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A review of fossil rhinoceroses from the Neogene of Myanmar with description of new specimens from the Irrawaddy Sediments

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ABSTRACT

Four genera and one indeterminate genus (total eight species) of fossil rhinoceroses (Mammalia; Perissodactyla; Rhinocerotidae) are recognized from the Neogene of central Myanmar. In the early Miocene, most area of central Myanmar were under the shallow marine condition, and no rhinocerotid remain has been documented yet. During the middle to late Miocene, the rhinocerotid remains are commonly found and are represented by "*Diceratherium*" *naricum*, *Brachypotherium perimense*, *Brachypotherium fatehjangense* and an indeterminate rhinocerotid. In the latest Miocene, these archaic rhinoceroses became extinct. In the late Neogene, the extant genera, *Rhinoceros* (late Miocene to Pleistocene) and *Dicerorhinus* (Plio-Pleistocene) first appeared in Myanmar. They appear to have dispersed to the Island Southeast Asia from the continental Asia during the early Pleistocene to middle Pleistocene when the eustatic sea level became low remarkably.

1. Introduction

Rhinoceroses, the family Rhinocerotidae, currently inhabit in Africa and South and Southeast Asia, represented by four genera and five species (Nowak, 1999). In the fossil record, the family was widely distributed in Eurasia, North America and Africa. The rhinocerotids were well diversified in the late Eocene to the early Oligocene of North America, although they were still poorly documented in contemporaneous Eurasia (Prothero and Schoch, 2002; Antoine et al., 2003a). In the late Oligocene, they began to diverge into major subfamilies and became common land mammals in the Neogene fauna of Europe, Africa, North America and Asia (Carrol, 1988). During the Neogene, they were widely spread in Eurasia, North America and Africa, showing high taxonomic diversity in the fossil records (Prothero et al., 1989; Prothero and Schoch, 2002). In the Pliocene, they were extinct in North America, but some rhinoceroses survived the Pleistocene in Eurasia (Prothero and Schoch, 2002; Prothero, 2005).

Fossil remains of rhinoceroses are common in the Neogene of central Myanmar and several species have been recognized (Pilgrim, 1910a; Colbert, 1938, 1943; Cotter, 1938; Chavasseau et al., 2006; Zin-Maung-Maung-Thein et al., 2006, 2008). However, most of the descriptions on these specimens have been provisional due to the fragmentary nature of materials. Furthermore, there has been no revision on the Neogene fossil rhinoceroses of Myanmar since Colbert (1938). In this work, we review the fossil rhinoceroses from the Neogene of Myanmar, describing several new specimens recovered from the Irrawaddy sediments.

2. Geological setting

The terrestrial Neogene sediments are widely distributed along Irrawaddy (=Ayeyarwaddy) and Chindwin Rivers in the central part of Myanmar (Fig. 1). These sediments are mainly composed of fluviatile sediments and are characterized by the abundance of silicified fossil woods. They interfinger with the marine deposits of the Oligocene to Miocene Pegu Group (between 20° and 22° N) in the northern part of central Myanmar. The interfingering was caused by the marine transgression and regression during the Miocene and later periods (Stamp, 1922). The terrestrial Neogene sediments of Myanmar yield remains of many terrestrial and aquatic vertebrates. The geological ages of these sediments have been esti-

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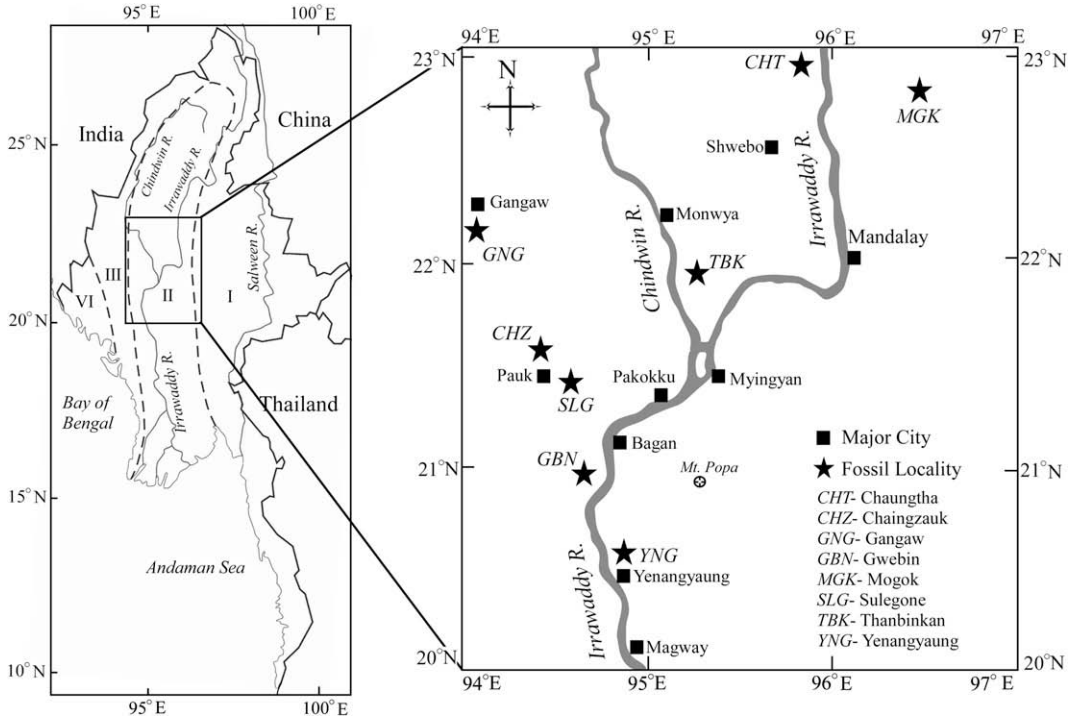

Fig. 1. Map of Myanmar, showing four major geological regions (left) and the fossil localities of rhinoceros in central Myanmar (right). I. Sino-Burman Ranges, II. Central Cenozoic Belt, III. Indo-Burman Ranges, IV. Arakan Coastal Plain.

mated on the basis of the correlation of vertebrate faunas to those of the Indian Subcontinent and China. However, at present, most of the mammalian fossils recovered from the terrestrial Neogene of Myanmar are fragmentary and the exact geological ages of these sediments have not been fully understood with confidence.

The terrestrial Neogene of Myanmar can be divided into three major units: in ascending order, the Freshwater Pegu Beds, Irrawaddy sediments and River Terrace Deposits (Fig. 2). Most of the fossil mammals from the Freshwater Pegu Beds show resemblances to those from the Kamlial and Chinji Formations of the Siwalik Group, suggesting an early to middle Miocene age (Takai et al., 2006). On the other hand, Colbert (1938) suggested an age of Oligocene through the late Miocene for Freshwater Pegu Beds on the basis of occurrence of the amynodont *Cadurcotherium*, the anthracothere *Telmatodon* sp., and the tragulid *Dorcatherium*. The Irrawaddy sediments are traditionally subdivided into upper and lower parts (Colbert, 1935; Bender, 1983). The Lower Irrawaddy sediments have been correlated to the Dhok Pathan Formation of the Siwalik Group, suggesting an age of the late Miocene to early Pliocene. However, the base of the Lower Irrawaddy sediments probably extends to the late middle Miocene because some taxa from the Lower Irrawaddy sediments, such as *Hemimeryx blanfordi*, *Brachypotheium fatehjangense*, *Siamotragulus* sp., and *Conohyus thailandicus* also occur in the Chinji Fauna of Indian Subcontinent (Bender, 1983; Chavasseau et al., 2006). The Upper Irrawaddy sediments have been conventionally referred to the early Pleistocene (Colbert, 1938, 1943; Bender, 1983). However, the Upper Irrawaddy fauna shows close resemblances to the Tatrot and Pinjor

Ma	Geological age		Myanmar		Indian Subcontinent	East Asia	Europe
	Pleistocene		River Terrace Deposits		Boulder conglomerate	Nihewanian	Biharian
	Pliocene	L	Irrawaddy sediments	Upper Irrawaddy	Pinjor		Villafranchian
		E			Tatrot	Yushean	Ruscinian
5	Miocene	L		Lower Irrawaddy	Dhok Pathan	Baodean/ Lufengian	Turolian
10					Nagri		Vallesian
		M			Chinji	Tunggurian	Astaracian
15			Freshwater Pegu Beds		Kamlial	Shanwangian	Orleanian
20		E			Dera Bugti	Xiejian	Agenian

Fig. 2. Stratigraphy of Neogene sediments in central Myanmar and their correlations to stratigraphy of the Indian Subcontinent and land mammal ages of East Asia and Europe.