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Paleoecological Evolution of the Fossil Suidae (Mammalia, Artiodactyla) in Neogene of Central Myanmar

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Abstract

In this work, the dental morphology the Neogene fossil Suidae of central Myanmar are analyzed, and the paleoecological evolution of the Neogene fossil suids are discussed. Morphological evolution of the third molar in suids has been considered an adaptation to more abrasive diet, that is from a browsing to grazing diets. In Myanmar, three distinct types of diet, predominant frugivore (Middle to Late Miocene), frugivore to hyperbrowser or folivore (Late Miocene to Early Pliocene) and predominant folivore (Middle Pliocene to Early Pleistocene), have been distinguished in the dental characteristics of suid fossils. The pattern of faunal transition in Neogene suids strongly suggests a critical floral change at the Late Miocene in Myanmar. The coexisted appearance of *Propotamochoerus* with *Sivachoerus* suggesting that the C3-C4 floral transition accompanying the last faunal turnover may have occurred to bring wide spreading of C4 plants in the Early Pliocene of Myanmar, later than that in Late Miocene of Siwalik of Indo-Pakistan.

Key Words: Neogene, Paleoecological evolution, Suidae

Introduction

Suidae is one of the most widely known Cenozoic fossil artiodactyls in Asia. At present, the earliest known fossil suid is recorded from the Late Eocene of Krabi Basin, Thailand, Southeast Asia (Ducrocq *et al.*, 1998). Fossil materials of Suidae have been discovered from the Neogene deposits of Myanmar. In the early 20th Century, there were some descriptions on suid materials of Myanmar but few detail systematic descriptions and discussions (Pilgrim, 1910a, 1910b, 1926, 1927; Matthew, 1929; Colbert, 1935, 1938, 1943; Cotter, 1938). These descriptions were done based on very few specimens, most of which are so poorly preserved that it is too inadequate for us to discuss their phylogeny and paleobiogeography. Recently, some genera of Myanmar Suidae have been revised within these years (Chit Sein *et al.*, 2009; Thaung Htike, 2008; Thaung-Htike *et al.*, 2005, 2006, 2007, 2008, 2010, 2014)

In Myanmar, the fossil materials of Suidae are recovered throughout the Neogene but relatively rare compared to other artiodactyls such as Bovidae and Hippopotamidae. Most suid genera of Myanmar can be correlated with those of Siwalik. The chronology of the Myanmar suids has been estimated mostly by comparing with their occurrences in Siwalik. Within these years, some new materials of Myanmar Suidae were discovered together with some well known mammalian fossils, which are not contemporaneous in Siwalik. It suggests that the first and last appearances of some Myanmar taxa may not be identical with those of the Siwalik taxa.

Three subfamilies, seven genera and at least 12 species of fossil Suidae have been identified from the Neogene sediments of Myanmar. In this study, well-preserved dentognathic materials of the fossil suids of Myanmar, most of them were discovered from the known horizons of Neogene deposits during the recent paleontological works, are studied, and it investigate the paleoecological evolution of the Neogene fossil suids are discussed.

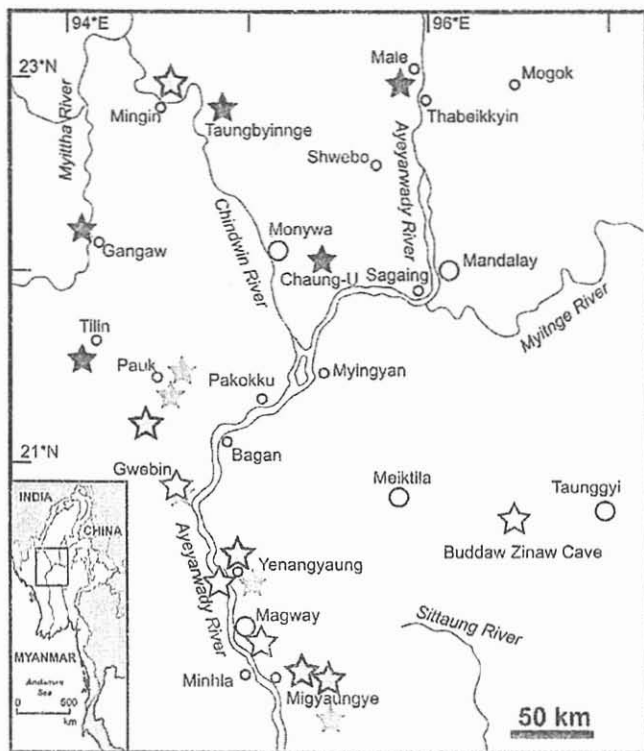
Materials and methods

Recently discovered dentognathic materials of Myanmar suids have been studied in this work (Table 1). All new fossil materials were collected in central Myanmar (Figure 1). They are now stored at the National Museum (Yangon, Myanmar), Department of Geology,

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University of Yangon (Yangon, Myanmar), Department of Geology, Mandalay University (Mandalay, Myanmar), Department of Geology, Magway University (Magway, Myanmar), and the Sagaing Buddha Museum, Sagaing, Myanmar. Dental terminology and measurement method used are according to Thaug-htike *et al.* (2006) (Figure 2).

The length of lower first molar has been used to compare the body size differences because M_1 is usually considered to express less size variation than other teeth, and mandibular fragments with lower cheek teeth are discovered more frequently than maxillary ones in general. Moreover M_1 length has been used to correlate to the body size by many workers (Legendre, 1986, 1989; Bown *et al.*, 1994; Damuth, 1999; Tsubamoto *et al.*, 2002, 2003).



Suid fossil localities

- | | |
|----------------------------|----------------------------|
| ★ M. Miocene localities | ★ L. L. Miocene - Pliocene |
| ☆ E. L. Miocene localities | ☆ Pleistocene |

Figure (1) Neogene suid fossil localities in central Myanmar.

Results

Occurrence and paleobiogeography of the fossil Suidae of Myanmar

In Myanmar, the first occurrence of fossil Suidae is introduced by *Listriodon* and *Tetraconodon* during the Middle Miocene. The origin of Listriodontinae is unknown, but the oldest record of Listriodontinae in Asia is in the Early Miocene of Bugti, Pakistan. Later

members of the subfamily are found in Europe and China, suggesting that the early listriodontines evolved somewhere south of the Himalayas (Made, 1996). In Siwalik, *Listriodon pentapotamiae* has been discovered from the Middle Miocene Chinji Formation. *Listriodon* has also been discovered from the late Middle Miocene in the southern part of China. The discovery of *Listriodon pentapotamiae* in Myanmar was reported by Pilgrim (1927). The associated fauna of Gomphotheriidae suggested the Middle Miocene occurrence. Although some trilophodont gomphotheres are contemporaneous with *Prodeinotherium* sp. in Thanbinkan area, there is no record for *Listriodon* from that area. The locality of *Listriodon* is in the northern part of central Myanmar, near the border of India, suggesting that Myanmar species might be an easternmost distribution of Siwalik species, during its dispersal from Siwalik to southern China.

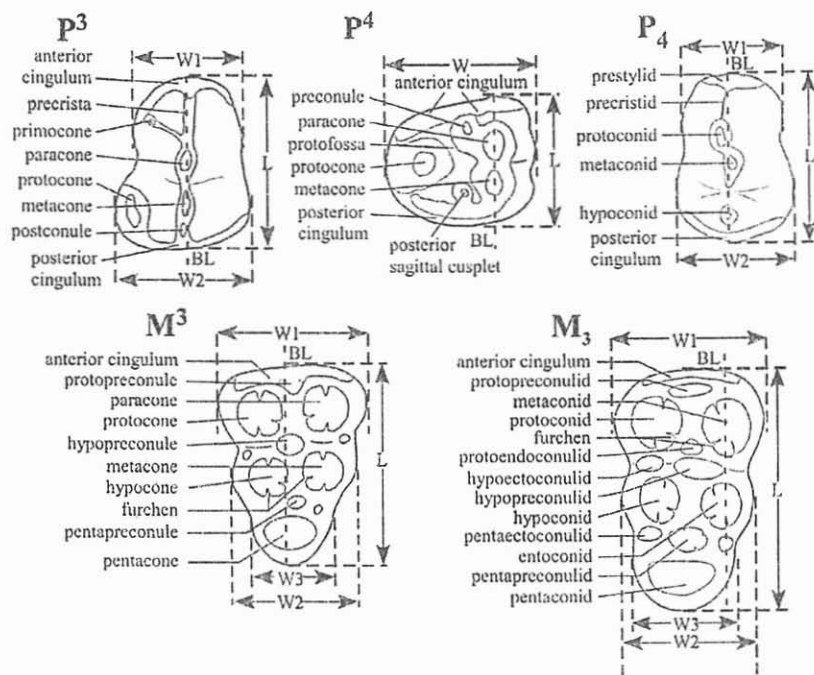


Figure (2) Dental terminology and measurement method of suid teeth.

All are left cheek teeth. Abbreviations: BL = base line; L = length; W = maximum width; W₁ = width of the first lobe; W₂ = width of the second lobe; W₃ = width of the third lobe in M³/₃ (upper and lower third molar).

The first appearance of *Tetraconodon* in Myanmar is associated with *Prodeinotherium* sp. and *Choerolophodon corrugatus*, suggesting the early Middle Miocene. The last occurrence of *Tetraconodon* in central Myanmar is from the basal strata of Irrawaddy Formation which is characterized by the co-occurrence with *Hipparion* sp. The arrival of an ancient horse, *Hipparion*, in the Indian Subcontinent from North America has recently been considered 11.1 Ma (Pickford & Liu, 2001). The occurrence of *Hipparion* in Myanmar is only from the basal part of Irrawaddy Formation, slightly above the "Red Beds" in Yenangyaung. In Siwalik, the Last appearance of *Tetraconodon*, *T. magnus*, has been suggested 9.3 Ma, early Late Miocene

(Barry et al., 2002). Large *Tetraconodon* of Siwalik and Myanmar may have become extinct during the early Late Miocene, after the first appearance of *Propotamochoerus* sp. In Myanmar, both the smallest and largest suids are *Tetraconodon*, and up to 5 species have been discovered between a relatively short period (the early Middle Miocene and early Late Miocene), suggesting that Myanmar was the most suitable environment for *Tetraconodon* during the late Middle Miocene and earliest Late Miocene.

The earliest Late Miocene time in Myanmar is also associated with the occurrence of *Parachleuastochoerus* sp., which was discovered also from the basal Irrawaddy deposits. The occurrence of *Parachleuastochoerus* sp. in Myanmar is contemporaneous with early Late Miocene *T. minor*, suggesting that *Parachleuastochoerus* sp. is also a member of the early Late Miocene fauna. In Asia, *Parachleuastochoerus sinensis* has been recorded from early Late Miocene of southern China and northern Thailand (Pickford & Liu, 2001; Pickford et al., 2004). The Dental size of *Parachleuastochoerus sinensis* is slightly larger than that of Myanmar *Parachleuastochoerus* sp. The oldest record of *Parachleuastochoerus* in the world is from the latest Middle Miocene (Made, 1999) in Europe, suggesting a probable migration of this genus from Europe to Asia (Pickford, 2001). Because of smaller size in Myanmar species compared to southern China and Thailand species, *Parachleuastochoerus* sp. of Myanmar might be an "intermediate" form of *Parachleuastochoerus*, which may have migrated from Europe to southern China and Thailand.

The first appearance of *Propotamochoerus* sp. in Myanmar is associated with the Late Miocene forms of China and Siwalik, *Propotamochoerus wui* and *P. hysudricus* (Chit Sein et al., 2009; Thaug Htike et al., 2006). However *P. wui* has not been recorded from Siwalik, suggesting that Myanmar species is the western extremity of the distribution of *P. wui*. In Myanmar, *P. hysudricus* is also contemporaneous with Pliocene tetraconodont, *Sivachoerus* prior. These two taxa are not associated in Siwalik fauna of northern Pakistan (Barry et al., 1982, 2002). *P. hysudricus* has been recorded from the Pliocene deposit of southern China, suggesting that *P. hysudricus* eastwardly spread from Siwalik during the late Miocene, appeared in Myanmar during the late Miocene, and reached China in the Pliocene.

Sivachoerus is contemporaneous with *Propotamochoerus hysudricus* in early Pliocene and cf. *Sus* sp. in the Middle to Late Pliocene. It is a typical Pliocene faunal member of Siwalik, and has been suggested as an immigrant from Africa. The first appearance of this species in Myanmar is not earlier than the Pliocene, suggesting that *Sivachoerus* migrated into Myanmar via Siwalik during Pliocene.

In Siwalik, *Sus*-like suid has been recorded from the Pliocene (Pickford, 1988) and it might be an immigrant form of Europe. In Myanmar, *Sus*-like species, cf. *Sus* sp., is recorded from the upper part of Irrawaddy deposit associate with Pliocene hippos, *Hexaprotodon iravaticus* and *Hex. sivalensis*. It suggests that the late Pliocene appearance of *Sus*-like suids in Myanmar can be correlated with that in Siwalik.

In the Pleistocene, *Potamochoerus* sp. widely occurred in Siwalik and China contemporaneously with *Sus* sp. In Myanmar, it is also associated with *Sus* sp. cf. *S. scrofa* suggesting that *Potamochoerus* widely spread in South Asia and northern part of Southeast Asia during the Pleistocene.

Nowadays, only single species, *Sus scrofa*, is distributed in Myanmar. The occurrences of that species in the Recent cave deposits suggest that present day wild boar appeared in Myanmar since the prehistoric times.

