Stegolophodon cautleyi from padri (Dhok Pathan Formation)

Middle Siwaliks, Jhelum, Punjab, Pakistan

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Abstract

The New fossil remains of Stegolophodon have been collected described and discussed from the site situated at the southeast of the Padhri (32° 52' 009 N: 73° 18' 297 E) outcrops of the Dhok Pathan Formation district Jhelum, Punjab, Pakistan at an altitude of about 1083 ft (Fig. 2). The described remains comprise second and third upper molars. After thorough investigation of the molar pattern, it is concluded that studied specimens clearly resembles to the species Stegolophodon cautleyi, which is found in the Late Miocene of the Siwaliks. The Stegolophodon suggests the evergreen forest.

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**Introduction**

Family Elephantidae includes genera *Stegolophodon*, *Stegodon*, *Mammuthus*, *Loxodonta* and *Elephas*. *Stegolophodon* is an undoubtedly a pure Asiatic genus and it appeared in the Middle Miocene of Japan (Yabe 1950; Shikama et al., 1956; Hatai, 1964). *Stegolophodon* was a Gomphothere with four tusks and a trunk. Its deposits are found in the Siwalik sediments of the Punjab at the time of Pliocene (Osborn, 1929; Hooijer, 1955). *Stegolophodon* stock might have got separated from its ancestral Gomphothere stock somewhere in upper Miocene (Sarwar, 1977). Three species of *Stegolophodon* discovered from the middle Miocene of Thailand which are *Stegolophodon nasaiensis*, *Stegolophodon praelatidens* and *Stegolophodon latidens* (Olivier et al., 2009). Another species *Stegolophodon xixiangensis* has been discovered from Hanzhong region of Shaanxi Province.

The Genus *Stegolophodon* is characterized by the superior tusks with longitudinal enamel band. Lower tusks were small in size. Molar pattern consists of 4-5 ridge-plates with 4 to 6 conules which were irregularly arranged in primitive species but transverse in advanced species. Accessory tubercles were also present. M³ has 4-5 ridge-plates while M¹ has less than 7 ridge-plates (Sarwar, 1977). The species *Stegolophodon cautleyi* described by (Lydekker, 1886) is known only from the Siwaliks of Pakistan and India where it appeared for the first time at the base of the lower Chinji (Osborn, 1929). This species survived to the late Pliocene. A deciduous molar tooth of *Stegolophodon cautleyi* was also observed from middle Siwaliks of Perim Island in India (Khan et al., 2005). Among the known Stegolophodonts, *Stegolophodon cautleyi* is the most primitive and is ancestral to the other species of the genus. From *S. cautleyi*, two lines of evolution can be derived. One leading to *S. daratensis* and the other to *S. latidens*. *S. daratensis* probably gave rise to *S. stegodontoids* while *S. latidens* to *S. cristatus* (Sarwar, 1977).

Record of genus *Stegolophodon* from Europe has been reported by Osborn (1942) and (Bergounioux et al., 1956) based upon *Mastodon sublatidens* and *Stegolophodon saldanensis* from Spain while the occurrence in Africa has been reported by (Petrocchi, 1943, 1954; Singer et al., 1958) based upon new species, *Stegolophodon sahabianus*. Another African record is *Stegolophodon lepersonnei* from Nyamavi region of Congo. There are three recorded cases of the occurrence of molars referred to *Stegolophodon latidens* (Clift, 1828) in Japan from different localities (Yabe, 1950). A broken left mandible of the genus *Stegolophodon* was also found in a mudstone boulder on the riverbed of the Nakagawa River at Katsura village, Ibaraki Prefecture, eastern Japan. The geological age of the fossil is assigned to the earliest middle Miocene based on fission track dating and chronostratigraphic data (Yoshiki et al., 2003).

Recent fieldwork in the Miocene basins of northern Thailand yielded the first complete molars of *Stegolophodon* ever found in this country. A complete M₃ from middle Miocene and a partial mandible with M₂₃ from early Miocene are described with new data on the evolution of the genus in South East Asia. A new species is described in the early Miocene locality, being the earliest known species of *Stegolophodon* (Tassy, 1992).

The aim of this article is to emphasize the feebly described fauna from the Siwalik Hills of Pakistan. In this paper it has described these scarce remains, assigning them to the genus *Stegolophodon*.

**Abbreviations**

AMNH, American Museum of Natural History; IM, Indian Museum Calcutta, India; En. Th., Enamel thickness; H, Height of crown; L, Anteroposterior length of the crown; W, Transverse width of the Crown; mm, Millimeter; l, Left, r, Right; PUPC, Punjab University Paleontological Collection; Ma,
Million years ago; H/W index, Height/Width x100; W/L index, Width/Length x100; M², upper second Molar; M³, upper third Molar.

Materials and methods
The studied specimens were collected from Padri, district Jhelum from Dhok Pathan type locality during the years 2008-2010. The specimens are properly cleaned and washed in the laboratory. Fine needles, camel hair brushes as well as light hammer is used to remove unwanted siliceous or clay material. The broken parts are assembled by using various gums and adhesives such as Araldite, Elphy and Peligon. The specimens are catalogued such as PUPC No. 09/13, the upper figure denotes the collection year while the lower one shows the serial no. of the respective year. The measurements of the specimens are made by metric Vernier Calipers and then tables are formulated. The photographs of the described specimens are taken with Digital Camera and hard copies were prepared by using Adobe Photoshop.

Systematic Palaeontology
Order PROBOSCIDEA (Illiger, 1811)
Suborder ELEPHANTOIDAE (Osborn, 1910)
Family ELEPHANTIDAE (Schlesinger, 1917)
Subfamily STEGOLOPHODONTINAE (Osborn, 1910).

Genus STEGOLOPHODON (Takai et al., 1961; Osborn, 1936).

Type species: Stegolophodon latidens (Clift, 1828).

Distribution: Stegolophodon is a purely Asiatic genus and its record from outside Asia is erroneous. It appeared for the first time in the middle Miocene of Japan (Takai and Fuji, 1961). It is also distributed in the Siwaliks of Pakistan and Perim Island of India.

Diagnosis: Superior tusks with longitudinal enamel band. Lower tusks present but small in size. Molar pattern transitional between Zygocephodon and Stegodon. Ridge-plates semibunodontine with few (usually 4 to 6) distinct conelets. The conelets arranged somewhat irregularly in the primitive species but transversely linear in advanced species. Accessory tubercles or conules present in the primitive species. A median cleft present at least in the anterior ridge-plates. Second molar has 4-5 ridge-plates while third molar has less than 7 ridge-plates.

Stegolophodon cautleyi (Lydekker, 1886).

Type specimen: (Lectotype) l. M, Brit. Mus. M. 2705 (Lydekker, 1886).

Type locality: Perim Island, India.

Stratigraphic range: Middle Siwaliks.

Distribution: The species is known only from the Siwaliks of Pakistan and India where it appeared for the first time at the base of lower Chinji. The species survived to the late Pliocene and its latest record is from the upper levels of the Dhok Pathan zone of the Middle Siwalik.

Diagnosis: Median cleft more or less prominent. Conules of the anterior ridge plates somewhat dislocated. Each ridge plate is surmounted by 4 to 5 conules in M3 and by 5 to 6 in intermediate molars. Small conules or accessory tubercles present in the transverse valleys. M3 4 crested.

Material: PUPC No. 09/120; a well preserved M² and PUPC No. 09/13; an anteriorly damaged M³.

Locality: Padri (Figs 1&2), Dhok Pathan Formation (Middle Siwaliks), District Jhelum, Punjab, Pakistan.

Description
PUPC 09/120 (Fig. 3)
M²
The preservation of studied tooth is excellent. It is extremely brachyodont and extremely narrow crowned. The molar has four preserved ridge-plates while first ridge-plate has broken down. The anterior two ridge-plates are worn with first in middle worn condition and second in early worn condition while
posterior two are unworn. All the ridge-plates are directing upward and have a conspicuous median cleft. The Second ridge-plate is occlusally divided into four conelets with a posterior accessory tubercle. Third ridge-plate has three complete but one partly damaged conelet. The fourth ridge-plate is unworn having four irregularly arranged conelets which are blunt, isolated and rounded. The fifth ridge-plate has three large, prominent conelets and two smaller conelets. The conelets of first, second and third ridge-plates are transversally arranged but that of fourth are irregularly arranged. The ridge-plates are widely spaced having prominent intermediate valleys which are deposited with cement. Enamel is fairly thick, almost smooth and simple. The first and second ridge-plates are in use and have been changed into complete enamel loops except the third and fourth where the conelets are still distinct and rounded. Roots are nicely preserved with large amounts of sediments deposited in between the roots.

Table 1. Measurements (in mm) of second (PUPC 09/120) and third upper molars (PUPC 09/13), referred to Stegolophodon cautleyi (Lydekker 1886).

<table>
<thead>
<tr>
<th></th>
<th>(PUPC 09/120)</th>
<th>(PUPC 09/13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preserved antero-posterior crowned length</td>
<td>165</td>
<td>210</td>
</tr>
<tr>
<td>Transverse width of 2nd ridge-plate</td>
<td>73</td>
<td>-</td>
</tr>
<tr>
<td>Transverse width of 3rd ridge-plate</td>
<td>70</td>
<td>110</td>
</tr>
<tr>
<td>Transverse width of 4th ridge-plate</td>
<td>63</td>
<td>90</td>
</tr>
<tr>
<td>Transverse width of 5th ridge-plate</td>
<td>60</td>
<td>75</td>
</tr>
<tr>
<td>Preserved crowned height</td>
<td>48</td>
<td>48</td>
</tr>
<tr>
<td>H/W index</td>
<td>65</td>
<td>43</td>
</tr>
<tr>
<td>W/L index</td>
<td>44</td>
<td>52</td>
</tr>
<tr>
<td>Enamel thickness</td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 2. Comparative measurements (in mm) of studied specimens with different species of genus Stegolophodon (comparative data taken from 7 *Studied specimens).

<table>
<thead>
<tr>
<th>Specimens, position and species</th>
<th>L</th>
<th>W</th>
<th>H</th>
<th>H/W index</th>
<th>W/L index</th>
<th>En. th.</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.Z. 69/633 (M²) Stegolophodon cautleyi</td>
<td>-</td>
<td>95</td>
<td>48</td>
<td>50</td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>U.Z. 69/330 (M²) S. cautleyi</td>
<td>-</td>
<td>87</td>
<td>46</td>
<td>52</td>
<td>-</td>
<td>7.5</td>
</tr>
<tr>
<td>*PUPC 09/120 (M³) S. cautleyi</td>
<td>165</td>
<td>73</td>
<td>48</td>
<td>65</td>
<td>44</td>
<td>7</td>
</tr>
<tr>
<td>*PUPC 09/13 (M³) S. cautleyi</td>
<td>210</td>
<td>110</td>
<td>48</td>
<td>43</td>
<td>52</td>
<td>7</td>
</tr>
<tr>
<td>U.Z. 70/24 (M³) S. daratensis</td>
<td>126</td>
<td>87</td>
<td>31</td>
<td>-</td>
<td>54</td>
<td>6.2</td>
</tr>
<tr>
<td>U.Z. 72/5 (M³) S. daratensis</td>
<td>163</td>
<td>88</td>
<td>30</td>
<td>-</td>
<td>54</td>
<td>6.3</td>
</tr>
<tr>
<td>AMNH 21978 (M³) S. latidens</td>
<td>140</td>
<td>76</td>
<td>-</td>
<td>-</td>
<td>54</td>
<td>-</td>
</tr>
<tr>
<td>PI.XXXVIII (M³) S. latidens [11]</td>
<td>300</td>
<td>101</td>
<td>-</td>
<td>-</td>
<td>34</td>
<td>-</td>
</tr>
</tbody>
</table>

PUPC 09/13 (Fig. 3)

M³

The tooth is poorly preserved and is narrow crowned, brachyodont with only two preserved ridge-plates. It is completely damaged at the anterior end but a partly damaged third ridge-plate and completely preserved fourth and fifth ridge-plates are present at the posterior end of the tooth. The first and second ridge-plates are completely damaged showing only traces of enamel. The third ridge-plate shows only two worn conelets at the outer margins, on the buccal side and other on the lingual side. Fourth ridge-plate is nicely preserved. It has four partly worn conelets with posterior accessory tubercle. The conelets of fourth ridge-plate are not strictly transverse but they are easily distinguished because of little wear. The fifth
ridge-plate is also preserved with five conelets which are irregularly arranged. The ridge-plates are closely spaced with inconspicuous intermediate valleys. Only trace amount of cement is present. Enamel is thick, smooth and simple. The roots are nicely preserved and sediments and minerals are deposited with roots.

Fig. 1. Type locality Padri, Dhok Pathan Formation, Middle Siwaliks, district Jhelum, Punjab, showing the studied specimen (PUPC 09/13).

Discussion and comparisons
According to (Sarwar, 1977), the crown is brachyodont in proboscidea except the later forms such as Elephas, Mammuthus and Loxodonta. Since the crown of PUPC 09/120 and PUPC 09/13 are low, they cannot be referred to any of these. In both studied specimens, the conules are arranged in transverse plates. Such type of arrangement is displayed by the teeth of Tetralophodon, Stegolophodon, Stegodon and Stegotetrabelodon. In Tetralophodon the conules are much compressed as compared to those of the other three genera. The ridge plates are widely spaced in the molar teeth of the genera Stegolophodon and Stegotetrabelodon (Osborn, 1942), whereas these are closely oppressed in those of the genus Stegodon (Lydekker, 1886). Thus, the specimens under study can either be referred to the genus Stegolophodon or to the genus Stegotetrabelodon. The genus Stegolophodon, being chronologically older than the genus Stegotetrabelodon, has more deep and prominent median cleft. The molar structure of PUPC 09/120 and PUPC 09/13 described above are quite typical of the genus Stegolophodon due to prominent and deep median cleft, dislocation of the conelets of the ridge-plates and the presence of accessory tubercles shown by these specimens clearly favor their inclusion in the species S. cautleyi (Tables 1 and 2).

Fig. 2. Map of the Potwar Plateau and generalized stratigraphic dates of the Siwalik formations; the studied locality is encircled and the studied chronostratigraphic context is shaded (data from Johnson et al., 1982; Barry et al., 2002; Nanda, 2002; Dennell et al., 2006; Cohen et al., 2008).

When compared with the lectotype molar (Brit. Mus. M. 2705 by Lydekker, 1886) of the species S. cautleyi, the examined specimens are somewhat smaller regarding the transverse width (73 mm in PUPC 09/120, 110 mm in PUPC 09/13 and 112 mm in the lectotype). This could be attributed to the individual difference. The deep median cleft and the presence of posterior and median accessory tubercles are
primitive proboscidean characters described by (Osborn, 1921) shared with the specimens under study. On the other hand, the Japanese species i.e. S. pseudolatidens (Yabe, 1950) and S. miyokoae (Hatai, 1964) are devoid of accessory tubercles and their ridge-plates are quite transversely linear (Sarwar, 1977) and they are more progressive than the S. cautleyi of the Siwaliks.

This is also supported by the fact that S. hueiheensis (Chow, 1959) is known from Pleistocene and in molar structure it compares well with the Japanese species. If it considers the Japanese species as of Pliocene age, then S. cautleyi which is structurally more primitive than the other known species, could be taken as ancestral to the others and the waves of migration were probably from the Siwaliks to Japan and China (Sarwar, 1977). Both dental features and the stratigraphic level, indicate that they belong to the most primitive species of the genus, Stegolophodon cautleyi. S. cautleyi differs from the species S. daratensis in which ridge-plates are more regular and accessory tubercles are absent. It also differs from S. cristatus which is highly progressive form due to having transversely linear ridge-plates comprising sharp conelets and open valleys (Bakr and Qureshi, 1966). The examined specimens are distinguished from that of the S. pseudolatidens which has got six conelets in each ridge-plate and enamel rugosity (Takai and Fujii, 1961). Stegolophodon cautleyi is supposed to be the ancestor of S. daratensis and S. latidens. This is supported by the fact that the third molar of S. daratensis can be derived from that of S. cautleyi through the loss of accessory tubercles and more regular arrangement of the conelets of the ridge-plates and hence the latter might be ancestral to the former. S. daratensis is primitive as compared to S. latidens in the number of ridge-plates but is advanced in the absence of accessory tubercles which are still retained by S. latidens. Hence, both the species, S. daratensis and S. latidens seems to be independent off-shoots from some common ancestor, probably the S. cautleyi (Sarwar, 1977).

Conclusions
The genus Stegolophodon is an Asiatic genus and was first observed from the middle Miocene of Japan. In the Siwaliks of Pakistan, it appeared first at the base of lower Chinji. It survived from Miocene to early Pleistocene. Stegolophodon is characterized by the presence of four tusks and a trunk. Molar pattern of Stegolophodon consist of 4-5 ridge-plates with 5 to 6 transversely arranged conules, which are rounded, blunt and isolated. Accessory tubercles and a prominent median cleft are also present in the anterior parts of the teeth. Fossil record of genus Stegolophodon has been observed from Europe,
Africa, Japan, Thailand and Asia including Siwaliks of Pakistan and Perim Island of India.

References


Illiger CD. 1811. Prodromus Systematis Mammalium et Avium Additis Terminis Zoographicis Uttriusque Classis, Salfeld.


Osborn HF. 1910. The Age of Mammals in Europe, Asia and North America, the Macmillan Co., New York. 8 p. 635.


Osborn HF. 1929. New Eurasiatic and American


Pilgrim GE. 1913. The correlation of the Siwaliks with mammal’s horizons of Europe. Survey of India 43, 264-326.


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