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MIOCENE FAUNAL REMAINS FROM THE BURJI-SOYAMA AREA, AMARO HORST, SOUTHERN SECTOR OF THE MAIN ETHIOPIAN RIFT

by

Gen Suwa*, Tim White, B Asfaw***, Giday WoldeGabriel****,Tesfaye Yemane*******

**Department of Morphology, Primate Research Institute, Kyoto University, Kanrin Inuyama-shi AICHI 484, Japan;*
***Department of Anthropology The University of California Berkeley, CA 94720 USA;*
****Palaeoanthropology Laboratory CRCCH, Ministry of Culture and Sports Affairs, P O Box 5171, Addis Ababa, Ethiopia*
*****Earth and Environmental Science Division, EES1/D462, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 USA*
******Ethiopian Institute of Geological Surveys, P O Box 2302, Addis Ababa, Ethiopia*

ABSTRACT

The Palaeoanthropological Inventory of Ethiopia is dedicated to the discovery and documentation of palaeoanthropologically significant study areas in the Main Ethiopian Rift and Afar Depression. Fieldwork in the area at the southern end of the Amaro Horst during the 1989 field season was focused on a fossiliferous sedimentary succession with intercalated volcanic horizons. Potassium-argon dating sets a minimum age of 11.1 my for sediments bearing vertebrate remains. The partial skeleton of a fossil proboscidean recovered at Burji is described, illustrated and assessed comparatively. The remains are those of a primitive species of choerolophodont mastodon. Biochronological considerations place this specimen in the time range of 15-17 my. The presence of fossiliferous sediments in the Burji area suggest that a rift-related basin had developed in this part of Ethiopia by Middle or Early Miocene times.

Palaeoanthropologists have, over the past six decades, established Africa as a continent with much fossil and contextual evidence elucidating human origins and evolution. Discoveries in the last thirty years have shown that the human family, genus and species all seem to have arisen in Africa. It is also in Africa that the earliest cultural evidence has been recovered. The substantial palaeontological data that anchor this knowledge have been acquired through the efforts of a very small group of fieldworkers, first in the southern, and subsequently in both the southern and eastern parts of the continent.

Among eastern African states, Ethiopia has contributed much to the growing knowledge of human origins and evolution. Field research has concentrated on a few key sites: the Omo, Melka Kontoure, Gadeb, the Middle Awash and Hadar. However, despite the length of the Ethiopian Rift and its relatively broad lake basins, only a small number of Ethiopian palaeoanthropological sites have yet been discovered, often by accident rather than by systematic survey. In a comparative sense, the Ethiopian Rift has not been investigated as thoroughly for palaeoanthropological resources as the rift in Kenya or Tanzania. As a result, it is currently impossible to accurately gauge the full extent of Ethiopian palaeoanthropological resources in quantity, spatial distribution or time depth.

Since the early 1980's, the development of Ethiopian manpower and facilities in palaeoanthropology has proceeded rapidly, and a strong infrastructure for intensified research is now in place. In 1988, the Ethiopian Ministry of Culture began a project designed to inventory the palaeoanthropological resources of the Ethiopian rift and Afar Depression. This project enables a closer monitoring of Ethiopia's antiquities and sets priorities for the scientific investigation of these resources.

Over 60 years ago the late Raymond Dart captured the attention of the palaeoanthropological world with his recognition of the Taung hominid. Now, as then, what is needed most in palaeoanthropology is the discovery of new fossils and contextual evidence. Although evidence will continue to come from sites that are already known, evidence from undiscovered sites may hold even more potential for advancing knowledge about our origins. We report here on the palaeontological content and potential of one of the areas visited by the inventory project in 1989. This is Burji, a Miocene palaeontological resource in the Amaro Horst region of the Main Ethiopian Rift (MER) of southern Ethiopia.

GEOGRAPHY

The southern terminus of the Main Ethiopian Rift is bifurcated into the Ganjuli and Galana grabens on either side of an uplifted and faulted block known as the Amaro Horst. The Burji palaeontological area lies at the southern tip of the Amaro Horst, above the headwaters of the Segen

River. It is approximately 40 km southwest of Agere Mariam, at an elevation of approximately 1650 m, in the Sidamo administrative region (Figure 1). Mapping in the Burji area by Ethiopian Institute of Geological Survey geologists resulted in the identification of terrestrial sediments interbedded with volcanics of unknown age (Seyid and HabteGiorgis 1987). Some vertebrate postcranial fossils had been collected from one locality by the geologists and brought to Addis Ababa. The inventory team went to Burji to establish the age of the sediments and to assess their palaeoanthropological potential.

GEOLOGY AND GEOCHRONOLOGY



Figure 1 Map of Ethiopia, showing four new palaeoanthropological study areas established in 1988 and 1989 by the Ethiopian Ministry of Culture's Palaeoanthropological Inventory of Ethiopia. The Burji area yielded the Miocene proboscidean remains which constitute the subject of this paper.

The Amaro Horst is a 90 km long and 25 km wide block that was uplifted about 1.5 km above the surrounding graben floors sometime in the Late Miocene (Levitte *et al.*, 1974). The block comprises crystalline basement rocks (Precambrian) overlain 5-30 m of sedimentary grits, and by widespread Tertiary volcanic flows and intercalated sedimentary strata of >150m in thickness (Mohr and Gouin 1968; Levitte et al. 1974; WoldeGabriel *et al.* in press). The vertebrate fossils and silicified wood described below come from a volcaniclastic deposit intercalated with mafic lavas southwest of Burji-Kilicho Village. The fossiliferous unit ranges in thickness from 10 - 20 m within the mapped area and consists of altered crystal and lithic tuff, finely bedded dark-brown silt and clay horizons with fossil wood and leaves, a thick reddish sandstone unit which yielded the vertebrate remains, and a yellow crystal tuff. This sedimentary unit is capped by 20-30 m thick, fresh, and sparsely porphyritic basalt flows. The flow above the fossil vertebrate site, BUR1, is a porphyritic olivine basalt that yielded a minimum K/Ar age for the vertebrate remains of 11,1 my (a correlative flow from the nearby Gembo Mountains yielded an age of 11,9 my; WoldeGabriel *et al.* in press).

PALAEOBOTANY

The fossiliferous volcaniclastic unit, with its reworked tephra, silt, and clayey beds, was probably primarily deposited in a lacustrine environment characterised by a swampy zone with abundant vegetation. Our survey team noted large (1-50 cm) pieces of petrified wood at the BUR1 locality. Where similar sediments crop out in the general area of Burji, fossil wood was found to be locally abundant, with tree trunk sections up to 70 cm diameter being fairly common. Associated sediments were not sampled for pollen and no identification of the macrobotanical specimens was attempted. These Burji palaeobotanical remains are, however, diverse and important, particularly in light of the poor but growing knowledge of Neogene eastern African palaeoflora from 3,6-18 my (Jacobs and Kabuye 1987).

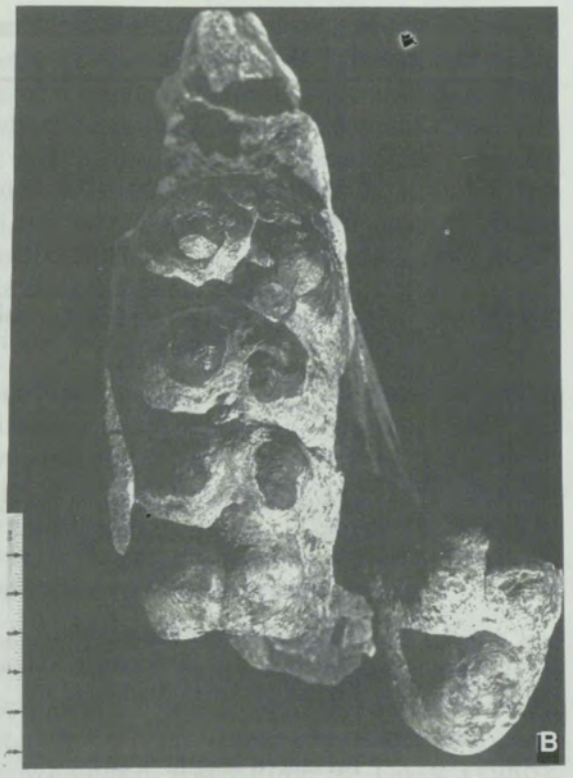
VERTEBRATE PALAEONTOLOGY

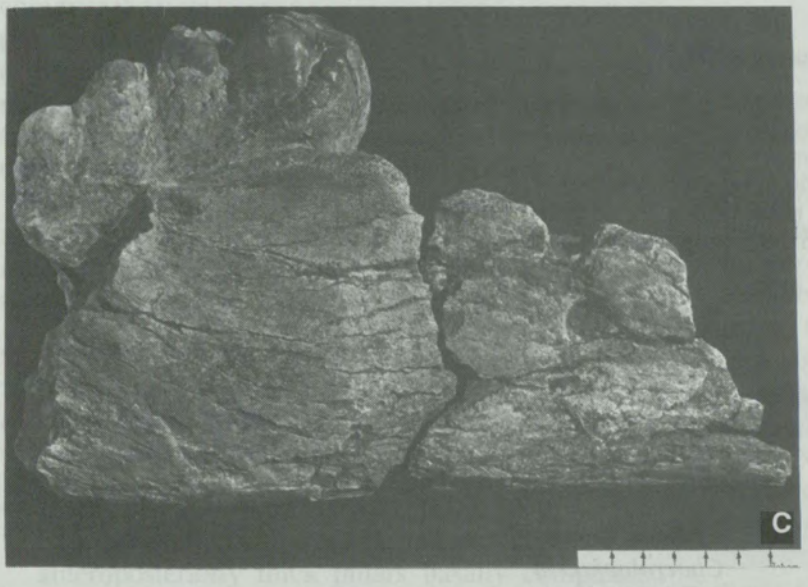
The Early to Middle Miocene vertebrate faunas of Eastern Africa are very well known due to the recovery of abundant and diverse remains from a large number of localities in Kenya and Uganda. The assemblages from these localities are perhaps best known for their primate faunas, but proboscideans, in particular, have been valuable elements in the resolution of regional biochronological relationships, with the best-known Early Miocene remains known from Rusinga (17,8 my; Drake *et al.* 1988), Buluk (>17,2 my; McDougall and Watkins 1985), and Kalodirr (16-18 my; Leakey and Leakey 1987). Middle Miocene sites with biochronologically significant proboscidean remains include Maboko (15-16 my; Andrews *et al.* 1981), Fort Ternan (14 my; Shipman *et al.* 1981), Ngorora (c. 10 - 12,7 my; Hill and Ward (1988), and Nakali (9 my; Pickford 1987).

Previous to the discovery of the Burji area, there were only two reported Miocene vertebrate occurrences in Ethiopia. These occurrences comprised a deinothere molar from Miocene lignites at Adi Ugri (Eritrea; Vialli 1966), and a small Upper Miocene vertebrate collection from Chorora, including *Stegotetrabelodon*, dated to c. 10 my (Sickenberg and Schonfeld 1975; Tiercelin et al. 1979). Due to the paucity of the Ethiopian record, the geographic placement of Ethiopia between the East African Miocene localities and others in Eurasia, the Burji BUR1 vertebrate fossil locality takes on particular significance.

The vertebrate remains from the BUR1 locality are all derived from a thin red sandstone bed located below the dated basalt horizon (11,1 my). The remains themselves are extremely well preserved, with complete fossilization and limited crushing of the postcranial elements. All of







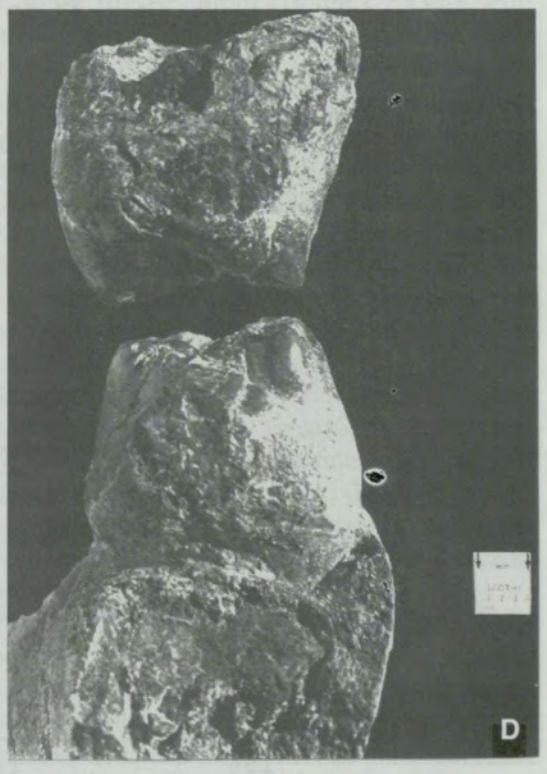


Figure 2 The gompothere remains from Burji. Arrows on the scales mark centimeters.
A. Postcranial and cranial remains described in the text
B. Mandibular dentition, occlusal view
C. Mandible, lateral view
D. Maxillary and mandibular third molars, mesial view

TABLE 1. Measurements on BUR1-1 (in millimeters)

Element	at Pillar Number	1	2	3	4	5
RM^3						
	Maximum breadth	66	66,2	-	-	-
	Basal breadth	c,59	59,3	-	-	-
	Lingual pillar height	55(w)	58	-	-	-
	Buccal pillar height	47,5(w)	53,1	-	-	-
RM_3						
	Basal length: 115+30 (from lt, side) = 145					
	Maximum length 122,5+33 (from lt, side) = 155,5					
	Maximum breadth	59,5	57,5	54	53,5	c,43
	Basal breadth	56	-	-	51	-
	Lingual pillar height	50(w)	52	-	53	-
	Buccal pillar height	50(w)	57,5	59,5	56,5	49(lt)

Mandible:

Height below mesial M_3:132 (medial); 109 (lateral)
Height below mesial M_2:87,5
Breadth at mid M_3:82
Breadth at mesial M_2 root: 43 (alveolar): 36,5 (basal)

M_2-M_3 alveolar length: 220
Center of mental foramen to corpus base: 57,5
Mental foramen diameter: 15

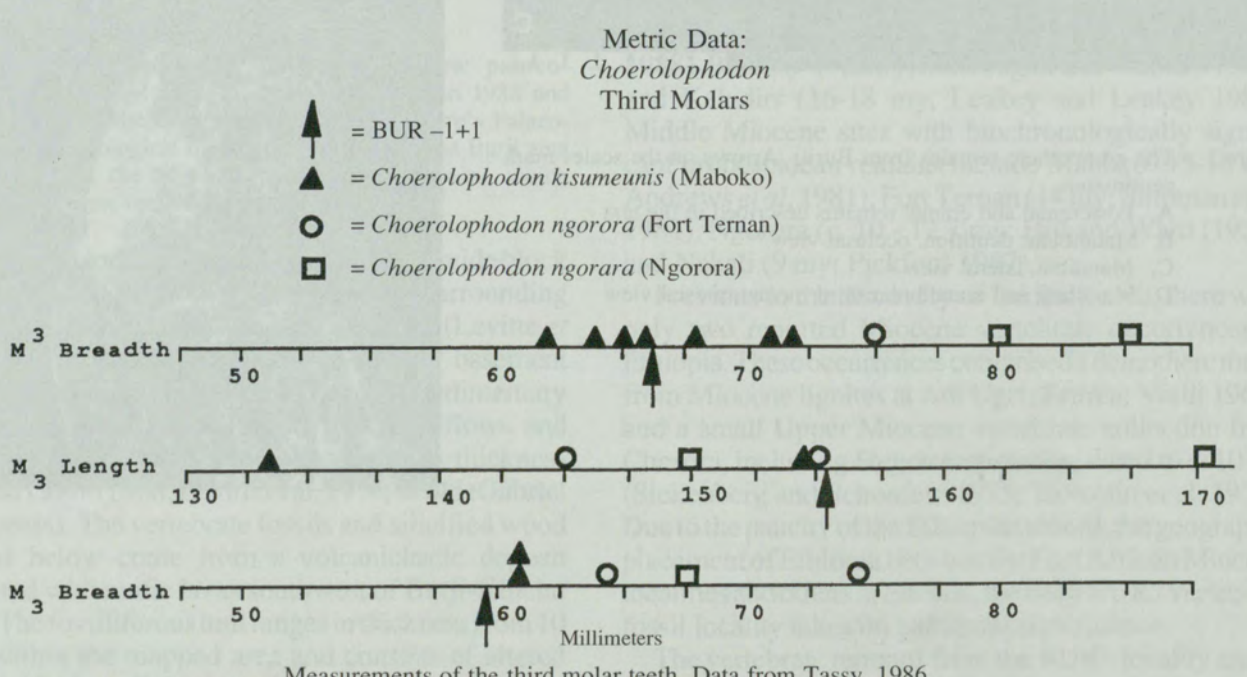
Lower tusk:

Preserved length: 630
Cross section at broken tip: 29 x 40,5, no pulp chamber
Cross section at 260 from broken base: 64,5 x 76, no pulp chamber
Cross section at base: 55x94; 21,5x39,5 pulp chamber

Upper tusk:

Preserved length: 120
Enamel band width: c,45
Enamel band thickness: 0,6-0,7
Larger cross section: 65,8x95,3, no pulp chamber
Smaller cross section: 61,0x85,5, no pulp chamber

(w)=worn tooth



Measurements of the third molar teeth. Data from Tassy, 1986

Figure 3 Comparison between measurements of the third molar teeth of various *Choerolophodon* fossils. The Burji specimen is indicated by the vertical arrows below each scale.

the vertebrate remains at the BUR1 locality were found within a radius of 50 m in adjacent, minor, north-to-south drainages. Fossilization and matrix of all specimens is identical. All but one element represent a large proboscidean, with no duplication of body parts, with compatibility of sizes of all elements, and with compatibility of all ontogenetic ages (young adult with third molars erupting, major vertebral, tibial, femoral and calcaneal epiphyses attached, with epiphyseal lines apparent). A second individual of indeterminate mammalian taxon is represented by a rhinoceros-sized humeral midshaft found in the eastern drainage, separated by 30 m from the closest other vertebrate fossil. No other remains were found in the limited 2-day reconnaissance of this locality and nearby exposures of contemporary sediments.

The Burji proboscidean remains are considered to represent a single individual designated BUR1-1. They comprise the right mandibular body with M_2 alveolus and root, and most of the M_3, the mesial right M^3, a lower tusk of 630 mm preserved length; fragments of upper tusk; right and left proximal tibiae; a right distal femur; the left femur lacking the proximal end; most of the ?left humerus; the right calcaneus; and five vertebral bodies.

The gnathic elements of this individual allow diagnosis as a choerolophodont mastodont. Our diagnosis is as follows (Figure 2; metric data in Table 1; comparative statements based in Tassy 1986 and Tobien 1973):

- M_3 with 4 lophids, 1 terminal pillar, no pillar alternation; M_2 with 3 lophids (judged from root). These characters exclude attribution as *Stegotetrabelodon*, *Tetralophodon* and *Anancus*.

- Both third molar crowns relatively narrow buccolingually, with steep buccal and lingual walls; anteroposteriorly thick pillars basally compressed against adjacent lophs/lophids, resulting in narrow valleys between adjacent lophs/lophids; high cingula. These characters differ from *Archaeobelodon* sp. and *Gomphotherium* sp. of Rusinga, Mfwangano, and Mwiti (Early Miocene); and from *Archaeobelodon filholi* of Buluk, Mwiti and Kalodirr (Early Miocene).

- M^3 crown with a thick, buccally high mesial cingulum; M^3 lophs with strong pretrite anterior conules, high and appressed to the main pretrite cone; M_3 lophids with fusion of pretrite conelet and anterior conule, with the conelet/conule complex placed anterolingual to the main pretrite cone; both third molars with a thin cementum cover. These traits conform to the *Choerolophodon* pattern.

- Our interpretation is that the BUR1-1 individual had an upper tusk with an enamel band, and a lower tusk. This is because the 630 mm long tusk piece, with portions of the pulp chamber preserved, has no enamel band, but another tusk fragment with larger cross-section dimensions has no pulp chamber and bears an enamel band. Possession of a lower tusk is the primitive condition for gomphotheres in general, and does not by itself contradict a *Choerolophodon* attribution. The lower tusk is oval in cross section. This character excludes *Archaeobelodon* of Buluk, Kalodirr and Mwiti and *Protanancus* of Maboko and Fort Ternan because both of these taxa have flattened lower tusks.

- Mandible slender. *Anancus* and *Archaeobelodon* mandibles are more robust.

- Calcaneus with same basic morphology as Fort Ternan specimens attributed by Tassy (1986) to *Choerolophodon*. Femur with same basic morphology but slightly smaller than largest Fort Ternan femora. Tassy (1986) refers the two Fort Ternan femora to ?*Protanancus*, but the BUR1-1 remains suggest a reconsideration of femoral variation.

The pattern described here is characteristic of *Choerolophodon*, but the features are shared with both *Choerolophodon kisumuensis* of Maboko and *Choerolophodon ngorora* of Fort Ternan, Ngorora, and Nakali (Middle Miocene). According to Tassy (1986), *Choerolophodon ngorora* is the more derived species, with larger, more rugose, more complex molars with thicker cementum cover, strong inferior inclination of the mandibular symphysis and deepening of the corpus anterior to the dental arcade, lack of an enamel band of the upper tusk, and inferred lack of a lower tusk. The last four characters are, however, unknown for *C. kisumuensis*.

The Burji specimen lacks the molar complexity seen in some Ngorora and Nakali specimens. Some Ngorora, Fort Ternan and Maboko specimens are fairly simple, but not to the degree seen in Burji, with the M_3 post-trite conelet present only on lophid 1 and the lack of discernible posterior conules on pretrite lophids 2-4 (M_3) or loph 2 (M^3). BUR1-1 is thus unique, but most closely approximated by Maboko counterparts in metrics and morphology of the third molar. Enamel rugosity and cementum cover is not extreme in BUR1-1, as opposed to some Ngorora/Nakali specimens. On the other hand, the expression of these traits is similar to the condition seen on other Ngorora and Fort Ternan specimens.

In summary, the Burji specimen appears to represent a primitive species of *Choerolophodon*, with molar features at the *Choerolophodon kisumuensis* stage of evolution. The extreme occlusal pattern simplicity exhibited by the Burji specimen is not a primitive pattern of gomphotheres in general, and must be either a uniquely derived condition, or a variation of the basal *Choerolophodon* pattern.

Characteristics of the tusks of *Choerolophodon kisumuensis* are unknown, and if this taxon is shown to lack lower tusks or lack enamel bands in upper tusks, the BUR1-1 specimen would be a different species.

The biochronological placement of a primitive *Choerolophodon* species like that described here for Burji

would be in the time range of 15-20 my. However, the lack of *Choerolophodon* in the Early Miocene of eastern Africa, particularly at the Kenyan site of Buluk, approximately 200 km to the southwest of Burji and with abundant proboscidean remains, would suggest a most likely age of the Burji specimen as 15 - 17 my.

SIGNIFICANCE OF THE BURJI AREA

The radiometric dating and biochronological information derived from our preliminary work in the Burji area have already led to a better understanding of volcanism and rifting in the southern section of the Main Ethiopian Rift (WoldeGabriel *et al.* in press). The discovery of vertebrate palaeontological remains at Burji holds out the promise that other localities, perhaps with primates, will be found nearby. It is clear that further investigation of the Burji locality's macrobotanical and vertebrate palaeontological potential is warranted. The Burji fossils are roughly contemporary with those from Pasalar, Turkey (Bernor and Tobien 1990). This part of the Middle Miocene is rapidly becoming better calibrated and understood (Steininger, Bernor and Fahlbusch 1990), allowing palaeontologists to model Old World Miocene faunal evolution as related to multiple, eustatically regulated intercontinental migration events (Bernor and Tobien 1990). Further investigation of the Burji locality, Ethiopia's first of this age, promises to contribute significant data to our understanding of Middle Miocene African floral and faunal evolution.

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We are pleased to be able to dedicate this contribution to Alun Hughes. We share great admiration and respect for the remarkable innovation and dedication which Alun has brought to his quest for knowledge about human origins. He will continue to inspire us wherever we engage in fieldwork.

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