



Is Yuan in China's Three Gorges a Gibbon or a Langur?

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Abstract

Clarifying the scientific identity of ancient biological names in historical archives is essential to understand traditional knowledge and literary metaphors of animals in human culture. Adopting a cross-disciplinary (Primatology, Linguistics, Historiography, Historical Sociology) analysis, we developed a theoretical framework for studies of the scientific identity of Chinese primate traditional names (e.g., Yuan 猿) throughout history, and interpret the historical evolution of the understanding of the Chinese word Yuan. Presently, the Chinese generally understand Yuan to be a gibbon (or “ape” in a broader sense), but this statement has many contradictions with the understanding of the word in relevant historical discourse. We review and comment on key evidence to support the traditional understanding of Yuan as a gibbon (Hylobatidae) and clarify the historical and current thought concerning Yuan. We find that the referent of the word Yuan has changed from “François’ langur (*Trachypitecus francoisi*) with long limbs” to the “long-armed ape or gibbon” known today through two major changes in the idea of Yuan. One transformation in the conceptualization of Yuan took place during the Tang-Song period, with the other beginning at the end of the nineteenth century and ending in the 1950s. An interaction between the conceptualization of animals and power (e.g., political opportunity; cultural movement toward learning western sciences in the semi-colonial era) played an important role in these two diachronic changes to the idea of Yuan. In contrast to the clear linear relation between a species and its Latin name, our study indicates that one traditional name can represent varying animal species in China. Our findings exemplify the implications of the sociocultural and linguistic basis for the species identification of primate

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names found in historical discourse for historical zoogeography, our understanding of the intricate cultural and religious connections between humans and primates, and efforts to decolonize primatology.

Keywords François' Langurs *Trachypithecus francoisi* · White-headed Langurs *Trachypithecus leucocephalus* · Dynamic semantic triangle · Power and the idea of Yuan · Wildlife names and empire · Decolonizing primatology

Introduction

Names are one of most powerful tools human beings have to identify and label objects, including species (Dolhinow, 2002). The relationship between animal names and their referents is of great significance and traces back to ancient times (Aldrin, 2016; Wang & Qi, 2005). With the help of animals' traditional names, modern researchers can extract historical data concerning the specific animal from historical documents throughout various ages for academic research. For example, long-term, historical records of gibbons (Hylobatidae) or snub-nosed monkeys (*Rhinopithecus* spp.) provide valuable biogeographic information that can help to understand changes in the spatial distribution of species across time (Li *et al.*, 2002; Chatterjee *et al.*, 2012). In an Ethnoprimateological framework, descriptions of nonhuman primates (hereafter primates) in literary narratives are an important tool to understand the human–primate interface over history (Radhakrishna, 2018; Zhang, 2015a). Studies of classic literature that includes primates as a protector, spiritual guide, or deity provide insights into the religious and cultural significance of primates in human culture (Ohnuki-Tierney, 1989; Radhakrishna, 2018). Finally, a comprehensive understanding of the ecological and cultural associations between humans and primates throughout history can help to design an effective strategy to ensure their survival and conservation (Radhakrishna, 2017; Turvey *et al.*, 2015).

The relationship between an animal's name and identity is not always clear or stable, however (Aldrin, 2016). On the one hand, names given to an animal vary with the cultures and perceptions of ethnic groups and populations and as a result of historical and sociopolitical events (Baker, 2013; Leibring, 2016; Rubis, 2020). For example, a recent cultural study reveals that the indigenous name *maias* given to orangutans (*Pongo pygmaeus*) was not as widely used as its western name (orangutan) and Latin name since the mid-nineteenth century as a result of colonization (Rubis, 2020). On the other hand, names used in traditional zoological knowledge describe perceptions of wildlife at the time of writing or naming. It is likely that current referent of a traditional name is not the same as the original identity, and a traditional name can be used to represent a variety of species (Baker, 2013; Li, 2006). Such “dislocation” of traditional animal names corresponding to the identity deepens the misunderstanding of traditional zoological knowledge in historical documents and influences the validity of extracting and

translating traditional knowledge into scientific formats (Alves & Lopes, 2018; Baker, 2013; Masaru, 2005).

China has a long history of civilization and is home to rich biodiversity (Guo *et al.*, 1999; Wei *et al.*, 2021). Although Chinese languages vary in pronunciation when spoken in different dialects, such as Mandarin or Cantonese, Chinese languages share written characters and are based on a common body of literature. Many classic works of ancient China contain traditional names and knowledge concerning animals (Huang *et al.*, 2017; Guo *et al.*, 1999; Wang, 2019). Modern scholars from various disciplines have shown keen interest in the archaeology of the traditional names of animals and plants. For example, biologists (Zhong, 1909; Hu, 1916) and sinologists (Masaru, 2005; van Gulik, 1967) have studied the identities of animal and plant names in historical texts. Since the 1980s, research on the relationship between traditional names and objects (species) has developed rapidly in China (Gao *et al.*, 1981; Guo *et al.*, 1999; He, 1988a, 1993; Huang *et al.*, 2017; Liu, 1980; Li *et al.*, 1989; Wen, 2003; Wang, 2019). These studies identify the objects of traditional names by means of mutual verification between historical textual evidence and scientific knowledge of animals and plants (Gao *et al.*, 1981; He, 1988a, 1993; Wang, 2019; Wen, 2003; Yan, 2020). However, the reliability and justifiability of some case studies have been questioned, based on concerns including a lack of solid theoretical basis, unreliable sources of evidence, insufficient research depth and research methods that are too simple (Sterckx, 2005; Wang, 1999; Yan, 2020; Zhang, 2015b). One highly controversial example is the book *History of Ancient Zoology of China* (Guo *et al.*, 1999) and its critics (Li, 2002; Sterckx, 2005; Wang, 1999).

Currently, there are 28 nonhuman primate species in China (Wei *et al.*, 2021). Frequent interactions and a close relationship between humans and these primates are recorded in ancient texts. Several types of primates, and especially “Yuan (猿 or 媛 or 媛-ape, usually gibbon)” and “Hou (猴-monkey),” have played important and diverse roles in Chinese traditional belief systems and cultures. The generic Chinese primate names have identical pronunciations or spellings to those of the earliest Chinese emperors. For instance, the character 獠 (Nao) is considered as the ancestral name of the royal family of Shang dynasty (商朝 ca. 1600–1050 BCE) (Cao, 1997; Wang, 2001). This word is used to denote a primate species that is good at climbing. Similarly, the character 禺 (Yu) represents a long-tailed monkey. This word is the same as the character 禹 (Yu), a legendary emperor well known for his brilliance in regulating floodwater (Huang, 2011). This association between primates and the earliest emperors indicates a possible totemic status for primates. Today, some people from various ethnic groups (e.g., Han, Qiang, Yi, Zang, Mian, Na Xi, Li Su, Jing Po) still worship monkeys (Yuan Hou) in China, although the scientific identity of these totems remains unclear (Huang, 2011; Wang, 1997). The speculation that primates were used as a totem is consistent with the symbolic existence of primates in important events related to birth and death. Monkeys are one of the Chinese Zodiac Animals. In ancient legends of Taoism, “after noblemen died, they became Yuan,” and “after Yuan reached a thousand years old, they became human” (vol. 4, *Tai-ping-yu-lan* also known as *Tai-ping Imperial Encyclopaedia* 太平御覽). Primates also appear in hymns and on sacrificial utensils in the Pre-Qin period (ca. 2100–221 BCE). One

of the most famous literati of China, Qu Yuan (屈原 ca. 340–278 BCE) wrote the sacrificial song of “Mountain Spirit (山鬼),” which mentioned Yuan and You (狢). Another type of primate, Wei (雌) was selected as an example of symbolic art on sacrificial utensils because of its ascribed moral obligation to look after elders (“*Yuren*” chapter, *Zhou-li* 周礼).

In ancient China, primates played an important role in cultural expressions, such as literature, music, art, Chinese medicine, and ethical codes. Many authors mention primates, especially Yuan, in their literary works. One famous example is the Monkey King Sun Wukong (孙悟空, also known as Xin Yuan or Monkey of the Mind 心猿) in *Journey to the West* (Wu, 2003). In music, Nao is the word of a basic skill in playing Chinese Guqin (古琴), which may stem from its similarity to the animal Nao's vocalizations (Mei, 2003). In art, Chinese painting of Yuan gained popularity in the Song Dynasty (Geissmann, 2008). In Chinese medicine, the ancient Chinese also recorded how they used primate meat, fur, or “Yuan wine” to promote health (Li, 1590; Ning, 1966). Some actions, such as “Arm Fist Boxing (通臂拳)” and “Five-Animal Exercises (五禽戏),” were created through an imitation of Yuan's movements to improve people's health through exercises (Pan & Ma, 2006). “Monkey performance (猴戏)” where macaques are trained to perform some human-like behaviors for secular, popular entertainment is a type of cultural folk drama, although it has gradually disappeared from most areas (Yang, 2008).

After evolutionary theory and science diffused into China in the modern era, scientists began to study primates. Some researchers have tried to link historical literature with modern science and explored primates' traditional names and scientific identities. In these studies, primates in ancient literature are considered to comprise mainly gibbons (Hylobatidae), macaques (*Macaca* spp.), snub-nosed monkeys, and langurs (*Trachypithecus* spp.) (He, 1993; Wen, 2009). The traditional names of these animals have been linked with their scientific identities based on current distributions and historical evidence. You (狢) is considered as a gibbon or snub-nosed monkey (Huang *et al.*, 2017; Liu, 1954; van Gulik, 1967; Wen, 2003), Nao as a gibbon or snub-nosed monkey or macaque (He, 1988a, 1991; Li *et al.*, 1989; van Gulik, 1967), Rong (狢) as a snub-nosed monkey or a callitrichid (Chen *et al.*, 1986; He, 1988a, 1991; Zhao, 1959), Guo Ran (猯然) as a snub-nosed monkey, or red shanked douc (*Pygathrix nemaeus*), or long-tailed monkey (*Cercopithecus* spp.) (He, 1991; Li, 2006; Xue, 1923), and Xing Xing (猩猩) as an orangutan (*Pongo* spp.) or gibbon (He & Wen, 1981; Yang, 2007).

Some descriptions of primates in the historical literature conflict with these assigned identities. For example, authors have generally considered Yuan to be a gibbon when seen in China, except in Guangxi Province where it is sometimes known as a langur (Gao *et al.*, 1981; Guo *et al.*, 1999; He, 1988b; Shou, 1959; Turvey *et al.*, 2015; van Gulik, 1967; Wen, 2009; Wang, 2019). These authors thought that long arms (*Chang Bi* 长臂) and long loud calls (*Xiao* 啸) were strong evidence to identify the traditional description of Yuan as a gibbon (Gao *et al.*, 1981; He, 1988b; van Gulik, 1967). However, other ancient descriptions of Yuan are not consistent with the characteristics of gibbons. For instance, Yuan occurs in caves, often climbs up and down cliffs, calls frequently at dusk and in the evening, and has a tail in some ancient books. Moreover, Yuan is said to be good at leaping (Shahar, 1992;

van Gulik, 1967; Wang, 1522; Zhang, 2015a). These descriptions contradict current knowledge of the ecology and behavior of gibbons, making the identification of Yuan as a gibbon questionable.

Study Aim and Approach

We attempted to untangle the complex relationship between the Chinese Yuan and its species identity throughout history. By means of comparative analysis of established scientific knowledge and unpublished data regarding potential candidate species corresponding to the historical evidence, we suggest a new identity that better explains the historical description relevant to the traditional understanding of Yuan. This new identity contradicts the current concept of Yuan in two ways: long arms and taillessness. To explain how these contradictions arose, we trace the key historical references and diachronically analyze important transformations of the interpretations of Yuan. Our holistic approach combines Primatology, Linguistics (Semantics), and Historiography (Chinese historiography, Conceptual history, Archaeology of knowledge), and Historical Sociology (Sociocultural analysis) and is based on multiple sets of evidence (Dong, 2017; de Stefani, 2016; Fleagle, 1999; Foucault, 1972; He, 1999; Huang, 2012). We used publications in primatology to provide empirical evidence for comparison with historical words and statements. From 2008, one of the authors made direct observations of *Rhinopithecus brelichii* and *T. francoisi* in long-term studies (Niu et al., 2010, 2016), and *T. leucocephalus*, *Macaca mulatta*, *Hoolock tianxing* in a few short field visits (*H. tianxing*, Fan et al., 2017; *T. leucocephalus*, Zhou & Huang, 2021). This study of primate species and

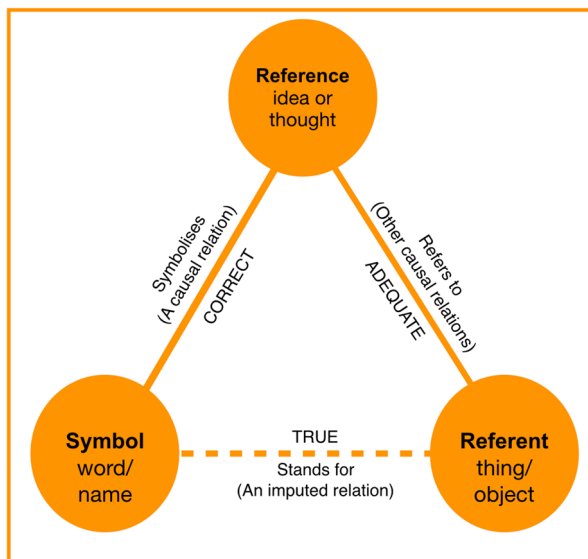


Fig. 1 Semantic Triangle (modified from Ogden & Richards, 1923)

their habitats brings direct observations and scientific data (e.g., vocal data) to help understand the traditional knowledge of these primates in China. The multiple types of historical evidence that we used include the meaning of some Chinese characters (e.g., from dictionaries), historical texts (e.g., historical records from local gazetteers), and cultural texts (e.g., descriptions from poems). We used online sources to search and analyze the cultural texts (Souyun Website, 2019). We included information (author, time periods, academic, and/or political background of the author) on the ancient sources in Electronic Supplementary Material (ESM) Table S1.

There is to date no coherent, satisfactory theory in identifying the identity of animals' traditional names (Aldrin, 2016; Yan, 2020). In linguistic theory the semantic triangle (Fig. 1; Ogden & Richards, 1923) distinguishes between symbols (words or names), references (ideas or thoughts), and referents (objects or things). To clarify the relationship between an animal's name and identity, we design a Dynamic Semantic Triangle theoretical framework, which differs from the current static views. We describe a three-component union of word-reference-referent for Yuan and primatological evidence suggesting a new interpretation of the name. Our explanatory framework consists of two subsystems: (1) A Static Subsystem to explain the relationship among symbol, reference and referent in a single semantic triangle; (2) A Dynamic Subsystem to compare the different concepts (and/or referents) of animal names between Static Subsystems.

We use this approach to show a dynamic interpretation of references and referents of Yuan throughout Chinese history. First, we challenge the conclusion that Yuan is a gibbon (Gao *et al.*, 1981) by using primatological data. Next, we clarify the misinterpretation of historical evidence in previous studies (Gao *et al.*, 1981; van Gulik, 1967) and provide a new interpretation of Yuan in Guangxi province. Through multiple sets of evidence, we show that the identities of Yuan in the Three Gorges and Yuan of Guangxi province are consistent. We then address a long-standing mystery: Does Yuan (the animal) have very long arms in ancient China (He, 1988b; Shou, 1959; van Gulik, 1967)? By critically analyzing multiple types of evidence, we find that the descriptor of "very long arms" is a distortion of the image of Yuan. We explain the historical transformation of Yuan's image between ancient and modern times and explain why and how the referent of Yuan changed from langurs to gibbons in early modern China. Finally, we present a dynamic model to explain on the diachronic concepts and referents of the Chinese Yuan throughout history and discuss the theoretical issues of identifying referents of those generic names and their implications for science, culture, and conservation.

Identity of Yuan in the Three Gorges Area

In 1967, Dutch sinologist Robert Hans van Gulik (高罗佩 1910–1967) studied Yuan in Chinese traditional culture from a Western viewpoint (van Gulik, 1967). The author considered Yuan to be a gibbon (Hylobatidae) in China. Pioneers of Chinese historical biogeography and zoology studied Yuan in Chinese poet Li Bai's (李白 701–762 CE) poem *Setting off Early from Baidi City* (早发白帝城: Fengjie, Chongqing City to Jingzhou, Hubei Province; Fig. 2) and other ancient (before 1840) documents and poetry and concluded that the traditional understanding of

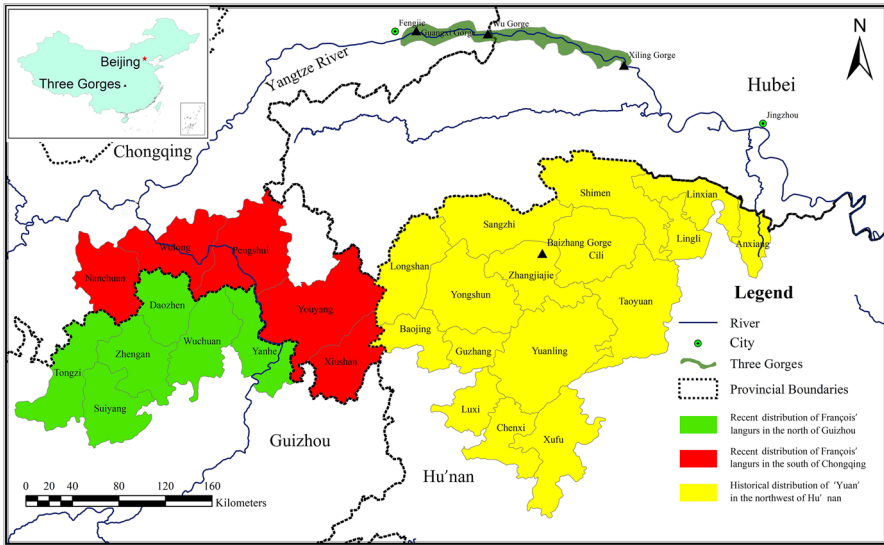


Fig. 2 Map of the Three Gorges area of the Yangtze River showing the locations of the Three Gorges, and the historical distribution area of Yuan in the northwest of Hu'nan connected to the recent distribution area of the François' langur in the south of Chongqing and the north of Guizhou

Yuan was indeed a gibbon (Gao *et al.*, 1981; Liu, 1980; Shou, 1959). This view has been generally accepted by scientists, translators, and the public (Chatterjee *et al.*, 2012; Fan, 2017; Geissmann, 2008; He, 1988b; Huang *et al.*, 2017; Lan, 1992; Quan *et al.*, 1981; Turvey *et al.*, 2015, 2018; Wang *et al.*, 2000; Wang, 2019; Wen, 2009; Zhang, 2015a). However, there was a lack of understanding of the primates found in China when these studies were published and several inferences that Yuan is a gibbon are not convincing. We review historical and primatological evidence related to the vocalizations, distribution, habitat, and behavior of Yuan in the Three Gorges area of the Yangtze River and in the northwest of Hu'nan, which suggest that Yuan is more likely to be a François' langur (*T. francoisi*) than a gibbon.

Historical Evidence

A black Yuan holding an infant (玄猿抱子) observed and recorded by the general of Shu Kingdom Deng Zhi (邓芝 178–251 CE) in the Fuling area supports the identity of Yuan as a langur (vol. 60, *Yi-wen-ju-lei* 艺文类聚; vol. 348, *Tai-ping-yu-lan*). This description of the fur coloration does not match the characteristics of a female gibbon, but it is consistent with those of the female François' langur. Fuling mainly corresponds to modern time Pengshui County and Youyang County in the south of Chongqing City (Fig. 2), and there are still some Endangered François' langurs in this area (Nadler *et al.*, 2020; Su *et al.*, 2002; Wang *et al.*, 1999).

Another key piece of historical evidence comes from the *Sinan fu* chapter of *Guizhou-tu-jing-xin-zhi* (弘治贵州图经新志). *Sinan fu* mainly refers to present-day Sinan County, Yanhe County, and Wuchuan County in Guizhou Province (Fig. 2). In this chapter, the authors state that there were Yuan in the northeast of Guizhou Province, close to the Three Gorges area, describing them as “Yuan, black and there is hair like a bun on the head (猿, 黑色, 首有丛毛如髻).” According to the description of Yuan’s ornamentation, Yuan is the François’ langur. This identification is consistent with the current distribution of langurs in this area (Li & Huang, 1993; Niu *et al.*, 2016: Wuchuan County, Yanhe County). As one of the earliest gazetteers of Guizhou Province, this book might have influenced subsequent gazetteers of this region. Thus, Yuan more likely represents the François’ langur in Guizhou Province.

Yuan’s Vocalizations

In “A Note on Jingzhou (荆州记)”, it states that: “at the beginning of a sunny day with morning frost, Yuan often has long calls with a higher position in a cold and quiet forest.” Gao and his coauthors (Gao *et al.*, 1981) interpreted this as Yuan making calls in the morning, and other poets added that the calls of Yuan also could be emitted at sunset (Code 1–3 Table S2) and in the evening (Code 4–6 ESM Table S2). However, more than 90% of gibbon songs are produced between 30 minutes before and 3 hours after the sunrise (Fan *et al.*, 2010: 187 days; Fei *et al.*, 2010: 228 days), and scientists have not recorded gibbon songs in China at sunset (5:00–7:00 p.m.) or after dusk (later than 7:00 p.m.) (Table 1).

In contrast, François’ langurs in Guizhou, China, make long loud calls in the morning (between 6:25 a.m. and 9:05 a.m.) and late afternoon (between 3:21 p.m. and 5:35 p.m. in winter) (Niu KF’s unpublished data). Similarly, a species closely related to the François’ langur, the Haitinh langur (*Trachypithecus hatinhensis*) in Vietnam makes loud calls in the morning (between 5:00 a.m. and 6:00 a.m.) and late afternoon (between 4:00 p.m. and 5:00 p.m., Haus *et al.*, 2009). This vocalization pattern coincides with several descriptions of the calls of Yuan in the early morning and at sunset or dusk (Code 7–9 ESM Table S2). Moreover, the long loud calls of François’ langurs can be heard from afar even if there are other competing noises

Table 1 Latest time of day that gibbons in China are observed to sing

Species	Latest time used for singing (daytime)	Reference
<i>Hoolock tianxing</i>	12:12 p.m.	Wu <i>et al.</i> , 2016
<i>Hylobates concolor</i>	mostly before 9:30 a.m.	Jiang & Wang, 1997
<i>Nomascus concolor</i>	12:14 p.m.	Li <i>et al.</i> , 2011
<i>Nomascus nasutus</i>	before 2:00 p.m.	Fei <i>et al.</i> , 2010
<i>N. nasutus</i>	2:38 p.m.	Zhang <i>et al.</i> , 2011
<i>Nomascus hainanus</i>	sunrise after 4 h (before 1:00 p.m.)	Deng <i>et al.</i> , 2014; Yang Tianyou, personal communication

in their habitat (Wu *et al.*, 1987). These observations contradict with Gao and colleagues' assumption that only gibbons sing loudly and are heard in the valleys.

In addition, the vocalization of Yuan is often described as “three types of notes in one call (一鸣三声)” (Gao *et al.*, 1981), giving off a sad or sorrowful feeling (Code 10–12 ESM Table S2). Fan Chengda (范成大 1126–1193) wrote that “Yuan emitted two or three calls on the upper branch in the tree (三声两声高树梢)...Occasionally one long loud call with a sad feeling can be heard (忽作哀厉长鸣号)...(Listening to Yuan at Bachangping 八场坪闻猿).” Li Shizhen (李时珍 1518–1593) wrote that “the male Yuan can be good at calling, and makes a call composed of three different types of notes.” Cui Zhongfang and Shi Rugong also recorded the long and short calls of Yuan mixed together in their poems (Code 13–14 ESM Table S2). François' langurs emit both long and short loud calls, which fit the descriptions of Yuan.

To describe the call structure of François' langurs, we collected the loud calls of an adult male at Mayanghe National Nature Reserve in Guizhou, China, using a video camera Sony HDR–CX160 at 08:19 a.m. on 4 January 2015. We documented the short and long loud mixed calls (Code 13–14 ESM Table S2) using Adobe Audition CC in MacBook Pro (Fig. 3) and produced spectrograms using Praat 6.1.06 software (Fig. 4). We found three types of sounds in the long loud calls, which can be described as a Harsh bark (a), Whoop unit (b), and Residual unit

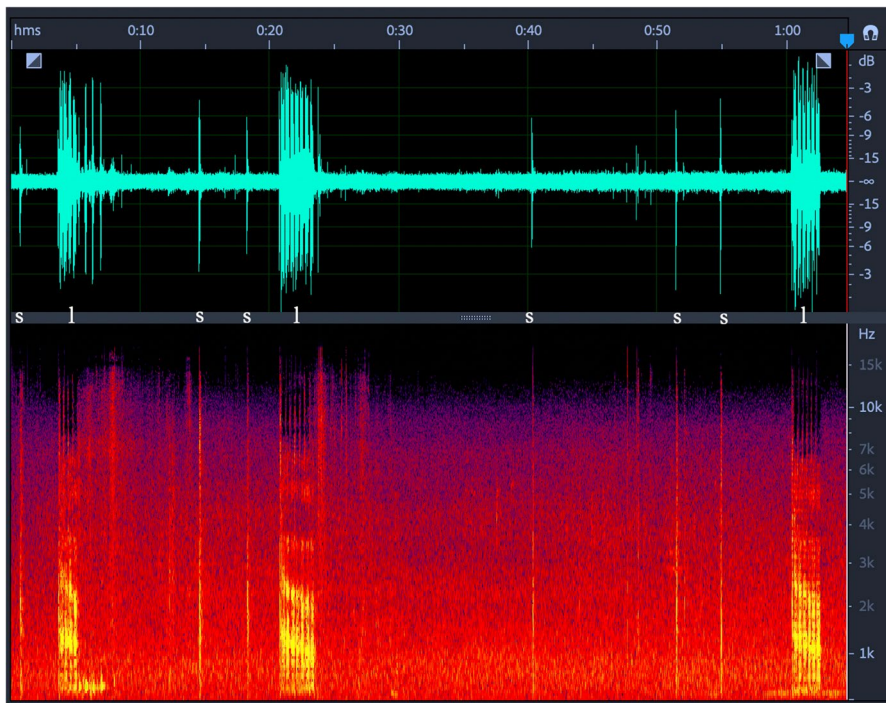


Fig. 3 Series of loud calls by an adult male François' langur (s: short loud call; l: long loud call). (Mayanghe National Nature Reserve in Guizhou, China on 4 January 2015)

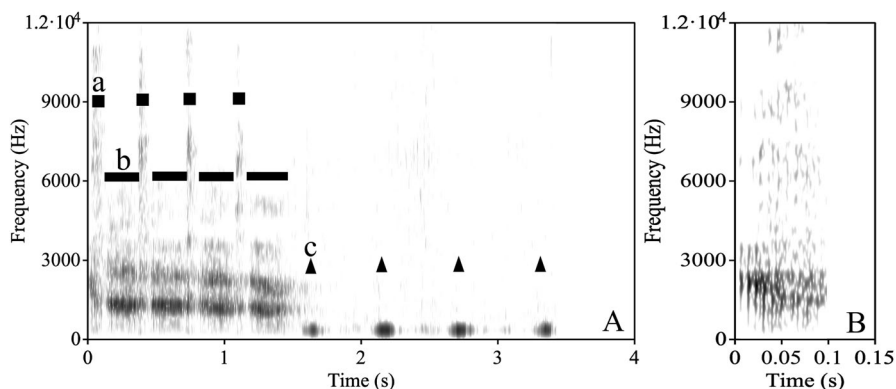


Fig. 4 Spectrograms of a long loud call (**A**) and short loud call (**B**) by an adult male François' langur. Typical long loud call comprising of Harsh bark (**a**), Whoop unit (**b**), Residual unit (**c**). (Mayanghe National Nature Reserve in Guizhou, China on 4 January 2015)

(c). The Residual units sound like “ao-ao,” which is mentioned in some poems (Code 2, 4 ESM Table S2). In contrast, the vocalizations of gibbons are continuous and complex (Fan *et al.*, 2009, 2010), making it impossible to distinguish as a stable call type composed of three types of notes or three syllables (van Gulik, 1967). For example, adult male Western black crested gibbons (*Nomascus concolor*) usually emit boom, aa notes, and modulated phrases, whereas adult females produce great calls. Adult males and females also produce complex duets (Fan *et al.*, 2010).

Distribution of Yuan

Gao *et al.* (1981) drew inferences from the purported distribution of Yuan (gibbons) in the Northwest region of Hu'nan Province, China, to support the existence of Yuan (gibbons) in the Three Gorges area. However, the distribution of Yuan (gibbons) in Hu'nan Province is questionable, because it does not fit the description that Yuan is good at climbing in this province (He & Huang, 2010; He, 1988b). Historically, the northwest of Hu'nan was in the hinterlands of the Tujia ethnic region and the counties of Lizhou, Anxiang, Shimen, Linli, Cili, Dayong, Yongshun, Longshan, Sangzhi, Baojing, Guzhang, Taoyuan, Yuanling, Luxi, Chenxi, Xupu in this area have recorded Yuan (Fig. 2) (He, 1988b; Wang, 2013). We reviewed the recent (1980 to present) distribution (by county) of the François' langur in the north of Guizhou and the south of Chongqing (Li & Huang, 1993; Niu *et al.*, 2016; Su *et al.*, 2002; Wang *et al.*, 1999; Zhang *et al.*, 1992) and historical records of Yuan in the northwest of Hu'nan Province extracted from several publications (He, 1988b; Wang, 2013). We analyzed the spatial relationship between the historical distribution of Yuan in the northwest of Hu'nan and the distribution of langurs in Chongqing and Guizhou using ArcGIS10.2 (Fig. 2). We discovered that this area is connected to the recent distribution area of the François' langur in the south of Chongqing and the north of Guizhou. This evidence indicates that there was a continuous geographical

distribution of the François' langur in these areas in the past. Hence, in contrast to Gao *et al.* (1981), we suggest that Yuan in the northwest of Hu'nan is the François' langur instead of a gibbon.

Habitat and Behavior

Terms, such as “snow Yuan” and “cold Yuan,” often are seen in poetry. Phrases like “Yuan is calling in a snowy forest near the Gorge (雪林猿叫峡)” also are used. These references appear to indicate that Yuan can survive in a cold climate. In the present day, gibbons can be found in subtropical forests as far as 24.5–25.8° north (Fan & Jiang, 2008; Fang *et al.*, 2020). The temperature reaches a low of $-2\text{ }^{\circ}\text{C}$ at Mt. Wuliang (Fan & Jiang, 2008). In contrast, François' langurs can tolerate temperatures as cold as $-8\text{ }^{\circ}\text{C}$ in the forests of Guizhou and $-14.4\text{ }^{\circ}\text{C}$ in the forests of Chongqing (approximately 29° north) (Liu *et al.*, 2017; Tang & Zhang, 1994; The Investigation Team of Guangxi Rare Animals Resources, 1979). This further suggests that Yuan more likely represents a François' langur than a gibbon.

Low temperature also limits food resources for arboreal primates. Primates living in such a climate may rely on fallback foods on the ground to survive in the winter. Gibbons rarely move on the ground and are unlikely to forage terrestrially, unlike snub-nosed monkeys (*Rhinopithecus*) or limestone langurs (Ren *et al.*, 2000; Zhou *et al.*, 2012). Again, this adds further evidence for Yuan more likely being a François' langur than a gibbon.

Yuan often was observed in the Three Gorges area. For instance, Yuan was recorded in the Wu Gorge (巫峡) and Guangxi Gorge (广溪峡, *Shui-jing-zhu* 水经注, *Commentary on the Water Classic*) in Chongqing, and also occurred at Baizhang Gorge (百丈峡) in the northwest of Hu'nan (Gao *et al.*, 1981; He, 1988b, Code 12 ESM Table S2; Fig. 2). The landscape of Yuan's habitat is often riverside cliffs (Code 15–20 ESM Table S2) and Yuan was noted to live in caves (Code 21–23 Table S2). These settings are not the typical habitats of extant gibbons. Currently, gibbons mainly inhabit montane evergreen or semievergreen broadleaf forests (Fan & Jiang, 2008; Fan *et al.*, 2013a; Nadler & Brockman, 2014). They have not been observed to use cliffs and caves as their primary activity places and sleeping sites, although one gibbon species, the Eastern black-crested gibbon (*Nomascus nasutus*), lives in limestone forest (Fan *et al.*, 2013a; Fei *et al.*, 2012). Black-crested gibbons sleep in tall trees (Fan & Jiang, 2008; Fei *et al.*, 2012). The main locomotor mode of gibbons is brachiation, which involves climbing a vertical support (Fan *et al.*, 2013b). Hence, gibbons cannot brachiate on cliffs. In contrast, the habitats of François' langurs are comprised of caves and cliffs and often are distributed along rivers in the tropical and temperate zones (Li & Huang, 1993; Niu *et al.*, 2016; Su *et al.*, 2002). As a skilled climber of cliffs, François' langurs align more with the identity of Yuan than gibbons do. François' langurs also sleep in caves and are adept at vertical climbing and leaping on cliffs (Chen *et al.*, 2020; Grueter & Ding, 2006; Zhou *et al.*, 2012). The use of cliffs and caves by Yuan is a strong indication that Yuan is a François' langur. Finally, some ancient texts describe drinking behavior in Yuan: “a group of Yuan climbed down from the top stone when they are thirsty (欲饮, 自高崖累累相援而下)” (He & Huang, 2010; Li, 1590; van Gulik,

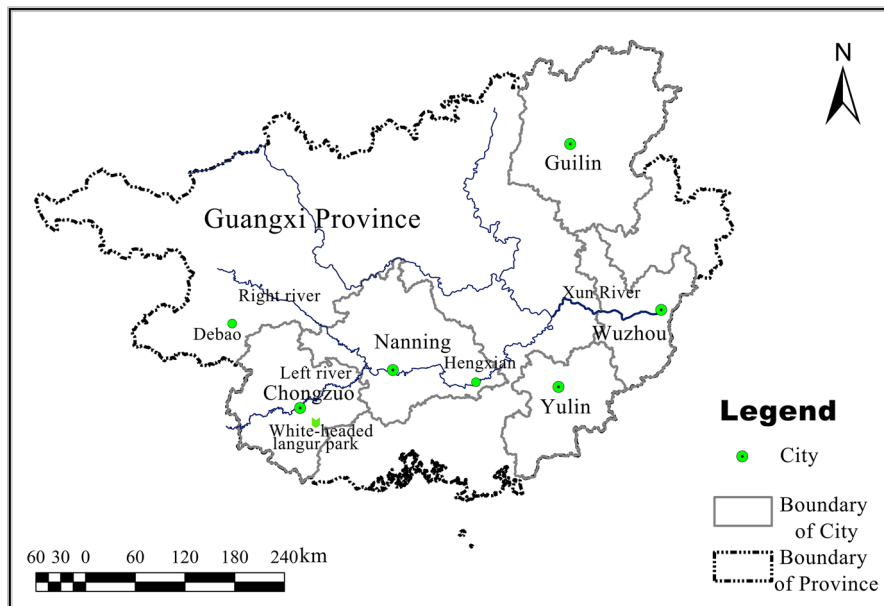


Fig. 5 Historical records of Yuan in Guangxi Province, China used in this study

1967). This description is very similar to the drinking behavior of François' langurs. Instead, the gibbon typically procures water from holes in tree trunks or indirectly by the ingestion of certain plant parts (Sharma *et al.*, 2016).

Identity of Yuan in Guangxi Province

In the Southern Song dynasty (南宋 1126–1279), Fan Chengda recorded the animals and plants found in Guangxi Province in the book *Gui-hai-yu-heng-zhi* (桂海虞衡志, *Record of the Forests and Marshes of the Gui region*), which was finished in 1175 (Fig. 5, Qi, 2007; Zhang, 2003). One detailed entry on Yuan reads: “There are three types of Yuan: the “jin-si (jin-si means “golden”) Yuan” with a yellow face, the “yu-mian (yu-mian refers to “the white appearance of the head”) Yuan” with a black face, and the purely black one also with a black face. The golden Yuan and the yu-mian Yuan are rare to observe. It was said that the black one is the male, and the golden one is female. Or the male can emit a long loud call while female will not (猿有三种: 金丝者黄, 玉面者黑, 纯黑者面亦黑。金丝、玉面皆难得。或云纯黑者雄, 金丝者雌。又云雄能啸, 雌不能也。” Here, the first sentence consists of a main clause and three subordinate clauses. This sentence has an unusual grammar structure in ancient Chinese due to a kind of ellipsis that leaves out the word “face (mian)” in the first two subordinate clauses (Sun, 2007). We added and underlined the omitted words “face (mian)” in our translation. Fan’s explanation of “three types of Yuan” had a great impact on people’s understanding of Yuan in Guangxi, Guangdong, and Hainan provinces. It influenced famous authors, such as Zhou

Qufei (周去非 1134–1189, the author of *Ling-wai-dai-da* 岭外代答), Li Shizhen (the author of *Compendium of Materia Medica*), and Qu Dajun (屈大均 1630–1696, the author of *Guang-dong-xin-yu* 广东新语). Gazetteers also were influenced by Fan's description (e.g., *Heng-zhou-zhi* 横州志, with Heng-zhou roughly being modern Hengxian County; *Jian-wu-zhi* 建武志, with Jian-wu roughly being modern South Nanning City). For instance, *Jian-wu-zhi* recorded that “the main distribution area of many Yuan was along the Left river and Right river in Nanning City (Fig. 5), Guangxi Province in the end of Southern Song dynasty.” Here, Yuan was described in exactly the same way as Fan's three types of Yuan. In addition, “three types of Yuan” was cited in the Qing era work, *Qiong-zhou-fu-zhi* (琼州府志) to record the primate species of Hainan Island. To identify Yuan of Hainan Island, Gao *et al.* (1981) explained Fan's descriptions of “three types of Yuan” in *Qiong-zhou-fu-zhi*. They wrote:

“Here three types of Yuan are actually the Hainan gibbon. Their fur color can vary across their age and sex. The purely black one is the male adult Hainan gibbon, the golden one is the female adult Hainan gibbon, and the yu-mian one is the juvenile or subadult (of this species).”

According to Fan Chengda, “the golden Yuan has a yellow face.” However, the female adult Hainan gibbon (*Nomascus hainanus*) known today has a black face and is not consistent with Gao *et al.* (1981)'s inference. Hence, it appears that Gao *et al.* (1981) misunderstood “three types of Yuan” as Hainan gibbons. The grammar in Fan's sentence quoted above may be the cause of this misinterpretation. This issue of syntactic structure was noted in van Gulik (1967), who thought that the original text of Fan's descriptions was incomplete.

Combining information on the distribution of the “three types of Yuan” and phenotypical traits, such as the color of their fur and face, we suggest that Yuan in Guangxi Province is more likely a limestone langur (*Trachypithecus*) than a gibbon. In Guangxi, limestone langurs are traditionally known as Yuan (He, 1993; Ning, 1966; Turvey *et al.*, 2015). The François' langur is called “black Yuan (乌猿),” whereas white-headed langurs (*T. leucocephalus*) are known as “white Yuan (白猿)” or “white-headed black Yuan (白头乌猿)” (Ning, 1966; Fig. 6). These langurs were preferred when making Guangxi “Yuan wine” in the past (Huang *et al.*, 2002; Ning, 1966). Below we provide a brief interpretation of each type of Yuan.

Black Yuan with Black Face

The *Guang-xi-tong-zhi* (广西通志, Jiaqing edition 1801) records that: “The black Yuan is black, with white cheeks and a long tail. People often breed it.” This description is consistent with the François' langur. In another book, *Yan-pu-za-ji* (檐曝杂记), Zhao Yi's (赵翼 1727–1814) record of a black Yuan in a cave at Duxiu hill (独秀山) in Zhen'an (镇安, which mainly refers to modern Debao County, Fig. 5) is unlikely to be a gibbon (van Gulik, 1967), because gibbons have not been reported to be found in caves in modern primatological studies. In contrast, all these records are consistent with the appearance and cave-dwelling habits of the François langur

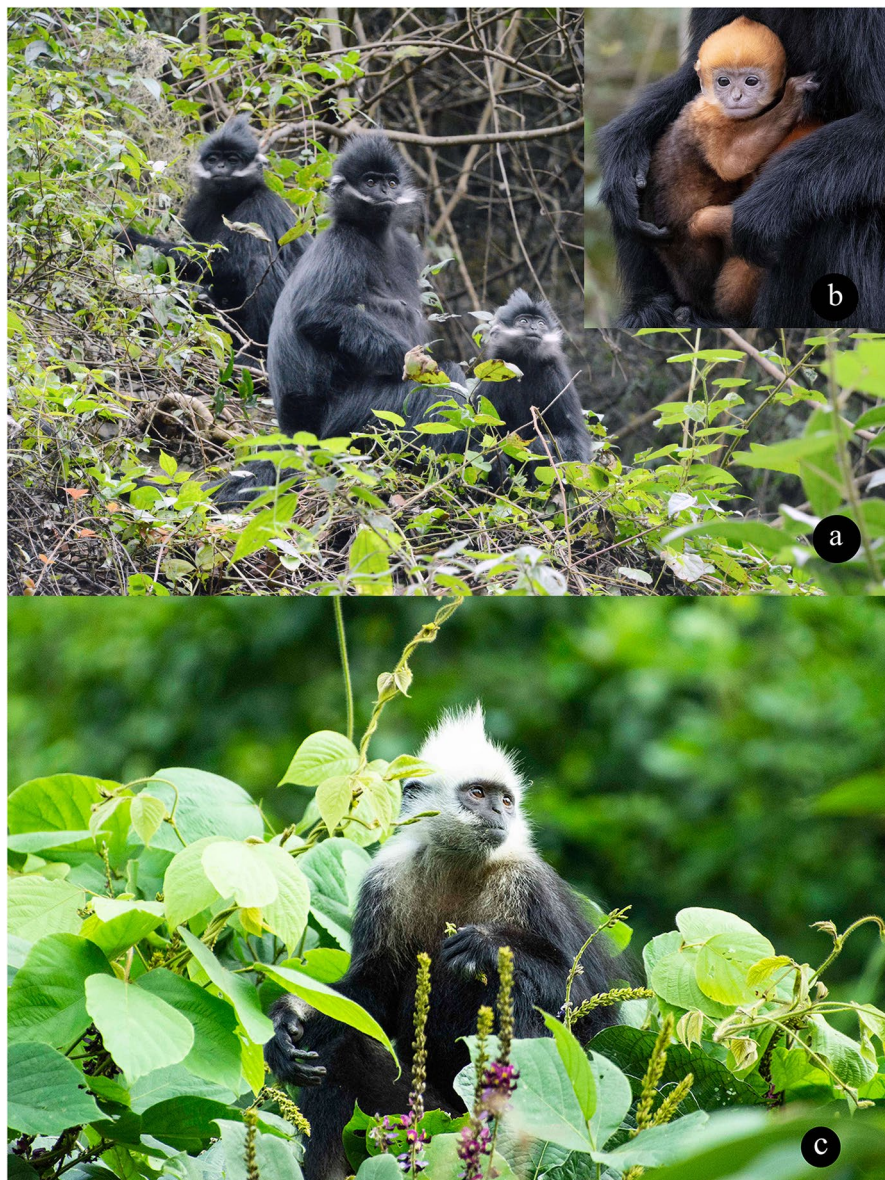


Fig. 6 a-b Adult and infant François' Langur *Trachypithecus francoisi* (photos by K. Niu [a] and X. Yan [b]); c Adult white-headed Langur *Trachypithecus leucocephalus* (photo by K. Niu)

in this area. Thus, the black Yuan with a black face is more likely to be the François' langur (excluding the infant langur) than a gibbon.

Yu-Mian Yuan with Black Face

“Yu-mian” in ancient Chinese can be translated as “pretty appearance” or “white face.” Because the color of the face is emphasized as black in Fan’s sentence, “yu-mian” is more likely referring to the white appearance of the head, not the white face. This agrees with the meaning of “mian” in ancient Chinese. The *Shuo-wen-jie-zi* (说文解字, *Explaining Graphs and Analyzing Characters*) (100–121 CE) describes “mian” as “the front of yan 颜,” with “yan” meaning forehead. This type of Yuan can be easily linked to the white-headed langur in Guangxi Province.

In addition, a Yuan with white fur and a black face was described in Wang Ji’s *Jun-zi-tang-ri-xun-shou-jing* (君子堂日询手镜, *Hand-held mirror for daily inquiries in the gentleman’s hall*). In this book, Wang (1522) wrote: “One Yuan was caught by a local to present to an elephant-trainer, Commander Deng, in the past. Yuan’s face is black and the fur of body is white. And on the top of its head, a black streak of about one finger’s width that ran all down its spine.”

van Gulik (1967) analyzed this description of Yuan and suggested that Yuan with a black face and white fur in the south of Nanning, Guangxi Province, must be the black-crested gibbon. However, this type of Yuan was more likely to be a white-headed langur or an albino langur, because some individuals among the white-headed langurs near Nanning City, Guangxi, indeed have a narrow strip of black fur on the top of their heads (The Investigation Team of Guangxi Rare Animals Resources, 1979), unlike the black-crested gibbon whose crown spots are much wider and whose coat is yellow. The first author of this manuscript confirmed that the hair on top of the head in some individuals of the white-headed langur is black based on direct observations in the Chongzuo White-headed Langur Park in Guangxi Province in 2019. Furthermore, the *Zhen-an-fu-zhi* (镇安府志, Guangxu edition, 1892) mentioned that one of the “three types of Yuan” in Guangxi Province had a white head. Thus, the yu-mian Yuan appears to be the white-headed langur (excluding the infant langur).

Golden Yuan with Yellow Face

The “golden Yuan” (jin-si-yuan 金丝猿) is likely to be the golden infants of *Trachypithecus* langurs. Infants François’ and white-headed langurs are gold with yellow faces, whereas female gibbons have black faces. The golden Yuan is described as “a golden Yuan with an entirely golden body” in the *Yue-xi-ou-ji* (粤西偶记). In a recent survey, several people from a monkey worship clan of the Yi ethnic group living in Wuliangshan Reserve referred to infant Indochinese gray langurs (*Trachypithecus crepusculus*) as the gray golden monkey (hui-jin-si 灰金丝, Cao Yuanming unpublished data). Hence, golden Yuan appears to be an infant langur.

Fan Chengda was asked to change his position from the Governor of Guangxi to the Governor of Chengdu (a city in Sichuan Province) in 1174. On the way to Chengdu, he observed a Yuan at Bachangping in the Three Gorges and recorded

Yuan in poetry (Listening to Yuan at Bachangping). This suggests that Yuan in Guangxi (*Gui-hai-yu-heng-zhi*) and Yuan in Three Gorges are *Trachypithecus* langurs, because Fan used the same character Yuan to write about them. An earlier poet, Tao Bi (陶弼 1015–1078), also suggested that Yuan in Guangxi are the same as those at the Three Gorges. When he visited Cangwu (currently known as Wuzhou City in Guangxi Province) in Guangxi Province, he wrote that “the water here looks like the river in Hu’nan and the sound of Yuan here is the same as those at Bashu (水有潇湘色, 猿同巴蜀听).” Here, “Bashu” mainly refers to modern Chongqing City and Sichuan Province, including the Three Gorges area. Thus, Yuan at the Three Gorges appears to be the same as those in Guangxi Province. Our interpretation of Yuan in Guangxi Province as a François’ langur is consistent with Fan’s and Tao’s opinions.

On Yuan’s Long Arms

Yuan’s long arms are one of the most important features for modern researchers to identify Yuan as a gibbon, because gibbons have longer arms than legs (He, 1988b; Shou, 1959; van Gulik, 1967). However, these features need further clarification. First, the initial description of Yuan’s limbs was given during the Jin dynasty (265–420 CE). The Jin period scholar Guo Pu (郭璞 275–324 CE) made notes about Yuan, which were recorded in the *Shan-hai-jing* (山海经 *The Classic of Mountains and Seas*) as follows: “Yuan resembles a Mi Hou (猕猴, most likely representing macaques: See the name Qie 擘 in chapter *Shi-shou*, *Er-ya-zhu* (Guo Pu). Guo thought that the mammals in the Mi Hou category had cheek pouches that were used to store food) but is larger, and its arms and legs are longer (*Bi Jiao Chang*). Yuan also is nimble. It can be black or yellow. Its call sounds sorrowful (*Shan-hai-jing-zhu* 山海经注: 猿似猕猴而大, 臂脚长, 便捷, 色有黑有黄。鸣, 其声哀).” Thus, the original descriptions of Yuan defined it as having long limbs rather than only long arms. Second, He (1988b) wrote that Yuan’s arms are long because its arm bones can be made into a flute. However, the length of the bone used in flutes can vary (Editor, 2013: 6–10 cm; Hao, 2000: 14.9 cm; Zhao, 2015: 20 cm). Thus, this statement does not provide strong evidence that Yuan has very long arms. Third, Wang Ji (王济 unknown–1540) recorded that the arms of Yuan were not as long as those of gibbons through direct observation of captive Yuan and questioned the views of his predecessors concerning the length of Yuan’s arms (Wang, 1522). Because scholars often ignored direct observations of species in ancient China (Sterckx, 2005; Zhang, 2015a), the evidence from Wang Ji is arguably more trustworthy. To clarify the contradictions about Yuan’s arms, we made a diachronic study of the history of the interpretations of Yuan, particularly relating to Yuan’s arms, from the Western Han dynasty (206 BCE–9 CE) to present.

Before the Tang Dynasty

Sima Qian (司马迁), a famous Western Han historian (145 BCE–unknown) in the chapter *Li Guang* (史记·李广传), *Shi-ji* (史记, *The Records of the Grand Historian*)

said: “Guang has ‘Yuan arms (*Yuan Bi* 猿臂),’ he is adept at shooting arrows (广为人长猿臂, 其善射).” This means that Guang, who was widely known as General Li Guang, had a pair of arms like those of Yuan; thus he was a talented bowman. He was even crowned as the “Yuan-armed General.” Since then, in China’s literary history, *Yuan Bi* has become a specialized term to describe someone with supple arms.

Several of the earliest dictionaries did not mention arm length when describing Yuan. For example, the *Er-ya* (尔雅 *Approaching Refinement*, ca. 350–450 BCE) states that Nao Yuan is good at climbing (猿猴善援) (“Nao Yuan” refers to the same animal as Yuan: van Gulik, 1967). The *Shuo-wen-jie-zi* (说文解字 *Explaining Graphs and Analyzing Characters* 100–121 CE) defines Yuan as “Yuan, good at climbing (猿, 善援).” The Jin dynasty scholar Guo Pu made an important early description of Yuan arm and leg length on and was later frequently cited by authors in various dynasties. Gu Yewang’s (顾野王 519–581 CE) *Yu-pian* (玉篇) goes: “Yuan resembles a Mi Hou (most likely representing a monkey: van Gulik, 1967; Zhang, 2015a) but larger; it can emit long, loud calls.” *Xiao-zi-zhuan* (孝子传 *Accounts of Filial Offspring*) written by Zhou Suoshi: “Yuan is a mammal of Fei (monkey: Li, 2006; one type of human-like animal: Huang et al., 2017) group, either yellow or black, ..., good at climbing, and is skilled in calling (猿, 狝属也, 或黄或黑, ..., 善缘妙吟).” [The exact date of the birth and death of the author are unknown, but it is certainly before the Sui dynasty (589–617 CE), *Tai ping Imperial Encyclopaedia*]. Thus, long arms were not used as an important feature to describe Yuan before the Tang dynasty.

During the Tang Dynasty: A Conceptual Change in Yuan

During the Tang dynasty, references to Guo Pu’s description led to a different understanding of Yuan. This change was noticed by the Qing dynasty scholar Hao Yixing (郝懿行 1757–1825). To show this change more clearly, we present Hao’s comments in his *Shan-hai-jing-jian-shu* (山海经笺疏), with the Tang dynasty’s Li Shan’s (李善 630–689 CE) and Li Xian’s (李贤 655–684 CE) commentaries:

Li Shan’s commentary on *Zhao-ming-wen-xuan*, *Selections from Zhao Ming* [see Ban Gu (班固)’s *Xi Du Fu* (西都赋 vol. 1)]: “Yuan resembles a Mi Hou (most likely representing macaques: Zhang, 2015a) but is larger, and its arms are longer (*Bi Chang*). Yuan also is nimble and black (猿似猕猴而大, 臂长, 便捷, 色黑).”

Li Xian’s commentary on *Hou-han-shu*, *History of Later Han* (Ban Gu’s *Xi Du Fu* vol. 40): “Yuan resembles a Mi Hou but is larger, and its arms are longer (*Bi Chang*). Yuan also is nimble and black.”

Hao’s comment in his *Shan-hai-jing-jian-shu*: “The *Shuo-wen-jie-zi* states: ‘Yuan, is adept at climbing and belongs to the group of Yu.’ The *Zhao-ming-wen-xuan-zhu* (Li Shan’s commentary on *Zhao-ming-wen-xuan* 昭明文选李善注) and *Hou-han-shu-zhu* (Li Xian’s commentary on *Hou-han-shu* 后汉书李贤注) record: ‘Yuan is nimble and its arms are long.’ There is no mention of the word ‘legs.’ It can be black, and they (Li Shan and Li Xian) did not mention the character ‘yellow’ (《

说文》曰：猿，善援，禺属。《文选西都赋注》、《后汉书班固传注》引此(郭注，并云：臂长，便捷。无脚字，色黑无黄字)。”

Hao's analysis is similar to a componential analysis (also known as Seme analysis) of the definition of Yuan, which is applied in semantics (Cao, 2001; Zhang, 1988). If we define the limbs and fur color of Yuan as Yuan's seme, the conclusion of an analysis of the limbs and fur color can be as follows.

$$Yuan_{guopu} = Yuan_{lishan} [+long\ legs] [+yellow] = Yuan_{lixian} [+long\ legs] [+yellow]; Yuan_{lishan} = Yuan_{lixian}$$

Note: The subscript indicates the name of author.

Hao pointed out that the famous Tang scholars Li Shan and Li Xian borrowed Guo Pu's description of Yuan in their commentaries. However, Li Shan's and Li Xian's citations differ on two points in comparison to the original sentence written by Guo Pu. One point is that Guo's description "long arms and legs" was modified by Li Shan and Li Xian to only "long arms"; the other is that the fur color of Yuan was recorded as being only "black," and Li Shan and Li Xian did not mention any "yellow".

Sociocultural Analysis: An Expansion of Li Shan's Commentary

It is interesting that Li Shan's and Li Xian's references to Guo Pu's description were the same. They lived in the same era and were familiar with each other. Li Xian was known as Prince Zhanghuai, who was the son of Empress Wu Zetian (武则天 624–705 CE) and Emperor Gaozong Li Zhi (李治 628–683 CE). Li Shan was the founder of the studies of *Zhao-ming-wen-xuan* and was a scholar-servant (侍读) of Prince Zhanghuai-Li Xian. This explains how these scholars ended up with the same citation for Guo's description of Yuan. Qi's (2012) research has shown that Li Shan's *Zhao-ming-wen-xuan-zhu* had a direct influence on Li Xian's *Hou-han-shu-zhu*, and some specific entries of the former were borrowed by the latter.

Li Shan's *Zhao-ming-wen-xuan-zhu* and Li Xian's *Hou-han-shu-zhu*'s incomplete use of Guo's explanations of Yuan affected later scholars' understanding of morphological traits of Yuan. On the one hand, *Zhao-ming-wen-xuan* is the earliest surviving collection of poems and essays in China. The oldest surviving and most famous commentary on it is Li Shan's *Zhao-ming-wen-xuan-zhu*. These works have had a great cultural influence on later scholars. On the other hand, Prince Li Xian used Li Shan's commentary to curry favors to retain his position, giving Li Shan much more political significance during the Tang dynasty beyond the realm of literature (Qi, 2012). For example, the dissemination of *Zhao-ming-wen-xuan* was largely influenced by the Tang dynasty's imperial examination, and the influence of Li Shan's commentary on *Zhao-ming-wen-xuan* on later generations of imperial literati textbooks is clear (Qi, 2012).

Syntactic Structures and Semantic Change: *Chang Bi* (长臂) the same as *Bi Chang* (臂长)?

Following Guo's description of Yuan's long legs and arms (*Bi Jiao Chang*), the feature of Yuan's long arms is not obvious before the Northern Song dynasty (北宋, 960 CE–1126). Besides commentaries from Li Shan and Li Xian, there are a few cases to link *Chang* (长) and *Bi* (臂) with Yuan in the Tang dynasty. Interestingly, these cases use different word sequences (*Chang Bi* rather than *Bi Chang*) to those in Guo Pu, Li Shan, and Li Xian's descriptions. Chinese mainly depends on word order and functional words (e.g., preposition, article, conjunction) to express definite grammatical meaning due to a lack of morphology and form change (Ji, 2003; Wang, 2006). Thus, such a difference in word order might be related to the structure and meaning of word phrases in syntactic and semantics.

One key piece of evidence to further clarify this point is from the Confucian scholar, exegesis interpreter, and historian Yan Shigu's (颜师古 581–645 CE) note on "Yang Xiong Biography, *Han-shu* (汉书)": "Jue, belongs to the Mi category, good at using its forearms and adept at fighting/leaping (*Chang Bi Shan Bo*). Its body is long (*Shen Chang*) and golden (獾, 亦猕类也, 长臂善搏。獾, 身长, 金色)." Here, *Chang Bi* (长臂) is used to describe the arms of a type of monkey (most likely referring to *Rhinopithecus roxellana*; He, 1991; Li, 2006). The author uses *Shen Chang* (身长) to describe Jue's long body. Given that Jue's arms are long, the long arms should be described as *Bi Chang*, same as *Shen Chang* in the same context. However, the author made a distinction between *Chang Bi* and *Shen Chang* in the placement of "Chang" in the word sequence. Thus, the meaning of *Chang Bi* is "adept at using its forearms" while "*Shan Bo*" is "good at fighting (or leaping)."

Table 2 Number of poems containing the keywords "猿臂 (*Yuan Bi*)"; "长臂 (*Chang Bi*)"; or "臂长 (*Bi Chang*)" in the corpus of Tang, Song, Yuan, and Ming period poetry on the Souyun website

Dynasty	No. poems containing the keyword <i>Yuan Bi</i>	No. of poems containing the keywords <i>Chang Bi</i> or <i>Bi Chang</i>
Tang (618 CE–907 CE)	10	1*
Song (960 CE –1279)	42	6
Yuan to Ming (1279–1644)	89	6
Total	141	13

Data sources from the Souyun website (<https://sou-yun.cn/QueryPoem.aspx>) (Accessed 1 October 2019)

We found only one description (*Chang Bi*) related to Yuan in poetry from the Tang dynasty. It appeared in the poet Li Shangyin's work from the late Tang dynasty; Xing-ci-xi-jiao-zuo-yi-bai-yun (行次西郊作一百韵) wrote: "200,000 archers, with *Chang Bi* like the Yuan (控弦二十万, 长臂皆如猿)." This cleverly describes those soldiers as having "Yuan arms" enabling be adept at archery. According to the word placement and rules of poetic antithesis, in this line, the Chinese "长Chang" works in concert with "控 Kong" to describe the soldiers as "adept at using [one's] arms" and nimble, and does not employ its common meaning of "long" or "length of something" respectively. This reminds us that until the Tang dynasty, "长臂 *Chang Bi*" and "臂长 *Bi Chang*," due to the word order of "长Chang" and "臂Bi" had different structure and different meanings

In the Tang dynasty and before, the words *Chang Bi* were used mainly to describe Yuan as good at using the forelimbs rather than simply meaning “long arms.” The word “*Chang*” in “*Chang Bi*” is a verb, similar in use to “善于 be very talented at...” (see *Kang-xi dictionary* p. 1328 <http://www.guoxuedashi.net/kangxi/pic.php?f=kx&p=1328>). This agrees with the meaning of the word *Yuan Bi* as “nimble, flexible arms” in the “*Li Guang chapter*” of *Shi-ji*.

After the Tang Dynasty: Mixed Use of Chang bi and bi Chang to Describe Yuan

From the Northern Song dynasty (960–1279 CE) onwards, wordsmiths, poets, artists, and scholars used *Chang Bi* or *Bi Chang* extensively when writing about Yuan. At this time, the meaning of *Chang Bi* and *Bi Chang* gradually became similar, and “*Chang*” was interpreted as “long.” We looked up the keywords “猿臂 (*Yuan Bi*),” “长臂 (*Chang Bi*),” or “臂长 (*Bi Chang*)” in the corpus of Tang, Song, Yuan, and Ming period poetry using the Souyun website (<https://sou-yun.cn/QueryPoem.aspx>) and searched for words and sentences related to Yuan's arms. Although *Chang Bi* or *Bi Chang* (long arms) was used in writing about Yuan in the Song dynasty (number of poems: $N=6$), this did not reduce the usage of the word *Yuan Bi* (number of poems: $N=42$) (Table 2). Like a line in Sima Guang's (司马光 1019–1086) poem, it described the long arms of Yuan: “reaching out like Yuan's long arms (伸如猿臂长).” The use of *Chang Bi* and *Bi Chang* is especially common in the poetry matched with art made between the Song and Ming dynasties. For example, “Wild deer are looking around, the long-armed (*Bi Chang*) Yuan is leaping (野鹿正周张, 猿投两臂长)” (*Pictures of Yuan and Deer* 猿鹿图). This seems to indicate that the appearance of “long arms” is more appropriate than the functionality of having “flexible arms” for the artist's symbolic characterization and depiction of Yuan.

Concurrently with the poets' descriptions of Yuan, more encyclopedias and dictionaries began to include entries relating to the “*Chang Bi*” of Yuan, but these had already mixed “*Chang Bi* (adept at using its arms)” with “*Bi Chang* (long arms)” to describe Yuan's arms:

Lu Dian (陆佃 1042–1102) of the Song dynasty in *Pi-ya* (埤雅 *Augmenting the Erya*) says: “Yuan, of the Hou (most likely representing macaques) group, *Chang Bi* and good at howling and climbing.” The *Er-ya-yi* (尔雅翼 *Wings of the Erya*) records: “Its (Yuan's) arms are very long, and people possessing such arms are adept at archery.”

Mei Yingzuo (梅膺祚) of the Ming dynasty (1368–1644) in the *Zi-hui* dictionary (字汇 1615) writes: “Yuan, of the Yu group, similar to the Hou (most likely representing macaques), *Chang Bi* and good at climbing on the branches of trees (禺属, 似猴, 长臂善攀援树枝).” In these descriptions, the interpretation of the word Hou in *Pi-ya* or *Zi-hui* stems from Liu Zongyuan's (柳宗元 773–819 CE) famous essay *Zeng-wang-sun-wen* (憎王孙文). Liu Zongyuan considered Hou to be a type of macaque (Zhang, 2015a).

By the end of the Ming dynasty and the beginning of the Qing dynasty (1644–1911), the terms *Bi Chang* and *Chang Bi* (flexible arm) of Yuan had merged

Table 3 Descriptions of Yuan and Yuan's arms in some gazetteers in Fujian province, China (Data sources from Wen, 2009, pp. 170–173)

Code	Period and/or year	Titles of gazetteers in Fujian Province	Descriptions of the Yuan and Yuan's arm
1	Kang-Xi 1718	Qing-tang-xian-zhi	Chang-Bi-Shan-Xiao
2	Qian-Long 1750	An-ji-zhou-zhi	Chang-Bi-Shan-Xiao
3a	Kang-Xi 1667	Fu-qing-xian-zhi-xu-lue	Bi-Chang-Shan-Yin
3b	Qing-Long 1747	Fu-qing-xian-zhi	Chang-Bi-Shan-Xiao
4	1931	Da-tian-xian-zhi	Qian-Bi-Chang
5	1922	Yong-tai-xian-zhi	Chang-Bi-Shan-Xiao
6a	1832	Shun-chang-xian-zhi	Chang-Bi-Shan-Xiao
6b	1936	Shun-chang-xian-zhi	Chang-Bi-Shan-Xiao
7	1919	Nan-ping-xian-zhi	Chang-Bi-Shan-Xiao
8a	Jia-Jing 1522–1566	Qing-liu-xian-zhi	Chang-Bi-Shan-Pan-Yuan
8b	1947	Qing-liu-xian-zhi	Bi-Chang-Shan-Pan-Yuan
9	1941	Yong-ding-xian-zhi	Chang-Bi-Shan-Ming
10a	Chong-Zhen 1636	You-xi-xian-zhi	Bi-Chang-Shan-Yuan
10b	1927	You-xi-xian-zhi	Bi-Chang-Shan-Yuan
11a	Kang-Xi 1691	Zhao-an-xian-zhi	Chang-Bi-Shan-Xiao
11b	1942	Zhao-an-xian-zhi	Chang-Bi-Shan-Xiao
12a	Qian-Long 1771	Xian-you-xian-zhi	Chang-Bi-Shan-Yin
12b	Tong-Zhi 1873	Xian-you-xian-zhi	Chang-Bi-Shan-Yin
13a	Jia-Jing 1522–1566	Ting-zhou-fu-zhi	Chang-Bi-Shan-Xiao
13b	Qian-Long 1752	Ting-zhou-fu-zhi	Chang-Bi-Shan-Xiao

in many works, because they all described the forelimbs of Yuan. For instance, Qu Dajun's nostalgic poem "Li Guang" seems to intentionally merge the two. He clearly wrote that Li Guang's arms are long and agile like those of Yuan: "Li Guang's long arms (*Chang Bi*) are powerful like Yuan's. *Hu* (currently meaning Tiger) is dead after only one crossbow shot (长臂双如猿有势, 大黄一发虎无声)."

More importantly, *Chang Bi* and *Bi Chang* were frequently used to describe Yuan in gazetteers since the Ming dynasty (Wen, 2009). We analyzed descriptions of Yuan's arms in county annals in Fujian Province based on Wen (2009, pp. 170–173) and found that *Chang Bi* was mixed with *Bi Chang* to describe Yuan in different periods for the same place (3a-b, 8a-b, Table 3). *Chang Qian* (fore-) *Bi* 长前臂 also changed into *Qian Bi Chang* to mean the long arms of Yuan (Table 3). Many regional chronicles from the Qing dynasty have inherited and continued this use of *Chang Bi Shan Xiao* (长臂善啸) or *Chang Bi Shan Pan* (长臂善攀), with the actual meanings "adept at using its forearms and good at howling" or "adept at using its forearms and good at climbing." If the meaning of *Chang Bi* is "very long arms," a species that is "good at climbing" but with "very long arms" appears to contradict itself in terms of primate locomotion, because very long arms like those of gibbons are not suited for climbing (Fleagle, 1999; Huang et al., 2015). However, *Chang*

Bi has taken the meaning of “very long arms (*Bi Chang*)” and was used as key evidence to support the identity of Yuan as gibbons in modern times (Du *et al.*, 1922; Shou, 1959).

From the Song (960–1279) to the Qing dynasty, the description and portrayal of the “long arms” of Yuan swept through poetry, genre books, and art, building up people’s cultural understanding of the “very long arms of Yuan,” which became the mainstream view and culture-cognition path dependence of Yuan’s arms amongst later Chinese generations. As in the modern era, several of the important Chinese dictionaries (*Han-yu-da-ci-dian*, *Chong-bian-guo-yu-ci-dian*, *Han-yu-ci-hai*, see References) described “Yuan’s arms (*Yuan Bi*)” as “The arms are long like those of Yuan; they (arms) can move freely (臂长如猿, 可以运转自如).” Thus, “*Yuan Bi*” already has two meanings: long arms and flexible arms.

Several authors objected to the idea that Yuan’s arms are long. For example, Wang Ji of the Ming dynasty recorded his observations on captive Yuan in his book (Wang, 1522), as follows: “Only the long armed one is called Yuan. All of them are short armed with black fur, although there is more than one type; the black one is Yuan; there is none with longer arms than those black ones.” This is a key piece of historical evidence to record that Yuan arms are not so long. Wang Ji goes on to write: “Yuan is good at climbing and leaping. And it moves so fast that it seems to fly.” This suggests that Yuan here is not a gibbon, because gibbons are not good at leaping (Fan *et al.*, 2013b; Fleagle, 1999). The length of Yuan’s arms recorded by Wang Ji did not change the general understanding that Yuan has very long arms. One of the most likely reasons for this may be the lack of support from a broader system of political power. The rare views that contradicted the “long arms” were soon submerged in the large collection of scrolls concerning “long arms.”

This analysis suggests that the term *Yuan Bi* symbolized flexible arms in earlier periods and that the meaning changed significantly between the Tang dynasty and the Song dynasty. Linguistic change led to a blending of slenderness (*Bi Chang*) and flexibility (*Chang Bi*) of Yuan arms, which became a common perception of Yuan arms amongst later Chinese generations. According to Guo’s original description, Yuan’s limbs are longer than those of the rhesus macaque (Mi Hou:

Table 4 Anatomical comparison of limb variables between primate species

Limb variables	<i>Trachypithecus francoisi</i> (<i>N</i> = 8)	<i>Macaca mulatta</i> (<i>N</i> = 65)	<i>Nomascus nasutus</i> (<i>N</i> = 9)
Forearm length (cm)	16.0	13.9	N.A.
Knee length (cm)	19.9	14.6	N.A.
Forelimb length (cm)	43.4	N.A.	62.8
Hindlimb length (cm)	52.3	N.A.	45.7

Data sources: *T. francoisi*: Pan *et al.*, 1989; *M. mulatta* (Population in both Hainan and Taihangshan): Zhang *et al.*, 2016; *N. nasutus*: Ma & Wang, 1986; N.A. = not available

The most likely species is the rhesus macaque because the body size of Mi Hou is small). Its forelimbs are not extremely long like the gibbons, based on Wang Ji's observation in Guangxi Province and primatological knowledge (currently, the eastern, black-crested gibbon is the only gibbon found in Guangxi Province). Meanwhile, primates with a strong leaping capability have a low intermembral index (relatively long hind limbs) (Fan *et al.*, 2013b; Huang *et al.*, 2015; Pan *et al.*, 1989). Thus, Yuan's hind limbs should not be thought of as short like a gibbon based on Guo Pu's texts, and its natural ability at leaping and climbing. The slenderness of Yuan's lower limbs could have helped people to correct the understanding of Yuan, but almost nobody paid attention to it after Guo Pu's description that Yuan has long hind limbs. If Yuan is a François' langur, the analyses on Yuan's, the rhesus macaque's and the eastern, black-crested gibbon's length of arms and legs mentioned above are consistent with their anatomical characteristics (Table 4). Specifically, the arms of the François langur are medium length, and the legs of the langur are longer than those of the gibbons. Thus, the identity of Yuan as the François' langur can better explain historical texts from a primatological perspective. In addition to empirical evidence, Guo Pu's original description that Yuan has long arms and legs (臂脚长) is exactly the same as the description of "long limbs (四肢细长)" in langurs by modern scientists (Mei *et al.*, 1987; Ning, 1966; Shou, 1962). Thus, the François' langur is more likely to be the original referent of Yuan than a gibbon.

From Long Arms to the Taillessness of Yuan

In various ancient Chinese books, Yuan was depicted as having a tail (*Tai-yin-da-quan-ji* 太音大全集, *San-cai-tu-hui* 三才图会, *Ben-cao-gang-mu*, etc.). However, this contradicted the identification of Yuan as a gibbon. Here, we describe the historical path of the perceived "taillessness" of Yuan and show that a mismatched translation of ape/gibbon as Yuan caused a change in the concept and referent of Yuan. This change has roots in the cultural movements of learning science in modern China.

Apes and Taxonomy: A Few Key Points

In Carolus Linnaeus' (1707–1778) book *Systema Naturae*, he established the classification unit of *Anthropomorpha* for what later became known as the Primates (Linnaeus, 1758). In a treatise on great apes for his pupil Hoppe he enumerated four species of Simia: *TROGLODYTA Boentii*, *LUCIFER Aldrouandi*, *SATYRUS Tulpii*, and *PYGMAEUS Edwardi*. In France, Comte de Buffon (1707–1788) gave a more in-depth description of the appearance of the apes in the *Histoire Naturelle*, because he obtained a live juvenile chimpanzee, and an adult gibbon from Asia, later known as the white lar gibbon (*Hylobates lar*) (Buffon, 1766). In 1859, Charles Robert Darwin's (1809–1882) *On The Origin of Species* was first published, which opened up an unprecedented discussion about the origin of human

beings in the western world. In this context, Thomas Henry Huxley (1825–1895), as a proponent of Darwinian thought and of the idea of a common ancestor between apes and humans, showed the world the progress of Western research concerning the connection between and similarity of apes and humans in his classic work *Evidence as to Man's Place in Nature* (Huxley, 1863). His description of the relationship between these creatures supported Darwin's evolutionary theory of apes as human relatives. In this book, written from a European perspective, the classification of apes was clear, and included gibbons, gorillas (*Gorilla* spp.), chimpanzees (*Pan* spp.), and orangutans.

Western Studies in China and Translations of Scientific Works

At around the same time as these European ideological transformations, the center of world power also had moved to Europe after the British Industrial Revolution, and a British-led international order was being formed (Guo, 1996a). Under the imperialism of European countries, especially Great Britain, China gradually became a semifeudal and semicolonial country (1840–1949) and had to learn from Europe and strengthen to preserve itself (Fu, 1988). In the early 1860s, the Qing government began the Westernization Movement (洋务运动), which lasted for 35 years, and was geared toward learning western scientific ideas and technologies to achieve independence and develop China (Chen, 2009; Lu, 2002). The impact of this introduction of modern scientific thought and technology on Chinese traditional culture and the Chinese worldview is easy to see (Ouyang, 2006; Wu, 2006).

The Qing dynasty authorities sent personnel to Western countries to learn science and technology skills from the West. The famous translator and educator Yan Fu (严复 1854–1921) was among these “Western Studies” personnel. He was sent to England in 1877 for Naval studies and returned to China in 1879 (Pi, 2000). In 1898, he began to write a series of drafts asking the Qing sovereign for what would later become the reform and modernization of ideas (An & Shen, 2008; Duan, 2006). Around this time, *Evolution and Ethics* (Huxley, 1893), was translated and published in Chinese (天演论 *Tian-yan-lun*, 1898) and laid the foundation for Yan Fu's claim to fame as the first Chinese Western Studies scholar in modern times (Ouyang, 2006; Zou, 2000). As a result, Huxley's work spread to thousands of households in China in a few years, becoming the most important representative work of Western thought in that era (Ouyang, 2006; Wu, 2006; Zou, 2000).

Although adhering to the translation standards of “faithfulness, expressiveness, and elegance (from the preface of the translation 译例言, *Tian-yan-lun*)” in the translation, Yan did not completely, faithfully reproduce Huxley's thoughts but supplemented them with his own rich commentary (Chen, 2012; Li & Yao, 2010). For example, in the chapter “the Crowd (人羣)” of *Tian-yan-lun*, Yan commented as follows:

“Darwin's ‘The Descent of Man (原人篇),’ Ernst Haeckel's (1834–1919) ‘The Rise of Man (人天演),’ Huxley's ‘Evidence as to Man's Place in Nature (化中人

Table 5 Referents and use of Yuan and Hou in selected bibliographies ($N = 27$) in biological anthropology and zoology from 1898 to 1955

Period (yr)	Style 1 Yuan as a stem-suffix for all primates (X + Yuan) ^a	Style 2 The mixed use of Yuan and Hou as stem-suffixs for most primates ^b	Style 3 Yuan as a stem-suffix for apes/gibbons (X + Yuan) while Hou for the rest of primates (X + Hou) ^c
1897–1919 Initiation period	Huxley, 1893-Chinese version Yan, 1898; 田寺寬二, 1906 ^d ; Liu, 1908; Chen, 1918	秋山蓮三, 1913 ^e ; Xu, 1917	
1920–1937 Transition period	Chang, 1930; Huxley, 1863-Chinese version Hua, 1931; Liu, 1931	Xue, 1923; Darwin, 1871-Chinese version Ma, 1930; Xue & Miao, 1934; Wu, 1935; Ji, 1936; Zhang, 1936	Du <i>et al.</i> , 1922; Thomson, 1923-Chinese version Wu, 1927; Wang, 1930; Zhang & Zhu, 1934; Zhou, 1936; Smith, 1931-Chinese version She, 1937
1938–1945 Stagnation period	Academic publishing was suspended because of Second Sino-Japanese War		
1946–1955 Standardization period		Zheng, 1948	Andrews, 1946-Chinese version Wu, 1949; Wu, 1950; Lin, 1951; Liu, 1954; Tan, 1955

^aYuan was used as a stem-suffix for (almost) all primates (e.g., lemurs, monkeys, and gibbons)

^bYuan mixed with Hou as stem-suffixs for most primates (e.g., lemurs and monkeys)

^cYuan was used as a stem-suffix for apes/gibbons while Hou for monkeys and lemurs *et al.*

^dYuan was translated into apes in the title of the book. But Yuan was used as a stem-suffix for all primates except a few species (e.g., great apes) in the main body of the book

^eYuan was used as a stem-suffix for most primates while Hou only for macaque monkeys

位论),’ all three books make it clear that man’s ancestors were Yuan. Among the various species of Yuan, there are two types of apes in Asia, gibbon (吉贡音奔) and orangutan (倭兰), and two closest types of gorilla (戈栗拉) and the chimpanzee (青明子) in Africa. How can it be so clear? With the function of the organs and the skeleton, apes are more similar to those of a person’s but less like other mammals and other Yuan (他猿). Since then, in the classification of biology, all Yuan and human beings are one order, named Primate (布拉默特). Primates are a first-class animal in Chinese.”

It can be seen from the text that Yan’s use of the word “Yuan” refers to all primates, including those apes and “other Yuan” listed in the text. This use is different from the idea and referent of Yuan in ancient China, and departs from the original meaning of Yuan in Chinese. In addition, Yan Fu seems to have deliberately emphasized the “apes” that are closer to humans. These species are precisely the apes described by Huxley (1863).

Yan Fu’s comments on Yuan and evolution followed the widespread popularity of *Tian-yan-lun* at that time. The assertion of, and thoughts on, evolution in this book had a strong influence on later scholars (Guo, 1996b; Ouyang, 2006; Zhang, 2004). In the following decades, there were long running discussions in China concerning the evolutionary relationship between humans and apes, and evolutionary thought (Guo, 1996b; Li & Yao, 2010). A constant stream of works on biology (zoology) and anthropology emerged at the time (Liu, 1991; Zhao & Xing, 2004). These included selected translations of popular Western classics by authors, such as Darwin, Huxley, and John Arthur Thompson (1861–1933). We looked up the keywords (“猿 Yuan”; “动物 Animal”; “人类 Human”) using the Gu-ji (2020) website (古籍网 <https://bookinlife.net>, 1898–1949) and the Baidu Scholar website (百度学术 <https://xueshu.baidu.com>, 1949–1955), and we obtained bibliographies concerning primate names and/or classification in addition to several books (Huxley, 1863, 1893; Thomson, 1923; Xu, 1917; Table 5). In these books, the author and the translator each have their own preferences for the names of primates, and the names used for primates are very varied, with the clearest examples being the use of Yuan_猿, and Hou_猴. Over time, the naming of primates in this era went from using Yuan mainly as a stand in for primates, to a stage of many debates on the mixed use of Yuan and Hou, to classification systems in which Yuan became a term for “anthropoid (especially gibbons)” (Table 5). In line with this, the scientific understanding of primates at the time went through a succession of changes, from knowing almost nothing (initiation period) to confusion in definitions (transition period) and then to a gradual demystifying (standardization period).

We selected a few key books as examples to illustrate the usages of Yuan and Hou for naming primates: Chen Yinghuang’s (陈映璜 1887–unknown) *Anthropology* (1918), Du Yaquan (杜亚泉 1873–1933) and his co-editors’ *Zoological Nomenclature* (1922), Xue Deyu (薛德焯 1887–1970) and his work (Xue, 1923; Xue & Miao, 1934), and Wu Kuangfu’s (伍况甫) translations of scientific works (Andrews, 1946; Thomson, 1923).

Chen had been studying as an anthropologist in Japan, and after returning to China, he published *Anthropology*, the first publication in Anthropology in modern

China. Chen translated each name of a primate species simply as a type of Yuan, with the exception of the great apes (Style 1, Table 5). This seems to have happened because the specific names of great apes (Xing Xing 猩猩, Da Xing Xing 大猩猩, Hei Xing Xing 黑猩猩) in several books were translated, used, and accepted commonly in earlier previous books (e.g., 田寺寬二, 1906; Liu 1908).

Unlike Chen's translation, Du *et al.* (1922) considered Yuan as a gibbon and used Hou as a stem-suffix for monkey names. They explained in their influential work:

“*Chang Bi Yuan* (English name: Gibbon)... It is also known as Yuan (猿). Its body is slender, limbs are long. Forelimbs are particularly long (体细长, 四肢长, 前肢为尤长)... only trace of tail kept (尾仅留基迹)...(they are) also good at leaping. Usually they can jump [more] than six Zhang (Zhang, a unit of length; six Zhang equal 20 m) (亦善跳跃, 往往可远达6丈余)...”.

This description of gibbons appears to stem from the traditional image of Chinese Yuan. Du *et al.* (1922) simultaneously used “long limbs” and “very long arms” to depict Yuan. In this book, “very long arms” is used as the key evidence to support why they matched Yuan with gibbons. They also mentioned that gibbons are “good at leaping”.

Du was a famous publisher and translator in the semicolonial era of China. He was a typical representative of translators of scientific works who introduced and spread natural science in China in the early twentieth century. The *Zoological Nomenclature* is the first significant Chinese dictionary of scientific terms in zoology (Huang, 2019). This dictionary of animal species was influenced by Japanese zoological terms of the time and had a deep impact on zoological nomenclature in modern China (Huang, 2019). The use of the word Yuan in this dictionary seems to have paved the way for the contemporary rationalization of the view that Yuan is a gibbon.

Later, another translator Wu Kuangfu translated and wrote a series of books on apes and made essential contributions to anthropological thought (Table 5). In his version of *What is Man* published in 1927 (Thomson, 1923), he translated the whole book, with the central theme being that the apes are greater, and the other primates are lesser, faithfully reproducing the western perspective of anthropology at that time. In the same manner as Du *et al.* (1922), when using the Chinese language to discuss apes and monkeys, he diverged from the original meanings in Chinese. He used Yuan specifically to represent apes (“man-like” Yuan 类人猿; gibbon as Chang Bi Yuan 长臂猿, long-armed ape), and Hou to refer to other “lower” species, such as monkeys or lemurs (named as “X+Hou,” e.g., lemur as Hu Hou, spider monkey as Zhi Zhu Hou). Wu's translations may have been strongly influenced by Du *et al.* (1922), because Du worked for the Commercial Press, which published *What is Man*, and was the director of the Institute for the Translation of Natural Sciences in the Commercial Press at that time (Zhou, 2016).

Some other usages of translations on Yuan or Hou also existed during this transition period (Table 5). For example, Xue (1923) and Xue and Miao (1934) used the word Yuan or Hou differently from their use in Chen's and Du's books. Xue and Miao (1934) used the word Hou as a stem-suffix for lemur (*Lemur*), colobus monkey (*Colobus*), or howler monkey (*Alouatta*) and Yuan for gibbon, proboscis monkey (*Nasalis larvatus*), or loris (*Loris*).

Due to their significant influence on earlier translations and the use of biological terms, we analyzed several books by Japanese scholars (Fu, 2014). Like Chinese scholars, earlier Japanese authors were confused in the usage of Yuan and Hou. For instance, the title of 人と猿 (in Japanese) was translated into *Man and Apes* or 人与猿 (in Chinese) (田寺寛二, 1906). Following the book title, Yuan represents apes. However, Yuan was used as a stem-suffix for all primates except the great apes in the main body of the book. In addition, long-tailed proboscis monkey is translated into Tian Gou Yuan (天狗猿), whereas macaques are translated as Mi Hou (猕猴) in the book *General Zoology, Vertebrates* (秋山蓮三, 1913).

The semantic change in Yuan was a microcosm of the semantic drift and confusion of what were classified as apes (or gibbons) and monkeys in that era of Chinese cultural shift (Style 2, Table 5). The change from traditional culture to western culture was influenced by the earlier Westernization Movement (e.g., Yan Fu) and the New Culture Movement between 1915 and 1927 (Chen, 2009; Guo, 1996b; Wang, 2012). The latter promoted a group of highly influential scholars (e.g., Chen Duxiu, Hu Shi) to build a new culture of science in China to replace traditional Chinese culture, such as Confucianism, through a series of thought reforms (Chen, 2009; Wang, 2012). In this process, a language revolution (such as a shift in the meaning of words) was one of the most important parts of a cultural shift and brought on linguistic drift in Chinese (Hamilton *et al.*, 2016; Mo & Liang, 2010; Yuan, 1997; Zhou, 2013).

The Scientific Community: Yuan as a Gibbon

In the context of the collision of Chinese and Western cultures, the earliest zoologist (to our knowledge) who clearly equated gibbons with Yuan was the animal taxonomist Ji Lianjin (嵇联晋, 1900–unknown). In the textbook *The Outline of Zoology* (1936), he wrote “gibbon also known as Yuan (p. 596).” The author did not clarify the reason for this equation, and we speculate that one of the main reasons might be the influence of his mentor, one of the pioneers of modern Chinese zoology, Xue Deyu (薛德焯 1887–1970) and his work. There is evidence for this speculation: The proofreading editor of *Outline of Zoology* is Xue himself (Ji, 1936). In 1934, Xue and Miao Weishui (缪维水) co-edited the publication of *The Mammals of the World*. They did not clearly equate gibbons as being Yuan in the book. However, the authors introduced gibbons as follows: “Groups of gibbons often sing loud, wailing, sorrowful songs in the woods (p. 25).” The negative emotional description of gibbon’s vocalization is the same as those sorrowful calls of Yuan recorded in ancient Chinese literature (Qu, 2008). The emotional description on vocal calls likely misled Ji’s understanding of the gibbons and Yuan. In July of the same year, *The Atlas of Mammals* also reads “Yuan are also known as gibbons (p. 122)” (Zhou, 1936). However, if the term “Yuan” represents gibbon in these texts (Ji, 1936; Xue & Miao, 1934; Zhou, 1936), this raises the question of why do the authors not include China in the distribution range of gibbons, because Yuan was recorded in many areas in China.

Around 1950, the books *Life History of Apes* (Wu, 1950), *Study on Apes to Humans* (Lin, 1951), and *Monkeys and Apes* (Liu, 1954) put a preliminary end to

the standardization of Chinese primate names and classification systems. *Study from Ape to Man* is the work of the famous anthropologist Lin Yaohua (林耀华 1910–2000). The references in the book include Wu Kuangfu's (1949) translation (*Meet your Ancestor*, Andrews, 1946). *Monkeys and Apes* is the masterpiece of another pioneer anthropologist Liu Xian (刘咸 1901–1987) and is China's first book dedicated to apes and monkeys. The book also refers to *Study on Apes to Humans*. As the two Anthropologists, Lin and Liu, pioneered the acceptance and application of the translation that the apes are Yuan (Style 3, Table 5), and the other primates are classified as Hou in their works (there are several exceptions in Liu's book, e.g., Fei Fei 狒狒 for baboon (*Papio*) and Shan Xiao 山魈 for mandrill (*Mandrillus*)), this framework soon became dominant in zoology, primatology, and anthropology in China. Since then, Yuan has become synonymous with the apes, especially “long-armed ape” or gibbons (Chang Bi Yuan) in China, whereas other primates are referred to as Hou. In the following decades, zoologists, primatologists, anthropologists, sinologists, and historical geographers began to explain intermittently that Yuan referred to gibbons in ancient Chinese books (Gao *et al.*, 1981; He, 1988b; Liu, 1980; Shou, 1959; Tan, 1955; van Gulik, 1967). This system and these appellations are still in use today.

In summary, the taillessness of Yuan stems from a change in the concept and referent of Yuan. On the one hand, the concept of Yuan was modified by Li Shan and Prince Li Xian from long limbs to long arms, which is different from the original definition of Yuan. On the other hand, a modified idea concerning Yuan, which was translated into and misinterpreted as gibbons (or apes), had been influenced by cultural movements in modern China around 1890s to 1950s. After two major changes in the idea of Yuan, the main referent of Yuan changed from langurs to gibbons, which led to a disappearance of any mention of it possessing a tail. The change in Yuan's identity explains why a handful of authors sometimes understand the word Yuan as monkey instead of gibbon (Li *et al.*, 2002; Shahar, 1992).

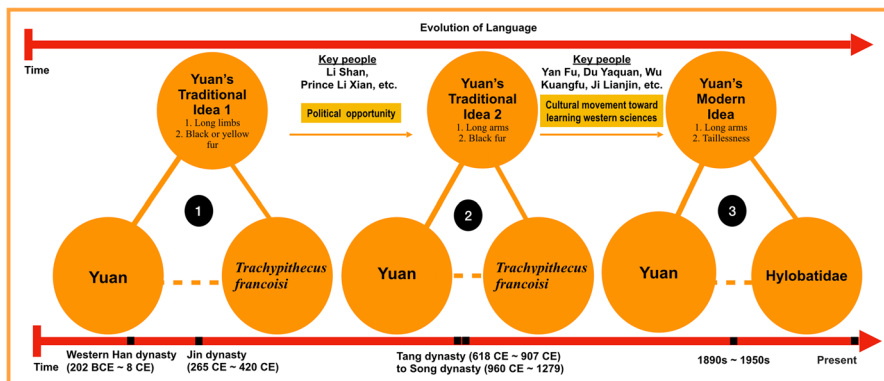


Fig. 7 Dynamic semantic triangle of the character Yuan and its interpretation. The number in the black circle represents the model of semantic triangle of the Character Yuan during a particular time period

Discussion

Researchers have identified the referents of traditional names by means of mutual verification between historical textual evidence and scientific knowledge of species (Gao *et al.*, 1981; He, 1988a, 1993; Wang, 2019; Wen, 2003; Yan, 2020). Such an approach appears to be helpful to untangle the complex relationship between names and referents. However, such an empirical methodology has limitations. For instance, the analytic procedure seems to have often identified the referents of an animal name based on a small number of isolated conceptual descriptions (Li *et al.*, 1989; Wang, 2019; Wen, 2003). There could be a high risk of misinterpretation when attempting to understand the animal name-object relationship without sufficient consideration of conceptual interpretations that vary from author to author. Accordingly, it is necessary to incorporate analysis of how ideas about an animal develop over time into the study of traditional animal names and their identities. The Dynamic Semantic Triangle theoretical framework provides a powerful tool to integrate a robust conceptual analysis with the empirical analysis. We make a clear distinction between words, references, and referents. The Static Subsystem is useful to analyze how an individual understands the reference-name relationship or the reference-referent relationship regarding an animal. The Dynamic Subsystem is helpful to clarify and present the intersubjective interaction of various ideas of a certain animal name and thus better understand the complex relationship between names and their identities.

This study shows the complex relations of “Yuan” as a word, thought, and referent. The referents of Yuan can be divided into the traditional Yuan (Fig. 7 Models 1 & 2) and current Yuan based on a transition between the 1890s and the 1950s (Fig. 7 Model 3). The mainstream idea of traditional Yuan gradually changed from a Yuan with long limbs to a Yuan only referred to as having long arms during the Tang-Song period. Our analysis suggests that the traditional Yuan is the François’ langur, whereas the current Yuan is the ape, particularly the gibbon.

The traditional Yuan was recorded as Yuan or Black Yuan (in Chinese: Xuan Yuan 玄猿, Wu Yuan 乌猿, Hei Yuan 黑猿) in many ancient books. These generic names most likely corresponded to the François’ langur (or white-headed langur in Guangxi province). The contradictions between the historical view and the current understanding are exacerbated by modern researchers regarding the traditional Yuan as gibbons.

Name, Reference, and Object: Primates Names in Historical Discourse

Words for some animals in Chinese have been used for hundreds of years since their appearance. Words that represent animals include those of primates found in many ancient books or archives made before modern scientific language was introduced to China. The justification for the linkage between generic names in historical records and species identities is largely overlooked (Li, 2006; Sterckx, 2005).

Our study agrees with several previous studies in that one species very likely has multiple generic names, whereas one generic name might represent different species (Baker, 2013; Wen, 2019). The generic names and classifications found in traditional culture are different from scientific language, which generally provides a clear linear relation between the species and its Latin name (Schiebinger, 2004). Further research should attend to epistemological changes in names, because it is challenging to match the traditional name with the scientific identity of species.

The roots of biology are in natural history (Buffon, 1766; Darwin, 2004). Mainstream (or representative) ideas of animals vary culturally and historically (Ohnuki-Tierney, 1989; Tsing, 1995). For example, whales were classified into a similar category as cod for the purposes of commercial fishing in 1851 but are regarded as mammals in current scientific taxonomy (Hampton, 2015). Such changes in mainstream understanding of animals are common in China and Japan due to cultural shifts (e.g., westernization movement) over history. In this case, a few major factors, such as those highlighted below (a-c) play an important role in the mainstream change of image of Yuan.

a. Linguistic Characteristics

The concept of an object is expressed by specific words in historical texts. In this case, the ideas of Yuan varied from description to description (e.g., Guo Pu's "long limbs," Li Xian's "long arms," Du Yaquan's "particularly long arms" and "taillessness"). Moreover, the change in meaning of a compound word *Chang Bi* in ancient Chinese (from "skilled in forearms" to "long arms") partly affects Yuan's traditional idea. Intriguingly, the change in the meaning of *Chang Bi* is not mirrored by its word structure. This is extremely unusual as the semantic status of the name is largely mirrored by the certain syntactic construction (van Langendonck and van de Velde, 2016). Therefore, it is necessary to compare and understand the concepts of animals based on syntactic as well as lexical elements.

Another key shift in the meaning of the word Yuan is relevant to the scientific translation of Yuan into primate names in early modern China. From a synchronic point of view, the word Yuan had different meanings when it was translated and used to rename primates (Table 5). To better understand the onomastic language contact (Sandnes, 2016) of Yuan, we must consider how authors translate or use the name in certain situations. It is essential to understand the complex relationships between names and references through a combination of primatology, conceptual history, and linguistic analysis in future studies.

b. Cultural Shift and Science

When biological terms were imported into China (mainly between the late nineteenth century and early twentieth century), a series of uncertain translations occurred between traditional names and the scientific identities of primate species. These uncertainties stem from reasons, such as a lack of adequate empirical analysis between scientific identity and Chinese names for animals, or linguistic change

caused by translation, and language evolution. Moreover, the official committee for biology nomenclature was not effectively involved to approve and unify the terms of zoology until 1932 in China (Fu, 2014). In this case, the Chinese Yuan's referent changed from François' langurs into gibbons. The corresponding relationship between other primate names and their referents also appears to vary over time. For instance, Fei Fei and Shan Xiao are primate names in ancient China. Until modern times, baboons were known as Fei Fei while the mandrill was named Shan Xiao (Liu, 1954). Baboons and mandrills are found in Africa and the Arabian Peninsula at present. It is inconceivable that these animals lived in ancient South China. Another case is Rong (猢), the name for *R. roxellana* in traditional Chinese (Yan Shigu's *Kuang-miu-zheng-su* 匡谬正俗; Zhao, 1959), which now represents callithricidae (Chen, 1986). The most controversial case is that of 猩猩 (Xing Xing; pronunciation in Chinese) (Huang, 2019; He and Wen, 1981; Yang, 2007). Xing Xing represents a specific primate in ancient China, but the word means the orangutan in current terminology (Lin, 1951; Liu, 1954). The orangutan presently is found in the north of Sumatra and on Borneo (Nater *et al.*, 2017). It is unlikely that orangutans existed on mainland China in the past. The original meaning of Xing Xing in Chinese may derive from monkeys that were often found "crying" (小而好啼) in the *Er-ya*. This mismatch led to a misunderstanding amongst modern historical zoogeographers and implied that wild orangutans were found in China at some point in history (He and Wen, 1981). Such mismatches appear not to be limited to the order primates. For example, Si Xi (兕犀) refers to the Javan rhino (*Rhinoceros sondaicus*) in current terminology but was a generic name used for a cattle-like mammal found in ancient times (Wen *et al.*, 2019; Yang, 2004).

c. Power and the Idea of Yuan

In this study, two important sociocultural events that created the mainstream pathway toward an understanding of Chinese Yuan are associated with political opportunities (e.g., the support of the power of Prince Li Xian; political pressures of European empires). There is a close interaction between the idea (both traditional and scientific) of Yuan and power.

The first event is Li Shan's view on Yuan (e.g., "long arms") being borrowed by Princes Li Xian as a key political opportunity to widely spread his new understanding of Yuan in the Tang dynasty. Li Shan's understanding of Yuan's long arms through a construction of political power gradually, became the mainstream view and culture-cognition path dependence of Yuan's arms amongst later Chinese generations. Compared with Li Shan, Wang Ji had a more reliable, direct observation of the animal Yuan in Guangxi (Wang, 1522). He recorded that Yuan's arms are not very long. However, his view of Yuan's arms had little influence on Chinese people's image of Yuan's arms due to a lack of political opportunity. This happened because the idea of an animal is a consciously constructed image that corresponded to political power. Not surprisingly, Wang Ji, who was in a less powerful position, failed to spread his "discourse (Foucault, 1972)" about Yuan widely.

The second event is related to a cultural movement toward learning western sciences in modern China. This event started from the westernization movement in the

early 1860s. It is a consequence of colonial expansion of European empires (the first opium war 1840–1842; the second opium war 1856–1860) in the nineteenth century (Chen, 2009). Around the earlier twentieth century, modern science was quickly adopted by China as a new form of practice and occupied a dominant position in the area of culture over the following decades (Lu, 2002). As a result, folk animal classification in Chinese traditional culture submitted to a biological taxonomy (Linnaean taxonomy) in the modern era. For the latter, the (re-) naming of objects in nature is not only a “logic” tool to understand the world but also part of a much broader process of taming nature by European empires (Haraway, 1989; Rubis, 2020). In the same spirit, naming wildlife in the name of science is not value-neutral in many non-Western cultures but as part of a colonizing methodology to classify nature (Smith, 1999). The name-giving and knowledge production in scientific taxonomy involves “epistemic violence (Spivak, 1985),” because science has been in alliance with capital and political power in the service of western colonial expansion (Anderson and Christen, 2019; Brockway, 1979; Haraway, 1989; Rubis, 2020; Schiebinger, 2004). Hence, scientific names and knowledge of wildlife reflect power tensions between imperial and indigenous epistemology. For instance, Schiebinger (2004) used the term “onomastic imperialism” to explain how the scientific nomenclature of plants, such as the peacock flower (*flos pavonis*), obtained domination over indigenous (e.g., India, Sri Lanka) practices of naming for the same species. Our study shows how the unequal distribution of power in naming wildlife in traditional and new cultures led to a disconnection and transposition of the traditional name (Yuan) and its identity—the François’ langur in China. This change of correspondence between name and identity contains two steps as follows: Step 1, the traditional name (Yuan) is used to rename “gibbon” in biological taxonomy due to a series of mismatched translations and word use; Step 2, the François’ langur was scientifically renamed by de Pousargès (1898). The scientific name of the species was translated to Hei Ye Hou, literally “black leaf-eating monkey” (Tan, 1955). In ancient China, Yuan was named because the François’ langur was good at climbing (Li, 1590). The Chinese traditional ways of naming and understanding the François’ langur as Yuan has been overshadowed by the new name.

To this day, scientific discourse on animals continues to greatly shape Eurocentric ideas of animals and influence wildlife conservation practices in modern society (Haraway, 1989; Rubis, 2020; Waters *et al.*, 2021). Thus, the interaction between the (re)conceptualization of animals and power must be considered in the study of animal name and identity in the future.

Implications for Science and Culture: Animal Names and Identity

Traditional animal names can be useful to help scientists reconstruct and understand environmental history (Chatterjee *et al.*, 2012; Elvin, 2004; Li *et al.*, 2002; Turvey *et al.*, 2015; Wan *et al.*, 2019). When traditional characters for wildlife were converted into scientific names in modern China, the question of how reliably traditional names equate to current species in scientific terms was overlooked. This study shows that the referents of Yuan varied from langurs to gibbon. Hence, various

identities must be taken into consideration when a traditional name is used to extract and translate traditional zoological knowledge into scientific formats.

The referents of animal names have implications for historical zoogeography. Chinese historical zoogeography was first established in the 1930s to 1940s and experienced a rapid development from the 1980s to the present day (Yang, 2012). However, a set of systematic research objectives, theories, and methods of Chinese historical zoogeography are not yet fully formed (Wen, 2019; Yang, 2012). One of most difficult challenges comes from the scientific identification of animals' traditional names in a mass of historical discourses (Wen, 2019; Yang, 2012). The incorporation of linguistic and historical approaches with sociocultural and empirical analysis could help to understand diachronic and synchronic identities of certain animal names. This study provides a cross-disciplinary approach and circumstantial evidence to clarify the scientific identities of those traditional primate names, such as Yuan.

Yuan or black Yuan generally represents gibbons in previous studies (Gao *et al.*, 1981; He, 1988b, 1991; Liu, 1980; Wen, 2009; Zhang, 2015a). These generic names and their scientific identities have been applied in understanding of historical distributions and conservation of gibbons (Chatterjee *et al.*, 2012; Turvey *et al.*, 2015, 2018; Wan *et al.*, 2019; Zhou & Zhang, 2013). If the most likely identity of Yuan in the past is not the gibbon but the François' langur, we need to revisit the temporal and spatial dynamics of primate species in ancient China.

In addition, analyzing primate tales using an ethnoprimateological approach can help primatologists understand the intricate cultural and/or religious connections between humans and primates in a particular cultural context (Burton, 2002; Radhakrishna, 2018). Here, the Monkey King in the Chinese classical novel *Journey to the West* is an example of how studying scientific identities of traditional names helps to explain cultural views of primates. As a popular cultural icon, the imagery of this supernatural hero-monkey pervades Chinese culture. Scholars have studied the prototype of the monkey hero since the 1920s (Hu, 1923; Dudbridge, 1970; Mair, 1989; Mei & Cui, 2002). Species, such as gray langurs (*Semnopithecus entellus*: Hu, 1923; Mair, 1989; Walker, 1998), Yuan (gibbon: Burton, 2002; Shahar, 1992; Walker, 1998; silvery langurs *Trachypithecus cristatus*: Dudbridge, 1970), and macaques (Burton, 2002; Walker, 1998: p. 54), have been proposed singly or in combination as its prototype based on biological and cultural characteristics, which they share with the Monkey King. So far, no specific species has been accepted by a majority of scholars as an appropriate prototype (Burton, 2002; Ji, 2009; Shahar, 1992).

A detailed analysis of the origin of the Monkey King suggested that Yuan in Linyin (Hidden Spirits) monastery in Hangzhou City, China, played a significant role in the emergence of the Monkey King in the *Journey to the West* (Shahar, 1992). According to our study of Yuan's traditional identity, the prototype for the Monkey King is most likely to be the François' langur. As this study demonstrates, appearance, ecology, and behavior, such as vocal behavior, and the sleeping sites of primate species can provide useful, empirical information for species identification with regard to a traditional name. The descriptions of Yuan in Linyin monastery during ancient times are consistent with appearance, ecological, and behavioral habits of the François' langur. For

instance, the most famous place to watch Yuan is at caves, such as Xianglin Cave (香林洞) or Huyuan Cave (呼猿洞) in Lingyin monastery, Hangzhou City. Shi Wenxiang (释文珣 1210–unknown), a Chinese poet of the Song Dynasty, observed Yuan and recorded: “I had a special journey to Xianglin Cave and attracted Yuan with the fruits. The bigger, black individuals with the small, yellow individuals were attracted by the fruits I provided. Only one white Yuan returned to the cave. It cannot be summoned by people (*Watching Yuan at Xianglin Cave* 香林洞口观猿).” Another poet Gu Feng (顾逢 Song dynasty) visited Feilai peak and wrote: “Tianzhu monastery (very close to Lingyin monastery, Shahar, 1992) is similar to the Ba Gorge. You cannot imagine its oddity only through a painting. One black arm overhangs on the rattan and prepares the fruit for her yellow infant (Yuan in Feilai peak 飞来峰猿).” Based on the fur color of Yuan described here, the adult Yuan are black while the infant is yellow. The white Yuan in Lingyin monastery could be a complete albino variation of the François’ langur, like a recent report in Guangxi Province (Huang *et al.*, 2018). Yuan also was often observed in caves. The long loud call of Yuan can be heard when people passed by the Cool Spring Pavilion (冷泉亭) in Lingyin monastery. Also, “Yuan howling at the Cool Spring Pavilion (冷泉猿啸, see *Qian-tang-shi-jing* 钱塘十景 written by Ling Yunhan 凌云翰)” was considered as one of top ten beautiful sights near West Lake during the Yuan dynasty (1271–1368). These historical descriptions can be explained by using Yuan’s traditional identity, the François’ langur. Yuan or Francois’ langurs were culturally and religiously significant animals. Yuan worship by humans can be traced back to the Pre-Qin period (ca. 2100–221 BCE) in China (van Gulik, 1967; Walker, 1998). The Monkey King rooted in cultural values and symbols of Yuan from the earlier periods serves as an example. This heroic and noble image resides in the Chinese spirit and is a continued literary construction of ideal personality in traditional society. The positive cultural attitude toward the Monkey King may be useful in promoting the bio-cultural conservation of the François’ langur in the future.

Conclusions

Animal names and the changes in the idea and/or referent behind them may contain key biological, sociocultural, graphic, and linguistic information to understand people’s perception of animals and human-animal relations from antiquity to the present day. We explored the Dynamic Semantic Triangle of the Chinese primate name “Yuan” based on cross-disciplinary analysis. There is a complex relationship between names, concepts, and identities of species in an ever-changing historical continuum. We found a series of hidden uncertainties with regard to naming animals when the Chinese learned biology as a modern scientific subject and created terms for wildlife around the world using existing Chinese words in early modern China (1890s–1950s). Thus, we propose application of the Dynamic Semantic Triangle theoretical framework to identify the scientific identity of traditional animal name and rethink animal names and their referents in those related disciplines in the future. Scholars are beginning to recognize the importance of traditional names and indigenous knowledge of wildlife, including primates for decolonizing conservation practice in postcolonial contexts (Gillman & Wright, 2020; Rubis, 2020; Waters *et al.*, 2021). As Smith (1999, pp. 29–30) argues, “History is important for

understanding the present and reclaiming history is a critical and essential aspect of decolonization.” This study clarifies the relationships between traditional Yuan and the François’ langur and revitalizes people’s understanding of the species in the context of traditional culture. Many traditional stories in the extensive written archives involve Yuan, such as the Monkey King. This study provides a starting point to incorporate traditional knowledge of Yuan into efforts to decolonize knowledge and conservation of the Endangered François’ langur.

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Declarations

Competing Interests The authors declare that they have no competing interests.

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