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The first discovery of *Parachleuastochoerus* (Mammalia, Artiodactyla, Suidae) from the Late Miocene of Myanmar

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Abstract

In this study, the discovery of a small-sized tetraconodont suid, *Parachleuastochoerus* (Mammalia, Artiodactyla, Suidae) from the Mingin and Yenangyaung townships of Myanmar is reported. The maxillary and mandibular fragments of *Parachleuastochoerus*, are firstly recorded from the basal part of the Irrawaddy Formation (Late Miocene) of Myanmar. The dental characteristics in Myanmar species compared to Europe, southern China and Thailand species indicate that *Parachleuastochoerus* sp. of Myanmar might be an "intermediate" form, which may have occurred during the migration of from Europe to Asia.

Key words: First discovery, Late Miocene, *Parachleuastochoerus*

Introduction

Among the tetraconodont suids, small to gigantic extinct pigs with enlarged third and fourth premolars and reduced first and second molars, *Parachleuastochoerus* is known well from Europe but poor from Asia. *Parachleuastochoerus* species are the smallest among the tetraconodont suids not only their size but also for their less size variation between posterior premolars and molars. In Asia, it has been known a single species from the Late Miocene of southern China and Thailand. The dental sizes of Asian species are distinctly larger compared to the Middle Miocene species of Europe.

During the recent works in Myanmar, the maxillary and mandibular fragments of *Parachleuastochoerus* were discovered from the Mingin and Yenangyaung townships. It is the first discovery in Myanmar. In this study the description of the Myanmar specimens are carried out and the distribution and phylogeny of the *Parachleuastochoerus* are reevaluated.

Abbreviations

NMM, National Museum, Yangon, Myanmar; MUDG-V, Mandalay University, Department of Geology-Vertebrate; P, premolar; M, molar.

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Geologic setting

The new dentognathic materials of *Parachleuastochoerus* are recovered from the lower part of the Irrawaddy Formation (Aung Khin & Kyaw Win, 1969) near Mingin Township, Sagaing Division and Yenangyaung Township, Magway Division (Figure 1). At Yenangyaung, the Irrawaddy Formation unconformably overlies the Kyaukkok Formation (Middle Miocene) of the Upper Pegu Group, and is unconformably overlain by the Middle Pleistocene Terrace Deposits. A mandible of the *Parachleuastochoerus* was discovered about the 50m above the base of the Irrawaddy Formation at Yenangyaung

The most common lithology for the Irrawaddy deposits is light colored, medium- to thick-bedded, medium- to coarse-grained, loosely consolidated sandstone with medium to large scale cross stratification and intercalation of clayey siltstone. Sandstone concretions are abundant in the sediments of the Lower more than of the Upper Irrawaddy. As for the Lower Irrawaddy deposits, coarse-grained massive sandstone beds with repetition of channel leg deposits are mostly common in the lower part, and fine sand with intercalation of clayey siltstone and mud clasts are common in the upper

A lot of mammalian fossils have been discovered from the Irrawaddy deposits, and suggested that the Late Miocene to Early Pleistocene equivalent for those strata (Bender, 1983).

Materials and Methods

The materials of *Parachleuastochoerus* are now stored at the National Museum (Yangon, Myanmar) and Department of Geology, University of Mandalay (Mandalay, Myanmar). Dental terminology and measurement method used are according to Thuang-Htike *et al.* (2005) (Figure 2). Dental measurements of the correlated foreign specimens were adopted from Heissig (1989), Pickford (1981), Pickford and Liu (2001), Pickford *et al.* (2004) and personal measurements data of J. van der Made. The length of first molar have been considered to express less size variation and chosen for the diagnoses of tetraconodont suids to compare the body size differences. The dental measurements of the newly discovered and correlated specimens are described in Table 1 and 2.



Figure 1. The fossil localities of *Parachleuastochoerus* in Myanmar.

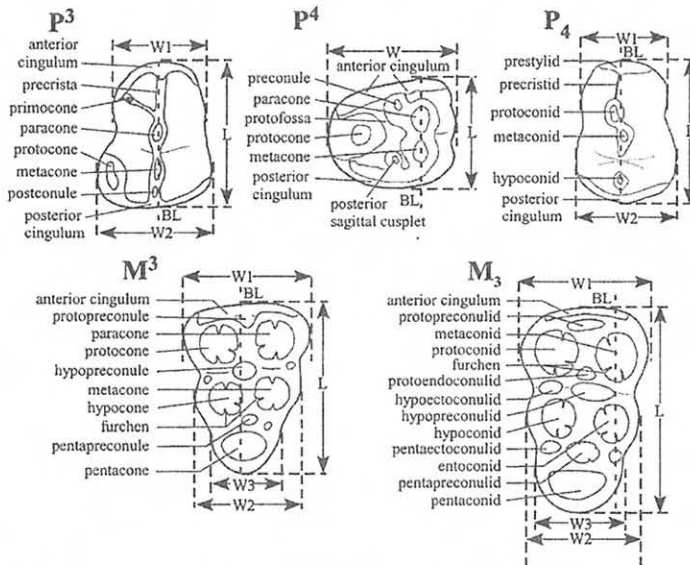


Figure 2. Dental terminology and measurement method of suid teeth. All are left cheek teeth. Abbreviations: BL = base line; L = length; W = maximum width; W1 = width of the first lobe; W2 = width of the second lobe; W3 = width of the third lobe in $M^{3/3}$

Systematic paleontology

Order Artiodactyla Owen, 1848

Family Suidae Gray, 1821

Subfamily Tetraconodontinae Lydekker, 1876

Dental diagnosis.—Small to gigantic Suidae with enlarged third and fourth premolars and reduced first and second molars. Enamel of the cheek teeth is thick and wrinkled. Furchen are wide and shallow. The buccal cingulum on the upper molars is distinct in the most species.

Genus *Parachleuastochoerus* Golpe Posse, 1972

Dental diagnosis.—Small tetraconodont with narrowest and relatively smallest premolars. The lower molars are narrower but longer than other small sized tetraconodont. Furchen in molars are distinct but shallow.

Type species.—*Parachleuastochoerus crusafonti* Golpe Posse, 1972

Other included species.—*Parachleuastochoerus steinheimensis* Fraas, 1870; *P. huenermanni* Heissig, 1989; *P. sinensis* Pickford & Liu, 2001.

Parachleuastochoerus sp. Golpe Posse, 1972

Figure 3

Distribution.—Most of the species of *Parachleuastochoerus* has been discovered from southern Europe except for *P. sinensis* which has been discovered from southern China and northern Thailand (Pickford *et al.*, 2004).

New material.—NMM Su 2, right mandibular fragment with M₃; NMM Su 3, right mandibular fragment with P₄, posterior part of P₃ and alveolus of P₂; NMM Su 4, left mandibular fragment with P₄, posterior part of P₃, alveolus of P₂ and anterior root of M₁, NMM Su 5, right maxillary fragment with M², NMM Su 6, left maxillary fragment with P³⁻⁴, NMM Su 7, left M², NMM Su 8, right P⁴, MUDG-V 1101, left mandibular fragment with M₃, and root of M₂.

Locality of new material.—NMM Su 2 - 8 are recorded near Mingin City, Sagaing Township, but exact locality of them are unknown. MUDG-V 1101 is discovered from Twingone, Yenangyaung City, Magway Division (20°29'07.1"N; 094°54'00.9"E) (Figure 1).

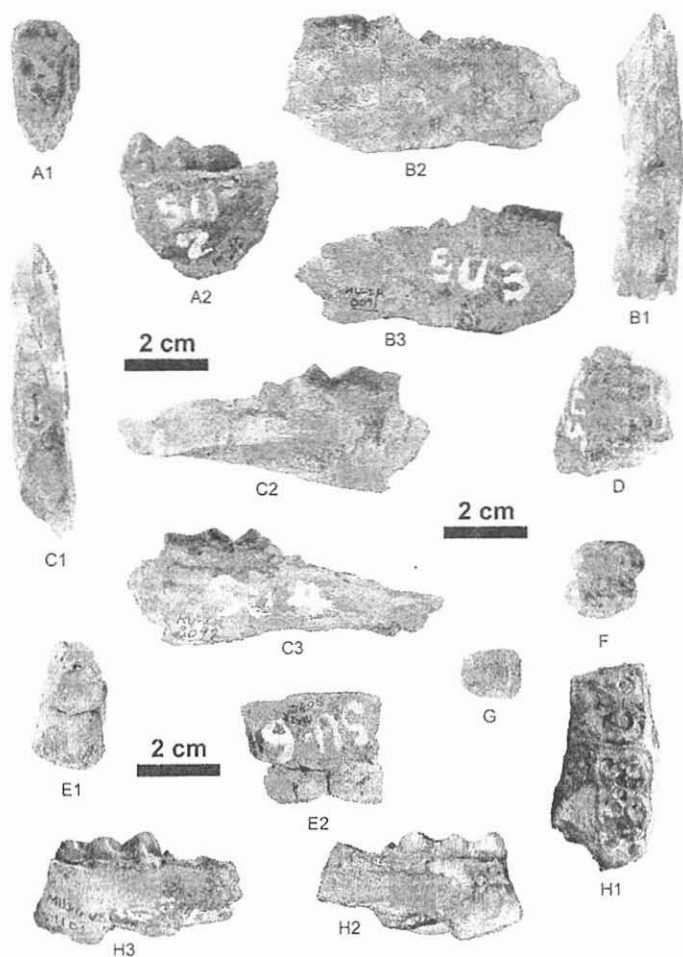


Figure 3. A-H, *Parachlenastochoeerus* sp. A, NMM Su 2, right mandibular fragment with M₃: A1, occlusal view; A2, lingual view. B, NMM Su 3, right mandibular fragment with P₄, posterior part of P₃ and alveolus of P₂: B1, occlusal view; B2, buccal view; B3, lingual view. C, NMM Su 4, left mandibular fragment with P₄, posterior part of P₃, alveolus of P₂ and anterior root of M₁: C1, occlusal view; C2, buccal view; C3, lingual view. D, NMM Su 5, right maxillary fragment with M²: occlusal view. E, NMM Su 6, left maxillary fragment with P³⁻⁴: E1, occlusal view; E2, buccal view. F, NMM Su 7, left M²: occlusal view. G, NMM Su 8, right P⁴, occlusal view. H, MUDG-V 1101, left mandibular fragment with M₃, and root of M₂: H1, occlusal view; H2, buccal view; H3, lingual view.

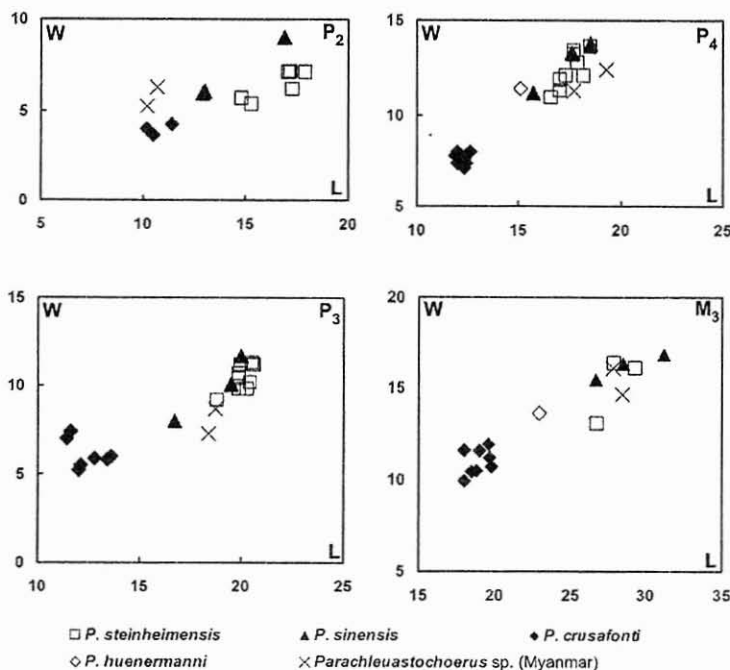


Figure 4. Bivariate plots for dental measurements of *Parachleuastochoerus* of Myanmar, Europe, China and Thailand. Measurements are described in Table 1. L = mesiodistal length. W = buccolingual width. Measurements data are in mm.

Taxa	Spec. no.	References	P ¹		P ²		M ¹			M ²			M ³		
			L	W	L	W	L	W1	W2	L	W1	W2	L	W1	W2
<i>Parachleuastochoerus</i> sp.	NMM SL-6	NMMP-KU-IR 0054	16.8	13.8	13.5	15.4	-	-	-	-	-	-	-	-	-
<i>Parachleuastochoerus</i> sp.	NMM SL-8	NMMP-KU-IR 0056	-	-	13.6	15.3	-	-	-	-	-	-	-	-	-
<i>Parachleuastochoerus</i> sp.	NMM SL-5	NMMP-KU-IR 0053	-	-	-	-	-	-	20.2	19.7	19.0	-	-	-	-
<i>Parachleuastochoerus</i> sp.	NMM SL-7	NMMP-KU-IR 0055	-	-	-	-	-	-	20.4	19.8	19.0	-	-	-	-

Taxa	Spec. no.	References	P ₂		P ₃			P ₄			M ₁			M ₂		
			L	W	L	W1	W2	L	W1	W2	L	W1	W2	L	W1	W2
<i>Parachleuastochoerus</i> sp.	NMM SL-4	NMMP-KU-IR 0052	10.2*	5.6*	18.7	8.7	8.7	19.3	10.3	12.4	-	-	-	-	-	-
<i>Parachleuastochoerus</i> sp.	NMM SL-3	NMMP-KU-IR 0051	10.7*	6.3*	18.4	-	7.3	17.7	10.2	11.3	-	-	-	-	-	-
<i>Parachleuastochoerus</i> sp.	NMM SL-2	NMMP-KU-IR 0050	-	-	-	-	-	-	-	-	-	-	-	27.9	16.1	14.0
<i>Parachleuastochoerus</i> sp.	MUDG-V 1101	-	-	-	-	-	-	-	-	-	19*	14.5*	14*	28.5	14.7	13.3

Table 1. Dental measurements (mm) of the Myanmar *Parachleuastochoerus* specimens, * = estimate.

Horizon and age—Basal part of Irrawaddy Group, early Late Miocene.

Description.—Isolated premolars and molars are mostly known. Base of the mandible in NMM Su 3 and 4 are broken, but the remaining fragments of dorsal portion indicate formerly deep mandible of these specimens (Figure 3, B&C). Upper and lower premolars show rounded buccal and lingual out line which can be seen mostly in tetraconodont suids.

P³ and P⁴ are highly worn, and it is difficult to trace their occlusal morphology. Anterior cingulum in P³ is very small and indistinct. Precrista of P³ is thick and distinct. Only M² is known for upper molar, and nearly square in occlusal outline. Thick enamel and shallow furchen are distinct in upper molar.

Crown morphology of P₂ is unknown because only root is preserved. The mesiodistal length of the root of P₂ is greatly shorter than that of P₃, which is a diagnosis of Tetraconodontinae. P₃ is nearly as mesiodistally long as but much narrower than P₄. P₃ is damage in all specimens so its occlusal morphology can not be traced. A distinct distal crest descends to a posterior minute cusplet of P₃. Buccal and lingual walls of P₃ are rounded in outline.

P₄ is worn. Its buccal and lingual walls are rounded. Isolated and centered protoconid can be traced. The prestylid of P₄ is beaded and distinctly lower. Precristid is distinct. Hypoconid is inflated. Small grooves are distinct in buccal and lingual walls, which separate protoconid and hypoconid.

The M₂ crown is not preserved, but, judging from the root width, M₃ is narrower than M₂, which is a characteristic of tetraconodont suids. M₃ has five bunodont main cusps (protoconid, metaconid, hypoconid, entoconid and pentaconid) with very thick enamel and shallow furchen are distinct. Distal border of M₃ has rounded outline. Hypoectoconulid, pentaectoconulid and pentapreconulid are distinct. Other minor cusps are worn out and indistinct.

Discussion

Sizes of isolated molars and premolars are similar to those of the Late Miocene to Pliocene *Propotamochoerus hysudricus* (Artiodactyla, Suidae, Suinae). However it can be identified as tetraconodontines by the following features, small, distinctly shorter P_2 than P_3 , thick enamel and shallow furchen in molars, nearly square occlusal outline in upper molar, and rounded P^3 with small and indistinct anterior cingulum. Appreciably narrow P_3 and P_4 in the present specimens is a characteristic only seen in *Parachleuastochoerus* among tetraconodont suids. The dental sizes of present specimens are distinctly larger than *Parachleuastochoerus crusafonti*, slightly larger than *P. huenermanni*, and slightly smaller than those of *P. steinheimensis* and *P. sinensis* (Figure 4). Mostly isolated cheek teeth for Myanmar specimens are difficult to identify on species level.

Tetraconodon minor, a typical member of the early Late Miocene tetraconodont suid (Pickford, 1988; Made, 1999) is discovered together with *Parachleuastochoerus* sp. in the Mingin locality.

Occurrence of the *Parachleuastochoerus* in Myanmar

From the earliest Late Miocene time of Myanmar, *Parachleuastochoerus* sp., was discovered from the basal Irrawaddy deposits. The occurrence of *Parachleuastochoerus* sp. in Myanmar is contemporaneous with the early Late Miocene *T. minor*, suggesting that *Parachleuastochoerus* sp. is a member of the early Late Miocene fauna. In Asia, *Parachleuastochoerus sinensis* has been recorded from the early Late Miocene of southern China and northern Thailand (Pickford & Liu, 2001; Pickford *et al.*, 2004). Dental size of *Parachleuastochoerus sinensis* is slightly larger than that of Myanmar *Parachleuastochoerus* sp. The oldest record of *Parachleuastochoerus* on the world is from the latest Middle Miocene in Europe (Made, 1999), 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, (Figure 4) *Parachleuastochoerus* sp. of Myanmar might be an "intermediate" form of *Parachleuastochoerus*, which may have occurred during the migration from Europe to southern China and Thailand.

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Taxa	Spec. no.	References	P ₂		P ₃		P ₄		M ₁		M ₂		M ₃	
			L	W	L	W	L	W	L	W	L	W	L	W
<i>Para. steinheimensis</i>	MGL LGr631+ 629+ 669+ 670	Made's personal measurements	17.1	7.1	19.9	10.7	17.3	12.1	16.4	12.4	19.3	15.2	29.3	16.1
<i>Para. steinheimensis</i>	MGL LGr633	Made's personal measurements	-	-	20.4	10.2	17.9	12.8	18	12.7	-	-	-	-
<i>Para. steinheimensis</i>	MGL LGr644	Made's personal measurements	-	-	-	-	18.2	12.1	-	-	-	-	-	-
<i>Para. steinheimensis</i>	MGL LGr645	Made's personal measurements	-	-	18.8	9.2	-	-	-	-	-	-	-	-
<i>Para. steinheimensis</i>	MGL LGr646	Made's personal measurements	-	-	-	-	17	11.3	-	-	-	-	-	-
<i>Para. steinheimensis</i>	MGL LGr647	Made's personal measurements	-	-	20.3	9.8	-	-	-	-	-	-	-	-
<i>Para. steinheimensis</i>	MGL LGr648	Made's personal measurements	17.2	7.2	19.9	10.4	17	11.9	-	-	-	-	-	
<i>Para. steinheimensis</i>	MGL LGr651	Made's personal measurements	-	-	20.6	11.2	17.7	13.4	17.4	14.4	19.8	15.4	27.9	16.4
<i>Para. steinheimensis</i>	MGL LGr661	Made's personal measurements	-	-	-	-	18.5	13.6	-	-	-	-	-	-
<i>Para. steinheimensis</i>	MGL LGr662	Made's personal measurements	-	-	20.5	11.3	-	-	-	-	-	-	-	-
<i>Para. steinheimensis</i>	MGL LGr663	Made's personal measurements	17.9	7.1	-	-	-	-	-	-	-	-	-	-
<i>Para. steinheimensis</i>	MGL LGr1606	Made's personal measurements	-	-	19.9	10.4	-	-	-	-	-	-	-	-
<i>Para. steinheimensis</i>	MGL LGr1627	Made's personal measurements	-	-	-	-	16.6	10.9	-	-	-	-	-	-
<i>Para. steinheimensis</i>		Made's personal measurements	17.3	6.2	-	-	-	-	-	-	-	-	-	-
<i>Para. steinheimensis</i>	SMNS 5281b	Made's personal measurements	-	-	-	-	-	-	18.6	-	21.8	-	-	14.8
<i>Para. steinheimensis</i>	SMNS 12963	Made's personal measurements	-	-	-	-	-	-	-	-	-	-	-	-
<i>Para. steinheimensis</i>	SMNS 4024b	Made's personal measurements	-	-	-	-	17.7	13.2	17.2	12.4	-	-	-	-
<i>Para. steinheimensis</i>	SMNS 5280	Made's personal measurements	-	-	19.9	9.8	-	-	17.5	11.8	20	-	26.8	13.1
<i>Para. steinheimensis</i>	NMB Sth683	Made's personal measurements	14.8	5.7	20	11.2	-	-	-	-	-	-	-	-
<i>Para. sinensis</i>	IVPP V 8092.1	Pickford & Liu (2001)	13	6.1	19.5	10.1	17.6	13.3	15.9	13.3	20.1	16.9	28.5	16.4
<i>Para. sinensis</i>	IVPP V 8092.7+	Pickford & Liu (2001)	12.9	6	16.7	8	15.7	11.2	-	-	-	-	-	-
<i>Para. sinensis</i>	IVPP V 8092.2	Pickford & Liu (2001)	-	-	-	-	-	-	-	-	19.8	14.8	26.7	15.5
<i>Para. sinensis</i>	CMU 201	Pickford <i>et al.</i> (2004)	16.9	9	20	11.7	18.5	13.8	17.8	12.2	23.2	15.9	31.2	16.9
<i>Para. crusafonti</i>	-	Pickford (1981)	11.4	4.3	13.4	5.8	12	8	12	8.9	15.1	11.1	19	11.6
<i>Para. crusafonti</i>	-	Pickford (1981)	10.5	3.7	12.1	5.5	12	8	12	9.7	15.4	9.7	19.8	10.7
<i>Para. crusafonti</i>	-	Pickford (1981)	10.2	4	12	5.2	12.3	7.1	12.8	8.9	15	10.4	18.8	10.5
<i>Para. crusafonti</i>	-	Pickford (1981)	-	-	13.6	6	12.3	7.6	12.4	8.4	14.4	10.5	18.5	10.4
<i>Para. crusafonti</i>	-	Pickford (1981)	-	-	11.6	7.4	12.6	8	12.5	8.9	14	9.2	18	9.9
<i>Para. crusafonti</i>	-	Pickford (1981)	-	-	11.4	7	11.9	7.8	12.6	8.4	14.5	10.5	18	11.6
<i>Para. crusafonti</i>	-	Pickford (1981)	-	-	13.6	6	12	7.4	11.5	8	14	10.9	19.7	11.2
<i>Para. crusafonti</i>	-	Pickford (1981)	-	-	12.8	5.9	12.4	7.4	12.6	8.5	14.4	10.1	19.6	11.9
<i>Para. huenemannii</i>	-	Heissig (1989)	-	-	-	-	15.1	11.4	15.3	11.2	16.6	12.7	23	13.7

Table 2. Dental measurements (mm) of the correlated foreign specimens.