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Imperial paintings show earliest brown rat domestication

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The early domestication of brown rats (*Rattus norvegicus*) is still unclear. The imperial paintings, The Silk Scroll of Three Rats, depicted domesticated brown rats with coat color variation in China during 1425–1435 AD. It was more than two centuries older than the known record in Japan, presenting the earliest evidence of brown rat domestication.

The domestication and breeding of brown rats (*Rattus norvegicus*) provide one of the most used lab animal models[1]. Nevertheless, tracing the early domestication of brown rats is challenging[2]. Its burrowing behavior can cause taphonomic disturbance in archeological investigation. The morphological identification of fragmentary skeletal remains is difficult, given the occurrence of sympatric rodent species[3]. As a commensal species, the continuous globalization since the Bronze Age has accelerated the spread of brown rats. The intricate gene flows can blur the clues of early domestication[4,5].

So far, the earliest domestication of brown rats as pets (known as "nezumi") was recorded in 1654 AD during the Edo era (1603–1867 AD) in Japan[1]. The breeding varieties with multiple coat color phenotypes (including albino) were documented and figured in the guidebooks entitled Yoso-tama-no-kakehashi (1775 AD) and Chinganso-date-gusa (1787 AD)[6], indicating a long history of raising rats in Japan[7]. Intriguingly, rats were documented and even ascribed as traditional medicine in ancient Chinese books[8]. As the homeland of wild brown rat[4,5], China was speculated to have domestication of brown rat[2,3]. However, the evidence is lacking.

The traditional Chinese paintings are not only fine arts but also valuable resources for exploring the history of biodiversity[9]. In the collection of the Palace Museum, we found that The Silk Scroll of Three Rats (Fig. 1a–c), painted by Zhanji Zhu (the Emperor Xuanzong of the Ming dynasty) during the Xuande era (1425–1435 AD), shed novel insights into domestication history of brown rat. The scroll consists of three paintings of three rats (Fig. 1a–c) showing the morphological characters of the brown rat[10]. In the two colorful paintings on silk, one rat is an albino (Fig. 1c), presenting a high similarity to ancient Japanese nezumi[6] and modern Wistar rat (Fig. 1d) with white hair and red eyes. The other one is light brown with a golden collar chain (Fig. 1b). Lychee (*Litchi chinensis*), an expensive fruit only produced in remote South China, was used to feed the two rats (Fig. 1b, c), indicating both rats were carefully raised in the imperial palace gardens in Beijing. Given substantial behavior (such as tameness) shifts based on genetic changes in the domestication of rats[1,2,11,12], it was unlikely that the emperor painted wild or tentatively captive brown rats.

The imperial paintings present the earliest evidence of brown rat domestication in China before 1435 AD, more than two centuries older than the record in Japan[1,6]. It is expected to inspire much more interdisciplinary efforts to trace the evolutionary trajectories of human-commensalism and animal domestication from various artworks. Like the situation in Japan[6], the early domesticated brown rat in China likely served as a pet. Population genomic analyses have revealed that inbred laboratory rat strains originated from a single source[11,13], likely carrying genetic components derived from eastern Asian wild brown rats[13]. Demographic history inference suggested that southward human migrations across China between the 800 s and 1550 s AD introduced wild brown rats into Southeast Asia, which were subsequently transported to West Asia and eventually to Europe via maritime trade routes[5]. This scenario raises the possibility that early domesticated rats may have spread, potentially alongside wild brown rats, during the Ming treasure voyages and subsequent maritime trades. Improved demographic inference methods[14] and the growing accumulation of genomic sequencing data, particularly from Japan's rat resources[7] or even qualified ancient DNA[15], hold promise for elucidating the fate of these early domesticated rats.

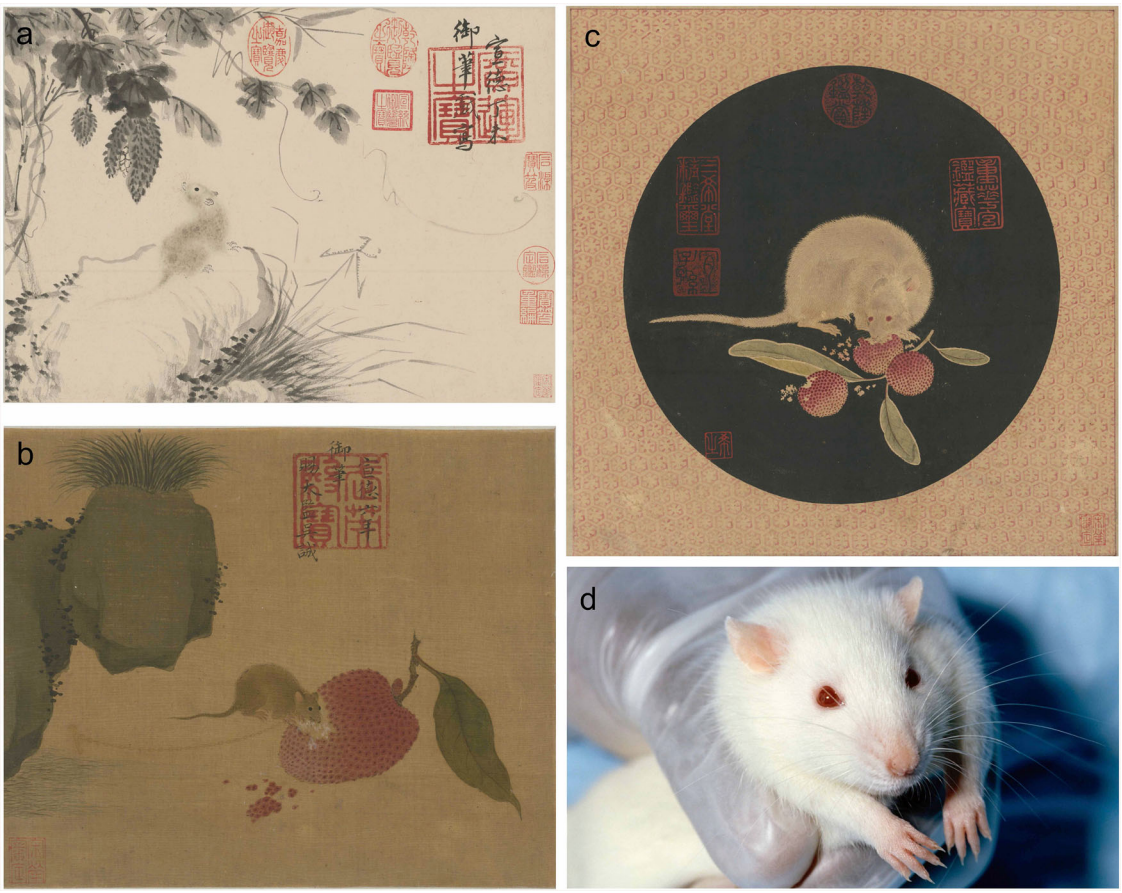

Fig. 1 | The Silk Scroll of Three Rats. The scroll is a collection of the Palace Museum in Beijing (https://digicol.dpm.org.cn, Access Number 新 00146247). It consists of three paintings of rats (**a**–**c**) and one Chinese postscript in a horizontal arrangement. The postscript was written by Jianshen Zhu (the Emperor Xianzong of the Ming dynasty) in 1484 AD. We adjusted the three paintings and removed the postscript for concise. **d** an albino Lobund-Wistar rat in laboratory. This image photographed by Janet Stephens is free of copyright restrictions (https://visualsonline.cancer.gov/details.cfm?imageid=2568).

Data availability

No datasets were generated or analyzed during the current study.

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Author contributions
M.-S.P. and Y.-P.Z. conceived the study and examined the paintings. M.-S.P. drafted the manuscript. W.C. revised the manuscript. All authors read and approved the final manuscript.

Competing interests
The authors declare no competing interests.

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