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New discovery of anthracotheres (Mammalia, Artiodactyla) from the Middle Miocene of Sagaing Region, Upper Myanmar

THAUNG HTIKE[1] and NWE NWE SAN[2]

Abstract

In this study, anthracotheres from the Middle Miocene of Sagaing Region, Upper Myanmar are re-investigated and newly discovered dental specimens are described. In Myanmar, two Middle Miocene localities are well known for anthracotheres, Male and Thanbinkan localities, Sagaing Region. Four species of anthracotheres (*Microbunodon silistrensis*, two definite bothriodont anthracotheres and cf. *Anthracotherium ingens*) are recognized. Most of these are forest-dwelling brachyodont and bunodont species suggesting that their habitats were not open land (savanna) but forest environment with relatively humid, thick forests and large rivers, located not so far from the sea shore.

Key words: anthracothere, environment, Middle Miocene

Introduction

In Myanmar, fossil anthracotheres (Mammalia, Artiodactyla) have been discovered from the Pondaung Formation (Upper Middle Eocene), Freshwater Pegu Beds (Middle Miocene), Irrawaddy Formation (Upper Miocene to Lower Pleistocene) and their equivalents. Fossil anthracotheres of Pondaung Formation are well known, and have been described by many workers. Compare to Pondaung taxa, Neogene anthracotheres were rarely discovered, and poorly known. Anthracotheres of Irrawaddy Formation were described since early 20th Century (Pilgrim, 1910; Colbert, 1938, 1943; Takai *et. al.*, 2006; Zin Maung Maung Thein *et. al.*, 2010) however, the Middle Miocene fauna are not well known. Recently, Tsubamoto *et. al* (2012) reported some Neogene anthracotheres from central Myanmar including Middle Miocene fauna. Up-to-date, in Myanmar, two Middle Miocene localities are well known for anthracotheres, near Male Village, Kantbalu Township, and near Thanbinkan village, Chaung-U Township, Sagaing Region.

In this work, anthracotheres from the Middle Miocene localities of Sagaing Region are re-investigated and newly discovered dental specimens are described. (Figure 1)

Materials and method

The fossils dentitions collected from the Khabo Sandstone of Thanbinkan-Tigyon area are formerly housed in Bodhi Tahtaung Monastery, Monywa Township, personal collection of the sayadaw U Wiseitta, and some of these are housed in the department of Geology, University of Mandalay. New bothriodont dental specimen was recovered from Kantbalu Township, Shwebo District, Sagaing Region, currently housed in the local Museum of the Department of Archaeology and National Museum (Shwebo) Ministry of Culture, Myanmar. The dental terminologies are mainly followed on Lihoreau and Ducrocq (2007).

Abbreviations

TBK-W, Thanbinkan, Wiseitta (U); MUDG-V, Mandalay University, Department of Geology-Vertebrate; AML-SBO, Department of Archaeology, National Museum and Library-Shwebo; P1, first upper premolar; M1, first upper molar; p1, first lower premolar; m1, first lower molar.

[1]Lecturer, Dr., Department of Geology, Shwebo University
[2] Assistant Lecturer, Dr., Department of Geology, Monywa University

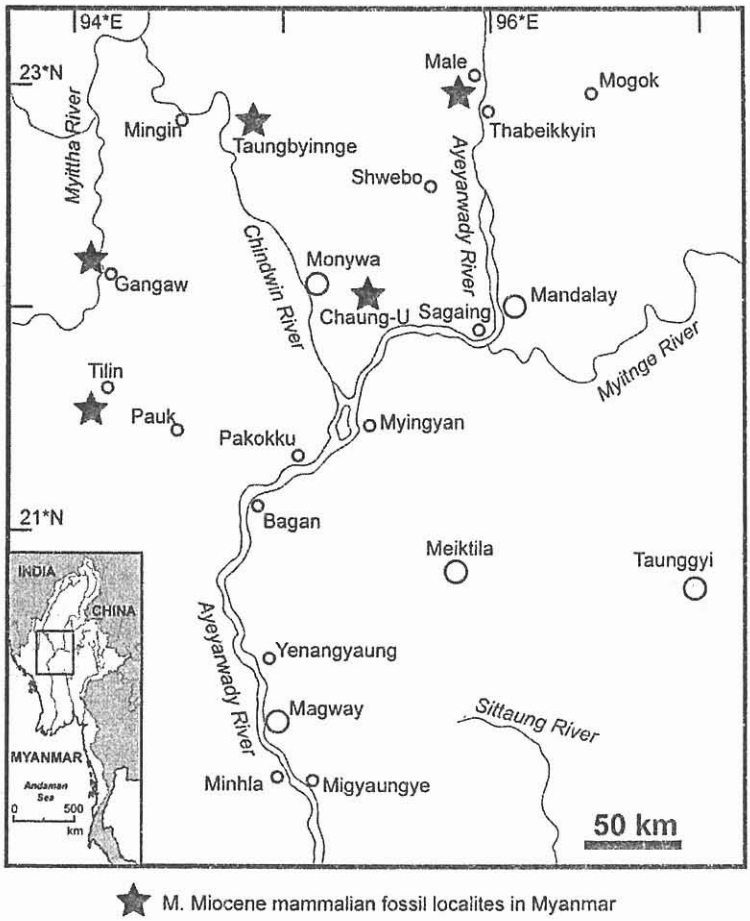

Figure 1. Location map of the Chaung-U and Male fossil sites.

Systematic Paleontology

Most of the specimens are dental materials; some of them have already been described by previous workers. Only systematic description for dental diagnosis on newly discovered materials are described and discussed here.

Order Artiodactyla Owen, 1848

Family Anthracotheriidae Leidy, 1869

Subfamily Microbunodontinae Lihoreau and Ducrocq, 2007

Genus *Microbunodon* Deperet, 1908

Microbunodon silistrensis Pentland, 1828

Figure 2

Only a material for this taxa was collected from Thanbinkan-Tigyon area. It is a left upper M3 and catalogued as MUDG-V1028. Zin Maung Maung Thein *et al.* (2010) described the above specimen under *Anthracotherium* sp. Tsubamoto *et al.* (2012) revised this material and described as *Microbunodon silistrensis*.

In Tsubamoto's description, it is a brachyodont, bunodont, and pentacuspidate upper molar. The mesostyle is distinct, the parastyle and metastyle are broken. At the tips of the paracone and metacone, the postparacrista and premetacrista extend mesiodistally and curve buccally, connecting to the mesotyle. The lingual metaconule crista is absent. The lingual cingulum is also absent.

Based on its small size and stronger bunodont, it is assigned to *Microbunodon silistrensis*. It is distinguished from M3 of *Microbunodon millaensis* in having smaller and from that of *Microbunodon minimum* in lacking a lingual cingulum (Tsubamoto *et al.*, 2012).

Subfamily Bothriodontinae Scott, 1940

Gen. et. sp. indet. 1

see Tsubamoto *et. al.*, 2012

This taxa has known for a material MUDG-V 1023. It is a right mandibular fragment with m1-m3. Zin Maung Maung Thein *et al.* (2010) used the term cf. *Hemimeryx* sp. for this material. It was revised as Gen. et. sp. indet. by Tsubamoto *et al.* (2012). According to them, the molars show selenodont and brachyodont having wrinkled enamel. The talonid is wider and longer than the trigonid. The cristid oblique and preprotocristid do not reach the lingual margin of the crown. There are a double premetacristid and a double postmetacristid. On m2, there is a distocingulid without a hypoconlid. On m3, there is no distocingulid. The m3 hypoconulid is strongly obliquely oriented and it forms a loop like structure with a lingually closed hypoconid basin.

According to Tsubamoto *et al.* (2012), it was assigned to Bothriodontinae for its selendont molars. It differs from *Hemimeryx*, *Telmatodon*, *Merycopotamus*, and *Libycosaurus* in being much smaller and in that the preprotocristid and cristid oblique do not reach the lingual margin of the crown. It differs from *Brachyodus*, *Bothriodon*, and *Aepinacodon* in being much smaller and in having four crests running down from the apex of the molar metaconid. It further differs from *Brachyodus* in having a less-open and narrower trigonid basin and a more obliquely-oriented m3 hypoconulid. However, it is impossible to identify the generic/species level from the single specimen, and it should be tentatively described as Gen. et. sp. indet. (Tsubamoto *et al.*, 2012).

Subfamily Bothriodontinae Scott, 1940

Gen. et. sp. indet. 2

Figure 2

It has known for a right maxillary fragment with M1 to M3, TBK-W 0002, a left mandibular fragment with m1, TBK-W 0003, and a left mandibular fragment with m2-m3 (MUDG-V 1022). All materials were recovered from Middle Miocene Khabo Sandstone, near Kodaungkan Village, Chaung-U Township, Sagaing Region, Myanmar.

In this taxa, the upper molars (Figure 2) are wider than long. They are tetracuspidate and paraconule is not present. They have selenodont cusps and a relatively higher crown. These characteristics of the upper molars are comparable to those of bothriodontid *Merycopotamus* (Lihoreau *et al.*, 2004; Lihoreau *et al.*, 2007; Lihoreau and Ducrocq, 2007) however, the present materials show wider and rounded selenodont features compare to *Merycopotamus*. The present upper molars are quite large in size to those of *Me. dissimilis*, *Me. medioximus*, and *Me. thachangensis*. The cingulum surrounds the mesial, lingual, and distal margins of the crown. It is weak at the distolingual corner of the metaconule. There is no buccal cingulum. Both the upper and lower molars of the specimens are highly worn and filled with cements. So it is difficult to describe the occlusal features of the molars. So, this taxa is tentatively name under gen. et sp. indet. 2, an indeterminate genus of the Bothriodontinae.

cf. *Anthracotherium ingens* Cooper, 1924

Figure 2

Only a specimen has known for this taxa, AML-SBO 48, a right mandibular fragment with root of p3, p4, and well preserved m1-m3. The locality of the present specimen is not exactly known, only Kantbalu Township, Shwebo District, Sagaing Region, is described in museum list. It is a large taxa of the anthracothere firstly discovered from the Miocene locality of Myanmar.

The lower dentition of the present specimen is characterized as follows. The p3 and p4 are broken, their smaller in size than molar can be traced only from their roots. Molars are bunodont with four distinct main cups (protoconid, metaconid, hypoconid, and entoconid) on first and second molar. Paraconid is absent.

The metaconid has distinct premetacristid, postmetacristid and distolingual metacristid. The preprotocristid extends mesiolingually and the premetacristid extends mesiobuccally, meet at the center of the mesial surface between protoconid and the metaconid. The post protocristid and the mentaconid meet at the notch transversally at the center of the distal trigonid wall. Distobucal postcristid poorly extend distally up to the base of the trigonid wall. Distolingual metacristid extends distally and disappears at the median transverse valley, a shallow groove, and face with entocristid.

The entoconid is fairly distal to the hypoconid. The entocristid extends mesially and disappears at the median transverse valley, face with distolingual metacristid. The lingual hypolophid is distinct and transversally stop at the base of buccal hypolophid.

In lower third molar, Postentocristid is distinct. The posthypocristid extends distolingually and link to the hypoconulid with a notch. The hypoconulid is very large with two cups, separated by a deep groove, the buccal and lingual (=entoconulid). The mesial cristid of the lingual cups extends mesiolingually and disappears at the base of the entoconid.

On m1 - m2, there are mesial and distal cingula, no distinct lingual and buccal cingula. On m3, there is a distinct mesial cingulum, and poorly distinct lingual and buccal cingula between the protoconid and the hypoconid and between the metaconid and entoconid. The talonid is wider than the trigonid. m1<m2<m3.

The lower molars of the present specimens are brachyodont and bunodont. It can be assigned to Anthrarcotheriinae. It differs from the Microbunodontinae in its extremely large size and Bothriodontinae in having bunodont dentition without selenodont. The outlines of cusp and ridge arrangement of the lower third molar for the present specimen resembles with the type of *Anthracotherium* rather than those of *Ancodus*, *Brachyodus*, *Hyoboops*,

Gelasmodon and *Merycopotamus* of Cooper (1924). According to its size, it is comparable with *Anthracotherium ingens* of Dera Bugti and quite larger than *Anthracotherium magnum.* Table 1, Figure 3.

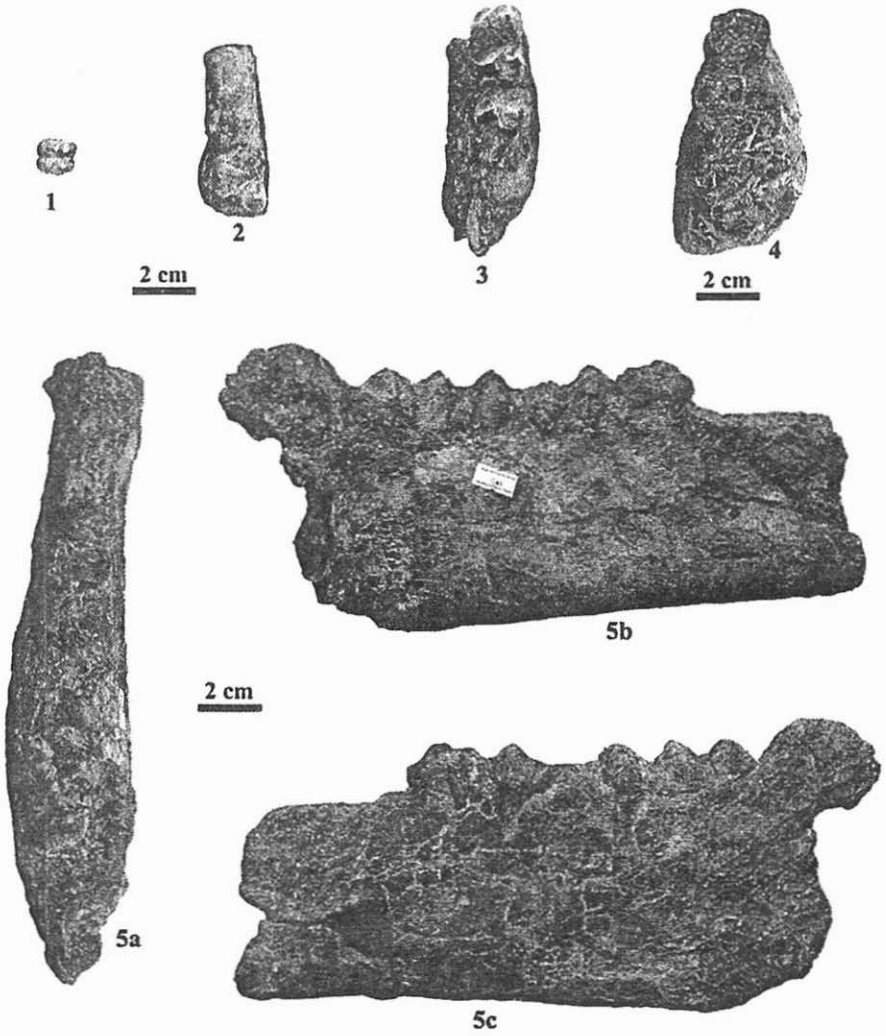

Figure 2. **1**, *Microbunodon silistrensis*, left upper M3; **2-4**, Bothriodontinae Gen. et. sp. indet. 2: **2**, left mandibular fragment with m1: **3**, left mandibular fragment with m2-m3: **4**, right maxillary fragment with M1 to M3; **5**, cf. *Anthracotherium ingens*, right mandibular fragment with root of p3, p4, and well preserved m1-m3: **5a**, occlusal view: **5b**, buccal view: **5c**, lingual view.

It is the first discovery of the large size anthracothere from the Miocene locality of Myanmar. According to its size, the most favorable taxa for this material is *Anthracotherium ingens* from the Lower Miocene Dera Bugti deposits of Baluchistan (Copper, 1924). In Myanmar, the Lower Miocene terrestrial deposits is still not yet reported, and the recovery position of the present specimen need to more study. According to above facts, it should tentatively assigns to the name cf. *Anthracotherium ingens* in this work

Table 1. Comparative dental measurements for cf. *Anthracotherium ingens* with other large size Miocene *Anthracotherium* species.

Taxa	m1			m2			m3			
	L	W1	W2	L	W1	W2	L	W1	W2	W3
A. ingens	-	-	-	-	-	-	97	48	50	35
A. ingens	-	-	-	-	-	-	92	44	44	35
A. ingens	-	-	-	46	34	38	80	41	44	34
A. ingens	38	34	35	59	45	49	?	52	?	?
A. ingens	?	?	24	42	30	34	-	-	-	-
A. magnum	-	-	-	44	29	30	69	32	33	25
A. magnum	-	-	-	?	28	30	?	32	33	?
A. bugtiense	43	30	28	52	36	39	?	43	45	?
cf. A. ingens	40.3	26.5	33.5	58	34	40*	82	43	42	33

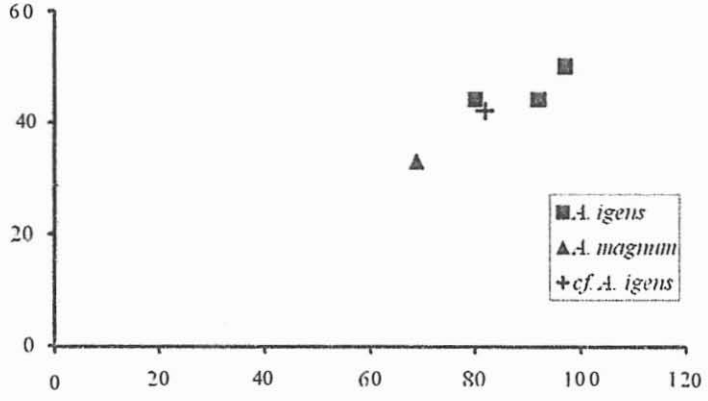

Figure 3. Bivariate plots for m3 size correlation among large size Miocene *Anthracotherium*. scale in mm; length for x-axis and width for y-axis.

Discussion and conclusions

The Middle Miocene atnhracotheres of Myanmar consists of three distinct types, micorobunodont, bothriodont and anthracotherid including at least four taxa (*Microbunodon silistrensis*, two definite bothriodont anthracotheres and cf. *Anthracotherium ingens*).

The small size taxa (*Microbunodon silistrensis*, two definite bothriodont anthracotheres) can be correlated with those of Lower Siwalik, Kamlial and Chiji fauna; such as the associated discovery of *Prodeinotherium*, *Dorcatherium*, *Brachypotherium* and amebilodontid and gomphotherid elephant. The above associated fauna indicate the Middle Miocene faunal group of lower Siwalik. Moreover, the contemporaneous discovery of Gomphothere, *Brachypotherium*, *Dorcatherium* and small tetraconodont suid can be correlated with the Middle Miocene fauna of Ban San Klang, Thailand.

According to the discovery of *Prodeinotheium*, the Thanbinkan specimens are ranged in smallest size of Siwalik forms and it suggest the appearance of *Prodeinotherium* in Thanbinkan area are probably equivalent with the just after period of Siwalik form which is the early Middle Miocene. The large size taxa (cf. *Anthracotherium ingens*) is resembled with those of Early Miocene Dera Bugti deposits of Baluchistan.

The primitive low crown *Microbunodon* is a primitive frugivorous or folivorous anthracotheres and its habitat in forested environment is widely accepted. The bunodont and brachiodont dentition in bothriodontid and large size anthracotherid from Miocene localities of Myanmar suggested that they were rather habitat in deep forest. According to Cerling *et al.* (1993), Quade and Cerling (1995) and Nelson (2007), the late Miocene global floral turnover greatly affected on forest dwelling Middle Miocene fauna, and fragmentation of forests caused the late Miocene faunal turnover. It can be suggested that the extinction of the Middle Miocene some bunodont anthracotheres from Myanmar due to that faunal turnover. The forest-dwelling brachyodont and bunodont species suggesting that during the Middle Miocene, their habitats were not open land (savanna) but forest environment with relatively humid, thick forests and large rivers, located not so far from the sea shore.

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