

SOME NEW REMAINS OF *HEXAPROTODON* (MAMMALIA, HIPPOPOTAMIDAE) FROM THE PINJOR FORMATION OF SARDHOK, PAKISTAN

Muhammad Khaled Siddiq, Muhammad Akbar Khan, Khalid Mahmood*, Muhammad Adeeb Babar, and Muhammad Akhtar

Dr. Abu Bakr Fossil Display & Research Centre, Department of Zoology, University of the Punjab, Quaid-e-Azam Campus, Lahore 54590, Punjab, Pakistan

*Corresponding author: Khalid Mahmood, E-mail: [khalidkasuri@hotmail.com]; Contact# +92343-8472919

ABSTRACT: Some new remains of hippopotamid from Pleistocene of the Siwaliks, northern Pakistan, were recovered and discussed. The Siwalik hippopotamids represent only one species *Hexaprotodon sivalensis*. The material comprises isolated teeth and a mandible fragment. The new material provides an additional knowledge of the taxon's morphology.

Keywords: Artiodactyls, *Hippopotamus*, Pleistocene, Pinjor, Siwaliks.

1.0 INTRODUCTION

The new Hippopotamidae material is recovered from the Pabbi Hills of Sardhok. The Sardhok village is situated in the Gujrat district, Punjab, Pakistan (Fig. 1) and the outcrops belong to the Pinjor Formation of the Siwaliks [1, 2, 3, 4, 5, 6, 7, 8]. Magnetostratigraphically, the type area is located in the Pinjor Formation of the Chandigarh region and dated from 2.48-0.63 Ma [9, 10]. The Pinjor Formation comprises Pleistocene sand as well as variegated clays. Its lower contact is transitional with the Tatrot Formation. Its upper contact is transitional with the Upper Boulder Conglomerates, it altered from the sandstones, mudstones and conglomerates to massive and thick boulder conglomerates [11,10].

The Pinjor mammalian fauna is the youngest fauna of the Siwalik Group which is ranging in age from 2.48 to 0.63 Ma. The Siwalik vertebrate fossil record ended in the Pinjor Formation and the overlying Boulder Conglomerate Formation is totally devoid of fossils [10, 12]. Moreover, the latest faunal turn-over events during the last Pliocene around 2.9 Ma introduced many Eurasian mammals in the Siwalik faunal province including cervids (*Rucervus*, *Cervus*, *Axis*), equids (*Equus*), elephantids (*Elephas*), giraffids (*Sivatherium*) and suids (*Sus*, *Sivachoeras*). This faunal change, termed as *Elephas planifrons* Interval-Zone [13, 10] and characterized by dominance of herbivore community of woodland habitat with a few adapted for riverine gallery forests. The principal feature of this community is continuing into the modern South Asian wildlife assemblages [14, 15, 10]. The migration and extinction process started at 1.79 Ma and after 0.63 Ma after that there is no record is found of this fauna from the Himalaya. [16,17,18,10].

The studied material is recovered from the Late Pleistocene deposits of the Sardhok village, northern Pakistan (Fig. 1). The primary means of collecting the mammalian remains was surface collection. The measurements are in millimeters. The collected fossils represent poor preservation. The diagnostic characters of the recovered fossils are discussed. In this paper we have described the Siwalik hippopotamid fossils from the Middle Pleistocene of Sardhok, Pabbi Hills, Pakistan.

2.0 SYSTEMATIC PALAEONTOLOGY

Family Hippopotamidae Gray, 1821

Genus *Hexaprotodon* Falconer and Cautley, 1836

***Hexaprotodon sivalensis* Falconer and Cautley, 1836**

Type specimen: BMNH M2269, a skull.

Diagnosis: Like *Hippopotamus amphibious*, but with six incisors of subequal size. First premolar large, brain case relatively small, well developed sagittal crest, lachrymal in contact with orbit but separated from nasal by an extension of the frontal. The anterior premolars diverge from each other [2] (p. 279).

Stratigraphic range: Upper Siwaliks (Pliocene-Pleistocene).

Geographic distribution: India, Sri Lanka, Nepal and Bhutan.

New material: Upper dentition: PUPC 14/47, left P2 (L, 36; W, 28.6). Lower dentition: PUPC 14/46, a part of symphysis; PUPC 14/48, partial molar.

Locality: Sardhok, Gujrat district, Punjab province, Pakistan.

Description and Comparison

Upper dentition: The second premolar is a conical tooth with a single strong cone which slopes backwards into a shallow shelf (Fig. 2). A well distinguished cingulum is present at crown base. The crown surface has three conical enamel projections antero-posteriorly. A vertical groove is present labio-lingually.

Symphysis: The symphysis is partially preserved with a width of 168.3 mm. The teeth are all damaged and the symphysis is broken posteriorly (Fig. 2). The symphysis is robust; a typical feature of hippopotamid. The incisors roots are preserved.

preserved part of the incisors indicate stout crown. The roots are circular to elliptical in cross section.

Lower dentition: The molar is broken antero-posteriorly (Fig. 2). The molar pattern is tetracuspid. The cingulum outgrowths in the form of small irregular prominences are present in the preserved crown. The preserved crown shows two large dentinal islands, fused to each other by dentinal channels.

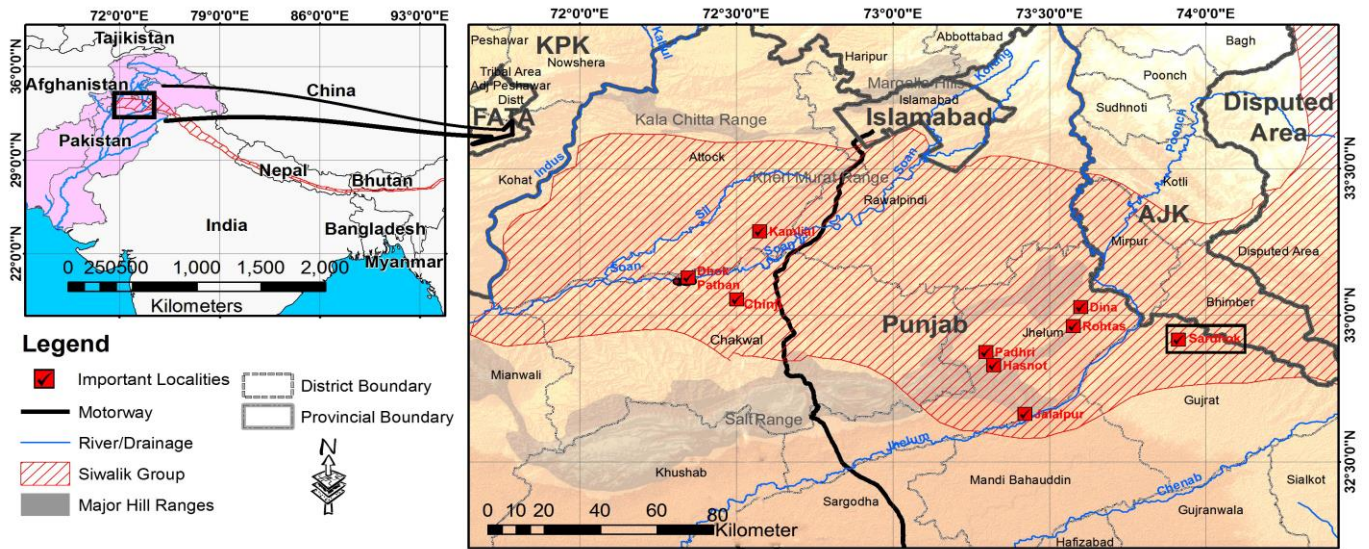


Fig. 1: The studied area of Sardhok (encircled), Gujrat district, Punjab province, Pakistan.



Fig. 2: *Hexaprotodon sivalensis*: 1. PUPC 14/47, left P2; 2. PUPC 14/46, part of symphysis; 3. PUPC 14/48, partial molar. Views: a, occlusal; b, lingual; c, labial.

The second premolar resembles with the premolar of *Hexaprotodon sivalensis* (Fig. 2). The robust symphysis with circular roots of the incisors associates the sample with *H. sivalensis*, recorded from the Upper Siwaliks of the subcontinent. The studied molar crown pattern is similar to the already studied specimens of *H. sivalensis*. Morphometrically (Fig. 2), the sample closes to the type specimen and earlier studied specimens of *H. sivalensis* [19, 2, 20 21]. The earlier researchers noted the peculiarity of six incisors and the large size of first premolar in this Siwalik form. The main distinguishing feature of the species is being the presence of six incisors in respect of four ones in the modern form.

3.0 DISCUSSION

Hexaprotodon sivalensis appears for the first time in the Plio-Pleistocene of the Siwaliks and the species is established wide geographic range extending from the Siwaliks to Eurasia in a very short interval [22, 19, 2, 20, 10]. The best record of *Hexaprotodon sivalensis* is found in the Siwaliks of Pakistan and India. *Hexaprotodon sivalensis* is apparently restricted to Pliocene of the Siwaliks [2, 10]. This species is found occasionally in the Siwaliks at Mio-Pliocene boundary which has age 5.3 Ma [23, 10]. The studied material extends the biostratigraphic age of the species from the Tatrot Formation Pliocene to the Sardhok Pleistocene of the Siwaliks.

Hexaprotodon sivalensis is considered primitive form of Hippopotamidae, which lacks derived features. This genus depicts the paraphyletic group of lineage of hippopotamines. Some earlier authors, especially [2, 10] noted close similarities between *Merycopotamus* (anthracotheriids) and *Hexaprotodon*. Of course, by studying C₄ grasses, it is confirmed that the animal inhabited the semi aquatic area, a niche previously occupied by the Anthracotheriidae [24, 10]. *Hexaprotodon* genus is also recovered from Miocene and Plio-Pleistocene localities of Africa and Eurasia [25, 20]. In Europe, many species of *Hexaprotodon*, having variation in size, have been reported from the Late Miocene of Spain, Italy and France [20, 10]. These species showing similarities in size and morphology with the species of Eurasia comparable in size and morphology with the species of Eurasia. Nevertheless, the expansion of *Hexaprotodon* in Africa occurs just earlier to Eurasia.

Hexaprotodon was present during the Pleistocene, exhibiting a same biogeography of *Stegodon* and went extinct before the start of Holocene Epoch [26, 10]. Late Pliocene of the Siwalik is best for the hippopotamus [2, 10]. *Hexaprotodon* represents semi aquatic appearance with fresh water mussels, showing riverine associations in the Sardhok area. *Hexaprotodon* depends upon open water habitat and its extinction in Southeast Asia is directly related to less rainfall and river flow due to more drying environment at that time [27, 10].

4.0 CONCLUSIONS

Hexaprotodon sivalensis is recovered from the Sardhok Pleistocene of Pabbi Hills, Pakistan. The large mammalian

fauna, with semiaquatic species *Hexaprotodon sivalensis*, indicate the important role of open landscapes throughout the Early Pleistocene of the Pabbi Hills. The presence of wooded biotopes along a major river is indicated by the frequent occurrences of these large mammals.

REFERENCES

1. Matthew, W. D., "Critical observations upon Siwalik mammals (exclusive of Proboscidea)," *Am. Mus. Nat. Hist. Bull.*, **56**: 437-560(1929)
2. Colbert, E. H., "Siwalik mammals in the American Museum of natural History," *Transactions of the American Philosophical Society*, **26**: 1-401(1935)
3. Pilbeam, D., Barry, J., Meyer, G. E., Shah, S., M. I., Pickford, M. H. L., Bishop, W. W., Thomas H. and Jacobs, L. L., "Geology and palaeontology of Neogene strata of Pakistan," *Nature*, **270**: 684-689(1977)
4. Sarwar, M., "Taxonomy and distribution of the Siwalik Proboscidea," *Bull. Deptt. Zool. Punj. Univ., Lahore*, **10**: 1-72(1977)
5. Barry, J. C., Morgan, M. E., Flynn, L. J., Pilbeam, D., Behrensmeyer, A. K., Raza, S., Khan, I., Badgely, C., Hicks J. and Kelley, J., "Faunal and environmental change in the Late Miocene Siwaliks of Northern Pakistan," *Paleobiology*, **28**: 1-72(2002)
6. Barry, J. C., Behrensmeyer, A. K., Badgley, C. E., Flynn, L. J., Peltonen, H., Cheema, I. U., Pilbeam, D., Lindsay, E. H., Raza, S. M., Rajpar A. R. and Morgan. M. E., "The Neogene Siwaliks of the Potwar Plateau, Pakistan," In: *Fossil Mammals of Asia: Neogene Biostratigraphy and Chronology* (ed. X. Wang, L.J. Flynn, and M. Fortelius), Columbia University Press, New York, USA, pp. 373-399(2013)
7. Siddiq, M. K., Khan, M. A. and Akhtar, M., "*Proamphibos* (Bovini: Bovidae: Ruminantia) from Sardhok Pleistocene of Pakistan," *Pak. J. Zool.*, **46**(4): 897-908(2014)
8. Siddiq, M. K., Akhtar, M., Khan, M. A., Ghaffar, A., Sarwar, K. and Khan, A. M., "New Fossils of *Rhinoceros* (Rhinocerotidae) from the Soan Formation (Plio-Pleistocene) of Northern Pakistan," *Pak. J. Zool.*, **48**(3): 657-664(2016)
9. Kumaravel, V., Sangode, S. J., Kumar, R. and Siddaiah, N. S., "Magnetic polarity stratigraphy of the Plio-Pleistocene Pinjor Formation (type locality), Siwalik Group, NW Himalaya, India," *Current Science*, **88**: 1453-1461(2005)
10. Siddiq, M. K., "Taxonomic studies of mammalian remains from the Siwalik hills of Sardhok, Punjab, Pakistan," PhD thesis unpublished, (2015)
11. Pilgrim, G. E., "Notices of new Mammalian genera and species from the Tertiaries of India-Calcutta," *Rec. Geol. Surv. India*, **40**: 63-71(1910)
12. Nanda, A. C., "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(2008)

13. Barry, J. C., Lindsay E. H. and Jacobs, L. L., "A biostratigraphic zonation of the middle and upper Siwaliks of the Potwar Plateau of northern Pakistan," *Palaeogeography, Palaeoclimatology, Palaeoecology*, **37**: 95-130(1982)
14. Arif, M., and Raza, S., "New findings of Cervidae (Mammalia) from the Upper Siwaliks of Potwar-Mirpur Areas, Pakistan," *Proceedings Pakistan Congress of Zoology*, **11**: 275-281(1991)
15. Arif, M., Shah S. M. I. and Vos, J. D., "*Cervus rewati* sp. nov. (Mammalia, Cervidae) from the Upper Siwaliks of Pakistan," *Geological Survey of Pakistan, Memoirs*, **17**: 1-11(1991)
16. Nanda, A. C., "Upper Siwalik mammalian faunas of India and associated events," *J. Asia. Earth Sci.*, **21**: 47-58(2002)
17. Dennell, R. W., "The taphonomic record of Upper Siwalik (Pinjor stage) landscapes in the Pabbi Hills, northern Pakistan, with consideration regarding the preservation of hominin remains," *Quaternary International*, **192**: 62-77(2008)
18. Ghaffar, A., Akhtar, M., Khan, M. A., Khan, A. M., Samiullah, K. and Iqbal, M., "Discovery of antler from a new site in the Pinjor Formation (Pleistocene) of Pakistan," *Jour. Geol. Soci. Ind.*, **80**: 119-122(2012)
19. Lydekker, R., "Additional Siwalik Perissodactyla and Proboscidea," *Memoirs of the Geological Survey of India Palaeontologica Indica*, **3**: 1-34(1884)
20. Hooijer, D. A., "The fossil Hippopotamidae of Asia, with notes on the recent species," *Zool. Verh. Museum Leiden*, **8**: 116-124(1950)
21. Nanda, A. C., "Fossil equids from the Upper Siwaliks subgroup of Ambala, Haryana," *Himalayan Geol.*, **8**: 149-177(1978)
22. Falconer, H. and Cautley, P. T., "*Sivatherium giganteum*, a new fossil ruminant genus from the valley of the Markanda in the Siwalik Branch of the Sub-Himalayan Mountains," *Asiatic Researches*, **19**: 1-24(1836)
- [23] Barry, J. C. and Flynn, L. J., "Key biostratigraphic events in the Siwalik sequence," In: (eds. E. H. Lindsay, V. Fahlbusch and P. Mein): *European Neogene Mammal Chronology*. NATO ASI Series, New York, Plenum. **180**: 557-571(1989)
24. Boisserie, J. R., Likius, A., Vignaud, P. and Brunet, M., "A new late Miocene hippopotamid from Toros-Me'nalla, Chad," *Journal of Vertebrate Paleontology*, **25**: 665-673(2005)
25. Hooijer, D. A., "Prehistoric and fossil rhinoceros from the Malay Archipelago and India," *NCB Naturalis*. **26**: 1-138(1946)
26. Maglio, V. J., "Origin and evolution of the Elephantidae," *Transactions of the American Philosophical Society*. **3**: 1-149(1973)
27. Jablonski, N. G., "The hippo's tale: how the anatomy and physiology of Late Neogene *Hexaprotodon* shed light on Late Neogene environmental change," *Quaternary International*, **117**: 119-123, 2004.