

KOBUS PORRECTICORNIS (REDUNCINI) FROM THE UPPER SIWALIKS OF TATROT, PAKISTAN

A. Iqbal, A. M Khan and M. Akhtar

Department of Zoology, University of the Punjab, Lahore, 54590, Pakistan

Correspondence Author's Email: majid.zool@pu.edu.pk

ABSTRACT

This paper presents newly discovered Reduncine fossils which are collected from the Tatrot Zone, of Soan Formation in the Upper Siwaliks of Pakistan. Reduncines are basically obligate grazers and have their dwellings in swamps, grassland, and Savanna woodland and even dry land having a source of water. The specimens under study include the lower teeth and exhibit the diagnostic characters of *Kobus* (Reduncini) including a distinct goat fold, a less sharp basal pillar, and a transverse flange at posterior side and a less constricted lobes at labial side. Reduncini recognized on the basis of rounded shape cusps while other bovids have blunt cusps is a prominent feature of this tribe. The present specimens are identified as *Kobus porrecticornis* on the basis of similarities with the already known specimens from the Upper Siwaliks.

Key words: Bovidae, Pleistocene, Siwaliks, Antelope, Reduncini, Molar.

INTRODUCTION

According to Dennell (2006) the Upper Siwaliks (Figure-1) dated about 3.3- 0.6 Ma, spanning the Late Pliocene to Middle Pleistocene. Pilgrim (1913) classified the Upper Siwaliks into the Tatrot Zone, Pinjor Zone and Boulder Conglomerate. The Paleomagnetic and

stratigraphic importance of the Upper Siwaliks has been elaborated by a number of researchers who belong to India, Pakistan and Nepal (Opdyke *et al.*, 1979; Ranga Rao *et al.*, 1988; Corvinus and Nanda, 1994; Dennell *et al.* 2005; Nanda, 2008).

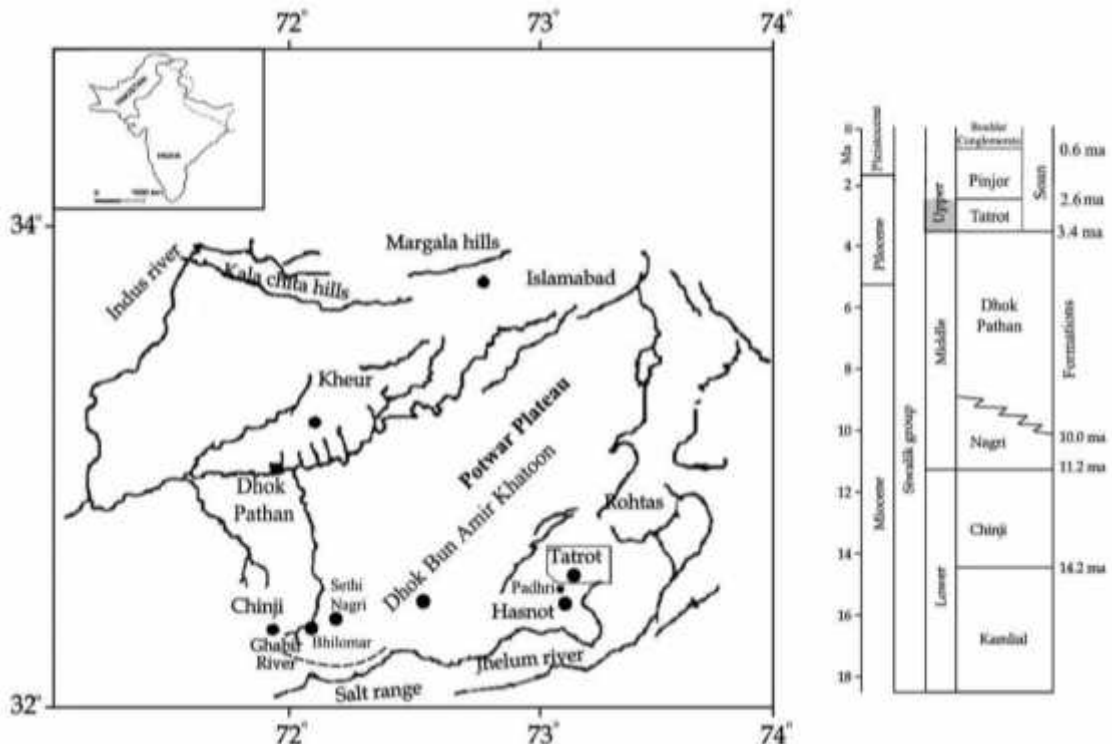


Fig. 1: A Map of the Potwar Plateau which showing the stratigraphic sections and study area of the Upper Siwaliks, Pakistan (Behrensmeyer and Barry, 2005; Nanda, 2008) and the boundary dates are from Dennell *et al.* (2006).

Bovidae is a family of ruminant herbivorous mammals containing cattle, sheep, goats and antelopes. Their horns consist of external keratinous sheaths mounted on bony cores and, unlike deer antlers, they have no branches and they are not seasonally shed. The habitat of bovids is commonly woodland, dry and wet grasslands and swampy places (Harris *et al.* 1988).

Reduncini has been considered as the most abundant tribe among Bovids (Lacruz *et al.* 2002). The primitive appearance of Reduncini fossils have been recorded from Africa and Eurasia. Reduncini contain a sister group *Redunca* and *Kobus*, the former known as a reedbuck while later is called as waterbuck (Ansell, 1971). The extant genus *Redunca* consist of three species including *R. fulvorufula*, *R. Redunca* and *R. arundinum*; while *Kobus* comprises five living species, including *K. megaceros*, *K. leche*, *K. ellipsiprymnus*, *K. kob* and *K. vardoni*.

The *Kobus porrecticornis* has been discovered from the Late Miocene to Pliocene of Dhok Pathan Formation and Early Pleistocene of the Tatrot zones (ca. 7.4-2.9 Ma). The previous name of the *Kobus porrecticornis* was *Dorcadoxaporrecticornis* given by Pilgrim (1939). This species closely resemble to existing species due to similar morphological characteristics (Vrba *et al.* 1995).

Abbreviations: PUPC – Punjab University Paleontological Collection; Ma – million years ago; M – upper molar; m – lower molar; l – largest molar length; w – molar width; h – molar height; h/w – height/width (hypsodonty).

MATERIALS AND METHODS

This collection includes four specimens of *Kobus porrecticornis* collected from the Tatrot Formation of the Upper Siwalik subgroup, Pakistan by the authors in 2014. Tatrot village is located between the Dhok Pathan and fossilized sediments (Pocock, 1910). The sample described in this paper consist of a mandible with p₂-m₃ and three isolated molars while one molar is half broken and one is upper molar. The terminology used in describing the specimens has been adopted from Pilgrim (1939) and Gentry (1999). The measurements are taken with the help of metric vernier caliper and are given in millimeters (mm). The photographs were taken with fine digital camera.

Systematic Palaeontology

Class: Mammalia Linnaeus, 1758

Order: Artiodactyla Owen, 1848

Family: Bovidae Gray, 1821

Subfamily: Antilopinae Gray, 1821

Tribe: Reduncini Blaine, 1914; Simpson, 1945

Genus: *Kobus* A. Smith, 1840

Type species: *Kobus ellipsiprymnus* Ogilby, 1833

Species: *Kobus porrecticornis*

Synonyms: *Dorcadoxa porrecticornis* Pilgrim, 1939

Locality: Unknown Locality, our material comes from Tatrot (Upper Siwaliks).

Stratigraphic Range: Middle and Upper Siwaliks.

Diagnosis: No Siwalik specimen has been published in which horn cores of *Kobus porrecticornis* are associated with teeth. A large sized antelope, upper and lower molars with basal pillars, constricted labial lobes in lower molars; upper molars with strong styles; localized ribs between the styles, central fossettes of upper molars with indentations (spurs) of their outlines and tending in later wear to have long, labially directed, transverse arms; lower molars with goat folds and front and rear out bowings of lingual walls; upper and lower p₂s small; lower premolars with an appearance of antero-posteriorly compression; p₄s with a strongly projecting hypoconid and often a deep and narrow labial valley in front of it; p₄s usually without paraconid-metaconid fusion to form a complete lingual wall (Gentry, 1990).

DESCRIPTION

The concerned specimens have a clear goat fold and a transverse flange at front end of the molar tooth which are a distinguished property of tribe Reduncini. Moreover, the tooth have a sharp and strong median basal pillar which is more prominent at labial side as compared to lingual side. The tooth are hypsodont and have deep fossettes. A spur is projected from the central fossettes and lobes are present which is constricted at lingual side. All the teeth have rounded cusps and a hazy keel is present. Reduncini have less transverse compression, the posterior surface is flatter than the middle one, a curvature which is directed behind in the proximal parts and an intense and vigorous longitudinal groove at the rear end. In the upper molars the constricted lobes present at lingual side while in lower molars it is present at labial side.

The upper molars are quadrate in shape and have high crown. The premolars have same features as like molars but have backward curvature, deep furrow and are reduced in size as compared to molar. The premolars have a distinct entoconid. (Figure -2).



Fig 2. *Kobus porrecticornis* from the Upper Siwaliks of Tatrot; 1 (a-c). PUPC 14/186, a mandible with Ip2 - m3; 2 (a-c), PUPC 14/187, m2 - m3; 3(a-c), PUPC 14/188, partial rm3; 4 (a-c), PUPC 14/190 IM2.

COMPARISON AND DISCUSSION

Reduncini have a well-defined fossil discovered about 7 Ma in the Late Miocene from Africa and Eurasia (Vrba, 1985; Gentry, 1990). Several authors Lydekker, (1878); Pilgrim, (1939); Ansell, (1971); Gentry, (1978, 1990); Cotterill, (2000); Vrba, (1985, 2006) Bibi *et al.* (2011) described the extinct and extant species belong to Reduncini. According to Pilgrim (1939) listed some genera discovered from the Middle Siwaliks and the Upper Siwaliks included *Vishnucobus*, *Hydaspicobus*, *Gangicobus*, *Indoredunda*, *Cambayella*, *Procobus*, *Kobikeryx*, *Sivadenota*, and *Kobus*. Ansell (1971) described about the extant species *Kobus kob*, *Kobus vardoni*, *Kobus leche*, *Kobus megaceros*, *Kobus ellipsiprymnus*, *Redunca fulvorufula*, *Redunca redunca* and *Redunca arundinum*.

The tribe Reduncini belongs to family Bovidae but they are different from other bovids due to their rounded cusps while bovids have blunt cusps. They have moderately large body size which increased with the time due to the coolness of environment (Ansell, (1971;

Fortelius and Solounias, 2000; Vrba, 2004). *Vishnucobus* was first time documented by Lydekker (1878) from the Upper Siwaliks and it was considered as an ancestor of the living genus *Kobus* due to its similar morphological characteristics. The horn cores are compressed as like modern species. Similarly *Sivacobus* have some resemblance to the genus *Kobus* due to its hypsodonty nature and presence of basal pillar which is smaller than *Kobus* and its premolars are also reduced as *Kobus* and high crown teeth. A long styliform and backward curve is also present in *Sivacobus* as like *Kobus*. *Hydaspicobus* was found in the Middle Siwaliks and from the Tatrot Formation and its generic position is not clear. The premolars are large in length about 35mm and its molars are approximately 57mm in length. The basal pillar is not present but have hypsodont teeth. The basal pillar is absent in the genus *Sivadenota* and this species recorded from the Middle and the Upper Siwaliks of India. The genus *Cambayella* regarded as the earliest in the tribe Reduncini which was found in the Middle Siwaliks and from the Pinjor Formation (Pilgrim, 1939).

Vishnucobus patulicornis also recorded in the Plio-Pleistocene age from the Siwaliks which resemble to lechwes and *K. busilcookei* with large horn core. *Kobus porrecticornis* considered as primitive antelope in Siwaliks and have different characters from African reduncines due to presence of less longitudinal grooves at posterior side and more transverse compression (Gentry, 1980).

Among living reduncines *Kobus* is different from *Redunca* due to havetiny nasal bones, shorter maxillary diastema, a long bushy tail and a sub-auricular gland is not present (Vrba *et al.*, 1994). *Kobus* is different from *Reduna* due to existence of circular horncore and its medio-lateral diameter is larger than antero-posterior side while both are aquaphile and found near water (Gentry, 1978).

In molar tooth of *Kobus porrecticornis* lobes are more constricted at lingual side as compared to labial side and small in size but ribs are protuberant between the styles. The premolars are reduced in size and have a deep furrow at posterior side which is prominent character of Reduncini.

K. porrecticornis and *K. busilcookei* both have equal body size but horn cores are shorter, more compressed, twisted from back and more divergent at the base in *Kobus busilcookei* (Vrba, 2010). *Kobus porrecticornis* inhabited in woodland, near the water area and grassland (Bibi, 2011). Comparative measurements has been provided in Table-1.

Table1: The comparative measurements of the dentition of *Kobus porrecticornis* (Reduncini). The studied specimen and comparative data are taken from Gentry (1997), Khan and Akhtar (2014) Iqbal *et al.* (2014).

Taxon	Specimen No.	Tooth	Length	Width	Ratio width\length	
<i>K. porrecticornis</i>	PUPC 14/186	lp2	11.5	6.0	0.52	
		lp3	12.5	7.5	0.6	
		lp4	13.5	8.0	0.59	
		lm1	18.2	11.0	0.60	
		lm2	19.0	11.5	0.60	
		lm3	19.0	10.7	0.56	
	PUPC 14/187	lm2	18.0	11.5	0.63	
		lm3	21.5	8.5	0.39	
	PUPC 14/188	rm3 (broken)	21.0	14.5	0.69	
	PUPC 14/190	lm2	20.0	14.5	0.72	
	<i>K. aff. porrecticornis</i> (Khan <i>et al.</i> , 2008)	PUPC 07/44*	lm2	18.7	11.4	0.60
			lm3	26.2	12.4	0.47
PUPC 07/45*		lm2	19.5	12.5	0.64	
<i>K. aff. porrecticornis</i> (Khan <i>et al.</i> , 2014)	PUPC 83/837*	lm1	16.5	10.8	0.65	
		lm2	19	11.5	0.60	
	PUPC 88/03*	rm2	17.4	9.6	0.55	
		rm3	23.5	-	-	
	PUPC 02/137*	rm2	21	10.6	0.50	
		rm3	23.5	-	-	
	PUPC 69/67*	rm3	25.7	13	0.50	
	PUPC 83/816*	lm3	28	12.5	0.44	
	PUPC 82/13	lm2	17.0	15.0	0.88	
	<i>K. aff. porrecticornis</i> (Iqbal <i>et al.</i> , 2008)	GCS 13/01*	lm1	17.6	7.6	0.43
GCS 13/02*		rm3	26.4	13.0	0.49	
GCS 13/05*		rm1	17.6	11.0	0.63	
<i>K. aff. porrecticornis</i> (Gentry, 1997)	WM975/92*	lm2	19	7.7	0.40	

PALAEOBIOGEOGRAPHY AND PALAEOCLIMATE OF *KOBUS* *PORRECTICORNIS*.

Reduncines may have lived around enduring shallow wetlands and water logged habitats if compared to their living relatives in Africa and Arabian Peninsula. Keeping in view the habitat requirements of the living

Reduncines, we may assume that *Kobus porrecticornis* would have lived in similar habitats in the Siwaliks. The modern analogue of *Kobus porrecticornis* and its assumed habitat may be found in Uganda and Sudan along the upper reaches of Nile River.

As the Tatrot beds are dated between 3.4Ma to 2.4Ma by Nanda (2008) and it corresponds to the Late Pliocene of the Siwaliks where the subfamilies Bovinae

and Antilopinae became more diverse during the Late Pliocene. Contrary to the Bovinae and Antilopinae, the tribe Boselaphini became rare in the Late Pliocene of the Siwaliks. The rarity of the boselaphines in the Tatrot locality can be attributed to the filling of the boselaphine niches by bovines and antilopines. The Tatrot beds provided an extremely diverse pattern of spatiotemporal habitat structure, with a wide variety of niches with browsing and mixed feeding supporting Bovines and Antilopines. The abundance of antilopines in the Tatrot locality indicates a mixture of woodland and grassland biome.

The taxonomic composition of Tatrot bovines indicates woodland and grassland habitats during the Late Pliocene in the Upper Siwaliks (Dennel et al., 2006). These habitats might have not been available for boselaphines to flourish in Tatrot. Reduncines and *Antilope* inhabit savanna, woodland, and grassland. In the Pliocene, the climate became drier, promoting the development of grasslands in place of the contracting woodland suggesting that more open habitats prevailed in Tatrot.

Conclusion: The Upper Siwalik bovids have large body size than the Lower and Middle Siwalik bovids and these bovids have strong taxonomic stability at generic and specific level. The species examined here belong to the tribe Reduncini of the family Bovidae, is morphometrically different from the other Upper Siwalik Bovid tribes. The described specimens are morphometrically comparable to the Reduncine species *K. porrecticornis*. The Upper Siwalik bovid fauna is closely related to extant fauna of the region.

The Tatrot outcrops of the Late Pliocene Upper Siwaliks are characterized by the presence of four antelope species, along with several other mammalian taxa, including *Equus sivalensis*, *Elephas planifrons*, *Hemibos triqueticornis*, *Hexaprotodon sivalensis*, and *Rhinoceros sivalensis*. These taxa indicate the dry season grasslands ecosystem in Tatrot. The faunal elements like antelopes became dominant in Tatrot at the expense of most of the browsing and browsing–grazing forms.

Acknowledgements: The work has been sponsored by HEC grant number 2Bm1-206. The authors are grateful to Dr. A.W. Gentry for providing valuable literature and are highly obliged and thankful for his critical review and valuable suggestions for improvement of the text. Mr. Ghyour Abbas is thanked for his help in the field work.

REFERENCES

Ansell, W.F.H (1971). Artiodactyla. In: *The Mammals of Africa: An Identification Manual*, J. Meester and H.W. Setzer, eds., pp. 34–44, Smithsonian Institution Press, Washington, D.C.

Proceedings of The National Conference and Training Workshop “Wildlife and Aerobiology” held on February 6-7, 2015 Lahore, Pakistan

- Behrensmeyer, A., Barry, J., (2005). Biostratigraphic Surveys in the Siwaliks of Pakistan. A Method for Standardized Surface Sampling of the Vertebrate Fossil Record. *Palaeontologia Electronica*, 8(1): 1–24.
- Bibi, F (2011). Mio-Pliocene Faunal Exchanges and African Biogeography: The Record of Fossil Bovids. *Plos one* 6(2): e16688. doi:10.1371/journal.pone.0016688
- Corvinus, G. and A.C Nanda (1994). Stratigraphy and palaeontology of the Siwalik Group of SuraiKhola and RatoKhola in Nepal. *Neues Jahrbuch Geologie und Paläontologie Mnonatshefte Abhandlungen*, 191: 25-68.
- Cotterill, F.P.D (2000). Reduncine antelope of the Zambezi basin. In: Biodiversity of the Zambezi Basin Wetlands, (Timberlake, J.R, ed.). Bulawayo: Biodiversity Foundation for Africa and Harare: The Zambezi Society, pp. 145-199.
- Dennell, R. W., Turner, A., Coard, R., Beech, M. and Anwar, M. (2005). Two Upper Siwalik (Pinjor Stage) Fossil Accumulations from Localities 73 and 362 in the PubbiHiils, Pakistan.
- Dennell, R., R. Coard, and A. Turner (2006). The biostratigraphy and magnetic polarity zonation of the Pabbi Hills, northern Pakistan: An Upper Siwalik (Pinjor Stage) Upper Pliocene-Lower Pleistocene fluvial sequence. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 234: 168-185.
- Fortelius, M. and N. Solounias (2000). Functional characterization of ungulate molars using the abrasion-attrition wear gradient: a new method for reconstructing paleodiets. *American Museum, Novitates*. 3301: 1-36.
- Gentry, A. W. (1999). Fossil Pecorans from the Baynunah Formation, Emirate of Abu Dhabi, United Arab Emirates. Chap. 22 in *Abu Dhabi pecorans*, Yale University Press, New Haven, 290-316.
- Gentry, A. W. and Gentry (1978). Fossil Bovidae of Olduvai Gorge, Tanzania. *Bidkfi of British Mircurn of Nntirni History (Geology) h7doil*. Part I, 29:289445. Part II, 30:1-83.
- Gentry, A.W (1980). Fossil Bovidae (Mammalia) from Langebaanweg, South Africa. *Annals of the South African Museum*, 79:213-337.
- Gentry, A.W (1990). Evolution and dispersal of African Bovidae. In G. A. Bubenik and A. B. Bubenik (eds.), *Horns, pronghorns, and antlers*, Springer-Verlag., New York: 195-227.
- Gentry, A.W (1994). The Miocene differentiation of Old World Pecora (Mammalia). *Historical Biology*. 7: 115-158.
- Gentry, A.W (1997). Fossil ruminants (Mammalia) from the Manonga Valley, Tanzania. In *Neogene*

- Paleontology of the Manonga Valley, Tanzania, pp. 107-135 (ed. T. J. Harrison). Plenum Press, New York.
- Gentry, A.W. (1978). Fossil Bovidae of Olduvai Gorge, Tanzania. *Bidkfiil of British Mirscurn of Nntirni History (Geology) h7doil*. Part 1, 29:289445. Part II, 30:1-83.
- Harris, J. M., E.H. Brown and M.G. Leakey (1988). Stratigraphy and paleontology of Pliocene and Pleistocene localities west of Lake Turkana, Kenya. Natural History Museum of Los Angeles County, Contributions in Science. 399:1-128.
- Iqbal, A., M. A. Baber., M. A. Khan, M. Akhtar, A. Fatehullah., S. G. Abbas & M. Iqbal. (2014). Some New Fossils of Reduncini (Bovidae, Ruminantia) from Tatrot Formation Pliocene of Northern Pakistan. *BIOLOGIA (PAKISTAN)* 2014, 60 (2), 261-266.
- Khan, M.A. and M. Akhtar (2014). Antelopes (Mammalia, Ruminantia, Bovidae) from the Upper Siwaliks of Tatrot, Pakistan, with Description of a New Species. *Paleontological J.* 48(1): 79–89.
- Khan, M.A., A.M. Khan, M. Iqbal, M. Akhtar, S. Mahboob (2008). Reduncine Fossils from the Upper Siwaliks of Tatrot. *J. Anim. Plant Sci.*, 18(1): 50-52.
- Lacruz, R.S., P.J. Brink, A.R. Hancox, A. Skinner, P. Herries, L.R. Schmid and Berger (2002). Palaeontology and Geological Context of a Middle Pleistocene Faunal Assemblage from the Gladys vale Cave, South Africa. *Palaeontologica Africana*, 38, 99-114.
- Lydekker, R. (1878). Indian Tertiary and Post-Tertiary vertebrate. *Crania of Ruminants. Pal. Ind.*, 10: 88-181.
- Nanda, A.C. (2008). Comments on the Pinjor mammalian fauna of the Siwalik Group in relation to the post-Siwalik faunas of Peninsular India and Indo-Gangetic Plain, Quaternary International, 192: 6–13.
- Opdyke, N.D., E. Lindsay, G.D. Johnson, N. Johnson, R.A.K. Tahirkheli, M.A., Mirza (1979). Magnetic polarity stratigraphy and vertebrate paleontology of the Upper Siwalik Subgroup of northern Pakistan. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 27: 1-34.
- Pilgrim, G.E. (1939). The fossil Bovidae of India. *Pal. Ind.*, N.S. 26(1): 1-356.
- Pocock, R.I (1910). On the specialized cutaneous glands of ruminants. *Proceedings of the Zoological Society of London*, 1910: 840-986.
- Ranga Rao, A., R.P. Agarwal, U.N. Sharma, M.S. Bhalla, N.C. Nanda (1988). Magnetic polarity stratigraphy and vertebrate palaeontology of the Upper Siwalik Subgroup of Jammu Hills, India. *J. Geological Society of India*, 31: 361–385.
- Vrba, E. S., (1985). African Bovidae: evolutionary events since the Miocene. *S. Africa J. Sci.*, 81: 263–266.
- Vrba, E. S., (2010). A possible ancestor of the living waterbuck and lechwes: *Kobus basilcookei* sp. nov. (Reduncini, Bovidae, Artiodactyla) from the Early Pliocene of the Middle Awash, Ethiopia. *Transactions of the Royal Society of South Africa*, 61:2, 63-74.
- Vrba, E. S., J.R. Vaisnys, J. E. Gatesy, R. DeSalle and K. Y. Yen, (1994). Analysis of pedomorphosis using allometric characters: the example of Reduncini antelopes (Bovidae, Mammalia). *Systematic Biology*, 43: 92–116.
- Vrba, E.S (2006). A possible ancestor of the living waterbuck and lechwes: *Kobus basilcookei* sp. nov. (Reduncini, Bovidae, Artiodactyla) from the Early Pliocene of the Middle Awash, Ethiopia. *Transactions of the Royal Society of South Africa*. 61(2): 63-74.
- Vrba, E.S., G.H. Denton, T.C. Partridge and L.H. Burckle (1995). *Paleoclimate and Evolution with Emphasis on Human Origins*. Yale University Press, New Haven, Connecticut, 556 pp.