitors, as they still do in other parts of the world. Tree squirrels live in a kind of symbiotic relationship with the trees they depend on, burying their nuts for the winter and thus planting the ones they end up not eating. They also eat fruit, insects, and leaves. Many tree squirrels live and nest in holes in trees, which means that they need forests with older trees. As the forests of lowland North China disappeared, people developed plantations of fast-growing trees that were cut down as soon as they became usable poles.⁶⁸ This satisfied people's need for timber without providing tree squirrels with suitable habitat. Several kinds of tree squirrels have been collected in North China in modern times,⁶⁹ but distribution maps in the *Guide to the Mammals of China* show that several more (especially flying squirrels) inhabit the dense forests of the Qinling, and we can be sure that some of these would have inhabited lowland forests.

Not all squirrels live in trees; ground squirrels and related rodents also burrow into the ground. Père David's rock squirrels (*Sciurotamias davidianus*) live in rocky forested areas, collecting acorns and other nuts. Daurian ground squirrels (*Spermophilus dauricus*) inhabit arid northern plains and live in dense colonies. Like their North American relatives, Siberian chipmunks (*Tamias sibiricus*) are omnivorous and live in forest burrows. The Malayan porcupine (*Hystrix brachyura*) also lives underground, digging large burrows in both forests and fields. Bamboo rats (*Rhizomys sinensis*) and zokors (*Eospalax* sp.) also dig underground tunnels, and are among the most common rodent excavated from archaeological sites. We suspect that they are often found in zooarchaeological assemblages not because people liked eating them, but because they died in their burrows and thus preserve well underground.

Another group of small mammals that inhabits burrows or hollows in mountain rocks are pikas (*Ochotona* sp.), which are still found in the high Qinling Mountains and the arid northwest.⁷⁰ Many pikas gather plants in their burrows to eat in the winter. Like their relatives the hares and rabbits, pikas play a key role in many ecosystems as a food source for carnivores.⁷¹

Because they live underground and are usually no bigger than mice, shrews and moles are among the most poorly understood mammals in China.⁷² Most eat insects and earthworms, but some eat a wider variety of small animals, from snails to fish. Several kinds of terrestrial shrews are found in the region,⁷³ as well as the Himalayan water shrew

⁶⁸Nicholas Menzies, *Science and Civilisation in China 6.3: Forestry*, ed. Joseph Needham (Cambridge: Cambridge University Press, 1996).

⁶⁹These include Swinhoe's striped squirrel (*Tamias swinhoei*), Pallas's squirrel (*Callosciurus erythraeus*), Eurasian red squirrel (*Sciurus vulgaris*) and Siberian flying squirrel (*Pteromys volans*).

⁷⁰The Daurian pika (*Ochotona dauurica*) inhabits the dry region to the northwest of the study region, but has also been found in the Qinling, where the most common species is the Qinling pika (*O. syrinx*). The taxonomy of these species is still being revised: Andrey A. Lissovsky, "Taxonomic Revision of Pikas *Ochotona* (Lagomorpha, Mammalia) at the Species Level," *Mammalia* 78.2 (2014): 199–216. The identification of pikas at the Neolithic site of Banpo (in Xi'an) is probably a mistake.

⁷¹E.g., Andrew T. Smith and J. Marc Foggin, "The Plateau Pika (*Ochotona curzoniae*) is a Keystone Species for Biodiversity on the Tibetan Plateau," *Animal Conservation* 2 (1999), 235–40.

⁷²Smith and Xie, *Guide to the Mammals of China*, 298.

⁷³Asian gray shrew (*Crocidura attenuata*), Asian lesser white-toothed shrew (*Crocidura shantungensis*), Chinese mole shrew (*Anourosorex squamipes*) and De Winton's shrew (*Chodsigoa hypsibia*).

(*Chimarrogale himalayica*), that spends much of its time in water. Of all mammals, moles are the most adapted to underground living, and at least two species are probably native to the lowlands of North China.⁷⁴

These small mammals have always been more numerous than larger ones, but are rarely depicted in ancient texts or artworks. Hopefully the increased use of sieves by Chinese zooarchaeologists in the future will reveal considerably more about the smaller fauna.

CARNIVORES

Having discussed some herbivores, we will now discuss the mammals that eat them, the carnivora. We will begin with the weasel family, most of which have long bodies with short limbs, and which humans prize for their dense fur. Smaller mustelids (under 3 kg) included martens,⁷⁵ weasels,⁷⁶ and ferret badgers (*Melogale moschata*), all of which eat small rodents, birds, berries, eggs, and other things. Archaeologists rarely find their remains in China, but references in early texts to small animals with valuable fur probably refer to such animals (e.g., *diao* 貂/貂 and *you* 鼬).

Both hog badgers (*Arctonyx collaris*, 10–12.5 kg) and Asian badgers (*Meles leucurus*, 3.5–9 kg) use their powerful forearms to dig out their burrows, from which they emerge in the evening to forage for earthworms, roots, and other things. Closely related to European badgers, Asian badgers are the most common mustelids found at Neolithic and Bronze Age sites (identified at over one-third of sites), which suggests that people often hunted them for their meat and fur.

Eurasian otters (*Lutra lutra*, 3–9 kg) once inhabited rivers, ponds, and lakes in much of China and were found across North China in modern times. They are solitary, nocturnal, and territorial, and eat large quantities of fish and other small animals that live around water. Otters were known to eat fish out of fishers' nets,⁷⁷ but were also trained to herd fish into them.⁷⁸

Solitary and nocturnal, masked palm civets (*Parguma larvata*, 3–7 kg) eat mostly fruits, but also various plants and small animals. They are the only member of the civet family still found in North China, though other civets probably inhabited the south of the region in earlier times.⁷⁹

Cats, the most carnivorous land mammals, generally hunt alone at night. The only small cat that is certainly native to the region is the leopard cat (*Prionailurus bengalensis*, up to 5 kg), which lived across North China, including around human settlements.⁸⁰

⁷⁴Large mole (*Mogera robusta*) and short-faced mole (*Scaptochirus moschatus*).

⁷⁵Yellow throated (*Martes flavigula*) and possibly beech (*M. foina*) martens.

⁷⁶Steppe polecat (*Mustela eversmanni*) probably inhabited the region, and ermine (*M. erminea*) and mountain weasel (*M. altaica*) were probably found on its northern edges.

⁷⁷Major et al., *Huainanzi*, 582; He Ning 何寧, ed., *Huainanzi jishi* 淮南子集釋 (Beijing: Zhonghua, 1998), 15.1046.

⁷⁸James Legge, *The Chinese Classics II: The Works of Mencius* (Taipei: SMC Publishing, 1991), 300; Otto Gabriel et al., *Fish Catching Methods of the World*, 4th ed. (Oxford: Blackwell, 2005), 33.

⁷⁹Such as the large Indian civet (*Viverra zibetha*) and small Indian civet (*Viverricula indica*).

⁸⁰Jean-Denis Vigne et al., "Earliest 'Domestic' Cats in China Identified as Leopard Cat (*Prionailurus bengalensis*)," *PLOS ONE* 11.1 (2016): e0147295.

Modern distribution maps suggest that several others would probably have inhabited some part of the Yellow River Valley when its natural ecosystems were intact.⁸¹ While it remains unclear whether cats were domesticated in China or arrived domesticated from elsewhere, we can be sure that as forests were replaced with human settlements full of small rodents and birds, wild cats would have learned to hunt in villages.

Both leopards (*Panthera pardus*, 37–90 kg) and tigers (*Panthera tigris*, 90–300 kg) were once found across the subcontinent, and their remains are commonly identified in Neolithic and Bronze Age sites.⁸² They are also frequently referred to in texts. Leopards are native to all of China proper, and are still found in the region.⁸³ Leopards are known to catch and eat all kinds of smaller animals. Tigers mainly eat deer, wild pigs, and many other large mammals, and can have a significant impact on the populations of their prey. They are also “the only carnivore that regularly feeds on humans.”⁸⁴ Lynx (*Lynx lynx*, 18–38 kg) remains were also found at one site in Hebei,⁸⁵ and it seems likely that their range once extended into the Taihang and Qinling mountains.

Canids native to the area are wolves (*Canis lupus*, 28–40 kg), dholes (*Cuon alpinus*, 10–20 kg), red foxes (*Vulpes vulpes*, 3.6–7 kg), and raccoon dogs (*Nyctereutes procyonoides*, 3–6 kg), all of which remained widespread in China in recent centuries.⁸⁶ While raccoon dogs and foxes usually live alone or in pairs, the larger dholes and wolves are pack hunters. Foxes, dholes, and wolves can inhabit a wide range of environments, while raccoon dogs are one of the few canids that live entirely in forests.

Raccoon dogs are shaggy, foxlike, and mostly nocturnal omnivores. Their remains have been identified at about 22% of all Neolithic and Bronze Age sites, making them one of the most commonly excavated wild carnivores. Foxes have been identified at about 14% of all sites. Both foxes and raccoon dogs were valued for their fur. Dholes have been identified at only a few sites, but these range widely in space and time, suggesting that dholes were widespread, but not widely hunted.⁸⁷ There are many references to them in Chinese literature, but scholars have often mistranslated *chai* 豺 as “wolf” or “jackal.”⁸⁸

Wolves are the wild progenitors of domestic dogs, the first domestic animal.⁸⁹ They live in packs of ten or fewer, and hunt the young, weak, and old of larger herbivores

⁸¹Most notably the Asian golden cat (*Catopuma temminckii*): Smith and Xie, *Guide to the Mammals of China*, 392.

⁸²About 6% of sites from this period contained leopard remains and 16% had tiger remains.

⁸³Andrew P. Jacobson et al., “Leopard (*Panthera pardus*) Status, Distribution, and the Research Efforts across its Range,” *PeerJ* 4 (2016): e1974.

⁸⁴Smith and Xie, *A Guide to the Mammals of China*, 402.

⁸⁵Yu Dan 于丹, “Tang xian Nanfangshui yizhi chutu dongwu yicun jiangding baogao” 唐縣南放水遺址出土動物遺存鑑定報告,” in *Tang xian Nanfangshui* 唐縣南放水, ed. Nanshui beidiao zhongxian qianxian gongcheng jianshe guanlijū and Hubei sheng wenwuju (Beijing: Wenwu chubanshe, 2011), 197–231.

⁸⁶Smith and Xie, *Guide to the Mammals of China*, 416–21.

⁸⁷Dhole have been found at Early Neolithic Dadiwan (Gansu), Middle Neolithic Gongjiawan, Jiangzhai, and Wuzhuanguoliang (Shaanxi), Late Neolithic Kangjia and Longgangcun (Shaanxi), and Shang/Zhou period Zhenjiangying (Beijing)

⁸⁸Edward H. Schafer, “Brief Note: The Chinese Dhole,” *Asia Major* 4.1 (1991): 1–6.

⁸⁹O. Thalmann et al., “Complete Mitochondrial Genomes of Ancient Canids Suggest a European Origin of Domestic Dogs,” *Science* 342.6160 (2013): 871–74; G. Larson and D.G. Bradley, “How Much Is That in Dog Years? The Advent of Canine Population Genomics,” *PLoS Genetics* 10.1 (2014): e1004093.

like deer. Like pigs and wild boar, it is not always possible to distinguish between the bones of domestic dogs and wild wolves, and wolves were likely present at many sites where only domestic dogs have been identified. Many archaeologists now believe that wolves in a sense domesticated themselves without much direction on the part of humans, by hanging around human camp sites and eating rubbish, thereby establishing a commensal relationship with humans.⁹⁰

Bears native to the region are Asiatic black bears (*Ursus thibetanus*, 50–240 kg) and brown bears (*U. arctos*, 125–225 kg, known as grizzlies in North America). Both are mostly herbivorous omnivores, eating a variety of different things depending on availability, though brown bears will hunt when the opportunity presents itself, including digging small mammals out from underground. The fact that brown bears were excavated from the Guanzhong during the Holocene megathermal shows that their current northern range is a product of the takeover of their southern range by humans, not of a climatic limitation.⁹¹ Black bears inhabit warmer forests throughout East and South Asia, and, like leopards, find it easier to survive around humans because they are mostly nocturnal. Brown and black bears are commonly identified at many sites in North China, with bears in the genus *Ursus* identified at about 24% of sites.

Giant panda bears (*Ailuropoda melanoleuca*, 85–125 kg) are native to the high Qinling Mountains of southern Shaanxi. As far as we know their habitat was always high mountain bamboo groves.⁹² Archaeologically, pandas have only been identified at a single site, Middle Neolithic Xiawanggang, Henan.

CONCLUSION

The Yellow River Valley was once home to a flourishing community of mammals. With a few exceptions, the larger ones have all disappeared. Of the smaller mammals, a few still inhabit the lowlands, while many more are now only found in the neighboring mountains. We know that some species, such as water buffalo and aurochs, were driven to extinction, and can expect that future research will discover other lost species.

While it is difficult for anyone who has visited or lived in North China to picture its previous mammalian diversity, in fact its combination of mammals is quite typical of Eurasia. Even in the Pleistocene epoch ice age landscapes were home to species of horses, cattle, rhinoceros, deer, mammoths, bears, and large cats. In the Holocene, many of the species found in the Yellow River Valley once ranged across Eurasia. The closest extant combination of large mammals is probably found in the northeastern corner of India, namely Assam's Kaziranga National Park, where there are wild water buffalo, Indian one-horned rhinoceros, Asian elephants, bears, tigers, gaur, and various deer. There is nothing particularly surprising about North China's native large mammals, except that they are gone.

⁹⁰Melinda A. Zeder, "Pathways to Animal Domestication," in *Biodiversity in Agriculture: Domestication, Evolution, and Sustainability*, ed. Paul Gepts et al. (Cambridge: Cambridge University Press, 2012), 227–59; Raymond Coppinger and Laura Coppinger, *Dogs: A Startling New Understanding of Canine Origin, Behavior & Evolution* (New York: Simon and Schuster, 2001).

⁹¹As in North America, where they once lived as far south as Mexico.

⁹²On pandas in Chinese culture, see Harper, "The Cultural History of the Giant Panda."

The general process is clear: growing human populations and the expansion of agriculture reduced animal habitats. Unlike South Asia, where the need for military elephants prompted kings to protect large swaths of forest, Chinese rulers had every incentive to promote the replacement of natural ecosystems with tax-producing farms.⁹³ The North China plain was the first region to become densely populated, and ancient writers commented on its lack of resources when compared with the less densely populated south, for example: “Jing [in the Central Yangzi] has Yunmeng Park. Rhinoceroses, buffalo and various kinds of deer fill it. The fish, turtles and alligators in the Yangzi and Han Rivers are the most abundant in the world, while it is said that Song [in the lower Yellow River Valley] does not even have pheasants, hares or foxes.”⁹⁴ Larger wild mammals were eliminated from North China’s lowlands by the late first millennium BCE, but survived longer in peripheral mountainous areas, which remained sparsely populated until New World plants arrived after 1500 and allowed people to colonize the highlands.⁹⁵ At present only the highest and steepest mountains still harbor large wild mammals.

We understand the general picture, but know little about the histories of specific animals, or the processes that eliminated them. While the spread of agricultural societies is the central causal factor, we should not underestimate the impact of hunting on animals that reproduce slowly. Subsistence hunting, trophy hunting by elites, and the hunting of animals for their parts (ivory, feathers, medicine, etc.) all played a role. The rise of markets and long-distance trade must have played a part, as did the practice of sending rare items to royal courts as tribute.

Moreover, this process began in the Yellow River Valley but extended far beyond it. The market for luxury animal products like elephant tusks and rhinoceros horns was established when such animals still inhabited the heartland of Chinese civilization. When they were gone, merchants brought them from the south. Markets in the Yellow and Yangzi River Valleys fueled hunting in South China, followed by Southeast Asia, and now Africa. The ability of commerce to bring animal parts from distant places was celebrated as early as the Warring States period, when Xunzi wrote “by the Southern Sea there are feathers and plumes, elephant tusks, rhinoceros hides, copper ores, and cinabar; still the Central States obtain and process them.... [E]ven though the tiger and leopard are ferocious beasts, the gentleman can have them skinned for his own use.”⁹⁶

The history of the extirpation of these animals is thus long and complicated. The only way we can really understand this process is to get a better understanding of when each

⁹³Thomas R. Trautmann, *Elephants and Kings: An Environmental History* (Chicago: University of Chicago Press, 2015); Brian Lander, “Environmental Change and the Rise of the Qin Empire: A Political Ecology of Ancient North China” (PhD diss., Columbia University, 2015).

⁹⁴蒍有雲夢，犀兕麋鹿滿之，江漢之魚鼈鼉為天下富；宋所為(謂)無雉兔狐狸者也。Ian Johnston, *The Mozi: A Complete Translation* (New York: Columbia University Press, 2010), 727; See also Sima Qian 司馬遷, *Shi ji* 史記 (Beijing: Zhonghua shuju, 1959), 129.3266; Burton Watson, *Records of the Grand Historian: Han Dynasty Vol. 2* (Hong Kong: Renditions-Columbia University Press, 1993), 444.

⁹⁵Ping-ti Ho, *Studies on the Population of China, 1368–1953*. (Cambridge: Harvard University Press, 1959), 183–92.

⁹⁶南海則有羽翻，齒革，曾青，丹干焉，然而中國得而財之...虎豹為猛矣然君子剥而用之。Wang Xianqian 王先謙, *Xunzi jijie* 荀子集解 (Beijing: Zhonghua shuju, 1988), 9.161; John Knoblock, *Xunzi: A Translation and Study of the Complete Works* (Stanford: Stanford University Press, 1988), vol. 2, 142.

species disappeared. The method pioneered by Wen Huanran and his colleagues, of interdisciplinary studies of single species, remains the best one for this.⁹⁷ While our current study has relied mostly on zooarchaeology because ancient texts are ambiguous, later texts can be more reliable and are certainly more abundant. More zooarchaeological research into wild animals is also necessary in order to answer both zoological questions and to help us understand the social and dietary roles of wild animal exploitation in agricultural societies. The excavation of residential sites dating after 1200 BCE would help a great deal. Only interdisciplinary histories of single species or closely related groups of species can clarify the causes and timing of the elimination of the natural fauna from the region, and from China more broadly.

SUPPLEMENTARY MATERIAL

The supplementary material for this article can be found at <http://doi.org/10.1017/jch.2017.45>

APPENDIX 1: NATIVE MAMMALS OF THE MIDDLE AND LOWER YELLOW RIVER VALLEY

This is a list of the mammals we consider native to the middle and lower Yellow River Valley. It is based mainly on zooarchaeology and on the distribution maps in Smith and Xie, *A Guide to the Mammals of China*, whose English, scientific, and Chinese names we adopt.

Primates

Rhesus macaque *Macaca mulatta* 獼猴 *mi hou*
 Golden snub nosed monkey *Rhinopithecus roxellana* 川金絲猴 *chuan jinsihou*
 Humans *Homo sapiens* 人 *ren*

Rodents

Siberian flying squirrel *Pteromys volans* 小飛鼠 *xiao feishu*
 Eurasian red squirrel *Sciurus vulgaris* 松鼠 *songshu*
 Complex-toothed flying squirrel *Trogopterus xanthipes* 複齒鼯鼠 *fuchi wushu*
 Pallas' squirrel *Callosciurus erythraeus* 赤腹松鼠 *chifu songshu*
 Perny's long-nosed squirrel *Dremomys pernyi* 珀氏長吻松鼠 *Poshichangwen songshu*
 Swinhoe's striped squirrel *Tamiops swinhoei* 隱紋松鼠 *yinwen songshu*
 Himalayan Marmot *Marmota himalayana* 喜馬拉雅旱獭 *Ximalaya hanta*
 Père David's rock squirrel *Sciurotamias davidianus* 岩松鼠 *yang songshu*
 Daurian ground squirrel *Spermophilus dauricus* 達烏爾黃鼠 *Dawuer huangshu*
 Siberian chipmunk *Tamias sibiricus* 花鼠 *huashu*
 Chinese zokor *Eospalax fontanieri* 中華鼯鼠 *Zhonghua fenshu*

⁹⁷Wen, *Zhongguo lishi shiqi zhiwu yu dongwu*.

North China zokor *Myospalax psilurus* 東北鼯鼠 *Dongbei fenshu*
 Chinese bamboo rat *Rhizomys sinensis* 中華竹鼠 *Zhonghua zhushu*
 Inez's vole *Caryormys inez* 苛嵐絨鼠 *kelan rongshu*
 Mandarin vole *Lasiopodomys mandarinus* 棕色田鼠 *zongse tianshu*
 Reed vole *Microtis fortis* 東方田鼠 *dongfang tianshu*
 Shanxi red-backed vole *Myodes shanseius* 山西絨鼠 *Shanxi rongshu*
 Striped dwarf hamster *Cricetulus barabensis* 黑線倉鼠 *heixian cangshu*
 Long-tailed dwarf hamster *Cricetulus longicaudatus* 長尾倉鼠 *changwei cangshu*
 Greater long-tailed hamster *Tscherskia triton* 大倉鼠 *da cangshu*
 Striped field mouse *Apodemus agrarius* 黑線姬鼠 *heixian jishu*
 South China field mouse *Apodemus draco* 中華姬鼠 *Zhonghua jishu*
 Korean field mouse *Apodemus peninsulae* 大林姬鼠 *dalin jishu*
 Harvest mouse *Micromys minutus* 巢鼠 *chaoshu*
 White bellied rat (or Confucian ninventer) *Niniventer confucianus* 北社鼠 *bei sheshu*
 Brown rat *Rattus norvegicus* 褐家鼠 *he jiashu*
 Oriental house rat *Rattus tanezumi* 黃胸鼠 *huang xiongshu*
 Malayan porcupine *Hystrix brachyura* 豪豬 *haozhu*

Lagomorphs

Daurian pika *Ochotona dauurica* 達烏爾鼠兔 *Dawuer shutu*
 Qinling pika *Ochotona syrinx* 黃河鼠兔 *Huanghe shutu*
 Tolai hare *Lepus tolai* 托氏兔 *Tuoshi tu*

Hedgehogs

Amur hedgehog *Erinaceus amurensis* 東北刺猬 *Dongbei ciwei*
 Hugh's hedgehog *Mesechinus hughii* 林猬 *lin wei*
 Daurian hedgehog *Mesechinus dauuricus* 達烏爾猯 *Dawuer wei*

Shrews and Moles

Asian gray shrew *Crocidura attenuate* 灰麝鼩 *hui shequ*
 Asian lesser white-toothed shrew *Crocidura shantungensis* 山東小麝鼩 *Shandong xiao shequ*
 Chinese mole shrew *Anourosorex squamipes* 短尾鼩 *duanweiqu*
 Himalayan water shrew *Chimarrogale himalayica* 喜馬拉雅水鼩 *Ximalaya shuiqu*
 De Winton's shrew *Chodsigoa hypsibia* 川西長尾鼩 *Chuanxi changweiqu*
 Large mole *Mogera robusta* 大缺齒鼹 *da quechian*
 Short-faced mole *Scaptochirus moschatus* 麝鼹 *shayan*

Bats

Greater horseshoe bat *Rhinolophus ferrumequinum* 馬鐵菊頭蝠 *matie jutou fu*
 Common serotine *Eptesicus serotinus* 大棕蝠 *da zongfu*
 Chinese noctule *Nyctalus plancyi* 中華山蝠 *Zhonghua shanfu*

Japanese pipistrelle *Pipistrellus abramus* 東亞伏翼 *Dongya fuyi*
 Asian particolored bat *Vespertilio sinensis* 東方蝙蝠 *dongfang bianfu*
 Large myotis *Myotis chinensis* 中華鼠耳蝠 *Zhonghua shuerfu*
 Chinese water myotis *Myotis laniger* 淮南水鼠耳蝠 *Huainan shui shuerfu*
 Eastern barbastelle *Barbastella leucomelas* 寬耳蝠 *kuanerfu*

Carnivores

Lynx *Lynx lynx* 猞猁 *sheli*
 Leopard cat *Prionailurus bengalensis* 豹貓 *baomao*
 Leopard *Panthera pardus* 豹 *bao*
 Tiger *Panthera tigris* 老虎 *laohu*
 Masked palm civet *Paguma larvata* 畫面狸 *huamian li*
 Wolf *Canis lupus* 狼 *lang*
 Dhole *Cuon alpinus* 豺 *chai*
 Raccoon dog *Nyctereutes procyonoides* 貉 *he*
 Red fox *Vulpes vulpes* 赤狐 *chihu*
 Brown bear *Ursus arctos* 棕熊 *zongxiong*
 Asiatic black bear *Selenarctos thibetanus* 黑熊 *heixiong*
 Eurasian otter *Lutra lutra* 水獺 *shuita*
 Hog badger *Arctonyx collaris* 豬獾 *zhuhuan*
 Yellow-throated marten *Martes flavigula* 青鼬 *qingyou*
 Asian badger *Meles leucurus* 狗獾 *gouhuan*
 Chinese ferret badger *Melogale moschata* 鼬獾 *youhuan*
 Mountain weasel *Mustela altaica* 香鼬 *xiangyou*
 Steppe polecat *Mustela eversmanni* 艾鼬 *aiyou*
 Siberian weasel *Mustela sibirica* 黃鼬 *huangyou*

Perissodactyls (Odd-toed ungulates)

Przewalski's horse *Equus caballus przewalskii* 野馬 *yema*
 Sumatran rhinoceros *Dicerorhinus sumatrensis* 蘇門答臘犀 *Sumendala xi*

Artiodactyls (Even-toed ungulates)

Wild boar *Sus scrofa* 野豬 *yezhu*
 Siberian musk deer *Moschus moschiferus* 原麝 *yuanshe*
 Forest musk deer *Moschus berezovskii* 林麝 *linshe*
 Siberian Roe deer *Capreolus pygargus* 西伯利亞麇 *xiboliya pao*
 Red deer (a.k.a. Wapiti) *Cervus elaphus* 馬鹿 *malu*
 Sika deer *Cervus nippon*⁹⁸ 梅花鹿 *meihua lu*
 Tufted deer *Elaphodus cephalophus* 毛冠鹿 *maoguan lu*

⁹⁸*Cervus hortulorum* in many excavation reports.

Elaphure (a.k.a. Père David's deer) *Elaphurus davidianus* 麋鹿 *milu*
Reeves's muntjac *Muntiacus reevesi* 小麋 *xiaoji*
Chinese water deer *Hydropotis inermis* 獐 *zhang*
Gazelle *Gazella* sp. 羚羊 *ling yang* and/or *Procapra* sp. 原羚 *yuanling*
Mongolian gazelle *Procapra gutturosa* 黄羊 *huangyang*
Aurochs *Bos primigenius* 原始牛 *yuanshi niu*
Wild water buffalo *Bubalus mephistopheles* 聖水牛 *sheng shuiniu*
Takin *Budorcas taxicolor* 羚牛 *lingniu*
Chinese serow *Capricornis milneedwardsii* 甘南鬣羚 *Gannan lieling*
Long-tailed goral *Naemorhedus caudatus* 中華鬣羚 *Zhonghua lieling*