

A new Miocene mammalian locality, Mae Soi and the occurrence of partial skeletons of rhinocerotids and gomphotheres from northern Thailand

Haruo Saegusa¹, Bejavun Ratanasthien², and Hideo Nakaya³

¹*Division of Earth Sciences, Himeji -Institute of Technology. Yayoigaoka, Sanda, Hyogo, 669-1546, Japan.*

²*Department of Geological Sciences, Faculty of Science, Chiang Mai University. Chiang Mai 50200, Thailand.*

³*Department of Earth Sciences, Kagawa University, Saiwai-cho, Takamatsu, Kagawa, 760-8522, Japan.*

Abstract

A New Miocene vertebrate fossil locality was found in Mae Soi, Chiang Mai Province. A nearly complete gomphothere skeleton was excavated from this site, together with several fragmental mammalian fossils. The gomphothere from Mae Soi could be either *Archaeobelodon* or *Gomphotherium*. The age of the deposits in which this gomphothere skeleton occurred is provisionally dated to the Early or Middle Miocene.

Partial skeletons of rhinocerotids were found in Na Sai, which is a well known locality of the Miocene in Northern Thailand. The rhinocerotid from this locality has been assigned to *Gaindatherium*, but cranial fragments included in a new skeleton suggest that the rhinocerotid from Na Sai could not be *Gaindatherium* but, rather, some other primitive genus of Rhinocerotidae. Further analysis of the skeletal elements of this rhinocerotid is necessary.

Introduction

The Cenozoic vertebrate fauna of Northern Thailand has been studied over the past two decades by Thai and French geologists and paleontologists (Ginsburg and Tassy, 1985; Ducrocq, et al., 1994). Mammalian fossils found from intermontane basins of northern Thailand suggest that the strata of those basins are Miocene in age but there remain differences as to how to correlate these Thai localities with other Asian localities (Ducrocq, et al., 1994; Mein and Ginsburg , 1997). These differences result, at least in part, from the absence of a long sedimentary sequence that shows the successive change of the Neogene mammalian fauna of Thailand. Further to this, in most localities small and large mammals

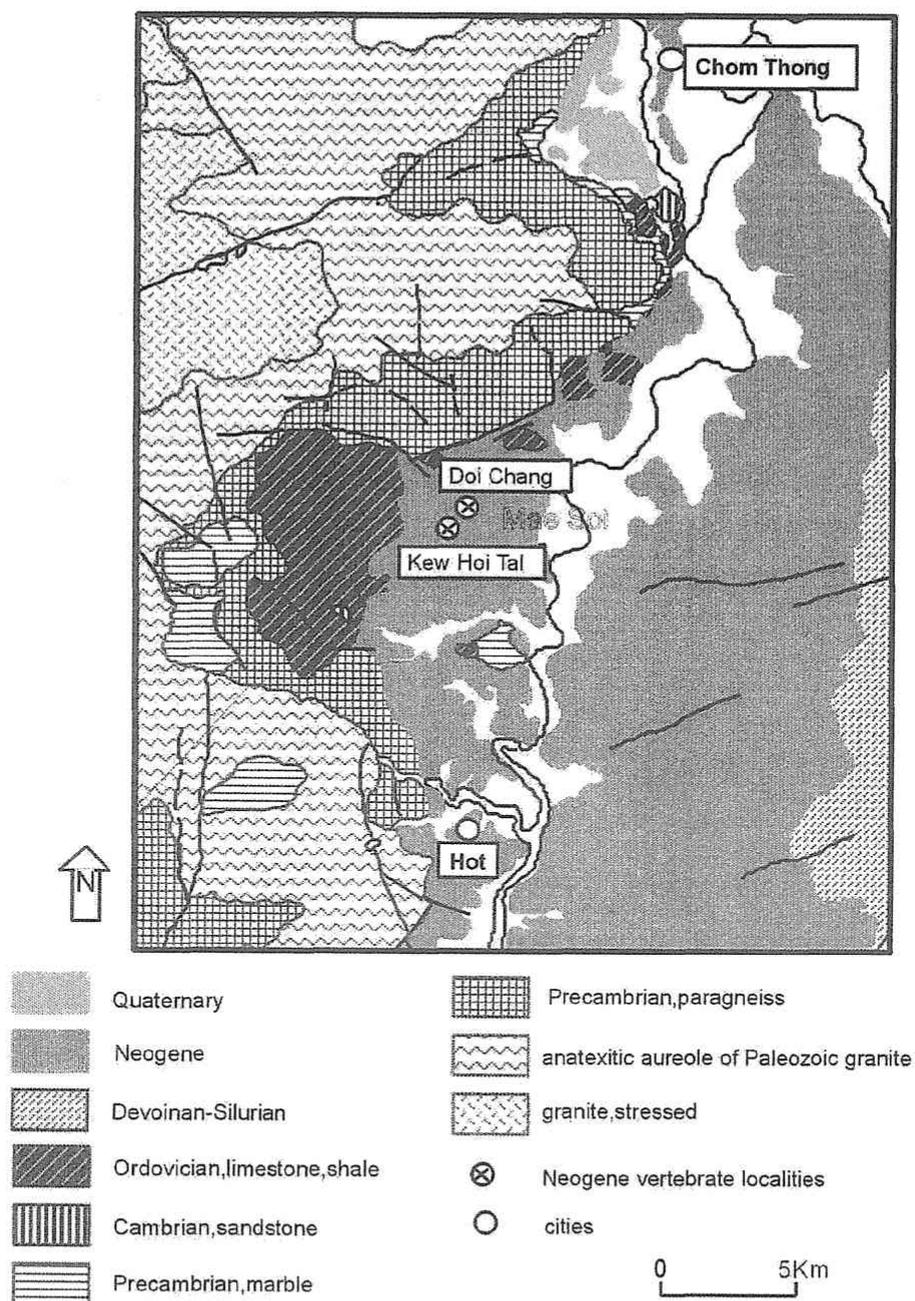


Figure 1. Location and geological setting of Mae Soi site. (modified from Baum *et al.*, 1982)

do not occur together. Thus, it is important to find a new locality that can fill the gap between previous localities. The new locality of Mae Soi could be such a locality.

A second drawback for mammalian paleontology in northern Thailand is the quality of the mammalian fossils found to date. The Neogene Thai fauna has several forms that are peculiar and that are, therefore, difficult to use for accurately correlating Thai locali-

ties with other Asian localities. An example of this is so called "*Gaiotherium*" from several localities in Northern Thailand which could belong to a different lineage than that recorded in the Siwaliks (Ducrocqet al., 1994). Precise phylogenetic relationships between the forms in Thailand and those of other areas of Asia must be determined, but to do this skull and post cranial element are necessary. Unfortunately, most Miocene mammalian fossils of Thailand are represented by isolated teeth and bones. There are isolated exceptions to this, such as the partial skeleton of *Siamotragulus* reported by Thoma and others (1990). The occurrence of two partial skeletons reported here is, thus, a rare and long awaited occurrence.

**Mae Soi site, a new mammalian fossil locality from northern Thailand
and a new gomphotheres skeleton from this site**

During March, 1997, villagers of Mae Soi village, which is about 10 kilometers north of Hot in Chiang Mai Province, found a gomphothere skeleton in a low hill west of the village (Fig. 1). The posterior half of the skeleton was excavated and brought to a temple in the village in order to calm the soul of this ancient large animal. After a ceremony held at the temple, most elements of the skeleton were reburied at the place where they were found. However, a few elements were sent to the National Museum in Chiang Mai for identification. The director of the museum informed one of author's, Benjavun Ratanasthien, of the occurrence of the fossil skeleton. Subsequently, the fossil skeleton was excavated between the end of November and the first week of December, 1997.

Most of the posterior half of the skeleton had been excavated by villagers but the left and right pelvis and anterior half of the skeleton, including a skull and tusks, were found in situ during the excavation (Table 1). The hill, Doi Chang, was found to have fossil localities besides that of the gomphothere skeleton. The entire hill area has been called the Mae Soi site.

The Neogene formation exposed in Doi Chang is largely siltstone that contains much intercalated sandstone and conglomerate (Fig. 2). Neogene sedimentary rocks that crop out in this area directly overlie Ordovician and Precambrian basement and forms a major part of Doi Chang (Fig. 1). This part of the Neogene sedimentary sequence is widespread in the Chiang Mai basin (Baum and others, 1982).

Another fossiliferous bed occurs at Kew Hoi Tal, which is about 1 kilometer from Doi Chang. This second locality contained fragments of suid and gomphothere limb bones and a gomphothere milk tooth. The formation exposed at this second fossil locality is mainly siltstone and intercalated sand and conglomerate beds (Fig. 2). The fossil material collected is not well enough preserved to allow precise identification but at least two large calcareous concretions contain skeletons of a large animal, possibly a gomphothere. The

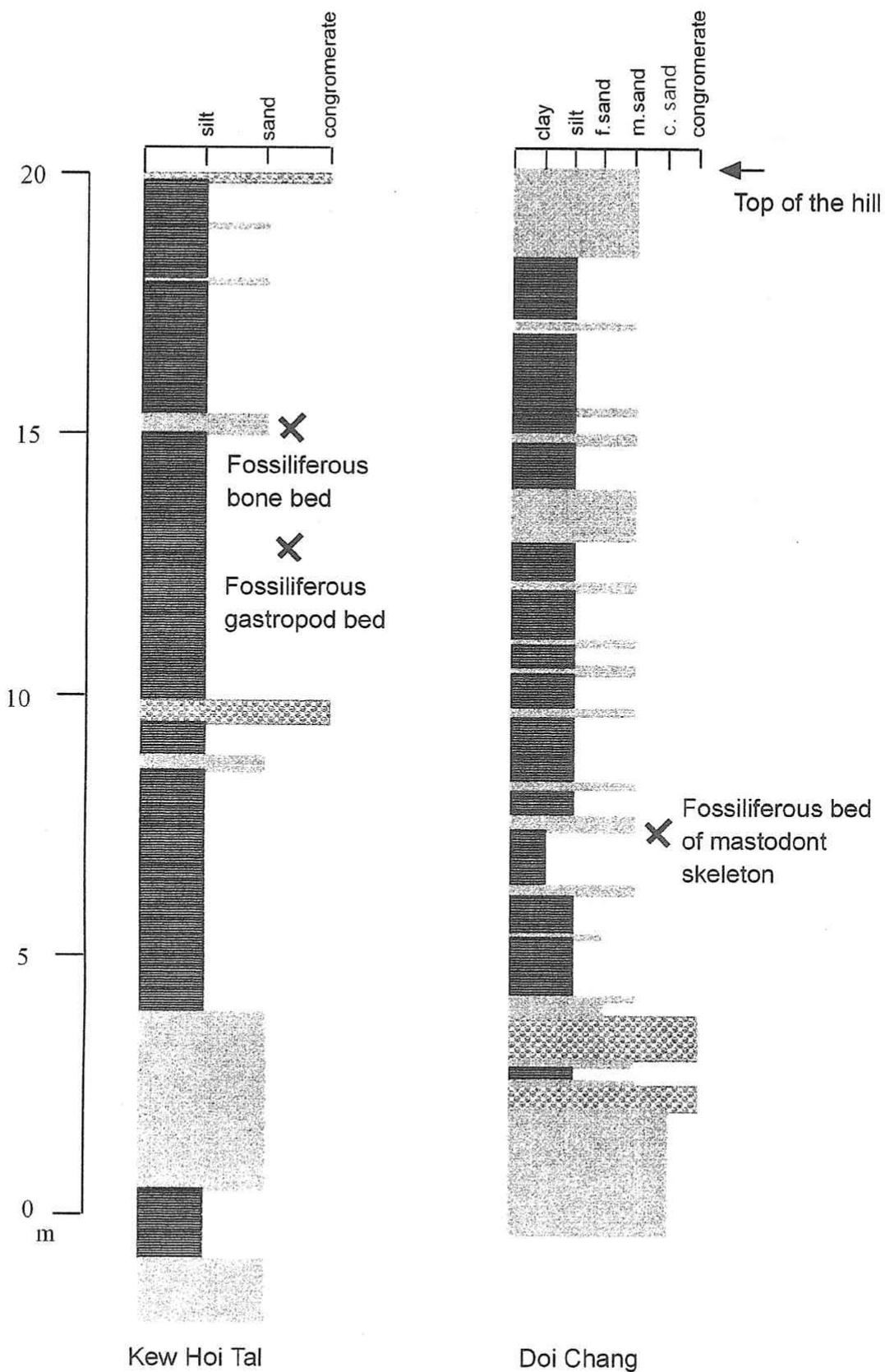


Figure 2. Lithology of vertebrate localities in Mae Soi.

Miocene localities in Northern Thailand

Table 1. Skeletal elements preserved in gomphothere skeleton from Mae Soi.

skeletal elements
Skull
Fragments of left and right mandible
Upper and lower third molars
Upper and lower incisors
Seven cervical vertebrae
Anterior thoracic vertebrae
Three lumbar vertebrae
Anterior rib bones
Humerus
Radius
Left and right innominate
Fragment of femur
Tibia
Calcaneum
Astragalus
Navicular

Table 2. Skeletal elements preserved in rhinocerotid skeleton from Na Sai.

skeletal elements
Left mandible with P ₂ -M ₃
Right mandible with P ₄ -M ₃
Upper left molars, P ³ -M ³
Upper right molars, P ⁴ -M ³
Right and left nasal bones
Postglenoid process and posttympanic process of the squamosal
Left occipital condyle
Atlas and axis
Five thoracic vertebrae
Fragments of rib bones
Fragments of left and right scapulae
Left humerus
Left magnum
Left scaphoid
Left pisiform
Three sesamoids

lithology of Kew Hoi Tal is similar to that of Doi Chang but the stratigraphic relationship between Doi Chang and Kew Hoi Tal is not clear.

Except for a fine gomphothere skeleton, only several fragments of limb bones of suids and ruminants and a milk molar of a gomphothere were found, but these are not suitable for further identification. Thus, only the partial gomphothere skeleton can be used to indicate the geological age of the Neogene beds in this area.

Among the skeletal elements of the gomphothere from Mae Soi, only the upper and lower tusk and molars can be used for identification because other elements are still under preparation. The skeleton obviously belongs to an old individual because both upper and lower third molars exhibit extreme wear. The molars have five ridges and exhibit bunodont condition. Except for those two characteristics, any morphological detail of the molar crown can not be determined because of heavy wear. Fortunately, the tusks are very well preserved (Pl. 1, Fig. 1). The upper tusks gently curve ventrally and have a distinct enamel band along the lateralo-ventral border, as in most gomphotheres. The lower tusks lack enamel, as do adult gomphotheres in general, and are slightly flat dorso-ventrally (Fig.3). On the dorsal and ventral surfaces of the tusks, there are shallow longitudinal grooves, sillon longitudinal. Presence of those grooves and moderate flatness are primitive characters seen in the early form of Neogene Elephantoida, such as *Gomphotherium angustidens*, *Eozygodon* , and *Archaeobelodon* (Tassy, 1986, 89). The molar of *Eozygodon* shows the typical zygodont condition and can be discounted for that reason. Thus, based

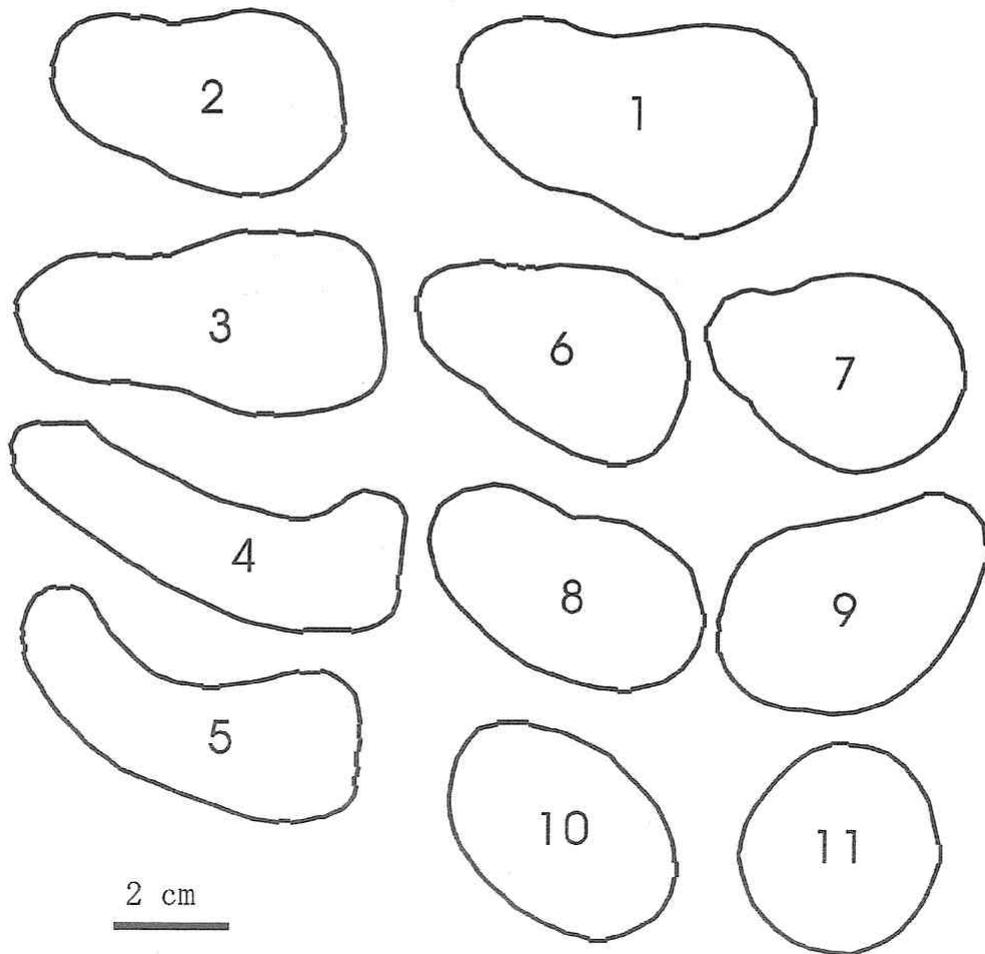


Figure 3. Cross-sections of lower incisors of gomphotheres from Thailand and various localities of Asia and Europe (in posterior view). 1: gomphothere from Mae Soi; 2: *Archaeobelodon filholi*, Sansan, Sa 2887 MNHN; 3: *A. filholi*, Sansan, Sa 2947 MNHN; 4: *A. filholi*, Sansan, mounted skeleton MNHN; 5: *Protoanancus chinjiensis*, loc. 53-54, Chinji Formation, AM 19421 AMNH; 6: *Gomphotherium angustidens*, En Pejouan, SEP 242 MNHN; 7: *G. angustidens*, En Pejouan, SEP 208 MNHN; 8 and 9: cf. indet. trilophodont gomphothere, Quadirpur, Chinji Formation, 906 BSM; 10 and 11: *G. browni*, loc. B 51, Chinji Formation, AM 19417 AMNH. 2,3,4,5,6,7: redrawn from Tassy (1982); 8,9,10,11: redrawn from Tassy (1983).

on tusk and molar morphology, the gomphothere from Mae Soi can belong to either *Archaeobelodon* or to *Gomphotherium*.

Tassy (1982) erected the genus *Archaeobelodon* for primitive gomphothere specimens that have a moderately flattened lower tusk and a relatively narrow bunodont molar. He suggested that *Archaeobelodon* is the most primitive genus of the Family Amebelodontidae, whose later forms, such as *Protoanancus*, *Platybelodon*, and *Amebelodon*, have a marked elongation of the mandibular symphysis and a very flat lower tusk. However, the validity of the genus *Archaeobelodon* is not fully accepted because specimens showing an intermediate morphology between typical *Archaeobelodon* and *Gomphotherium* are known from several European and Middle East localities (Gentry, 1987).

; Mazo, 1996). Mae Soi mastodon has such intermediate morphology in tusk dimensions (Fig.3).

The generic status of *Archaeobelodon* for the Mae Soi mastodon is only tentative because the whole skeleton is still being prepared. However, the characteristics of the tusk could indicate the geological age of the beds, even if their generic status is not certain. Lower tusks with characteristics of Mae Soi mastodon are confined to deposits of Orleanian and Astracian age in Europe, spanning the late Early to Middle Miocene time interval (Tassy, 1990; Mazo, 1996). Forms of gomphotheres and Amebelodontidae from the Late Miocene, however, are very distinct from each other in dental morphology. Thus, if tusks that have moderate flatness and ventral and dorsal grooves are found in a bed, the bed might be Middle Miocene or older in age.

This rule could be applied to Asian case. Numerous mastodon fossils have been described from Siwaliks, but *Archaeobelodon* or its allied form is not known to occur there. Siwalik gomphotheres that have lower tusks are *Gomphotherium browni* and *Protoanancus chinjiensis* from the Chinji Formation of Siwalik (Tassy 1983). However, both of these are more derived in the morphology of the lower tusk than the Mae Soi mastodon. *Gomphotherium browni* has a round or oblong tusk cross section and *Protoanancus chinjiensis* has a flat tusk cross section, which is a distinct derived character of Amebelodontidae (Tassy 1983). Other unidentified lower tusks of gomphotheres are known from Chinji (Tassy 1983, p. 267). These are similar to those from Mae Soi in flatness (Fig. 3), but are more derived than the latter in the absence of ventral longitudinal grooves and poor, or no, development of dorsal longitudinal grooves. Thus, primitive gomphotheres comparable to the Mae Soi form do not occur in Chinji and they must be sought in the Kamlial Formation that underlies the Chinji Formation. Unfortunately, proboscideans from the Kamlial Formation are less well defined compared to those in the overlying Siwaliks. The only known proboscideans in the Kamlial Formation are indeterminate trilophodont and primitive choerolophodont gomphotheres (Tassy 1983). Thus, it is uncertain whether primitive gomphotheres comparable to the one in Mae Soi were present in southern Asia during the time the Kamlial Formation was deposited.

Absence of *Archaeobelodon*-like forms from the Siwalik may be because they were not preserved as fossils, even though they may have been present during the time of Kamlial deposition, and/or that they were extinct before the time of Chinji. If this is the case, the deposits in Mae Soi should be older than Chinji and they could belong to a period ranging from late Early Miocene to middle Middle Miocene. Future correlation of outcrops and continued collection of fossiliferous material should yield a more precise age for the Mae Soi fossil deposits.

Partial skeletons of rhinocerotids from Na Sai

Na Sai coal mine, 18 kilometers southwest of Li in Lampang Province, contains numerous remains of large mammals. These mammals include *Brachiodus*, *Conohyus* cf. *sindensis*, *Gaindatherium* sp., and *Stegolophodon nasaiensis* (Ginsburg and Tassy, 1985; Tassy *et al.*, 1992; Ducrocq *et al.*, 1994). Mammalian remains from this locality are isolated teeth and bony elements, but in 1996 an incomplete skeleton of a rhinocerotid was found.

The rhinocerotids skeleton was in a lignite bed in the Na Sai coal mine. The skeletal elements found are listed in Table 2. Left and right mandibles are nearly completely preserved but crania is shattered. However, some important parts of the crania, including squamosal and nasal bones, were found. All of the the upper cheek teeth were found isolated (Pl.1, Fig. 2), but most of the lower cheek teeth were still implanted in the mandible, except for the right lower premolars (Pl. 1, Fig. 3). Postcranial elements, including anterior limb elements and cervical and thoracic vertebrae and ribs, were found, but no posterior elements were recovered.

The character of the teeth of this skeleton are:

Upper premolar

Molarization stage of premolar reaches the paramolariform or molariform stage

Premolars are fully bilophodont; overall size increased

Upper molar

Upper molar has a low crown and short antero-posterior length

Well developed paracone

No lingual cingulum (mesial and distal cingulum is present)

Crochets and mediofossettes developed on molars

Crista developed on the M³

Antecrochet lost

Lower premolar and molar

Groove on buccal side of the molar is deep

Low crown.

Lower incisor

Lower incisors were present because there are sockets for them on the mandible

The dental characters of the rhinocerotid skeleton are consistent with the assignment of rhinocerotids from Na Sai to *Gaindatherium* sp. (Ginsburg and Tassy, 1985; Ducrocq *et al.*, 1994) but the new skeleton's cranial characters contradict this assignment. The right post glenoid process and a part of posttympanic process of the squamosal are pre-

served in the skeleton. These preserved parts of the skull indicate that the auditory meatus is not closed ventrally. This primitive character state contradicts the assignment to *Gaindatheirum* because in *Gaindatheirum* the auditory meatus is closed (Colbert, 1934). Also, the left and right nasals are relatively flat and are not fused at the sagittal suture, in contrast to the fused nasal bones in the skull of *Gaindatherium* from Siwalik. Therefore, the rhinocerotids from Na Sai can not belong to *Gaindatherium* but must be some other primitive genus of Rhinocerotidae. This matter could be clarified by detailed study of postcranial parts.

Conclusion

A gomphothere skeleton was found at a new Miocene mammalian locality, Mae Soi, in Chiang Mai Province, Thailand. This is the first gomphothere skeleton known from the Chiang Mai intermontane basin in northern Thailand. The dentition of the skeleton suggests that this gomphothere could be either *Archaeobelodon* or *Gomphotherium*. This fossil material suggests that the sedimentary sequence in the southern part of the Chiang Mai Basin is Miocene in age, possibly late Early Miocene or Middle Miocene.

The rhinocerotid skeleton from Na Sai has characteristics that suggest that it is not *Gaindatherium* but is a more primitive Rhinocerotidae genus.

Future detailed geological surveys, continued collection of fossiliferous material, and further preparation of excavated materials should yield a more precise age for the deposits of the Mae Soi site.

Acknowledgements

We are grateful to the director of Chiang Mai Museum for support during the excavation of the Mae Soi mastodon. This study was supported by grants from the Japanese Ministry of Education, Science and Culture, grants no. 06041079 and 09041161.

References

- Baum, E., F.v.Baum, A. Hess, and K.E. Koch (1982) Geological Map of Northern Thailand. Sheet 5 (Chiang Mai). Federal Institute for Geosciences and Natural Resources, Hannover
- Colbert, E. H. (1934) A new rhinoceros from the Siwalik beds of India. *American Museum Novitates* no. 749 1-13
- Ducrocq, S., Chaimanee Y., Sutteethorn V. and Jaeger J. J. (1994) Age and paleoenvironment of Miocene mammalian faunas from Thailand. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 108, 119-163.
- Gentry, A.W. (1987) Mastodons from the Miocene of Saudi Arabia. *Bulletin of the British Museum (Natural History) Geology* 41(4):395-407
- Ginsburg L., and Tassy P. (1985) The fossil mammals and the age of the lignite beds in the intramountain basins of Northern Thailand. *Journal of the Geological Society of Thailand, Bangkok* 8(1-2), 13-27.
- Mazo, A. (1996) Gomphothere and mammutids from the Iberian Peninsula. In *The Proboscidea. Evolution*

- and Palaeoecology of Elephants and Their Relatives, (eds. J. Shoshani and P. Tassy), pp.136-142. Oxford University Press, Oxford.
- Mein, Pierre & Ginsburg, Léonard (1997) Les mammifères du gisement miocène inférieur de Li Mae Long, Thaïlande: systématique, biostratigraphie et paléoenvironnement. *Geodiversitas*.19(4), 783-844.
- Tassy, P. (1982) Le mastodonte * dents étroites, le grade trilophodonte et la radiation initiale des Amebelodontidae. Actes du Symposium Paléontologique G. Cuvier, Montbeliard, P. 459-473.
- Tassy, P. (1983) Les Elephantoidea Miocènes du Plateau du Potwar, Groupe de Siwalik, Pakistan. *Annales de Paléontologie (Vert.-Invert.)*, 69, (2), p. 99-136; (3) 235-97; and (4) 317-54.
- Tassy, P. (1986) Nouveaux Elephantoidea (Mammalia) dans le Miocène du Kenya: essai de réévaluation systématique. *Cahiers de paléontologie*, Éditions du Centre National de la Recherche Scientifique (CNRS), Paris.
- Tassy, P. (1990) The "proboscidean datum event:" how many proboscideans and how many events? In *European Neogene mammal chronology*, (E.H. Lindsay, V. Fahlbusch, and P. Mein eds.), pp.237-252. Plenum, New York.
- Tassy, P, P. Anupandhanant, L. Ginsburg, P. Mein, B. Ratanasthien, and V. Suteethorn. (1992) A new Stegolophodon(Proboscidea, Mammalia) from the early Miocene of Northern Thailand. *Geobios*, 25(4): 511-523
- Thomas, H., Ginsburg, Léonard, Hintong C. & Sutteethorn V. (1990) A new tragulid, *Siamotragulus sanyathanai* n.g., n. sp. (Artiodactyla, Mammalia) from the Miocene of Thailand (Amphoe Pong, Payao Province). *Comptes rendus de l'Académie des Sciences, Paris, série II*, 310 (7): 989-995.

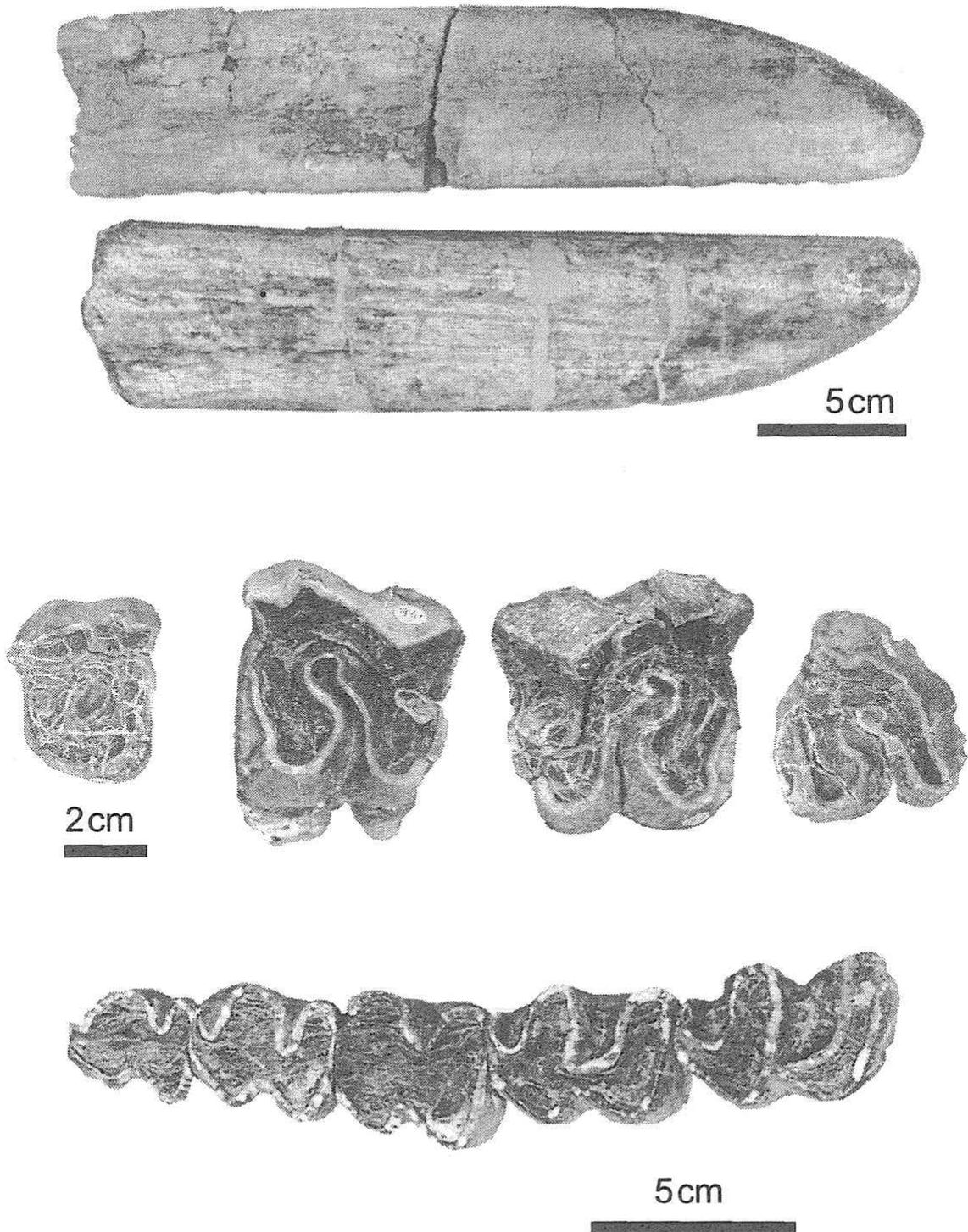


Plate 1. 1. Gomphothere, from Mae Soi, Left and right lower tusk, lingual view. 2a. Rhinocerotid, from Ban Na Sai, right upper fourth premolar, occlusal view. 2b. Rhinocerotid, from Ban Na Sai, left upper first molar, occlusal view. 2c. Rhinocerotid, from Ban Na Sai, right upper second molar, occlusal view. 2d. Rhinocerotid, from Ban Na Sai, left upper third molar, occlusal view. 3. Rhinocerotid, from Ban Na Sai, left lower cheek teeth series (P₃-M₃), occlusal view.