

Vertebrate Fossil from the Irrawaddy Formation of the Pebinsan-Kunon Area, Magway Township, Magway Region

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Abstract

The Pebinsan- Kunon area is situated about 40 miles southeast of Magway Township lying on the eastern bank of the Ayeyarwaddy River. It is located between the latitudes 19° 53' N and 19° 59' N and between the longitudes 95° 06' E and 95° 14'E, referring to UTM topographic map 1995-01 (85 M-1). In the Tebingan - Kunon area, vertebrate fauna consists of six orders, seven families and seven genera. The geological age of the Irrawaddy Formation in present area is not older than 11 Ma due to the occurrences of extinct horse, Hipparion and not younger than the Pliocene (~ 5 Ma) due to the existence of boar, Propotamochoerus and Rhinoceros, Brachypotherium. Therefore, the geological age of the Irrawaddy Formation in present area is likely to be the late Miocene (~11 to ~5 Ma). The paleoenvironment of the Irrawaddy Fauna is assumed to be diversified from the grassland to woodland/forest condition. The paleoenvironment of the study area is assumed to be forest dominated condition associated with riverine environment, not far from the shore line.

Keywords: Pliocene, Miocene, riverine environment

Introduction

Location and Size

The Migyaungye-Kunon area is situated about 40 miles southeast of Magway Township. It is located between the latitudes 19°53' N and 19°59' N and between the longitudes 95°06' E and 95°14'E, referring to UTM topographic map 1995-01 (85 M-1). The study area is 11 kilometers long in the north-south direction and 14 kilometers wide in east-west direction, covering an area of 154 square kilometers of rolling hill. As the study area lies on the eastern bank of Ayeyarwady River near the Malun Bridge on the Magway-Minhla motor road, it is accessible throughout the year.

Purpose of the study

- (1) To construct a geological map of the study area.
- (2) To define the stratigraphic position of the rock units
- (3) To study the systematic paleontology of the vertebrate fossils
- (4) To interpret the paleoenvironments of the Irrawaddy Formations

Previous Works

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Irrawaddy Formation, exposed in the eastern part of the study area, yields several vertebrate taxa. Chit Sein (2006) studied the vertebrate fossils from present area for his doctoral thesis and described dental remains of several extinct mammals (*Chalicotherium*, *Amphicyon*, *Stegodon*, *Stegodolophdon*) from the late Miocene Irrawaddy Formation of proposed area (Chit Sein et al., 2008, 2009, 2011, 2014).

Vertebrate paleontology of the irrwaddy formation

The study area is situated as a small segment of southernmost portion of the Minbu Basin of Central Cenozoic Belt. The siliciclastic rocks belonging to the upper Pegu Group and Irrawaddy Formation are mainly exposed in the study area. The Irrawaddy Formation of the present area yields the remains of elephants, wild boar, rhinoceros, bovids and horses and reptiles. The recovered specimens include the dental and gnathic materials as well as skeletal materials. Most specimens were collected from the stream section along the Kunon, Yedwet and Myebyar stream.

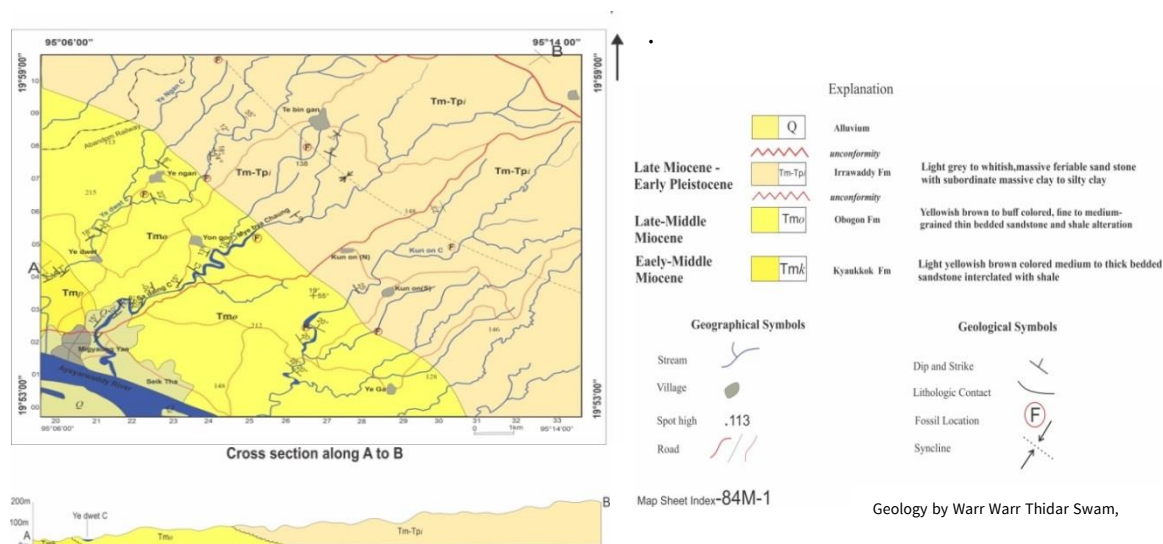


Fig: (1) Geological Map of the Pebinsan -Kunon Area showing the fossil localities

Materials and methods

The taxonomic assignments to generic/species level are based mainly on the dentognathic materials which are the most reliable for taxonomic comparison. All fossil materials used in this work are deposited in the University of Mandalay and Magway University. Measurements of teeth were made with a digital caliper. Taxonomic system mainly follows those of Carroll (1998) and McKenna and Bell (1997).

Institutional Abbreviation. MGU-IR, Magway University-Irrawaddy Formation; MU-IR=Mandalay University-Irrawaddy Formation

Anatomical Abbreviations. C, canine; I1/, first upper incisor; P1/, first upper premolar; M1/, first upper molar; I/1, first lower incisor; P/1, first lower premolar; M/1, first lower molar.

Systematic paleontology

Phylum Chordata

Class Chondrichthyes

Order Carcharhiniformes Compagno 1973

Family Carcharhinidae Jordan & Evermann 1896

Genus *Glyphis* Agassiz 1843

Glyphis pagoda Noetling 1901

Material: MU-IR 1, 2, 3, 4, 5, lower teeth; MU-IR 6, Upper Tooth (Fig. 2)

Locality: Kunon Chaung (19° 53' 37" N, 95° 10' 44" E); Yedwet Chaung (19° 56' 14" N, 95° 06' 58" E)

Horizon and Age: Middle Miocene and lower part of Irrawaddy Formation, late Miocene.

Description: The upper tooth of the shark shows the broad triangular crown that approaches equilateral triangle. Both mesial and distal margins of the tooth show finely serrated pattern which becomes coarser towards base. The height of the upper teeth is 5 mm and the width is 11.5 mm. The lower tooth shows narrow, sharply-pointed crown and tooth root that may be narrow or broad. The heights of the lower teeth range from 11 to 5 mm and the width range from 3 to 1 mm (Fig. 2). The apex of crown in teeth with narrow root may be distinctly broad to form spearhead shape.

Discussion: Noetling (1901) described *Glyphis pagoda* on the basis of teeth collected from an uncertain Miocene horizon near Thayet Township in Magway Region. Shimada et al., (2016) carried out the systematic description of shark teeth discovered from the Obogon Formation and lower most part of Irrawaddy Formation in Yinseik and Migyaungye Areas in Magway Township. The shark, *Glyphis* (Carcharhiniformes: Carcharhinidae), commonly known as 'river sharks' sparsely inhabit tropical streams and estuarine waters in south-southeast Asia and northern Australia. Similarly, the fossils of this shark are recovered from the shallow but low- to high-energy nearshore marine environments as well as fluvial and lacustrine environments (Shimada et al., 2016).

Order Crocodilia Gmelin 1789

Superfamily Gavialoidea Hay 1930

Family Gavialidae Hay 1930

Genus *Gavialis* Oppel 1811

Gavialis sp.

Material: MU-IR 8, mandibular fragment; MGU-IR 6, Osteoderm; MGU-IR 7, isolated teeth

Locality: southwest of Pebinsan Village (19° 59' 58" N, 95° 08' 28" E)

Horizon and Age: Lower Irrawaddy Formation, Late Miocene.

Description: The mandibles (MU- IR 8) show longitudinal furrows on the ventral surface. The anterior most region of the dentary is not preserved. For most of its length, the dentary is perfectly straight. The present fragmentary dentary contains 20 to possibly 22 alveoli. Osteoderms (bony plate) are square and the majority of them are rectangular, being wider than long (Fig. 3) and flat

to slightly convex. They are relatively thin and bear only a few relatively large pits on their dorsal surface. The edges of these osteoderms are irregular, bearing small spiny outgrowths possibly indicating the presence of a suture. The isolated crocodile teeth show long conical shape and there are fine striations on the dental surface (Fig. 3).

Discussion: The genus *Gavialis* comprises a single living species. It is characterized by its extremely long, thin jaws, which are regarded as an adaptation to a primarily piscivorous diet (fish eating). The oldest fossil material allegedly referable to this genus has been recovered from the Miocene of Pakistan. *Gavialis* is abundant in continental Pleistocene deposits of the Indo-Pakistani region. The genus was also reported from the Pleistocene of Java, Myanmar and Thailand.

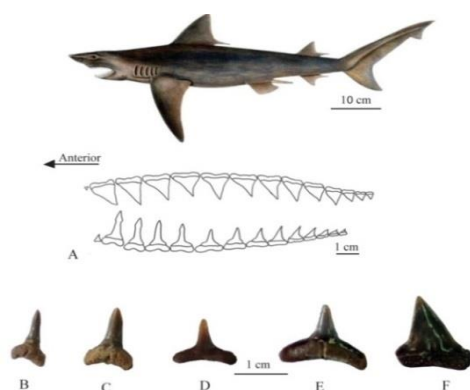


Fig: (2) *Glyphis pagoda*, A. Illustration of *Glyphis* and its dental arcade, B-E. isolated lower teeth, F. upper tooth.

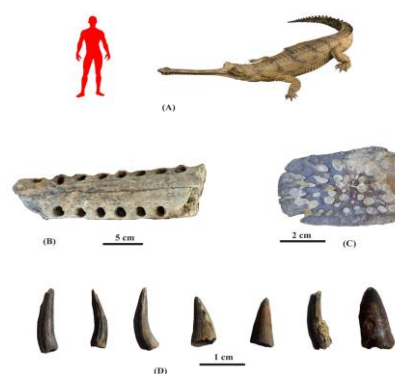


Fig: (3) *Gavialis* sp, A. Illustration of *Gavialis*, B. mandibular fragment, C. Osteoderm, D. isolated teeth

Order Testudines Batsch 1788

Superfamily Trionychia Hummel, 1929

Family Trionychidae Fitzinger 1826

Gen et sp. indet.

Material: MGU-IR 8, Fragment of carapace (costal scute?)

Locality: southwest of Pebinsan Village (19° 59' 580" N, 95° 08' 28" E)

Horizon and Age: Lower Irrawaddy Formation, Late Miocene

Description: The carapace is thin and shows square shape. It is slightly convex and trace of suture can be found on the edge. The outer surface of the carapace is smooth and inner one shows crenulation on the surface (Fig. 4).

Discussion: Turtles (Testudines) are a diverse group of reptiles that inhabit a wide range of terrestrial, freshwater and marine environments. In Myanmar, the fossils of turtles are common in the Pondaung and Irrawaddy Formations. However, most of the recovered specimens are fragmentary and it is usually difficult to define their taxonomic affinity. According to the

depositional environment of Irrawaddy Formation, Irrawaddian turtles are likely to be terrestrial or riverine habitat associated with flood plains and lake.

Order Artiodactyla Owen, 1848

Family Bovidae Gray, 1821

Subfamily Bovinae Gray, 1821

Tribe Boselaphini Kretzschmar-Meyer, 1907

Selenoportax sp.

Material: MU-IR 9; right mandibular fragment with P/4-M/2

Locality: southwest of Pebinsan Village (19° 58' 59" N, 95° 09' 11" E)

Horizon and Age: Lower Irrawaddy Formation, Late Miocene

Description: The mandible is broken at the base and the teeth are moderately worn. The P/4 is larger and has open posterior valley until the onset of late stages of wear. M/1 show square shape and worn out. Protoconid, and hypoconid are distinct and lingual part of the molar is broken. M/2 shows basal column and a distinct stylid. The present specimens belong to the boselaphine by the presence of the moderately large hyposodont teeth with the highly rugose enamel, the strong buccal folds and a strong basal column. (Fig. 4)

Discussion: Stem Bovini were likely present in southern Asia (Siwaliks) by 9 Ma, as represented by *Selenoportax* (Bibi 2007). In Myanmar, remains of bovids are reported from the late Miocene to Pliocene deposits in Magway Region (Colbert, 1935). The dento-gnathic materials referred to *Selenoportax* are much larger than those of cf. *Tragoporotax* and the tooth sizes resemble those of *S. vexillaris* from the Dhok Patan of the Siwalik Group. This genus is known from the late Miocene to early Pliocene of the Indian subcontinent (Pilgrim, 1939) and late Miocene of Myanmar (Nishioka et al., 2018).

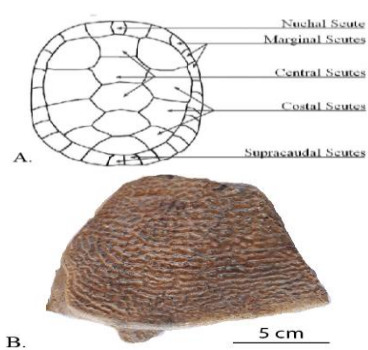


Fig: (4) A. Typical carapace of a turtle
B. Costal scute? of a turtle

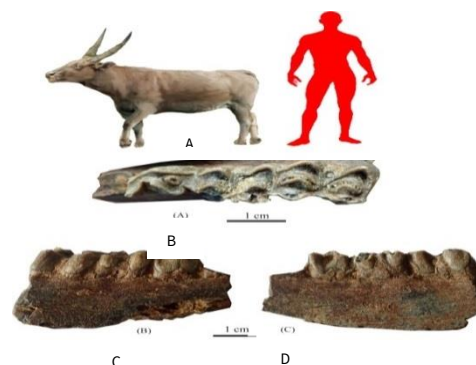


Fig: (5) A. Reconstruction of primitive Boselaphini, B-D.
Right mandibular fragment of *Selenoportax*, B. occlusal
view, C. buccal view, D. lingual view

Family Suidae Gray, 1821

Genus *Propotamochoerus* Pilgrim, 1925

Propotamochoerus wui Stehlin, 1899

Materials: MU-IR 10; right mandibular fragment with P/3 to M/3

Horizon and Age: Lower Irrawaddy Formation; Late Miocene

Locality: southwest of Pebinsan Village (19° 58' 59" N, 95° 09' 10" E)

Description: In the present specimen, P/4 is distinctly wider and larger than P/3 and molarized. Outlines of M1 and M2 are similar, being nearly rectangular in occlusal view. In M/1 is heavily worn, that detailed morphology can only be seen in M/2. In M2, there are four main cusps with shallow and distinct furchen (groove). The anterior cingulum is small but distinct. The M/3 is larger than M2 in length but nearly similar width. It is elongated and the distal width is narrower than the mesial. The third lobe is simple with a large and distinct pentaconid.

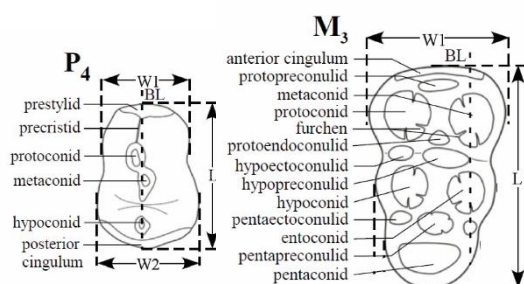


Fig: (6) Dental terminology of suidae
(After Thaung Htike, 2007)

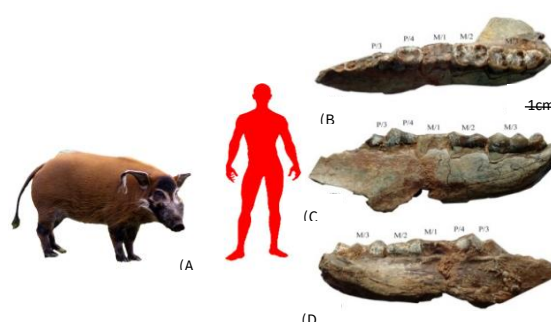


Fig: (7) A. Illustration of *Propotamochoerus wui*, B. occlusal view, C. buccal view, D. lingual view

Discussion: The present specimen shows simple bunodont molar with moderately deep furchen (groove) and can be correlated with the morphology of the extinct boar, *Propotamochoerus*. The dental characteristics and tooth sizes of the present specimens resemble those of *Propotamochoerus* from the late Miocene to Pliocene of middle Siwalik. The dental size of the present specimen is smaller than those of *P.hysudricus* of Indian Subcontinent and similar to *P. wui* from the early late Miocene Lufeng of Southern China. So far, two species of *Propotamochoerus*, *P.hysudricus* and *P.wui* have been recognized from the late Neogene Irrawaddy sediments of Myanmar (Thaung Htike et al., 2006; Thaung-Htike, 2008; Chit Sein, 2009).

Order Perissodactyla Owen, 1848

Family Rhinocerotidae Owen, 1845

Tribe Teleoceratini Hay, 1902

Genus *Brachypotherium* Roger, 1904

Brachypotherium perimense Falconer and Cautley, 1847

Materials: MU-IR 11, a right mandibular fragment with M/1 (broken) and M/2;

Horizon and Age: Lower Irrawaddy Formation; Late Miocene

Locality: Yengan Chaung (19° 58' 49" N, 95° 09' 07" E); Kunon Chaung (19° 56' 24" N, 95° 11' 54" E)

Description: The mandibular fragment is broken at the base and covered with the matrix in some places. The teeth are moderately worn; the lingual groove is shallow and hypolophid is long; the

posterior valley is deeper than the anterior one. Lingual cingulum is absent, but the labial cingulum is represented by the array of the small tubercle. On M/1, it is broken and only a part of protolephid is preserved. On M/ 2, paralophid weak; the paralophid is short; the hypolephid is long and show smooth curve. Trigonid and talonid are nearly same level due to the advanced wear stage (Fig. 8, 9).

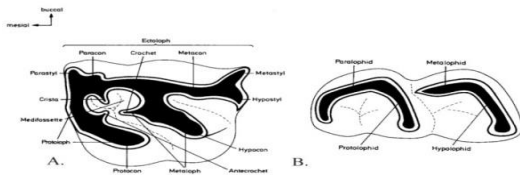


Fig: (8) Dental Terminology of Rhinoceros. A. upper molar, B. lower molar

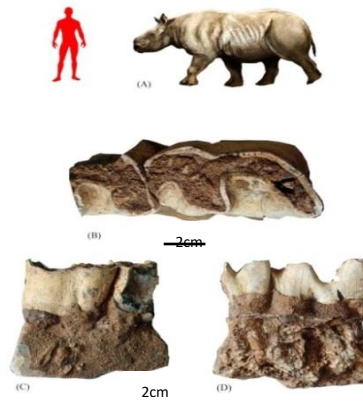


Fig: (9) *Brachypotherium perimense*, A. Illustration, B. Occlusal view, C. Buccal view, D. Lingual view

Discussion: *Brachypotherium* is a large, hornless rhinoceros, a hippo-like rhinoceros due to its morphological criteria, and might have spent a part of its daily life in water (Hessig, 1989). In Myanmar, remains of this rhinoceros are recovered from the terrestrial sediments of Khabo Formation and Lower Irrawaddy Formation in Central Myanmar (Takai et al., 2006; Chit Sein, 2006; Zin-Maung-Maung-Thein et al., 2010). The distribution of this rhinoceros in Myanmar and its neighboring region suggests the Southeast Asia and India and Pakistan are in the same biogeographic province since the middle late Miocene.

Order Perissodactyla Owen, 1848

Family Equidae Gray, 1821

Tribe Hipparionini Quinn, 1955

Genus *Hipparion* Christol, 1832

Hipparion sp.

Materials: MGW-IR 01, an isolated left P2/; MGW-IR 02, isolated P4/

Horizon and Age: Lower Irrawaddy Formation; Late Miocene

Locality: Yengan Chaung (19° 58' 49" N, 95° 09' 07" E); Kunon Chaung (19° 56' 24" N, 95° 11' 54" E); Myebya Chaung (19° 55' 43" N, 95° 09' 02" E)

Description: The MGW-IR 01 is a second right upper premolar and moderately worn. A thin layer of cement is present on the lingual as well as on the buccal sides. The enamel is moderately thick. P2/ of the *Hipparion* is almost triangular with a well-developed anterostyle. The parastyle and mesostyle are well developed. All major cusps are well developed and preserved. The protocone is an isolated compressed pillar and elongated or oval shape. The MGW-IR 02 is in an initial stage of

wear and the enamel plication is complex to moderately complex. The molars are hypsodont and broad crowned with well-developed cusps. The protocone show oval shape and the hypocone constriction is present. It is a difficult task to make assignment of isolated dentition of *Hipparion* to a proper species. However, isolated teeth are useful for biostratigraphy correlation (Fig. 10, 11).

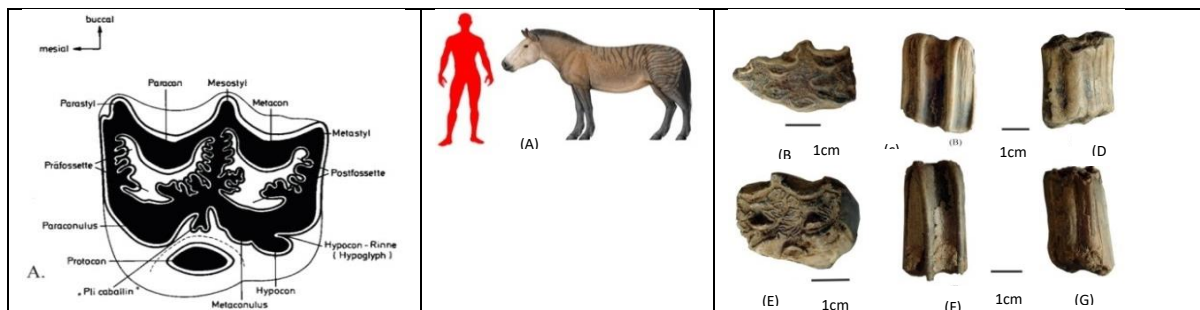


Fig: (10) A. Dental terminology of the *Hipparion* upper molar

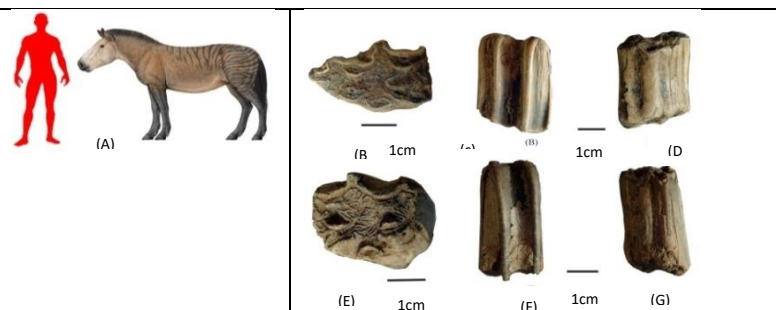


Fig: (11) *Hipparion*, A. Illustration B-D, Upper premolar P2/. B, occlusal view, C. buccal view, D. lingual view, E-G, upper premolar P4/. E, occlusal view, F. buccal view, G. lingual view

Discussion: The three toe extinct horse, *Hipparion* was originated in the middle Miocene of North America and invaded Old World around 12 Ma (MacFadden, 1992). The several isolated teeth and a lumbar vertebra of *Hipparion* were recovered from the late Miocene Irrawaddy sediments in Yenangyaung and Magway Area (Stamp, 1922; Colbert, 1938; Takai et al., 2006; Jaeger et al., 2011). It is difficult to assign the isolated dentition of this animal to a proper species and is usually referred to *Hipparion* based on their dental sizes and morphologies (Colbert, 1938).

Order Proboscidea Illiger, 1811

Suborder Elephantidea Osborn, 1910

Family Elephantidae Schlesinger, 1917

Subfamily Stegolophodontinae Osborn, 1910

Genus *Stegolophodon* Osborn, 1936

Stegolophodon sp.

Material: MGW-IR 03, mandibular fragment with M3 (broken); MGW-IR 04; upper molar; MGW-IR 05, isolated lower molar

Locality: southwest of Pebinsan Village (19° 58' 59" N, 95° 09' 10" E); Kunon Chaung (19° 56' 24" N, 95° 11' 54" E); Myebye Chaung (19° 55' 43" N, 95° 09' 02" E)

Horizon and Age: Lower Irrawaddy Formation, Late Miocene

Description: The preservation of a mandible (MGW-IR 03) is poor and enamel of the tooth is broken and only dentine is preserve. In MGW-IR 04, enamel is thick, smooth, simple and unworn at all. It is brachyodont tooth showing rectangular outline. The molar has four lophs, showing the typical stegolophodon molar type (Fig. 12). In MGW-IR 05, the tooth is not unworn, showing rectangular outline. Third loph has partly damaged conelet. The fourth loph is unworn having four irregularly arranged conelets which are blunt, isolated and rounded. The fifth loph has two large, prominent

conelets and two smaller conelets. The lophs are widely spaced having prominent intermediate valleys which are deposited with cement. Enamel is thick, almost smooth and simple (Fig. 13).

Discussion: Family Elephantidae includes genera *Stegolophodon*, *Stegodon*, *Mammuthus*, *Loxodonta* and *Elephas*. *Stegolophodon* is an undoubtedly pure Asiatic genus. It lived in the Miocene and Pliocene Epochs and started to decline towards the end of Pliocene (Pilgrim, 1913). *Stegolophodon* is characterized by the presence of four tusks. The earliest *Stegolophodons* are documented from the early to middle Miocene in Thailand. In Myanmar, the remains of this elephant are discovered from late Miocene sediments of the Irrawaddy Formation in Magway Region (Chit Sein, 2006, Takai et al., 2006).

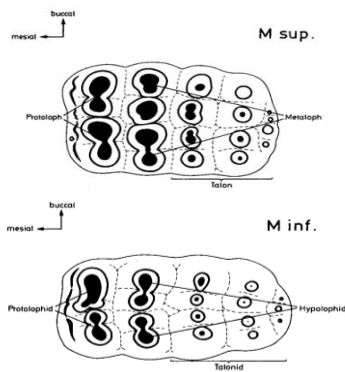


Fig: (12) Dental Terminology for *Stegolophodon* sp.

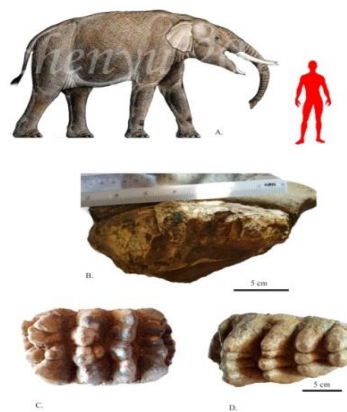


Fig: (13) MGW-3, distal lower molar fragment of *Stegolophodon*, A, Illustration, B. Mandibular fragment (molar broken), C. upper molar, D. lower molar

Result and Discussion

The paleoenvironment of the Irrawaddy Fauna is assumed to be diversified from the grassland to woodland/forest condition. The wild boars are normally inhabited forests/woodlands and the extinct boars (*Propotamochoerus*) were likely to prefer same habitat as its extant counterpart. The extinct elephant, *Stegolophodon*, show brachyodont (short-crown tooth) and likely to be forest dwelling animals. The extinct rhinoceros, *Brachypotherium* is regarded as a hippo-like rhinoceros due to its morphological criteria, and might have spent a part of its daily life in water. The bovids might have roamed in the open grass land or on rolling hills as cattle of the present day. However, the remains of bovid are rare compared to other mammals. The equid probably depended on the forest dominated environment. So, the paleoenvironment of the study area is assumed to be forest dominated condition associated with riverine environment.

Conclusion

The Pebinsan- Kunon area is situated about 40 miles southeast of Magway Township lying on the eastern bank of the Ayeyarwaddy River. In the Migyaungye- Kunon area, vertebrate fauna

consists of six orders, seven families and eight genera. The geological age of the Irrawaddy Formation in present area is not older than 11 Ma due to the occurrences of extinct horse, *Hipparion* and not younger than the Pliocene (~ 5 Ma) due to the existence of boar, *Propotamochoerus* and Rhinoceros, *Brachypotherium*. Therefore, the geological age of the Irrawaddy Formation in present area is likely to be the late Miocene (~11 to ~5 Ma). The paleoenvironment of the study area is assumed to be forest dominated condition associated with riverine environment, not far from the shore line.

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