



## ***ELEPHAS* SP. CF. *E. PLANIFRONS* (ELEPHANTIDAE, MAMMALIA) FROM PARMANDAL SANDSTONE (=TATROT/ SAKETI FORMATION), NORTHWEST SIWALIK, DISTRICT SAMBA, J. & K., INDIA**

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### **ABSTRACT**

In this paper, three specimens of *Elephas* are reported from the mudstone-siltstone interface in a stream cutting section of the Parmandal Sandstone Formation, north of Labli village in Samba District, Jammu and Kashmir, India. The systematic identification of the reported molar specimens based on the crown morphological parameters (hypsodont index, lamellar frequency, plate numbers, crown height, length and width, enamel and dentine thickness) has been carried out and the specimens are tentatively referred as M<sub>3</sub>, M<sub>2</sub> and M<sup>1</sup> of *Elephas* sp. cf. *E. planifrons*. A brief review on age of these specimens is also discussed in the paper.

**Keywords:** *Elephas* sp. cf. *Elephas planifrons*, Labli village, Parmandal Sandstone, NW Siwalik, Samba District, India.

### **INTRODUCTION**

The most diversified Elephantidae family which includes both extinct (*Primelephas*, *Mammuthus*, *Stegotetrabelodon*, *Stegodibeldon*, *Stegodon*, *Anancus*, *Morrillia*, *Tetralophodon*, *Paratetraraphodon*, *Stegomastodon*, *Cuvieronius*) and extant (*Elephas* and *Loxodonta*) genera is well studied all over the world by number of workers (Osborn, 1942; Hooijer, 1949, 1955; Aguirre, 1969; Maglio, 1973; Soshani, 1982; Cerling, 1999; Foronova and Zuddin, 1999; Lister, 2001; Todd, 2010; Lister, 2013) from time to time on various aspects viz. origin, evolution, migration, taxonomy, biozones, age and distribution. True elephants probably evolved from *Stegodon* between 7ma to 6ma, which are distinct relatives of *Mastodons* (Lister, 2009). Proboscideans evolved into three genera i.e. *Loxodonta* (African Elephant), *Elephas* (Asiatic Elephant) and *Mammuthus* (European Elephant), *Loxodonta* stayed in Africa while *Elephas* migrated to South-East Asia and *Mammuthus* to Europe.

In Indian subcontinent, the outer Himalayan belt which is also known as Siwalik Group is bounded by river Brahmaputra in the east and river Indus in the northwest. It shows the presence of rich assemblage of vertebrates including Primates, Lagomorpha, Rodentia, Carnivora, Suoidea, Proboscidea, Hippopotamoidea, Traguloidea, Girrafoidea, Insectivora, Equoidea, Edentata, Rhinoceroidea and Bovoidea. Of these fossil groups from the Siwalik Group, Proboscideans are well studied by a number of palaeontologists (Falconer and Cautley, 1845; Chakravati, 1965; Badam, 1973; Nanda, 1980, 1988, 2015; Badam and Kumar, 1982; Tripathi and Basu, 1983; Nanda and Corvinus, 2000, Paliwal, 2003; Rai, 2004; Khan *et al.*, 2011; Samiullah, 2014). *Elephas* is the most common taxa in the Indian subcontinent, and it is represented by four species including *Elephas maximus*, *Elephas planifrons*, *Elephas hysudricus* and *Elephas namadicus*. Out of these four species, *Elephas planifrons*, *Elephas hysudricus* and *Elephas namadicus* are extinct and only surviving species is *Elephas maximus*.

The Siwalik belt of Jammu region lies between the Line of Control (with Pakistan) in the west and Ravi River (with Panjab) in the east. Several workers (Wadia, 1925; Yokoyama

*et al.*, 1987; Ranga Rao *et al.*, 1988; Gupta and Verma, 1988; Basu and Verma, 1990, Agarwal *et al.*, 1993; Ganjoo, 1992; Verma *et al.*, 2001; Koul, 2001; Prasad *et al.*, 2005; Kundal and Prasad, 2011; Kundal and Kundal, 2011; Kundal, 2012, 2013, 2015; Sankhyan and Sharma, 2014, Kundal *et al.*, 2017 a and b; Kundal, 2018) have carried out work on proboscidean and vertebrate fauna of Jammu region. The specimens under study are reported from the exposed stream cutting sections north of Labli village (Fig.1) from the Parmandal Sandstone Formation of Upper Siwalik Subgroup, and are described herein the present work and preserved in the Vertebrate Palaeontology Laboratory, Department of Geology, University of Jammu under catalogue numbers JU/DG/VPL/9003-05.

### **GEOLOGICAL SETTING**

Himalaya is the product of collision between two plates viz. Indian plate and Asian plate. Himalaya is divided into three parts from north to south i.e. Higher Himalaya, Lesser Himalaya and Outer Himalaya. The Higher Himalaya is separated from lesser Himalaya by MCT and the Outer Himalaya is separated from Lesser Himalaya by MBT. The Outer Himalaya which is also known as the Siwalik is very rich in vertebrate fossils. The tectonic setting of the Himalaya is as under



### **Stratigraphy of Study area**

The siwalik deposits are thin towards eastern and thick towards western part. The standard division of the Siwalik group of rocks which are in use till date was given by Pilgrim in 1934.

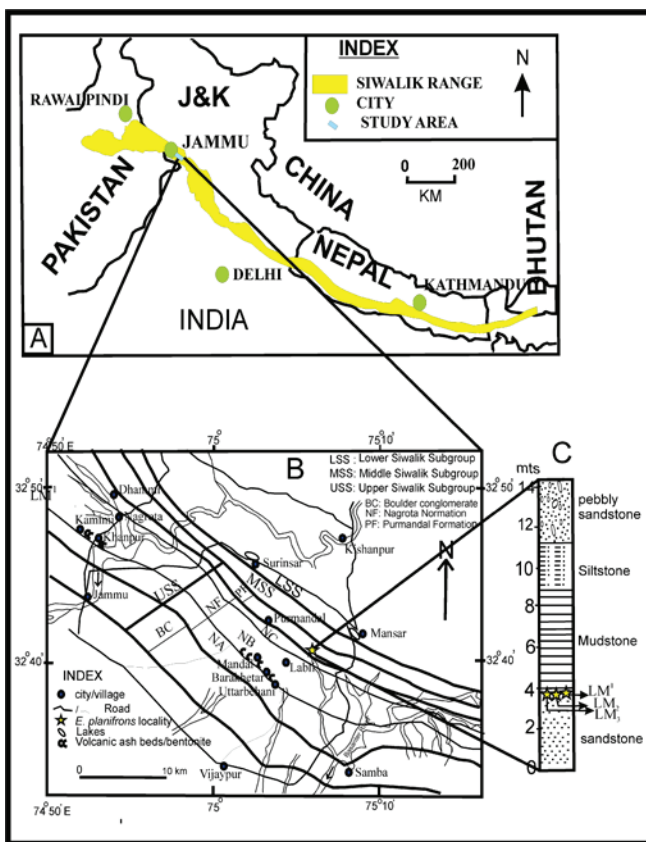


Fig. 1. A. Range of Siwalik hills (modified after H.De Terra and T person, BAMP, G.C. Mahapatra, G. Corvinus) B. Stratigraphic Subdivision of Upper Siwalik Sub group of Jammu and locality of *Elephas* sp. cf. *E. Planifrons* (modified after Bhat *et al.*, 2008). C. Position of *Elephas* sp. cf. *E. planifrons* in the lithocolumn.

On the basis of faunal assemblages, he classified the Siwalik Group into three subdivisions viz. Lower Siwalik Subgroup, Middle Siwalik Subgroup and Upper Siwalik Subgroup. The Lower Siwalik Subgroup was further divided into Kamli and Chinji formations, Middle Siwalik Subgroup into Nagri and Dhok Pathan formations and Upper Siwalik Subgroup into Tatrot, Pinjor and Boulder Conglomerate formations. He also assigned the age to Siwalik Group ranging from Middle Miocene to Middle Pleistocene. The local classification of Jammu Siwalik which borders from east by Ravi River (Punjab) and west by Line Of Control (Pakistan) has been given by various authors (Ranga Rao *et al.*, 1988; Gupta and Verma, 1988; Agarwal *et al.*, 1993; Gupta, 2000). The proposed new lithostratigraphic classification and type sections in the Indian part of the Siwalik Group are given by Elias *et al.* (2017). The lithostratigraphic classification of Siwalik Group is given in Table 1. In this paper we follow the local classification given by Ranga Rao *et al.*, 1988 which is based on vertebrate fossils, lithology and magnetostratigraphy and its equivalent type sections proposed by Geological Survey of India (Eliyas *et al.*, 2017). Ranga Rao *et al.* (1988) classified the Upper Siwalik of Jammu into three formations viz Parmandal Formation (=Tatrot Formation), Nagrota Formation (=Pinjor Formation) and Boulder Conglomerate (Tawi Conglomerate). Stratigraphically, the present specimens were recovered from the Parmandal Formation (= Tatrot/Saketi Formation) of Upper Siwalik Subgroup of Jammu.

## SYSTEMATIC PALAENTOLOGY

Phylum **Chordate**  
 Class **Mammalia**  
 Order **Proboscidea** Illiger, 1811  
 Family **Elephantidae** Gray, 1821  
 Genus ***Elephas*** Linnaeus, 1735

*Elephas* sp. cf. *E. planifrons* Falconer and Cautley, 1845  
 (Pl. I, figs. 1-9)

*Material*: JU/DG/VPL/9003, complete Molar (LM<sub>2</sub>)  
 JU/DG/VPL/9004, complete Molar (LM<sub>3</sub>)  
 JU/DG/VPL/9005, broken Molar (LM<sub>1</sub>)

*Locality*: Stream cutting section, north of Labli village,  
 Samba district, J&K, India

*Horizon*: Parmandal Sandstone (=Tatrot / Saketi Formation)  
*Age*: Late Pliocene-Early Pleistocene

### JU/DG/VPL/9003, LM<sub>2</sub>, Plate I, figs. 1-3

*Dimensions/measurements*: length of molar = 190mm, width of molar=76 mm, length/width ratio of molar = 2.5 mm, number of plates preserved = 9, average length of plates (occlusal) = 60 mm, average width of plates (occlusal) = 13.4 mm, lamellar frequency (LF) = 04, maximum enamel thickness = 4.6, average enamel thickness (ET) of worn plates = 3.64 mm, average cement thickness (CT) between plates = 6.6 mm, average dentine thickness (DT) of worn plates = 4.92 mm, crown length = 180 mm, crown width = 60 mm, maximum crown height = 64 mm, hypsodonty index = 106.66

The molar (JU/DG/VPL/9003) has thick enamel layer, widest in the middle, little bit curved at the posterior end, molar height is even at both ends, weak inclination of plates, valley shape near the base is compressed, worn plates exhibits a strong median expansion in the form of salient loop, thick cement material covers the molar, enamel height above the cement is high, molar roots are broken out, strong anterior and posterior columns appeared in four born plates, the posterior two unworn plates are broken, the placement of folds appeared in the entire length of enamel figure, amplitude of enamel folding is high, the spacing between the enamel folds are tight, lateral side of enamel figure is rounded and are even, the enamel figures are symmetrical in line with long axis of molar. The plate wise description of molar from anterior to posterior is as under:

*Plate first*: The first plate from anterior side is broken and the dental features such as enamel and dentine not identified clearly. The length of plate is 40 mm.

*Plate second*: The enamel of this plate is broken but dentine and cement are well preserved. The length (occlusal from lingual to labial) of this plate is 55 mm and width (anterior to posterior) at occlusal surface is 10.33 mm. The plate consists of two well developed and worn out conelets which they joined laterally to form plate first. This plate shares a common enamel figure i.e. posterior of second plate and the anterior of third plate has a common enamel figure. The average enamel thickness is 3 mm and the average dentine thickness is 5 mm. The plate has no anterior-posterior columns. The shape of the enamel figure of this plate is as rounded loops. The lateral side of enamel figure are rounded and even.

*Plate third*: The anterior enamel of this plate shares common features with the posterior enamel of second plate. The length of plate third is 65 mm and the width is 19.2 mm. The average enamel thickness is 3.5mm and dentine thickness is 10.75 mm. The anterior enamel is broken from anterior but posterior enamel

is completely exposed. The enamel height above the dentine is 4 mm and from cement is 8 mm. The enamel of this plate is broken both from lingual and labial sides. The shape of plate is parallel sided with median loops. The plate has rounded and even lateral sides of enamel figure. The in-contact medial edges of enamel figured of this plate with its anterior and posterior plates are appearing in this specimen. Undulating of folds in the entire length of enamel figure is present in this plate. The plate exhibits low angle of enamel figure and the space between the enamel is tight.

*Plate fourth:* The plate has strong anterior and posterior columns. The enamel height above the dentine is 3 mm. The plate has parallel-sided enamel figure shape with median loop. The lateral sides of enamel figure are broken both lingually and labially but may be rounded as in other plates. The direction of lateral sides of enamel in this plate is even and symmetrical in line with long axis of molar. The plate is strongly connected with third and fifth plate only at the medial edges of enamel figures. The plate has low amplitude of enamel folds and placed in the entire length of enamel figure with undulating. The spacing between enamel folds is tight as in other plates of this molar. The length of the plate fourth is 75 mm and width of the plate is 18.57 mm. The average thickness of enamel figure of this plate is 4 mm and the dentine thickness is 5.5 mm. The average enamel height above the cement is 10 mm from the anterior and 5 mm from the posterior. This plate is responsible for curvature of the molar. The plate is compressed little bit labially and expanded lingually to form convex-concave structure of molar.

*Plate fifth:* The plate is well preserved with enamel characters and is little bit broken towards lingual. The length (occlusal) from lingual to labial of the plate is 75 mm which is equal to plate four (75 mm) and extended towards labial side. The width (anterior-posterior) of plate is 16mm. the enamel thickness is 4mm and dentine thickness is 5.5 mm. The average cement thickness between plates which fix the plate towards anterior i.e. fourth and fifth is 4mm and posterior i.e. fifth and sixth is 6mm. The shape of the enamel figure in this plate is parallel sided with median loop and the enamel figure lateral sides are rounded. The lateral side's direction of the enamel figure is even and the enamel figure is symmetrical in line with long axis of molar. The plate is well connected with plate fourth from anterior and plate sixth from posterior by medial edges of enamel figures. There is an undulating folding of enamel figure with entire length of enamel. High amplitude of enamel with tight spacing between enamel folds is developed in this plate. The plate shows strong median expansion and slanting towards posterior. The dentine at the centre of loop forms an eye shaped structure.

*Plate sixth:* Well developed plate with central loops. The length (occlusal) of this plate is 65 mm and width (anterior-posterior) of plate is 15mm. The average cement thickness between plates fourth and fifth is 6 mm. The enamel thickness of this plate is 4 mm and the dentine thickness is 4.33 mm. The plate has strong anterior and strong posterior columns. The enamel height above the cement is high i.e. 15 mm from anterior and 5 mm from the posterior. The shape of enamel figure is parallel. Rounded lateral sides of enamel figures in this plate

are appeared. The lateral side's direction of enamel figures is even and the enamel figures are showing symmetry with long axis of molar. The medial edge of enamel figure of this plate from anterior is well connected with plate fifth. The plate shows undulated enamel folding and placement of folding in the entire length of enamel with low amplitude. This enamel of plate is slanting towards posterior with low angle. From this towards posterior the curvature of the molar starts towards posterior. The cement towards labial and lingually side which fix this plate is washed out but at the centre the cement is well preserved. The height of the enamel above the dentine is 1mm. The enamel figure and dentine is little bit broken at lingual.

*Plate seventh:* The seventh plate consists of four conelets. The three conelets from lingual side are wearing out and connected one another and fourth conelet which is towards labial side is separated from the three conelets. The enamels of all the conelets are broken from top. Among the three connected conelets, the conelets which is lying towards labial side and centre of the plate is at great height w.r.t. other molar plates. The length of this plate is 65 mm and width of the plate (anterior-posterior, occlusal) is 10.6 mm. The average cement thickness between plate seventh and eighth is 10 mm. The average enamel thickness is 4mm and average dentine thickness is 3.71. From anterior, the maximum height of enamel above the cement is 11 mm and from posterior the height of enamel is same as cement. The enamel above the dentine is about 3 mm. The plate shows separated medial edges of enamel figures. Plate shows irregular enamel folding in the entire length of the enamel. The lateral sides of enamel are rounded and even. The enamel figure shape of this plate has rounded loops. The cement between plates sixth and seventh is washed out from lingually and labially.

*Plate eighth:* Half the enamel of the second plate from anterior (lingual) is broken but towards labial side half of plate is developed. The thickness of cement between plates eighth and ninth is 15 mm towards lingual side and 5mm towards labial side. The length (occlusal) of plate eighth is 50 mm and the width of the plate is 10 mm. The average cement thickness between plates eighth and ninth is 8 mm. The enamel thickness of the plate is 3 mm and dentine thickness is 5 mm. The enamel height above the cement and dentine is 7 mm and 3 mm. No anterior and posterior columns are visible in this plate as the posterior enamel of plate is broken. The sides of enamel figure are even. The posterior enamel of plate shows little bit regular folding and amplitude is low.

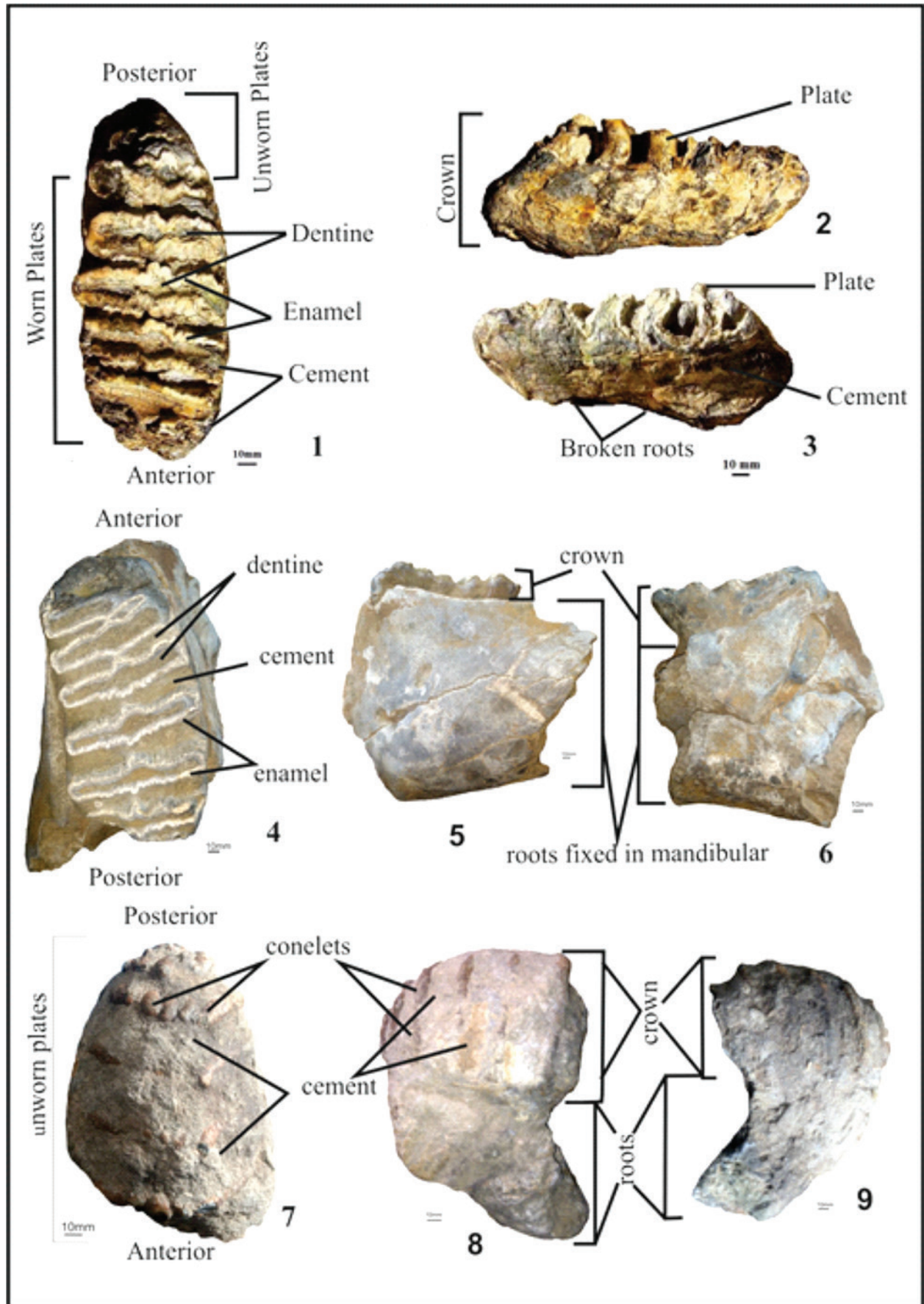
*Plate ninth:* The conelets of plate from anterior side are broken, only dentine and cement are visible, and the enamel of the plate ninth is totally destroyed. The length from lingual to labial of the plate (occlusal) is 45 mm and the maximum width of the plate (anterior-posterior) is 10 mm.

## COMPARSION

The specimen JU/DG/VPL/9003(LM<sub>2</sub>) under study is well compared with the specimens described by Maglio (1973). JU/DG/VPL/9003 is distinguished from various species of *Elephas* by dental morphological characters. JU/DG/VPL/9003 has 09 numbers of plates, whereas *Elephas hysudricus*, *Elephas*

## PLATE I

Figs. 1-9. *Elephas cf. planifrons*: M<sub>2</sub> in occlusal view (1), lateral-labial view (2), lateral-lingual view(3) ; M<sub>3</sub> in occlusal view (4), lateral-labial view (5), lingual-lateral view (6); and M<sub>1</sub> in occlusal view (7), occluso-labial view (8), occluso-lingual view (9).



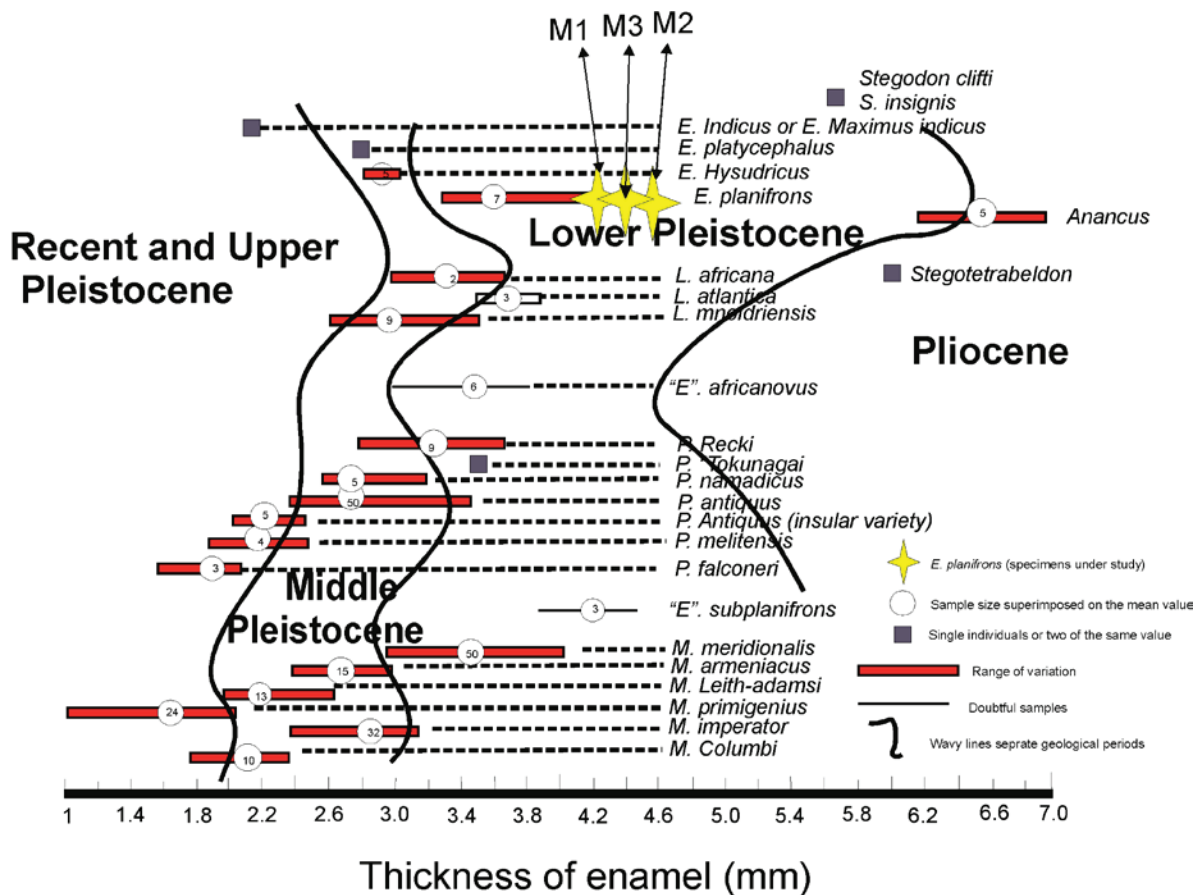


Fig. 2. *Elephas* cf. *Elephas planifrons* (M<sup>1</sup>, M<sub>2</sub>, M<sub>3</sub>, large stars) plotted on chart of Aguirre (1969). Species of Proboscideans showing range of variation of enamel thickness and geological age.

*namadicus*, *Elephas antiquus* and *Elephas subplanifrons* have 10, 9-14, 9-13 and 6 respectively. The length of present molar is 190 mm whereas *Elephas hysudricus* has 190-200mm, *Elephas namadicus* has 242-292 mm, *Elephas antiquus* 185-240 mm and *Elephas subplanifrons* has 85 mm. Similarly the width, height, lamellar frequency, enamel thickness and hypsodonty index of present molar is 76 mm, 85 mm, 4.0, 4.6 mm and 106 mm respectively, whereas *Elephas hysudricus* has 71-76 mm width, 93-97 mm height, 4.9-5.3 lamellar frequency, 2.7-3.1mm enamel thickness and 128-135 hypsodonty index. *Elephas namadicus* has 66-99mm, 119-126mm, 43-68, 1.6-3.0 and 180-188mm respectively and of the *Elephas antiquus* is 185-240mm, 106-193mm, 4.9-6.9, 1.8-2.5mm and 160-234mm. The specimen is also compared with *Elephas subplanifrons* having 06 number of plates which has length 85mm, width 68mm, height 45mm, lamellar frequency 4.6-4.8, enamel thickness 5.0-5.5 and hypsodonty index 67mm. The specimen is also compared with the specimens of *Elephas (A) planifrons* (GSI type No.21098 plate 125, fig.1; GSI type No. 21105, Plate 131 fig. 1a; GSI type No. 21108, Plate 133, fig 1) collected by GSI scientists (Verma et al., 2002) from the Siwalik of Jammu and in other parts of India. The GSI type No.21098 has 9 numbers of straight and parallel plates. The enamel outline is gently folded. Thick coating of cement is present on sides and valleys. Similarly, GSI type No.21105 has 9 plates which are straight. The enamel is thick, crenulated and expanded along the median line. The cement filled the valleys. The GSI type No.21108 has 7 plates;

the folded enamels make a large loop on the anterior side along central axis. The plates directed towards posterior. The specimen (JU/DG/VPL/9003) under study has 09 numbers of plates, thick folded enamel, low crown and cement fill the valleys and median expansion indicate that the compare is favourably with the above said specimens and specimens belongs to *Elephas planifrons*. The specimen well compared with M<sub>2</sub> specimens of *Archidiskodon planifrons* preserved at American Museum (No. 19778, 19870, 19871) collected from India (near Kalka, Siswan, near Chandigarh) by Barnum Brown in 1922. The specimen also compared with the primitive type molar of *Palaeoloxodont (Archidiskodon?) tokunagai junior* (Mastsumoto, 1929) at the Kyoto Imperial University and resembles most of the dental morphological parameters (ridge plates 111/2, length 223mm, breadth 73). Low crowned, thick enamel, widely ridge plates, strong median expansion of lophs, lameller frequency suggests that the present specimen belongs to *Elephas planifrons* and tentatively referred as M<sub>2</sub> of *Elephas* sp. cf. *E. planifrons*.

#### JU/DG/VPL/9004; LM<sub>3</sub>, Plate I, figs. 4-6

*Dimensions/measurements*: length of molar= 158 mm, width of molar=78 mm, length/width ratio of molar=2.02 mm, number of plates preserved=8, average length of plates (occlusal)=66 mm, average width of plates (occlusal)=18mm, lamellar frequency (LF)=4.5, average enamel thickness (ET) of worn plates =4.3 mm, average cement thickness (CT) between plates = 10mm, average dentine thickness (DT) of worn plates =6mm, crown length=158 mm, crown width =78 mm, maximum crown

Table 1. Lithostratigraphic classifications of the Siwalik sequence of Indian and Jammu region.

GROUP	Siwalik Subgroups	Classical subdivisions and type sections in Pakistan (Pilgrim,1934)	Ranga Rao <i>et al.</i> , 1988 (Upper Siwalik classification of Jammu region)	Agarwal <i>et al.</i> , 1993 (Upper Siwalik classification of Jammu region)	Classification and New Proposed Type Sections In Indian Part of Siwalik (Elias <i>et al.</i> , 2017)	Age
SIWALIK	Upper Siwalik Subgroup	Boulder Conglomerate	Tawi Conglomerate		Kalar	Middle Pleistocene
		Pinjor Formation	Nagrota Formation	Nagrota Member A	Pinjor Formation	Lower Pleistocene
				Nagrota Member B		
				Nagrota Member C		
	Tatrot Formation	Parmandal Sandstone		Saketi Formation	Upper Pliocene	
	Middle Siwalik Subgroup	Dhokpathan Formation			Mohargarh Formation	Middle Pliocene
		Nagri Formation			Dewal Formation	Lower Pliocene
	Lower Siwalik Subgroup	Chinji Formation			Nahan Formation	Upper Miocene
		Kamlial Formation			Dodenal Formation	Middle Miocene

height (anterior)=70mm, minimum crown height (posterior)=40 mm, average crown height=55 mm, hypsodonty index =89.74

JU/DG/VPL/9004 is well preserved small and broad in mandibles, the anterior most plate is broken out, the posterior most plate and second anterior most plate broken partially. Enamel figures not much folded. Crown height is approximately equal to maximum crown width, the molar is slanting toward anterior; the plates are thick and widely spaced. The plate wise description of molar from anterior to posterior is as under

*Plate first:* partial broken from labial side, enamel figures and dentine well seen in the form of connected conelets having thickness 2.5 mm and 3 mm respectively. The cement thickness between plates first and second is 5cm.

*Plate second:* well preserved plate and little bit broken from labial side, enamel figures not folded, enamel thickness is 4mm and dentine thickness is 5 mm. at the centre, the enamel figure show median expansion, plate / ridge slanting anteriorly and the maximum cement thickness between plates second and third at middle of plate is 7mm.

*Plate third:* complete well preserved plate with median expansion of enamel figures, 75 mm in length, 14 mm in width at the middle, plate slanting anteriorly, enamel thickness is 5 mm, maximum dentine thickness is 7 mm; the anteriorly enamel figures of plate show little bit folding.

*Plate fourth:* length of plate is 73mm and width of plate is 20 mm. The plate shows well median expansion at the centre. The average enamel thickness is 4 mm and the maximum dentine thickness is 10 mm. In the middle, the enamel figure is very close to the enamel figures of the third and fourth plates.

*Plate fifth:* length of plate is 70mm, width of plate is 18mm, and average enamel thickness 5mm, maximum dentine width is 9 mm. Well exposed median expansion at the middle of plate and the enamel figure meet with enamel figure of the plate sixth posteriorly. Towards anterior the enamel figures does not meet

with fourth plate, the size of plate is less compared with the plate fourth.

*Plate sixth:* enamel thickness is 4mm and dentine thickness is 8mm, in the middle the plate shows excellent median expansion of the enamel figures and connected with the enamel figures of the seventh and eighth plate. The plate slants less towards anterior side as compared to plate fifth.

*Plate seventh:* the anteriorly enamel figure and dentine of the plate are well preserved and the posterior part of the plate is little bit broken out. The length of plate is 60mm and width of plate is 10mm; the enamel figures of the plate are well connected with plate sixth at the middle anteriorly. The posterior enamel is broken out.

*Plate eighth:* completely broken out, only enamel figure is seen at one point having thickness 3.5mm.

## COMPARISON

JU/DG/VPL/9004 (LM<sub>3</sub>) has 8 number of plates, 158mm length, 78mm width, 4.5 lamellar frequency, 4.3 enamel thickness and 89.74 hypsodonty index and is differentiated from *Elephas namadicus* in plate numbers (13-18), enamel thickness (1.8mm-3.4mm), hypsodonty index (145-302), length (232.6mm-339mm) and width (50mm-88mm). The LM<sub>3</sub> is differentiated from the living *Elephas maximus* having 22-27 number of plates, lamellar frequency (5-9), enamel thickness (2.5mm-3mm) and number of enamel folds present. Differentiated from *Elephas hysudricus* having 12 to 17 number of plates, length (354mm-354mm), width (74mm-107mm), enamel thickness (1.8mm-3.5mm) and hypsodonty index (177-182). Similarly the specimen JU/DG/VPL/9004(LM<sub>3</sub>) differentiated from *Elephas hysudricus* having 18-21 number of plates, molar length and width (293mm-316mm, 72mm-82mm), lamellar frequency (6.5), enamel thickness

Table 2. Comparative study of JU/DG/VPL/903-05 with allied species of *Elephas* (described in Maglio, 1973).

Dental characters	<i>Elephas namadicus</i>	<i>Elephas maximus</i>	<i>Elephas hysudricus</i>	<i>Elephas hysudrindicus</i>	<i>Elephas planifrons</i>	JU/DG/VPL/9004, specimen under study
<b>M<sub>3</sub></b>						
Number of plates	13-18	22-27	12-17	18-21	8-13	8
length	232.6-339	270	254-354	293-316	186-321	158
width	50-88	190	74-107	72-82	72-119	78
Lameller frequency	4.4-6.5.0	5.0-9.0	4.1-6.5	6.5	3.2-5.8	4.5
Enamel thickness	1.8-3.4	2.5-3.0	1.8-3.5	2.5-3.0	2.2-5.2	4.3
Hyposdnty index	145-302	211.76	124.3-166	177-182	83.2-115	89.74
<b>M<sub>2</sub></b>						
Number of plates	9-13	-	10	-	9	JU/DG/VPL/9003, specimen under study 9
length	185-240	-	190-211	-	186-321	190
width	53.80	-	71-76	-	96	76
Lameller frequency	4.9-6.9	-	4.9-5.3	-	3.8	4
Enamel thickness	1.8-2.5	-	2.7-3.1	-	4.5	4.6
Hyposdnty index	160-234	-	128.1-135	-	100	106.66
<b>M<sup>1</sup></b>						
Number of plates	9-11	-	9-10	-	6-8	JU/DG/VPL/9005 specimen under study 6+2( broken out)
length	131-179	-	121-180	-	161.9-187	135mm( not exact due to broken molar specimen)
width	31-57	-	52-78	-	78.0-91.2	90mm
Lameller frequency	6.5-8.1	-	5.1-8.2	-	3.2-4.9	5
Enamel thickness	1.5-2.0	-	1.0-2.7	-	3.0-4.8	4mm
Hyposdnty index	230	-	129.6-42.3	-	113-114	89 (not exact due to broken specimen)

(2.5mm-3mm) and hyposodnty index (177-182). The specimen was well compared with specimens of *Elephas (A) planifrons* described by Verma *et al.* (2002) from the Siwalik of Jammu and in other parts of India. GSI type No. 21099 has 10<sup>1/2</sup> plates, enamel thin, crenulated and folded. Enamel expanded along the median line and thick cement surrounds the teeth. Similarly, GSI type No. 21100 also has 10 1/2 plates, thick enamel expanded along the median line and cement covers the entire teeth. The GSI type No. 21102 has 7<sup>1/2</sup> plates, enamel highly crenulated expanded in the middle and thick cement surrounding the tooth. GSI type No. 21103 has 8<sup>1/2</sup> plates, broad teeth and brachydont, highly crenulated enamel expanded along the median line and have thick cement on the sides and vellys. GSI type No. 21107 has 11<sup>1/2</sup> plates, moderately crowned tooth, moderately thick enamel and crenulated, valleys filled with cement. The above described characters of specimens from siwalik resembles with the present specimen indicate that specimen belongs to *Elephas planifrons*. The dental parameters of specimen under study (JU/DG/VPL/9004(LM<sub>3</sub>)) also compare with *Elephas planifrons* (number of plates 8-13, length and width (186mm-321mm,72mm-119mm), lameller frequency 3.2 -5.8, enamel thickness 2.2mm to 5.2mm and hyposodnty index 83.2-182) described in origin and evolution of the Elephantidae (Maglio, 1973) and show close resemblance with *Elephas planifrons* and tentatively referred as M<sub>3</sub> of *Elephas* sp. cf. *Elephas planifrons*.

#### JU/DG/VPL/9005, LM<sup>1</sup>, Plate I, figs. 7-9

*Dimensions/measurements:* length of molar=135 mm, width of molar=90 mm, length/width ratio of molar=1.28

mm, number of plates preserved=6, average length of plates (occlusal)=80 mm, average width of plates (occlusal)=12 mm, lamellar frequency (LF) =5, average enamel thickness (ET) of worn plates =4mm, average cement thickness (CT) between plates = 15 mm, average dentine thickness (DT) of worn plates = not available as there is no completely worn plate, crown length =135 mm, crown width =100 mm, maximum crown height (middle)=80 mm, minimum crown height (posterior)=50 mm, average crown height=65 mm, hypsodonty index =89 ( not actual due to broken molar).

The molar specimen (JU/DG/VPL/9005) has eight plates. The anterior two plates are broken out. All the other plates are completely unworn and consist of the conelets. Roots of the specimen are well preserved. The molar is widest towards anterior and its width decreases towards posterior. Plate first is completely missing in this specimen and posterior part of plate second little is bit seen in the specimen, the anterior part is completely broken out. The third plate consists of five conelets, some of conelets not exposed due to overlying cementing material. The length of plate third is 100 mm and the width is 10 mm. Plate third is separated from plate fourth with a thick cementing material. Only three conelets are seen in the plate fourth. The length of plate fourth is 80mm and width is not observed due to overlying cementing material. The fifth plate is also not exposed due to overlying cementing material. The unworn plate fifth is completely exposed and consists of five conelets. Plate seventh is also consists of five conelets and the last plate eighth one is consists of three conelets and less in size than the conelets of other plates of this specimen.

## COMPARSION

JU/DG/VPL/9005(LM<sup>1</sup>) dental parameters are well compared with the specimens (*Elephas namadicus*, *Elephas hysudricus* and *Elephas planifrons*) described in the origin and evolution of the Elephantidae by Vincent J. Maglio, 1973. The specimen was also compared with the specimens of *Elephas (A) planifrons* described by Verma *et al.* (2002) from the northwest Himalaya. GSI type No. 21106 has 6<sup>1/2</sup> plates, enamel crenulated and expanded along the median line and valleys and sides filled with thick cement, whereas GSI type No.21101 is broad and subhypsodont and have thick cement cover. This specimen (Plate=8, enamel thickness=4, lameller frequency=5, length=135, width=90) also compare with the specimen (Plate=71/2, enamel thickness=3.5-4, lameller frequency=7, length=146, width=69) described by Khan (1962) from Siwalik. The specimen well compared with No.WIF/A (Plate=8, enamel thickness=2.9, lameller frequency=5.4, length=148, width=75) recovered from the Bharoli, Pinjor Formation of siwalik Group. The comparative study shows close affinity with M<sup>1</sup> of *Elephas planifrons* and tentatively referred as M<sup>1</sup> of *Elephas* sp. cf. *Elephas planifrons*.

The comparative study of JU/DG/VPL/9004(LM<sub>3</sub>), JU/DG/VPL/9003(LM2) and JU/DG/VPL/9005(LM<sup>1</sup>) is given in the Table 2.

## AGE OF JU/DG/VPL/9003-05

The specimens (JU/DG/VPL/9003-05) under study plotted on the Aguirre's chart (Aguirre, 1969) to know the age (Fig. 2). As the enamel thickness of the specimen is 4mm, 4.3mm and 4.6mm which falls in the Lower Pleistocene column so the age of specimens under study is Late Pliocene-Early Pleistocene. Earlier *Elephas planifrons* has not been recorded from any Formation older than the Villafranchian which should be included in the Lower Pleistocene as its basal member and not in the Upper Pliocene as regarded by Pilgrim, (1944). The specimen under study recovered from the mudstone-siltstone interface horizon sixty meters below the geochronologically dated (2.48Ma) volcanic ash beds. The oldest record of *Archidikodon planifrons* in India is from the Tatrot Stage and also from Java and China Formations, which can be correlated with the Late Pliocene-Early Pleistocene age. This specimen is also reported first time from the Tatrot formation/Parmandal formation from Jammu Siwalik.

## SIGNIFICANCE

The specimen of *Elephas* sp. cf. *E. planifrons* is of great significance as it is recovered from the new fossil yielding site approximately 60 meter below the geochronologically dated (2.48 m.y.) volcanic ash bed. The specimens under study fall under the *Elephas planifrons* range zone (3.6Ma to 2.48Ma) proposed by Kundal *et al.* (2017). These specimens are useful for biochronological correlation of the various Siwalik rock strata exposed in Pakistan, Nepal and India. *Elephas planifrons* was the transition link between *Stegodon* and the true elephants of India and has thrown light on the lineage and migration. This species earlier reported from Lower Nagrota and Upper Nagrota Formations of Jammu and also reported from the Saketi to Pinjor formations of Himachal Pradesh.

## CONCLUSION

The recovery of *Elephas* sp. cf. *E. planifrons* from the Labli village of Parmandal Sandstone (=Tatrot / Saketi Formation) is the new additional site of fossil elephants. As the specimen recovered from the mudstone horizon about 60 meter below the geochronologically dated volcanic ash beds exposed in the Siwalik of Jammu so its age is not younger than the ash beds. Earlier, *Elephas planifrons* Interval range zone was proposed between 3.6. Ma to 2.6 Ma (Nanda (1997), Now, the upper range of this *Elephas planifrons* Interval range zone has been extended up to 2.48 Ma. (Kundal, 2017). The present specimen under study fall under the *Elephas planifrons* Interval range zone between 3.6Ma to 2.48Ma.

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