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# The Folklore of Dinosaur Trackways in China: Impact on Paleontology

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Fossilized footprints made by extinct creatures have captured the attention of humans worldwide. Many different prescientific cultures have attempted to identify the trackmakers and account for the tracks of unfamiliar species. In China, local folklore about dinosaur footprints is preserved in oral traditions of great antiquity, which persist today in at least five regions with conspicuous tracksites. Although folk explanations are expressed in mythological terms, they are based on careful observation over many generations. Ichnological myths often contain details that reveal attention to size, morphology, and sedimentology of tracks. Chinese folklore identified dinosaur tracks as those of divine or fantastic birds of various sizes, legendary large mammals, sacred plants, and deities or heroes. Popular knowledge of dinosaur tracksites and myth-based descriptions of mysterious footprints in stone could serve as a guide for paleontologists in East Asia, leading them to identify new trackways previously unknown to science.

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**Keywords** Ichnofossils, Dinosaur footprints, Myths, Folklore, China

## INTRODUCTION

Abundant evidence suggests that long before modern science discovered and described dinosaur tracks (Hitchcock, 1836; Lockley, 1991) and fossils (Mayor, 2005), local inhabitants of fossiliferous areas in which they were preserved already possessed knowledge of conspicuous footprints in stone and attempted to account for them (Mayor and Sarjeant, 2001; Mayor, 2005; Baucon et al., forthcoming). Taphonomically, dinosaur tracks are often difficult to move and destroy, differentiating them from skeletal fossil remains, which are more

susceptible to removal and/or erosion. Because trackways can be exposed for relatively long periods of time on rock surfaces, fossilized tracksites were known to many generations of local observers.

In prescientific cultures, such mysterious traces of extinct creatures, along with other fossil material, such as unfamiliar bones and teeth, were incorporated into myths, legends, art, music, dance, folk beliefs, and ritual practices. The ancient Greek historian Herodotus (ca 450 BC), for example, reported that the mythic heroes Hercules, Perseus, and others left sandal or barefoot marks on stones in Italy, Scythia (Ukraine), and Egypt; the tracks of mythical cattle and horses were also described in classical antiquity (Mayor and Sarjeant, 2001; Baucon et al., forthcoming). Among the most famous examples in North America are the Navajo, Apache, Zuni, Hopi, and other Southwestern Native American beliefs associated with abundant tridactyl dinosaur tracks of the Colorado Plateau, usually interpreted as the footprints of giant sacred birds (Lockley, 1991; Mayor, 2005). In the American Southwest, petroglyphs of birds, lizards, and tracks were created near impressive three-toed theropod and five-toed *Cheirotherium* track sites, demonstrating awareness and cultural significance of the footprints. Examples include Cub Creek in Dinosaur National Monument, Grand Staircase-Escalante National Monument, Flag Point Track Site in Vermillion Cliffs, and Zion National Park, all in Utah; other rock art panels replicate dinosaur tracks in Arizona and New Mexico (Mayor and Sarjeant, 2001; Mayor, 2005; Lockley et al., 2006a; Staker, 2006; Mayor, 2007). In Europe, dinosaur tracks in the Rhine Valley, Germany, supported belief in legendary dragons (Mayor and Sarjeant, 2001), and in Portugal sauropod tracks were given a religious interpretation as a giant mule that carried the Virgin Mary (Antunes and Mateus, 2003; Baucon et al., forthcoming). According to Ellenberger et al. (2005), Bushmen of Lesotho, Africa, attempted to reconstruct dinosaurs in rock art in caves based on their observations of dinosaur footprints and skeletal material.

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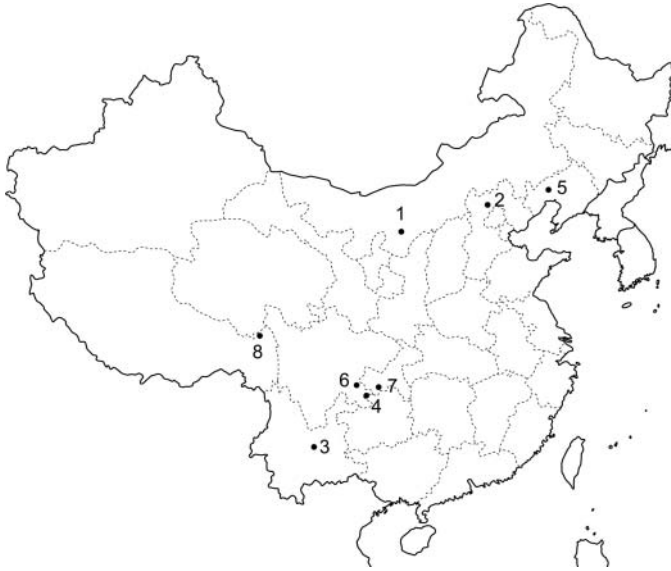


FIG. 1. Locations of Chinese track sites discussed in this paper. 1: Chabu; 2: Luofengpo; 3: Xiaoxiyan; 4: Chishui; 5: Nanbajiazi; 6: Luoguan; 7: Lianhua Baozhai; 8: Morong.

In China, the discovery of rich beds of vertebrate fossils has a long history. The most ancient record may be the *Shanhaijing* (*The Classic of Mountains and Seas*), a collection of oral mythogeographical traditions compiled beginning in the 3rd century BC (Birrell, 2000). A Chinese chronicle of the 2nd century BC noted that a canal was named Dragon-Head Waterway because “dragon bones” were unearthed there (Mayor, 2011). In China, *long* (dragon) bones was the catch-all term for the fossil remains of extinct creatures, mostly mammals but also dinosaurs, traditionally regarded as medicinal (Zhen, 1961; Li, 1974).

The first Chinese dinosaur tracksite was reported in 1929 from the Middle Jurassic Period in Shenmu County, Shaanxi Province (Teilhard de Chardin and Young, 1929). About 30 years later, these tracks were described and named *Sinoichnites youngi* (Kuhn, 1958). This represents the first formal description of dinosaur tracks in Chinese scientific history. Since then, more than 50 track sites have been discovered in China (Chen et al., 2006; Matsukawa et al., 2006).

Here, we review the links between known dinosaur tracksites in China and Chinese folklore (Fig. 1). Myths and popular legends associated with unusual tracks on stone deserve careful scientific attention by paleontologists. Recently, Chinese paleontologists have discovered heretofore unknown dinosaur fossil deposits by enlisting the help of farmers familiar with locations of “dragon bones” (Mayor, 2011). We propose that local oral traditions about footprints embedded in stone may be useful guides to identifying new fossil tracksites in China.

Folklore shows that popular interpretations of fossil footprints fall into four categories: mythical birds, mammals, plants, and gods or heroes.

## BIRD TRACKS

### Shen Niao (Divine Bird) Tracks from Chabu, Inner Mongolia

In 1979, Shang-yu Gao from the Lanzhou Institute of Desert Research, Chinese Academy of Sciences, discovered a set of theropod tracks in the Lower Cretaceous Yijinhuoluo Formation, Chabu area, Etuoke Banner, Inner Mongolia (Gao et al., 1981; site 1 on Fig. 1). This was the first scientific record of dinosaur tracks in that region. Since at least the 1950s, these tracks were well known to herdspeople of the region. They dubbed them “*Shen Niao* (Divine Bird) Tracks” because the three-toed impressions resembled the footprints of an enormous bird. The herders believed that the tracks represented beautiful wishes for human happiness left by the sacred bird Shen Niao (M. Bator, pers. comm., 2010).

Thousands of footprints from eight localities are widely distributed over an area of more than 500 km<sup>2</sup> in the Chabu area. Trackmakers include nonavian saurischian (theropod and sauropod) dinosaurs and birds (Lockley et al., 2002; Li et al., 2006, 2009). Among the abundant theropod footprints is the holotype specimen of *Chapus lockleyi* (Li et al., 2006). The track is 58.2 cm (23 inches) long and preserves distinct claw impressions (Fig. 2A). The bird-like appearance of the dinosaur impressions is the primary reason the herdsmen called them Shen Niao tracks. In addition, this tracksite does include some smaller avian footprints (Li et al., 2009) (Fig. 2B). The presence of recognizable avian tracks among the huge tracks would have encouraged the assumption that all the marks were made by birds of different sizes.

These theropod footprints from Inner Mongolia may have influenced other folk interpretations. For example, ethnic Mongolians, who practice shamanism, have long worshipped the Divine Eagle. This worship can be traced to the Hongshan culture (ca. 6500–5000 BC; Wang, 2007). Numerous historians, such as Duan Chengshi (Tang Dynasty, 618–907 BC) in the text *Yuyang Zazu* and Chen Menglei (Qing Dynasty, 1644–1912 BC) in the text *Gujin Tushu Jicheng*, have recorded legends about the Divine Eagle. It is possible that the abundance of conspicuous theropod footprints in the Chabu area was also taken as evidence of the Divine Eagle.

### Feng Huang Tracks from Chicheng, Hebei Province

In 2001, Deng-hai Sun from the Chicheng County Vocational Education Center discovered abundant dinosaur tracks at the Upper Jurassic–Lower Cretaceous Tuchengzi Formation in Chicheng County, Zhangjiakou City, Hebei Province. More than 100 tracks were attributed *Therangospodus* isp. (Fig. 2C) and *Megalosauripus* isp. All the tracks are tridactyl, ranging from 16 to 22 cm (6 to 8.5 inches) in length, and preserve claw impressions. The trackways exhibit a predominantly northwest orientation (Xing et al., in press a).

Again, these tracks had been known to the locals for many years. As Mayor (2007) pointed out, some geomythological

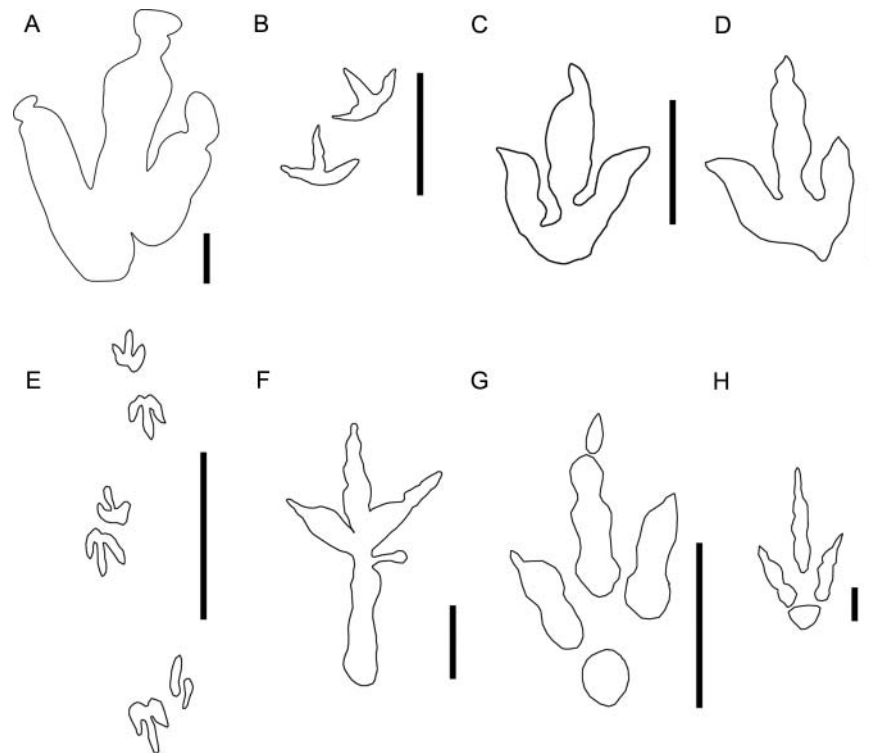


FIG. 2. Morphological diversity of “bird tracks” in China. **A.** *Chapus lockleyi* (Li et al., 2006); **B.** Undescribed avian tracks from Chabu (after Xing, 2010); **C.** *Therangospodus* (Xing et al., in press a); **D.** *Grallator limnosus* (after Zhen et al., 1986); **E.** *Grallator limnosus* trackways (after Zhen et al., 1986); **F.** Theropod tracks from Chishui (Xing et al., in press b); **G–H.** *Grallator* (after Fujita et al., 2007). A–D, F, G: scale bar = 10 cm; E: scale bar = 1 m; H: scale bar = 1 cm.

place names may reflect ancient or popular knowledge of fossil bone beds and tracksites. Traditional names and folklore about physical evidence of remarkable or sacred creatures sometimes signal paleontologically significant sites. In China, for example, the place names “Feng Huang Mountain” and “Luofengpo” derive from ancient legends about mythical birds. The dinosaur tracks reported by Deng-hai Sun in Chicheng are located on Feng Huang Mountain (altitude 1,296 m). The Feng Huang, analogous to the western Phoenix, is a mythological bird that reigns over all other birds, described in the *Shanhaijing* (Birrell, 2000). Early in the Shang Dynasty (1600 BC–1046 BC), images of the Feng Huang appeared as motifs on pottery and in bronze and jade figurines (Editorial Committee, 1997). Feng Huang birds combined fantastic and natural features and were worshipped by various ancient Chinese cultures and clans (Chang, 1982, 1987, 1999). The mountainside on which the tracksite is visible (site 2 on Fig. 1) was known as Luofengpo (or Luofenggou), which means “ravine of the fallen Feng Huang.” This particular mountain was thought to be the place where the celestial Feng Huang came to rest.

### Jin Ji (Golden Chicken) and Tian Ji (Heavenly Chicken) tracks from Yunnan, Guizhou, and Liaoning Provinces

In 1982, Shao-jin Hu from Jinning County Cultural Palace discovered abundant dinosaur tracks in the Fengjiahe Formation

(Lower Jurassic) at Xiaoxiyan Village, Xiyang Yi Nationality Village, Kunming City, Yunnan Province (site 3 on Fig. 1). Local Yi people call them the footprints of *Jin Ji* (Golden Chicken) and worship them in festivals. Evidence for domesticated poultry appeared as early as the late Neolithic in China (Yan and Yin, 1992), in Hongshan, western Liaoning (Wang, 2004; Chen, 2008). Hunting fowl and training eagles or hawks were both also ancient practices in China (Institute of Archaeology, 1961, 1984). Divine chickens and other birds were revered early in Chinese history (Sun, 2003; Jin, 2004).

Lacking an understanding of the process of fossilization, Yi storytellers assumed that the footprints were imprinted directly onto stone. The ability to create a footprint on solid stone implied something supernatural about the trackmakers. During funeral processions, villagers gather and walk along the orientation of the sacred trackway, believing that it represents the pathway to heaven (Zhang, 2002).

Zhen et al. (1986) described more than 200 dinosaur tracks at Xiaoxiyan Village, all tridactyl and possessing distinct claw impressions, and referred the specimens to the *Grallator-Eubrontes* type (Figs. 2D, E). *Grallator* tracks lack characteristic webbed toes of living anseriform waterfowl. Accordingly, the legends attributed such footprints to three-toed birds such as poultry or eagles rather than to ducks or geese.

In 1995, Chang-fu Li from the Renhuai City National Tax Bureau reported dinosaur tracks from the middle Cretaceous Jiaguan Formation at Baoyuan Township, Chishui City, Guizhou Province (site 4 on Fig. 1). Local oral traditions refer to these footprints as *Tian Ji* (Heavenly Chicken) tracks, identifiable by possessing backward-oriented “claws.” The rock in which they are preserved was termed *Xian Ji* (Celestial Chicken). In 2009 and 2010, the senior author investigated the fossil site and discovered at least seven trackways attributable to theropod dinosaurs, with footprints ranging from 22–36 cm in length. The backward-oriented “claws” actually are in impressions from the metatarsal fat pads (Fig. 2F).

Legends about *Jin Ji* tracks are also popular in west Liaoning, another region rich in dinosaur trace and body fossils. In 1992, *Wan-lian Zhang*, a journalist from the *Chaoyang Daily newspaper*, discovered numerous dinosaur tracks at the Upper Jurassic–Lower Cretaceous Tuchengzi Formation of Sijiaban Village, Nanbajiazi Township, Beipiao City, Liaoning Province (site 5 on Fig. 1). Local people have long believed that these are the tracks made by a divine Golden Hen leading her flock (Zhang, 2005). Fujita et al. (2007) described these tracks and attributed them to the theropod *ichnogenus Grallator* (Figs. 2G–H). Footprints at the site are represented by three distinct size categories: Type A, average length 4.5 cm (more than 100 footprints); Type B, average length 13.4 cm (3 footprints); and Type C, average length 16.7 cm (14 footprints). Also in honor of local legends about “Golden Chicken” tracks from the Tuchengzi Formation in Liaoning, Lockley et al. (2006b) described bird tracks named *Pullornipes aureus*, literally meaning “golden chicken tracks.” These tracks are actually attributable to birds, not theropods. Additional footprints similar in morphology to *Grallator* were discovered at another nearby fossil site (Zhang et al., 2004). *Jin Ji* and *Tian Ji* might also be names referring to the golden pheasant (*Chrysolophus pictus*) (Xu Shen [Han Dynasty: 206 BCE–220 CE] in the text *Shuowen Jiezi*; Li Shizhen [Ming Dynasty: 1368–1644] in the text *Bencao Gangmu*). A large bird with golden plumage native to China, golden pheasants were once present in this region, but their range no longer includes the areas of the trackways.

## MAMMAL TRACKS

### Legendary Rhinoceros Tracks from Fushun County, Zigong City

In 2009, Guang-zhao Peng from the Zigong Dinosaur Museum reported Early Jurassic sauropod tracks at Luoguan (or Longguan) Mountain, altitude 400 m. This site (site 6 on Fig. 1) is located at Tongsi Town, Fushun County, Zigong City, Sichuan Province (Chen and Ye, 2009). The footprints are oval, an average of 20 cm wide and 32 cm long (Fig. 3). One set of about 18 footprints comprises a distinct trackway. The tracks at Luoguan Mountain are famous among the local people who have long called them “rhinoceros footprints.” An ancient tradition



FIG. 3. Sauropod tracks interpreted as “rhinoceros footprints” at Luoguan (photograph by Guangzhao Peng). (See Color Plate III.)

recounts how a rhinoceros went to Luoguan Mountain to collect Lingzhi (reishi mushrooms, celebrated for medicinal powers) to save the life of its master. The tradition of counting the footprints to pray for good fortune is popular.

Before becoming extinct in China, the Javan rhinoceros (*Rhinoceros sondaicus*) was frequently recorded in ancient literature. For example, Mencius (4th century BC) stated that “the monarch of Zhou Dynasty (1046 BC–256 BC) drove tiger, leopard, rhinoceros, and elephants to expedition” (Mencius in the text *Mencius*). The last recorded sighting of the Javan rhinoceros in China was in 1922 at Xishuangbanna, Yunnan (National Agricultural Regional Planning Commission, 1987). Extinction of this rhinoceros in China was due in large part to changing climate and overhunting (Sun et al., 1998); the horns were valued for medicinal purposes. At Chengdu City, southwest China, about 160 km away from Zigong City, abundant fossil remains show that this area was home to both the Javan rhinoceros and Asiatic elephant (*Elephas maximus*) during the Western Zhou Dynasty period (11th century–771 BC) (Fu et al., 2006). The legend of Luoguan Mountain thus complements the ancient range of the Javan rhinoceros in Zigong.

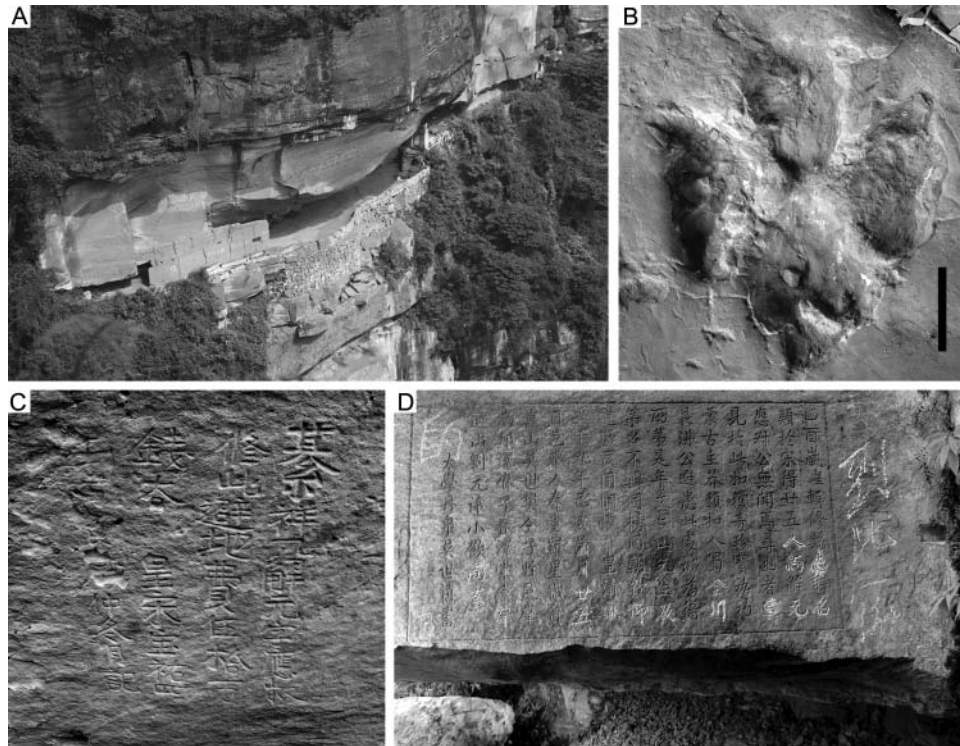


FIG. 4. Tracks at the Lianhua Baozhai site, Qijiang County. **A.** Overall profile; **B.** Hadrosaurid tracks (scale bar = 10 cm); **C.** Southern Song Dynasty rock carving; **D.** Qing Dynasty rock carving. (See Color Plate IV.)

## PLANT TRACES

### Lotus “Protector” at Lianhua Baozhai, Qijiang County

In 2006, personnel from the Qijiang County Bureau of Land and Resources, Chongqing, and the Southeast Sichuan Geological Team discovered a rich collection of dinosaur tracks (Fig. 4A) in the middle Cretaceous Jiaguan Formation of Laoying Mountain, Sanjiao Town, Qijiang County (site 7 on Fig. 1). The site includes at least 329 footprints spread over an area of 140 m<sup>2</sup>. Xing et al. (2007) attributed these to hadrosaurs (Fig. 4B), ankylosaurs, and theropods.

The tracksite is located in a massive erosional break where mudstone has been weathered from between thick sandstone layers in a cliff. A rock shelter was built at this fossil site about 750 years ago. During our investigations in 2007 and 2009, we discovered a *rock-carved inscription* dating to the Southern Song Dynasty (Fig. 4C). The inscription reads: “Qi Xiangyi, courtesy named Yinshu, Jieyuan [a scholar who won first place in provincial imperial examinations] it cost 500 thousand Qian [ancient Chinese currency] to build this shelter. In the winter of Baoyou 4th year [1256], Southern Song Dynasty.” This is the first record of construction at the fossil site, apparently selected because the tracks were interpreted as bestowing supernatural protection. The structure might have been part of defenses against attacks from Mongolia (Tuo, 2006). In Daoguang 19th year (1839), a military officer writing the history of Qijiang

County confirmed the history of the shelter and left another inscription (Fig. 4D). In Tongzhi 1st year, Qing Dynasty (1862), the site was named Lianhua Baozhai, which translates as “the mountain stronghold protected by lotus.”

In Asian cultures, the lotus symbolized purity because the beautiful water lily flowers arise unstained from mud. According to local folklore, the hardened mud cracks at the tracksite represent the veins of lotus leaves. The hadrosaur tracks with ovoid digits II–IV and clover-leaf-shaped metatarsophalangeal pads were interpreted as the remains of the petals of the lotus blossoms. Fossilized ripple marks preserved on the strata indicated the past aquatic environment. Anticipating the modern sedimentological interpretations, these ripple marks were noticed in antiquity and suggested the watery habitat of lotus flowers.

## TRACKS OF DEITIES AND HEROES

### Tracks of the Mountain Deity and King Gesar, Morong Village, Changdu County, Tibet

In 1999, construction workers discovered several large footprints while building the No. 214 state highway to connect Bangda Airport and Changdu County in Morong Village, Aixi Township, Changdu County, Changdu Prefecture, Tibet Autonomous Region (site 8 on Fig. 1). Local Tibetans declared that the road construction crew had disturbed the Shan Shen

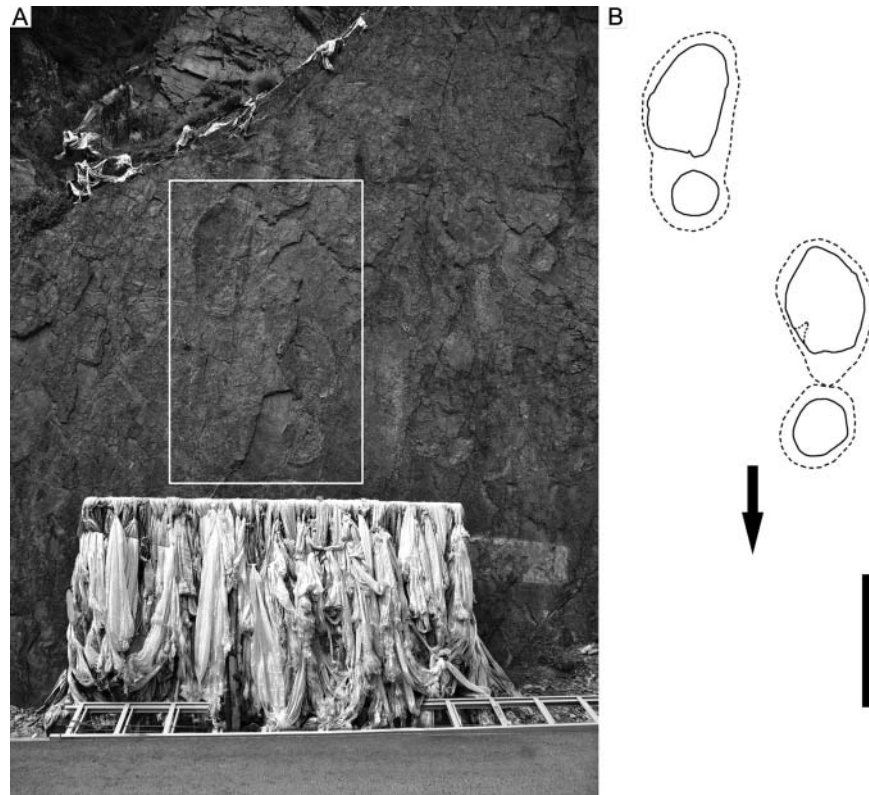


FIG. 5. “King Gesar’s footprints,” Morong track site, Tibet. **A.** Photographs; **B.** Outline drawings (scale bar = 1 m). (See Color Plate V.)

(Deity of the Mountains). According to the villagers, the alarmed Shan Shen escaped from its mountain home, leaving the footprints. Other Tibetans maintained that the footprints had been left by mythological warrior King Gesar, hero of the national epic poem of Tibet which is about 1,000 years old and is based on folktales, legends, songs, and proverbs. One of the few living epics remaining in the modern world, it is still passed down orally from one generation to the next by ballad singers. The epic is familiar among Tibetan, Buryat, Tu, and Mongolian ethnic groups, especially farmers and herders (Wang et al., 2009). Tibetan religion combines ancient native shamanism with later Himalayan Lamaist Buddhism (Liu, 2003). *Khata*s (traditional ceremonial scarves used at sacred places in Tibet and Mongolia) have been tied near the footprint site (Fig. 5A).

In 2000, 2003, and 2010, the senior author studied these dinosaur tracks, which represent sauropod manus prints that range from 57–64 cm in length and pes prints that range from 104–112 cm in length (Fig. 5; Xing et al., 2011). Manus prints overlap the pes prints, giving the impressions the appearance of large humanoid footprints. This seemingly human shape of the tracks influenced the local legends of the Mountain Deity and King Gesar.

## CONCLUSION

Ancient Chinese people were accustomed to attributing inexplicable natural evidence to mythical beings or supernatural

events (Ding, 1961; Tian, 1998). Despite the mythological terms and concepts, however, the traditional interpretations of fossil dinosaur footprints were based on careful observation of size, shape, and surrounding sediments. Certain generalizations were evident. In geographically disparate regions, fossilized dinosaur tracks were identified and attributed to various organisms depending on the shapes, sizes, and surrounding sediments of the trackways. Because living birds were the only known creatures with three toes, tridactyl theropod tracks with claw impressions on stone were attributed to divine birds, as in the examples of Feng Huang, Jin Ji, Tian Ji, and Shen Niao. However, in some cases the Cretaceous tracks observed may have been actual bird tracks (Lockley et al., 2006b). These associations, based on ancient cultural worship of supernatural birds, matched the distinctive shapes of the tracks. Similar interpretations based on comparison of the strange tracks to those of living species of birds and mammals are found around the world. For example, some Native Americans associated theropod trackways with giant raptors or thunderbirds, while indigenous people of Brazil interpreted such prints as the tracks of giant, flightless, ratite birds like the rhea, which is native to South America (Mayor and Sarjeant, 2001; Mayor, 2005; Lockley et al., 2006a). Other folkloric explanations identified the large, rounded tracks left by sauropods and imagined their makers as divine mammals, such as super-sized rhinoceroses such as at Luoguan Mountain, Sichuan. Overlapping sauropod tracks resembling gigantic

human footprints have led to anthropomorphic interpretations, as in Tibet. Thus, folk references to the traces of mythical or special birds, mammals, plants, or humanoid beings could serve as important clues for locating dinosaur track sites new to science. The folk descriptions and names may even signal the kinds of dinosaur species represented there. We suggest that in China, as a supplement to geological and paleontological clues, local oral traditions are worthy of scientific attention.

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