

The Late Miocene to Early Pliocene Fauna from the Kongia and Tirr Tirr Formations, Samburu Hills, Northern Kenya

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During the 2003 to 2004 field season, we conducted a palaeontological survey in the basal and middle parts of the Upper Miocene Kongia Formation and the basal part of the Lower Pliocene Tirr Tirr Formation, Samburu Hills, Northern Kenya. Seven new fossiliferous outcrops were mapped and seventeen fossil remains were collected including *Hipparion*, proboscideans, bovids, hippopotamids and crocodiles from the basal part of the Tirr Tirr Formation. However, we found no remains in the Kongia Formation.

KEY WORDS: *Hexaprotodon*, *Hipparion*, bovids.

Introduction

The Samburu Hills Area is located on the eastern flank of the Great Rift Valley, Northern Kenya, about 500 km north of Nairobi and about 30 km west of the Baragoi Township, Samburu District (Figure 1). The Miocene succession unconformably overlies rocks of the latest Precambrian Mozambique Belt in many sites, from base to top, of the Nachola, Aka Aiteputh, Namurungule and Kongia Formations (Figure 2; Sawada *et al.*, 1998; 2001). The Lower Pliocene Tirr Tirr Formation unconformably overlies the Kongia Formation in the north (Figure 2).

Since the 1980 field season, the Japan-Kenya Expedition has conducted geological, palaeontological and palaeoanthropological surveys in this area (*e.g.*, Ishida *et al.*, 1984; Ishida & Ishida, 1987). The Middle to Upper Miocene Aka Aiteputh and Upper Miocene Namurungule Formations have yielded numerous vertebrate and invertebrate remains including large hominoids (Nakaya *et al.*, 1984; 1987; Nakaya, 1994; Pickford *et al.*, 1987; Ishida & Pickford, 1997; Ishida *et al.*, 1999; Tsujikawa, 2005). In contrast, the Upper Miocene Kongia Formation has yielded few fossils, which are a few hippopotamid fragments and several molluscs (Pickford, 1984; Pickford *et al.*, 1984). During the 2003 to 2004 field season, we re-examined outcrops of the

Kongia Formation and the basal part of the Pliocene Tirr Tirr Formation. This paper presents the results of our studies of the fossil remains collected from there.

Lithostratigraphy

The Kongia Formation is over 200 m thick and consists predominantly of basalt lavas with intercalated lacustrine sediments (Pickford *et al.*, 1984; Pickford & Morales, 1994; Nakaya, 1994). This formation unconformably overlies the Namurungule Formation at the rift floor, and the Aka Aiteputh Formation at the rift flank (Figure 2; Sawada *et al.*, 1998). At the base of this formation, gravel and sandstone beds are exposed at several places in this research area (Figure 1; Sawada, pers. comm.).

The Tirr Tirr Formation, unconformably overlying the Kongia Formation, consists of basal sediments with tuff, overlain by trachytes and basalts (Makinouchi *et al.*, 1984). The basal sediments are exposed at several outcrops in the cliffs of the Tirr Tirr plateau (Figure 1).

The basal part of the Kongia Formation consists of gravels and sandstones (Figure 3).

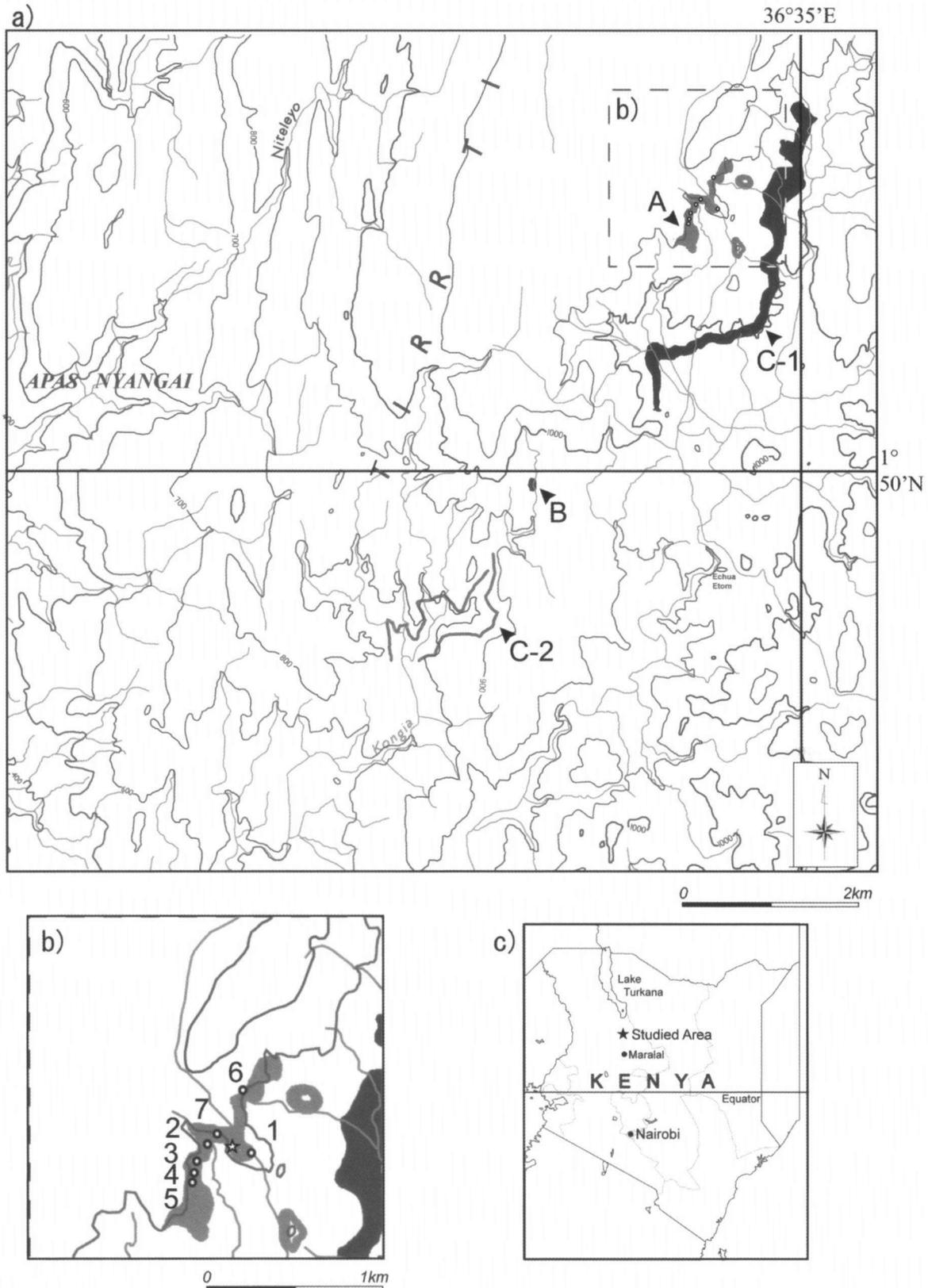


Figure 1. Study area; numbers 1 to 7: fossiliferous localities TT-1 to TT-7; star: photography point for the outcrops TT-2 to TT-5 (see Figure 5); black and gray areas with alphabets A, B, C-1 and C-2: outcrop areas from the geologic map (Ishida *et al.*, 1994); A: the basal part of the Tirr Tirr Formation; B: SH 47 and 48, the middle part of the Kongia Formation; C-1: northeastern area of Echua Etom, the basal part of the Kongia Formation; C-2: northern area of the upper Kongia River, the basal part of the Kongia Formation. Topographic maps are modified after the Lobar sheet (65/1) of series Y 731 (D.O.S. 423) 1:50,000 Topographic map published by D.O.S. for the Kenya Government (Survey of Kenya), 1982 (Map datum: New Arc 1960).

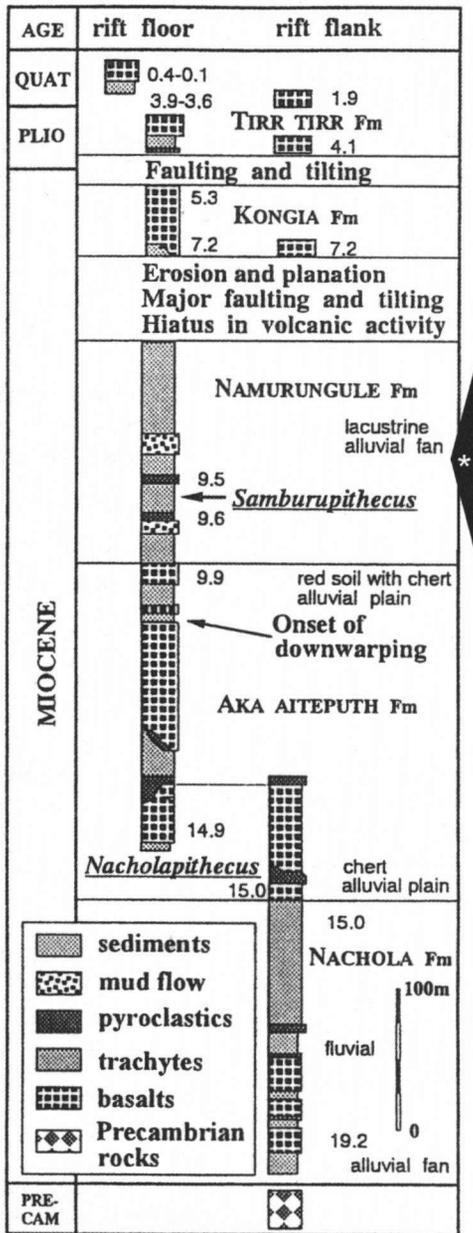


Figure 2. Stratigraphic columns, K-Ar age determinations and hominoid fossils of the Neogene formations in the eastern flank and floor of the Rift Valley, Samburu Hills, Northern Kenya (Sawada *et al.*, 1998). * denotes main period of downwarping with faulting.

It is exposed at northeast of Echua Etom (Figure 1: C-1) and north of the upper reaches of the Kongia River (Figure 1: C-2), and along the lower part of the Kongia River near the Suguta Valley (Figure 1; Sawada pers. comm.). The basal part is dated as older than 7.2 Ma by whole rock K-Ar ages (Sawada *et al.*, 1998). The middle part of the Kongia Formation is predominantly composed of basalt with intercalated lacustrine sediments (Figure 3; Sawada *et al.*, 1998). It is exposed 2.5 km northwest of Echua Etom (Figure 1: B). During the 1982 field season, localities SH 47 and 48 yielded several molluscs and a few hippopotamids (Pickford *et al.*, 1984).

Age (Ma)	Formation	Layers	Localities	Faunal Sets
4	Tirr Tirr	Trachyte lavas	TT 1-7	PVIII
		Basal Part (4-5 Ma)		
5	Kongia	Basalt lavas	SH 47-48	PVII
		Middle part sediments (5-7 Ma)		
		Basalt lavas		
6		Basal part gravels & sandstones (>7.2 Ma)		
7				
9.5	Namurungule			PVI

Figure 3. Stratigraphy and localities of the Kongia and Tirr Tirr Formations. PVI-VIII: Faunal Sets VI-VIII of Pickford (1981).

The middle part is considered to be 7-5 Ma on the basis of the presence of the hippopotamid, *Hexaprotodon* sp. and whole rock K-Ar ages (Pickford & Morales, 1994; Sawada *et al.*, 1998).

The basal part of the Tirr Tirr Formation (Figure 4) is exposed mainly along the east cliffs of the Tirr Tirr Plateau (Figure 1: A; Ishida *et al.*, 1994). This part consists of tuff beds with intercalated gravely sandstone bed and sandstone beds which exhibit trough cross-stratification. Whole rock K-Ar ages indicate that this part is 5-4 Ma (Sawada pers. comm.).

Fossiliferous outcrops

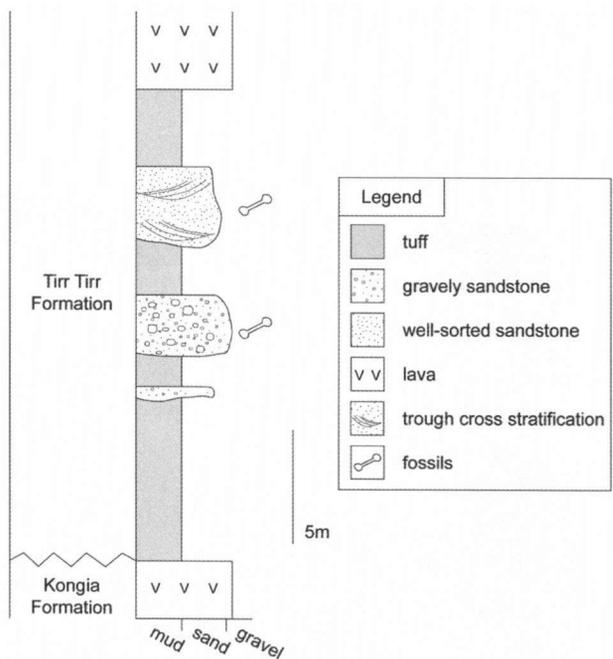


Figure 4. Stratigraphic column of the basal part of the Tirr Tirr Formation.

The basal and middle parts of the Kongia Formation – We examined three areas in which the basal and middle parts are exposed (Figure 1; B, C-1 and C-2). However, we found no sign of fossil remains there.

The basal part of the Turr Turr Formation (Figures 1, 5; Table 1) – We found seven fossiliferous outcrops which are named as TT-1 to TT-7, and collected several vertebrate and one botanical remains from the surface. The fossil remains derived from the gravely sandstone bed and well sorted sandstone beds with trough cross-stratification.

Locality	Latitude (N)	Longitude (E)	Taxa
TT-1	01°51'31.7"	036°34'30.3"	Proboscidea, cf. <i>Hipparion</i> , ?Bovidae
TT-2	01°51'32.5"	036°34'21.1"	Crocodylia, <i>Hipparion</i> , Bovidae
TT-3	01°51'28.6"	036°34'19.7"	<i>Hipparion</i>
TT-4	01°51'27.2"	036°34'18.5"	large animal
TT-5	01°51'26.1"	036°34'18.4"	Bovidae
TT-6	01°51'42.6"	036°34'29.6"	Proboscidea, Hippopotamidae
TT-7	01°51'36.0"	036°34'23.3"	<i>Hipparion</i>

Table 1. Fossiliferous localities, coordinates and finds of the Turr Turr Formation. Latitudes and longitudes were given by GPS data in Arc 60.

Site TT-1 – This outcrop exposes in the skirts of a small hill. Tooth fragments of proboscidean and *Hipparion* were collected. GPS coordinates N01°51'31.7" and E036°34'30.3" in Arc 1960.

Site TT-2 – This outcrop exposes on the cliff slope located to the west of TT-1. Horn core fragments of bovid, a crocodylian tooth, and *Hipparion* tooth fragments were discovered. GPS coordinates N01°51'32.5" and E036°34'21.1".

Site TT-3 – This is adjacent to TT-2 to the south. A *Hipparion* tooth was found here. GPS coordinates N01°51'28.6" and E036°34'19.7".

Site TT-4 – This is adjacent to TT-3 to the south. A long bone fragment of a large animal was collected. GPS coordinates N01°51'27.2" and E036°34'18.5".

Site TT-5 – This is adjacent to TT-4 to the south. A bovid lunar was found here. GPS coordinates N01°51'26.1" and E036°34'18.4".

Site TT-6 – This outcrop exposes on a hill slope located to the north of TT-1. Tooth fragments of proboscidean and hippopotamid were collected. GPS coordinates N01°51'42.6" and E036°34'29.6".

Site TT-7 – This is located on a hill slope between TT-1 and TT-2. A *Hipparion* tooth was found. GPS coordinates N01°51'36.0" and E036°34'23.3".

Fauna

Fossil remains collected from the studied area are stored at the National Museums of Kenya (KNM). The list of specimens collected from the Turr Turr Formation is given in Table 2. We compared the specimens to material in the Division of Palaeontology and the Division of Osteology of the National Museums of Kenya.

- Class Reptilia
- Order Crocodylia
- Crocodylia gen. et sp. indet.

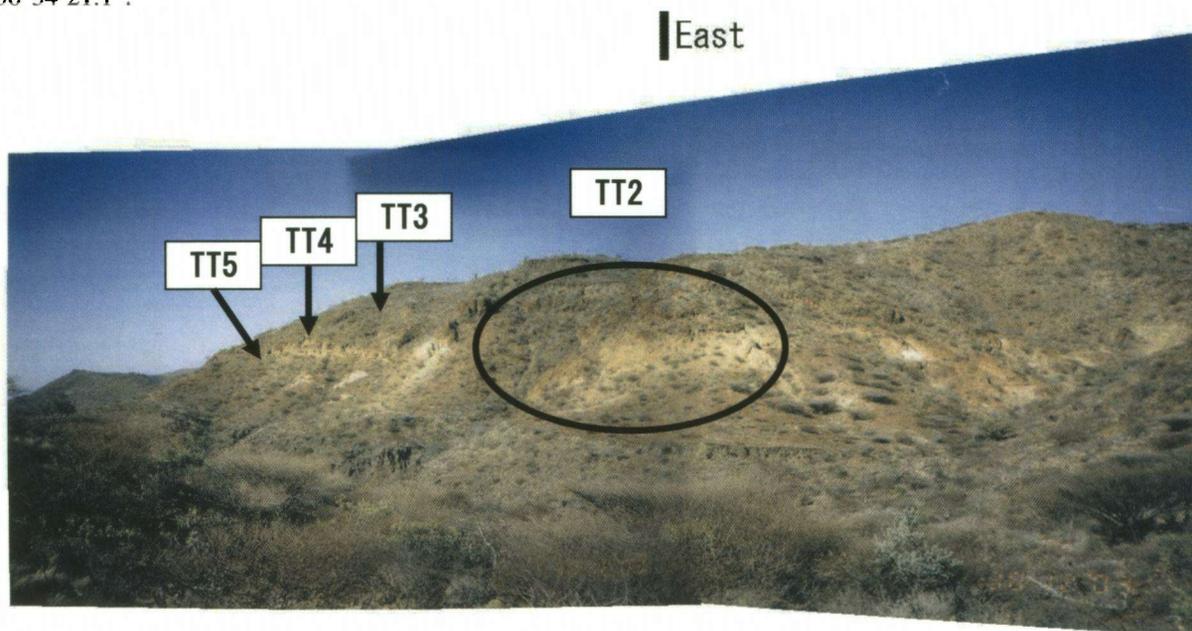


Figure 5. Sites TT 2-5. Photography point is shown in Figure 1.

Catalogue no.	Field no.	Taxon	Part	Locality
KNM-TR 45652	TT3-10-03	<i>Hipparion</i> cf. <i>sitifense</i>	right upper cheek tooth	TT-3
KNM-TR 45653	TT6-14-03	<i>Hipparion</i> cf. <i>sitifense</i>	right M ₁	TT-6
KNM-TR 45654	TT2-06-03	<i>Hipparion</i> cf. <i>sitifense</i>	right upper cheek tooth frag.	TT-2
KNM-TR 45655	TT2-05-03	<i>Hipparion</i> cf. <i>sitifense</i>	left upper cheek tooth frag.	TT-2
KNM-TR 45688	TT7-17-03	<i>Hipparion</i> cf. <i>sitifense</i>	upper cheek tooth frag.	TT-7
KNM-TR 45689	TT4-11-03	Mammalia (large)	long bone frag.	TT-4
KNM-TR 45690	TT2-04-03	Crocodylia	isolated tooth	TT-2
KNM-TR 45691	TT2-09-03	cf. Bovidae	femoral head	TT-2
KNM-TR 45692	TT1-01-03	Proboscidea gen. et sp. indet.	tooth enamel frag.	TT-1
KNM-TR 45693	TT6-15-03	cf. <i>Hexaprotodon</i> sp.	molar frags.	TT-6
KNM-TR 45694	TT1-03-03	?Bovidae	?left lateral malleolus, fibula	TT-1
KNM-TR 45695	TT5-12-03	Bovidae	right lunar	TT-5
KNM-TR 45696	TT2-07-03	Bovidae gen. et sp. indet.	horn core frag.	TT-2
KNM-TR 45697	TT6-16-03	Plantae	stem or branch frag.	TT-6
KNM-TR 45698	TT2-08-03	Bovidae gen. et sp. indet.	horn core frag.	TT-2
KNM-TR 45699	TT6-13-03	Proboscidea	tooth frag.	TT-6
KNM-TR 45700	TT1-02-03	cf. <i>Hipparion</i>	tooth frag.	TT-1

Table 2. Fossils from the Tuff Bed of the Turr Turr Formation, frag. denotes fragment(s).

A small isolated tooth, KNM-TR 45690, consists of a crown that is slightly curved. Lateral and medial ridges extend vertically along the curve. From the Aka Aiteputh and Namurungule Formations, numerous crocodylian tooth and bone fragments were found and were assigned as *Crocodylus* cf. *niloticus* (Laurenti, 1768) (Pickford *et al.*, 1987; Nakaya, 1994).

Class Mammalia

Order Proboscidea

Superfamily Elephantoidae

Elephantoidae gen. et sp. indet.

A few thick tooth enamel fragments were collected. They apparently do not belong to Deinotheriidae.

Order Perissodactyla

Family Equidae

Hipparion cf. *sitifense* Pomel, 1897

Figure 6: A-D

Several isolated cheek teeth and tooth fragments were collected. KNM-TR 45652 is a right upper cheek tooth being well worn. Roots were formed but are missing due to breakage. Thick cementum is well preserved around the buccal side of the paracone and metacone. Measurements (mm) of the tooth are 20.4 in occlusal length, 20.1 in length at 10 mm above roots, 22.2 in occlusal breadth, 22.0 in breadth at 10 mm above roots, 24.2 in crown height, 7.3 in protocone length and 4.0 in protocone breadth. The axis of the crown is straight. The occlusal surface is flat except for the posterior region behind the postfossette, in which a weak ridge runs linguo-buccally. The occlusal outline is nearly square. The antero-posterior occlusal length is slightly

shorter than the linguo-buccal breadth. The protocone is separated from the main part of the tooth, slightly compressed, oval to subtriangular, and more lingually placed than the hypocone is. The pli-caballin is small, short and single. The enamel surrounding the prefossettes and postfossettes are fairly wrinkled. There is one placation on the anterior face, there are six on the posterior face of the prefossette, six on the anterior face and none on posterior face of the postfossette. The hypogryph is moderately deep.

KNM-TR 45655 is a moderately worn upper left permanent cheek tooth. The axis of the crown is slightly bent. The anterior part of the crown is missing. The pli-caballin is small and single. The enamel surrounding the fossettes is wrinkled. There are four placations on the posterior face of the prefossette, three on the anterior face and none on posterior face of the postfossette. The hypogryph is moderately deep.

KNM-TR 45653 is a lower first molar being well worn. It is surrounded by thin cementum. Measurements (mm) of the tooth are 20.4 in occlusal length, 20.2 in length at 10 mm above roots, 12.4 in occlusal breadth, 12.4 in breadth at 10 mm above roots, 7.7 in crown height. The occlusal outline is rectangular. A small ectostylid is present. The metaconid and metastylid are round. The ectoflexid does not separate the metaconid and metastylid. An elongated oval protostylid is present. The entostylid and ptychostylid are absent. The median valleys between the protoconid and hypoconid, and between the metaconid and metastylid are deep and approach each other.

Those specimens are fairly small in size. They are apparently smaller than *H. africanum* Arambourg, 1959, *H. primigenium* Bernor *et al.*, 1997, or *H. turkanense* Bernor & Harris, 2003, but are consistent with *H. sitifense* Pomel, 1897 (Churcher & Richardson, 1978).

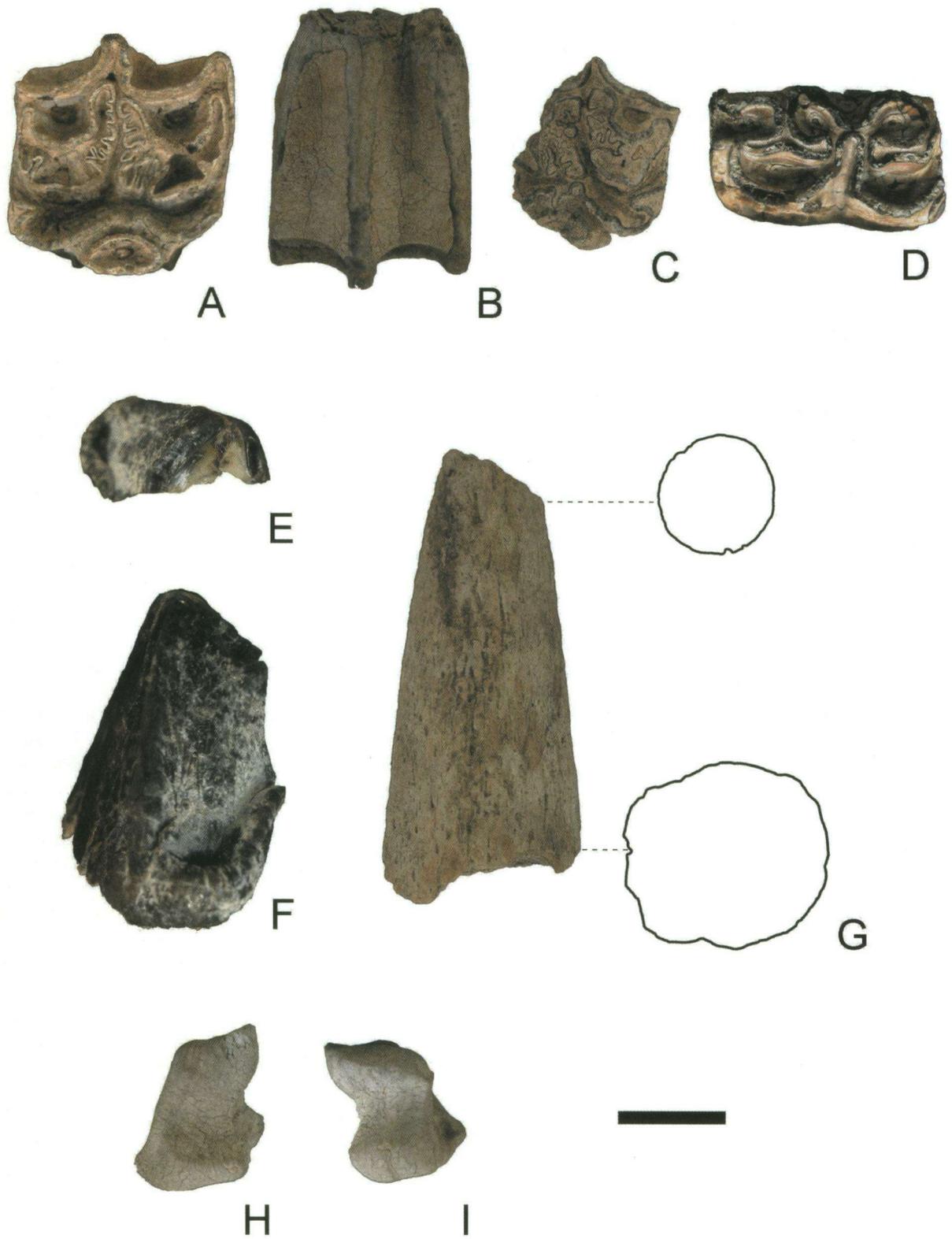


Figure 6.

Figure 6. Right upper cheek tooth of *Hipparion* cf. *sitifense* Pomel, 1897. A, occlusal; B, buccal views, left upper cheek tooth fragment; C, occlusal view, right M1 of *Hipparion* cf. *sitifense* Pomel, 1897; D, occlusal view, molar fragment of cf. *Hexaprotodon* sp.; E, occlusal; F, ?anterior views, horn core fragment of Bovidae gen. et sp. indet.; G, lateral or medial view, and distal and proximal cross sections, right lunar of Bovidae gen. et sp. indet.; H, proximal; I, distal views. Scale in cm.

Order Artiodactyla
Family Hippopotamidae
cf. *Hexaprotodon* sp.
Figure 6: E-F

A molar fragment, KNM-TR 45693, was collected. A partial cusp of the molar with cingulum is preserved. The tooth is slightly worn. The cusp is high. The crown height is 29.2 mm. It is smaller than *Hippopotamus*, larger than *Kenyapotamus* and as large as or slightly smaller than the other species of *Hexaprotodon*. The tip of the cusp is bordered by two ridges. The cingulum is slightly rugose. The lateral surface of the enamel is flat and smooth.

A wrinkled ridge extends from the tip of the cusp to the edge of the cingulum.

Although tooth fragments of *Hexaprotodon* sp. were previously found from localities SH 47 and SH 48 of the Upper Member of the Kongia Formation (Pickford, 1984; Pickford & Morales, 1994), we could not relocate any of the specimens in the National Museums of Kenya.

Family Bovidae
Bovidae gen. et sp. indet.
Figure 6: G-I

Two small horn core fragments and one right lunar were collected. The horn cores preserve parts near the tip. They are not compressed medio-laterally or antero-posteriorly. The axis of the horn core has no prominent torsion. The cross section of the horn core is subcircular. Those horn cores are not likely to be *Gazella* because of the absence of lateral compression of the horn core (Gentry, 1978).

The lunar is slightly larger than that of extant *Gazella thomsonii* Günther, 1884, and smaller than that of *G. granti* Brooke, 1872, or *Aepyceros melampus* (Lichtenstein, 1812) It has a deep articular surface for the magnum and uniciform and a flat one for the radius.

Discussion and conclusions

The basal and middle parts of the Late Miocene Kongia Formation consist mainly of basalt lava with lacustrine sediments (Figures 3 & 4). The basal part of the Early Pliocene Turr Turr Formation, unconformably overlying the Kongia Formation, consists of tuff beds with gravely sandstone and well-sorted sandstone (Figures 3 & 4). From the basal part of the Turr Turr Formation (5-4 Ma), vertebrate remains including crocodile, proboscideans, *Hipparion*, hippopotamids and bovids were collected. However, the basal and middle parts of the Kongia Formation yielded no

fossils although previous molluscs and hippopotamids were collected (Pickford *et al.*, 1984).

The fauna from the basal part of the Turr Turr Formation is significantly different from that of the underlying Namurungule Formation because of the presence of an advanced hippopotamid, *Hexaprotodon*. However it shows no difference from the one of the middle part of the Kongia Formation due to the paucity of specimens.

The fauna from the basal part of the Turr Turr Formation is of little use for biostratigraphic purposes. *Hexaprotodon* suggests that the member is younger than 7 Ma. The last appearance of *Kenyapotamus* is during the Faunal Set VI (10.5-7.5 Ma: Pickford, 1981; 1983). The first appearance of *Hippopotamus* or *Hexaprotodon* is about 7 Ma in the Mpesida Beds, Kenya (Pickford, 2002). The presence of *Hipparion* cf. *sitifense* Pomel, 1897, indicates an age younger than 10.5 Ma. The fauna correlates the Faunal Set VII or VIII.

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