CHAPTER IV

PALEONTOLOGY OF PROBOSCIDEAN FOSSILS

4.1 Occurrence of Fossils

In the present study, the sediments in the sandpit are mainly of sand and gravel deposit, containing abundant organic matter, horizon of large logs and fossil bones. A number of tree trunks are discovered in the sandpits, and they have been carbonized and partially pyritized in the lower gray sands under a reductive environments. Silicified woods occur at upper level in oxidized sediments. Extraordinal rich fauna of fossil mammals has been reported. The present fauna primary consists of bone fossils in association with molars and elephant tusks (Sato, 2002). Sometimes characteristic minerals to the bone are discovered. Bigger bone fossils, humerus and femur of elephant fossils had been suffered from pyritization and usually the surfaces of bones are black colored. On the surface and inside spongy texture of smaller parts of bone were found the fresh blue colored mineral, its name vivianite (Sreprateep *et al*., 2003).

In the field, fossils were found in the sandpit such as bivalve, bone and teeth of proboscidean fossils, bone of cattle and buffalo as well as antler of deer. Bivalve was found in the layer of fine sand reddish yellow, 4.35 m in depth. Almost of the fossils were not accumulated on the specific horizons. Lower than the Tektile horizon, the fossils were found every horizon. Almost of bones are scattered in the beds of very coarse sand with granule to pebble and structureless (see Figure 4.1and 4.2). These fossils were deposited parallel to bedding plane from the eastern to western direction that the same as water current direction in the present. Some fossils were found in the layer of clay such as teeth of *Elephas*, cattle and buffalo. The preservation of ancient teeth are not good but can be identified. Except *Sinomastodon* tooth is rather well preserved but this fossil is soaked so it broken when it was moved. Vertebrate bones also are not articulated but all the processes are nearly preserved. The conditions of erosion on the surface of these fossils were suggested that they were not transported for long distances but they were transported by a turbulence water current, rapidly deposited and high slope but not reworked fossils because position names can be identified. If they are derived fossil, they would impossible to determine the position of bones. For some fossils that can not be identified. Fragmentation and abrasion of fossils are conspicuous, they might be reworked fossils which reworked from the old sediment but not older too much. Skull has not been discovered in these pits.

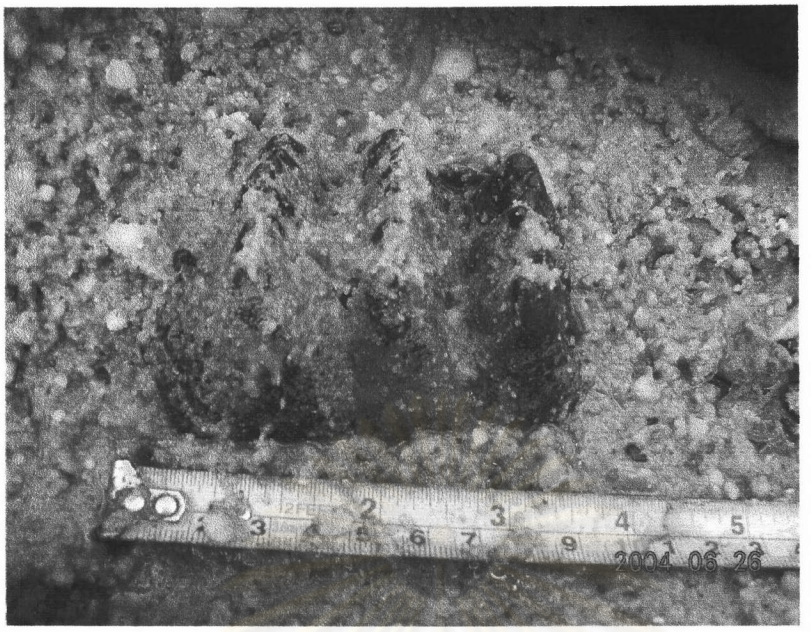


Figure 4.1 The elephant fossil molar of *Stegodon* found in situ in the very coarse sand with granule to pebble and structureless

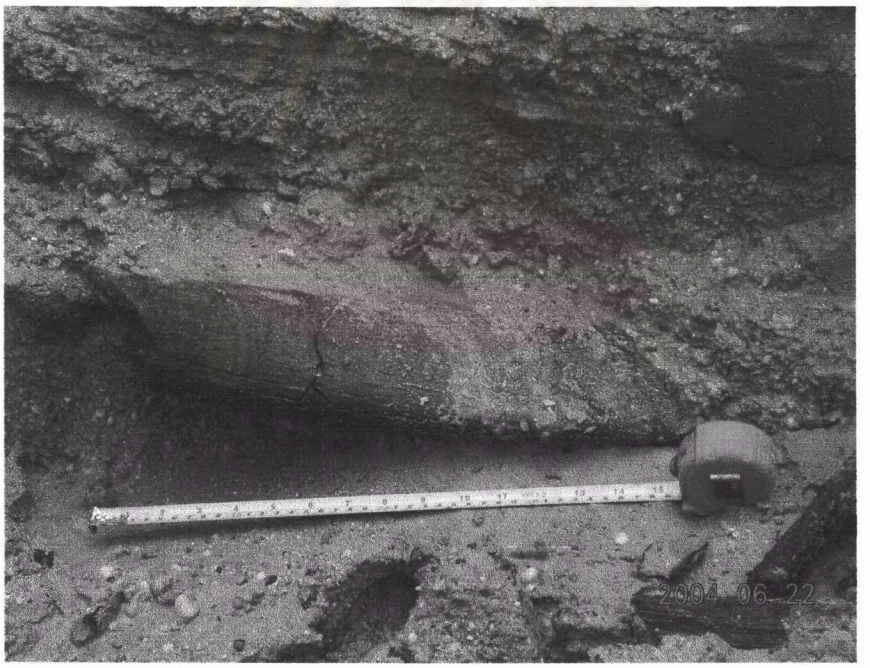


Figure 4.2 The fossil bone found in situ in the very coarse sand with granule to pebble and structureless

Elephant fossils from the Northeastern Research Center for petrified wood and Natural Resources Museum were used to study in this research. All of them

were recovered from Tha Chang Sandpits. The ancient elephant teeth were excellent preserved and their dental lamellas were never detached. All of the fossils at this museum have not been documented for the position of stratigraphy sequence. The conditions of erosion on the surface of these fossils revealed that they were not transported for long distances.

4.2 Proboscidean fossils

The Proboscidea order has over 50 million years and contained over 350 species. They were of African origin but, in contrast with other subungulates, succeeded in invading the other continents and by middle and later Cenozoic times were widespread in Eurasia and North America and even reached South America. These animals inhabited every continent of the world, except for Antarctica and Australia. Today, however, only two forms survive are *Loxodonta* and *Elephas.*

The direct ancestor to the modern-day elephant is unknown, but fossils of numerous evolutionary off-shoots, such as the moeritheres (40 million years ago), the barythenes (40 to 35 million years ago), paleomastodons (40 million years ago), gomphotheres such as the mastodon, the stegodon, and the mammoth have all been found and studied. There is still debate about which groups were early proboscideans, as other groups such as anthracobunids (55 million years ago) are considered by some to be the ancestors of moeritheres and sirenians (sea cows), but fossils are being discovered on an on-going basis, and the search for the proboscidian ancestor continues. Most of our knowledge of these animals is based on the teeth, as these are not only durable, but very characteristic in these particular animals. We may perhaps best treat this interesting group by describing the highly specialized structures of dentition found in the later elephants before taking up the earlier stages in their development.

4.3 Dentition

Elephant have unique teeth, and are known as 'lophodont': their teeth are huge, made up of a stack of enamel ridges, and move forward in the mouth like a conveyor belt as others are worn away. Besides, the elephant are diphyodont, having only two sets of teeth. The deciduous or milk teeth present in immature are usually replaced by a set of permanent teeth that are retained for life.

As explained by Tassy (1996), dental characters of proboscidean taxa have changed dramatically during the past 50-45 million years. All changes are related to an increase in body size and the type of food consumed. The number of cheek teeth in adults did not change, canines were lost, and the incisors or tusks were reduced in number.

Table 4.1 Showing the replacement of teeth which are present at different ages.

Dentition		
Molar	**Molar Appearance**	**Molar Loss**
I	birth	2 years
II	birth	6 years
III	1 year	13-15 years
IV	6 years	28 years
V	18 years	43 years
VI	30 years	65+ years

Each tooth is elongate and exceedingly hypsodont and is formed of a large number of high, thin, crosswise ridges. The spaces between these 'leaves' is filled by cement, so that with wear all three elements of the tooth are exposed in a regular pattern- dentine in the center of the ridges, an enamel band about this, and cement forming the outer portions. The number of ridges increases considerably from earlier to later teeth, the milk premolars being much simple in structure.

Instead of having all the teeth in place at once, as is usually the case in mammals, the elephants normally have exposed at any given time only four teeth in all, one in each half of each jaw. As these four teeth are worn down, they are pushed forward and the next group of teeth, which meantime has been forming in the maxilla or dentary, takes their place. This process is repeated until all members of a series are utilized

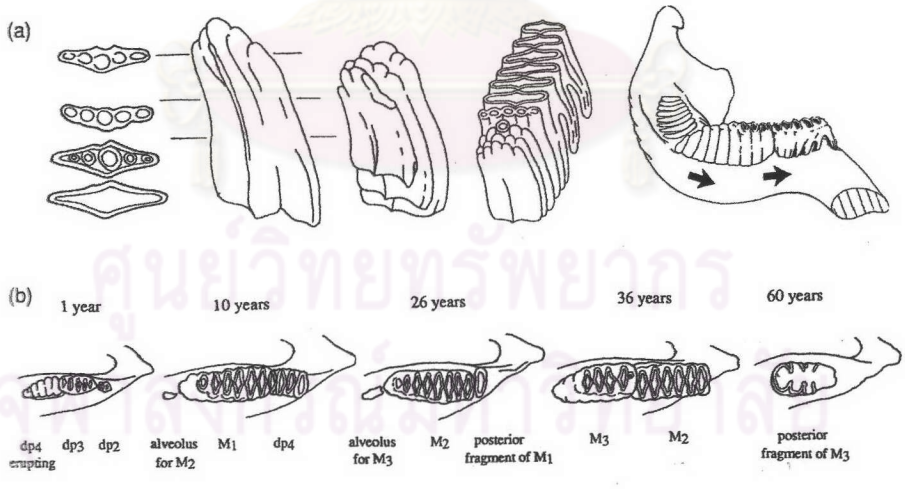


Fig 4.3 Simplified diagrams showing: (a) cross-sections of isolated lamellae at different locations to reveal patterns on occlusal surfaces, a tooth, and a left dentary in medial view (arrows indicate direction of horizontal tooth displacement); (b) mandible of *Loxodonta africana* depicting teeth which are present at different ages (Tassy and Shoshani, 1996).

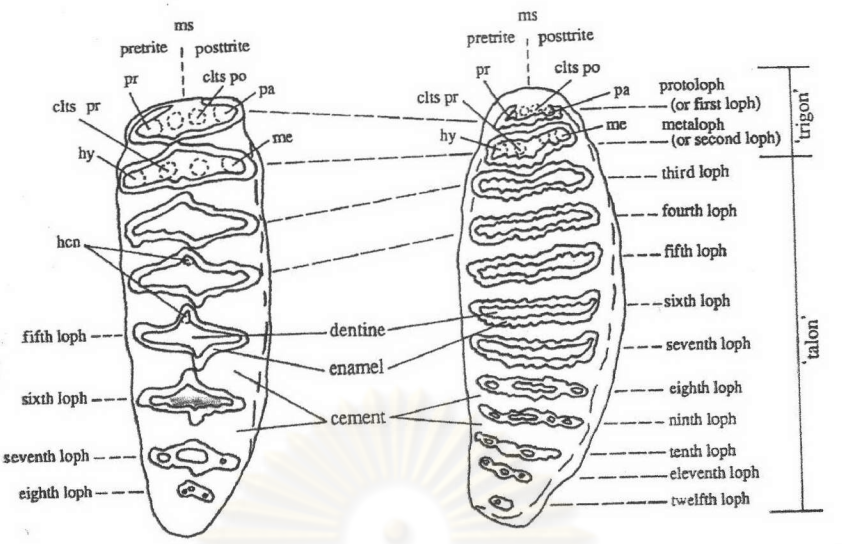


Fig 4.4 Upper left third molars of *Loxodonta africana* (left and *Elephas maximas* (right) in occlusal views (Shoshani and Tassy 1996).

4.3.1 Anatomy of Proboscidean tooth

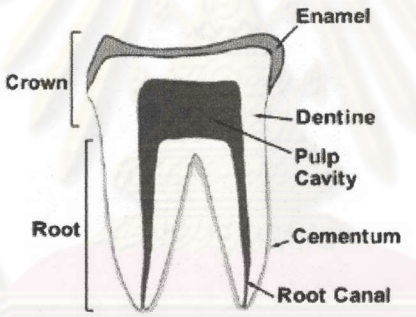


Fig 4.5 Diagrammatic cross section of a mammalian tooth

Teeth can be divided into two sections. The part above the gum called the crown and the part embedded in the gum called the root. The crown is the outside of the part of the tooth that is above the jaw bone, it is the part that does all the hard work. The root is the portion fitting in to the alveolus or socket in the jaw. Teeth with a particularly high crown are termed hypsodont, and those with a particularly low crown are brachydont. Points and bumps on the crown of the tooth are generally termed cusps. The side of a tooth closest to the tongue is termed the lingual side, and the side closest to the cheek is the labial or buccal side. The surface of a tooth that meets with a tooth in the opposing jaw is termed the occlusal surface (DeBlase and Martin, 1974).

The major portion of each tooth is made up of a bonelike material called dentine. The crown has a thin layer of extra hard substance, usually white, called enamel covering the dentine. Enamel is 96% mineral while the dentine is 70%

mineral and the root is covered by a layer of bonelike cementum. The central, living portion of a growing tooth, the pulp, is supplied with blood vessels and nerves through one or more openings in the base (DeBlase and Martin, 1974).

In elephants, the alveoli of the cheek teeth converge into a groove and tooth replacement occurs only at the posterior end of the toothrow. As the anterior tooth is worn away, a new tooth develops from the rear and the entire row moves forward. A total of six cheek teeth are available to each quadrant, but only one or parts of two teeth are functional at any one time. (DeBlase and Martin, 1974)

The basic rules of naming tooth structures, each cusp is called a cone. Different cones are identified by different prefix, the major ones being pro-, para-, meta-, hypo-, and ento-. Minor cusps may have the the suffix –ule added to the name (e.g., hypoconule). An –id added to the name of a cusp indicates that it is part of a tooth in the lower jaw; for example, a protocone is a major cusp on an upper molar, while a protoconid is on a lower molar. A cingulum is a shelf –like ridge around the outside of an upper molar, cingulid on a lower tooth. The stylar shelf is an expansion of the cingulum; it often bears small cusps.

4.3.2 Definitions of dental

Abaxial cone : On each loph the conelet that is most distant from the median sulcus (= pretrite and posttrite main cusps)

Adaxial cone : On each loph the conelet that is close to the median sulcus (=mesoconelet)

Interloph : Transverse valley or space between two lophs

Median sulcus : Sulcus between pretrite and posttrite half-lophs

Mesoconelet : The cusp close to the median sulcus (adaxial)when the main cusp of each half-loph is subdivided

Pretrite : Refer to the more worn half of each loph; which is buccal in lower and lingual in upper molars

Posttrite : Refer to the less worn half of each loph; which is lingual in lower and buccal in upper molars

Trefoil : Part of each half-loph made of the main cusp and conules. Pretrite trefoil = pretrite half-loph; posttrite trefoil = posttrite half-loph (Tassy, 1996).

4.4 Classification of proboscidean fossil

Many authors established classification of proboscidea such as Osborn (1936,1942), Simpson (1945), Magilo (1973) and Coppens et al. (1978), Tassy (1988*a*) and Shoshani and Tassy (1996), the comparison of classifications is as shown in Table 4.2. This study respects Shoshani and Tassy's classification (2005) because of an up-to-date compilation from many references.

Table 4.2 Comparative classification of Order Proboscidea (Shoshani and Tassy, 1996)

Osborn(1936,1942)	Simpson (1945)	Magilo (1973) and coppens et al. (1978)	Tassy (1988*a*) and Shoshani and Tassy (1996),	Shoshani and Tassy (1996),
				Anthracobune
Moeritherioidea	Moeritherioidea			
Moeritheriidea	Moeritheriidea		*Moeritherium*	Moeritheriidea
			Numidotherium	Numidotheriidae
	Barytherioidea			
	Barytheriidea		*Barytherium*	Barytherioidea
Deinotherioidea	Deinotherioidea			
Cortognathidae	Deinotheriidea		Deinotheriidea	Deinotheriidea
			Elephantiformes	Elephantiformes
			Palaeomastodon	*Palaeomastodon*
			Phiomia	*Phiomia*
			Hemimastodon	*Hemimastodon*
Mastodontoidea	Elephantoidea	Mammutoidea	Elephantoidea	Elephantoidea
Mastodontidea	Mammutidea	Mammutidea	Mammutidea	Mammutidea
Palaeomastodon				
			Eozygodon	*Eozygodon*
Zygolophodon		*Zygolophodon*	*Zygolophodon*	*Zygolophodon*
Mastodon	*Mammut*	*Mammut*	*Mammut*	*Mammut*
Stegolophodontinae		Stegodontidae		
Stegolophodon		*Stegolophodon,* *Stegodon*		
			Choerolophodon	*Choerolophodon*
		Gomphotherioidea	Amebelodontidae	
Bunomastodontidae	Gomphotheriidae	Gomphotheriidae	gomphotheres (1 and 2)	Gomphotheriidae
Longirostrinae	Gomphotheriinae	Gomphotheriinae		
Trilophodon	*Gomphotherium*	*Gomphotherium*	*Gomphotherium*	*Gomphotherium*
Amebelodontinae, Phiomia	*Palaeomastodon*, *Phiomia*	*Palaeomastodon*		
			Tetralophodon	*Tetralophodon*
			Anancus	*Anancus*

(continued)

Osborn(1936,1942)	Simpson (1945)	Magilo (1973) and coppens et al. (1978)	Tassy (1985, 1988*a*) and Shoshani and Tassy (1996),	Shoshani and Tassy (1996),
Stegodontoidae			*Paratetralophodon*	*Paratetralophodon*
Stegodontidae			Stegodontidae	Stegodontidae
Stegodontinae			*Stegilophodon*	*Stegilophodon*
Stegodon			*Stegodon*	*Stegodon*
Elephatoidea				
Elephantidea	Elephantidea	Elephantidea	Elephantidea	Elephantidea
Osborn(1936,1942)	Simpson (1945)	Magilo (1973) and coppens et al. (1978)	Tassy (1985, 1988*a*) and Shoshani and Tassy (1996),	Shoshani and Tassy (1996),
Loxodontinae	Stegodontinae	Stegotetrabelodontinae		
Loxodonta	*Stegolophodon*	*Stegotetrabelodon*	*Stegotetrabelodon*	*Stegotetrabelodon*
Palaeoloxodon	*Stegodon*	*Stegodibelodon*		*Stegodibelodon*
Hesperoloxodon				
Elephantinae	Elephantinae	Elephantinae	Elephantinae	Elephantinae
Elephas	*Loxodonta*	*Primelephas*	*Stegodibelodon*	*Primelephas*
Hespelephas	*Elephas*	*Loxodonta*	*Primelephas*	*Loxodonta*
Platelephas		*Elephas*	*Loxodonta*	*Elephas*
Mammuthinae			*Elephas*	
Archidiskodon				
Metarchiskodon				
Parelephas				
Mammonteus	*Mammuthus*	*Mammuthus*	*Mammuthus*	*Mammuthus*

4.5 Systematic Description

Ancient elephant teeth had been reported from Tha chang, Nakhon Ratchasima by Suthethorn, *et al.* (1997), Sato (2002), Chaimanee, *et al.* (2003), Nakaya *et al.* (2003) Thasod and Ratanasthien (2005). They were composed of *Sinomastodon* sp., Amebelodontid gomphothere (*Protanancus chinjiensis*), *Gomphotherium* sp., *Prodeinotherium* sp., *Stegolophodon* cf. *stegodontoides*, primitive *Stegodon*, advanced *Stegodon* and *Elephas*.

In this study, the majority of the materials described are stored in the Northeastern Research Center for Petrified wood and Natural Resources Museum about 32 specimens. The specimens were found from the Siam sandpit in the field of study about 11 specimens. Four species of elephant fossil teeth from the sandpit were identified. They compose of *Sinomastodon* sp., *Stegolophodon* sp., *Stegodon* sp. and *Elephas* sp. (Plate 1). The specimens from the Northeastern Research Center for Petrified wood and Natural Resources Museum can be identified seven species as *Gomphotherium* sp., tetralophodon gomphothere, *Prodeinotherium* sp., *Protanancus* sp., *Stegolophodon* sp., *Stegodon* sp. and *Elephas* sp. (Plate 2 and 3).

The systematic classification and morphological terms were used in this study based on Shoshani and Tassy (2005) (Table 4.2). All linear measurements of specimens are in millimeters (mm). The description of proboscidean fossils in this study are shown below.

Superorder Ungulata Linnaeus, 1766
Order Proboscidea Illiger, 1811
Class Mammalia Linnaeus, 1758
Subclass Theria Parker and Haswell, 1897
Family Deinotheriidae Bonaparte, 1841
Genus *Prodeinotherium* Ehik, 1930

Material: A single right lower jaw with M_1, M_2 and M_3 (Reg. no. RIN-15) from the Northeastern Research Center for Petrified wood and Natural Resources Museum, Nakhon Ratchasima. (see Figure 4.6)

Description: This specimen is belonging to *Prodeinotherium* molar. It composed of right lower molar with M_1, M_2 and M_3. Length of the toothrow is 208.3 mm. and height 45.3 mm. M_1 has three transverse lophs. Its width is nearly equal and not complete. The tooth of M_2 is quadrate in occlusal outline. It has two transverse lophs and equal width. The metaloph has two protocristids that extend medially and end on the anterior cingulum. The tooth of M_3 has two transverse lophs and marrows posteriorly.

Comparison and Discussion: *Prodeinotherium* first appearance in Europe towards the end of the early Miocene, and is documented as well from the early Miocene of South Asia. In both Europe and Asia, as in Africa, *Deinotherium* replaced *Prodeinotherium* by the start of the late Miocene (Sander *et al*., 2004). The sharper crest, the paracone, metacone, and metaconule fully incorporated into an ectoloph ornamented by mammillons, and creating a more continuous characteristic is typically of *Prodeinotherium* and *Deinotherium.*

Diagnosis: It differ from *Deinotherium* by various details in the shape and form of the teeth. Beside, it differ from the m2, m3, and M3 of *Chilgatherium* as development of a tritoloph. The m2 of *Chilgatherium* is composed of two rounded cusps that are not connected by a transverse ridge and that are lower than the cusps in the first two lophids.

Life span of taxon: Early and Middle Miocene

Habitat : They may be live in the forest

Distribution : Europe, Asia and Africa. In Thai found in A. Pong, Phayoua and in the sand pit Tha Chang, Nakhon Ratchasima

Table 4.3 Measurement of the right lower molars of *Prodeinotherium* (Reg. no. RIN- 15) from the Northeastern Research Center for Petrified wood and Natural Resources Museum, Nakhon Ratchasima.

	Length (mm.)	Anterior width (M_1. M_3 metalophid)	Posterior width (hypolophid)	Tritolophid width
M_1	70.4	42.0	45.6	-
M_2	70	59.0	59.0	-
M_3	70	61.0	55.0	-

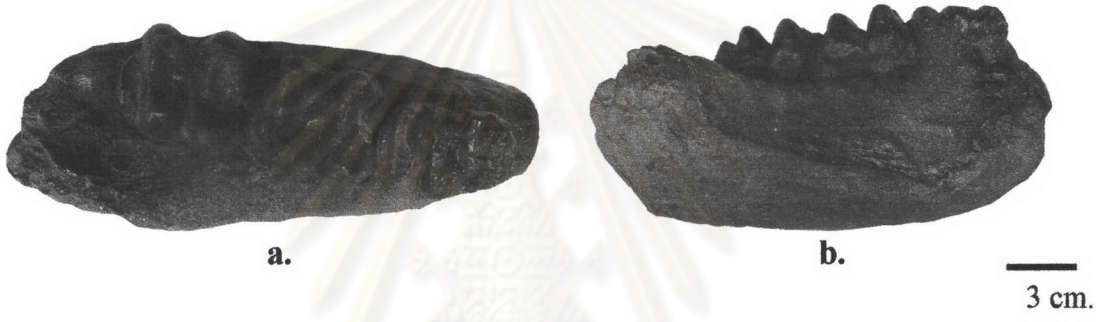


Figure 4.6 (a.) Right lower jaw with M_1, M_2 and M_3 of *Prodeinotherium* (Reg. no. RIN- 15)
(b.) the same specimen as in (a.) but in a lateral view.

Superfamily Gomphotherioidea Hay, 1922
Family Gomphotheriidea Hay, 1922 (trilophodont gomphotheres)
Genus *Gomphotherium* Burmeister, 1837

Material : A single right lower jaw with M_2, M_3 (No Reg. number) from the Northeastern Research Center for Petrified wood and Natural Resources Museum, Nakhon Ratchasima. (see. Figure. 4.7)

Description : This fossil is a bunodont molar. It is 227.5 mm in length, 115.5 mm in width and 6.3 mm in enamel thickness. M_2 is composed of 3 lophs and a talon. M_3 is composed of 5 and half loph. The interlophs are rather wide. The interlophs exhibit projections among the pretrite elements. The development of trefoils on the posttrite hemilophs is poorly.

Comparison and Discussion: They share simple bunolophodont molars belonging to the simple pattern of the trilophodont grade, dp4, M1, M_2 with three lophs. The outline of their cheek teeth similar to Gomphotheres, which consist of round cusps. M3 with three to four and a fraction loph; trefoils on the posttrite hemilophs absent or poorly develop (Mazo, 1996).

Life span of taxon: Middle Miocene

Habitat: They live near the lake in the forest semi arid but some species live in swamp

Distribution : Western Europe, Africa, North America, Asia and Thai

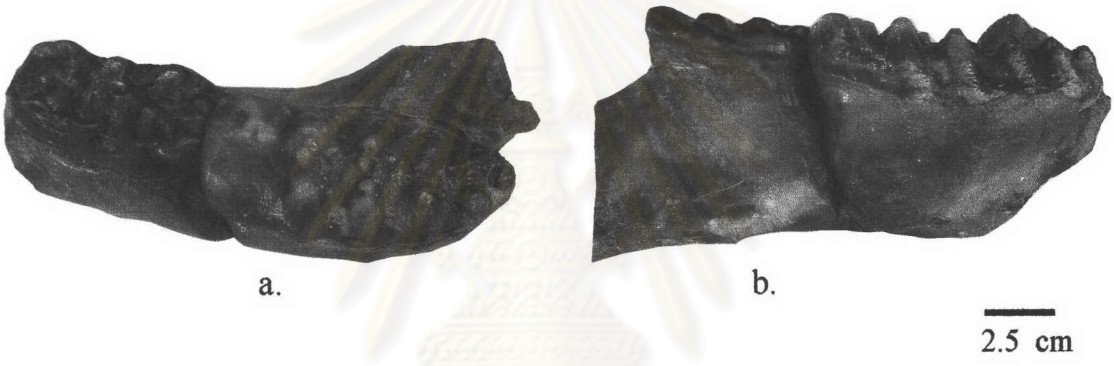


Figure 4.7 (a.) Right lower jaw with M_2 (left), M_3 (right) (No. Reg. number) of *Gomphotherium*, in occlusal view.
(b.) the same specimen as in (a.) but in a latteral view.

Order Proboscidea Illiger, 1811
Suborder Elephantiformes Tassy, 1988a
Supperfamily Elephantoidea Gray, 1821
Family Gomphotheriidae Hay, 1922
Subfamily Amebelodontinae Barbour, 1927
Genus *Protanancus* Arambourg, 1945

Material: A single right lower jaw with M_2, and M_3 (Reg. no. RIN-25), Stored in Northeastern Research Center for Petrified wood and Natural Resources Museum, Nakhon Ratchasima, Thailand.

Description : This tooth belongs to the trilophodont grade composed of M_2 has three lophs and a talon. It is about 120 mm. in length, 48.8 mm. in width and 35.2 mm. in height. M_3 has four lophs with a big talon. It is about 142 mm. in length,

51.7 mm. in width and 48.4 mm. in height. The cusps of M_2 are blunt. It is heavily worn. The anterior and postterior central conules present both of the pretrite and posttrite half-lophid. The posttrite half-lophid are bigger than the posttrite half-lophid. The main tubercles of M_3 are rather than long and sharp. The median sulcus is clearly defined. The main cusps of posttrite and pretrite half-lophid divided into two small conule. The pretrite and posttrite half-loph consist of main cusp, a mesoconelet, and a little posterior central conules in pretrite half-loph and two posterior central conules in postrite half-loph.

Comparison and Discussion: This specimen similar to *Protanancus* as trilophodont grade, intermediate loph has three lophs, and M_3 is tetralophodont. M_3 with two definite cuspids at rear.

Life span of taxon: Middle Miocene

Habitat : They are believed to have inhabited close to water sources.

Distribution : Africa, Asia and Thai

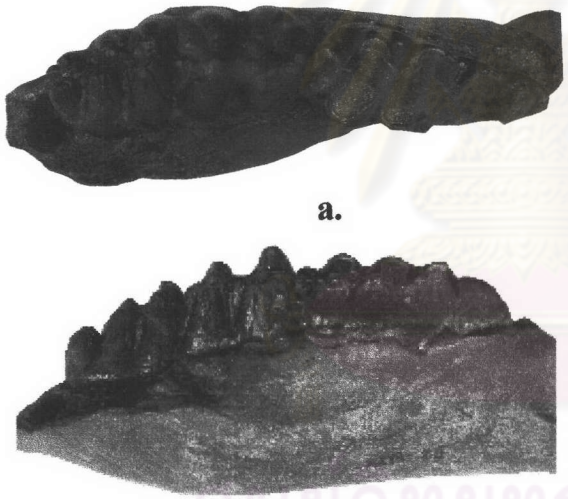


Figure 4.8
(a.) Right lower jaw with Dp_2, Dp_3 and Dp_4 (Reg. no. RIN- 25) of *Protanancus*, in occlusal view.

(b.) the same specimen as in (a.) but in a latteral view

Order Proboscidea Illiger, 1811
Family Gomphotheriidea Hay, 1922
Genus *Sinomastodon* Tobien& Chen & Li, 1986

Material: Posterior part of left lower molar M_3 (Reg. No. CUGM-011) from Siam sandpit, Nakhon Ratchasima.

Description: This fragment of a bunodont molar with simple tooth pattern. It composed of two lophs, incomplete (Fig 4.9). It is about 99.9 mm. in length, 73.7 mm. in width. The lophs are composed of 2 round tubercles of the same height.

There are lateral tubercles at the entrance of the valleys on the pretrite side. The pretrite half-loph is composed of a main cusp, a mesoconelet, anterior and posterior central conule. On the postrite half-loph is composed of a main cusp, and mesoconelet. Median sulcus is clearly defined. Chevron is formed by the pairs of opposite half-lophs.

Comparison and Discussion: The *Sinomastodon* is different from *Anancus* by trilophodont intermediate molars and opposite loph structures (chevroning). It is similar to *Sinomastodon* sp. B, there are accessory conules on the lateral position of the transverse valleys

Life span of taxon: Pliocene-Pleistocene

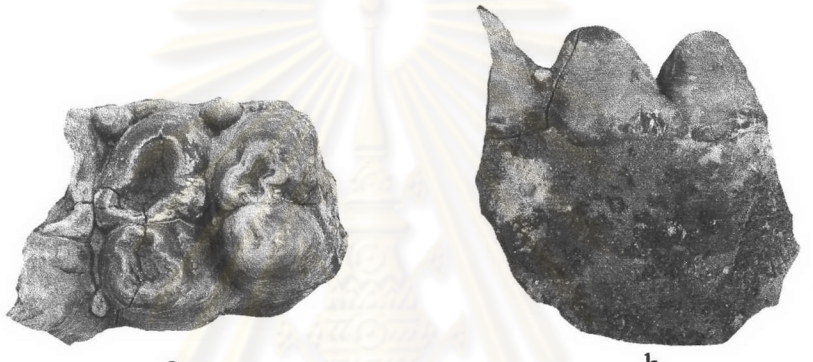


Figure 4.9 (a.)Posterior part of a left lower molar, occlusal view of *Sinomastodon*. (Reg. No. CUGM-011)
(b.) the same specimen as in (a.) but in a lateral view.

Superfamily Elephantoidea Gray, 1821
Family incertae sedis Genus *Tetralophodon* Falconer, 1857
(tetralophodont gomphothere)

Material : A single left lower molar M_2 (Reg. no.RIN-349) from the Northeastern Research Center for Petrified wood and Natural Resources Museum, Nakhon Ratchasima.

Description : This specimen composed of four lophs and a talon. It is 162.9 mm. in length, 75.3 mm. in width. The main tubercles are wide at the base with binary division, the interlophs exhibit projections among the pretrite elements.

Comparison and Discussion: The outline of their cheek teeth similar to Gomphotheres, which consist of round cusps. It is bunolophodont molars belonging to tetralophodont grade, M_2 with four lophs.

Life span of taxon: Middle Miocene-Pliocene

Distribution: Europe, Asia, North America and Thai

Figure 4.10 (a.) Left lower molar M_2 (Reg. no. RIN- 349) of *Tetralophodon,* occlusal view. (b.) the same specimen as in (a.) but in a latteral view.

Order Proboscidea Illiger, 1811
Family Stegodontidae Osborn, 1918
Genus *Stegolophodon* Schlesinger, 1917

Material: Posterior part of lower left molar M_3 (Reg. no. CUGM-009).

Description: This fragment is a bunodont molar. It composed of two lophs and incomplete (Fig 4.11). There is clearly median sulcus. It is 55 mm. in length, 70 mm. in width. The lophs are composed of 4 round tubercles of the same height.

Comparison and Discussion: This specimen similar to *Stegolophodon* due to clearly in median sulcus. Central conules enlarged more than *Stegodon* and *Gomphotherium.*

Life span of taxon: Late Miocene-Early Pliocene

Distribution: China,India, Burma and Thai

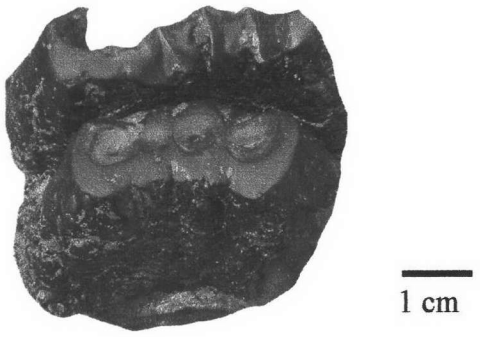


Figure 4.11 Anterior part of a third molar, *Stegolophodon* sp. (Reg. no. CUGM-009), in occlusal view.

Material : A single right upper molar M^3 (Reg. no. RIN-804), left upper molar (Reg. no. RIN-35), upper molar (Reg. no. RIN- 348), upper molar (Reg. no. RIN-33), right upper molar M^3 (Reg. no. RIN- 36), upper molar $M^{2-3?}$ (Reg. no. RIN-66), left upper molar (Reg. no. RIN-61), right upper molar (Reg. no. RIN- 65), Dp^4 (Reg. no. RIN- 67), lower molar (Reg. no. RIN- 805&534), and right lower molar (Reg. no. RIN-3) from the Northeastern Research Center for Petrified wood and Natural Resources Museum, Nakhon Ratchasima. (Figure 4.12 and Plate 2)

Description: This specimen is bunodont molar composed of 4-5 lophs with a posterior talon They are about 84-221.6 mm in length, 56.7-118.5 mm. in width. Each lophs is composed of 4 round tubercles of the same height. There is median sulcus that separates the pretrite and posttrite halves. They are brachydont with a height less than the breadth of the tooth. The anterior margin is broad but from the third loph posteriorly there is gradual diminishment in breadth, to create a wedge-shaped occlusal surface.

Discussion and Comparison: These specimen can be allocated to *Stegolophodon* because of them brachyodonty, the equal height of the tubercles of each loph, the regular cone shaped tubercles and the convex sides of the lophs (Ginsdurg and Tassy, 1985) They differ from *Stegodon* by clearly in median sulcus and central conules enlarged. *Stegolophodon* differ from *Gomphotherium* by central conules enlarged in M^{1-3} and M^3 is pentalophodont or more while M^3 of *Gomphotherium* is trilophodont.

Life span of taxon: Late Miocene-Early Pliocene

Distribution: China,India, Burma and Thai

Table 4.4 Measurement of molars of *Stegolophodon* from the Northeastern Research Center for Petrified wood and Natural Resources Museum, Nakhon Ratchasima.

Tooth	Specimen	Site	Crown Length	Crown Breadth	Crown Heigth	Plate Frequency	Width of the Posterior loph	Heigth of the Pretrite	Enamel Thickness
M3 (L)	RIN 35	TC	221.6	118.5	44.6	5(incomplete)	51.1	32.2	8.5
M3	RIN 348	"	211.6	104.5	57.2	5	79.7	-	-
M3 ®	RIN 804	"	183.9	93	36.6	5+	72.1	32.9	6.9
M3	RIN 33	"	206.4	92.8	54.3	6	67.3	41.3	-
M2	RIN 33	"	132.2	92.2	37	4	incomplete	22.1	5.7
M3 ®	RIN 36	"	202.4	113.4	33.5	5(incomplete)	97.8	-	9.1
M2-3	RIN 66	"	173.4	98.3	36.1	4 (incomplete)	-	36.1	6.7
M3 (L)	RIN 61	"	202.9	88.5	28.5	6	74.7	-	6.1
M2 ®	RIN 65	"	197.4	90.7	25.8	5	85.8	27.6	7.9
Dp4	RIN 67	"	84	56.7	28.6	4	-	-	2.6
	RIN 805 &	"	201.75	78.5	25.6	6 (incomplete)	-	-	-
	RIN 534	"	20185	77.1	25	6 (incomplete)	43.6	-	4.6
M2 ®	RIN 3	"	2089	92	38	5	73.1	42.5	-

Figure 4.12 (a.) Right upper molar M^3 (Reg. no. RIN- 804) of *Stegolophodon*, occlusal view
(b.) the same specimen as in (a.) but in a latteral view.

Order Proboscidea Illiger, 1811
Family Stegodontidae Osborn, 1918
Genus *Stegodon* Falconer, 1857

Material: M1? (Reg. no. CUGM-007) from Siam sandpit, Nakhon Ratchasima. (see. Figure 4.13)

Description: This fragment is belong to bunodont molar composed of 4 lophs, in complete. It is about 89.5 mm in length, 66 mm. in width. The median sulci become indistinct and disappear. The fusion of the principal cone and mesoconelets. The shape of a valley between lophs is Y-shaped.

Comparison and Discussion: This specimen can be allocated to *Stegodon* because of its brachyodonty. There is something that indicates a number of distinct *Stegodon* characteristics such as a scalloped enamel pattern and the valley between lophs is Y-shaped which is typically of *Stegodon* used to distinguish elephantids from *Stegodon*) It differ from *Stegolophodon* such as; the degeneration of median sulci may be caused by enlargement of mesoconelets followed by fusion of mesoconelets and the principal cone, fusion of the main posttrite and pretrite cusp and this group shown as increase of conelets, fine folding of the enamel loop.
Life span of taxon: Late Pliocene- Pleistocene

Habitat : They are believed to have inhabited forested areas close to water sources, and their diet may have consisted of bamboo shoots and leaves.

Distribution: Africa, Asia and Thai

Figure 4.13 Lateral view of M1?, *Stegodon* sp. (Reg. no. CUGM-007), in occusal view

Material : A single left lower molar M_3 (Reg. no. RIN-14), right upper molar M^3 (Reg. no. RIN-50), right upper molar M_3 ((Reg. no. RIN-1), M? (Reg. no. RIN-31), right upper molar M^3 (Reg. no. RIN- 24), left lower molar M_3 (Reg. no. RIN-46), left lower molar M_3 (Reg. no. RIN- 43), molar (Reg. no. RIN- 48), left lower molar M_3 (Reg. no. RIN- 60), and left lower molar M_2 (Reg. no. RIN- 30) from the

Northeastern Research Center for Petrified wood and Natural Resources Museum, Nakhon Ratchasima (Figure 4.14 and Plate3).

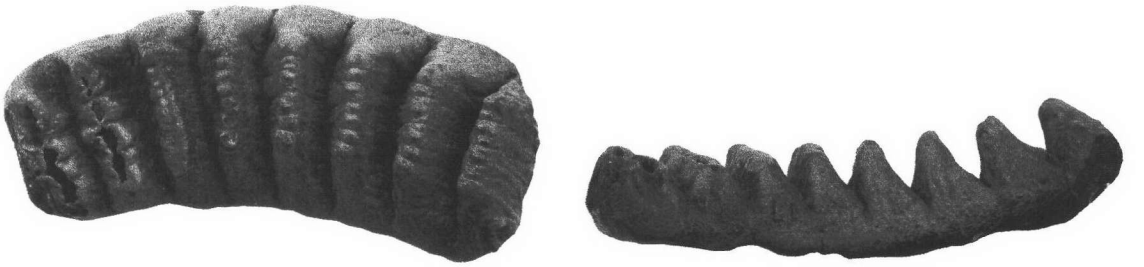
Description: These specimen are bunodont molar composed of 5-8 lophs. They are about 179.7-273 mm in length, 91.3-113.2 mm. in width. The median sulci become indistinct and disappear. The fusion of the principal cone and mesoconelets. The shape of a valley between lophs is Y-shaped.

Comparison and Discussion: This specimen can be allocated to *Stegodon* because of its brachyodonty. There is something that indicates a number of distinct *Stegodon* characteristics such as a scalloped enamel pattern and the valley between lophs is Y-shaped which is typically of Stegodon used to distinguish elephantids from Stegodon) It differ from Stegolophodon such as; the degeneration of median sulci may be caused by enlargement of mesoconelets followed by fusion of mesoconelets and the principal cone. Fusion of the main posttrite and pretrite cusp and this group shown as increase of conelets, fine folding of the enamel loop.

Life span of taxon: Late Pliocene- Pleistocene
Habitat : They are believed to have inhabited forested areas close to water sources, and their diet may have consisted of bamboo shoots and leaves.
Distribution: Africa, Asia and Thai

Table 4.5 Measurement of molars of *Stegodon* from the Northeastern Research Center for Petrified wood and Natural Resources Museum, Nakhon Ratchasima.

Tooth	Specimen	Site	Crown Length	Crown Breadth	Crown Heigth	Plate Frequency	Width of the Posterior loph	Heigth of the Pretrite	Enamel Thickness
M3	RIN 14	TC	273	113.2	69.4	8	86.2	65.3	4.6
M3	RIN 50	"	263.8	124.4	65.3	7	96	67.8	-
M3	RIN 1	"	213.4	129	64.7	5 (incomplete)	-	65	-
M ?	RIN 31	"	155.4	106.7	54.4	4 (incomplete	-	-	1.1
M3	RIN 24	"	202	114	57	6	-	-	6.0
M3	RIN 46	"	295.1	102	64.2	7	52.7	63.7	3.9
M3	RIN 43	"	107.4	102.4	58.8	4 (incomplete)	77.7	54	-
M3	RIN 32	"	49.3	96.7	48.3	3 (incomplete)	-	-	0.75
M	RIN 48	"	162	117.5	66.4	4 (incomplete)	-	-	o
M3	RIN 60	"	179.7	79.7	54.2	5	73.6	42.6	0
Dp2	RIN 68	"	48	48.2	24.2	-	-	-	0.46
M2	RIN 30	"	186.4	91.3	47.5	5	71.8	44.5	0.56
M1	RIN 28	"	243.2	154	51.1	6	86.4	32.3	0.56
M2	RIN 27	"	155.3	99.9	37.2	5 (incomplete)	-	34.4	0.43
M2	RIN 27	"	155.3	99.9	37.2	5 (incomplete)	-	34.4	0.43



a. b.

3 cm

Figure 4.14 (a.) Left lower molar M_3 (Reg. no. RIN-14) of *Stegodon,* in occlusal view (b.) the same specimen as in (a.) but in a lateral view.

Family Elephantidae Gray, 1821
Subfamily Elephantinae Gray, 1821
Tribe Elephantini Gray, 1821
Genus *Elephas* Linnaeus, 1758

Material: A single third molar m3 (Reg. no. CUGM 0017) from Siam sandpit, Nakhon Ratchasima.

Description : This specimen is incomplete. Molar composed of about 6-7 plate. It is hypsodont and have multiple roots. The lophodont grinding surfaces are composed of closed enamel loops whose centers are filled with dentine and which are held together by cementum. The molars are broad and high and with numerous closely apperessed edge-plates.

Comparison and Discussion: It similar to the specimen from the Northeastern Research Center for Petrified wood and Natural Resources Museum, Nakhon Ratchasima but it is smaller than them. Because of it broken. It differ from *Loxodonta africana* such as, the molar of *Loxodonta africana* is rather narrow and relatively low crowned, with a comparatively small number of ridges, which with wear, tend to show a rhomboidal pattern. (Romer, 1933)

Figure 4.15 A single third molar molar of *Elephas* sp. (Reg. no. CUGM 0017), in occusal view.

Specimen : A single upper molar (Reg. no. RIN- 44) and third M3 (Reg. no. RIN-10) from the Northeastern Research Center for Petrified wood and Natural Resources Museum, Nakhon Ratchasima, and one molar (Reg. no. TF 2283) from Department of Mineral Resources (Figure 4.16, and Plate 3)

Description: These specimens are hypsodont and have multiple roots. Molar composed of about 8-12 plate, 139.4-238.3 mm. in length and about 65.4-102.5 mm, in width. The lophodont grinding surfaces are composed of closed enamel loops whose centers are filled with dentine and which are held together by cementum. The molars are broad and height, and with numerous closely apperessed edge-plates.

Comparison and Discussion: *Elephas* differ from *Loxodonta* such as, the molar of *Loxodonta* are rather narrow and relatively low crowned, with a comparatively small number of ridges, which with wear, tend to show a rhomboidal pattern. (Romer, 1933), but *Elephas* molars are broad and high and with numerous closely appressed ridge-plates. For Mammoths, they differ from *Elephas* such as; the thinning of molar enamel and increase in the number of lamellae (enamel plates) (Lister, 1996). The number of plates is variable. In some early and primitive Asiatic species even the last molars have but ten or a dozen plates; these teeth in some woolly mammoths have the extreme figures of twenty-seven to thirty ridges. (Romer, 1933)

Life span of taxon: Pliocene-Recent

Habitat : They occupies a variety of habitats but it appears to prefer forested areas and transitional zones between forests and grasslands where a greater variety of food types is a available. Its habitats range from sea level to mountainous regions at about 2,000 meters above sea level or even higher.

Distribution: They is found in Asia (India, Nepal, Sri Lanka, China, Burma, Thai, Malaysia, Vietnam, Laos, Cambodia, Borneo and Sumatra)

Table 4.6 Measurement of molars of *Elaphas* from the Northeastern Research Center for Petrified wood and Natural Resources Museum, Nakhon Ratchasima.

Tooth	Specimen	Site	Variable							
			Occlusal Length	Length Crown	Width of Crown	Heigth of Crown	Number of a Plate	Enamel Thickness	Lamellar Frequency	Hypsodonty index Heigth / Width
m3	RIN10	TG	199.4	234.5	102.5	98.7	12	5.3	53.2	0.96
upper molar	RIN 44	TG	139.4	127	83.6	226.7	8	03.9	-	2.71
M	TF2283	TG	238.3	238.3	65.4	139.8	12	4.2	48.3	2.14

Figure 4.16 (a.) Upper molar (Reg. no. RIN- 44) of *Elephas,* in occlusal view (b.) the same specimen as in (a.) but in a latteral view.