During the course of our extensive explorations of the Upper Sivaliks of the area under study, a large number of vertebrate and invertebrate fossil material was collected. For the purposes of the present investigation, sixteen mammalian taxa, including two new species and a new variety, have been studied in great morphological detail.

In general the author has followed the dental terminology used by Osborn (1907). In some cases, the topographic terms have been employed. These terms have been used merely to describe some additional details of the crown having apparently no phylogenetic implications. Unless
otherwise stated, the classification of mammals proposed by Simpson (1945) has been followed.

The fossil specimens described and referred here, are catalogued in the Department of Anthropology, Panjab University, Chandigarh. The detailed descriptions have been attempted of the most complete and well-preserved representative specimens. The descriptions of the referred material have not been attempted to avoid duplication. However, the measurements of the referred specimens have been included in the tables whenever required for the sake of comparison. In the succeeding pages an attempt has been made to describe the aforesaid material in detail.

Order                  Carnivora                  Bowdich, 1821
Suborder               Fissipeda                   Blumenbach, 1791
Superfamily            Feloidea                    Simpson, 1931
Family                 Viverridae                  Gray, 1821

Diagnosis:

Skull usually narrow and long. Auditory bullae formed almost equally by tympanic and entotympanic; auditory unlike in other Feloidea, sometimes not fully ossified (genus Nandinia). Bony auditory meatus moderately long or short. Alisphenoid canal present for the most part.
Canines usually long, pointed often with transverse grooves. Among the premolars only $P_1$ sometimes absent. $M^1$ almost always large and triangular; $M^2$ almost always present. Carnassials usually weakly specialized (except in Cryptoprocta, Fossa and certain other genera); $P^4$ almost always with strong inner process and small metastylar blade; $P^4$ broad and short, no longer than $M^1 + M^2$; $M_1$ almost always lack longitudinal blade and has broad trigonid and long talonid. $M_2$ always present. Extremities as a rule short, tetra- or pentadactyl, plantigrade or semidigitigrade. Humerus with or without entepicondylar foramen, without median epicondylar foramen. Second phalanges with symmetrical or asymmetrical distal ends; third phalanges moderately flattened, with small collar; claws nonretractile or slightly retractile. Upper Eocene or Lower Oligocene to present (Gromova, 1968).

Subfamily Viverrinae Gill, 1872

Diagnosis:

Viverridae with auditory bullae oval or rather conical, broad and truncated, and not everted behind, narrow in front and more or less compressed at the sides; ectotympanic very small and flat; external auditory meatus with scarcely any lower lip, its orifice being close to the tympanic ring; paroccipital process triangular, its apex
projecting slightly beyond the bulla; claws strongly curved and more or less retractile (Pilgrim, 1932).

Genus Vishnuictis Pilgrim, 1932

Diagnosis:

Viverrinae of medium to large size, with elongated, high and narrow skull; contracting gradually but upto considerable distance behind the post-orbital processes, also contracting in front of the post-orbital processes; slender muzzle; sides of face steeply descending from a nasal maxillary ridge; teeth not compressed laterally and with rather blunt cusps; brain case exceptionally narrow; upper molars rather large, relatively broad internally; P3 without an internal cusp; premolar series rather spaced; premolars simple; mandible rather stout but shallow; M1 with relatively long trigonid; relatively short talonid; M2 rather large, oblong (Pilgrim, 1932).

Type species Vishnuictis salmontanus Pilgrim, 1932

Species Vishnuictis choprii sp. nov.

(Pl.8, Figs. A, B, C; Text Fig.26)

Diagnosis:

A medium-sized species of Vishnuictis. Mandible shallow but stout and slender; M1 with trigonid almost double
than talonid and having subequal cusps; obliquely placed cutting blades formed by paraconid and protoconid; talonid low and basin-shaped with a slight development of hypoconulid. **Holotype:** PUA 78/94, a left mandibular fragment with M₁ and roots of P₄ and M₂.

**Horizon:** Pinjor Formation of Upper Śivaliks.

**Locality:** About 0.2 km south-east of Nadah.

**Etymology:** The species has been named after Professor S.R.K. Chopra in recognition of his work on Śivalik mammals.

**Description:**

The mandible under description is shallow but stout and slender. It is deepest below M₁ and reveals the posterior root of P₄ and anterior root of M₂. The horizontal ramus is broken mesial to M₁, retaining portion of the posterior root of P₄ as well, and distal to the anterior root of M₂. The ventral border of the horizontal ramus displays a slight mesio-distal convexity.

M₁ is roughly rectangular in outline and presents an elevated and mesially placed trigonid and a low and distally placed talonid. The trigonid of this molar is nearly double the length of the talonid. Three major cusps, viz., paraconid, protoconid and metaconid, can be demarcated on the trigonid. Paraconid constitutes the anterior part of M₁ and it is separated from the protoconid by a well-developed
carnasial notch. The mesial border of the paraconid is slightly nicked. Protoconid, which projects much higher than the other conids of the molar, is placed buccally and distal to the paraconid. The tip of the protoconid is slightly chipped. The postero-lingual margin of the trigonid is occupied by the metaconid which is slightly damaged.

The major portion of the talonid is formed by a basin-shaped depression, the posterior side of which is bounded by a lingually placed entoconid and a buccally placed hypoconid. The distalmost portion of the talonid shows a slightly developed hypoconulid. Along the buccal margin, the tooth exhibits a faint basal cingulum which commences faintly at the base of the protoconid and gradually becomes more prominent towards the distal end of the tooth. The molar is slightly touched by wear.

Discussion:

The genus Vishnuictis is known mainly by V. durandi, V. chinjiensis, V. salmontanus, and V. hariensis from the Sivalik sediments of India. The other genus of subfamily Viveraeae, Viverra, is represented by V. bakerii from the Upper Sivaliks of India. Because Viverra bakerii and Vishnuictis durandi are known only from the maxillary dental parts, it is difficult to compare them with the present specimen, which is a mandibular fragment. This limitation also prevents a discussion of the affinities of specimen
No. PUA 78/94 with either *Viverra bakerii* or *Vishnuictis durandi*. Nevertheless, the reconstruction of the present specimen, does not fit into the larger skulls of *Viverra bakerii* and *Vishnuictis durandi*.

Prasad (1970) reported two new viverrids, viz., *Viverra nagrii* and *Vishnuictis hariensis*, from the Nagri beds at Haritalyangar. These two forms are different from the present specimen mainly because of their smaller size.

The only form with which the present specimen may be compared to a limited extent is *Vishnuictis salmontanus*. However, the specimen under discussion (PUA 78/94) differs from *Vishnuictis salmontanus* in its slender mandible and greater overall length of M₃. Further, it shows a slightly developed hypoconulid at the distal end of M₃, which is absent in *Vishnuictis salmontanus*. Apart from these differences, a wide age gap separates *V. salmontanus* and the present specimen, the former having been recovered from the Dhokpathan Formation and the latter from Pinjor Formation. Thus, in view of its morphological and matrical differences with other Sivalik viverrids, the present specimen (PUA 78/94) is provisionally assigned to a new species, *Vishnuictis choprii*. Hande (1974, p.82), without providing adequate justifications, suggested that the genus *Vishnuictis* may be considered as a subgenus of *Viverra*. But the author prefers to follow Pilgrim (1932) who presented these two forms as distinct genera.
### Comparative measurements of the M₁ of some Sivalik viverrids

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Viverra(? chinjiensis G.S.I.D214 Pilgrim, 1939, Pl.4, Fig.9)</th>
<th>Vishnuictis salmontanus G.S.I.D 760</th>
<th>Vishnuictis choprii present specimen FUA 78/94</th>
<th>Vishnuictis Zebatha present specimen FUA 78/94</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. mesio-distal dia.</td>
<td>10.00</td>
<td>10.40</td>
<td>12.00</td>
<td>14.30</td>
</tr>
<tr>
<td>Max. bucco-lingual dia.</td>
<td>5.20</td>
<td>6.00</td>
<td>5.30</td>
<td>-</td>
</tr>
<tr>
<td>Index</td>
<td>52.00</td>
<td>57.69</td>
<td>44.16</td>
<td>-</td>
</tr>
<tr>
<td>Depth of ramus below M₁</td>
<td>12.00</td>
<td>13.00</td>
<td>11.10</td>
<td>17.20</td>
</tr>
<tr>
<td>Thickness of ramus at M₁</td>
<td>5.50</td>
<td>6.50</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Text Fig. 26  Left mandibular fragment with M₁ of *Vishnuictis choprii* sp. nov. (x 2)
(A) Occlusal view, (B) Lateral view
Order Proboscidea Illiger, 1811
Suborder Elephantoidea Osborn, 1921
Family Elephantidae Gray, 1821

Diagnosis:

Large animals (except for some dwarf forms). Skull short and high, with its height always greater than length of cranial region. Air cavities very strongly developed. Lower jaw and its symphysial section short; pronounced mental prominence sometimes present. $1^\text{1} O_0 C^\text{0} P^\text{2-0} M^\text{3}$; there are milk pd$_3^3$, taken by some to be P$_2^2$. Only upper tusks present, these being long, almost rounded in cross-section, and either completely without enamel or covered with it only at ends. Cheek teeth with transverse crests or plates and low crowned to very high crowned. From 6 to 30 crests or plates on $M^\text{3}$. Supernumerary tubercles absent. Valleys from moderately broad to very narrow. One to two molars functional at a time. Milk premolars almost never replaced (except in Protelephas planifrons). Lower Pliocene to present (Gromova, 1968).

Subfamily Stegodontinae Osborn, 1918

Diagnosis:

Anterior breadth of the premaxillae smaller than the posterior breadth or slightly greater than the latter; always less than breadth of skull at level of zygomatic
arches. Alveoli of tusks always almost parallel. Tusks without enamel. Cheek teeth with transverse crests, and low to moderately high. From 6-15 crests on \( M_2 \). Central part of crests sometimes lower than one of the lateral parts. Cement poorly to moderately developed, usually present at the bottom of the valleys or partly filling them; it sometimes completely fills the valleys but never covers the lateral walls of the teeth. Valleys broad or moderately broad, and Y-shaped in longitudinal section. Enamel thick (more than 3 mm). Lower Pliocene to Middle Pleistocene (Gromova, 1968).

Genus *Stegodon* Falconer and Cautley, 1847

**Diagnosis:**

Lower incisors absent, upper incisors powerfully developed, without a band of enamel. Molars composed of six to twelve low, roof-shaped, slightly convex, and usually multipapilllose transverse crests, the intermediate valleys being partially filled with cement. In a given jaw, first and second molars as a rule with equal number of crests; teeth of mandible usually exhibit more crests than corresponding upper molars (Zittel, 1925).

Type species *Elephas insignis-ganesa* Falconer and Cautley, 1845.

Species *Stegodon insignis* (Falconer and Cautley), 1845

(Pl.9, Figs. A,B; Text Fig.27).
1845 *Elephas insignis*, Falconer and Cautley, *Fauna Antiqua Sivalensis*, pl. 2, fig. 6; pls. 15-17; pl. 18, figs. 1-6.

1845 *Elephas ganesa*, Falconer and Cautley, *Fauna Antiqua Sivalensis*, pl. 3, fig. 7; pl. 20A, fig. 1-2; pls. 21-23; pl. 24, figs. 1-5; pl. 24A, fig. 1.


1942 *Stegodon insignis* (Falconer and Cautley), Osborn, *Proboscidea*, vol. 2, p. 886, figs. 748-753.


1965 *Stegodon ganesa* (Falconer and Cautley), Chakravarti, *Wadia Commemo.* vol., pp.264-266.

**Diagnosis:**

\[
\begin{align*}
&\text{Mm': } 2\times(5-6), 7, \quad M \times (7-8), (7-8), (9-11) \\
&\text{Ridges of cheek teeth usually rather taller and narrower than in } \text{Stegodon bombifrons, their average number greater, cement more abundant. Third, molar usually narrower posteriorly and enamel frequently thinner (Lydekker, 1866).}
\end{align*}
\]

**Lectotype:** British Museum Number M3015, a cranium with M\textsubscript{3} of both sides.

**Horizon:** Probably Pinjor Formation of Upper Śivaliks.

**Locality:** Śivalik Hills.

**Hypodigm:** A number of specimens referred by Osborn (1942), lying mainly in the British Museum (Natural History), American Museum of Natural History and Indian Museum.

**Horizon:** Upper Śivaliks.

**Localities:** Mainly in the Śivalik Hills.

**Additional Material:** PUA 79/7, a right mandibular half with a complete M\textsubscript{3}.

**Horizon:** Pinjor Formation of Upper Śivaliks.
Locality: about 4 km, east of Mirzapur.

Description:

The specimen under description is the right half of mandible holding a third molar. It preserves the horizontal ramus and a small part of the ascending ramus. The horizontal ramus is narrow mesially and comparatively wide distally. Anterior to the molar, the mandible shows a sharp and crest like diastema which runs obliquely forwards and downwards. A portion of the diastema immediately mesial to the molar is broken. The anterior one third portion of the horizontal ramus is relatively convex on the buccal side and concave on the lingual side. In its distal two third portion, the lingual and buccal sides of the mandible display mesio-distal convexity and concavity, respectively. On the lingual side the mandible is damaged below the first five plates. A broad and gentle ridge commences at the level of the fifth mesial plate on the lingual side of the ramus and becomes indistinguishable at the level of the tenth plate. A small mental foramen can be seen on the buccal side, about 83 mm below the second mesial plate. The inferior side of the mandible shows a contour with a gentle antero-posterior convexity.

The last molar held by the mandible possesses 10 ridges and a posterior talonid. The molar is comparatively narrow at the distal end, and relatively broad at the mesial
end. Out of the first eight plates which show wear, the first six are appreciably worn. The tooth is concave along its buccal margin and convex along the lingual one. The valleys between the ridges of the molar are Y-shaped and are not completely filled with cement. The enamel is thick and bluish grey in colour. The plates show a strongly crimped enamel, especially in the middle of the occlusal surface.

The first plate is slightly broken on the lingual as well as buccal sides. The mesial enamel wall of this plate is completely missing; perhaps it was lost due to heavy wear. The distal enamel border is tightly pressed against the mesial enamel wall of the second plate, thereby completely obliterating the valley between the first and second plates. The enamel of this plate is strongly crimped.

The second plate from the mesial side has acquired a more or less rectangular shape. The lingual enamel of this plate is chipped. The mesial enamel wall of this plate is slightly convex while the distal enamel wall is mildly concave. The buccal and lingual enamel borders of this plate are nearly flat. The plate is relatively more worn in the middle and on the lingual side. Due to excessive wear, the valley between the second and third plates has vanished and the distal enamel border of the second plate is in contact with the mesial enamel border of the third plate.
The third plate is a roughly rectangular enamel body with comparatively flat lingual and buccal sides. The mesial enamel border of this plate is produced forwards in the middle, and is tightly pressed against the distal wall of the preceding plate. The distal enamel wall is almost flat. The valley between the third and fourth plates is also obliterated due to excessive abrasion of the plates.

The fourth plate from the mesial side is more worn in the middle than on the sides. Its mesial enamel wall is convex anteriorly and touches the distal wall of the preceding plate in the middle. The distal wall of this plate is nearly flat. The valley between the fourth and fifth plates is blocked in the middle by the anteriorly convex mesial enamel wall of the fifth plate.

The fifth plate is comparatively less worn than the preceding four plates. Both the mesial and distal enamel walls of this plate are convex. The enamel is more crimped, especially in the centre of the plate. The valley between the fifth and sixth plates is on the whole shallow but deeper on the lateral sides than the middle.

The sixth plates is much less worn than the first five plates. The wear is more prominent in the middle of the plate. The mesial enamel wall of this plate is slightly convex while the distal wall is almost flat. The valley
between the sixth and seventh plate, which is broader on the lingual side, is comparatively deeper and shows little cement.

The seventh plate displays very little wear. The dentine is exposed only in the middle of the plate. The distal enamel wall of the plate is nearly vertical while the mesial wall slopes slightly forwards. The valley between the seventh and eighth plates is comparatively broader and deeper than the preceding valleys. The valley is partly filled with cement.

The eighth plate is only slightly touched by wear. The dentine is not exposed on any of the six conules of the plate. The second lingual conule is the largest and shows signs of apical bifurcation. The first buccal conule is unworn and is divided into two at its summit. The valley between the eighth and ninth plates is broad and is filled with cement.

The ninth plate is constituted by five conules. The second and third lingual conules are the largest and are divided into a small and a large conule at their apex. The first lingual conule is still covered by a thin layer of cement. None of the tubercles shows any sign of wear. The valley between the ninth and tenth plates is the broadest and is completely filled with creamish coloured
The cement filling the valley shows a mildly developed median transverse cleft. On the buccal side the cement is slightly broken.

The tenth plate displays six tubercles. The first buccal tubercle is the smallest and, in height, reaches up to the middle of the second buccal tubercle. The first two lingual tubercles are covered with a thin layer of cement. The valley between the tenth plate and the posterior talonid is comparatively small. The cement that filled the valley is broken.

The posterior talonid has not completely cut the gum. Except a single prominent tubercle, all other tubercles are covered with cement.

Referred material:

PUA 76/28, a partial maxillary second molar with six plates recovered from Pinjor Formation about 1 km northeast of Nadah.

PUA 77/83, fragment of a mandibular molar with three plates recovered from Pinjor Formation about 3.5 km east of Siswan.

PUA 78/86, partial second maxillary right molar with 5 plates recovered from Pinjor Formation about 0.60 km northeast of Siswan.
PUA 78/87, partial second mandibular molar with seven plates recovered from Pinjor Formation about 0.5 km north of Nadah.

Discussion:

The genus *Stegodon* is represented in the Sivalik sediments of India by five species, viz. *S. clifti*, *S. elephantoides*, *S. bombifrons*, *S. insignis* and *S. pinjorensis*. The present specimen can be differentiated from *S. pinjorensis* by its lower ridge formula and also by the lesser height of the ridges above the alveolar rim. It differs from the corresponding molars of *S. clifti*, *S. elephantoides* and *S. bombifrons* in possessing more ridges. It further differs from *S. clifti* by the complete absence of the median longitudinal cleft.

On the basis of skull and teeth, which probably came from the Pinjor Formation, Falconer and Cautley (1846) established two species of *Stegodon*, viz. *S. ganesa* and *S. insignis*. Subsequent workers, including Wadia (1925), Osborn (1942) and Hooijer (1955) considered these two species as the male and female of a single species, and thus synonymous. The differences between their skulls were taken to be sexual ones. In 1965 Chakravarty put forward some dental traits to differentiate between *S. insignis* and *S. ganesa*. According to him these two forms are not the males and females of the same species but on the
contrary are distinct species. He differentiated the molars of *S. ganesa* from those of *S. insignis* by virtue of its thick enamel, narrow transverse valleys and less amount of cement. He contended that, in a vertical section the anterior and posterior borders of enamel ridges were convex in *S. ganesa* and plane in *S. insignis*. Following Wadia (1925) and Hooijer (1955), in the present work the author prefers to consider *S. ganesa* as a synonym of *S. insignis*. The tooth under discussion differs from *S. insignis birmanicus* (Osborn, 1929) in being shorter in length and in having less open ridges. Another subspecies of *S. insignis*, i.e. *S. insignis-ganesa primigenius* was created by Bakr (1966, pp. 94-97, pl. 2) on the basis of a right *M₁*, recovered from Upper Sivaliks of Pabbi Hills, Pakistan. The present specimen can be differentiated from *S. insignis-ganesa primigenius* by the absence of a longitudinal cleavage and curved ridges which characterize this subspecies. In view of its close morphological and metrical similarities with *S. insignis* and its clear differences with other species of Stegodon, the present specimen is assigned to *Stegodon insignis*. 
### Comparative measurements of some species of Stegodon from Upper Śivaliks

<table>
<thead>
<tr>
<th>Measurement</th>
<th>S. bombifrons</th>
<th>S. insignis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Max. mesiodistal dia.</strong></td>
<td>340.00</td>
<td>180.00+</td>
</tr>
<tr>
<td></td>
<td>276.00</td>
<td>297.00</td>
</tr>
<tr>
<td></td>
<td>174.00+</td>
<td>88.00+</td>
</tr>
<tr>
<td></td>
<td>123.00+</td>
<td></td>
</tr>
<tr>
<td><strong>Max. buccolingual dia.</strong></td>
<td>107.00</td>
<td>56.00</td>
</tr>
<tr>
<td></td>
<td>81.00</td>
<td>99.00</td>
</tr>
<tr>
<td></td>
<td>79.00</td>
<td>82.50</td>
</tr>
<tr>
<td></td>
<td>91.00</td>
<td></td>
</tr>
<tr>
<td><strong>Index</strong></td>
<td>0.31</td>
<td>0.33</td>
</tr>
<tr>
<td></td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Max. Height</strong></td>
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<td>50.00</td>
</tr>
<tr>
<td></td>
<td>39.00</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>48.00</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>55.00</td>
</tr>
<tr>
<td><strong>Height breadth index</strong></td>
<td>0.62</td>
<td>0.50</td>
</tr>
<tr>
<td></td>
<td>0.48</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>0.58</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>0.60</td>
</tr>
<tr>
<td><strong>Number of ridges</strong></td>
<td>$\frac{1}{2} - 9 - \frac{1}{2}$</td>
<td>11 $\frac{1}{2}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10 $\frac{1}{2}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3+</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5+</td>
</tr>
<tr>
<td><strong>Lamellar frequency</strong></td>
<td>3.00</td>
<td>5.00</td>
</tr>
<tr>
<td></td>
<td>4.10</td>
<td>3.53</td>
</tr>
<tr>
<td></td>
<td>4.02</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>4.06</td>
</tr>
<tr>
<td><strong>Thickness of enamel</strong></td>
<td>-</td>
<td>5.20</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>4.80</td>
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<td>5.60</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>5.70</td>
</tr>
</tbody>
</table>

* Exact position of the tooth indetermined
Text Fig. 27  Right mandibular half with $M_3$ of *Stegodon insignis* ($\times 1/3$)
Subfamily Elephantinae Gill, 1872

**Diagnosis:**

Anterior breadth of premaxillae always greater than posterior breadth, sometimes exceeding breadth of skull at level of zygomatic arches. Alveoli of tusks sometimes strongly divergent to front. Tusks covered with enamel only at ends. Cheek teeth laminal and moderately to very high. From 10 to 30 plates on $\text{M}_2$. Central part of the plates always the highest. Cement strongly developed, completely filling the valleys and laterally covering the teeth. Valleys moderately broad or narrow, and V-shaped. Enamel thickness variable. Upper Pliocene to present. (Gromova, 1968).

**Genus Archidiskodon** Pohling, 1885

**Diagnosis:**

Trunk relatively short, high. Skull low. Occiput broad (wider than zygomatic breadth). Forehead moderately long, concave. Nasal opening situated far from crown of skull. Premaxillae moderately broad, very slightly broadened toward anterior ends, with maximum breadth less than zygomatic breadth. Depression on dorsal surface of premaxillae narrow and deep. Alveoli of tusks almost parallel. Mental prominence on lower jaw long. Tusks slightly curved and not greatly separated from each other at their point of emergence from the alveoli. Number of plates on $\text{M}_2$ 11-17,
with density of 4-6.5. Enamel thickness 2.5 to 3.5 mm.
Type of abrasion-- or variable. Median sinus often well-
developed. Crown low and broad; many species. Upper Pliocene
to Lower Pleistocene. (Gromova, 1968).

Type species Elephas meridionalis Nasti, 1825
Species Archidiskodon planifrons
(Falconer and Cautley), 1845.
(Pl.10, Figs. A, B; Text Fig.28)

1845 Elephas planifrons, Falconer and Cautley, Fauna
Antiqua Sivalensis, pl.2, fig.5; pl.6, figs. 4-6; pls.9-11;
pl.12, figs.1-12; pl.13A.

1846 Elephas planifrons, Falconer and Cautley, Fauna
Antiqua Sivalensis, pl.14, figs. 8-9, pl.18, fig.7;
pl.18A, figs.1-2.

1868 Elephas (Loxodon) planifrons Falconer and Cautley,
Falconer, Pal. Mem., vol. 1, pp.110-111; 2, 6, 91, 93,
94, 108.

1880 Loxodon planifrons (Falconer and Cautley), Lydekker,

1935 Palaeoloxodon priscus var. bosei, Chakraverti, Proc.

1935 Archidiskodon planifrons (Falconer and Cautley), Colbert,


**Diagnosis:**

Enamel ridges on molars intermediate in height between those of *Stegodon insignis* and *Elephas hysudricus* (*Elephas hysudricus*); when worn crowns present lozenge-shaped cross-sections of ridges, often with detached cylinders of enamel near median line of tooth; enamel of great relative thickness, and much crenulated or crimped in higher portions of ridges, but inferiorly this crimping is absent causing great difference in appearance of crown surface of little-worn and much-worn tooth. Molars readily distinguished from those of *Stegodon* by cement completely filling up intervals between enamel ridges (Lydekker, 1880).
Lectotype: Brit. Mus. No. M3062, M²
Horizon: Pinjor Formation of Upper Śivaliks
Locality: Śivalik Hills.
Additional Material: PUA 78/80, a maxillary third molar.
Horizon: Pinjor Formation of Upper Śivaliks.
Locality: about 0.5 km west of Nadah.

Description:

The specimen under description is a left last maxillary molar. The maximum width of the molar lies in the centre and gradually narrows down towards the distal end. The molar is well worn showing more wear on the buccal side of the occlusal aspect. Eleven plates and a posterior talon are discernible on the occlusal surface, which is slightly concave transversely. The buccal side of the molar is more convex as compared to the lingual one. Except the posterior talon, all the plates show signs of abrasion. The first two plates are badly abraded, especially in their buccal halves, where they have fused with each other. The tooth possesses a moderately high crown. The enamel is thick (3.55 mm), on the whole smooth and greyish-brown in colour. The cement, filling the intervening valleys, displays a creamish tinge. In the mesial one third portion of the molar, the enamel plates slope forwards.

The first plate is partly preserved and displays excessive wear. The valley separating the first and second plates is completely obliterated in the buccal half of the
molar. In the lingual half, the distal enamel wall of the first plate has become continuous with the mesial wall of the second plate. The second plate is chipped on the lateral sides. As a result of attrition, the distal and mesial walls of second and third plates, respectively, have fused with each other thereby closing the intervening valley on the buccal side.

The third plate does not form a complete enamel loop due to the abrasion of the enamel on the buccal side. The plate is slightly folded near the middle of the plate. The valley between the third and fourth plates is broader laterally and comparatively narrow in the middle.

The fourth plate is more complete than the first three plates. On its buccal side the enamel is slightly broken. The mesial enamel wall is convex mesially, while the distal wall is relatively flat. The plate is slightly expanded towards its buccal half. The valley between the fourth and fifth plates is narrow in the middle and wider on the lateral sides.

The fifth plate forms a complete enamel loop and is more worn medially as compared to the lateral sides. The mesial wall is nearly flat. The plate displays an expansion, towards the mesial side, in the middle. The distal enamel wall of this plate shows a couple of small folds, which are much different from the minute plications encountered in
Elephas hysudricus. The valley separating the fifth and sixth plates is narrower in the middle than the previous valley.

The sixth plate is also a complete enamel loop with a median sinus. Both the enamel walls of this plate are slightly folded in the middle. The buccal part of the plate is slightly bent towards the posterior side. The valley between the sixth and seventh plates is very narrow in the middle and on the lingual side.

The seventh plate displays three distinct and unequal portions, the lingual, central and the buccal. These three portions are arranged in such a manner that they give the deceptive appearance of three independent structures. The lingual portion of this plate is the smallest and displays an anterior bending at its lingual margin. Medially, it is attached with the central part which is expanded mesially and distally so that, it nearly touches the preceding and succeeding plates. Transversely, the buccal part of this plate is the longest.

The eighth plate is constituted by three independent lozenge-shaped enamel loops. The lingual one is the smallest and shows a slight distal bending at the lingual margin. The central loop has a slightly undulating enamel and exhibits mesial and distal expansion. The buccal loop is transversely
the longest, and has smooth enamel.

The ninth plate is comparatively less worn and shows three independent enamel figures, out of which the central enamel figure is transversely the longest and displays a slightly folded enamel. The lingual enamel figure is smaller than the buccal one.

The tenth enamel plate shows three distinct enamel figures. The central figure shows mesio-distal expansion and is transversely longer and more complicated than the lateral ones. The lingual enamel figure is not well-worn and is tubercle like. The buccal figure is broken on the buccal side and is more worn than the lingual one.

The eleventh plate shows four conules which are slightly touched by wear. The second conule from the lingual side is the largest.

The posterior talon of the molar is constituted by four relatively small tubercles. Except the second tubercle from the lingual side, the three other tubercles are slightly broken at their tips.

**Referred material:**

PUA 77/106, a partial maxillary third molar with three plates, recovered from Pinjor Formation about 1 km southeast of village Tanda.
PUA 77/102, a partial maxillary molar with four plates recovered from Pinjor Formation about 0.5 km southwest of Tanda.

PUA 76/17, fragment of a right maxillary molar with eight plates recovered from Pinjor Formation about 1 km southwest of Tipparian.

PUA 77/36, fragment of molar recovered from Pinjor Formation about 0.25 km east of Tanda.

PUA 77/106, fragment of maxillary last molar recovered from Pinjor Formation about 1 km northeast of Tanda.

PUA 78/68, fragment of a right mandibular molar with five plates recovered from Pinjor Formation about 1 km northeast of Masol.

Discussion:

The genus Archidiskodon is known from the Upper Sivalik Formation of India by a single species, A. planifrons. The genus Archidiskodon was created by Pohling and was accepted as valid by Osborn (1942), with two species, viz. A. meridionalis and A. planifrons. The species planifrons was however, assigned to a new genus Protelephas by Garutt (1957). A new species, A. gromovi was created for Early Villafranchian forms by Alekseeva and Garutt (1965). Aguirre (1968-69) and Maglio (1973), while carrying out revision of family elephantidae, rejected the genus Archidiskodon and grouped it under Mammuthus. Azzaroli (1973) differed from
Aguirre (1968-69) and Maglio (1973), and retained *Archidiskodon* as a genus separate from *Mammuthus*. The author fully agrees with the views of Azzaroli (1973).

The present specimen PUA 78/80 can be easily distinguished from *Stegodon* by its relatively higher ridges and V-shaped valleys completely filled by cement. The crown height of the present molar is lesser than that of *Elephas hysudricus*. The presence of mid expansion of the plates and thick enamel clearly differentiate the molar under discussion from *Elephas hysudricus*. It further differs from *Elephas hysudricus* in having a comparatively smooth enamel. Although, the central portion of a few plates of the present molar shows some folding of enamel, but this folding is definitely different from the minute and fine plications encountered in *Elephas hysudricus*. The molar under discussion shows a distinct median sinus, which is characteristic of *A. planifrons*. The enamel thickness of the present specimen is 3.55 which falls well within the range of *A. planifrons* when plotted on the chart of Aguirre (1969), that shows the range of variation of enamel thickness.

The lameller frequency of this specimen is slightly higher (Table-10). Nevertheless, it still falls within the range for *Archidiskodon* (4-6.5), as suggested by Gromova (1968). Lameller frequencies upto 6 have been reported by Osborn (1942, p.954) for the third maxillary molars of *A. planifrons*. 
Since the present specimen shows clear morphological and statistical resemblances with *A. planifrons*, it has been assigned to *Archidiskodon planifrons*.
<table>
<thead>
<tr>
<th>Measurement</th>
<th>M3</th>
<th>Exact position undeterminable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PUA 78/80</td>
<td>PUA 77/106</td>
</tr>
<tr>
<td>1 Max. mesio-distal dia.</td>
<td>169.8+</td>
<td>115.5+</td>
</tr>
<tr>
<td>2 Max. bucco-lingual dia.</td>
<td>85.5</td>
<td>107.5</td>
</tr>
<tr>
<td>3 Max. height</td>
<td>73.3</td>
<td>64.0</td>
</tr>
<tr>
<td>4 Number of ridges</td>
<td>11</td>
<td>3.5+</td>
</tr>
<tr>
<td>5 Thickness of enamel</td>
<td>3.5</td>
<td>4.4</td>
</tr>
<tr>
<td>6 Lamellar frequency</td>
<td>6.5</td>
<td>-</td>
</tr>
</tbody>
</table>

Comparative measurements of the teeth of Archidiskodon planifrons.
Text Fig. 28  Left $M^3$ of *Archidiskodon planifrons* (x 1)
Genus *Elephas* Linnaeus, 1758

**Diagnosis:**

Dental formula: \(1.0.0.3\) \(0.0.0.3\) (more rarely \(1.0.2.3\) \(0.0.2.3\)).

Upper incisors without band of enamel. Molars consisting of five to twenty-seven deep, compressed transverse plates, with indented superior margin, intermediate valleys being completely filled with cement, which also covers entire crown of teeth. Plane surface produced through wear. Three milk cheek teeth preceding molars and with somewhat less numerous transverse ridges (Zittel, 1925).

**Type species** *Elephas maximus* Linnaeus

**Species**

*Elephas hysudricus* Falconer and Cautley, 1845

(Pl.11, Figs.A,B; Text Fig.29)

*Elephas hysudricus*, Falconer and Cautley, Fauna *Antiqua Sivalensis*, pl.1, fig.3; pls.4-5; pl.6, figs.1-3; pl.7; pl.8, figs.1, 3-4; pl.12B, fig.4; pl.12C, fig.6; pl.13A, fig.7; pl.13B, fig.7.


1942 Hypselephas hysudricus (Falconer and Cautley), Osborn, Proboscidea, vol.2, p.1340, figs.1198-1203, 1206, 1210-1215.

1955 Elephas hysudricus Falconer and Cautley, Hooijer, Zool. Verhand., no.28, pp.107-110, pl.13, fig.3; pl.14, figs.3-4.


Diagnosis:

Ridge formula, excluding talons, appears to be

\[ M_3 (5-7), (9-11) M (9-12), (10-12), (13-17) \]

\[ M_3 (7-9), (9-11) M (9-12), (12-13), (14-18) \]

Crowns of cheek teeth wide in proportion to length, and ridges usually taller, narrower and more numerous than in *E. meridionalis*, enamel frequently very thin and much plicated, and ridges closely approximated with their worn dentine surface, relatively narrow (Lydekker, 1886).

Lectotype: Second maxillary molar, *Fauna Antiqua Sivalensis*, pl.8, fig.3a.
Horizon: Pinjor Formation
Locality: Sivalik Hills.
Hypodigm: Numerous specimens preserved primarily in the British Museum (Natural History), American Museum of Natural History, Indian Museum, and described by Falconer and Cautley (1845-1846) and Osborn (1942).

Additional Material: PUA 76/16, a right third mandibular molar.

Horizon: Pinjor Formation of Upper Sivaliks.
Locality: About 0.75 km south of Tipparian.

Description:

The specimen (PUA 76/16) under description preserves right $M_3$ and a part of the horizontal ramus of the mandible. The lingual and inferior portions of the horizontal ramus are altogether missing, and only its buccal part is preserved which is attached to the buccal side of the third molar. Anteriorly and posteriorly, the horizontal ramus is broken just in front of the first and behind the thirteenth plates, respectively. The preserved portion of the horizontal ramus displays an oval-shaped mental foramen, about 46 mm below the first plate from the mesial side.

As such, the third molar consists of thirteen plates, behind which the tooth is broken. The shape of the distal end of the molar indicates that it possessed two or three
more plates, distal to the thirteenth plate. The tooth is convex on the lingual side. The maximum width of the molar is observed at the sixth plate, behind which it gradually narrows down towards the distal end. The molar presents a mesio-distally concave occlusal surface. The cement completely fills the valleys. But the cement which once covered the lingual and buccal sides is not preserved, thereby denuding the plates on the lingual side. The individual plates are comparatively narrow. The worn plates display a highly plicated and relatively thin (2.5 mm) enamel. On the whole, the plates lack the median expansion, and the plications they display are very fine. Although, all the ridges exhibit signs of wear, the first eight ridges are comparatively more worn than the last five.

The first plate is broken mesially and only its distal enamel wall is preserved. It is also broken on the lingual and buccal sides. The valley between the first and second plates is relatively narrow and is completely filled with cement.

The second plate is chipped on the lingual side. Both the mesial and distal enamel walls of this plate are flat. The enamel displays fine plications which are more prominent in the middle of the plate. The valley between the second and third plates is narrow.

The third plate is nicked on the lingual side. The
mesial enamel wall of this plate is flat and the distal wall shows a mild convexity towards the posterior side. The enamel plications of this plate are comparatively more pronounced than the first two plates. The valley between the third and fourth plates is relatively broad.

The fourth plate forms a complete enamel loop and its mesial and distal enamel walls are slightly curved backwards. The enamel plications are much stronger in the middle of the plate than the sides. The valley separating the fourth and fifth plates is broader than the preceding valley. It is relatively narrow in the middle due to the backward projection of an enamel plication of the distal wall of the fourth plate.

The lingual and buccal sides of the fifth plate are slightly chipped. Its buccal half exhibits a slight bending towards the distal side. The lingual one fourth portion of this plate is directed slightly mesially. The plications of the enamel are stronger in the middle than on the sides. The valley setting apart the fifth and sixth plates has narrowed down in the middle as a result of the backward projection of a couple of enamel folds of the distal wall of the fifth plate.

The sixth plate is comparatively less worn than the first five plates. It displays two distinct enamel figures. The buccal enamel figure is smaller than the lingual one, the lingual end of which is forwardly directed. Alike the fifth plate, the enamel plications of this plate are also
stronger in the middle. The valley intervening the sixth and seventh plates is wider on the lingual side. In the middle of the occlusal surface, a couple of strong crimps of the distal wall of this plate project backwards, thereby reducing the width of the valley.

Similar to the sixth plate, the seventh plate also presents two enamel bodies. The buccal enamel body is much smaller than the lingual one, which shows a forward bending near its relatively less plicated lingual end. The valley between the seventh and eighth plates is narrow in the middle due to the distal extrusion of the enamel crimps of the seventh plate. This valley is broader in the buccal half of the occlusal surface.

The eighth plate presents three enamel figures. The central enamel figure is the widest and shows strongly plicated enamel. The buccal enamel figure is slightly larger, than the lingual one. Both the lingual and buccal enamel figures are slightly forwardly directed. The valley separating the eighth and ninth plates is similar to the previous valley except that the cement in the middle of the plate is broken.

The ninth plate is constituted by three enamel bodies which are separate from each other. The mesial enamel wall of the central body, which is largest, is chipped. The lingual enamel body is fractured in the middle and a part of
its dentine is chipped. The enamel of this plate is comparatively less plicated. The valley between the ninth and tenth plates is narrower than the preceding valley and it is more open on its lingual side.

The tenth plate is much less worn than the first nine plates and it exhibits four distinct enamel figures. The two enamel figures in the middle possess slightly folded enamel and show more wear than the two figures flanking them. There is not much variation in size of these enamel bodies. The valley between the tenth and eleventh plates is narrow and comparatively shallow. The lingual side of the valley is more open than the buccal side.

The eleventh plate is comprised of six unequal tubercles. The two lingual tubercles are unworn while the remaining four are slightly touched by wear. The two central tubercles are the largest. The third lingual tubercle tends to bifurcate. The valley between the eleventh and twelfth plates is narrow and very shallow.

The twelfth plate is represented by six tubercles. There is little wear on them and they have not fused with each other to form a plate. The second tubercle from the buccal side is the smallest while the third from the buccal side is the largest and slightly folded. The first two lingual tubercles of this plate are completely unworn. The valley between the twelfth and thirteenth plates is narrow and is completely
filled with cement which is almost reaching up to the summit of the tubercles.

Like the previous two plates the thirteenth plate is also constituted by six tubercles. Except the third tubercle from the lingual side, which is the largest, other tubercles are unworn. The first lingual tubercle is covered with cement and it does not reach up to the complete height of the plate. The third tubercle from the lingual side is the smallest and it is closely attached with the second lingual tubercle. The molar is broken behind this plate. From the shape of the distal end of the molar it appears that it possessed two or three plates more, behind the thirteenth plate.

Referred material:

PUA 76/18, left maxillary second molar with 8 plates recovered from Pinjor Formation about 1 km north of Tipparian.

PUA 77/100, left deciduous last molar with 8 plates recovered from Pinjor Formation about 1 km northeast of Tanda.

PUA 77/101, partial left maxillary third molar with 10 plates recovered from 0.5 km northwest of Tanda.

PUA 77/104, badly weathered left maxillary molar fragment with 3 plates recovered from 0.25 km northeast of Tipparian.

Discussion:

The genus *Elephas* is represented by a single species, *Elephas bhsudricus* in the Indian Sivaliks. The present
specimen PUA 76/16, which shows close morphological and metrical similarities with this form, has been assigned to *Elephas hysudricus*. The specimen under discussion is marked by strong plications of the enamel and possess thin enamel (2.6 mm). It can be clearly differentiated from Archidiskodon planifrons by the absence of a median sinus in the plates, which is a characteristic feature of the latter. It further differs from *A. planifrons* by the presence of thin and strongly crimped enamel. In *A. planifrons* the enamel is comparatively thick and free from crimps. Besides this, the lamellar frequency of the present molar is more than the corresponding molars of *A. planifrons*. In 1969 Aguirre published a chart showing the plots of the enamel thickness of various forms of elephants. When plotted on Aguirre's chart, the enamel thickness of the present specimen falls well within the range of *E. hysudricus*.

There are some doubtful and unauthentic reports of the occurrence of the living species *E. maximus* in the Upper Śivaliks, based on very fragmentary and meagre material. Karir *et al.* (1975) described a molar fragment with three plates from the Upper Śivaliks east of Chandigarh. They referred the specimen to *E. maximus*. From the published plate of the specimen (pl.1, figs.1 & 2), it appears that the specimen possessed thick and comparatively less crimped enamel. In the thickness of enamel the specimen nowhere comes near
the range of *E. maximus*. Since it lacks the median expansion of the plates and possesses slightly plicated enamel, the author prefers to put it under *Elephas hysudricus*. 
Measurements of some *Elephas bshudricus* specimens collected from the area under study

<table>
<thead>
<tr>
<th>Measurement</th>
<th>PUA 76/16 (m₃)</th>
<th>PUA 77/101 (m³)</th>
<th>PUA 76/18 (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Max. mesio-distal dia.</td>
<td>192.0+</td>
<td>153.0+</td>
<td>97.0+</td>
</tr>
<tr>
<td>2. Max. bucco-lingual dia.</td>
<td>77.0</td>
<td>76.00</td>
<td>82.5</td>
</tr>
<tr>
<td>3. Number of ridges</td>
<td>13+</td>
<td>10+</td>
<td>5+</td>
</tr>
<tr>
<td>4. Thickness of enamel</td>
<td>2.6</td>
<td>2.4</td>
<td>2.8</td>
</tr>
<tr>
<td>5. Lamellar frequency</td>
<td>7.0</td>
<td>7.2</td>
<td>6.8</td>
</tr>
<tr>
<td>6. Max. Height</td>
<td>97.5</td>
<td>107.5</td>
<td>-</td>
</tr>
</tbody>
</table>
Text Fig. 29  Right $M_3$ of *Elephas hysudricus* (x $\frac{1}{2}$)
Order: Perissodactyla  
Suborder: Hippomorpha  
Superfamily: Equoidea  
Family: Equidae

Diagnosis:

\[ \frac{\frac{3}{2}}{2} \text{ C} \frac{1}{2} \frac{4}{4} - \frac{3}{3} \text{ M}_2. \]

Full number of incisors. Canines almost always small, sometimes absent. Crowns of cheek teeth progressively higher, and very high in late forms. Premolars (except P_4) completely molarized, except in the earliest forms; P_4 simple, and in the latest forms absent. Upper molars, except in the earliest forms, with crests; a longitudinal ectoloph, both its parts arcuately curved, and transverse proto- and metaloph; in later forms the latter partly assume a longitudinal direction and enamel folds develop on them; at higher stages they are reduced to marks. On lower molars metaconid progressively enlarged, metastylid is at point of junction of both lophids, and entoconid is large. Extremities progressively lengthened, especially the manus and pes; in early forms manus tetradactyl and pes tridactyl, in later ones all extremities tridactyl to monodactyl; unguligrade. Lateral digits progressively reduced in size until they disappear. Distal phalanges of middle digit short and hoof-shaped. Body, light and slender, except in earliest forms. Lower Eocene to present (Gromova, 1968).
Subfamily Equiane Steinmann et Doderlein, 1890

Diagnosis:

Orbit posteriorly delimited by a bony ring. On the incisors, although only on the upper ones, more or less developed marks are present, which in later forms are borne by all incisors. The permanent cheek teeth have moderately high and high crowns progressively growing higher, with height at least as great as or considerably greater than length; covered with cement deposited in the marks and small valleys as well; minute enamel folds present, sometimes in very large numbers. Premolars large and all except P₁ fully molarized; p₁ small, less than half the length of P₂. In upper cheek teeth protoloph and metaloph join ectoloph even at early stages of wear; both marks as a rule become closed (sometimes open in P₂). Protocone pinched off or completely separate from protoloph, and oval, with its major axis parallel to the axis of the tooth. Tubercles in lower cheek teeth fused into two crescents the ends of which are connected in the middle of the tooth; metaconid and metastylid completely fused, with their common column more or less elongated along the axis of the tooth, divided internally by a groove and on the occlusal surface by a notch, and in later forms having the form of a double loop. Ulna greatly narrowed, sometimes medially interrupted and completely fused with the radius; fibula very narrow, sometimes appearing only as proximal and distal rudiments; fused distally with the tibia. Lateral metacarpals,
metatarsals and digits shortened, greatly narrowed, and
displaced back with respect to middle digits; distal ends
of metacarpals and metatarsals backwardly geniculate; lateral
hoof-bearing phalanges laterally compressed, without
supporting plantar surface; in late forms lateral metacarpals
and metatarsals greatly shortened and downwardly pointed
(transformed into "splint bones"), with lateral digits absent
or in form of nonfunctional granular rudiments. Middle
Miocene to Present (Gromova, 1968).

Genus Equus Linnaeus, 1758.

Diagnosis:

Skull with or without rudimentary antorbital fossae;
facial region as a rule lower than in Hipparion; longitudinal
crest at least of cranial region lacking or low; fossae above
occipital condyles poorly developed; fossa on occiput for
nuchal ligament small; sagittal crest lacking; bony auditory
meatus variable in length and direction. Coronoid process of
lower jaw lower than in Hipparion; ascending ramus inclined
backwards; swelling anterior to mental foramina not pronounced.
Degree of development of the small cup on the lower incisors
variable; canines as a rule absent in females. Cheek teeth
high crowned; upper ones always have protocone connected to
the protoloph and are with or without a few enamel folds; lower
cheek teeth with well-developed double loop, almost always
lack parastylid, have anterior valley, the posterior outer horn
of which is considerably longer than the anterior horn, and have bipartite posterior lobe on $M_2$; depth of outer valley on molars variable; ectostyloid almost always lacking on milk teeth. Extremities straighter than in Hipparion; ulna often interrupted in the middle; all extremities monodactyl, and lack lateral digits; the rudiments of lateral metacarpals and metatarsals are greatly shortened and downwardly pointed ("splint bones"); the median metacarpals and metatarsals bear traces of contact with the lateral ones along no more than 2/3 of their length; there is no rudiment of a fifth metacarpal; hooved phalanges without a slitlike notch along the anterior margin. Upper Pliocene to present (Gromova, 1968).

**Type species** *Equus caballus* Linnaeus, 1758

**Species**

*Equus sivalensis* Falconer and Cautley, 1849

(Fig. A-F; PI.12, Figs.A-F; PI.13, Figs.A-C; Text Figs.30,31)

1849 *Equus sivalensis*, Falconer and Cautley, *Fauna Antiqua Sivalensis*, pl.81, figs.1-4; pl.82, figs.1-6, pl.84, figs.1-4, pl.85.

1848 *Equus namadicus*, Falconer and Cautley, *Fauna Antiqua Sivalensis*, pl.81, figs.5-7; pl.82, figs.1-6.

1849 *Equus palaeonous*, Falconer and Cautley *Fauna Antiqua Sivalensis*, pl.82, figs.9-11.


1869 *Equus palaeonous* Falconer and Cautley, Falconer, Pal. Mem.,
Diagnosis:

Protocone of premolars small, never longer than $M^2$. This distinguishes it from *E. caballus*; resembles *E. hemionus*, but larger in size and $P^1$ less reduced. Distinct trace of preorbital fossa. Muzzle shorter than in *E. caballus*, jaw deeper, approaching *E. hemionus*, Limbs and feet relatively slender (Matthew, 1929).
Horizon: Pinjor Formation of Upper Śivaliks.
Locality: Śivalik Hills.

Cotypes:
Brit. Mus. Nos. 16227, posterior part of a cranium; M2666, a left maxilla; M2698, a premaxilla and symphysis; 22107, portion of a right ramus; 22108 portion of a mandible; M2667, premaxilla with incisors; 16171, a left maxilla; Amer. Mus. No. 19806, portion of left and right maxillae.

Horizon: All these specimens are from Pinjor Formation.
Locality: Śivalik Hills.

Additional Material: Specimen numbers PUA 77/53, a right maxillary molar probably M\(^1\); PUA 77/59, a left maxillary M\(^3\); PUA 79/9, a right mandibular fragment with P\(_2\)-M\(_1\); and PUA 78/65, a well preserved mandible of a juvenile with a complete set of deciduous cheek teeth.

Horizon: Pinjor Formation of Upper Śivaliks.
Locality: PUA 77/53, about 0.25 km east of Tanda. PUA 77/59, about 0.25 km northwest of Nadah. PUA 79/9, about 2.5 km northeast of Siswan. PUA 78/65, about 1.5 km north of Tanda.

Description:
PUA 77/53 (M\(^1\)):

The present specimen is hypsodont and nearly squarish in outline. The buccal side of the tooth is slightly convex and the lingual concave in the vertical plane. The occlusal
surface of the molar exhibits mesio-buccal paracone and disto-buccal metacone, which are fused together to form a continuous ectoloph. One the buccal side, the tooth shows three styles which run down the entire height of the crown. The mesio-buccal parastyle is more prominent than the medio-buccal and the disto-buccal styles. Metastyle is slightly developed. The mesio-lingual aspect of the molar is occupied by the protocone which is joined with paracone through protoloph. Along the distal margin of the molar, the metaloph joins the metacone with the disto-lingual hypocone. The medio-lingual part of the molar is occupied by a slightly elongated protocone. The paracone and protocone are set apart by prefossette, in the mesial half of the molar. The distal half of the molar displays a postfossette placed between metacone and hypocone. Both the pre- and postfossettes display a highly plicated inner enamel border. The outer borders of each of these cement filled fossettes exhibit a strong pli. There is a moderately deep pit in the centre of these fossettes. This moderately thick enameled tooth exhibits medium wear.

PUA 77/59 (M3)

It is roughly triangular in outline with the apex of the triangle placed distally. In its basic crown morphology it is similar to the previous tooth. However, its mesial half is considerably smaller than the distal one. The protocone is comparatively elongated and more compressed bucco-lingually. The centre of the hypocone displays an oval-shaped enamel
island. The metastyle is much stronger than the parastyle and mesostyle. The enamel of this tooth is thicker and it is more worn than the preceding specimen.

PUA 79/9 (mandibular fragment)

The mandibular fragment of the right side, under description, is deep and robust. The depth and the thickness of the ramus gradually increase from the mesial to the distal end. It preserves P₂ to M₁. Mesially, the horizontal ramus is broken mesial to second premolar. On the distal side only mesial portion of the second molar is intact.

P₂:

The second premolar is roughly triangular in outline with the apex directed mesially. The tooth crown displays four major conids, viz. mesio-buccal protoconid, disto-buccal hypoconid, medio-lingual metaconid and disto-lingual entoconid. The mesial part of the tooth is occupied by a well-developed parastylid which is damaged mesially. Metaconid, parastylid and protoconid enclose a comparatively small cement filled metaflexid which is connected lingually to a narrow opening between parastylid and metaconid. The enamel borders of the metaflexid are not cremulated. Distal to the metaconid, the lingual side of the tooth displays a comparatively larger metastylid, which is connected to metaconid by a narrow metaisthamus. A narrow and V-shaped lingual depression can be distinguished on the lingual side between metaconid and
metastyld. A similar but relatively shallow buccal depression is discernible on the buccal side between protoconid and hypoconid.

The distal half of the molar displays an elongated and bucco-lingually compressed entoflexid which is surrounded by metastyld, hypoconid and entoconid. The entoflexid is more elongated than metaflexid and its buccal border is comparatively more plicated. The buccal border of entoflexid shows a broad and shallow fold in the middle, which gives a bilobed appearance to it. The entoflexid opens on the lingual side in between metastyld and entoconid through a narrow opening. The disto-lingual border of the tooth is occupied by the entoconid which is connected to a narrow and bucco-lingually elongated hypoconulid forming the distal border of the tooth. The enamel is greyish brown in colour and moderately thick. The premolar exhibits moderate wear.

P₃:

It is rectangular in outline and is the largest tooth of the molar and premolar series. In its basic morphology this tooth is similar to P₂ except that it is rectangular in shape and its buccal depression is deeper and broader. The metaconid is larger than that in P₂. The parastyld in this premolar is smaller than that in the preceding tooth. The metaflexid and entoflexid are larger than those in P₂.
P₄;

This tooth resembles P₃ in its basic crown morphology. It is slightly smaller than P₃ and the enamel folds of the distal border of entoflexid are more prominent than those in P₃.

M₄:

The first molar is similar to P₄ in the morphological details of its crown. It is slightly smaller than P₄ in its overall size. The metaflexid and entoflexid are smaller than those in P₄ and their enamel borders comparatively smooth. The hypoconulid is comparatively smaller than that in P₄.

A small part of M₂ showing parastylid, metaflexid, metaconid and a very small part of protoconid, is attached to the distal end of M₁.

PUA 78/65

(Two mandibular halves of a juvenile individual with a complete set of deciduous cheek teeth)

The milk cheek teeth resemble in their basic morphology with those in PUA 79/9 except that they are longer and narrower. The first deciduous molar (dm₂) differs from the cheek teeth of PUA 79/9 in having a small metaconulid on the lingual side near the opening of the metaflexid. The milk teeth also differ from the permanent cheek teeth of PUA 79/9 in having a comparatively thin and light coloured enamel.

Referred material:

PUA 76/7, a right M₂ recovered from Pinjor Formation about 1.5 km southeast of Mirzapur Rest House.
PUA 76/8, a left P4 recovered from Pinjor Formation about 1 km northeast of Mirzapur Rest House.

PUA 77/34, distal end of a left metapodial recovered from the Pinjor Formation about 1.5 km northeast of Tanda.

PUA 77/58, an isolated left dm2 recover from Pinjor Formation about 0.75 km north of Nadah.

PUA 77/61, a partial maxillary cheek tooth recovered from Pinjor Formation about 0.75 km north of Siswan.

PUA 77/62, an isolated left upper cheek tooth recovered from Pinjor Formation about 0.25 km southeast of Nadah.

PUA 77/63, a fragmentary maxillary cheek tooth recovered from Pinjor Formation about 1 km southeast of Mirzapur.

PUA 77/64, an isolated left M1 recovered from Pinjor Formation about 0.25 km southeast of Nadah.

PUA 77/65, an isolated right M3 recovered from Pinjor Formation about 0.75 km northwest of Naipli.

PUA 77/81, an isolated left maxillary cheek tooth recovered from Pinjor Formation about 0.3 km south of Tipparian.

PUA 77/92, an isolated left M1 recovered from Pinjor Formation about 0.5 km south-east of Tanda.

PUA 77/111, right tibial tarsal bone recovered from Pinjor Formation about 1.5 km northeast of Tanda.
PUA 78/21, a left mandibular fragment with $P_2$ and a broken $P_3$ recovered from Pinjor Formation about 3.5 km northeast of Mirzapur.

PUA 78/33, an isolated left mandibular cheek tooth recovered from Pinjor Formation about 0.5 km southwest of Tipparian.

PUA 78/56, a portion of a mandibular symphysis with roots of incisors recovered from Pinjor Formation about 1.25 km northeast of Tanda.

PUA 78/81, an isolated right mandibular cheek tooth recovered from Pinjor Formation about 0.25 km south of Tipparian.

PUA 78/83, distal end of a right metapodial recovered from Pinjor Formation about 0.5 km northwest of Tanda.

Discussion:

Falconer and Cautley (1849) in their 'Fauna Antique Sivalensis' recognized two species of fossil horse, viz. *Equus sivalensis* and *Equus namadicus*. Later on, Hopwood (1936) created a third species of *Equus*, *E. cautleyi*, on the basis of two large mandibular rami (Brit. Mus. No. 23107 and Amer. Mus. No. 19884), Matthew (1929), Colbert (1935) and Hooijer (1949) doubted the validity of *E. namadicus*, also known from the Middle and Upper Pleistocene of Narbada valley, and considered it to be synonymous with *E. sivalensis*. Colbert (1935, p. 162) further asserted that *E. namadicus*, due to its younger geological age, may possibly be a progressive *Equus*. Azzaroli
(1966) assigned *E. namadicus* and *E. sivalensis* to the subgenus *Hippotigris*.

*E. cautleyi* was created by Hopwood (1936) simply due to the larger size of the mandibular ramii. Khan (1961) also supported the presence of *E. cautleyi* in Sivaliks. Table-13 shows that the metric differences between the ramii of *E. sivalensis* and *E. cautleyi* are not considerable and they fall well within the range of variation of a species. Moreover, variation in size alone is not a sufficient ground for the creation of a separate species; it must be substantiated by clear cut differences in the morphology (Howe, 1970). Since the specimens referred to as *E. cautleyi* by Hopwood (1936) are morphologically similar to the mandibular ramii of *E. sivalensis*, *E. cautleyi* is considered here synonymous with *E. sivalensis*. The differences in size may be attributed to age or sex differences. Badam and Tewari (1974) also subscribe to this view.

There are different views regarding the affinities of *E. sivalensis*. It was considered to be caballine by Schwartz (1922, 1927) and Hopwood (1936). Khan (1961), Azzaroli (1966), and Badam and Tewari (1974) on the other hand, stress the zebrine affinities of *E. sivalensis*, a proposition which to the present author appears more convincing than the previous one.

The present specimens show morphological details characteristic of *Equus sivalensis*. In their metrical details also, they fall well within the range of *E. sivalensis*. Hence, they have been referred to *Equus sivalensis*. 
### Comparative Measurements of the Maxillary Dentition of Equus sivalensis

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</thead>
<tbody>
<tr>
<td>Max. bucco-lingual dia.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.96</td>
<td>0.69</td>
<td>0.14</td>
<td>1.02</td>
<td>0.00</td>
<td>0.00</td>
<td>0.30</td>
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</tbody>
</table>

**Index**

Max. bucco-lingual dia. of M1
Max. bucco-lingual dia. of M2
Max. bucco-lingual dia. of P4
Max. bucco-lingual dia. of P3
Max. bucco-lingual dia. of p2
Max. bucco-lingual dia. of p3
Max. bucco-lingual dia. of p4
Max. bucco-lingual dia. of P1
Max. bucco-lingual dia. of P2
Max. bucco-lingual dia. of P3
Max. bucco-lingual dia. of P4
Max. bucco-lingual dia. of p1
Max. bucco-lingual dia. of p2
Max. bucco-lingual dia. of p3
Max. bucco-lingual dia. of p4
Max. mesio-distal dia. of M1
Max. mesio-distal dia. of M2
Max. mesio-distal dia. of P4
Max. mesio-distal dia. of P3
Max. mesio-distal dia. of p2
Max. mesio-distal dia. of p3
Max. mesio-distal dia. of p4
Max. mesio-distal dia. of P1
Max. mesio-distal dia. of P2
Max. mesio-distal dia. of P3
Max. mesio-distal dia. of P4
Max. mesio-distal dia. of p1
Max. mesio-distal dia. of p2
Max. mesio-distal dia. of p3
Max. mesio-distal dia. of p4

**Present Collection**

**Lydekker, 1882**

1273

**Max. mesio-distal dia. of the posterior dentition of Equus sivalensis.**

**Table**
**TABLE**

Comparative Table of Mandibular Teeth of Vivid Slavestes

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Present Collection</th>
<th>Original Collection</th>
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<tbody>
<tr>
<td>Max. buccal-lingual dia. of P4</td>
<td>25.50 18.50 0.72</td>
<td>18.00 10.00 0.42</td>
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<tr>
<td>Max. buccal-lingual dia. of P1</td>
<td>35.00 15.00 0.62</td>
<td>18.50 10.00 0.49</td>
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<tr>
<td>Max. buccal-lingual dia. of M3</td>
<td>30.00 0.49</td>
<td>18.50 0.42</td>
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<tr>
<td>Max. mesio-distal dia. of P4</td>
<td>15.00 0.54</td>
<td>18.50 0.42</td>
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<tr>
<td>Max. mesio-distal dia. of P1</td>
<td>15.00 0.54</td>
<td>18.50 0.42</td>
</tr>
</tbody>
</table>

**Note:**

- Present Collection
- Original Collection
Text Fig. 30  Equus sivalensis (x1)

A. $M^1$ (a, occlusal view; b, buccal view; c, lingual view)

B. $M^3$ (a, occlusal view; b, buccal view; c, lingual view)
Text Fig. 31 Occlusal aspect of a right mandibular fragment with P₂-M₁ of *Equus sivalensis* (x 1)
Variety **Equus sivalensis minor** var. nov.
(Pl. 14, Figs. A-F; Text. Fig. 33)

**Diagnosis:**
A smaller and comparatively slender variety of *Equus sivalensis*. Upper molar smaller in size with comparatively thin enamel; borders of fossettes relatively simple; protocone comparatively broad bucco-lingually. Lower molars small and narrow with comparatively thin enamel.

**Holotype:** PUA 77/3, a right M1.

**Horizon:** Pinjor Formation of Upper Sivaliks.

**Locality:** About 3.0 km northeast of Mirzapur.

**Paratype:** PUA 78/23, a left M3.

**Horizon:** Pinjor Formation of Upper Sivaliks.

**Locality:** About 3.5 km northeast of Mirzapur.

**Etymology:** The variety has been so named, due to its much smaller size and slender nature.

**Description:**
PUA 77/3 (M1)

Present molar is roughly squarish in outline. On its buccal side, a mesio-buccal paracone and disto-buccal metacone can be distinguished. Due to wear the paracone and metacone have fused to form a continuous ectoloph which runs along the buccal margin of the molar. The buccal border of the tooth exhibits three styles, viz. mesio-buccal parastyle, medio-buccal mesostyle and disto-buccal metastyle. The mesostyle
is the most prominent style and the metastyle is only slightly developed. Protocone occupies the medio-lingual portion of the molar and is broad and pinched from the rest of the tooth. It is continuous with protoconule which is present on the mesio-lingual side of the crown. The disto-lingual hypocone is slightly broken. The mesial half of the molar shows a pre-fossette between paracone and protoconule. In the distal half of the tooth, a post-fossette is placed between metacone and hypocone. The fossettes are comparatively small and their enamel borders are relatively simple. The tooth enamel is relatively thin and shows moderate wear.

PUA 78/23 (M₂)

Present tooth is roughly triangular in outline with its apex lying distally. It is comparatively narrow. The mesial border of the tooth is occupied by the parastylid which travels buccally to join protoconid. On the lingual side, the mesial part of the tooth displays an oval-shaped metaconid which is separated from a medially placed metastylid by a V-shaped and relatively broad lingual depression. Distal to metastylid, the tooth crown shows a slightly damaged entoconid, on the lingual side. The distalmost portion of the tooth is occupied by the hypoconulid which is slightly pinched off from the entoconid.

The buccal aspect of the molar exhibits a mesially placed protoconid and a distal hypoconid. Protoconid and hypoconid are separated by a buccal depression on the buccal
border. A strongly developed enamel plication can be seen in the buccal depression. The mesial half of the molar displays a cement-filled metaflexid which opens on the lingual side between parastylid and metaconid. Entoflexid is present in the distal half of the tooth and opens on the lingual side between metastylid and entoconid. The enamel borders of the cement filled entoflexid are comparatively more crenulated. The molar possesses relatively thin enamel and it is moderately worn.

**Referred material:**

PUA 78/22, distal portion of a right metapodial recovered from Pinjor Formation about 3.5 km northeast of Mirzapur.

**Discussion:**

The specimens under discussion are roughly similar to *Equus sivalensis* in their basic morphological details. However, they clearly differ from it in their very small size. Apart from size, the present M₁ can be distinguished from that of *E. sivalensis* on the basis of a comparatively thin enamel, relatively short and broad protocone and rather simple borders of fossettes. The present third molar can be differentiated from *E. sivalensis* by its small size, less bucco-lingual diameter and relatively thin enamel. It differs from the M₃ of *Hipparion* in the absence of tripartite third lobe and by the presence of a V-shaped (instead of a U-shaped) lingual depression. The present metacarpal is smaller and more slender than the
metacarpal of *E. sivalensis*. It differs from the same of *Hipparion* in the absence of concavities posterior to the tuberosities and by the presence of more circular condyles.

Text Fig. 32a, shows the scatter diagram of the mesiodistal and bucco-lingual diameter of M$^1$ of *E. sivalensis* and present M$^1$. The present molar is placed much away from the cluster of *Equus sivalensis*, pointing towards its metric differences from the latter. The plot of length and breadth of the protocones of first molars of *E. sivalensis* and present M$^1$ (Text Fig. 32b) displays a pattern similar to the previous plot, thereby establishing distinctness between first molars of *E. sivalensis* and the present M$^1$.

From the foregoing discussion it is clear that the present specimens belong to a form somewhat different from that of *E. sivalensis*. These differences would warrant the emplacement of the present material in a new species. But since the differences between the present material and *E. sivalensis* are less of morphological and more of metrical nature, and since the material is isolated and insufficient for the creation of a new species, the present material is assigned to a new variety of *E. sivalensis*, viz. *E. sivalensis minor*. This variety of *Equus sivalensis* shows a slightly broad and a V-shaped lingual depression between metaconid and metastylid, thereby pointing towards its zeberine affinities.
SCATTER DIAGRAMS OF M\(^1\) OF Equus sivalensis AND Equus sivalensis minor var. nov.

(a) MAX. MESIO-DISTAL DIA. OF M\(^1\)

(b) BREADTH OF PROTOCONE OF M\(^1\)

LENGTH OF PROTOCONE OF M\(^1\)

TEXT FIG. 32
### Comparative measurements of M₁ of Upper Sivalik Equus

<table>
<thead>
<tr>
<th>Present Collection</th>
<th>Equus sivalensis</th>
</tr>
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<tr>
<td>ov.</td>
<td>PUA 77/3</td>
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<tbody>
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<td>PUA 77/59</td>
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<td>28.00</td>
<td>30.20</td>
<td>26.00</td>
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<td>30.00</td>
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<td>29.00</td>
<td>31.00</td>
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<tr>
<td>PUA 127B</td>
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<td>30.00</td>
<td>29.00</td>
<td>28.00</td>
<td>30.00</td>
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</table>

| fig. 1    | 22.30         | 28.00                     | 30.20                        | 26.00                      | 30.50                        |
| fig. 2    | 28.50         | 30.00                     | 28.00                        | 29.00                      | 30.00                        |
| 19806     | 27.80         | 30.00                     | 28.00                        | 29.00                      | 31.00                        |
| 19827     | 28.00         | 30.00                     | 29.00                        | 28.00                      | 30.00                        |
| 1.09      | 1.04          | 1.02                      | 1.04                         | 0.97                       | 1.00                         |
| 1.00      | 1.07          | 0.95                      | 1.00                         | 0.97                       | 1.07                         |
| 1.00      | 1.10          | 1.00                      |                               |                            |                              |

| 10.50     | 11.70         | 11.00                     | 11.20                        | 11.50                      | -                            |
| 5.50      | 4.30          | 4.00                      | 4.30                         | 4.20                       | -                            |
| 0.52      | 0.36          | 0.36                      | 0.38                         | 0.36                       | -                            |

| 12.00     | 4.50          | 0.37                      |                               |                            |                              |
### TABLE - 16

Comparative measurements of M3 of Upper Sivalik Equus

<table>
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<tr>
<th>Measurement</th>
<th>Present collection</th>
<th>Equus sivalensis</th>
<th>Equus sivalensis</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Equus</td>
<td>PUA</td>
<td>PUA</td>
</tr>
<tr>
<td></td>
<td>sivalensis</td>
<td>78/23</td>
<td>77/65</td>
</tr>
<tr>
<td>minor var. nov.</td>
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<tr>
<td></td>
<td>PUA 135B</td>
<td>135B</td>
<td>Colbert, 1935</td>
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<td></td>
<td></td>
<td></td>
<td>Amer. Mus. No.</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>19884</td>
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<tr>
<td>Max. mesio-distal dia.</td>
<td>27.90</td>
<td>37.00</td>
<td>33.00</td>
</tr>
<tr>
<td>Max. buccal-lingual dia.</td>
<td>1.70</td>
<td>18.00</td>
<td>17.50</td>
</tr>
<tr>
<td>Index</td>
<td>0.42</td>
<td>0.49</td>
<td>0.53</td>
</tr>
<tr>
<td>Thickness of enamel</td>
<td>1.05</td>
<td>1.35</td>
<td>1.45</td>
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</table>

* Estimated from the figure
Text Fig. 33 *Equus sivalensis minor* (x 1)

A. $M_3$ (a, occlusal view; b, buccal view; c, lingual view)

B. $M_1$ (a, occlusal view; b, buccal view; c, lingual view)

C. Right metapodial (a, anterior view; b, lateral view; c, posterior view)
Diagnosis:

Size ranges from small to large; either hornless, or with one or two horns (without bony cores) on the nasals or frontals, which in the latter case bear knobbed, rugose areas for horn attachment. Skull elongated or relatively narrow. Nasals vary in length and are sometimes supported by a bony septum lacking in representatives of other families; no sagittal crest, postglenoid and post-tympanic processes in contact or separated. Unlike in other Rhinocerotoidea, the lower jaw sometimes has an expanded symphysial section.

I \frac{3-0}{3-0} c \frac{1-0}{1-0} p \frac{4-2}{4-2} m^{3} \frac{3}{3}. Anterior teeth often reduced, number of incisors varies, I^{1} and I^{2} in certain forms specialised as large tusks. Canines almost always absent save in certain early forms. Cheek teeth low to high crowned; premolars reduced in number in late forms. Degree of molarization of upper premolars variable. In almost all forms P^{2}-P^{4} is more than half as long as M^{1}-M^{3} (except in Elasmotherinae). Upper molars with two transverse crests connected to the ectoloph. Supplementary folds on the crests are developed to various degrees, anterior rib approximated to the parastyle, ectoloph of M^{3} either does not project back beyond the metaloph or (in certain early forms) does so only slightly. Lower molars made up of two crescents bent at an angle; outer branch of
hypolophid connected to posterior branch of the metalophid, the outer valley separating them being deep. Extremities either long and slender (but always shorter than in Indricotheriidae) or short and massive; forelimbs and hindlimbs always functionally tridactyl. Radius almost always supported by two carpals, the scaphoid and lunar; head of capitate bone supports only the lunar of the first row, which is not ventrally wedged in between the bones of the second row. Lesser trochanter of the femur in the form of a crest on the inner margin of the bone; third trochanter strongly developed, bent forwards and situated almost in the middle of the bone. Metacarpals and metatarsals relatively broad and arranged almost in a row, with the laterals slightly narrower than the medians. Articulations of carpus and tarsus, with well-developed relief, phalanges of all digits relatively short and broad, the phalanges usually having relatively short "branches".

Middle Eocene to present (Gromova, 1968).

Subfamily Rhinocerotinae Dollo, 1885

Diagnosis:

Skull brachycephalic to semi-brachycephalic, occiput more or less inclined anteriorly. Single horn attached to middle of nasals. Nasals pointed, generally slender at terminal point. Molars large, canines robust (Piveteau, 1958).

Genus Rhinoceros Linnaeus, 1758

Diagnosis:

Skull short; nasal strongly thickened with rugose boss
to which single horn attached. Cranial profile saddle-shaped. Post-glenoid process and post temporal process close beneath auditory meatus; angle of mandible robust. Molars subhypsoodont. Pleistocene-Recent. There are two living species, *R. unicornis*, the Indian rhinoceros, and *R. sondaicus* which is the Java rhinoceros (Piveteau, 1958).

<table>
<thead>
<tr>
<th>Type species</th>
<th>Rhinoceros unicornis Linnaeus, 1758</th>
</tr>
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<tbody>
<tr>
<td>Species</td>
<td>Rinoceros sivalensis Falconer and Cautley, 1847</td>
</tr>
</tbody>
</table>

(Pl.15, Figs.A-C; Text Fig.34)

1847 *Rhinoceros sivalensis*, Falconer and Cautley, Fauna Antiqua Sivalensis, pl.73, figs.2,3; pl.74, figs.5,6; pl.75, figs.5-6.


1876 *Rhinoceros sivalensis* Falconer and Cautley, Lydekker, Pal. Indica, ser. 10, vol.1, pt.2, pp.8-11, pl.4, figs.2, 8; pl.5, fig.4; pl.6, fig.1.


1881 *Rhinoceros sivalensis* Falconer and Cautley, Lydekker, Pal. Indica, ser.10, vol.2, pt.1, pp.28-42, pls.5,6, figs.2,3; pl.7, fig.1, pl.10, fig.4.

Rhinoceros sivalensis Falconer and Cautley, Lydekker, 

1885 Rhinoceros sivalensis Falconer and Cautley, Lydekker, 
Catalogue of Siwalik Vertebrates in the Indian Museum, 
pt.1, pp.61-64.

1886 Rhinoceros sivalensis Falconer and Cautley, Lydekker, 

1910 Rhinoceros sivalensis Falconer and Cautley, Pilgrim, 

1913 Rhinoceros sivalensis Falconer and Cautley, Pilgrim, 

1929 Rhinoceros sivalensis Falconer and Cautley, Matthew, 

1935 Rhinoceros sivalensis Falconer and Cautley, Colbert, 
Trans. Amer. Phil. Soc., n.s., vol.26, p.80, fig.78.

1938 Rhinoceros sivalensis Falconer and Cautley, Colbert, 

1970 Rhinoceros sivalensis Falconer and Cautley, Prasad, 

**Diagnosis:**

Molars with a parastyle buttress, distinct crochet which may unite with the protoloph to enclose a fossette, and without a crista. Dorsum curved, narrow median valley,
antecrochet absent; two fossettes on worn crown (Lydekker, 1876 and Colbert, 1935).

**Lectotype:** Brit. Mus. (Nat. Hist.) No. 39626, part of a skull.

**Cotypes:** Brit. Mus. Nos. 39625, a skull; 39646, a mandibular symphysis; 39647, a part of a skull.

**Horizon:** Upper Śivaliks

**Locality:** Śivalik Hills

**Additional material:** PUA 77/97, an isolated left M₃.

**Horizon:** Pinjor Formation of Upper Śivaliks.

**Locality:** About 1.5 km northeast of Tanda.

**Description:**

The molar under description is roughly triangular in outline. It does not preserve the hypocone and a small part of the ecto-metaloph. The enamel on the mesio-lingual margin is chipped. The mesio-buccal part of the molar represents paracone and the mesio-lingual aspect is occupied by protocone which displays a prominent depression on its mesial side. The mesio-buccal parastyle depicts a shallow fold that gradually fades towards the bottom of the crown. At the mesio-buccal angle of the molar and slightly medial to the parastyle fold, a partially broken parastyle buttress can be differentiated. The external wall of the tooth is slightly undulating. The protoloph runs along the mesial border, being convex in the middle and concave at the buccal and lingual portions. In the middle of the molar, an obliquely placed and comparatively
narrow median sinus is discernible. The disto-lingual opening of the median sinus is comparatively narrow. The enamel border near the disto-lingual part of the sinus is slightly chipped. Both the borders of the median sinus run almost parallel to the ecto-metaloph. The upper half of the median sinus shows a moderately pronounced crochet which is blunt at its free end. The crista and antecrochet are not distinguishable in the present specimen. The hypocone and a part of the ecto-metaloph is broken. The molar displays three robust roots. This thick enameled tooth is moderately touched by wear.

**Referred material:**

PUA 79/6, a right maxillary fragment with badly weathered $P^2$-$P^4$, recovered from Pinjor Formation about 0.6 km north of Nadah.

PUA 79/6, a left maxillary fragment with badly weathered $M^2$ and $M^3$, recovered from Pinjor Formation about 0.6 km north of Nadah.

**Discussion:**

The genus Rhinoceros is represented by two species, viz. *R. sivalensis* and *R. palaeindicus* from the Upper Sivalik Formations of India. Recently, Heisig (1972) changed the generic status of the genus Gaindatherium to that of a subgenus of Rhinoceros, i.e., *Rhinoceros* (Gaindatherium).
The specimen under discussion (PUA 77/97), though, not very well preserved, shows distinguishing characters of *R. sivalensis*, i.e., the presence of a parastyle buttress, absence of three fossettes on the crown, absence of crista and the presence of a comparatively narrow median sinus. It can be easily distinguished from *Coelodonta platyrhinus* in the absence of crista and by the presence of a single fossette. It further differs from *C. platyrhinus* by the presence of a parastyle buttress and a comparatively smooth enamel. In *C. platyrhinus* the molars possess well defined crista, three fossettes on worn crown and slightly rugose enamel.

Although, the enamel at the mesio-buccal angle is slightly broken, the remnants of what could have been a parastyle buttress are traceable just mesial to the parastyle fold. The presence of parastyle buttress differentiates the present specimen from *R. palaeindicus*. It further differs from *R. palaeindicus* by the presence of only a single fossette and a comparatively narrow median sinus. In *R. palaeindicus*, the worn crown usually possesses three fossettes (Lydekker, 1886). According to Lydekker (1876, p.9), *R. sivalensis* differs from *R. palaeindicus* in the presence of a curved dorsum and a narrow median valley.

The present specimen shows close morphological and metrical similarities with $M^3$ of *R. sivalensis* figured in
Lydekker (1876, pl.4, fig.2). Thus, in view of its
differences with C. platyrhinus and R. palaeindicus, and
its similarities with R. sivalensis, the present specimen
has been assigned to <i>Rhinoceros sivalensis</i>. 
TABLE - 17

Comparative measurements of the third maxillary molar of Rhinoceros sivalensis

<table>
<thead>
<tr>
<th>Measurement</th>
<th>PUA 77/97 present specimen</th>
<th>Lydekker, 1876, pl.4,fig.2</th>
<th>Lydekker, 1881, p.32</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. mesio-distal dia.</td>
<td>55.00*</td>
<td>56.00</td>
<td>61.00</td>
</tr>
<tr>
<td>Max. bucco-lingual dia.</td>
<td>56.00*</td>
<td>57.00</td>
<td>56.00</td>
</tr>
<tr>
<td>Index</td>
<td>101.81</td>
<td>101.78</td>
<td>91.80</td>
</tr>
</tbody>
</table>

* Approximate
Text Fig. 34  Left $M^3$ of *Rhinoceros sivalensis* (x1)
(A) Occlusal view, (B) Lateral view
Species: *Rhinoceros palaeindicus* Falconer and Cautley, 1847.

(Pl. 16, Figs. A-C; Text Fig. 35)

1847 *Rhinoceros palaeindicus*, Falconer and Cautley, *Fauna Antiqua Sivalensis*, pl. 73, fig. 1; pl. 74, figs. 1-4; pl. 75, figs. 1-4.


1881 *Rhinoceros palaeindicus* Falconer and Cautley, Lydekker, *Pal. Indica*, ser. 10, vol. 2, pt. 1, pp. 42-48; pl. 6, fig. 1; pl. 7, figs. 2, 3; pl. 10, fig. 3.


**Diagnosis:**

Like *R. sivalensis*, but wider across the frontals, with a slightly different cranial profile. Molars distinguished by narrow median valley, simple crochet, straight dorsum, absence of buttress at external angle and of antecrochet, three fossettes on worn crown. Readily distinguished from
**Rhinoceros sivalensis** by the absence of buttress (parastyle) on upper molars and also by usual presence of three fossettes on worn crowns as compared to only two in *R. sivalensis* (Lydekker, 1876; Colbert, 1935).

**Lectotype:** Brit. Mus. No.16444, a skull.

**Horizon:** Upper Śivaliks.

**Locality:** Śivalik Hills.

**Cotypes:** Brit. Mus. Nos.M2727, a skull; 36740, a skull; 39740, a skull; 39644, posterior part of left mandibular ramus; 39645, part of right mandibular ramus; 39646, mandibular symphysis and many specimens figured in *Fauna Antiqua Sivalensis.*

**Horizon:** Upper Śivaliks.

**Locality:** All specimens from Śivalik Hills.

**Additional material:** PUA 77/18, a left mandibular fragment with P₄-M₁.

**Horizon:** Pinjor Formation of Upper Śivaliks.

**Locality:** About 2 km northeast of Mirzapur.

**Description:**

The mandibular fragment under description is very deep and robust, and preserves P₄, M₁ and a small part of M₂. The horizontal ramus is broken mesially, infront of P₄, and distally behind the middle of M₂. The ramus is oval in cross-section and displays a deep posterior root of P₃ and two anterior roots of M₂ on its mesial and distal sides,
respectively. As such, the mandibular fragment grows deeper and thicker from anterior to posterior side.

\( \text{P}_4: \)

It is nearly rectangular in shape. Its anterior and posterior lobes have fused with each other due to wear. The anterior half of the premolar is composed of a mesio-buccal paraconid, medio-buccal protoconid and a medio-lingual metaconid. Paralophid starts at the paracone and travels lingually, along its mesial border to terminate at the mesio-lingual angle of the tooth. The metaconid and paralophid are set apart by a shallow and medially directed metaflexid. As a result of attrition the metalophid has become broad.

The distal half of the premolar is constituted by a disto-buccal hypoconid and a disto-lingual entoconid. A shallow buccal depression can be distinguished almost midway on the buccal margin. The metaconid and entoconid are separated by a buccally and mesially directed entoflexid which is shallower than the metaflexid. Due to excessive wear, the hypolophid has broadened and fused with the metalophid. A very faint cingulum can be differentiated, along the cervical margin, on the buccal side of the premolar. The enamel is thick and displays signs of parallel lines of wear caused most probably by siliceous diet. The interdental attrition has partially worn out the distal border of the premolar.
This tooth is similar to \( P_4 \) in its fundamental features, but differs from the same in its greater breadth and lesser length. The enamel on the lingual border and the distal half of the buccal border is chipped. The enamel on the mesial and distal borders has worn out due to interdental attrition. The molar is excessively worn and all the enamel structures, except the enamel wall surrounding the molar, have been obliterated. The paralophid and the metaflexid are indistinguishable.

**Discussion:**

The lower teeth of *Rhinoceros* are not easy to tell from the lower teeth of *Coelodonta*. Most of the differences have been made either on the basis of maxillary dentition or the symphysis, but unfortunately the symphysis is not preserved in the present specimen. Nevertheless, the specimen under discussion can be differentiated from *Coelodonta* by the absence of rugose enamel and a well defined cingulum. In *Coelodonta* the lower teeth possess a comparatively rugose enamel and a prominent cingulum. The lateral walls of the lower teeth of *Coelodonta* taper from the base of the tooth to the summit. In the present mandible the teeth do not show any such tapering, which differentiates it from the same in *Coelodonta*.

The lower teeth of *R. sivalensis* display a well-developed tubercle in the entoflexid. The present specimen
differs from *R. sivalensis* in the absence of any such tubercle in the entoflexid of its teeth. In general, it is seen that \( P_4 \) in *R. palaeindicus* is longer than \( M_1 \) while it is the reverse in *R. sivalensis*. The present mandibular fragment is similar to the *R. palaeindicus* specimen described by Lydekker (1881, p.48), in which too \( P_4 \) is longer than \( M_1 \). Although, the present specimen is slightly larger, but on the basis of morphological similarities with the mandibular fragment described by Lydekker (1881, p.48), it has been assigned to *Rhinoceros palaeindicus*. 
## Comparative measurements of the lower teeth of some Upper Sivalik rhinocerotids

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Rhinoceros palaeindicus</th>
<th>Rhinoceros palaeindicus</th>
<th>Rhinoceros sivalensis</th>
<th>Coelodonta platyrhinus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. mesio-distal dia. of P₄</td>
<td>53.00</td>
<td>42.00</td>
<td>42.00</td>
<td>43.00</td>
</tr>
<tr>
<td>Max. bucco-lingual dia. of P₄</td>
<td>33.00</td>
<td>28.00</td>
<td>24.00</td>
<td>29.00</td>
</tr>
<tr>
<td>Index</td>
<td>62.26</td>
<td>66.66</td>
<td>57.14</td>
<td>67.44</td>
</tr>
<tr>
<td>Max. mesio-distal dia. of M₁</td>
<td>48.00</td>
<td>37.00</td>
<td>52.00</td>
<td>41.00</td>
</tr>
<tr>
<td>Max. bucco-lingual dia. of M₁</td>
<td>35.00</td>
<td>27.00</td>
<td>32.00</td>
<td>33.00</td>
</tr>
<tr>
<td>Index</td>
<td>72.90</td>
<td>72.97</td>
<td>61.53</td>
<td>80.48</td>
</tr>
</tbody>
</table>
Text Fig. 35  Left mandibular fragment with $P_4$ and $M_1$ of *Rhinoceros palaeindicus* (x 1)
Subfamily Dicerorhininae Simpson, 1945

Diagnosis:

Medium-sized to large animals. Hornless (early forms) or with one horn on the nasals and one on the frontals; callosities on the nasals and frontals either absent (in early forms) or present. Skull moderately to very long. Nasals varying in length and shape depending on the presence or absence of horns and nasal septum. Parietal crests close or separated. Shape of occipital region variable. Post-tympanic and post-glenoid processes usually fused. Symphysial section of lower jaw anteriorly narrow or broadened, angular section projects back slightly or not at all. For the most part one pair of upper and of lower incisors, with upper ones sometimes lacking. Cheek teeth from low to high crowned (though lower than in Elasmotheriinae) and sometimes possess cement. There are three or four premolars, all fully molarized (except in early forms). Parastyle fold on upper molars deep or shallow; crochet and antecrochet well developed, crista not always present, protocone and hypocone not sharply separated from the transverse crests. Skeleton light or more massive, extremities long or somewhat shortened, forelimbs tridactyl. Upper Oligocene to present (Gromova, 1968).

Genus Coelodonta Bronn, 1831

Diagnosis:

Large. Two horns, one on the nasals and one on the frontals. Skull very long. Nasals long, broad and bent down.
Bony nasal septum present, and in adult specimens complete. Occipital region strongly inclined back. Symphysial section of lower jaw anteriorly broadened. Incisors lacking (if present then very small and shed early). Cheek teeth high crowned, with cement. Crista and crochet well developed, not branched, coalescing with each other through wear, and mark off a closed supplementary valley. Transverse crests of upper molars very oblique to longitudinal axis of tooth. Extremities shortened and relatively massive. (Gromova, 1968).

<table>
<thead>
<tr>
<th>Type species</th>
<th>Rhinoceros antiquitatis</th>
<th>Blumenbach, 1807</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species</td>
<td>Coelodonta platyrhinus</td>
<td>(Falconer and Cautley), 1847</td>
</tr>
</tbody>
</table>

(Pl.17, Figs.A-F; Text Fig.36)

1847 *Rhinoceros platyrhinus*, Falconer and Cautley, *Fauna Antiqua Sivalensis*, pl.72, figs.1-7; pl.78, figs.9-12.


**Diagnosis:**

Upper cheek teeth resembling those of *Coelodonta antiquitatis*, having crista, third fossette on worn crown, no buttress at antero-external angle (i.e., parastyle buttress) and plane of wear horizontal with moderately rugose enamel. Differs from typical specimen by the presence of strong anterior cingulum to true molars (Lydekker, 1886).

**Lectotype:** Brit. Mus. No.33662, a battered skull without any molars.

**Horizon:** Upper Śivaliks.

**Locality:** Śivalik Hills.

**Cotypes:** Brit. Mus. Nos. M2731, a back portion of the skull; M39620, anterior part of mandible; M39640, right M\(^3\); M39641, right upper molar; 36942, symphysis with right ramus of mandible; 39643, right maxilla.

All these specimens are from Upper Šivaliks and the localities in Šivalik Hills.

**Additional material:** PUA 78/89, a left P\(^2\); and PUA 78/64, a left maxillary fragment with dm\(^2\) and dm\(^3\).
Horizon: Pinjor Formation of Upper Sivaliks
Locality: PUA 78/89, about 0.75 km east of Mirzapur; PUA 78/64, about 1.5 km north of Tanda.

Description:
PUA 78/89 (P2)

The specimen under description is a left second maxillary premolar. It is roughly rectangular in shape and shows three unequal roots, two on the buccal side and one, strongest of all, on the lingual side. The buccal aspect of the tooth displays a mesio-buccal paracone and a disto-buccal metacone. Both these cones are connected to each other through ectoloph. Mesially, the paracone shows a moderately developed parastyle which does not display any parastyle buttress. Due to slight chipping of the enamel near the distal end of the buccal border, the metastyle cannot be clearly demarcated.

The lingual half of the premolar possesses a mesially placed paracone and a distally placed hypocone. Along the mesial border, the protoloph starts at the protocone and travels medio-buccally to join the ectoloph. The premolar shows a well-developed and an obliquely directed crista which is fused slightly with the crochet, and cuts off an oval shaped midfossette from an elongated and obliquely placed midsinus, which is closed lingually. There is no sign of antecrochet on the occlusal surface. Near the distal margin, in its middle, the tooth shows a closed and oval-shaped
postfossette. On the mesial border a cingular shelf starts at the base of the protocone and travels medio-buccally to merge with the mesial wall of the premolar, at the level of the anterior end of median sinus. The tooth has moderately thick enamel, but due to interdental attrition, the distal enamel border has thinned down. The premolar is moderately worn and shows a pressure facet on the mesial and distal sides.

PUA 78/64 (right maxillary fragment)

This specimen is a right maxillary fragment with last two milk molars. It is not very well preserved and the enamel on the buccal and lingual borders is chipped. The inferior surface of the maxillary fragment shows a permanent molar in the germ.

It is roughly squarish in outline and shows four cusps on its comparatively flat occlusal surface, viz., mesio-buccal paracone, distobuccal metacone, mesio-lingual protocone and a disto-lingual hypocone. The paracone and metacone are broken along the buccal side; the parastyle and metastyle are not preserved. A part of the ectoloph is also chipped.

In the mesial aspect of the tooth, the protoloph starts from the protocone and travels medio-buccally to meet the ectoloph. The metaloph is placed along the distal margin of the tooth, between metacone and hypocone. The lingual part of the molar, between protoloph and metaloph, displays a
median sinus which is closed on its lingual side. Due to heavy wear, the crista and crochet have fused with each other, connecting the protoloph and metaloph, and in the process cutting an oval-shaped mid-fossette in the centre of the occlusal surface. The antecrochet cannot be differentiated. Near the distal margin, the tooth exhibits an oval post-fossette. The enamel of the milk molar is comparatively thin and light brown in colour. This heavily worn tooth is supported by four roots, one below each of the four major cones. 

$\text{dm}^2$

Except being larger in size, this tooth retains the basic structure of the preceding tooth. The paracone, metacone and a part of the ectoloph are chipped. The median sinus is comparatively bigger and shows a small plication at its disto-medial angle. Unlike $\text{dm}^2$, it opens narrowly at the lingual border just mesial to hypocone. The lingual half of the mesial border displays a cingular shelf which is thickest at the lingual border and gradually narrows down medially. It is comparatively less worn than $\text{dm}^2$.

Referred material:

PUA 78/52, mandibular fragment with $P_3-\text{M}_1$ recovered from Pinjor Formation about 1 km north of Tanda.

Discussion:

Genus *Coelodonta* is represented in the Sivaliks by a single species, *Coelodonta platyrhinus*. The present specimens,
PUA 78/89 and PUA 78/64, exhibit morphological characters typical of Coelodonta, viz., presence of a well-developed crista and crochet, absence of parastyle buttress and presence of three fossettes. The P$^2$ under discussion can be distinguished from that in Rhinoceros sivalensis and Rhinoceros palaeindicus by the presence of a well-developed crista. It further differs from R. sivalensis by the absence of a parastyle buttress. Though slightly smaller in size, the present P$^2$ resembles greatly P$^2$ of C. platyrhinus figured in Lydekker (1881, pl.8).

The milk molars of specimen No.PUA 78/64, differ from the same of Rhinoceros in the presence of a prominent crista. There are three fossettes on the crown which differentiate it from the milk molars of R. sivalensis. The milk molars under discussion differ from another Upper Sivalik rhinocerotid, Punjabitherium, in the presence of another Upper Sivalik rhinocerotid, Coelodonta, C. antiquitatis, by the presence of a strong cingulum. The dm$^2$ and dm$^3$ of the specimen under discussion exhibit close morphological as well as metrical similarities with the dm$^2$ and dm$^3$ of C. platyrhinus figured in Colbert (1935, p.180; fig.78). Keeping in view their morphological and metrical similarities with C. platyrhinus and their differences with other rhinocerotids, the specimen Nos.PUA 78/89 and PUA 78/64 have been referred to Coelodonta platyrhinus.
### Comparative measurements of maxillary dentition of *Coelodonta platyrhinus*

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Present specimens</th>
<th>Colbert, 1935</th>
<th>Lydekker, 1881</th>
<th>CASGF</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PUA 78/64</td>
<td>PUA 78/89</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. mesio-distal dia.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$d_m^2$</td>
<td>38.00</td>
<td>-</td>
<td>34.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$d_m^4$</td>
<td>49.00</td>
<td>-</td>
<td>49.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$d_m^6$</td>
<td>-</td>
<td>37.00</td>
<td>45.00</td>
<td>45.00</td>
<td>-</td>
</tr>
<tr>
<td>$p$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Max. bucco-lingual dia.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$d_m^2$</td>
<td>41.00</td>
<td>-</td>
<td>40.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$d_m^4$</td>
<td>49.00</td>
<td>-</td>
<td>49.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$d_m^6$</td>
<td>-</td>
<td>45.00</td>
<td>53.00</td>
<td>53.00</td>
<td>-</td>
</tr>
<tr>
<td>$p$</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Index</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$d_m^2$</td>
<td>107.89</td>
<td>-</td>
<td>117.64</td>
<td>-</td>
<td>-</td>
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<tr>
<td>$d_m^4$</td>
<td>100.00</td>
<td>-</td>
<td>100.00</td>
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<td>-</td>
</tr>
<tr>
<td>$d_m^6$</td>
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<td>-</td>
<td>94.54</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$p$</td>
<td>-</td>
<td>121.62</td>
<td>117.70, 117.70</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Text Fig. 36  *Coelondonta platyrhinus* (x 1)
(A) Left p²
(B) Left maxillary fragment with dm² and dm³
Order: Artiodactyla  
Suborder: Suiformes  
Family: Suidae

Owen, 1848  
Jaeckel, 1911  
Gray, 1821

Diagnosis:

Facial part of skull considerably longer than cranial part, except in early forms. Sagittal crest present in early forms, absent in late ones. Zygomatic arches and lower jaw without processes. $I_3 - I_1, P_4 - P_2, M_3$. The incisors have roots and decrease in size from $I_1$ to $I_3$; upper ones short and oval in section, lower ones long. Canines large except in early forms; upper ones generally rounded in section and often bent upwards, lower ones trihedral. In males of later from the canines are rootless (permanently growing). Molars are from low to very high (Phacochoerus), with four principal cusps and with supplementary ones especially numerous in highly developed forms, which also display a long and complex talon and talonid on $M_3$. Extremities short and tetradactyl; the digits are close together, the later ones being weaker than the middle ones. Oligocene to present (Gromova, 1968).

Subfamily: Suinae

Zittel, 1893

Diagnosis:

Facial part of skull considerably longer than cranial part. Zygomatic arches well developed, sometimes
powerful. Sagittal crest absent. $1^3_{3/2} - I^3_{4/2}$, $C^3_{3/2} - P^4_{4/2}$, $M^3_{5}$. Long diastema between I and C and between C and P. Canines of different sizes, more often large; upper canines rounded in section and often upwardly curved, lower ones trihedral. Premolars simple and not enlarged; $P^4_{4}$ bi- or tricuspid, $P^4_{4}$ more rarely monocuspid. Molars low, more rarely high (in Phacochoerus and Hippohyus), and elongated, with four principle tubercles and many small supplementary ones, especially on $M^3_{3/2}$, which possess a well-developed talon or talonid. Upper Miocene to present (Gromova, 1968).

Genus Potamochoerus

Gray, 1854

Diagnosis:

A genus probably nearer to Propotamochoerus. The stoutness of premolars in Propotamochoerus and Potamochoerus distinguishes them from Choerotherium and Sus-Hippohyus branch of the genera. The height of main cusp of $P^4_{4}$, which exceeds that of the anterior and posterior cusps, distinguishes it from Sus-Hippohyus series. The cone-like character of the main cusp of $P^4_{4}$ distinguishes it from corresponding tooth of Dicoryphochoerus branch, in which the premolars are equally stout, and the Sus-Hippohyus branch. Often, there is a trace of a faint subsidiary peak immediately behind the main one, but this is quite different to the well-marked internal cusp of Dicoryphochoerus, or the equally well-marked posterior or slightly internal cusp of Sus and Hippohyus. Lower premolars of Conohyus
and Sivachoerus are relatively larger than the molars in comparison to Potamochoerus and Propotamochoerus. Differs from Propotamochoerus in the reduction in number of lower premolars - three instead of four - and their decrease in length, which has proceeded concurrently with the increase in length of the molars, especially the last molar (Pilgrim, 1926).

Type species Sus koiropotamus Desmoulins
Species Potamochoerus theobaldi Pilgrim, 1926

(Pl. 18, Figs. A-C; Text Fig. 37)

1926 Potamochoerus theobaldi. Pilgrim, Pal. Indica, n.s., vol. 8, no. 4, pp. 27-28, pl. 10, fig. 3.


Diagnosis:

P₄ with typical aspects of Potamochoerus. A species of probably much the same size as P. palaeindicus but the premolars are very much more reduced in size relative to the molars, and the talon of M₃ is much longer and more complex (Pilgrim, 1926).

Holotype: Ind. Mus. B11, a right mandibular ramus with P₄-M₃.

Horizon: Upper Sivaliks, probably in the upper part of Pinjor or even the Boulder Conglomerate.
Locality: Gagret, in the Kangra District.

Additional Material: PUA 78/54, a left mandibular fragment with $M_2$ and $M_3$.

Horizon: Pinjor Formation of Upper Sivaliks.

Locality: About 1 km northeast of Tanda.

Description:

The specimen under description preserves $M_2$ and $M_3$ implanted in a portion of the left horizontal ramus of the mandible. Only a part of the alveolar margin of the horizontal ramus is preserved; the lower portion of the body is broken.

$M_2$

The second molar is roughly rectangular in outline. The tooth crown displays four major conids, viz., mesio-buccal protoconid, mesio-lingual paraconid, disto-buccal hypoconid and disto-lingual metaconid. The paraconid is broken mesio-lingually and the enamel on the mesio-buccal margin of the protoconid is slightly chipped. The anterior transverse row of conids, comprising the paraconid and protoconid, is separated from the hypoconid and metaconid by a valley which is occupied by a prominent median valley conule. The distal-most part of the molar is occupied by the hypoconulid. The molar displays a moderately thick enamel and shows moderate wear. The tooth is implanted in the mandible by four roots.
The third molar is elongated in shape; its length greatly exceeds its breadth. The moderately high crown of this tooth is divisible into a mesial and a distal half. The mesial half consists of four conids, i.e., paraconid, protoconid, metaconid and hypoconid. The mesio-lingual aspect of the tooth is occupied by the paraconid and the mesio-buccal by the protoconid. The tip of the paraconid is slightly broken. The metaconid lies on the lingual side, distal to the paraconid. The disto-buccal part of the anterior half of $M_3$ exhibits a comparatively low hypoconid. The valley separating the protoconid and paraconid from the metaconid and hypoconid is filled by a nearly flat anterior median tubercle. The buccal opening of the median valley is blocked by a small median valley conulid. Mesially, the tooth shows a shelf-like anterior cingulum which starts at the mesio-buccal border of protoconid and proceeds lingually to terminate at the mesio-lingual margin of the paraconid. On the mesio-lingual margin, a small but prominent comule can be seen, arising from the anterior cingulum, at the base of the paraconid.

The distal half or the talonid is comparatively complex and displays many accessory cuspulids. The distal end of the talonid shows a relatively less developed
hypoconulid. Just mesial to the hypoconulid, two well-developed but blunt accessory tubercles can be differentiated, The one on the buccal side is the accessory tubercle-I, and the other on the lingual side is the accessory tubercle-II. The valley between these accessory tubercles and the distal transverse row of major conids, i.e., hypoconid and metaconid, is occupied by a posterior median tubercle. This valley is blocked by small accessory conulids on both lingual and buccal sides. The third molar is secured in the mandible by five roots, one each below the four major conids of the mesial half and one below the talonid. The root supporting the talonid is the strongest. The tooth exhibits slight wear.

Discussion:

The present specimen forms the first record of Potamochoerus theobaldi from the Pinjor Formation of this area. The only other report of this form is from Gagret (Kangra District), from where the holotype was recovered (Pilgrim, 1926).

The specimen differs from Propotamochoerus hysudricus in its overall larger size and a longer and complex talonid of $M_3$. There is not much difference between Potamochoerus palaeindicus and Potamochoerus theobaldi. Nevertheless, the present specimen can be differentiated from $P$.palaeindicus by its elongated and more complex
talonid of $M_3$ and by its generally larger dimensions. The present mandibular fragment shows close morphological resemblance with the holotype of *P. theobaldi* (Ind. Mus. B.11) figured and described by Pilgrim (1926, pl. 10, fig. 3).

Both species of *Potamochoerus*, viz., *P. palaeindicus* and *P. theobaldi*, which occur in Upper Sivaliks, were erected on meagre material and their stratigraphic position is disputed - the former coming from the top of Tatrots or from the basal Pinjors and the latter from top Pinjors or Boulder Conglomerate. Also, the differences in size and morphology of these two taxa seem to be within the range of variation for the population of a species. However, separate specific positions have been maintained here in view of the meagre material available at our disposal. This position may change with the recovery of more complete material and with further geological investigations aimed at solving the stratigraphic confusion prevalent at present.
### TABLE 20

Comparative measurements of some taxa of Upper Sivalik Suinae

<table>
<thead>
<tr>
<th>Measurement</th>
<th><em>Potamochoerus theobaldi</em></th>
<th><em>Potamochoerus palaeindicus</em></th>
<th><em>Propotamochoerus hysudricus</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PUA 78/54</td>
<td>Pilgrim, 1926</td>
<td>Pilgrim, 1926</td>
</tr>
<tr>
<td>Max. mesio-distal dia. of $M_2$</td>
<td>30.00</td>
<td>28.00</td>
<td>26.00</td>
</tr>
<tr>
<td>Max. bucco-lingual dia. of $M_2$</td>
<td>19.00</td>
<td>21.50</td>
<td>19.00</td>
</tr>
<tr>
<td>Max. height of $M_2$</td>
<td>18.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Index</td>
<td>66.33</td>
<td>77.00</td>
<td>73.00</td>
</tr>
<tr>
<td>Max. mesio-distal dia. of $M_3$</td>
<td>50.00</td>
<td>47.00</td>
<td>41.00</td>
</tr>
<tr>
<td>Max. bucco-lingual dia. of $M_3$</td>
<td>23.50</td>
<td>23.50</td>
<td>21.00</td>
</tr>
<tr>
<td>Max. height of $M_3$</td>
<td>21.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Index</td>
<td>47.00</td>
<td>49.00</td>
<td>51.00</td>
</tr>
</tbody>
</table>

*Estimated by the author from the figure.*
Text Fig. 37 Left mandibular fragment of *Potamochoerus theobaldi* with $M_2$ and $M_3$ (x 1)

(A) Occlusal view, (B) Lateral view
Genus Sus Linnaeus, 1758

Diagnosis:

Facial part of the skull narrow and low, about twice as long as the cranial part. Roof of braincase moderately broad and long, in form of a low transverse vault; Occipital region of variable length. Orbits rounded and generally situated above $M_3$. Zygomatic arches moderately developed, descending steeply downwards to the level of $M_3$ or slightly above it. Alveolar crest above the upper canines moderately developed in the form of a sheath. Diastema between C and P usually shorter than $M_3$. $P_4^1$ always present. Upper and lower canines large (especially in males); lower canines triangular in section, the outline of the section varying (belonging either to the scrofa or verrucosus type), upper canines rounded and in males curved upwards. Molars as in Microstonyx, usually with a somewhat less complicated occlusal surface and a shorter talon and talonid on $M_3$. Lower Miocene to present (Gromova, 1968).

Type species Sus scrofa Linnaeus, 1758
Species Sus falconeri Lydekker, 1884

(Pl.19, Figs.A-C; Text Fig.38)

1847 *Sus giganteus* (in parte), Falconer and Cautley, *Fauna Antiqua Sivalensis*, pl.69, figs.3 and 4; pl.70, figs.4-7; pl.71.


1926 *Sus falconeri* Lydekker, Pilgrim, *Pal. Indica*, n.s. vol.8, no.4, p.63, pl.20, fig.15.


**Diagnosis:**

An extremely large suid, with hypsodont cheek teeth, and a much elongated third molar. The skull is distinguished by the preorbital portion, and the posterior portion of the orbit; the mandible has a high ascending ramus and a long, heavy symphysis (Colbert, 1935).
Holotype: Brit. Mus. No. 16386, a skull (catalogued by Lydekker, 1885, as No. 15386).

Horizon: Upper Sivaliks

Locality: Sivalik Hills

Paratypes: Brit. Mus. Nos. M2044, a skull; M2042; a skull; M2013, a skull; 2043; a palate; M2012, a mandible; 16614, a mandible; 15387, a mandible; 16612, a mandible; Sci. Art. Mus. Dublin Nos. C27, a skull; C26, a mandible; G.S.I. Nos. B16, fragment of a ramus and B18, fragment of a maxilla.

Horizon: Upper Sivaliks

Locality: Sivalik Hills

Additional material: PUA 77/39, a left M3.

Horizon: Pinjor Formation of Upper Sivaliks.

Locality: About 1.5 km northeast of Tanda.

Description:

The present molar is somewhat elongated and roughly triangular in shape with its apex towards the distal side. A part of the mandibular ramus is attached on the lateral side of the tooth. This high-crowned tooth presents a complex pattern of conids, conulids, accessory tubercles and valleys. The occlusal surface is divisible into mesial and distal portions.

The mesial portion of the molar displays four major conids, viz., mesio-lingual paraconid, mesio-buccal
protoconid, disto-buccal hypoconid and disto-lingual metaconid. Paraconid is the most prominent conid and projects higher than the other three conids. The anterior cingulum is slightly beaded and starts at the mesio-buccal margin of protoconid, travels lingually and terminates below paraconid. The lingual aspect of the tooth does not display a distinct cingulum, but some cingular development can be demarcated on the buccal side of the base of hypoconid. On its mesial border, the molar exhibits a small pressure facet apparently caused by its contact with the distal margin of the second molar. A median valley separates the mesial row of major conids from the distal row. The middle of this valley is occupied by a median accessory tubercle-I. The valley is obstructed on the buccal side by a small median valley conulid.

The distal portion or the talonid is much elongated and shows many accessory tubercles which are less developed than the four major conids. The distalmost part of the talonid is occupied by a well-developed hypoconulid. A small tubercle can be seen arising from the basal cingulum on the lingual side of hypoconulid. On the buccal aspect, the space between hypoconid and hypoconulid is occupied by a prominent posterior accessory tubercle-I. Similarly, on the lingual side an equally well-developed posterior accessory tubercle-II can be differentiated between metaconid and hypoconulid. The valley separating this
pair of accessory tubercles and the hypoconid and metaconid is occupied by a median accessory tubercle-II. On the disto-buccal margin of the talonid, a very faint cingulum can be differentiated. The molar is supported by five robust roots, one below each of the four major conids and one below the talonid. The root supporting the talonid is the strongest. Except slight wear on the protoconid, the molar shows almost no wear.

The metric details of the present tooth have been compared with those of other published specimens and shown in Table-21.

**Referred material:**

PUA 78/84, a highly worn right $M^3$ recovered from Pinjor Formation about 0.75 km northeast of Nadah.

PUA 79/5, a partial left $M^3$ recovered from Pinjor Formation about 0.5 km north of Nadah.

**Discussion:**

In its morphological and metrical details the present specimen resembles *Sus falconeri*. It differs from *Potamochoerus* by its longer and complicated $M_3$. Its talonid is much longer than that in *Hippohyus*. It differs from other species of *Sus* in its overall larger size and the complexity of the talonid of $M_3$. 
### Comparative measurements of $M_2$ of *Sus falconeri* and some other suid taxa from Upper Sivaliks

<table>
<thead>
<tr>
<th>Measurement</th>
<th><em>Sus falconeri</em></th>
<th><em>Sus hysudricus</em></th>
<th><em>Potamochoerus theobaldi</em></th>
<th><em>Potamocherus palaeindicus</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Present specimen</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PUA 77/39</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pl. 8, figs. 2 and 9*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. mesio-distal dia.</td>
<td>64.00</td>
<td>59.00</td>
<td>33.50</td>
<td>47.00</td>
</tr>
<tr>
<td>Max. bucco-lingual dia.</td>
<td>23.00</td>
<td>24.00</td>
<td>16.50</td>
<td>23.00</td>
</tr>
<tr>
<td>Index</td>
<td>36.00</td>
<td>40.67</td>
<td>49.25</td>
<td>48.93</td>
</tr>
<tr>
<td>Max. height</td>
<td>23.50</td>
<td>19.00</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*Estimated from the figure by the author*
Text Fig. 38  Left $M_3$ of *Sus falconeri* (x 1)
(A) Occlusal view, (B) Lateral view
Species  

Sus *pinjorensis* sp. nov.  

(Pl.20, Figs.A-C; Text Fig.4©)  

**Diagnosis:**

A large species with relatively high crowned cheek-teeth. $I_3^1$, $C_1^1$, $P_4$, $M_3$. Symphysis long and heavy, extending up to the mesial border of $P_3$; $M_1$ and $M_2$ comparatively short; $M_3$ much elongated with a very complex talonid and a prominent disto-buccal cingulum. Last molar longer than the combined length of $P_4$, $M_1$ and $M_2$. The lateral view of the talonid gives the appearance of closely spaced columns.

**Holotype:** PUA 78/26, a partial left mandible with $P_2$-$M_3$, symphysis, and roots of canines, lateral incisors and central incisors.

**Horizon:** Pinjor Formation of Upper Śivaliks.  
**Locality:** About 3.5 km northeast of Mirzapur.  
**Etymology:** The species has been named after the Pinjor Formation of Upper Śivaliks from where the holotype was recovered.

**Description:**

The present mandibular fragment preserves the left horizontal ramus with $P_2$-$M_3$ and the symphysis, the anterior part of which is broken. The ramus is broken just distal to $M_3$. The teeth show differential wear. The symphysis
slopes downwards and backwards showing a convex mental surface and a highly concave lingual surface. Posteriorly, the symphysis joins with the horizontal ramus at the level of P₂. This robust horizontal ramus is deepest below M₂. The maximum thickness is observed at the level of the mesial part of M₃. The lateral surface of the body is strongly convex mesio-distally as well as vertically. There are two mental foramena on the lateral surface of the ramus; the one anterior to P₂ is slightly bigger than the one at the level of M₁ and travels posteriorly becoming broader and shallower in the process. The lingual surface of the horizontal ramus is nearly flat, except near the distal end of M₃ where it bends slightly towards the lateral side. The alveolar border of the ramus, which is narrow anteriorly and widens posteriorly, follows roughly the axis of the ramus.

Anteriorly, the broken symphysis depicts nearly circular roots of the first and second incisors. The roots of the lateral incisors are not discernible; probably the symphysis broke posterior to the distalmost end of their roots. From the cross-section of their roots the canines appear moderately large and of verrucose type.

Most of the second premolar is broken; it preserves only a small posterior secondary cusp. However, from the
alveolus which holds its root, the outline of the tooth appears to be oval.

$P_3$

It is more or less triangular in shape with its apex directing mesially. It is larger than $P_2$. The major portion of the crown is constituted by a very prominent main central cuspid which is preceded by a small anterior accessory cuspid. The distalmost part of the tooth has a moderately large posterior accessory cuspid which is demarcated from the main central cuspid by lingual and buccal depressions. The premolar shows moderate wear.

$P_4$

The fourth premolar which is roughly rectangular in outline is the largest tooth of the premolar series. It is slightly chipped along its lingual border. Despite wear, four distinct cusps can be differentiated on its buccal aspect. The principal central cuspid which lies distal to a comparatively small anterior secondary cuspid is the most prominent cuspid of the crown. A narrow depression demarcates the anterior secondary cuspid from the principal cuspid along the buccal margin of the premolar. Distal to the principal cuspid, the crown shows two posterior secondary cusps, the mesial one of these two cusps is placed near the middle of the crown. Partly due to wear and partly due to the damage to the tooth, the
structures on the lingual side of the premolar are indistinct. It is implanted in the mandible by two deep roots.

\( M_1 \)

The first molar is roughly rectangular and it is worn to such a great extent that all the morphological features of the crown are obliterated leaving behind only the dentine. All the major conids, viz., mesio-lingual paraconid, mesio-buccal protoconid, disto-lingual metaconid and disto-buccal hypoconid have disappeared due to heavy attrition, giving the crown a flattened surface. Bucco-lingual diameter of the tooth is less at its mesial end than at its distal end. The molar is implanted in the mandible by four moderately deep roots.

\( M_2 \)

It is more or less a squarish tooth and shows features similar to \( M_1 \), except that it is comparatively larger and its mesial and distal tranverse diameters are almost equal. As in \( M_1 \), the enamel on the occlusal surface of \( M_2 \) has been completely eroded by excessive wear.

\( M_3 \)

The third molar is very much elongated and exhibits a very complex crown pattern. The mesio-distal diameter of the molar is greater than even the combined length of \( P_4, M_1 \) and \( M_2 \). The occlusal surface of the tooth
can be divided into a mesial and a distal part.

The mesial part of the tooth displays a mesio-lingual paraconid, mesio-buccal protonid, disto-lingual metaconid and a disto-buccal hypoconid. Due to excessive wear, the enamel in this half of the molar has been reduced to small enamel islands. The median accessory tubercle can not be distinguished. The enamel at the mesial border of the tooth has probably been eroded due to interstitial wear.

The distal part of the tooth, or the talonid, is very complicated and much longer than the mesial part. The mesial portion of the talonid shows a pair of equally pronounced tubercles, viz., the anterior accessory tubercles-I and anterior accessory tubercle-II. Both these tubercles seem to be as pronounced as the two conids mesial to them. Distal to these tubercles there is another pair of posterior accessory tubercles-I and II; the posterior accessory tubercle-I is larger than its lingual counterpart and shows a small accessory conule just lingual to it. The distalmost portion of the heel is occupied by a well-developed hypoconulid which displays yet another accessory tubercle on its disto-buccal side. When viewed from the lateral side, the molar gives an impression of closely spaced columns. The disto-buccal aspect of the talonid exhibits a strong cingulum which starts prominently at the base of
the anterior part of the posterior accessory tubercle-I and travels distally terminating at the base of the hypoconulid. The enamel of the tooth is comparatively thick and smooth.

Discussion:

The Upper Sivaliks of India are represented by a number of suid genera, namely Sivachoerus, Tetraconodon, Dicoryphochoerus, Potamochoerus, Hypchoerus and Sus. The present specimen differs from Sivachoerus and Tetraconodon in its small posterior premolars and a very complicated and elongated third molar. In both Sivachoerus and Tetraconodon the posterior premolars are greatly enlarged and the talonid of the last molar is poorly developed. It can be differentiated from Dicoryphochoerus by the great elongation of the talonid of M₃. Genus Dicoryphochoerus is characterized by the presence of two closely appressed cones on the fourth premolar, comparatively short teeth and relatively simple talonid on M₃.

The present specimen clearly differs from Potamochoerus in the structure of its fourth premolar and the last molar. The P₄ in Potamochoerus exhibits only a single cusp, when viewed from the lateral side. The specimen under discussion displays four cusps on P₄, as is the case with Hypchoerus and Sus. It further differs from Potamochoerus in the complexity of the crown of its M₃,
which possesses a very long talonid. In Potamochoerus $M_3$ is relatively simple and the talonid is comparatively short.

The genus Hippohyus is characterized by molars with a very complex enamel pattern and a comparatively small third molar. The present specimen can be clearly distinguished from Hippohyus, as it lacks the complex enamel pattern of Hippohyus and its last molar is much longer and intricate than the corresponding tooth of Hippohyus. In its morphological details, the present specimen is similar to Sus.

Pilgrim (1926) proposed three new species of the genus Sus, viz., S. peregrinus, S. bakeri and S. cautleyi, from the Upper Sivaliks. Present mandible differs from S. peregrinus in its overall larger size. Besides this, unlike the present specimen, the cheek teeth in S. peregrinus are slender and simple. The cusp pattern and the talonid of $M_3$ of the mandibular fragment under discussion are very much different from that of S. bakeri which is characterized by molars with simple cusps and a simple talonid on $M_3$. In the present case, $M_3$ exhibits complicated cusp pattern and a long and complex talonid.

Sus cautleyi was erected on the basis of maxillary teeth. Since only the mandibular dentition is available in the present specimen, it is not possible to compare it with Sus cautleyi. However, the present specimen differs
from *S. cautleyi* in the size of second molar which is shorter than the maxillary second molar of *Sus cautleyi*. Although, $M_2$ of *S. cautleyi* is not available for comparison, in all probability it must have been longer than $M_2$ of the present specimen, as the lower molars are usually longer than the corresponding upper molars. The specimen under discussion differs from *Sus hysudricus* in its complex $M_2$ with a very long and complicated heel. It further differs from *S. hysudricus* in the shortening of posterior premolar and molar series (except $M_2$). A plot of the maximum length of $M_2$ and the combined length of $M_1$ and $M_2$ of some Upper Sivalik suids is presented in Text Fig. 39.

The only form to which the present mandible is to some extent comparable, is *Sus falconeri*. But, it differs from the latter in having a longer $P_4$. The $M_1$ and $M_2$ of the present specimen are roughly squarish and they differs from the same of *Sus falconeri* in their shorter length and greater breadth. It can be further differentiated from *Sus falconeri* by its more elongated $M_3$ with a talonid of great complexity. The present specimen is characterized by the shortening of the posterior premolar and molar series, excluding $M_3$ which has lengthened at their expense. The length of its $M_2$ is much greater than the combined length of $P_4-M_2$ and almost approaches the combined length of $P_2-M_2$. In the case of *Sus falconeri* the length of $M_3$ is
TEXT FIG. 39

SCATTER DIAGRAM OF MAX. MESIO-DISTAL DIAMETERS OF M + M AND M OF SOME UPPER ŠIVALIK Sus SPECIES
slightly more than the united length of $M_1$ and $M_2$, as is evident in the scatter diagram (Text Fig.39). In other words, there is much less reduction in the posterior premolar and molar (except $M_2$) series in *S. falconeri* than the present specimen. The present specimen can be further distinguished from *Sus falconeri* by the presence of a prominent cingulum at the disto-buccal border of $M_3$, and in having a comparatively thick (2.3 mm) enamel on the molars. Thus, keeping in view its morphological and metrical differences with other suid taxa known from Upper Sivaliks, the present specimen has been assigned here to a new species of *Sus*, viz., *Sus pinjorensis*. $M_3$ in this form has elongated at the expense of the remaining molars and the last two premolars. From the complexity of its $M_3$ and from the aforesaid characters it appears that *Sus pinjorensis* was a very advanced *Sus*, approaching the warthog to a certain extent.
Text Fig. 40 Occlusal view of a left mandibular half of *Sus pinjorensis* sp. nov. (x 1)
Infraorder Ancodonta Matthew, 1929

Superfamily Anthracotherioidea Gill, 1872

Family Hippopotamidae Gray, 1821

Diagnosis:
Facial region of skull considerably exceeds cranial in length. Sagittal crest present. Orbit closed posteriorly by bony arch. Zygomatic arches without processes. Lower jaw massive, with broad symphysial part and with two small processes below (possibly corresponding to angular processes). $I \frac{3}{3} - 2 C \frac{1}{1} P \frac{4}{3} - \frac{3}{2} M \frac{3}{3}$. Incisors cylindrical and rootless (permanently growing) and curved back; canine enamel coarsely rugose (grooved). Upper canines reniform in cross-section, have a deep groove posteriorly, and point down; lower ones triangular in cross-section and with shorter posterior side. Molars have moderately high crowns and four blunt plicated tubercles. $M_3$ with a mono- or bicuspid talonid, $M_3$ without talon. Upper Miocene to present (Gromova, 1968).

Genus Hexaprotodon Falconer and Cautley, 1836

Diagnosis:
Dentition complete, six incisors almost equal, arranged in the transverse range. Premolars strong, whose disposition strongly diverge anteriorly, especially regarding the mandible. The brain-case is relatively small. Frontal is disposed between the lacrimal and nasal,
like Choeropsis. Premaxillae are coming in contact on all their length. Astragalus is relatively narrow, having tibial trochella in oblique direction. Pliocene to Pleistocene (Piveteau, 1961).

Type species **Hexaprotodon sivalensis**

*Falconer and Cautley, 1836*

Species **Hexaprotodon sivalensis**

*Falconer and Cautley, 1836*

(Pl.21, Figs.A-F; Text Fig.41)


1838 *Hexaprotodon sivalensis* (Falconer and Cautley), McClelland, *Jour. As. Soc. Bengal*, vol.7, p.1042, pl.59, fig.4.

1847 *Hippopotamus (Hexaprotodon) sivalensis* Falconer and Cautley, *Fauna Antiqua Sivalensis*, pls.59-61; pl.62, figs.1-10, pls.63-66; pl.58, figs.19-21.


1950 *Hippopotamus sivalensis* Falconer and Cautley, Hooijer, *Zool. Verhand.*, No.8, pp.40-49, pl.4, fig.2; pl.10, fig.2.

**Diagnosis:**

Size moderate to large; orbit low to moderate; occiput high to moderate, brain case relatively small; well-developed sagittal crest; lacrymal in contact with orbit but separated from nasal by an extension of the frontal; post dental part of calvarium long to moderate. Upper molars large with lobes of anterior cusps in transverse valley opposed to those of posterior cusps; posterior lobe of paracone never markedly extending buccally beyond anterior lobe of metacone; cingulum variable in development. Mandibular symphysis very long to long relative to width, and very low relative to length. Horizontal ramus low to moderately low at M₂ relative to length and height at M₂ equal to or less than M₁-M₃. I₂ two thirds to about equal in size to I₁, and I₃ slightly smaller than I₁. First premolar large (Colbert, 1935; Hooijer, 1950).
Holotype: A calvarium described by Falconer and Cautley in 1836

Horizon: Upper Šivaliks

Locality: Šivalik Hills

Additional Material:

PUA 78/90 a left mandibular fragment with M₂- M₃ and the alveolii of M₁, P₄ and P₃.

PUA 78/91, a right M₂.

Horizon: Pinjor Formation of Upper Šivaliks.

Locality: PUA 78/90, about 0.5 km north of Nadah; PUA 78/91, about 0.25 km northwest of Tanda.

Description:

PUA 78/90

The left mandibular fragment under description preserves a portion of the horizontal ramus with M₂, M₃ and alveolii of M₁, P₄ and P₃. Anteriorly, it is broken mesial to the alveolus for P₃ and posteriorly, distal to M₃. The horizontal ramus exhibits a mild outward curvature, resulting in a tooth row which is slightly divergent mesially. The buccal as well as lingual surfaces of the ramus are smooth. It shows a gradual increase in depth from mesial to the distal end and is deepest below M₂, where a slight protuberance is visible on the lower border. On the buccal surface, the ramus shows a moderately developed mantle foramen that lies 48 mm below the alveous of P₄.
The crown of $P_3$ is broken, leaving behind two robust roots, implanted in the alveolus.

Like the previous tooth the crown of this tooth is also not preserved and only two roots are visible in the alveolus.

It is broken at the cervical margin, preserving only the roots. From the alveolus, it appears that it was the smallest tooth of the molar series.

It is roughly rectangular in outline and exhibits a well worn crown. The tooth is slightly broken along its buccal margin. Due to excessive wear, most of the morphological features of the tooth have been obliterated. The molar consists of four major conids, viz. mesio-buccal protoconid, mesio-lingual paraconid, disto-buccal hypoconid and disto-lingual metaconid. Along the buccal margin of the molar, protoconid and hypoconid are damaged. Lingually, a narrow re-entrant separates paraconid and metaconid. Two enamel islands, in the mesial and distal halves of the molar are represented by dentine alteration pits. The remnant of the anterior folds of the paraconid are still visible near the mesio-lingual angle of the molar. The tooth displays two strong pressure facets, one each on the mesial and distal walls. The molar displays a comparatively thick enamel (2.9 mm).
It is rather elongated, and is roughly triangular in shape with the apex of the triangle directed distally. The tooth crown shows four major conids namely, protoconid, paraconid, hypoconid and metaconid. The folding of the conids has given the occlusal surface a trefoil pattern. The protoconid occupies the mesio-buccal aspect of the crown and shows mesial and distal folds running vertically along its height. The medial walls of protoconid and paraconid have worn down, and are represented by a small enamel island in the medial plane of the mesial half of the tooth. The mesio-lingual aspect of the tooth is occupied by paraconid which also shows mesial and distal folds. The distal lobe of paraconid lies lingually to the mesial lobe of hypoconid.

The distal half of the tooth is formed by a disto-buccal hypoconid and a disto-lingual metaconid. Like the protoconid and paraconid, the hypoconid also displays medial and distal folds. Metaconid is much smaller than hypoconid and lacks the mesial and distal folds. The medial wall of the metaconid is tightly pressed against the hypoconid. The median transverse valley, between the mesial and distal rows of conids, is blocked in the median plane by distal and mesial loes of paraconid and hypoconid, respectively.
The distal-most portion of the tooth is occupied by a much pronounced hypoconulid which is slightly touched by wear. On the buccal side, mesial to the base of hypoconulid, a small and well-developed accessory tubercle can be differentiated. A very prominent anterior cingulum starts at the base of protoconid and travels lingually, taking the shape of a mesio-distally compressed lophid, to terminate at the base of metaconid. Due to wear, the anterior cingulum has become continuous with paraconid. The tooth enamel is rather smooth and thick (4.0 mm at hypoconulid).

PUA 78/91

The specimen under description is a beautifully preserved right M₂ which does not exhibit much wear. It is roughly rectangular in outline with a fairly high crown. The occlusal surface shows four prominent cuspids, viz., mesio-buccal protoconid, mesio-lingual paraconid, disto-buccal hypoconid and disto-lingual metaconid. All the four major cuspids show vertical, mesial and distal grooves which impart a trefoil pattern to the tooth. The protoconid is the largest conid and its distal lobe extends up to the median valley where it lies lingual to the mesial lobe of the hypoconid. The mesial lobe of protoconid is much smaller than its distal lobe. The paraconid is smaller than the protonid and its mesial lobe is larger than the distal one which is pressed against the medial wall of protoconid.
The distal half of the molar consists of a disto-buccal hypoconid and a disto-lingual metaconid. The metaconid is smaller than hypoconid. The mesial and distal vertical grooves of these two conids are comparatively less prominent. The metaconid and hypoconid are pressed together thereby blocking the median valley. The distalmost portion of the molar is occupied by a relatively small hypoconulid which is slightly broken at its tip. The hypoconid is lower than other conids of the molar. Mesially, the tooth displays a very strong cingulum which has acquired the shape of a strong wall. The anterior cingulum is almost as high as other conids and is beaded on the top. The anterior cingular development shows an easily distinguishable pressure facet apparently caused by the preceding tooth. Lingually, a prominent cingular shelf encircles the base of paraconid. Cingular developments can also be noticed at the base of hypoconid. The molar shows four robust roots, one each below protoconid, paraconid, hypoconid and metaconid. A few comparatively shallow pits can be seen on the tooth which might have been the result of dental caries.

**Referred Material:**

PUA 78/92, a mandibular fragment with \( M_2 \) and \( M_3 \) recovered from Pinjor Formation about 0.75 km northeast of Saketri.
PUA 78/93, a lower canine recovered from Pinjor Formation about 2 km northeast of Parach.

Discussion:

Falconer and Cautley created Hexaprotodon as a subgenus of Hippopotamus. Owen (1845) raised Hexaprotodon from a subgeneric status to a generic rank. Lydekker (1882b) and other subsequent workers held the view that it was not justifiable to separate Hexaprotodon from Hippopotamus. Matthew (1929) doubtfully distinguished Hexaprotodon from Hippopotamus, without giving a complete list of its distinguishing characters. It was Colbert (1935) who, after a careful study, firmly advocated the distinct generic status of Hexaprotodon and he innumerated a number of distinguishing characters.

From India, Burma and Ceylon, the genus Hexaprotodon is known by five species, viz., H. sivalensis, H. namadicus, H. palaeindicus, H. iravaticus and H. sinhaleyus. H. sivalensis occurs in the Sivaliks from Dhokpathan Formation (Middle Pliocene) to Pinjor Formation (Lower Pleistocene). H. namadicus and H. palaeindicus have been reported from the Narbada Basin (Middle Pleistocene) and Godavari basis (Upper Pleistocene), respectively. H. iravaticus comes from the Irawady System of Burma, while H. sinhaleyus have been reported from the Ratanpur Series (Upper Pleistocene) of Ceylon. Two more species of
Hexaprotodon, viz., *H. platyrhynchus* and *H. megagnathus* were created by McClelland (1838) on the basis of their snout characters. But Lydekker (1884) considered the validity of these two species as doubtful. Lydekker distinguished two further subspecies of *H. sivalensis*, viz., *H. sivalensis latidens* and *H. sivalensis angustidens*. He differentiated these two forms on the basis of the breadth of the molars; the former with broad molars, and the latter with narrow molars. After studying the skulls of Sivalik hippopotami, Matthew (1929) opined that there existed a lot of individual variation in the anatomical features of skulls. His work negated the conclusions of Lydekker, who had suggested subspecific differences in this group. Colbert (1935) also expressed doubts regarding the varietal distinctions within the species *Hexaprotodon sivalensis*.

The present specimen, PUA 78/90 shows a strongly diverging premolar series, as is evident from the alveoli of premolars. This is a feature that characterizes *Hexaprotodon* (Piveteau, 1961). In this respect the present specimen differs from *Hippopotamus*, in which the premolars are almost parallel. The molars in the present ramus are arranged in a straight line thereby differing from *Hippopotamus* in which the last molar is placed slightly laterally resulting in a greater distance between the last molars as compared to the distance between the second
premolars. In other words, in *Hexaprotodon sivalensis* the molars are nearly parallel to each other (Colbert, 1935). It is not easy to give its specific identification on the basis of the morphology of mandibular teeth. The identification is more accurate if the symphysis is also preserved. Unfortunately, in the specimen under discussion the symphysis is not preserved. The present material differs from *H. iravaticus* by its larger size and greater complexity of enamel pattern. *H. sivalensis* can be differentiated from other species of *Hexaprotodon* by its greater length of the molar series in comparison with the depth of the horizontal ramus below M₂. Hooijer (1950) laid stress on the height of the ramus at M₂ in relation to the length of the molar series, while discussing the genus *Hexaprotodon*. The length-height index (length of M₁-M₂/Depth of ramus at M₂ x 100) for *H. sivalensis* varies from 100 to 141. For the present specimen this index is 107, and in this regard it falls well within the limits of *H. sivalensis*. Since *H. namadicus* and *H. palaeindicus* are known only from the Narbada and Godavari basin, respectively, and since *H. sivalensis* is the only species known from the Śivaliks, in most probabilities, therefore, the present specimen PUA 78/90 belongs to *Hexaprotodon sivalensis*. 
### Comparative measurements of some species of *Hexaprotodon*

<table>
<thead>
<tr>
<th>Measurement</th>
<th><em>H. sivalensis</em></th>
<th><em>H. palae-_indicus</em></th>
<th><em>H. iravaticus</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>PUA Present</strong></td>
<td><strong>Colbert, Hooijer,</strong></td>
<td><strong>Hooijer,</strong></td>
</tr>
<tr>
<td></td>
<td><strong>collection</strong></td>
<td><strong>1935,</strong></td>
<td><strong>1950</strong></td>
</tr>
<tr>
<td></td>
<td><strong>PUA</strong></td>
<td><strong>No. 19776</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>fig. 125</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of molar series (M₁⁻M₃)</td>
<td>123.90</td>
<td>- 154.00*</td>
<td>-</td>
</tr>
<tr>
<td>Depth of ramus below M₂</td>
<td>115.00</td>
<td>- 118.00</td>
<td>-</td>
</tr>
<tr>
<td>Max. mesio-distal dia. of M₁</td>
<td>25.00</td>
<td>- - 36.00</td>
<td>38.00</td>
</tr>
<tr>
<td>Max. bucco-lingual dia. of M₁</td>
<td>- - 32.00</td>
<td>33.00</td>
<td>-</td>
</tr>
<tr>
<td>Index</td>
<td>- - 88.88</td>
<td>86.84</td>
<td>-</td>
</tr>
<tr>
<td>Max. mesio-distal dia. of M₂</td>
<td>41.00 43.50</td>
<td>52.90 44.00</td>
<td>48.00</td>
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<tr>
<td>Max. bucco-lingual dia. of M₂</td>
<td>34.50 39.30</td>
<td>37.80 40.00</td>
<td>39.00</td>
</tr>
<tr>
<td>Index</td>
<td>84.14 90.34</td>
<td>71.45 90.90</td>
<td>81.25</td>
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<tr>
<td>Max. mesio-distal dia. of M₃</td>
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<td>- 64.50 60.00</td>
<td>72.00 68.00</td>
</tr>
<tr>
<td>Max. bucco-lingual dia. of M₃</td>
<td>35.50</td>
<td>- 38.00 42.00</td>
<td>41.00 43.00</td>
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<tr>
<td>Index</td>
<td>60.16</td>
<td>- 58.91 70.00</td>
<td>56.94 63.23</td>
</tr>
</tbody>
</table>

* Approximate
** Estimated from the figure
Text Fig. 41  Left mandibular fragment with $M_2$ and $M_3$ of *Hexaprotodon sivalensis* (x 1)
Diagnosis:

Dimensions variable, ranging from the size of a rabbit to that of a large elk. Except in the earliest forms the males of almost all species possess on their frontal bones at least one pair (sometimes more) of solid antlers of varying shape and size; these antlers are usually branched and located on frontal processes, are not covered by sheaths, and are shed yearly (except for the pedicels), in most forms increasing in complexity with age from year to year. The females are hornless except in Rangifer. No air cavities in the frontal bones on the pedicels. Facial region of the skull considerably longer than the cranial region. In earlier forms there is a low sagittal crest, in later forms the parietal crests are widely separated. Unlike other ruminants the notch between the anterior ends of the premaxillae is almost closed in form of a ring. Anteorbital fossae, of varying size and depth almost always present; lachrymal bones bear two lachrymal foramina. Incisor crowns short, well delimited from the root, with one or two crests on the posterodorsal surface; incisors straight or with an outer
angle highly elongated laterally and an asymmetrical triangular crest, with \( I_1 \), usually broader than the rest. The incisors do not overlie each other. Upper canines either absent or present and of varying shape and size, being larger in males and sometimes long and saber-like. \( P_1 \) always absent and \( P_4 \) usually so. Cheek tooth crown height from low to moderate, with crown broader than root. Premolars longer in early forms, subsequently shortening. Molars exhibit pronounced selenodonty, having four (on \( M_3 \), five) crescents, and in many forms a Palaeomeryx fold. Extremities almost always (except in the recent Cervulinae) functionally tetradaactyl, with lateral digits thinner and shorter than the middle ones. Median metapodia always fused, lateral ones complete in early forms, with only their proximal or distal ends - or both - retained in lateral ones. (Gromova, 1968).

\[ \text{Subfamily Cervinae Braid, 1857} \]

**Diagnosis:**

From medium-sized to very large. Parietal crests widely separated and not converged into a sagittal crest. Antlers always present in males and mounted on short pedicels whose length from the margin of the orbit is almost always smaller than the length of the upper cheek-tooth row; deciduous parts long, with a main beam and in
adults at least three tines (differing in size and shape), and sometimes spatulate. Vomer as in subfamily Cervulinae. Ethmoidal fissure always present; anteorbital fossae vary in size. Auditory bullae variable. Anterior margins of the premaxillae as in subfamily Cervulinae. Upper canines of the males absent or small and blunt, more rarely saberlike. Molar crown height from moderate to low; no palaeomeryx fold in most forms, and cingulum absent or weak. Premolars as in subfamily Cervulinae. Upper Miocene to present (Gromova, 1968).

Genus **Rucervus** Hogdson, 1838

**Diagnosis:**

Antlers without the second tine ("surandouiller"). Muzzle naked and well-developed. Upper molars with an accessory column on the internal side. Height at shoulders varies between 1.03 meter to 1.15 meter. Three living species, which have their antlers so much different that this character is sufficient to distinguish them from one another (Grasse', 1955).

**Species** **Rucervus simplicidens** (Lydekker), 1876

(Pl. 22, Fig.A; Text Fig. 42)

1876 *Cervus simplicidens* Lydekker, Pal. Indica, ser. 10. vol. 1, p. 51, pl. 8, fig. 3.


Diagnosis:
Molar crowns square with small accessory pillars, not obliquely set, and with slightly rugose enamel. It differs from C. punjabiensis by the acute shape of the inner crescents of upper molars (Colbert, 1935 and Azzaroli, 1954).

Holotype: G.S.I. No.B204, a maxillary fragment with left M¹-M².
Horizon: Probably Upper Śivaliks (Brown); Middle Śivaliks (Pilgrim).

Locality: Śivalik Hills of Punjab.

Additional material:

PUA 78/79, a partial antler with the burr, brow-tine and a part of the beam.

Horizon: Pinjor Formation of Upper Śivaliks.

Locality: About 0.5 km west of Nadah.

Description:

The specimen under description is the basal portion of the antler, probably of the right side. The pedicle is not preserved and the base of the antler shows a strongly developed burr with an irregular margin. On the lateral side of the antler, a part of the burr is not preserved. The beam is comparatively slender and displays a slight backward bend. It is nearly circular in cross-section and shows longitudinal grooves on its surface. The lateral side of the beam is more rough as compared to the inner side. A shallow depression starts in the middle of the inner surface of the beam, just above the brow-tine, continues for some distance and becomes indistinguishable near the free end of the beam. The brow-tine arises slightly above the burr and makes an obtuse angle (88°) with the beam.
The brow-tine is thick at its base and gradually tapers towards its free end, where it is broken. As such, the brow-tine seems to be curving slightly forwards and somewhat away from the beam and is roughly oval in cross-section. The base of the antler, just above the burr, is brown while the other parts are greyish in colour.

Referred material:

PUA 77/41, a portion probably of the right antler with the burr and a part of the beam, recovered from Pinjor Formation about 1 km. northeast of Nadah.

PUA 79/1, a portion of the base of the antler with a broken pedicle, burr and a small portion of brow-tine, recovered from Pinjor Formation about 0.5 km north of Nadah.

Discussion:

The Upper Sivaliks of India are represented by two cervid genera, namely, *Cervus* and *Rucervus*. Genus *Cervus* is known from the Indian Sivaliks by four well recognised species, viz., *C. sivalensis*, *C. triplidens*, *C. simplicidens* and *C. punjabiensis*. Lydekker (1876) established a new species, *C. latidens*, based on two isolated maxillary molars. He reassigned this species to the genus *Oreas*, some years later. Azzaroli (1954) proposed a new species, *C. colberti*, on the basis of a skull (A.M., 19829) which was earlier designated as *C. sivalensis* by Colbert (1935).
C. triplidens was based on meagre material, and its validity was doubted by Colbert (1935).

Azzaroli (1954) recognised the occurrence of the genus Rucervus from Indian Šivaliks, when he changed the generic status of Cervus simplicidens to Rucervus simplicidens. On the basis of skull and dental features he reassigned the type material of Cervus simplicidens to Rucervus simplicidens. In the same paper, he referred the antlers in the British Museum to three species of the genus Rucervus, viz., Rucervus sp. I, Rucervus sp. II and Rucervus sp. III, without giving any specific names. The beams of all the antlers referred to the aforesaid three species of the genus Rucervus show backward bending and are not significantly different from each other. The amount of differences shown by them can be easily attributed to the variation within a species. As is evident from the figures of the specimens, these three species are very much similar to R. simplicidens. Hence, Rucervus sp. I, Rucervus sp. II and Rucervus sp. III should be put under Rucervus simplicidens.

Following Azzaroli (1954), the present antler has been provisionally assigned to Rucervus simplicidens. It can be differentiated from Cervus sivalensis by its slender nature and inferior size. The present specimen shows a comparatively rough and longitudinally grooved surface. In this regards it differs from C. punjabiensis in which the
antler is comparatively smooth. The beam of the antler under discussion shows a backward bending. The species \textit{R. simplicidens} can be differentiated from the species \textit{C. punjabiensis} by the backward curvature of the beam in the former (Azzaroli, personal communication). The brow-tine of the present antler seems to be curving more forwards thereby differing from \textit{C. punjabiensis} in which the brow-tine curves less forwards and more towards the beam. The brow-tine in the specimen under consideration arises nearer the burr as compared to the same portion in \textit{C. punjabiensis}. 
<table>
<thead>
<tr>
<th>Measurement</th>
<th>R. simplicidens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. length of the preserved portion</td>
<td>98.00</td>
</tr>
<tr>
<td>Transverse dia. above burr</td>
<td>37.00</td>
</tr>
<tr>
<td>Antero-posterior dia above burr</td>
<td>47.50</td>
</tr>
<tr>
<td>Circumference of beam above brow-tine</td>
<td>111.00</td>
</tr>
<tr>
<td>Angle of brow-tine with beam</td>
<td>88°</td>
</tr>
</tbody>
</table>
Text Fig. 42 Basal part of the antler of *Rucervus simplicidens* (x1)
Family Giraffidae Gray, 1821.

**Diagnosis:**

Medium-sized to large mammals; the living forms reach a height of 3 meters at shoulder. The skull usually bears horns which are as a rule small, simple and vary in number, position and shape; in living forms they are covered with hairy skin. The air cavities of the frontals pass into the basal part of the horn and sometimes also spread into the whole length of the main stem of the horn (*Sivatherium*). Ratio of cranial to facial region varies. Sagittal crest and antorbital fossae lacking; one or two lachrymal foramina on lachrymal bone. $I^{0}_{3} C^{0}_{1} P^{2}_{3} M^{3}_{2}$. The outer incisors slightly overlie the inner ones; crown as a rule elongated and well-marked off from roots. No upper canines; lower ones, unlike in other families, are bilobed. $P^{1}_{1}$ always lacking. Cheek teeth have low to moderately high crowns, with wrinkled enamel; premolars moderately long, with some general type of structure as in Bovidae. Palaeomeryx folds as a rule absent, there is no cement on the teeth. Unlike in other ruminants, extremities and neck more or less elongated in many forms, in some of them the forelimbs being longer than the hind ones. Extremities bidactyl; carpals and tarsals as in Bovidae. Third and fourth metapodia fused, the lateral metapodia sometimes persisting in the form of very small proximal rudiments;
the lateral digits are lacking. Lower Miocene to present (Gromova, 1968).

Subfamily Sivatheriinae Zittel, 1893

Diagnosis:
Large animals; skull short and broad in most genera; the horns are sometimes lobed, flattened, and situated on the frontals and parietals. Air cavities of skull large. Crown height of teeth moderate. Neck and extremities for the most part massive and not elongated. Upper Miocene to Pleistocene (Gromova, 1968).

Genus Sivatherium Falconer and Cautley, 1835

Diagnosis:
A gigantic Pleistocene giraffid; male skull short, high, and sharply broadened from front to back, bearing two pairs of horns; a conical, forward-directed anterior pair on the frontals, and a powerful lobate and flattened posterior pair on the parietals. Frontals broadened and flat, with anterior section somewhat concave longitudinally. Nasals short and vertically bowed in the form of a dome. Female skull hornless, longer and lower, and not sharply broadened from front to back; frontal bone convex. Facial region short in both the sexes, and anterior margin of orbit situated above $M^2$. Cranial region higher than facial region, more considerably so in the male than in the
female. The teeth are large, with rugose enamel; great development of costae on the external surface. Body and limbs heavy, limbs not elongated; metacarpals much expanded laterally (Colbert, 1935; Gromova, 1968).

Type species: **Sivatherium giganteum** Falconer and Cautley, 1835

Species:** Sivatherium giganteum** Falconer and Cautley, 1835


1871 *Sivatherium giganteum*, Falconer and Cautley, Murie, *Geol. Mag.*, vol. 8, p. 448.


**Diagnosis:**

A gigantic Pleistocene giraffid, with four horns in the male, an anterior conical pair, arising from the frontals, and a posterior, palmate pair situated on the parietals. As in other gigantic Sivalik giraffids there are deep pits in the temporal fossa for the temporal muscles, and on the supra-occipital for the neck muscles.
The face is very short, the nasals being retracted and strongly curved. The teeth are large, with rugose enamel. Body and limbs heavy, limbs not elongated (Colbert, 1935).

**Holotype:** Brit. Mus. No.15283, a skull.

**Paratypes:** Brit. Mus. Nos.40667, a mandible; 39525, fragment of a posterior horn-core.

**Horizon:** Upper Sivaliks.

**Locality:** Sivalik Hills.

**Additional material:** PUA 77/51, a partial right maxilla with M₁-M₃.

**Horizon:** Pinjor Formation of Upper Sivaliks.

**Locality:** About 1 km northeast of Tanda.

**Description:**

The specimen under description preserves the right maxilla, with a full complement of molars, and a part of the palate. The maxilla is broken above the mesio-distally convex alveolar process, thereby exposing the sinuses of maxilla. The preserved portion of the palate is nearly flat.

M₁

The first molar is the smallest tooth of the molar series and its bucco-lingual diameter exceeds the mesio-distal diameter. The tooth is excessively worn and most of the enamel features of crown have obliterated.
The fossettes cannot be differentiated. The molar is implanted in the alveolus by four robust roots.

$M^2$

This molar is also broader than long and is bigger in size than $M^1$. The crown shows four major cones, viz., mesio-buccal paracone, mesio-lingual protocone, disto-buccal metacone and disto-lingual hypocone. In its mesial and distal halves the molar exhibits prefossette and post-fossette, respectively. Due to heavy wear, the fossettes are reduced to shallow enamel bound depressions. A narrow and bucco-lingually elongated fossette can be seen between pre-fossette and post-fossette. The tooth enamel is moderately thick and highly rugose. This heavily worn molar is supported by four stout roots, one below each of the four major cones. The lingual side of the molar is slightly damaged.

$M^3$

The third molar is roughly squarish in outline and is the best preserved tooth of the molar series. Its distal half is narrower than the mesial one. The tooth crown displays four cones, viz., mesio-buccal paracone, mesio-lingual protocone, disto-buccal metacone and disto-lingual hypocone. The buccal aspect of the molar exhibits three styles namely, mesio-buccal parastyle, medio-buccal mesostyle and disto-buccal
metastyle. Parastyle is the most developed style; the metastyle is only slightly developed. Two prominent costae, one between parastyle and mesostyle and the other between mesostyle and metastyle, can be distinguished on the buccal side of the molar. The mesial costa is more prominent than the distal one.

Paracone and protocone are separated by a deep pre-fossette, in the mesial half of the molar. A similar fossette, the post-fossette, is discernible between metacone and hypocone, in the distal half of the tooth. The distal limb of the pre-fossette is slightly plicated. The tooth enamel is moderately thick and highly rugose. The molar is moderately worn.

Referred material:

PUA 77/29, distal portion of a left metacarpal recovered from Pinjor Formation about 1.5 km east of Tanda.

PUA 79/4, a left maxillary M² recovered from Pinjor Formation about 0.5 km north of Nadah.

Discussion:

Genus Sivatherium is known from the Sivaliks of India by a single species, S. giganteum. The only other species of Sivatherium, S. olduvaiensis, which was established on a very meagre material, is known from the Pleistocene of Africa.
The present specimen differs from *Giraffa punjabiensis* and *Giraffa sivalensis* in its overall larger size. Pilgrim (1910) created a new giraffid taxon, viz., *Indratherium majori* from the Upper Sivaliks. The type of this giraffid, a hornless skull, was originally described as a hornless female of *Sivatherium* by Falconer and Cautley. Matthew (1929, p.552) held the view that *I. majori* was the hornless female of *Sivatherium*. Colbert (1935, p.348) stated that *I. majori* was probably synonymous with *S. giganteum* and the type skull was the hornless female of the latter.

Present specimen shows close morphological and metrical resemblances with *S. giganteum*, therefore, it has been assigned to *Sivatherium giganteum*. 
TABLE 25

Comparative measurements of the maxillary molars of some Upper Sivalik giraffids

<table>
<thead>
<tr>
<th>Measurements</th>
<th>Sivatherium giganteum</th>
<th>Giraffa punjabiensis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Present specimens</td>
<td>Colbert, 1935, p.345</td>
</tr>
<tr>
<td></td>
<td>PUA 777/71</td>
<td>PUA 79/4</td>
</tr>
<tr>
<td>Length of molar series M₁-M₃</td>
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</tr>
<tr>
<td>Max. mesio-distal dia. of M₁</td>
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<td>-</td>
</tr>
<tr>
<td>Max. bucco-lingual dia. of M₁</td>
<td>47.00</td>
<td>-</td>
</tr>
<tr>
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<td>120.00</td>
<td>-</td>
</tr>
<tr>
<td>Max. mesio-distal dia. of M₂</td>
<td>48.00</td>
<td>49.00</td>
</tr>
<tr>
<td>Max. bucco-lingual dia. of M₂</td>
<td>54.00</td>
<td>50.00</td>
</tr>
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<td>102.04</td>
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<tr>
<td>Max. mesio-distal dia. of M₃</td>
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<td>-</td>
</tr>
<tr>
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<td>51.00</td>
<td>-</td>
</tr>
<tr>
<td>Index</td>
<td>98.07</td>
<td>-</td>
</tr>
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</table>

* Estimated from the figure.
Text Fig. 43  Occlusal aspect of a right maxilla with $M^1 - M^3$ of *Sivatherium giganteum* (x 1)
Family Bovidae Gray, 1821

Diagnosis:
Size variable, ranging from that of a rabbit to that of a large bull. On the frontals, the males and often also the females bear a pair of permanent, non-deciduous outgrowths (horn-cores) covered by permanent sheaths of cornified epidermal skin. The frontals usually contain sinuses which often extend into the horn-cores and sometimes reach their tips. The facial region of the skull is (generally) longer than the cranial region, and if shorter, then very rarely by more than 1/6 of the length of the latter. The parietal crests are always separated and do not form a sagittal crest. Anteorbital fossae present or absent; the lachrymal bone bears one lachrymal foramen. \(1\frac{3}{5} 0 \cdot 0 \cdot 3 + 2 \cdot 2 - 2 \cdot 2 - \frac{3}{2}\). \(P^1\) and \(P_1\) always absent, \(P_2\) sometimes as well. Incisors from short crowned, with a distinct boundary between crown and root, to long crowned with indistinct merging of crown with root; variable in shape, the inner ones (\(I_1\)) sometimes being considerably broader than the rest, with an asymmetrical triangular crown in which the outer angle is strongly elongated laterally. The outer margins of the incisor crowns often overlie each other. There are no upper canines. The cheek teeth are from low crowned (in primitive forms) to high crowned (in progressive forms). Premolars are relatively short, the upper premolars being molarized. The molars
are distinctly selenodont, with four cresents \( M_3 \) usually bears a fifth, accessory lobe, the heal); the palaeomeryx fold is always absent. The cheek-tooth enamel is smooth and unwrinkled, very often covered from above by a cement layer. The extremities are functionally bidactyle. In the carpus the capitate bone is fused with the trapezium, and in the tarsus the navicular is fused with the cuboid and the second cuniform with the third. The second and third metapodia are always fused, the lateral ones (second and fifth) being absent or incomplete (without their distal ends); in the skeleton of the lateral digits there remain at most the rudiments of one or two phalanges (and that very rarely) (Gromova, 1968).

Subfamily Bovinae Gill, 1872

**Diagnosis:**

Large, more rarely medium-sized. Skull in early and more primitive forms with well-developed cranial and post-horn region, growing shorter in course of evolution; in more progressive forms post-horn region greatly shortened, sometimes completely displaced back and situated vertically in the same plane as the occiput or even overhanging the latter; contrarily, the frontal region broadens and grows longer at the expense of the abbreviation of the post-horn region. Facial region sometimes shorter than cranial region, and when longer then by no more than 1/3 of the length of the
latter. Squamous portion of the temporal always contiguous with the supraoccipital bone; mastoid bone not contiguous with the parietal. Auditory bullae usually large, inflated, laterally compressed, and almost always project below the level of the basioccipital. Basioccipital elongated, posteriorly broadened and anteriorly narrowed, sometimes ventrally flattened only in the median part; lateral margins not pointed. In the region of the pterygoid crest, at the boundary between the temporal fossa and orbit, the arrangement of bones varies, but the orbitosphenoids are sometimes not connected with the temporal. Position of the posterior margin of the bony plate with respect to the posterior margin of the toothrow varies. Anteorbital fossae present only in the most primitive and early forms; ethmoidal fissure present or absent. Nasals moderately long or long, with their posterior ends little broadened, and do not participate in the formation of the anteorbital fossae; profile of the nasals straight or slightly convex. Orbits project laterally to various degrees, and their anterior margins are not retracted beyond the level of $M^3$. In typical cases the frontal bones are highly pneumatized, often giving off cavities not only into the horn-cores (to their tips), but also into the neighbouring bones (the parietals and occipital); the shape of the frontal surface varies, being usually uneven and interorbitally depressed. The supraorbital foramina vary in size and shape.
Horns, except in the most primitive forms, are present in both sexes. The horn-cores are usually widely separated basally and display various external appearances and directions, progressive forms being characterized by a migration of the bases of the horns for back beyond the orbits, sometimes to the very margin of the braincase; the horn-cores are rounded, oval or triangular in cross-section, usually with three carinae.

Incisors with short crowns distinctly delimited from the roots, and are broad; either they evenly decrease in breadth from the first pair towards the incisors, or the inner pair (I₁) is markedly broader than the rest and possesses asymmetrical crowns, the outer corners of which are strongly elongated laterally. Cheek-teeth of early and primitive forms with short crowns, sharply increasing in height in the course of evolution; upper molars with or without accessory styles, lower molars usually possessing accessory tubercles or styles. Outer surface of upper molars of various types, with the ribs and styles on these teeth sometimes reaching a high level of development. Middle Miocene to recent (Gromova, 1968).

Tribe Bovini Simpson, 1945

Diagnosis:
Bovidae of large size, in which the legs tend to become short and massive. The skull enlarged at the level
of orbits as well as at the occipital. Basicranial facial angle around 30°. Parietal, in the case of primitive form (Proamphibos) forms, in the posterior part of the cranial roof, a plane which makes an angle of around 145° with that of face. In the case of advanced forms this is reduced and passes on the occipital level to the point of forming of acute angle with the frontal (Bos). Frontals develop spongy tissues and progressively elongate. The horn-cores exist on both sexes, except in some primitive forms (Leptobos), have the tendency to further behind the orbit. Primitively their section is triangular and becomes subcircular in most primitive cases. The lachrymal is elongated along the contact with the nasal and extends on the face. The squamosal projects to the exterior and forms a large concave (curvature). The basioccipital is short and triangular in its side; tympanic bullae elongate and tend to flatten out laterally. The dentition is primitive partially brachydont, with high crowns and little cement, becomes more and more hypsodont and cement thickens. The upper molars have developed sub-quadrate section and a robust internal median pillar (Piveteau, 1961).

Genus Leptobos Rutimeyer, 1878

Diagnosis:

Large. Skull with well-developed post-horn region, the latter no shorter than the post-orbital region of the
forehead; upper surface of the post-horn region participates in the formation of the roof of the braincase. Surface of parietal region steeply positioned, forming a very obtuse angle with the plane of the forehead, but the parietal surface of the supraoccipital bone slopes back strongly and forms an obtuse angle with the plane of the occiput. Profile of post-horn region in the form of an angle whose vertex is directed forward. Parietal crests project strongly and sharply delimit the parietal surface from the temporal fossae, whose posterior openings are easily seen from the dorsal aspect posterior to the horns; unlike in other genera of the subfamily, these openings are directed towards each other, being separated only by a narrow strip of the parietal surface between the crests. Frontal surface elevated above the orbits, medially depressed or longitudinally concave, merging rearwards without any sharp boundary into the surface of the posthorn region. Supraorbital foramina open into vascular grooves at or somewhat behind the level of the orbits. Forehead broad, its inter-orbital breadth no greater than the breadth of the skull at the level of the molar tubercles. Frontals pneumatized; forehead and sinciput smooth, but, unlike in other genera, the parietal crests give off inwardly-directed supplementary crests posteriorly delimiting the flat post-horn surface. Orbits project markedly to sides, with their anterior margins situated at
the level of $M^3$. Basioccipital bone anteriorly narrowed, while the anterior part of its ventral surface is flattened. Auditory bullae large, laterally compressed. Vomer does not completely divide the choanae and is not fused with the palatine bones; posterior margin of bony palate situated behind the level of the posterior margin of $M^3$. Anteorbital fossae absent; ethmoidal fissures present. Premaxillae connected with the nasals.

Horns present only in males. Horn-cores long (sometimes longer than the skull) and widely separated at base; branch out from the skull not far behind the orbits and are directed backwards at variable angles laterally, then bending in and sometimes also up and forward, displaying a distinct homonymous curve. Surface of horn-cores without carinae but bears numerous longitudinal grooves; cross-section of horns rounded or dorsoventrally flattened.

Cheek teeth high, with a cement layer over the enamel; outer surface of upper molars with well-developed ribs and high rounded sytles, upper and lower molars having highly developed accessory styles (Gromova, 1968).

Type species **Leptobos falconeri** Rutimeyer, 1878
Species **Leptobos falconeri** Rutimeyer, 1878
(P1.24, Fig.A; Text Fig.44)
1878 **Leptobos falconeri**, Rutimeyer, Abh. Schweiz. Palaont. Ges., vol.5, p.157, pl.1, figs.7, 8; pl.4, figs. 3-6, pl.6, fig.9.


1939 **Leptobos falconeri** Rutimeyer, Pilgrim, Pal. Indica, n.s., vol.26, mem.1, pp.305-308, pl.6,fig.6.

**Diagnosis:**

Leptobos with slender skull, especially narrow in brain case; face bent down on parietal surface at angle of about 10° to 20°; supraoccipital foramina opposite orbit and not very far apart; horn-cores with almost circular cross-section, diverging at an angle of about 65° to 80°, but little curved anteriorly and very slightly twisted; parietals about one third the length of frontals; braincase and temporal fossae very shallow; hinder extremities of the temporal fossae very pointed, approaching one another very nearly, interval between them being less than twice as great as length of supraoccipital exposed above lambdoid crest; supraoccipital much deflated towards plane of occipital, being inclined at angles of about 140° and 125° to it and to parietal, respectively (Pilgrim, 1939).
Lectotype: Brit. Mus. (Nat. Hist.) No.40887, a skull figured by Rutimeyer (1828, pl.1, figs.7-8).

Horizon: Probably Pinjor Formation.

Locality: Šivalik Hills.

Additional Material:

PUA 79/2, a horn-core with a part of the frontal bone.

Horizon: Tatrot Formation.

Locality: About 0.25 km east of Masol.

Description:

The specimen under description (PUA 79/2) is a right horn-core which is broken about 96 mm above the base. Only a small part of the frontal bone surrounding the base of the horn-core is preserved. The inner portion of the preserved part of the frontal displays a highly irregular surface which was perhaps in contact with the parietal at the fronto-parietal suture. The undersurface of the bone displays a concavity, probably a part of the cerebral cavity.

The horn-core as such exhibits a slight but gradual reduction in diameter from the base to the free end. It is roughly oval in cross-section and is slightly compressed dorsoventrally. The horn-core does not display any carinae and its surface is marked with numerous longitudinal grooves which are more prominent on its outer side. It is
solid and does not possess air cavities. The preserved part of frontal bone indicates that the horn-core was directed backwards, outwards and upwards, and it formed an angle of less than 90°, probably between 50°-70°, with the skull.

**Referred material:**

PUA 79/3, a partial right maxilla with $P^4-M^3$ which was found in association with the aforedescribed horn-core.

**Discussion:**

The genus *Leptobos* is known from the Indian Sivaliks by a single species, *Leptobos falconeri*, which probably came from the Pinjor Formation of Upper Sivaliks.

The present specimen is characterized by an oval cross-section, absence of carinae and air cavities, and the presence of numerous well-defined grooves on its surface. It differs from *Hemibos* by the absence of carinae, presence of grooves and the absence of air cavities. The specimen under discussion displays an oval cross-section and seems to be bending backwards, outwards and upwards, and in these regards it can be further differentiated from *Hemibos*, the horn-cores of which are characterized by a triangular cross-section and they slope strongly backwards, even below the level of forehead. It differs from *Bubalus* by the absence of carinae and by
the presence of an oval cross-section. In *Bubalus*,
the horn-cores are triangular in cross-section and they
display three well define carinae. The present horn-
core can be differentiated from *Bison* by its lower angle
of divergence. In *Bison*, just after branching from the
skull, the horn-cores diverge laterally at right angles
so that both the horn-cores are at 180° from each other.
It is not easy to calculate the exact angle, but from
the small portion of the frontal bone preserved at the
base of the horn-core, it appears that in any case the
angle which the horn-core made with the skull was less
than 90°, perhaps somewhere between 50° and 70°. The
horn-core under discussion differs from *Bos* by the presence
of numerous distinct longitudinal grooves on the surface
which
of horn-cores are non existent in *Bos*. The present
specimen is smaller in its diameters than the horn-cores
of the holotype. Since it shows morphological features
characteristic of *L. falconeri*, the present specimen has
been assigned here to *Leptobos falconeri*. 
### Comparative measurements of the horn-cores of some genera of Bovini

**TABLE 26**

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Leptobos falconeri Pilgrim, 1939, BM 40867</th>
<th>Leptobos falconeri PILAR 79/2</th>
<th>Leptobos falconeri CAS # 97</th>
<th>Hemibos triquetricornis Pilgrim, 1939, p. 269</th>
<th>Hemibos acuticornis Pilgrim, 1939, p. 269</th>
<th>Hemibos antilopinus Pilgrim, 1939, p. 269</th>
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<td>Max. antero-posterior dia.</td>
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<td>54</td>
</tr>
<tr>
<td>Max. transverse diameter</td>
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<td>47</td>
<td>76</td>
<td>97</td>
<td>77</td>
<td>83</td>
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</table>
Text Fig. 44  Horn-core of *Leptobos falconeri* (x1)