Siwalik Antelopes and Oxen in The American Museum of Natural History

By Guy E. Pilgrim

BULLETIN

OF

THE AMERICAN MUSEUM OF NATURAL HISTORY

Vol. LXXII, Art. VII, pp. 729–874

New York

Issued March 31, 1937

Article VII.—SIWALIK ANTELOPES AND OXEN IN THE AMERICAN MUSEUM OF NATURAL HISTORY

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Text Figures 1 to 81

CONTENTS

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INTRODUCTION

Through the generosity of The American Museum of Natural History and of Professor Henry Fairfield Osborn, former President, and Dr. Barnum Brown, Curator of Fossil Reptiles, in particular, I have been afforded the opportunity of studying the fine collection of Bovidae, which the latter made in India in 1923. The information so obtained is just what was needed to throw light on hitherto obscure problems of identity, affinity and taxonomy, and to enable me to publish with greater confidence conclusions to which the material in Calcutta had already led me (Pilgrim, 1925, p. 216). In many ways the fossil bovid collections from India in New York, Calcutta and London supplement one another, and I propose at a very early date to review the whole group with the aid of the combined material in all three museums.

Meanwhile this paper contains a summary of my general conclusions. It is, strictly speaking, only a description of the fossil Indian Bovidae in the American Museum. This is as full as necessary where the material warrants it, and I have figured all specimens which seem likely to afford information of any value. Not in all cases, however, has it been possible to choose, from amongst such figured specimens, the holotype of a new species, even where they may happen to be the first specimens of that species to be figured, since sometimes the existence of another specimen in Calcutta, which shows the specific characters better, has obliged me to select that as the holotype, in anticipation of its description and illustration in the near future. In addition I have freely drawn upon undescribed Calcutta material for characters which are not represented in the American Museum specimens, and many of the diagnoses have been amplified from that source.

Doctor Brown's collection was made from districts as widely separated as the Siwalik Hills, Belaspur, one of the Simla Hill States, Jammu and the country north of the Salt Range; but by far the greater part of the material here described came from the latter area, chiefly from the neighborhood of Dhok Pathan, Chinji and Hasnot, and belongs to the Lower and Middle Siwalik.

It may assist the reader to grasp my interpretation of the correlation of the various sections in the Upper Tertiary beds of India, from which the specimens mentioned in the following pages were derived, if he consult a diagram which has recently been published in American Museum Novitates No. 704, 1934. A list of the more important literature in which the stratigraphy of the deposits is discussed is also included in the bibliography of the paper just quoted. Three published maps may also

help to locate the fossil sites referred to in these pages and elsewhere, and supply the evidence for assigning the several species to their respective geological horizon. These are contained in Rec. Geol. Surv. Ind., XLIII (1913), Pl. XXVII; Mem. Geol. Surv. Ind., LI, 2 (1928), Pl. XI; Mem. Geol. Surv. Ind., LII, 2 (1933), Pl. XIX. It may be mentioned that Chinji Bungalow, which is frequently quoted as the index of Lower Siwalik fossil sites in Dr. Barnum Brown's notes, is situated 3 miles south of Chinji village, the latter alone being marked in the published map.

I may here express my thanks to Dr. E. H. Colbert for helping me in regard to information on and measurements of certain specimens which I had insufficiently studied myself when in New York, and for reading and editing the manuscript, and to Mr. and Mrs. John Germann and Mrs. Margaret Matthew Colbert for the care and trouble which they have taken over the drawings of teeth and the retouching of photographs which illustrate this paper.

The Bovidae in the American Museum collection comprise, so far as the material is identifiable, representatives of the following subfamilies and genera:

BOVINAE

Bubalus. Pinjor stage.
Hemibos. Pinjor stage.
Leptobos. Pinjor stage.

GAZELLINAE

Gazella. Chinji and Dhok Pathan stages.
Antilope. Tatrot and Pinjor stages.

BOSELAPHINAE

Selenoportax, n. gen. Nagri, Dhok Pathan and probably Tatrot stages.
Pachyportax, n. gen. Nagri, Dhok Pathan and probably Tatrot stages.
Strepsiportax, n. gen. Chinji stage.
Helicoportax, n. gen. Chinji stage.
Tragoportax, n. gen. Dhok Pathan stage.
Tragocerus. Dhok Pathan stage.
Sivaceros, n. gen. Chinji and Dhok Pathan stages.

It will be seen that the majority of the genera are here assigned to the subfamily Boselaphinae; in fact some 95 per cent of the specimens in the collection belong to members of that subfamily. The remaining five per cent include some fine skulls of *Leptobos*, *Hemibos* and *Bubalus*, some Bovine teeth and jaws, two skulls and some teeth of *Gazella*, a horn-core and teeth of *Antilope* and a few fragmentary skulls and teeth, of which the systematic position is uncertain.

DISCUSSION.—Hitherto the only forms which have been considered to bear any close affinity to the living Nylghai, *Boselaphus tragocamelus* are: the living *Tetraceros quadricornis;* the Pleistocene *Boselaphus namadicus* Rütimeyer (1878, p. 89), *Duboisia kroesenii* Stremme (1911, p. 115); *Proboselaphus watasei* and *liodon* Matsumoto (1915, pp. 12–19); the upper Pliocene or Pleistocene *Tetraceros daviesi* Lydekker (1886, p. 19); the lower Pliocene *Boselaphus* sp. Lydekker (1884 p. 114), *Paraboselaphus ameghinoi* Schlosser (1903, p. 152), and *Protetraceros gaudryi* Schlosser (1903, p. 136). Of these the second, third and fourth species are sufficiently well known to render their relationship to the Nylghai obvious. The last four species are known only by teeth. It may be remarked that Teilhard and Young (1931, p. 35) have referred *Protetraceros gaudryi* to the genus *Gazella.* The affinity of the first, *Tetraceros quadricornis,* to *Boselaphus,* formerly suggested by Rütimeyer on the cranial structure (1877, pp. 56–58) and advocated by Pocock on external characters (1910, p. 926; 1918, p. 441), has been generally accepted. The inclusion of *Cephalophus* in the same group, also advocated by Rütimeyer (1877, pp. 56, 57) and adopted by Schlosser (Zittel, 1923, p. 592), was opposed by Pocock (1910, p. 926) and has now been rejected by most other authors (Lydekker and Blaine, 1914, p. 60; Max Weber, 1928, p. 585). Rütimeyer regarded the African tragelaphines as belonging to a distinct group from *Boselaphus* and *Tetraceros.* Most recent authors have, however, considered that certain similarities of structure afford strong grounds for including both the living and Pontian tragelaphines as well as *Boselaphus* and *Tetraceros* in the one subfamily, Tragelaphinae. Pocock (1910, pp. 921–932; 1918, pp. 440–448) has clearly emphasized these, more particularly as regards the glands. Even Pocock, however (1910, p. 845) envisaged the advantage of erecting two distinct subfamilies to contain these genera; and Schlosser (Zittel, 1923, p. 592) took this course, though, as I have remarked above, he included *Cephalophus* with the Boselaphinae.

It is true that the tendency to torsion in the horns of many of the Miocene and Pliocene fossil antelopes of India described below may be regarded as evidence of some genetic connection with the Tragelaphinae, but the fact that all of them share certain special characters with *Boselaphus,* which neither living nor fossil Tragelaphinae exhibit, militates against any very close affinity. Even if, as seems probable, it were shown that the Tragelaphinae have at some time been represented in India, yet none of the Pontian or later genera occur there. The Lower

Siwalik (i.e., Tortonian) Boselaphinae are equally unknown in Europe, and it is not until the Pontian that there is any correspondence between the bovid faunas of the two countries. Moreover, the Pontian Tragelaphinae are in many respects in a more advanced stage of evolution than any of the Siwalik Boselaphinae. Such considerations incline me to the opinion that the connection between the Tragelaphinae and the Boselaphinae must have ceased almost as long ago as the Middle Miocene and that the subsequent evolution of both groups proceeded in separate regions apart from one another. It seems likely that the developmental center of the Tragelaphinae was not European, since the group suddenly makes its appearance in the Pontian represented by numerous genera, many of them possessing an extremely complicated horn structure, advanced bending down of the face on the cranial axis, and a progressive structure of P_4, without any trace of direct predecessors in earlier European deposits, so that they must almost certainly have been migrants from a region still unknown, but probably in or near Northern Africa.

Although we are acquainted with antelopes in India from the Kamlial stage, which is probably the equivalent of Sansan, upward, yet there, as in Europe, we have no evidence of the direct evolution of any one genus from any other. In spite of the gradation, sometimes almost imperceptible, of certain characters from one genus to another, yet previous to the Pleistocene we cannot claim any form as the immediate ancestor of *Boselaphus*, *Proboselaphus* or *Duboisia*, and we have to admit an equal ignorance in the case of the new genera described below, *Selenoportax*, *Pachyportax*, *Strepsiportax*, *Helicoportax* and *Tragoportax*. Sometimes a single genus is represented by two or more apparently closely allied species at different horizons. Examples of this are seen in *Pachyportax*, *Selenoportax* and *Strepsiportax*, and the same is true of *Boselaphus namadicus* as compared with the living Nylghai. This may suggest some degree of local evolution, but cannot affect the inference which we are forced to draw, that the Boselaphinae reached India, as the Tragelaphinae reached Europe from an equally unknown neighboring region in a series of waves of emigration.

It has been considered, but on no very convincing evidence (Schlosser, 1904, pp. 93, 94), that such forms in the Miocene of Europe as *Antilope clavata*, *A. martiniana* and *A. cristata*, and *Protragocerus chantrei* are ancestral to *Tragocerus* and other genera of the Pontian. Knowing nothing else but the fact that they exhibit a very primitive structure of the skull as well as of the horns and dentition and have somewhat com-

pressed horn-cores, such as might have preceded the *Tragocerus* type, we cannot feel assured that they are not survivals of an early migration, or that *Tragocerus* was any more likely to have been autochthonous in Europe than the Tragelaphinae. The genus *Tragocerus* has been referred by Schlosser (1904, p. 88) to the same subfamily as *Pseudotragus* and *Protoryx*, but it shares so many characters in common with the Indian Boselaphinae, with which it is connected by transitional types such as *Tragoportax*, that I can hardly doubt that it essentially belongs to the same lineage.

Definition

The Boselaphinae as now defined by me are characterized by horn-cores which have a subtriangular cross-section, produced by the formation of a strong anterior keel originating as a more or less prominent crest adjacent to the supraorbital foramina, a weaker posterior keel separated from the anterior keel by a flat or slightly convex face and a third angle defined by the more or less abrupt union of two slightly convex faces. This type of horn-core is doubtless derived from one with a circular cross-section, to which that of *Tetraceros* approximates more nearly than that of any of the other genera included in the group. The living Nylghai exhibits the triangular cross-section in its typical form, without lateral compression, as an equilateral triangle. A smaller horn-core from Burma, which is in Calcutta (Geol. Surv. Ind. No. B791), has an even more distinctly triangular cross-section, since all three of its angles are sharp and the faces which they enclose almost plane. In most other boselaphine genera the lateral compression of the horn-core has to a varying extent obliterated the third angle, two faces being united to form a single convex surface. In *Tragoportax* the asymmetry of this convex surface renders the third angle more evident, since the enclosing faces have become very unequal. This inequality has become very marked in *Tragocerus*, in which the cross-section is an isosceles triangle with two almost plane faces and a short base with rounded angles. In the Tragelaphinae, which also have keeled horn-cores, the cross-section either remains approximately circular or where laterally compressed is symmetrical, so that there is no face which is almost plane. *Tragelaphus* and *Prostrepsiceros* are seeming exceptions to this. In them, however, the position near the supraorbital foramen, which in the Boselaphinae is occupied by the strongest keel, is marked by no keel or only a faint one, while a strong keel is formed at a considerable distance from this at the

postero-internal corner. This is separated from the postero-external keel by a concave face, as shown in figure 1.

In addition to the distinctive character of the horn-cores, the Boselaphinae are marked off from the Tragelaphinae, to whom their often twisted horns give them a resemblance, by: (1) the retention of certain primitive features which the Tragelaphinae have lost even as early as the Pontian; (2) certain specializations, which have either failed entirely to develop in the Tragelaphinae or at any rate only in a very slight degree.

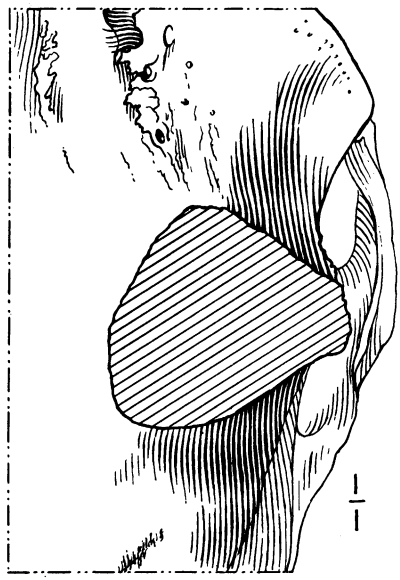


Fig. 1. Frontal of *Tragelaphus scriptus* with cross section of horn-core, to show position of keels and their analogy to those of the Boselaphinae. Natural size.

In the first category come:

(a) The small degree of bending down of the face on the cranial axis.
(b) The narrowness and relative lowness of the auditory bulla.
(c) The short basioccipital with the anterior tuberosities not in front of the bulla.
(d) The quadrate shape of the upper molars.
(e) The rugosity of the tooth enamel.
(f) The simple structure of P_4.

In the second category come:

(g) The broadening of the frontals with progressive movement apart of the horns.
(h) The strong development of the temporal ridges.
(i) The rugosity of the surface of the frontal and parietal.

(j) The broadening of the occiput, with development of the mastoid, and lateral extension of the hinder part of the squamosal.
(k) The large occipital condyles and broad foramen magnum.
(l) The diminution in size of the supraorbital pits, and the tendency of the supraorbital canals to bury themselves in the bone and to form deep channels in front of the orbits.
(m) The tendency to enlargement of the teeth.
(n) The precocious hypsodonty.

Two additional characters, not by any means confined to the group and only present in its most advanced members, are perhaps worthy of mention:

(o) The backward shifting of the horns in *Boselaphus*, *Proboselaphus* and *Duboisia*. This is not shared by other genera of the subfamily, but that it is a secondary character, carried to excess in *Proboselaphus*, is proved by the greater approximation of the horn-cores to the orbit in *Boselaphus namadicus* as compared with *Boselaphus tragocamelus*.
(p) The progressive diminution in size of the lachrymal fossa. Its absence in the living Nylghai is probably due to atrophy, since *Tetraceros*, in many ways a more primitive type than *Boselaphus*, has a deep lachrymal fossa; moreover it is present in all the Pontian Tragelaphinae, though missing in the living forms, its suppression being obviously correlated with the total absence of preorbital glands. It should be remarked that such complete atrophy of the preorbital glands has not taken place in the Nylghai which still has small ones (Pocock, 1910, p. 926). Consequently it is not surprising that a shallow lachrymal fossa should exist in the Lower and Middle Siwalik Boselaphinae, or that it should be deep in the more primitive *Tragocerus* and *Tragoportax*.

It will, of course, be recognized that in the oxen not only have the two last named developments arisen in an advanced degree, but that most of the characters detailed above are carried to excess, a proof that their affinity with the Boselaphinae is very close. It is, in fact, difficult to draw a dividing line between the earliest oxen and genera like *Pachyportax* and *Selenoportax*.

SELENOPORTAX, NEW GENUS

GENOTYPE.—*Selenoportax vexillarius*, new species.

DIAGNOSIS.—Boselaphinae of large size; skull wide both at the frontals, brain case and occipital; face but little bent down on the cranial axis; occiput extremely short, the distance between the mid point of the orbits and the occipital crest being to the width of the brain case in the ratio of 1.15 to 1; horn-cores large and long, faintly twisted clockwise, situated immediately above the orbits and far apart on the frontals, with prominent antero-internal and postero-external keels, keel axis extremely oblique to skull axis, keels when prolonged tending to meet at an extremely obtuse angle; horn-cores directed moderately backward and very considerably outward

for half their length, then curving inward through their upper half; cross-section at base subtriangular, elongate, laterally compressed, inner face between the keels weakly convex, third angle external, not very distinct; supraorbital pits rather large and elongate; temporal ridges very strong; occipital extremely low; lambdoid crest very prominent; teeth large relative to the size of skull, strongly hypsodont, enamel very rugose, upper molars quadrate, with strong external folds and ribs, strong basal pillar, inner profile straight; inner cusp of P_4 isolated from the anterior and posterior wings.

REMARKS AND COMPARISONS.—The affinities of this genus are closer to the living Nylghai, to *Boselaphus namadicus* and to *Duboisia kroesenii* than to any other hitherto known antelope. By their distance apart and by their general curvature the horn-cores approach those of the Nylghai more nearly than those of any other of the Siwalik antelopes described in this paper. If the horn-cores of the Nylghai were shifted forward and at the same time more inclined outward and moved round somewhat so as to increase the angle between the anterior keels, and then laterally compressed and lengthened, we should reproduce the condition found in *Selenoportax*. Both possess the two main keels. In the Nylghai on account of the great postero-internal expansion of the horn-core a third keel is also extremely prominent. In *Selenoportax on the contrary* the third keel is hardly visible, the cross-section consisting of a convex surface external to the keel axis and a flattened surface internal to that axis. *Tragoportax*, *Pachyportax* and *Strepsiportax* resemble *Selenoportax* in the absence of a third distinct keel, but in those genera it is the external face which is flattened and the internal face which is convex. Since the third keel of the Nylghai is also internal, its two bounding faces would seem to correspond to the inner convex face in the three genera last named. The cross-section of the horn-core of *Helicoportax* is rather similar to that of *Selenoportax*, and in the case of *H. tragelaphoides* the horn-cores are as divergent as in *Selenoportax*, but they differ by being almost straight and by being more twisted. It should be noted that the horns of *Selenoportax* show a faint amount of torsion, not present in those of the Nylghai. The *Tragocerus* horn-core tends towards the type of *Tragoportax* and *Strepsiportax*, but in any case the elongate isosceles triangular shape with two basal rounded angles distinguishes it from that of *Selenoportax*. As for the other skull characters the almost parallel direction of the cranial and facial axes, the broad frontals, the strong temporal ridges, the low and broad occipital, the prominent lambdoid crest, the strong development of the mastoid and of the hinder part of the squamosal are features which *Selenoportax*

shares in common with the Nylghai, and which separate it from the Tragelaphinae and still more from other subfamilies of antelopes.

Apart from the horn-cores the most notable feature of difference from the Nylghai is the extreme shortness of the occiput. This equally distinguishes it from the other Siwalik genera and brings it nearer to the oxen. In fact, by the length and shape of its horn-cores and by the more extreme development of many of the features detailed above as similar in the Nylghai and in *Selenoportax*, the latter genus is closer than the Nylghai to primitive forms of buffalo such as *Hemibos*.

Assuming that the various dentitions referred below to *Selenoportax vexillarius* and *lydekkeri* really belong to it, the correspondence with the Nylghai is remarkable. In addition to the specimens figured by Lydekker, figures of numerous other upper and lower teeth referred to this genus which are in the American Museum may be seen on pages 828–831. where more detailed comparisons with other genera are made. The size of the teeth, their hypsodonty, rugose enamel, strength of the folds and ribs on the outer surface of the upper molars, quadrate shape, antero-posterior compression of the crescents in wear, the marked neck at the base of the crown and the great increase in antero-posterior diameter combined with the decrease in transverse diameter as the summit is reached, the bending over of the external walls of the upper molars and the internal walls of the lower molars near the summit of the crown, and finally the primitive structure of P_4 in which the inner cusp is almost isolated from the anterior and posterior wings; all these features are present in *Selenoportax* as in the Nylghai. In regard to their dentition equally as in their cranial characters, *Selenoportax* and the Nylghai both approach the oxen, but the resemblance is much closer in the case of the Siwalik genus. Thus the molars are more hypsodont, the external folds and the median internal basal pillar of the upper molars are stronger, the antero-posterior compression of the worn crescents is greater.

On the contrary, in the Tragelaphinae the special features which distinguish the teeth of the Nylghai and *Selenoportax* are either not observable or only in a slight degree. That is to say they are more antelopine and less bovine. In one tooth character only do the Tragelaphinae show themselves more progressive than the Nylghai and *Selenoportax*. The structure of P_4 is invariably more complex. Instead of the isolated condition of the inner cusp which we find in those genera, in the Tragelaphinae there is union in various degrees with the anterior and posterior wings: in *Tragelaphus* quite complete, in *Taurotragus* almost so, in *Strepsiceros* complete union with the anterior wing only, in *Prostrepsiceros* union

with the posterior wing only, in *Palaeoreas* complete union with the posterior wing and almost complete union with the anterior wing. *Protragelaphus* seems to be at a stage nearly as advanced as *Palaeoreas*.

The attribution of the teeth and especially of the lower dentition in the case of most of the other Lower and Middle Siwalik antelopes is largely guesswork, but at any rate the vast bulk of the teeth exhibit the same characters as detailed above for the Nylghai and *Selenoportax* but in a much less marked degree. In particular most specimens of P_4 are primitive and have an isolated, or almost isolated, inner cusp, and those which are not so are probably assignable to a tragelaphine genus, the presence of which is indicated by frontlets in the Calcutta collection.

Selenoportax vexillarius, new species

Figures 2 to 5, 52 to 54, 56, 80

HOLOTYPE.—Amer. Mus. No. 19748, a skull lacking the maxilla and dentition and most of the basicranium.

PARATYPES.—A series of five teeth from three miles east of Dhok Pathan, which comprise a fragment of the right ramus, a left M_1 and M_2 and a right and left M^2, probably belong to the same individual (Amer. Mus. No. 19844). Three of these are figured on page 828. They are referred with some degree of confidence to the same species as the holotype skull, because antelopine teeth of this type are the only ones met with in the Middle Siwaliks which attain a size large enough to be reasonably associated with the skull, with the exception of those of *Pachyportax latidens*, of which the association with the Calcutta skull (Geol. Surv. Ind. No. B488) leaves no doubt as to the correctness of their attribution, and the still larger ones of *Selenoportax lydekkeri*. Although the latter are of a precisely similar type to Amer. Mus. No. 19844, they are too large for the skull of *Selenoportax vexillarius* and may more appropriately be united with the much larger but in many respects almost identical horn-cores from Perim Island (Geol. Surv. Ind. No. B790, and Br. Mus. No. M2402a). Numerous other similar teeth both upper and lower are contained in the collections in Calcutta as well as in New York. Descriptions of these and comparisons with those of allied genera will be found on pages 828–831.

REFFERRED SPECIMENS

Amer. Mus. No. 19514—jaw, 1 mi. W. Hasnot.
" " " 19694—jaw, 4 mi. E. Dhok Pathan.
" " " 19894—jaw, near Bhandar.
" " " 19984—molar, 3 mi. W. Chandigarh.
" " " 29847—lower jaws and teeth, 3 mi. N. Hasnot.
" " " 29852—lower jaws and teeth, 4 mi. W. Dhok Pathan.
" " " 29875—lower jaws and teeth, 1 mi. N. E. Hasnot.
" " " 29898—lower jaws and teeth, 4 mi. W. Dhok Pathan.
" " " 29902—lower jaws and teeth, 3 mi. N. Hasnot.
" " " 29903—molar, 3 mi. S. Hasnot.

Amer. Mus. No. 29904—premolar, 1 mi. N. Hasnot.
" " " 29916—molar, 4 mi. E. Dhok Pathan.
" " " 29917—lower jaw, $1^1/_2$ mi. E. Hasnot.
" " " 29919—lower jaw, 4 mi. W. Dhok Pathan.
" " " 29920—lower jaw, near Bhandar.
" " " 29921—lower jaw, 1 mi. W. Dhok Pathan.
" " " 29923—teeth, 1 mi. N. E. Hasnot.
" " " 29943—molar, 5 mi. E. Chinji Bungalow.
" " " 29946—premolar, 4 mi. N. E. Chinji Bungalow.
" " " 29968—lower jaw, 2 mi. N. E. Hasnot.
" " " 29984—cuboid-navicular, 1 mi. W. Chinji Bungalow.

HORIZON AND LOCALITY.—Four miles west of Hasnot. This locality, according to the geological map (Pilgrim, 1913, Pl. XXVII), must be near the boundary between the Lower and Middle Siwaliks, and so cannot be regarded as younger than the Nagri stage.

DIAGNOSIS.—The diagnosis is that of the genus. Horn-cores strongly curved throughout their course and much compressed laterally. The referred teeth are much smaller than those of *Selenoportax lydekkeri*, are somewhat less hypsodont and have a weaker median basal pillar in the upper molars.

DESCRIPTION AND DISCUSSION.—The skull itself provides internal evidence in favor of the reference adopted, since it possesses characters which approximate more nearly those of the living Nylghai than those of other Middle Siwalik skulls, thus harmonizing with the complete absence of any other teeth in the Middle Siwaliks, which bear as close a resemblance as these to the teeth of the Nylghai.

DESCRIPTION OF HOLOTYPE.—The skull is fairly complete as to its upper part from the orbital region back to the occipital.

The attachment of the horn cores to the frontal leaves nothing to be desired as to accurate fit. The right horn-core is perfect up to within approximately 65 mm. of the tip. The left horn-core is even more truly attached to the frontal, but except for two small sections intermediate between the basal 40 mm. and the tip, the rest is missing and has been restored on the analogy of the right horn-core so as to include the portions preserved. The upper margins of the orbits are not quite complete, and the lower portions are missing entirely, so that the measurements given in the table on page 857 are merely estimates. The frontals are preserved for about 60 mm. in front of the mid-line of the crest uniting the anterior keels of the horn-cores, and show the supraorbital pits moderately well. In addition to its upper surface, the brain-case is moderately complete on the left side, and the occipital surface is also preserved on the left side down to the foramen magnum. The right side, however, has been entirely broken away, with both the occipital condyles and the greater part of the basicranium, except the presphenoid, and the base of the left paroccipital process, so that the measurements of the breadth and height of the occipital given in the table on page 857 are approximate.

Both zygomatic arches are gone and with them even on the left side a part of the squamosal is missing. The cheek and palatal region together with the entire dentition has been destroyed.

The horn-cores arise immediately above the orbits and stand far apart from one

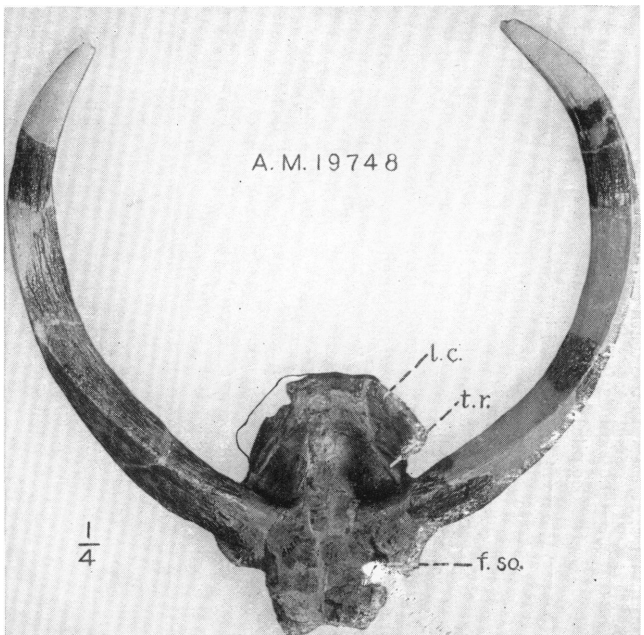


Fig. 2. *Selenoportax vexillarius*, new genus and species. Type, Amer. Mus. No. 19748, partial skull; from four miles west of Hasnot. Top view. One-quarter natural size. *f. so.*, supraorbital foramen; *l. c.*, lambdoid crest; *t. r.*, temporal ridge.

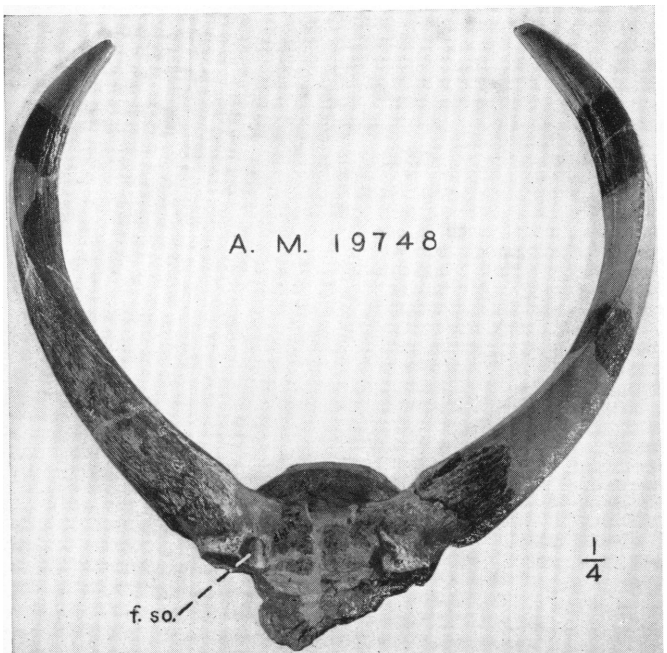


Fig. 3. *Selenoportax vexillarius*, new genus and species. Type, Amer. Mus. No. 19748, partial skull; from four miles west of Hasnot. Front view. One-quarter natural size. *f. so.*, supraorbital foramen.

another. They are long and rather large and possess prominent antero-internal and postero-external keels, between which the surface is irregularly ridged. The keels are very faintly twisted clockwise. The cross-section of the horn-core at the base is an elongate oval, strongly convex external to the axis of the keels and weakly convex internal to it. Farther up the horn-cores the external convexity becomes transformed into a third very definite posterior keel. The axis of the keels lies very obliquely to the skull axis and the keels when prolonged in front tend to meet at an extremely obtuse angle. The horns are directed moderately backward, forming for the first one-third of their length an angle of about 73° with the surface of the occiput, which angle is but little diminished for the remaining two-thirds. At the same time they are

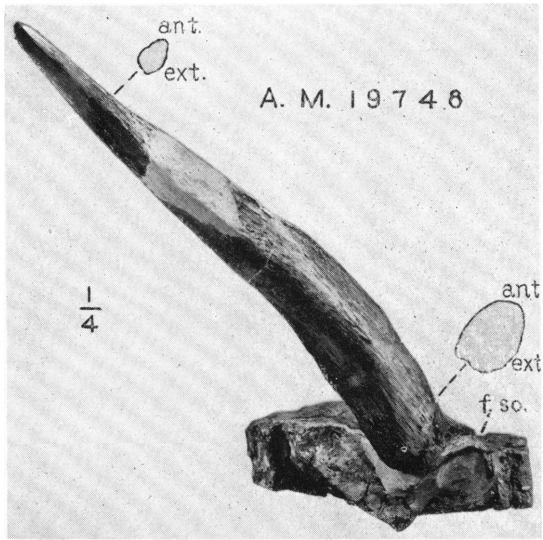


Fig. 4. *Selenoportax vexillarius*, new genus and species. Type, Amer. Mus. No. 19748, partial skull; from four miles west of Hasnot. Lateral view. One-quarter natural size. *f. so.*, supraorbital foramen. Cross-sections of right horn-core at base and at tip; *ant.*, anterior; *ext.*, external.

directed outwardly to an enormous extent for about half their length, making an angle of about 55° with the vertical. For the remainder of their course they gradually curve inward and for the uppermost 95 mm. are directed towards one another.

The frontals form a broad, rounded, slightly elevated surface between the horn-cores, falling gently in front to a flat or slightly concave area within which are the supraorbital pits, of which the margins are about 54 mm. apart. The edges of the pits are somewhat broken; they appear to be deep, but the actual area of the pit is uncertain; the foramina are probably more like those of *Boselaphus*, which open directly on to the surface, than like those of the Tragelaphinae, which open into a large cavity. It cannot be seen whether a lachrymal fossa is present or not. Behind the horn-cores in the mid-line the frontal hardly falls appreciably from the slight

frontal elevation. From just behind the horn-cores two extremely prominent temporal ridges run inward, at first overhanging the lateral walls of the brain case which, however, very soon bulge out laterally on either side of the temporal ridges. The temporal ridges are separated by deep cavities from the upper surface of the brain case. They become less prominent as they run backward. The bifurcation of each ridge, about 28 mm. from the lambdoid crest into an inner branch which presumably joins its fellow of the opposite side at the suture between the parietal and the supra-

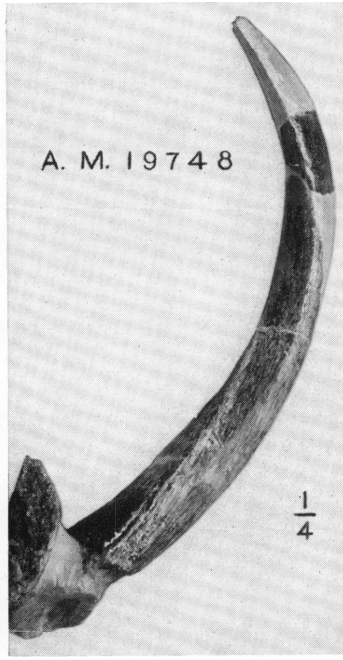


Fig. 5. *Selenoportax vexillarius*, new genus and species. Type, Amer. Mus. No. 19748, partial skull; from four miles west of Hasnot. Back view of the right horn-core. One-quarter natural size.

occipital and an outer branch which curves round outward to join the lambdoid crest, cannot be seen distinctly on account of the poor state of preservation, nor is the inner branch actually visible, but the outer branch can be traced sufficiently to lead one to suppose that the structure is as described on the analogy of *Boselaphus*, *Tragocerus* and *Pachyportax latidens*. No rugosity is visible between the temporal ridges as in many Boselaphinae, but this may be due merely to its destruction by the action of the weather.

The occiput is extraordinarily short in relation to its breadth, even more so than in *Taurotragus*, the distance between a point midway between the orbits and the occipital crest being to the width of the brain case in the ratio of 1.15 to 1. The position of the fronto-parietal suture lies probably about 45 mm. behind the highest point of the frontal, but age has so greatly obliterated all the sutures that it is not quite certain. In any case the parietal occupies a very small area on the upper surface of the skull.

The occipital is broad in proportion to its depth, though less so than in many of the boselaphine genera of the Siwaliks. The ratio between the width at the mastoid and the distance from the base of the condyles to the summit of the occipital crest is approximately 1.6 to 1. In *Boselaphus tragocamelus* it is 1.39; in *Boselaphus namadicus* 1.37; in *Tragoportax* about 1.62; in *Helicoportax* 1.66; in *Strepsiportax* 1.61; in *Pachyportax* 1.47; in *Tragocerus punjabicus* 1.43, but in *Tragelaphus scriptus* 1.34 and in *Tragocerus browni* only 1.06. The surface of the occipital is approximately at right angles to that of the supraoccipital, and parietal, but in the absence of the condyles it is impossible to determine the extent to which they projected behind. The center of the occipital is a broad, rounded, elevated area, which narrows from above towards the middle, its breadth above being 42 mm., and at the middle 29 mm. The occipital crest occupies the middle of this area, and on either side of it are broad, shallow depressions. The lambdoid crest is very prominent, as is also the mastoid process. The paroccipital process is laterally compressed. Besides this the only part of the basicranium preserved is the rounded front end of the prominent basisphenoid, immediately under the level of the orbits.

Selenoportax lydekkeri (Pilgrim)

Figures 55, 57 to 59

Boselaphus sp. LYDEKKER, 1884, Pal. Ind., (10) III, p. 114, Pl. XIII, figs. 1–4, 7, 8, 11.

Boselaphus lydekkeri PILGRIM, G. E., 1910, Rec. Geol. Surv. Ind., XL, p. 70.

LECTOTYPE AND COTYPES.—Lydekker figured no less than seven different specimens under the name of *Boselaphus* sp. When I established the species *Boselaphus lydekkeri* on this material, I omitted to name any one as the holotype. I now select the original of Lydekker, Pal. Ind., (10) III, Pl. XIII, fig. 1, (Geol. Surv. Ind. No. B213) as the holotype of the species. With the exception of the mandibular ramus in figure 5, the other specimens figured by Lydekker vary but little from one another either in size or details of structure. They may accordingly be regarded as cotypes. The original of figure 5 agrees very well with numerous specimens which have been referred to *Selenoportax vexillarius*, amongst them being Amer. Mus. No. 19514 (page 830, figure 54).

REFERRED SPECIMENS

Amer. Mus. No. 19710—molar, 1 mi. W. Dhok Pathan.
" " " 19933—teeth, 2 mi. E. Hasnot.
" " " 19937—molar, 2 mi. N. E. Hasnot.
" " " 19976—molar, $1^1/_2$ mi. N. Hasnot.
" " " 19977—molar, 1 mi. N. Hasnot.
" " " 19986—molar, 3 mi. E. Dhok Pathan.
" " " 29846—palate frag. 2 mi. N. E. Hasnot.
" " " 29911—premolar, 1 mi. N. Hasnot.
" " " 29959—molar, 3 mi. N. Hasnot.
" " " 29966—molar, 3 mi. N. Hasnot.
" " " 29991—premolar, 4 mi. W. Dhok Pathan.

HORIZON AND LOCALITY.—Lydekker's specimens are recorded merely as collected by Mr. Theobald from the Punjab, but as most of Mr. Theobald's specimens so labeled came from the Salt Range area and not from an older horizon than the Dhok Pathan

stage we may assume these to be the locality and horizon, respectively. This is confirmed by the presence of numerous teeth in the American Museum collection both from Dhok Pathan and Hasnot identical with the holotype and paratypes. Most of these belong beyond doubt to the Dhok Pathan stage. It is, however, possible that the species passes up into the Tatrot stage, since Doctor Brown considers that a young jaw (Amer. Mus. No. 29847) may have come from that level and the same may be true of a few other specimens collected north of Hasnot, near the boundary cliff between the Dhok Pathan and Tatrot stages but probably not *in situ*.

DIAGNOSIS.—A *Selenoportax* of very large size, with extremely hypsodont teeth and with a very strong median basal pillar in the upper molars. On the assumption that the horn-cores from Perim Island belonged to this species, its horn-cores are stouter and less strongly curved than in *Selenoportax vexillarius*.

REMARKS.—The teeth of the holotype and other specimens are, except for their larger size and higher crowns, almost identical with those referred with a high degree of probability to *Selenoportax vexillarius*. This alone would justify their provisional reference to the genus *Selenoportax*, but the existence in Calcutta of a fragmentary horn-core (Geol. Surv. Ind. No. B790) from Perim Island, which is of a precisely similar type to that of *Selenoportax vexillarius*, but much larger, provides us with a potential skull large enough to belong to the teeth in the holotype. The beds of Perim Island are in my opinion (Pilgrim, 1932, p. 6) the equivalent of the Dhok Pathan stage. A very similar horn-core, also from Perim Island, is in existence in the British Museum (Br. Mus. No. M2402a). This was catalogued by Lydekker (1885, p. 54) as Genus non det. resembling *Cobus*. Its connection with a part of the frontal renders the identification with *Selenoportax* even more certain than in the case of the Calcutta horn-core.

Selenoportax sp.

Amer. Mus. No. 19980—molar, $2^1/_2$ mi. N. Hasnot.

HELICOPORTAX, NEW GENUS

GENOTYPE.—*Helicoportax praecox*, new species.

DIAGNOSIS.—Boselaphinae of rather small size; skull extremely wide both at the frontals and the occipital; face moderately or little bent down on the cranial axis; occiput probably low, very short, the distance between the mid-point of the orbits and the occipital crest being to the width of the brain-case in the ratio of about 1.3 to 1; horn-cores slender, of moderate length, twisted slightly or as much as half a revolution, situated immediately above the orbits and far apart on the frontals, with prominent antero-internal and postero-external keels, keel axis considerably oblique to the skull axis, keels when prolonged tending to meet at an acute or obtuse angle; horn-cores directed moderately backward and either moderately or strongly outward, almost straight, cross-section at base subtriangular, elongate, laterally compressed, inner face between the keels almost flat; third angle moderately distinct, postero-external; supraorbital pits narrow and elongate; lachrymal fossa long and

shallow; temporal ridges probably strong; nasals ending only a short distance in front of the orbits; basioccipital short, with rounded surface, slightly hour-glass-shaped, anterior tuberosities faint; auditory bulla short, broad, moderately inflated; paroccipital process moderately compressed laterally. Upper molars moderately hypsodont, quadrate, outer folds moderately strong, posterior median rib weak, median basal pillar present, at any rate in some species, inner profile straight.

REMARKS.—Since the holotype of *Helicoportax praecox* lacks the occiput, many of the characters mentioned in the above diagnosis cannot be ascertained from it. There are, however, two specimens from Chinji in Calcutta which there is good reason to believe belong to the genus, and provisionally it is assumed that the missing portions of the holotype would show a similar structure. These specimens are (1) a hornless female skull (Geol. Surv. Ind. No. B576), of which the palate and teeth are practically identical in size and structure with those in the holotype; (2) a right horn-core with a portion of the orbit and frontal preserved, which will be described and figured subsequently as the holotype of *Helicoportax tragelaphoides.*

A third specimen (Amer. Mus. No. 19654), consisting of the occiput of a hornless female skull (figures 8–11), resembles the female skull mentioned above sufficiently closely to render it at least possible that it belongs to *Helicoportax.* Since it is not identical with the occiput of Geol. Surv. Ind. No. B576, on the assumption that the latter belongs to *Helicoportax praecox,* this will be provisionally referred to *Helicoportax tragelaphoides.*

COMPARISONS.—The torsion of the horn-cores of *Helicoportax* seems to invite a comparison with the Tragelaphinae, but in most of the genera of that subfamily the cross-section is approximately circular, and where it is laterally compressed is symmetrical, having two equally convex faces between the keels. Thus it is entirely different from the cross-section of the horn-core of *Helicoportax,* in which the inner face is much flattened while the outer face is strongly convex. *Tragelaphus* seems to be an exception to this rule, but as remarked above (page 735), the flat face of the horn-core of *Tragelaphus* is not only entirely posterior, but the two keels are not homologous with those of *Helicoportax.* In the latter, as in all the Boselaphinae, the anterior keel is adjacent to the supraorbital foramen, and in this position there is such a faint indication of a keel in *Tragelaphus* that it may be said to be absent.

The actual keel in *Tragelaphus,* as it exists in the living species, is situated at a considerable distance internal to the axis which seems to correspond to that joining the two keels of *Helicoportax.* Thus it would appear to represent the third angle of the boselaphine horn-core, which in

Helicoportax is very weak, and in any case is external instead of internal to the line joining what I conceive to have been the two original keels. *Antilospira licenti* Teilhard and Young (1931, p. 43) has the typical tragelaphine horn-core, of which the cross-section is diamond-shaped instead of triangular. Whether its internal keel corresponds to the antero-internal keel of *Helicoportax* or to the postero-internal keel of *Tragelaphus*, I cannot be certain without seeing the specimen. *Spirocerus* Boule and Teilhard (1928, p. 66; Teilhard and Piveteau, 1930, p. 69) seems to be as clearly marked as a tragelaphine by the symmetrical cross-section of the horn-core.

Quite apart from its horn-cores, however, the holotype of *Helicoportax praecox* presents characters which ally it to *Boselaphus* rather than to the Tragelaphinae: the great breadth at the frontals with horn-cores very far apart; the small supraorbital foramina; the quadrate shape of the upper molars with basal pillars and rugose enamel. On the very probable assumption that the female skull in Calcutta belongs to the same species as the holotype, then the approximate parallelism of the cranial and facial axes, the strong overhanging temporal ridges, the rugose sculpture of the frontals and parietals, the great mastoid breadth, with outward development of the hinder part of the squamosal, and the rather hypsodont molars considerably increase the boselaphine affinities of *Helicoportax*.

Of the other genera referred to the Boselaphinae, *Helicoportax* seems to be most closely allied to *Selenoportax*. Although the horn-cores are twisted in *Helicoportax*, which is only slightly the case in *Selenoportax*, yet both genera agree in having the flattened face of the horn-core internal, instead of external as in *Pachyportax*, *Tragoportax* and *Strepsiportax*. Moreover in *Helicoportax tragelaphoides* the strong divergence of the horn-cores is like that of *Selenoportax*. The outline of the supraoccipital as exposed on the upper surface of the skull is the same in both. In *Tragoportax* and *Strepsiportax* it is also similar but in *Pachyportax* the suture between the parietal and the supraoccipital lies much nearer to the occipital crest. The occipital is as low or lower than in *Selenoportax*. The occiput is longer than in *Selenoportax* but shorter than in *Boselaphus*.

Helicoportax praecox, new species

Figures 6 and 7, 62, 64 to 67, 70, 79

HOLOTYPE.—Amer. Mus. No. 19476, fragmentary skull with much worn cheek dentition, lacking the occiput.

REFERRED SPECIMENS

Amer. Mus. No. 19608—jaw frags. and teeth, 5 mi. E. Chinji Bungalow.
" " " 19645—jaw frags., 5 mi. E. Chinji Bungalow.
" " " 19729—tibia, $4^1/_2$ mi. W. Hasnot.
" " " 29906—lower jaw, 3 mi. W. Chinji Bungalow.
" " " 29973—molar, 2 mi. W. Chinji Bungalow.
" " " 29974—molar, $1^1/_2$ mi. N. Chinji Bungalow.

HORIZON AND LOCALITY.—Four miles west of Hasnot. This is evidently close to the boundary between the Chinji and Nagri stages, but may be considered as lowest Nagri.

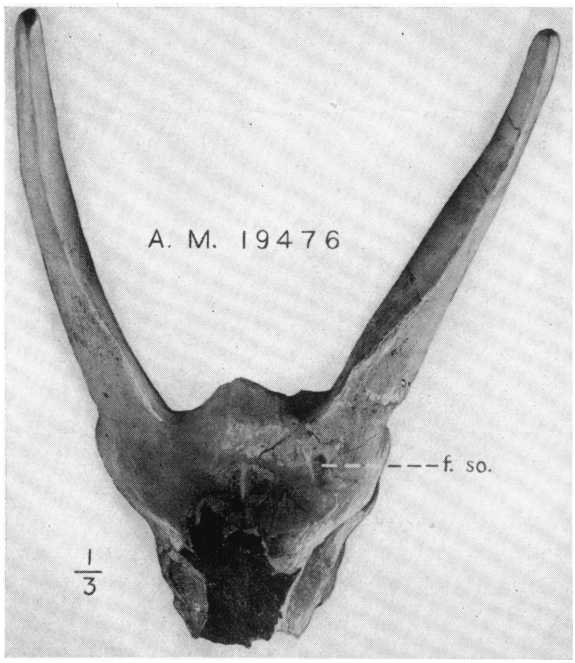


Fig. 6. *Helicoportax praecox*, new genus and species. Type, Amer. Mus. No. 19476, partial skull; from four and a half miles west of Hasnot. Front view. One-third natural size. *f. so.*, supraorbital foramen.

DIAGNOSIS.—The diagnosis is that of the genus. The horn-cores diverge at an angle of about 45°; they are slightly twisted to less than a quarter of a revolution; the inner face of the cross-section is slightly convex, and the posterior keel is rounded; the axis of the keels is inclined to that of the skull at an angle of 35°.

DESCRIPTION.—The skull fragment shows the palate with the cheek dentition on the right side complete, except for the loss of P^2, though much worn down on account of the advanced age of the animal. The cheek dentition on the left side is some-

what broken and lacks the premolar series. The face on both sides is preserved up to the suture with the nasals or the ethmoidal vacuity, but lacks the front of the maxillae and the whole of the nasals, though a fragment of the left premaxilla was collected. On the right side the face is continued back to form the complete lower and front border of the orbit, but the upper portion of the orbit with the greater part of the right frontal and the right horn-core, except a fragment 55 mm. in length and occupying a position about 27 mm. from the base, is all missing. On the left side the whole of

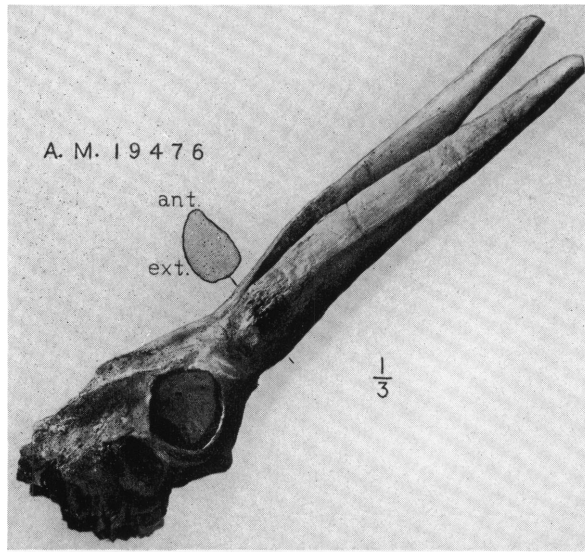


Fig. 7. *Helicoportax praecox*, new genus and species. Type, Amer. Mus. No. 19476, partial skull; from four and a half miles west of Hasnot. Lateral view. One-third natural size. Cross-section of right horn-core at base; *ant.*, anterior; *ext.*, external.

the orbit is missing, but the middle part of the lachrymal fossa is still united to the frontal, which except for small gaps is fairly complete with the left horn-core for the lowest 70 mm. of its length. Everything behind this horn-core is missing, so that the facial angle is unknown. Owing to faulty restoration or pathological defect the left horn-core does not reproduce exactly the cross-section and torsion which we find on the fragment of the right horn-core, since the postero-internal face is more convex and the keel twists somewhat irregularly. The fragment is slightly crushed in the vertical plane, but not much since the orbit is little if at all distorted, but the nasals were probably flattened out and broken away and the palate is more concave than should be the case naturally, so that the tooth rows are too close together.

The horn-cores are situated extremely far apart on the very wide frontals, even more so relative to the size of the orbits and the palate than in the living *Boselaphus*

and *Strepsiportax*. They are situated immediately above the orbits and are tilted backward almost in the plane of the face. They diverge at an angle of about 45° near the base but curve slightly inward for their upper half. They have a slight clockwise twist, more than in *Strepsiportax, Selenoportax* and *Tragoportax*, but yet hardly amounting to as much as a quarter of a revolution. Each horn-core is strongly compressed laterally, the compression being less near the tip. There is a sharp antero-internal keel and a rounded postero-internal keel, between which the inner surface of the horn-core is slightly convex and its outer surface strongly convex. The cross section may, however, be said to be subtriangular, since a very distinct angle external to the keel axis is formed by the convergence of two curved faces; this angle is less marked near the base than near the tip, and is situated much nearer to the posterior than to the anterior keel. The axis of the keels is very oblique to that of the skull, being inclined to it at an angle of about 35°. The surface of the horn-cores has been polished by weather but a network of anastomosing striae or furrows can still be distinguished, which recalls the better impressed sculpture seen on horn-cores of *Helicoportax tragelaphoides*.

The hinder part of the left supraorbital pit is well seen about 21 mm. in front of the horn-core. The absence of the bone prevents us from seeing how it ended in front, but it seems to have been elongate and not very wide, though more so than in the living *Boselaphus*. The lachrymal fossa was long and shallow. The frontals extended only a short distance in front of the orbits. Between the horn-cores they form a low eminence, which descends suddenly behind, leading one to infer the presence of a deep cavity behind the horn-core and internal to the temporal ridge, as is the case in *Selenoportax vexillarius*. The temporal ridges are, however, gone, together with all the adjacent portions of the frontal and parietal.

The palatal view of the type skull, showing the upper dentition, is figured on page 837. There the characters of the teeth are described, less on the evidence of the type, in which they are in an extreme stage of wear, than on various unworn dentitions, which are considered to belong to the same species.

Helicoportax tragelaphoides, new species

Figures 8 to 11, 63, 68 and 69

HOLOTYPE.—Geol. Surv. Ind. No. B797, right horn-core attached to a portion of the frontal.

REFERRED SPECIMENS

Amer. Mus. No. 19609—jaw frag., 1 1/2 mi. N. W. Chinji Bungalow.
" " " 19634—miscellaneous, 1 1/2 mi. N. W. Chinji Bungalow.
" " " 19654—brain case, 6 mi. W. Chinji Bungalow.
" " " 19922—miscellaneous, near Ramnagar.
" " " 29935—lower jaw, 1 1/2 mi. N. W. Chinji Bungalow.

HORIZON AND LOCALITY.—From one mile south of Bhilomar, in the neighborhood of Chinji, Chinji stage.

DIAGNOSIS.—A *Helicoportax* of somewhat larger size than *H. praecox*, with horn-cores diverging at an angle of about 100° more twisted than in *H. praecox* to as much

as half a revolution; the inner face of the cross-section is flat and the posterior keel is sharp; the axis of the keels is more oblique to that of the skull than in *H. praecox*.

DESCRIPTION OF HOLOTYPE.—The holotype of the species is a right horn-core attached to a portion of the frontal, which shows part of the orbit and the supraorbital foramina, but lacks everything behind the horns. From the position of the orbit and the supraorbital foramen, it is evident that the horn-core must have pro-

Fig. 8. (?)*Helicoportax tragelaphoides*, new species. Referred hinder part of skull, Amer. Mus. No. 19654; from Kariti, six miles west of Chinji Bungalow. Top view. Natural size.

jected laterally at a considerable angle to the vertical plane, the angle of divergence of the horn-cores being about 100°. The tip of the horn-core is missing but I estimate its original length as about 225 mm. The antero-posterior diameter at the base is 43 mm., and the transverse diameter 29 mm. It is almost straight. The outer face is strongly convex, while the inner face is quite flat. It is more twisted than in *Helicoportax praecox*, the torsion amounting to as much as half a revolution. Both the antero-internal and the postero-external keels are remarkably sharp. The supraorbital foramen is sunken in a moderately large pear-shaped pit.

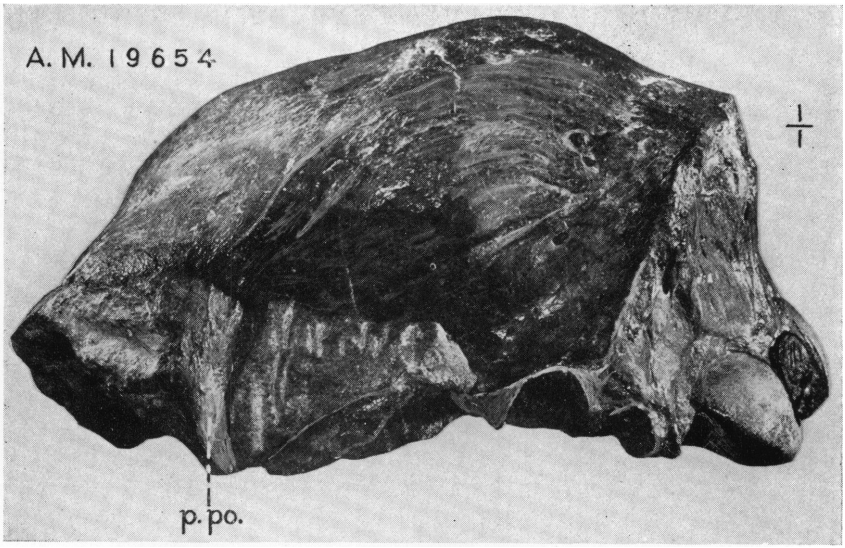


Fig. 9. (?)*Helicoportax tragelaphoides*, new species. Referred hinder part of skull, Amer. Mus. No. 19654; from Kariti, six miles west of Chinji Bungalow. Lateral view. Natural size. *p. po.*, postorbital process.

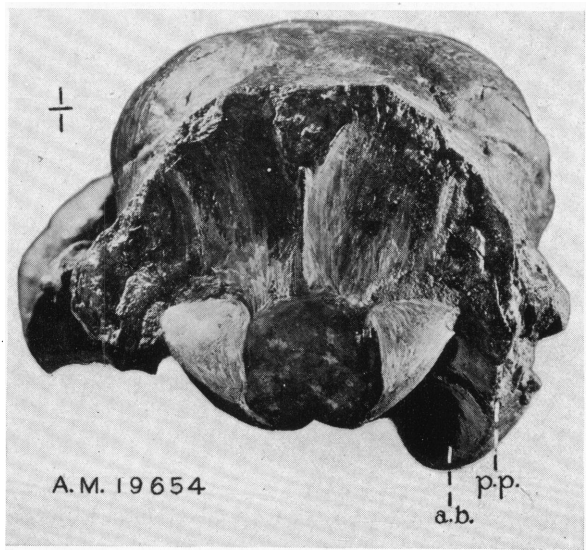


Fig. 10. (?)*Helicoportax tragelaphoides*, new species. Referred hinder part of skull, Amer. Mus. No. 19654; from Kariti, six miles west of Chinji Bungalow. Occipital view. Natural size. *a. b.*, auditory bulla; *p. p.*, paroccipital process.

DESCRIPTION OF REFERRED SPECIMENS.—A portion of a horn-core, fractured some distance above the base (Amer. Mus. No. 19634), from the Chinji stage $1^1/_2$ miles northwest of Chinji Bungalow, resembles the holotype very closely, but is slightly more twisted and has a slight inward curvature. Another horn-core of a pre-

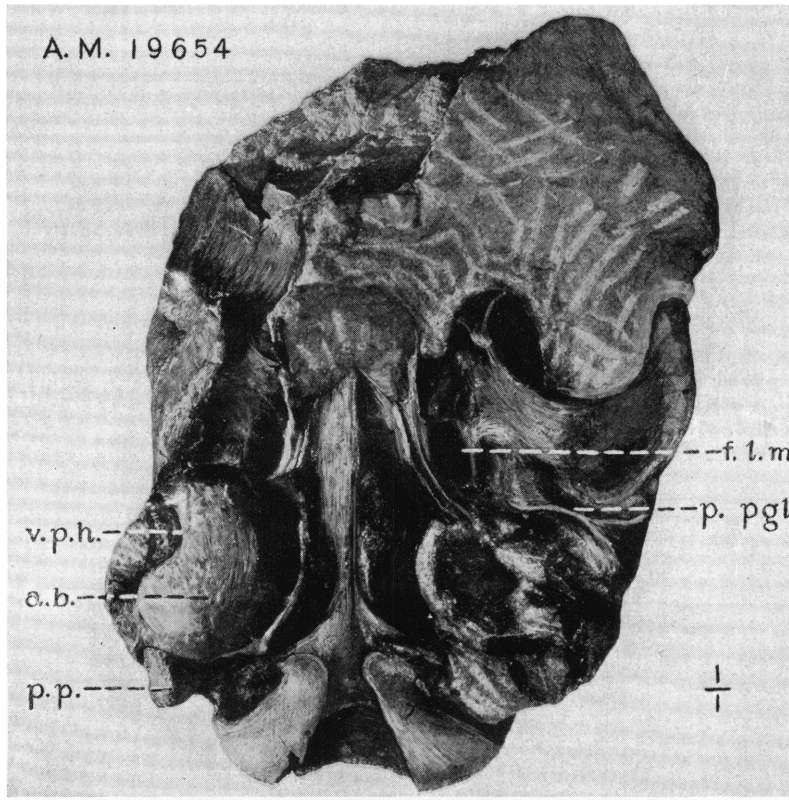


Fig. 11. (?)*Helicoportax tragelaphoides*, new species. Referred hinder part of skull, Amer. Mus. No. 19654; from Kariti, six miles west of Chinji Bungalow. Basicranial view. Natural size. *a. b.*, auditory bulla; *f. l. m.*, foramen lacerum medium; *p. p.*, paroccipital process; *p. pgl.*, postglenoid process; *v. p. h.*, vagina processus hyoidei.

cisely similar type (Amer. Mus. No. 19922) was collected near Ramnagar, Jammu state, and is said to be from the Lower Chinji stage.

The fragmentary occiput (Amer. Mus. No. 19654) referred to above (page 747), was collected near Kariti, 6 miles west of Chinji Bungalow, and is apparently from the Lower Chinji stage. It is illustrated in figures 8–11. The left orbit of this specimen is represented behind by the actual bone and in front by an internal cast. As may be

seen by the rough measurements collected on page 856, the width at the orbits is very great. The upper surface of the occiput is flat and rather high from midway between the orbits to a point about 40 mm. in front of the occipital crest. Behind and in front of this the profile falls rather steeply. From this one is inclined to infer that the face was more bent down than is the case in other Boselaphinae. One is led to infer a similar condition from the portions of the frontal which are preserved in the holotype. On the contrary in the skull (Geol. Surv. Ind. No. B576) referred to *Helicoportax praecox* (page 25), the face is but little bent down on the occiput. The temporal ridges are weak, as is usual in the females, but are very distinct. The fronto-parietal suture is well seen as an undulating line about 17 mm. behind the hinder level of the orbits. The occiput is very short, the distance from the mid-point of the orbits to the occipital crest being to the width of the brain case in the ratio of approximately 1.28 to 1. In Geol. Surv. Ind. No. B576 the same ratio is about 1.36. In *Selenoportax vexillarius* it is about 1.15; in *Strepsiportax gluten* about 1.56; in *Pachyportax latidens* about 1.58; in *Tragoportax* aff. *salmontanus* about 1.77; in *Boselaphus tragocamelus* about 1.80 and in *Tragocerus punjabicus* about 1.43. The width at the mastoid is great but less so relative to the height of the occipital than in Geol. Surv. Ind. No. B576. The supraoccipital occupies a narrower area on the upper surface of the skull than in *Strepsiportax gluten*, the suture between it and the parietal being about 13 mm. distant from the occipital crest. The hinder part of the root of the zygomatic process of the squamosal is very prominent and concave, as in most of the Boselaphinae. The surface of the occipital is concave vertically, though the knob which forms the top of the occipital crest is broken off.

The foramen magnum is large and the condyles project somewhat to the rear. The basioccipital is high and rounded, with a prominent median ridge. The posterior tuberosities are expanded laterally but the anterior tuberosities are faint, and lie well behind the anterior end of the bulla. Although the anterior tuberosities are poorly developed yet the expansion of the basioccipital at this place is much more marked than in most of the other Boselaphinae of the Siwaliks, so that the outline is hour-glass-shaped rather than triangular. In this respect it agrees with the Nylghai. The auditory bulla is much shorter and broader than in *Strepsiportax gluten* or *Tragocerus punjabicus*. It is also broader and relatively much larger in every dimension than in the Nylghai. The glenoid is both wide and long.

Helicoportax sp.

Amer. Mus. No. 19449—jaw frag. and teeth, 2 mi. W. Chinji Bungalow.
" " " 19476—skull, 4 mi. W. Hasnot.
" " " 19617—jaws, $1\frac{1}{2}$ mi. W. Chinji Bungalow.
" " " 19994—molar, 13 mi. E. Chinji Bungalow.
" " " 19995—jaw, 1 mi. W. Chinji Bungalow.
" " " 19997—Pm^{3-4}, 3 mi. N. W. Chinji Bungalow.
" " " 19998—maxilla, 3 mi, N. W. Chinji Bungalow.
" " " 29850—jaw frag. and teeth, 2 mi. N. E. Pardial.
" " " 29858—jaw, $1\frac{1}{2}$ mi. W. Chinji Bungalow.
" " " 29867—palate, 5 mi. E. Chinji Bungalow.
" " " 29900—jaw, 3 mi. W. Chinji Bungalow.
" " " 29909—maxilla, 3 mi. W. Chinji Bungalow.
" " " 29924—maxillae, 3 mi. W. Chinji Bungalow.

Amer. Mus. No. 29925—molars, 5 mi. E. Chinji Bungalow.
" " " 29926—molars, 4 mi. W. Chinji Bungalow.
" " " 29927—molars, 5 mi. E. Chinji Bungalow.
" " " 29928—horn-core, $1^1/_2$ mi. N. W. Chinji Bungalow.
" " " 29929—horn-core, near Ramnagar.
" " " 29930—maxilla, near Ratta Kund, 6 mi. W. Chinji Bungalow.
" " " 29931—lower jaw, 5 mi. E. Chinji Bungalow.
" " " 29945—maxilla, 3 mi. W. Chinji Bungalow.
" " " 29961—maxilla, 10 mi. E. Chinji Bungalow.
" " " 29992—molar, 1 mi. S. Nathot.
" " " 29994—teeth, 1 mi. S. Nathot.
" " " 29995—jaw, 2 mi. W. Chinji Bungalow.

STREPSIPORTAX, NEW GENUS

GENOTYPE.—*Strepsiportax gluten*, new species.

DIAGNOSIS.—Boselaphinae of rather small size; skull extremely wide both at the frontals and the occipital; face very slightly bent down on the cranial axis; occiput with convex profile, moderately short, the distance between the mid-point of the orbits and the occipital crest being to the width of the brain case in the ratio of about 1.56 to 1; horn cores slender, short or of moderate length, slightly twisted, situated immediately above the orbits and far apart on the frontals, with moderately prominent antero-internal and postero-external keels, keel axis rather oblique to the skull axis, keels when prolonged tending to meet at an acute angle; horn-cores directed moderately backward and slightly outward, generally with a slight inward curve; cross-section subtriangular, elongate, laterally compressed, outer face between the keels slightly convex, third angle moderately distinct, postero-internal; supraorbital pits narrow and elongate, lachrymal fossa shallow; temporal ridges strong; surface of frontals with reticulate sculpture; nasals narrowly indenting the frontals, ending slightly in front of the orbits; basioccipital short with rounded surface, hour-glass-shaped, with posterior tuberosities much expanded laterally, anterior tuberosities small; auditory bulla laterally compressed, considerably inflated; paroccipital process laterally compressed; supraoccipital occupying a wide rectangular area on the upper surface of the skull.

REMARKS AND COMPARISONS.—It has been shown above that the horn-cores of *Selenoportax* and *Helicoportax* have a very similar cross-section. In *Strepsiportax* the cross-section differs in the flattened face being external instead of internal to the keel axis. Its horn-cores more nearly resemble those of *Pachyportax*, *Tragoportax* or even *Tragocerus*. The resemblance to *Pachyportax* is particularly noticeable. If the horn-cores of *Strepsiportax* were longer, less compressed laterally and somewhat more twisted, the difference from those of *Pachyportax* would vanish. *Tragoportax* is more remote because the torsion of the horn-cores is slight and may even be altogether absent. Moreover the third angle of the cross-section in the latter genus is more marked and the expanded bases of the horn-cores join one another, or

tend to do so, as a raised ridge across the frontals, which is by no means the case in *Strepsiportax*. *Tragocerus* often resembles *Tragoportax* in regard to the last named character, but the cross section of the horn-core is much more elongate and the third angle is at the base of an isosceles triangle. *Strepsiportax* possesses all the cranial characters mentioned on page 736 as diagnostic of the Boselaphinae. The structure of the basioccipital agrees with that of *Helicoportax*, *Pachyportax* and some species of *Tragoportax* and *Tragocerus* and differs from that of *Boselaphus* and a few species of *Tragocerus* and *Tragoportax* in having a rounded surface without a median furrow. It seems that this character is not altogether constant in any genus, since *Proboselaphus* Matsumoto, though allied to *Boselaphus* in many of its characters, including the backward shifting of the horns, has a basioccipital with a median keel but without a median furrow, as in the Siwalik genera here mentioned. On the assumption that the female skulls (Geol. Surv. Ind. B576 and Amer. Mus. No. 19654) belong to *Helicoportax*, then the bulla of *Strepsiportax* is narrower and agrees with that of *Tragocerus*, *Tragoportax* and *Boselaphus*. In respect to the longer distance between the parieto-supraoccipital suture and the occipital crest *Strepsiportax* differs from *Pachyportax* and approaches somewhat the condition seen in *Tragocerus*, *Tragoportax* and probably *Helicoportax*. The occiput is longer than in *Helicoportax* and *Selenoportax* but shorter than in *Pachyportax latidens*, *Boselaphus*, *Tragoportax* and the normal *Tragocerus*. One species, however, which has been referred to *Tragocerus*, *Tragocerus latifrons* Sickenberg (1929, p. 63) from the Upper Miocene (Sarmatian) of Oberhollabrunn in the Vienna basin, has an equally short occiput. In many other respects *T. latifrons* is quite unlike other species of *Tragocerus* and bears a striking resemblance to *Strepsiportax*. This will be gathered from the comparisons which I draw between it and *Tragoportax* on page 778. It is true that the cross-section of the horn-core in *T. latifrons* has the typical isosceles triangular shape of *Tragocerus*, while *Strepsiportax* has the third angle in the middle of the internal face, but in the wide-spacing, curvature and torsion of the horns, in the outline and sculpture of the frontal, in the low, broad occipital, in the short occiput, in the larger and more elongate supraorbital foramen and in the shorter extension of the supraoccipital on the upper surface of the occiput, the two are strikingly similar. The horn-cores of *Strepsiportax* are smaller, more slender, more twisted, farther apart, with a greater number of longitudinal ribs and more tilted backward. The two forms serve to link *Tragocerus* with the more normal Boselaphinae.

A suggestive resemblance exists between the horn-cores of *Strepsiportax* and *Protragocerus chantrei* from La Grive St. Alban (Dépéret, 1887, p. 204, Pl. XII, fig. 4). The horn-cores of the latter are shorter and free from torsion, but the cross-section is almost identical. Unfortunately the skull of *Protragocerus* and even the nature of the insertion of the horn-cores are unknown, so that one cannot predicate its possession of a broad skull like *Strepsiportax* or a narrow one like *Tragocerus*.

One other European species affords some scope for comparison with *Strepsiportax*. This is *Miotragocerus monacensis* (Stromer, 1928, p. 36) from the Upper Miocene (Sarmatian) of the Flinz formation near Munich. By its broad frontals, with widely spaced, keeled horn-cores, strong temporal ridges having a rugose surface between them, it obviously belongs to the boselaphine group with which we are dealing. Not only, however, are the horn-cores not twisted, but their cross-section is elongately oval instead of being triangular. It, therefore, represents a more primitive condition, which might easily have developed into that of *Tragocerus*, *Tragoportax* or *Strepsiportax*, although this actual species is unlikely to have been the direct ancestor of any of them, since the extreme backward tilt of its horns and the pronounced boselaphine character of the frontals point to an already advanced evolution along other lines than the shape of the horn-cores would indicate.

Although the dentition of *Strepsiportax* cannot be definitely identified (see, however, page 843 for a description of a maxilla which may be referred to *Strepsiportax*), yet since the great majority of the teeth from the Chinji stage display in a minor degree the same structure as those of *Boselaphus* and *Selenoportax*, and since it may be assumed that *Strepsiportax* teeth are included amongst these, it follows that the tooth characters of *Strepsiportax* are probably boselaphine, although one would expect the hypsodonty to be less, possibly no greater than in *Tragocerus*. It may be remarked that the teeth of *Protragocerus* are narrower than those of *Tragocerus*, so that the fact that only quadrate molars are found among the collections from Chinji militates against the generic identity of *Strepsiportax* and *Protragocerus*.

Strepsiportax gluten, new species

Figures 12 to 15

HOLOTYPE.—Amer. Mus. No. 19746, a skull lacking most of the face and the dentition.

REFERRED SPECIMENS

Amer. Mus. No. 29933—horn-core, 4 mi. N. E. Chinji Bungalow.

HORIZON AND LOCALITY.—4½ miles west of Hasnot. This must be almost on

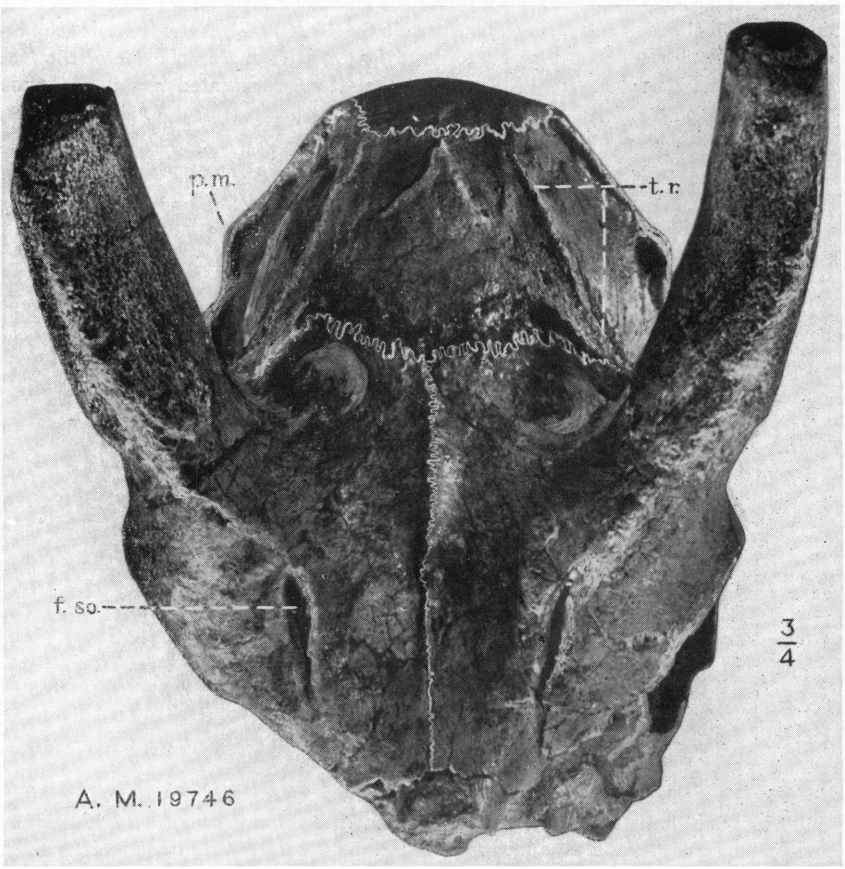


Fig. 12. *Strepsiportax gluten*, new genus and species. Type, Amer. Mus. No. 19746, partial skull from four and one-half miles west of Hasnot. Top view. Three-quarters natural size. *f. so.*, supraorbital foramen; *p. m.*, mastoid process; *t. r.*, temporal ridge.

the boundary between the Chinji and Nagri stages, but may be considered as uppermost Chinji.

DIAGNOSIS.—The diagnosis is that of the genus. The horn-cores are rather short and laterally compressed; hinder end of the nasals about 12 mm. in front of the orbit; depression between the supraorbital pits strongly marked; distance between the

mid-point of the orbits and the occipital crest bearing to the width of the brain-case the ratio of 1.56 to 1.

DESCRIPTION.—The skull is almost complete from the orbits back, including the entire base of both horn-cores, which, however, lack approximately the upper two-thirds of their length. The left bulla and the tips of both paroccipital processes are missing. Most of the face is gone and with it the dentition, but the frontals are preserved as far as their suture with the nasals and a part of the left side of the face showing the shallow lachrymal fossa. The horn-cores are situated very far apart on

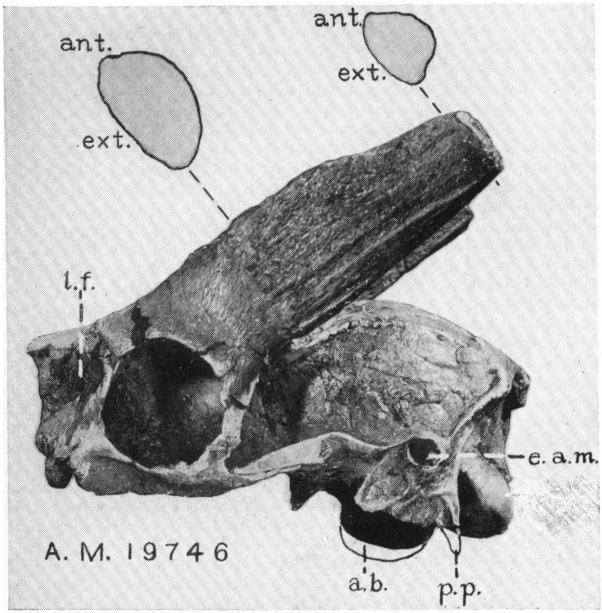


Fig. 13. *Strepsiportax gluten*, new genus and species. Type, Amer. Mus. No. 19746, partial skull from four and one-half miles west of Hasnot. Lateral view. One-half natural size. *a. b.*, auditory bulla; *e. a. m.*, external auditory meatus; *l. f.*, lachrymal fossa; *p. p.*, paroccipital process; cross-sections of left horn-core at base and in mid-portion; *ant.*, anterior; *ext.*, external.

the very wide frontals. They are attached immediately above the orbits, and are tilted backward almost in the plane of the face, forming an angle of about 35° with the surface of the occiput. They diverge at an angle of about 55° for their lower 30 mm. but gradually curve inward above this. They have a very slight clockwise twist, and they possess fairly prominent antero-internal and postero-external keels. The keel axis is inclined about 15° to the skull axis. Between the keels the outer surface is slightly convex and the inner surface strongly convex. The cross-section may be considered as subtriangular, the third angle formed by the convergence of two

curved faces being internal to the keel axis, instead of external as in *Selenoportax* and *Helicoportax*, and situated much nearer to the posterior than to the anterior keel. The surface of the horn-cores is covered with a finely reticulate sculpture. The frontal suture is slightly swollen in the mid-line and remains at the same level between a point opposite the center of the horn base and the parieto-frontal suture. In front of this it descends into a broad depression, which occupies not only the remaining space between the horn-cores but extends forward to the level of the supraorbital pits, which,

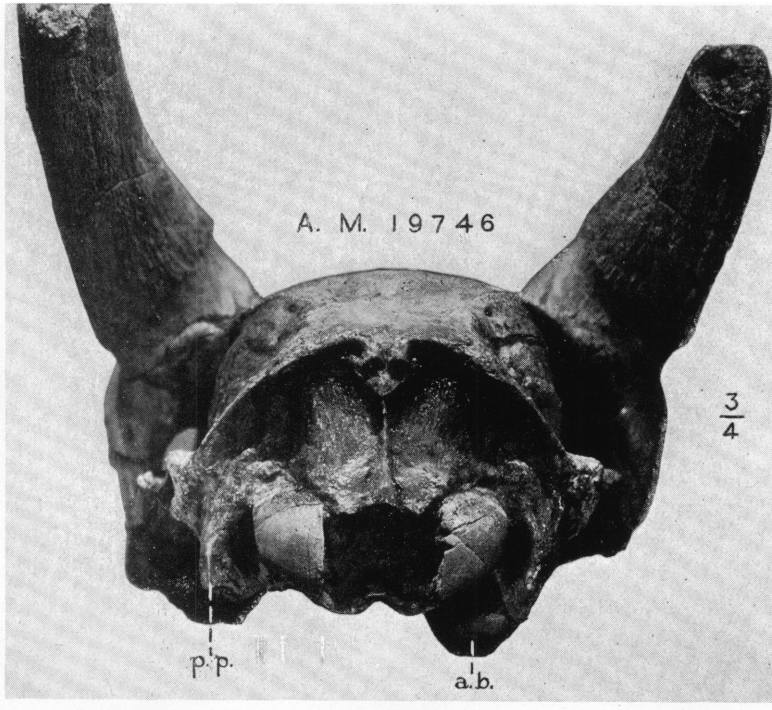


Fig. 14. *Strepsiportax gluten*, new genus and species. Type, Amer. Mus. No. 19746, partial skull from four and one-half miles west of Hasnot. Occipital view. Three-quarters natural size. *a. b.*, auditory bulla; *p. p.*, paroccipital process.

however, lie above and are not included in this depression. Going forward to the fronto-nasal suture the level again ascends until it is as high as that of the region behind the horn-cores. The supraorbital pits lie opposite the anterior third of the orbit; they are long and narrow and are continued forward some way in front of the orbits as narrow, faintly marked grooves. From the posterior end of the supraorbital pits a narrow, tuberculated and roughened ridge runs up along the pedicle, eventually joining the anterior keel of the horn-core as in the Nylghai. The fronto-nasal

suture is apparently about 12 mm. in front of the orbit and narrowly indents the frontals. The orbit is quite circular. Its lower rim is exceedingly prominent and forms a projecting roof over the surface of the jugal as in the Nylghai. The upper border of the orbit passes up gradually into the horn-core and does not project much

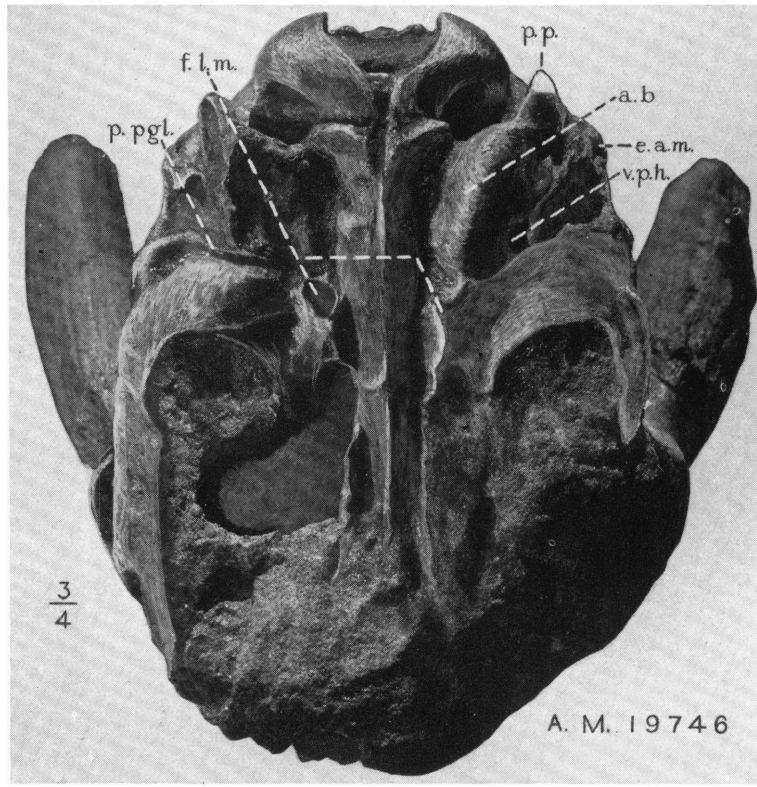


Fig. 15. *Strepsiportax gluten*, new genus and species. Type, Amer. Mus. No. 19746, partial skull from four and one-half miles west of Hasnot. Basicranial view. Three-quarters natural size. *a. b.*, auditory bulla; *e. a. m.*, external auditory meatus; *f. l. m.*, foramen lacerum medium; *p. p.*, paroccipital process; *p. pgl.*, postglenoid process; *v. p. h.*, vagina processus hyoidei.

outside it. A shallow lachrymal fossa is present. Between and behind the horn-cores the surface of the frontals shows a trace of slightly granulated irregular ridges, resembling the sculpture of the Nylghai. These would no doubt be stronger if the fossil were less weathered. A pair of extremely prominent temporal ridges, bounded on the inside by a shallow depression, similar to but much less deep than in *Seleno-*

portax vexillarius, run backward and overhang the brain-case as far back as the parieto-frontal suture. Behind this the brain-case projects laterally beyond them. Becoming less strong farther back, the temporal ridges bifurcate a little behind the parieto-frontal suture. The inner branch continues almost in the line of the original ridge and joins its fellow at the suture between the parietal and supra-occipital, the two enclosing a flat elevated area. The outer branch runs back less obliquely and finally bends round by the side of the supra-occipital to join the lambdoid crest. The profile of the occiput is convex, sloping down to the occipital crest from a point about midway between it and the horn-cores. The brain-case is short but less so than in *Helicoportax*, and much less so than in *Selenoportax*, the distance between a point level with the middle of the orbits, and the occipital being to the width of the brain-case in the ratio of 1.56 to 1. The supraoccipital occupies a rather rectangular area on the upper surface of the occiput in distinction from the transversely elongate ellipse of *Pachyportax*. In this it seems closer to *Boselaphus*, *Helicoportax* and *Tragocerus*, although the area is broader in *Strepsiportax* than in the two last named genera. The distance from the suture between the supraoccipital and the parietal to the summit of the occipital crest is about 16 mm. The occipital is exceedingly broad in relation to its height, in which it agrees with *Selenoportax vexillarius* and with *Helicoportax*. Its shape, however, is rather different from that in the latter genus, because it increases in breadth regularly from above downward, so that the back profile of the lambdoid crest forms a uniform convex curve, whereas in *Helicoportax* the curve is slightly concave for its lower two-thirds. This latter condition occurs more markedly in *Tragoportax* and *Tragocerus*. The surface of the occipital is approximately at right angles to that of the parietal and supraoccipital. Its middle portion forms a broad area some 31 mm. across, concave in a vertical direction and almost flat horizontally with a narrow median vertical ridge, which terminates above in a prominent, knob-like occipital crest. On either side of the central raised area are depressions which are continued downward into the hinder edge of the paroccipital process. The foramen magnum is rather broad and low, and the occipital condyles project slightly to the rear of the occipital crest. The lambdoid crest is very strong. It forms the hinder boundary of a deep and broad hollow in the squamosal, which passes out into the prominent mastoid process, which overhangs the external auditory meatus and the stylomastoid foramen. This passes forward into the broad root of the zygomatic process. The basioccipital is subtriangular in shape. The posterior tuberosities are enormously expanded and are separated by a shallow groove. This groove does not continue forward as in the Nylghai, *Tragocerus* and to some extent in *Tragoportax*, but there is a low, anterior median keel as in *Helicoportax* of which the upper surface is rounded. The anterior tuberosities are small and lie behind the anterior end of the bulla. The basioccipital is expanded at this point as is the case in *Helicoportax*, so that it is somewhat hour-glass-shaped. The auditory bulla is rather long and laterally compressed and so nearly resembles that of *Tragocerus* and differs from that of *Helicoportax*, in which the bulla is broad and short. It is, however, considerably inflated, like *Helicoportax* but unlike *Tragocerus*. Its anterior end is hardly indented by the attachment of the hyoid. The paroccipital process is both short and laterally compressed. The glenoid area is very broad and long. The foramen lacerum medium is much as in the Nylghai, and so is smaller than in the Tragelaphinae and the Bovinae, and less exposed in direct view from below.

Strepsiportax chinjiensis, new species

Figures 16 and 17

HOLOTYPE.—Amer. Mus. No. 19450, skull lacking most of the face and the dentition.

HORIZON AND LOCALITY.—12 miles east of Chinji Bungalow, possibly high up in the Lower Chinji stage.

DIAGNOSIS.—A *Strepsiportax* of slightly smaller size than *S. gluten;* with stouter horn-cores; nasals farther back, their hinder end being about the same level as the

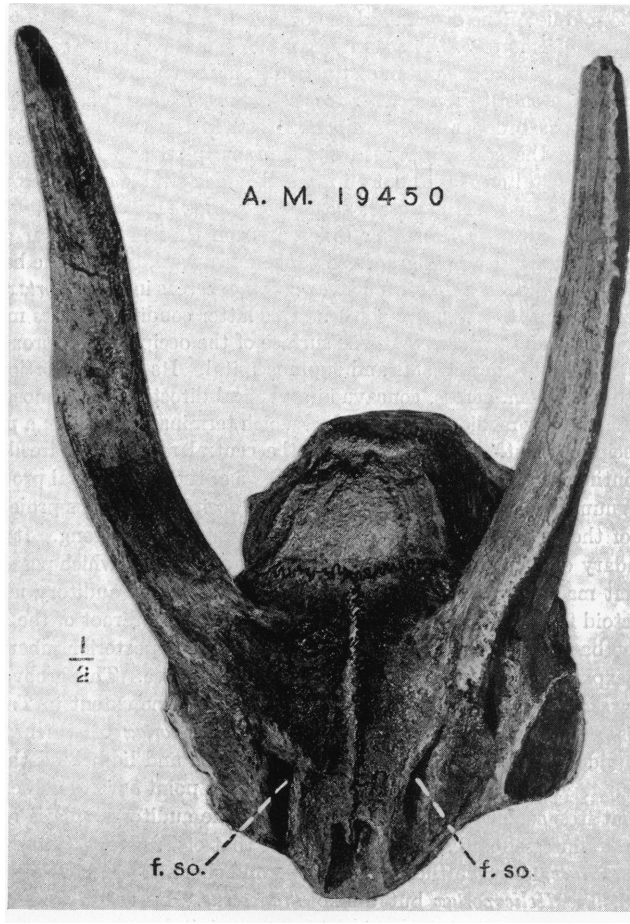


Fig. 16. *Strepsiportax chinjiensis,* new species. Type, Amer. Mus. No. 19450, partial skull from twelve miles east of Chinji Bungalow. Top view. One-half natural size. *f. so.*, supraorbital foramen.

front edge of the orbit; depression between the supraorbital pits shallower; braincase shorter.

DESCRIPTION.—The skull has been considerably crushed vertically, for which reason it is open to some doubt as to whether the differences from *Strepsiportax gluten*

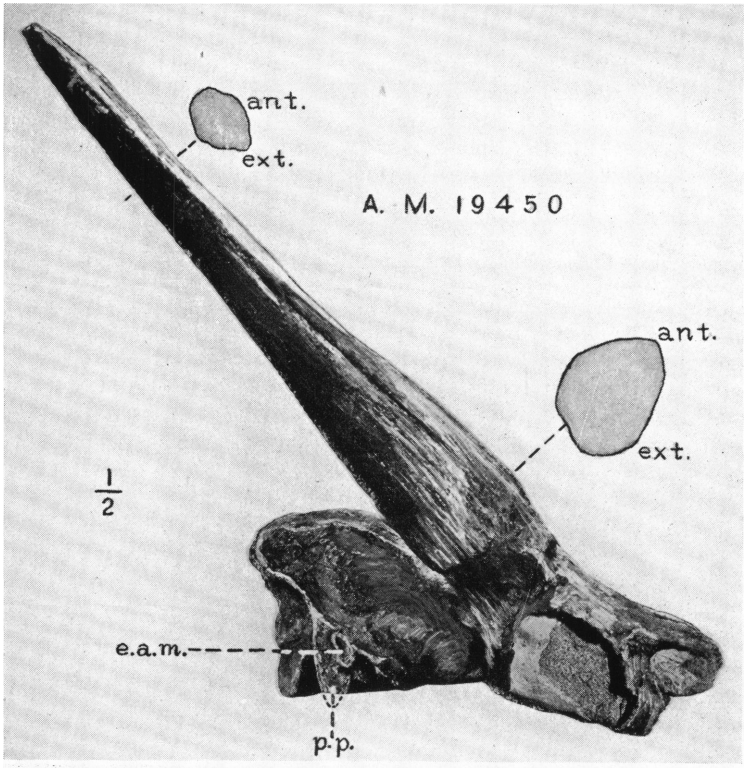


Fig. 17. *Strepsiportax chinjiensis*, new species. Type, Amer. Mus. No. 19450, partial skull from twelve miles east of Chinji Bungalow. Lateral view. One-half natural size. *e. a. m.*, external auditory meatus; *p. p.*, paroccipital process. Cross-sections of right horn-core at base and near tip; *ant.*, anterior; *ext.*, external.

are as great as I believe to be the case. Otherwise its state of preservation is very similar to that of the holotype of the sister species. The supraorbital pits, the lachrymal fossa and the fronto-nasal suture are better shown, but the basicranial region shows the structure less distinctly.

Strepsiportax sp.

Amer. Mus. No. 19578—jaw, 1½ mi. N. W. Chinji Bungalow.
" " " 19582—jaw fragments, 1½ mi. N. W. Chinji Bungalow.
" " " 19993—jaw, 13 mi. E. Chinji Bungalow.

Amer. Nus. Mo. 29859—jaw fragments, 5 mi. E. Chinji Bungalow.
" " " 29862—palate, 3 mi. N. W. Chinji Bungalow.
" " " 29863—jaw, 1 1/2 mi. W. Chinji Bungalow.
" " " 29866—jaw fragments, 5 mi. W. Chinji Bungalow.
" " " 29899—teeth, 5 mi. E. Chinji Bungalow.
" " " 29901—molar, 1 mi. S. Nathot.
" " " 29907—lower jaw, 12 mi. E. Chinji Bungalow.
" " " 29932—horn-core, near Ramnagar.
" " " 29934—lower jaws and teeth, 2 mi. W. Chinji Bungalow.
" " " 29936—lower jaws and teeth, 4 mi. W. Chinji Bungalow.
" " " 29937—horn-core and tooth, 1 1/2 mi. W. Chinji Bungalow.
" " " 29990—lower jaw, 4 mi. W. Chinji Bungalow.

PACHYPORTAX, NEW GENUS

GENOTYPE.—*Cervus latidens* Lydekker, 1876, Pal. Ind., (10) I, p. 65.

DIAGNOSIS.—Boselaphinae of small to large or very large size; closely allied to *Strepsiportax* but differing from that genus by the much more massive skull, with horn-cores longer, stouter, more twisted and less curved inwardly; occipital condyles and foramen magnum larger; mastoid process and squamosal shelf more developed; supraoccipital exposed on the upper surface of the occiput as a narrowly elliptical area much extended transversely; basioccipital approaching a rectangular shape, with posterior tuberosities not greatly expanded; upper molars strongly hypsodont but less so than in *Selenoportax*, quadrate, with strong basal pillars, external folds weaker and less divergent than in *Selenoportax*, external ribs weaker than in *Selenoportax*, in particular the median rib of the posterior lobe flattened, enamel rather thick, somewhat less rugose than in *Selenoportax*, with traces of cement.

Pachyportax latidens (Lydekker)

Figures 18, 51

Cervus latidens LYDEKKER (1876, Pal. Ind., (10) I, p. 65, Pl. VIII, figs. 7, 10).
Oreas(?) *latidens* LYDEKKER (1884, Pal. Ind., (10) III, p. 111).
TYPE.—Geol. Surv. Ind. No. B219, an isolated M^3.

REFERRED SPECIMENS

Amer. Mus. No. 9906—horn-core, near Hasnot.
" " " 19906—femur, 4 1/2 mi. W. Hasnot?
" " " 19730—jaw, 1 mi. S. Padri.
" " " 19744—jaws and teeth, 2 1/2 mi. N. E. Hasnot.
" " " 19973—molars, 1 1/2 mi. N. Hasnot.
" " " 19982—teeth, 4 mi. W. Dhok Pathan.
" " " 29913—molar, 1 mi. N. Hasnot.
" " " 29914—molar, 1 1/2 mi. N. E. Hasnot.
" " " 29915—molar, 4 mi. W. Dhok Pathan.
" " " 29918—molar, 1 1/2 mi. E. Hasnot.
" " " 29940—molar, 3 mi. E. Dhok Pathan.
" " " 29942—molar, 3 mi. W. Chinji Bungalow.
" " " 29960—part of tibia, 1/2 mi. S. Dhok Pathan.

HORIZON AND LOCALITY.—From the Lower Portion of the Upper Siwaliks, Tatrot Zone. Hasnot and adjacent localities, Punjab.

DIAGNOSIS.—A *Pachyportax* of extremely large size; upper molars with relatively strong external folds, median ribs broad and relatively prominent, internal basal pillar much extended transversely.

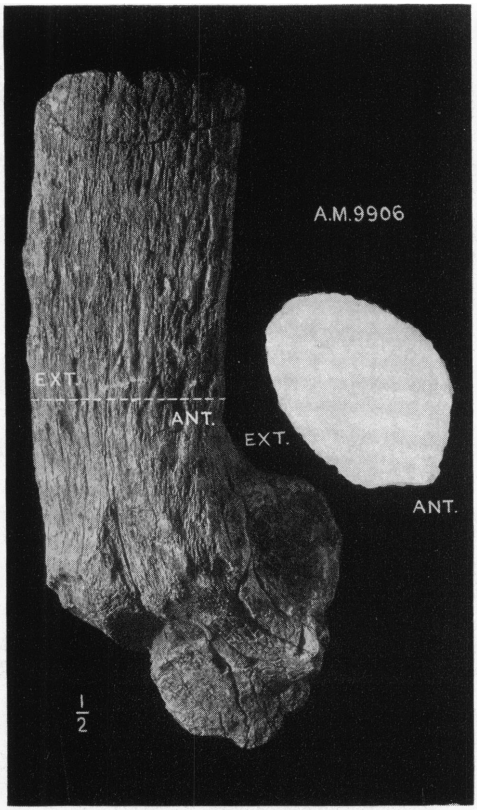


Fig. 18. *Pachyportax*, new genus, *latidens* (Lydekker). Part of horn-core, Amer. Mus. No. 9906, from near Hasnot, probably the Tatrot stage. Posterior view, somewhat oblique, and cross-section at base. One-half natural size. *Ant.*, anterior; *ext.*, external.

DISCUSSION.—The holotype of *Cervus latidens* Lydekker was an isolated M^3 collected near Hasnot (Pal. Ind., (10) I, p. 65, Pl. VIII, figs. 7, 10). This is preserved in Calcutta (Geol. Surv. Ind. B219). To the same species Lydekker referred a left maxilla with $P^{3-4}M^{1-3}$ and provisionally assigned both specimens to the genus *Oreas* (= *Taurotragus*) (Pal. Ind., (10) III, p. 111, Pl. XIII, figs. 12, 13). This specimen is also in Calcutta (Geol. Surv. Ind. No. B218a). At a later date a skull of an aged individual, of which the face had been completely shattered but

still retained two molars, was collected at Nila. This is in Calcutta (Geol. Surv. Ind. Nos. B488 and 489). The two molars may undoubtedly be identified both as to size and structure with those of B218. They are smaller than the holotype of *Cervus latidens* and differ from it in certain details of structure. This skull will be fully described and figured in another publication, but meanwhile its characters are briefly outlined in the foregoing diagnosis of the genus *Pachyportax* and its measurements are contained in the table on pages 856–7.

Numerous upper molars exist both in Calcutta and in the American Museum Collection in New York, which agree with the holotype and with the molars of Geol. Surv. Ind. Nos. B218 and 489. The larger sized ones have, however, been found only near Hasnot from localities which are very close to the base of the cliff where the Tatrot outcrop begins. On the other hand the smaller sized ones occur both from other localities near Hasnot and from localities on the Soan river which certainly belong to the Dhok Pathan stage, since no Tatrot beds are there exposed. I now suggest the possibility that the larger molars may belong to a distinct variety found only in the Tatrot stage. To this variety I assign a large horn-core (Amer. Mus. No. 9906) collected by Mr. Vinayak Rao near Hasnot, here figured for the first time, and also a portion of another large horn-core (Geol. Surv. Ind. No. B246) described and figured by Lydekker (Pal. Ind., (10) I, Pl. XXVIII, fig. 3) under the name of *Capra* sp.

Pachyportax latidens dhokpathanensis, new subspecies

Figure 51

TYPE.—Geol. Surv. Ind. Nos. B488 and 489, a skull associated with two molar teeth. From Nila.

PARATYPE.—Geol. Surv. Ind. No. B218a, a left maxilla with P^3–M^2.

REFERRED SPECIMENS

Amer. Mus. No. 19495—brain-case, near Dhok Pathan.
" " " 19841—maxilla, 4 mi. W. Dhok Pathan.
" " " 19851—humerus, 1/2 mi. W. Dhok Pathan.

HORIZON AND LOCALITY.—From the Middle Siwaliks, Dhok Pathan zone. From Hasnot, Nila and adjacent localities in the Punjab.

DIAGNOSIS.—A variety of *Pachyportax latidens* of smaller size than the type; upper molars with weaker external folds, median ribs narrower and less prominent, internal basal pillar lower and less extended transversely than in the type; occiput relatively high and long with a rather straight profile.

REMARKS.—The skull from Nila and the various upper teeth which agree with its two molars will provisionally be known as *Pachyportax*

latidens var. *dhokpathanensis*. A brain-case fractured behind the horn-cores (Amer. Mus. No. 19495), which is almost identical with the skull from Nila, was collected by Doctor Brown at Dhok Pathan.

Pachyportax sp.

Figures 19, 20

A still smaller horn-core (Amer. Mus. No. 19764), figure 19, below, was collected at Harsai, 21 miles northwest of Bilaspur, Simla Hill States. The horizon is unknown but since the great majority of the Bilaspur fossils belong to the Nagri stage it is at least possible that the horn-core came from that level. It is clearly of the same type as *Pachyportax*, but somewhat more slender relatively than the ones from

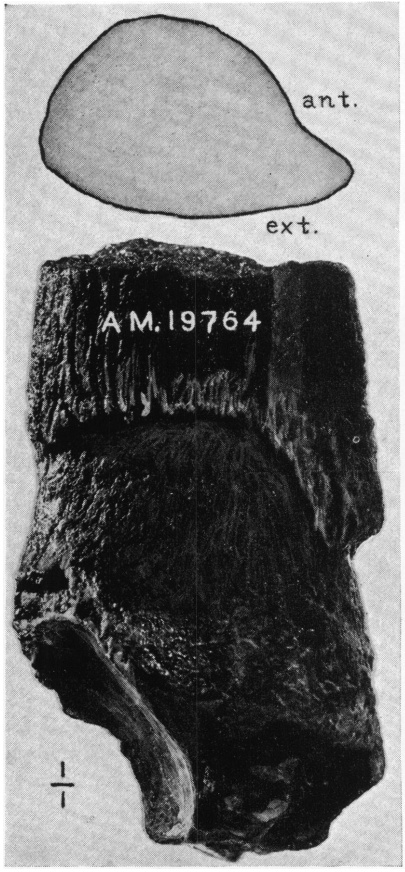


Fig. 19. *Pachyportax*, new genus, sp. Amer. Mus. No. 19764. Fragment of frontal with base of horn-core, from Harsai, near Haritalyanger, 21 miles northwest of Bilaspur, Simla Hill States. Natural size. Cross-section; *ant.*, anterior; *ext.*, external.

Dhok Pathan. Its measurements at the base are: ant.-post. diameter 46 mm., trans. diameter 30 mm.

It is possible that it may go with a female occiput in Calcutta (Geol. Surv. Ind. No. B560) from Nagri, which agrees fairly well, except for its smaller size and shortness, with the skull from Nila.

Yet one more horn-core of this type (Amer. Mus. No. 29965, Fig. 20) came from the Chinji stage of Chinji. Only 31 mm. of the horn-core are left but the cross-section and adjacent frontal are like those of *Pachyportax latidens*. It is, however, much narrower and has the anterior keel more pronounced. No torsion is as yet evident. Its measurements at the base

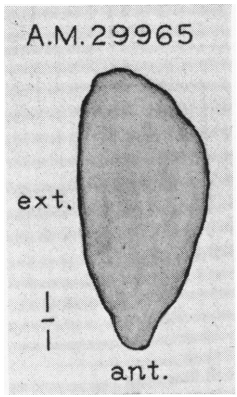


Fig. 20. *Pachyportax*, new genus, sp. Amer. Mus. No. 29965. Fragment of frontal with base of horn-core, from the neighborhood of Chinji. Cross-section at base of horn core. Natural size.

are: ant.-post. diameter 38 mm., trans. diameter 21 mm. This might alternatively belong to the Calcutta occiput from Nagri mentioned above.

TRAGOPORTAX, NEW GENUS

GENOTYPE.—*Tragoportax salmontanus*, new species.

DIAGNOSIS.—Boselaphinae of moderate size; skull wide at the frontals and occipital; face somewhat bent down on the cranial axis; occiput long or moderately short; horn-cores rather short, with or without a slight twist, situated far apart on the frontals, but with their inner base expanded considerably so as to form a swelling on the frontals which sometimes bridges the entire interval between the horn-cores as an elevated belt falling abruptly to the rear; with prominent antero-internal and postero-external keels; keel axis very oblique to skull axis; horn-cores directed strongly backward and moderately or strongly outward, with or without an inward curve; cross-section at base subtriangular, laterally compressed, compression increasing above the base, outer face between the keels weakly convex, third angle internal, about two-thirds of the way from the anterior keel to the rear, rounded;

supraorbital pits small, circular; temporal ridges very strong; frontals rugose; lachrymal fossa deep; basioccipital short, subtriangular, with or without a shallow median groove; supraoccipital exposed as a rectangular area on the upper surface of the skull; upper molars quadrate, moderately hypsodont, outer folds and ribs rather strong, median rib in posterior lobe weaker than in anterior lobe, median basal pillars present in all the molars.

REMARKS AND COMPARISONS.—It seems wiser to take the species *Tragoportax salmontanus* as the genotype of *Tragoportax*, just as it seems on the whole necessary to choose the skull (Amer. Mus. No. 19467) as the holotype of that species, in spite of the fact that there are numerous fragmentary skulls, horn-cores and dentitions in Calcutta which conceivably might be united specifically with the New York skull, for in the first place the above-mentioned specimen is the only skull from India so far known with which the dentition is definitely associated, and in the second place we may be forced later on to separate all or most of the other remains as a distinct species from *Tragoportax salmontanus*. As I explain in the succeeding paragraph, the European species *Tragocerus leskewitschi* Borissiak bears so close a resemblance to the Indian forms that I find it difficult to draw any generic distinction between them. The inclusion of *Tragocerus leskewitschi* in the genus *Tragoportax* is, therefore, convenient, but since it is only provisional, I can hardly make Borissiak's species the type of the new genus. Meanwhile, however, the features missing in the New York skull, but which are shown by other fragments in Calcutta or by *Tragocerus leskewitschi*, have been utilized in framing the foregoing diagnosis.

Certain European species afford scope for the most interesting comparisons with *Tragoportax salmontanus*. Two of these are *Tragocerus leskewitschi* from the Sarmatian beds of Sebastopol, described and figured by Borissiak (1914, pp. 36, 127, Pl. IV, V) and *Tragocerus latifrons* Sickenberg (1929, pp. 63–72), from the Upper Miocene Sarmatian beds of Oberhollabrunn in the Vienna basin. I am much indebted to Professor Borissiak for presenting me with casts of the types of the Sebastopol species, which were specially prepared in Leningrad. A cast of the type of *Tragocerus latifrons* was presented to the British Museum by Professor Abel. A careful comparison of these with the Indian species has enabled me to judge of the differences between them more adequately than would otherwise have been the case. A detailed account of these differences is given below on pages 777–79. Both the European species differ from the normal *Tragocerus* by their greater breadth both at the orbits and at the occipital. *Tragocerus latifrons* is closer to the

Indian species in regard to the curvature and torsion of the horn-cores and their greater spacing and divergence, but on the other hand their cross-section is typical of *Tragocerus*. *Tragocerus leskewitschi* on the contrary resembles *Tragoportax* in the cross-section of the horn-cores, but is further removed from it in regard to the other characters mentioned. If we lay greater stress on outline of the cross-section, as I have tended to do throughout this paper, then *T. leskewitschi* may be included in the genus *Tragoportax*, while *T. latifrons* may remain provisionally as an abnormal species of *Tragocerus*, although, in my opinion, with which its author Doctor Sickenberg concurs, it would be more convenient to separate it generically from *Tragocerus*. It may also be mentioned that except in the cross-section of the horn-cores the resemblance of *Tragocerus latifrons* to *Strepsiportax* is very striking.

I, like Professor Borissiak, could have found no useful purpose in separating *Tragoportax salmontanus* and *T. leskewitschi* from *Tragocerus*, were it not that their peculiar characters pass almost imperceptibly in one direction into those of *Tragocerus latifrons* and in the other into those of the smaller *Strepsiportax* and the larger *Pachyportax*, and serve as a chain, lacking but few of its links, which connects *Tragocerus* with *Boselaphus*. Consequently, unless we were to consider *Strepsiportax* and *Pachyportax* as generically the same as *Tragocerus*, which is quite unfeasible, we are almost forced to admit the validity of *Tragoportax*.

So far as concerns the horn-cores their short antero-posterior diameter in *Tragoportax* and their cross-section, which is that of a scalene triangle with the third angle near the middle of the inner side, is very different from their very elongate cross-section in *Tragocerus*, of the shape of an isosceles triangle with a sharp anterior keel and two rounded angles at the base. The horn-cores in *Tragoportax* seem in general to be shorter, to show more divergence, more tendency to torsion and more inward curvature than in *Tragocerus*. *Tragocerus latifrons* is an exception. All known species of *Tragocerus* except *T. latifrons*, have, moreover, a narrower forehead, a long slender occiput and a high face and occipital. The occipital condyles are larger and project more to the rear than in *Tragocerus*.

The horn-cores of *Protragocerus chantrei* (Dépéret, 1887, p. 204, Pl. XII, fig. 4) from La Grive St. Alban, these being unfortunately the only part of the skull which is known, present the most striking resemblance to those of *Tragoportax*. The cross-section is identical, but the horn-cores, though slightly curved inward, are shorter and show no sign of torsion. Were it not for the narrower molars, it might prove impossible

to separate *Protragocerus* from *Tragoportax* generically, unless the structure of the rest of the skull should contradict the impression given by the horn-cores.

The species *Miotragocerus monacensis* (Stromer, 1928, p. 36) from the Upper Miocene (Sarmatian) of the Flinz formation of Munich, already referred to on page 758, presents a much less close analogy to *Tragoportax*, because not only are its horn-cores elongately oval in cross-section without much indication of a triangular shape, but their inner base is not expanded to form a frontal elevation. Strong temporal ridges and broad and rugose frontals exist, however, as in *Tragoportax*. As remarked on pages 758 and 780, it is not inconceivable that some less progressive species of *Miotragocerus* might have given rise to *Tragoportax*.

The molars in the holotype of *Tragoportax salmontanus* are too much worn down to afford any idea of their original height or detailed structure, so that they supply no evidence that the dentition differed from that of *Tragocerus*. There is, however, some reason to believe that certain specimens of the upper dentition of a *Tragocerus*-like antelope which are in Calcutta (Geol. Surv. Ind. Nos. 792 and 795) and which were collected from a quarry which yielded numerous remains of *Tragocerus punjabicus* differ from that species in just the same way as the teeth of *Tragocerus leskewitschi* are stated by Borissiak to differ from *Tragocerus amalthea:* namely, by their greater hypsodonty, the stronger external folds and ribs on the upper molars and the increase in antero-posterior diameter from the base to the summit of the crown. They are rather larger than would correspond to the holotype of *Tragoportax salmontanus* but might easily be associated with numerous fragmentary skulls and horn-cores of *Tragoportax* in Calcutta, which much exceed the holotype in size. The differences from *Tragocerus* noted bring the dentition nearer to that of *Boselaphus*, which accords perfectly with the conclusions to which the study of the skull and horn-cores have led me.

Besides *Tragocerus* the genera to which *Tragoportax* is most nearly allied are *Strepsiportax* and *Pachyportax*. The cross-section of the horn-core, in which the third angle is internal, distinguishes all these genera from *Helicoportax* and *Selenoportax*, in which the third angle is external. *Boselaphus* is distinguished by its equilateral triangular cross-section with a well-marked internal keel. *Tragoportax* is almost intermediate between *Strepsiportax* and *Tragocerus*. In *Strepsiportax* the horn-cores are longer, more slender, more twisted, and not expanded at the base into a frontal swelling. The occiput is shorter, broader and lower, the lachrymal fossa is shallower, the supraorbital pits are more elongated.

The basioccipital lacks the median groove and is generally rounded on the surface. The occipital condyles are smaller and less prominent at the rear than is sometimes the case in *Tragoportax*. The supraoccipital occupies a broad area on the surface of the skull, in distinction from the antero-posteriorly elongate rectangle which we find in *Tragoportax*. Except for its much more massive skull, and larger, much more twisted horn-cores, *Pachyportax* is closer than *Strepsiportax* to *Tragoportax*. But it also has a broader forehead and occiput, lacks the lateral expansion of the horn-core into a frontal swelling; the basioccipital is rounded, without a median furrow; and the supraorbital pits are elongate.

Tragoportax salmontanus, new species

Figures 21 and 22, 60, 61, 78

HOLOTYPE.—Amer. Mus. No. 19467, skull lacking the hinder end of the occiput.

REFERRED SPECIMENS

Amer. Mus. No. 19499—jaw, between Hasnot and Chakual.
" " " 19983—jaw, 4 mi. E. Dhok Pathan.
" " " 29821—metatarsal, 1/2 mi. S. W. Dhok Pathan.
" " " 29853—jaw and tooth, 4 1/2 mi. W. Hasnot.
" " " 29877—lower jaws, 1 mi. N. Hasnot.

HORIZON AND LOCALITY.—A quarry one mile south of Dhok Pathan, from the Dhok Pathan stage of the Middle Siwaliks.

DIAGNOSIS.—A *Tragoportax* of relatively small size; with short, slightly twisted horn-cores, having a slight inward curve, slightly divergent, the angle of divergence being about 40°; keels of the horn-cores meeting, if prolonged, at a right angle between the supraorbital foramina; horn-cores much expanded internally at the base and with a strong frontal swelling between them; occiput short and relatively broad, the length of the temporal fossa being to the width of the brain-case in the ratio of about 0.93 to 1.

DESCRIPTION.—The skull is fractured at the suture between the parietal and the supraoccipital and behind the glenoid crest, so that the entire occipital is missing as well as the auditory bulla and the adjacent parts. The upper surface of the skull is perfectly preserved up to the fronto-nasal suture, including both horn-cores, except for some deficiencies on one side or the other. The most important of these are: the upper margin of the right orbit; the base of the right horn-core on the outer side; the lower part of the anterior keel of the left horn-core. The lower and front margin of the right orbit and the whole of the left orbit, together with part of the zygomatic process of the jugal on both sides, are preserved. The greater part of both maxillae is in place, together with the cheek dentition except for the loss of the right P^2. The extremely worn surface of the tooth crowns, however, testifies to the advanced age of the animal. Though somewhat crushed in the vertical plane and fractured across the lachrymal, yet the general character of the face can be distinguished. It is believed that the attachment of the fractured parts and the necessary restoration is substantially correct.

The face is moderately bent down on the cranial axis, the angle between them being about 40°. The horn-cores are situated far apart on the very wide frontals, but their considerable internal expansion at the base brings the anterior keels rather close to one another, so that if prolonged they would meet at a right angle midway between the supraorbital foramina. This expansion forms a greatly swollen belt on

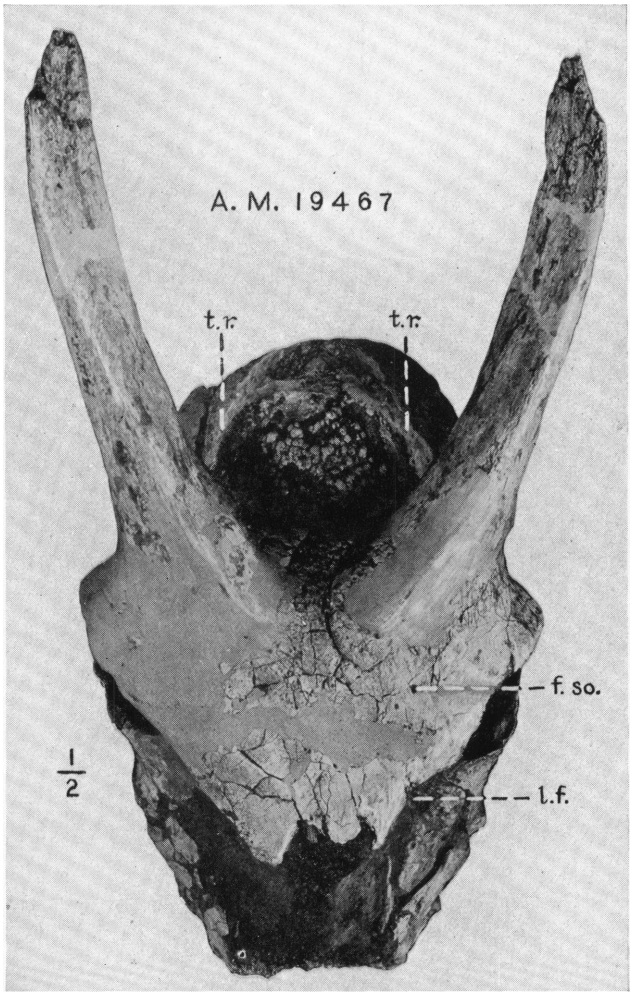


Fig. 21. *Tragoportax salmontanus*, new genus and species. Type, Amer. Mus. No. 19467, partial skull, from one mile south of Dhok Pathan. Front view. One-half natural size. *f. so.*, supraorbital foramen; *l. f.*, lachrymal fossa; *t. r.*, temporal ridge.

the frontals entirely connecting the horn-cores. From this the descent to the nasals is gradual, but that to the rear is abrupt, so that even before reaching the hinder end of the horn-cores the level has fallen to that of the general level of the occiput. The horn-cores are short and are attached immediately above the orbit, their anterior keel being on a level with the middle of the orbit, when the occiput is placed hori-

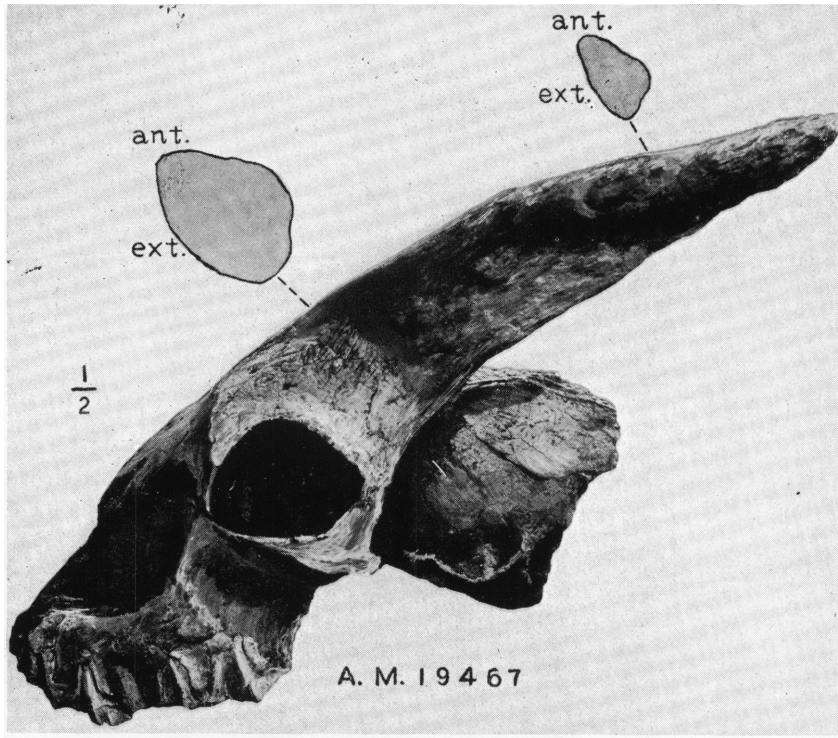


Fig. 22. *Tragoportax salmontanus*, new genus and species. Type, Amer. Mus. No. 19467, partial skull, from one mile south of Dhok Pathan. Lateral view. One-half natural size. Cross-sections of left horn-core at base and near tip; *ant.*, anterior; *ext.*, external.

zontally. They are tilted backward almost in the plane of the face and diverge at an angle of about 36° for the lower third of their length, curving inward slightly above this. They have a very slight clockwise twist, so that the keel axis, which is inclined to the skull axis at an angle of about 35° at the base, is parallel to that axis at half the length of the horn-core. They possess fairly prominent antero-internal and postero-external keels. Their cross section is subtriangular, the third angle being rounded, internal and nearer the rear. The external face is slightly convex. Near the base the cross-section is almost an equilateral triangle, but becomes rapidly compressed

laterally higher up, so as to be very similar to that of *Strepsiportax gluten*. The frontals are perfectly flat in front of the horn-cores and apparently terminate in the mid-line about 22 mm. in front of the orbits. The supraorbital foramina are situated 23 mm. from the orbital margin and the same distance from the origin of the anterior keel of the horn-core. They are extremely small and are practically flush with the bone. The orbits are antero-posteriorly elongated, and although this is partly due to the vertical crushing it seems to be in part natural. In front of them is a deep lachrymal fossa, of which the anterior limit is hidden by the fracture of the specimen. The temporal ridges are very prominent. Starting from the hinder end of the horn-cores each ridge runs inward for about 20 mm. to a point at which it probably bifurcates, though the outer branch is not very distinct. The inner branch curves round and joins its fellow in the mid-line, not far in front of the suture between the parietal and the supraoccipital. The rhomboidal area enclosed between the temporal ridges and the frontal eminence which unites the horn-cores is thickly covered with a series of conspicuous granules quite similar to what is generally found in *Tragocerus* and *Boselaphus*. Almost from the level of the horn-cores the brain case expands laterally and projects considerably beyond the temporal ridges.

Of the basicranial region all that is visible are the two anterior tuberosities of the basioccipital, which are moderately prominent and enclose a furrow between them, in the middle of which is a narrow keel, which runs backward as the crest of a rounded area. Doubtless this convexity of the surface continued over the posterior portion of the basioccipital, which has been broken away, at any rate as far as the posterior tuberosities.

As mentioned above, page 773, the teeth, figure 60, page 834, are too worn down to afford evidence of more than some kinship to *Tragocerus*. Certain Calcutta dentitions, which it is believed belong to a closely allied species of *Tragoportax*, are, however, briefly described on p. 833, together with an American Museum mandible (page 834, figure 61) which may be provisionally referred to *Tragoportax salmontanus*.

COMPARISONS.—*Tragoportax salmontanus* shows certain distinct differences from *T. leskewitschi*. The skull (Geol. Surv. Ind. B265) and horn-cores in Calcutta which may be referred to this species show to some extent the same differences. On the other hand, in certain of their characters they are closer to the Sebastopol species. On account of the loss of the hinder part of occiput in the holotype of *T. salmontanus*, it is impossible to be sure as to whether this part of the skull resembles more nearly *T. leskewitschi* or the Calcutta skull (Geol. Surv. Ind. B265). The chief points in which the Indian species differs from *T. leskewitschi* are the following: The horn-cores are more divergent, more twisted and have a slight inward curvature, while the anterior keels when prolonged meet at a right angle midway between the supraorbital foramina. In *T. leskewitschi* they meet at an acute angle in front of the supraorbital foramina. *T. salmontanus* has shorter horn-cores and the antero-posteior diameter is less. This difference does not exist in the Calcutta specimens. The expansion at the base is greater and the frontal elevation

more pronounced in *T. salmontanus*. Some of the Calcutta specimens approach *T. leskewitschi* in the latter respect. The orbits are farther forward in the Indian species, and the breadth of the skull between them is relatively greater. The occiput seems to be broader in *T. salmontanus*, but whether the breadth of the occipital as much exceeds that of *T. leskewitschi* as it certainly does in the Calcutta skull is not certain. In the latter specimen the large size of the occipital condyles and their marked projection to the rear of the occipital crest affords a striking difference from *T. leskewitschi*, but I am unable to say whether this exists in *T. salmontanus*. Again the actual length of the occiput in *T. salmontanus* is unknown. The Calcutta skull has a longer occiput than *T. leskewitschi*. The basioccipital seems to differ in the Sebastopol and Indian species. Whereas in the former its surface is convex, with a faint keel and little trace of anterior tuberosities, in the Calcutta skull both the anterior tuberosities and a median furrow are pronounced, and there is an indication of the same structure in the holotype of *T. salmontanus*, though perhaps less marked. The isolated upper dentitions in the Calcutta collection agree well enough both in size and structure with that of *T. leskewitschi*. That of the holotype of *T. salmontanus* is smaller but is too worn to afford any useful comparison.

Although we are precluded from classifying *Tragocerus latifrons* Sickenberg with *Tragoportax* on account of the cross section of its horn-cores, yet in many other respects it resembles that genus so closely that comparison can hardly fail to be useful. The horn-cores of *Tragocerus latifrons* have in cross-section the shape of an isosceles triangle with a sharp anterior keel, two almost plane faces and two rounded angles at the base. This outline is typically tragocerine, and is distinguished from that of *Tragoportax*, *Strepsiportax* and *Pachyportax* by the rounded angle situated about the middle of the inner face which we find in the three last-mentioned genera. If we were to disregard the shape of the horn-cores, a highly improper proceeding, in my opinion, the other characters of the skull are so strikingly boselaphine that there would be no hestitation in including it in *Tragoportax* or perhaps with even more justification in *Strepsiportax*. The horn-cores are shorter than in the normal *Tragocerus*, about the same length as many horn-cores of *Tragoportax* in the Calcutta collection, but longer than those of the holotype of *Tragoportax salmontanus* or of *Strepsiportax gluten*. They stand farther apart than in *Tragoportax* and lack the internal expansion at the base which passes into the strong frontal swelling seen in the holotype of *Tragoportax salmontanus*. The position of the horn-cores and the

shape and sculpture of the frontal in the European species are, in fact, almost identical with the corresponding features in *Strepsiportax gluten*. The torsion and inward curvature of the horn-cores is as great as in *Tragoportax salmontanus* but less than in *Strepsiportax*. The horns are more upright than in either of the Indian genera. The face is even less bent down on the occiput than in *Tragoportax* and thus agrees with most of the other boselaphine genera described in these pages. As may be seen from the measurements collected on page 856, the breadth at the orbits, the size of the brain-case, the breadth at the mastoid, the lowness of the occipital and the shortness of the occiput are as great or even in excess of what is the case in *Tragoportax*. The supraoccipital is broad but occupies only a short antero-posterior extension on the upper surface of the occiput, as is the case in *Strepsiportax* and *Pachyportax*. On the contrary in the normal forms of *Tragocerus* and "*Tragocerus*" *leskewitschi* the supraoccipital occupies a long narrow area on the surface of the occiput. The Indian specimens of *Tragoportax* do not show the suture well enough to indicate the condition of affairs. The supraorbital foramina are small and circular in *Tragoportax* as they are in the normal *Tragocerus*. In *Tragocerus latifrons* they are larger and more elongate, as is the case in *Strepsiportax*. The condyles hardly project backward beyond the occipital crest, unlike the condition in the Calcutta skulls of *Tragoportax* sp. The basioccipital is short; its anterior tuberosities being distinct, the median furrow slight and a low median keel present but the surface is generally convex as is the case in *T. leskewitschi*, probably *T. salmontanus* and *Strepsiportax*, whereas in the Calcutta skulls of *Tragoportax* sp. the median furrow is broad and the anterior tuberosities more pronounced.

TRAGOCERUS GAUDRY

GAUDRY, 1861, C. R. Acad. Sci. Paris, LII, p. 298.

GENOTYPE.—*Capra amalthea* Roth and Wagner, 1854, p. 453, Pl. XII, fig. 2.

DIAGNOSIS.—Boselaphinae of medium or fairly large size; skull long and slender; the distance between the mid-point of the orbits and the occipital crest being to the width of the brain-case in the ratio of about 1.83 to 1 (except in "*Tragocerus*" *latifrons* in which the brain-case is much wider); horns long to moderately short, strongly compressed laterally with a strong anterior keel, cross-section of horn-core a narrow, elongate isosceles triangle with the two angles at the base rounded, occasionally very faintly twisted, tilted backward to a greater or less degree, slightly or much curved, more or less divergent, generally close together in front and separated behind, often connected by a high frontal swelling from which the contour falls away to the front and to the rear; lachrymal fossa variable but generally long and rather deep; supraorbital foramina not sunken in depressions; occipital rather high and

narrow; basioccipital short, subtriangular, with a shallow median furrow; paroccipital process elongate antero-posteriorly, narrow; auditory bulla narrow, but little inflated; dentition moderately hypsodont; premolar series large and long; P_2 with rather complex structure; upper molars with basal pillars and moderately strong ribs.

REMARKS.—It has been demonstrated that the various Indian fossil forms described in the foregoing pages are related more or less closely to *Boselaphus*. The study of these, together with certain European species such as "*Tragocerus*" *latifrons*, "*Tragocerus*" *leskewitschi*, *Protragocerus chantrei* and *Miotragocerus monacensis*, now seems to indicate clearly that the true position of *Tragocerus* in the scheme of classification is with the Boselaphinae and not, as Schlosser has thought, with the Pseudotraginae. Hardly any of the features taken as diagnostic of the Boselaphinae on page 736 are missing in *Tragocerus*, while on the other hand the regularly elliptical horn-cores of *Protoryx*, *Pseudotragus* and *Tragoreas*, their strongly bent down face, the weakness of the temporal ridges and the absence of rugosity on the frontals clearly separate them as a distinct group from *Tragocerus*. Although it is true that the normal forms of *Tragocerus* have retained a primitively narrow occiput, yet the horn-cores are more progressive than those of other members of the family by their lateral compression and antero-posterior elongation, with which is correlated the position of the third angle of the triangular cross-section at the base. Such a form as *Tragocerus latifrons* which should no doubt be generically separated from *Tragocerus* constitutes a perfect connecting link between the normal *Tragocerus* and *Tragoportax*, *Protragocerus*, *Strepsiportax* and *Pachyportax*, these forming a branch which is a little way removed from *Helicoportax*, *Selenoportax* and *Boselaphus*, the latter being in some respects nearer to the oxen.

We cannot point with certainty to any genus as the direct ancestor of *Tragocerus*. *Protragocerus* seems by its stouter build and its narrower molars to have already reached a more advanced stage, although its horn-cores, figured by Dépéret (1887, Pl. XII, fig. 4), might easily have developed into those of *Tragocerus*, as explained above. If we were better acquainted with it, *Protragocerus* might prove generically inseparable from *Strepsiportax* or *Tragoportax*, and in that case the broad skull and occiput would equally be more progressive than those of *Tragocerus*. *Miotragocerus* with its elliptical horn-cores slightly flattened on one side obviously represents a still more primitive stage, in which the triangular cross section is not apparent, and one cannot deny that the horn-core of *Tragocerus* might have developed from this without the inter-

mediate stage of *Protragocerus*. *Graecoryx valenciennesi* and *Sivaceros* may be survivals of the same primitive stock.

Since writing the above early in 1934, an interesting paper by Bohlin (1935A) on *Tragocerus* has appeared. Since it contains much that is relevant to the discussion, it is fortunate that I am able to add the following just as my manuscript is about to go to press. Bohlin's observations give considerable support to the idea that the *Tragocerus* horn-core originated, not from one of the *Tragoportax* type, but from one with a regularly elliptical laterally compressed cross-section. He has advanced strong evidence that the prominent anterior keel of the horn-core in *Tragocerus* is only gradually developed during the animal's lifetime by successive additions of material at the base, thus often producing a more or less abrupt change in the character of the cross-section from an extremely elongate, keeled oval below to a slightly oval or even circular cross-section above (see below page 794). Whether *Graecoryx* when mature possessed horn-cores like those of *Tragocerus*, as Bohlin thinks, or not, we may nevertheless admit the probability that the ancestral type of *Tragocerus* had horn-cores with a regularly oval cross-section with or without faint keels, such as we find in *Sivaceros*.

Bohlin sees in the irregular growth of the horn-core in *Tragocerus* a proof that the horn sheaths were periodically shed, like those of *Antilocapra*. I do not think that this necessarily follows. It seems, however, more possible on the analogy of *Antilocapra* that the horns of *Tragocerus* might have been sometimes forked.

Tragocerus browni, new species

Figures 23 to 29, 81

HOLOTYPE.—Amer. Mus. No. 19662, a skull.
PARATYPE.—Amer. Mus. No. 19463, a skull.

REFERRED SPECIMENS

Amer. Mus. No. 19932, jaw, 2 mi. S. Dhok Pathan.
" " " 29817, jaw, 1/2 mi. N. W. Hasnot.
" " " 29873, palate, 1/2 mi. S. Dhok Pathan.
" " " 29884, lower jaw, 1/2 mi. S. Dhok Pathan.
" " " 29888, palate, 1/2 mi. S. Dhok Pathan.
" " " 29967, maxilla, 1/2 mi. S. Dhok Pathan.

HORIZON AND LOCALITY.—A quarry near Dhok Pathan, from the Dhok Pathan stage of the Middle Siwaliks.

DIAGNOSIS.—A *Tragocerus* of large size; face little bent down on the cranial axis, the angle being about 10°; skull broader at the orbits and narrower at the occiput than in many other species; horn-cores long but with a smaller antero-posterior

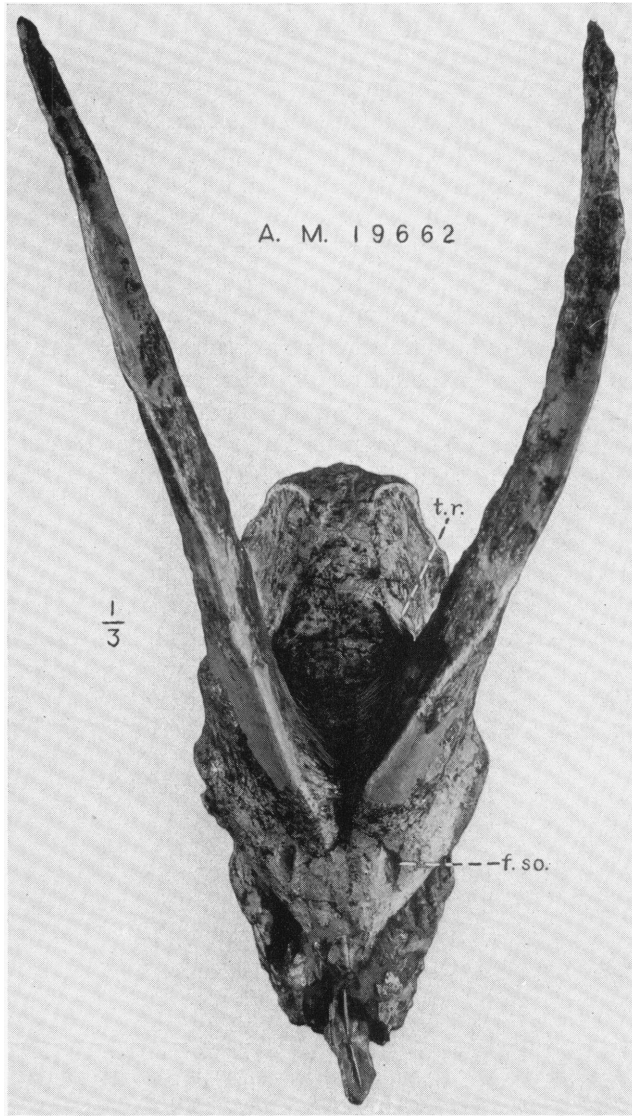


Fig. 23. *Tragocerus browni*, new species. Type, Amer. Mus. No. 19662. Partial skull, from a quarry near Dhok Pathan. Top view. One-third natural size. *f. so.*, supraorbital foramen; *t. r.*, temporal ridge.

diameter than many other species, much tilted backward and strongly curved, the angle between the lower part of the horn-core and the occiput being about 45°, while the tips end as far behind the occipital surface as that surface is behind the highest point of the frontal.

DESCRIPTION.—The holotype is a skull well preserved as to the frontals and the occiput, with both horn-cores perfect. It lacks the zygomatic arches and the auditory bullae. The upper portion of the maxillae, part of the lachrymal and the posterior edge of the orbits are broken away, but the cheek dentition is complete, though considerably worn down by age. The nasals and premaxillae are missing.

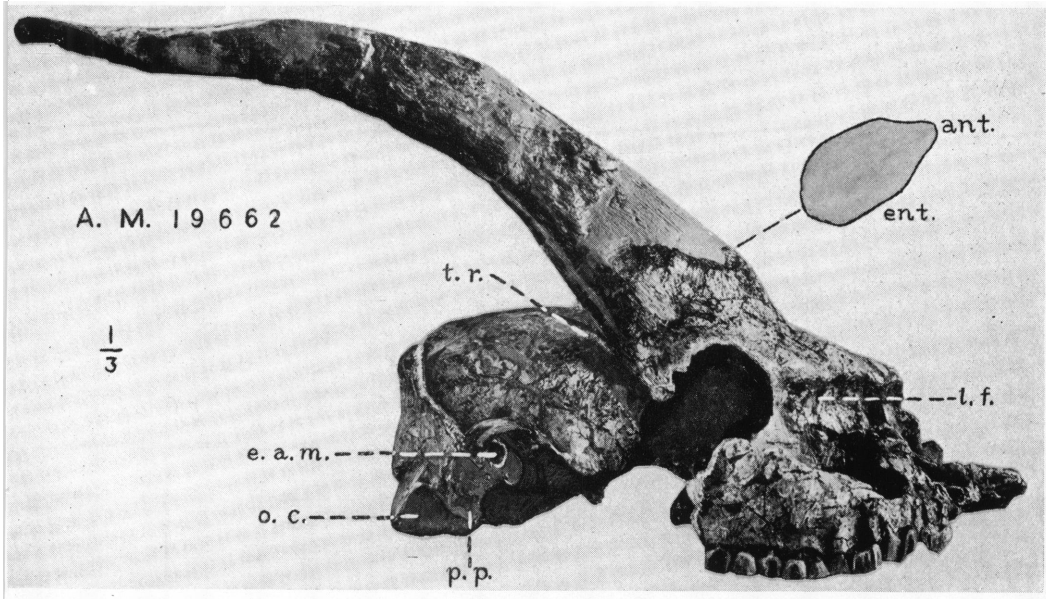


Fig. 24. *Tragocerus browni*, new species. Type, Amer. Mus. No. 19662. Partial skull, from a quarry near Dhok Pathan. Lateral view. One-third natural size. *e. a. m.*, external auditory meatus; *l. f.*, lachrymal fossa; *o. c.*, occipital condyle; *p. p.*, paroccipital process; *t. r.*, temporal ridge. Cross-section of right horn-core at base; *ant.*, anterior; *ext.*, external.

Note.—*ent.* should read *ext.* in this figure.

In size this skull falls somewhat behind the largest known species, *T. curvicornis* and *T. recticornis* and the largest races of *T. amalthea*. The face is relatively but little bent down on the cranial axis, the angle being about 10°. The horn-cores lie on a level with the anterior edge of the orbit, when the occiput is placed in a horizontal position. They are situated on swellings which unite below the front of the horn-core and descend from here abruptly to the surface of the frontal in front, and even more steeply behind to the surface of the occiput behind the horn-cores. They di-

verge at an angle of about 50° and slope backward considerably, forming an angle of about 45° with the occiput for one-third of their length, and for the remaining two-thirds even more strongly, ending as far behind the occipital surface as that surface is behind the highest point of the frontal, so that their curvature is very great. They are strongly compressed laterally, but their antero-posterior diameter is less than usual in the genus. Their cross-section is an isosceles triangle with a sharp anterior

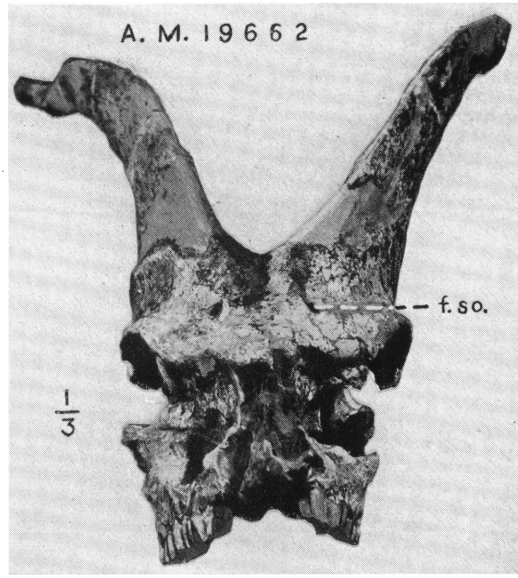


Fig. 25. *Tragocerus browni*, new species. Type, Amer. Mus. No. 19662. Partial skull, from a quarry near Dhok Pathan. Front view. One-third natural size. *f. so.*, supraorbital foramen.

keel and a base with rounded corners. A faint keel can be discerned at the postero-external corner. The long axis is oblique to the skull axis, with which it forms an angle of about 30°. The supraorbital pits lie in front of the swellings from which the horn-cores originate and external to the sagittal axis of the horn-core. They are situated in small, extremely shallow depressions. The lachrymal fossa is extremely deep and very extensive, it reaches back to the orbit, but its anterior limit cannot be seen on account of the fracture. The frontals end about 60 mm. in front of their highest point between the anterior keels of the horn-cores. The orbit appears to be elongated antero-posteriorly. Strong temporal ridges run inward from behind the horn-cores as far as the fronto-parietal suture, but there is not a marked depression between them nor is the frontal suture swollen in the mid-line. The parietals extend in the mid-line of the surface of the skull for a distance of 36 mm. The supraoccipital descends gently from the suture with the parietal to the occipital crest, and forms a

rather long rectangular area. The surface of the occipital is slightly concave in a vertical direction, but the occipital condyles project but slightly to the rear of the summit of the occipital crest. On either side of the occipital crest are shallow depressions. The occipital is rather high, broad below and narrowing above. The lambdoid crest is fairly prominent, but the width at the mastoid is comparatively small. The foramen magnum is high and narrow. The condyles are rather promi-

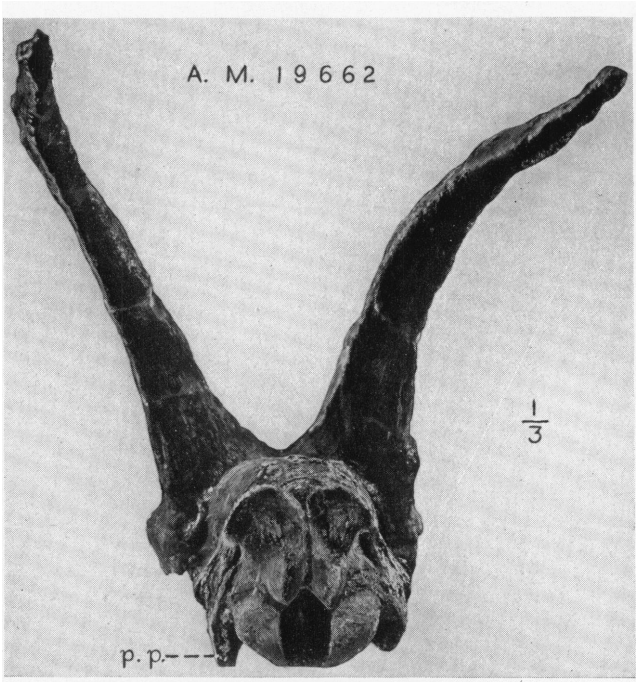


Fig. 26. *Tragocerus browni*, new species. Type, Amer. Mus. No. 19662. Partial skull, from a quarry near Dhok Pathan. Occipital view. One-third natural size. *p. p.*, paroccipital process.

nent. The paroccipital process is triangular at the base and laterally compressed above. The basioccipital is short and subtriangular, not extending farther forward than the bulla. It has a slight median groove. The posterior tuberosities are broad and club-shaped, while the anterior tuberosities are small and have little lateral expansion. The auditory bullae are missing.

The height of the molars cannot be determined. The external folds and ribs are strong. The median rib is stronger on the anterior than on the posterior lobe. Fairly strong median basal pillars are present on all the molars. The surface of the enamel is slightly rugose. P^4 has strong anterior and posterior folds on the outer

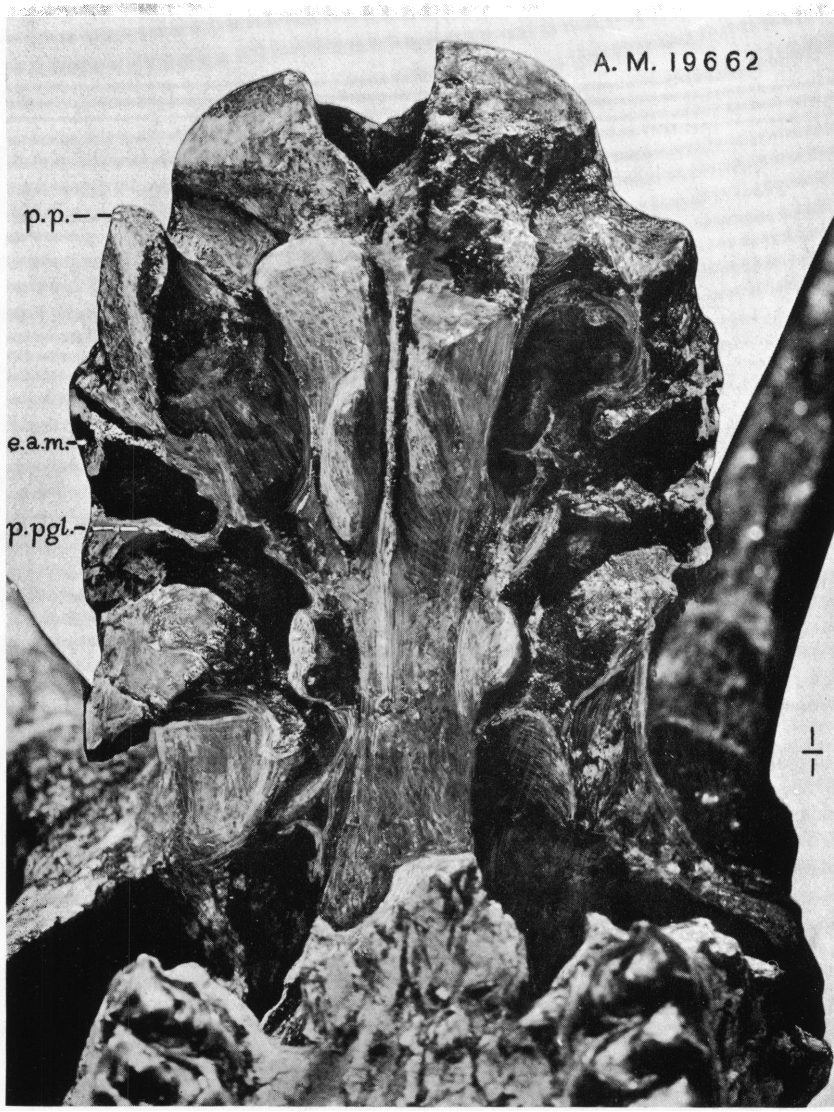


Fig. 27. *Tragocerus browni*, new species. Type, Amer. Mus. No. 19662. Partial skull, from a quarry near Dhok Pathan. Basicranial view. Natural size. *e. a. m.*, external auditory meatus; *p. p.*, paroccipital process; *p. pgl.*, postglenoid process.

side and a slight median rib. P^3 is larger than P^2 and its breadth is excessive. It has a narrow but very pronounced anterior fold, a broad and strong posterior fold and a median rib about one-third of the distance from front to rear. P^2 is similar,

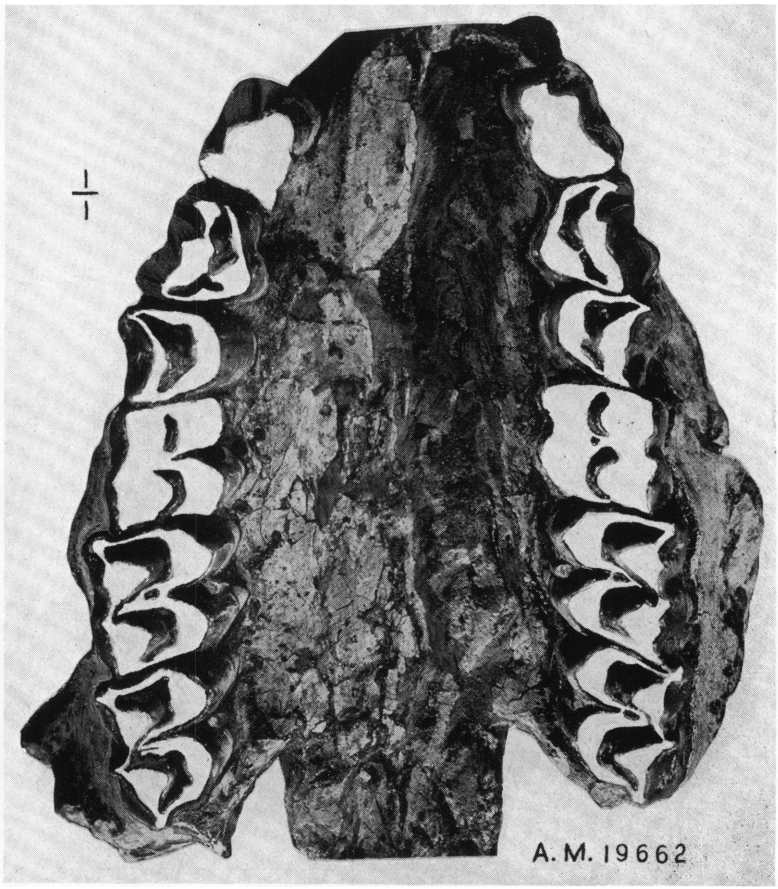


Fig. 28. *Tragocerus browni*, new species. Type, Amer. Mus. No. 19662. Partial skull, from a quarry near Dhok Pathan. Palatal view. Natural size.

but the posterior fold is weaker. The measurements of these teeth as well as those of a referred mandible (Amer. Mus. No. 29884) are contained in a table on page 854.

A second skull with some associated parts of the skeleton (Amer. Mus. No. 19463) was excavated from a quarry one-half mile southwest of Dhok Pathan. The occiput has been somewhat distorted by crushing but the frontal is in its true position with the left horn-core perfect for about 200 mm. from the base and the right horn-core

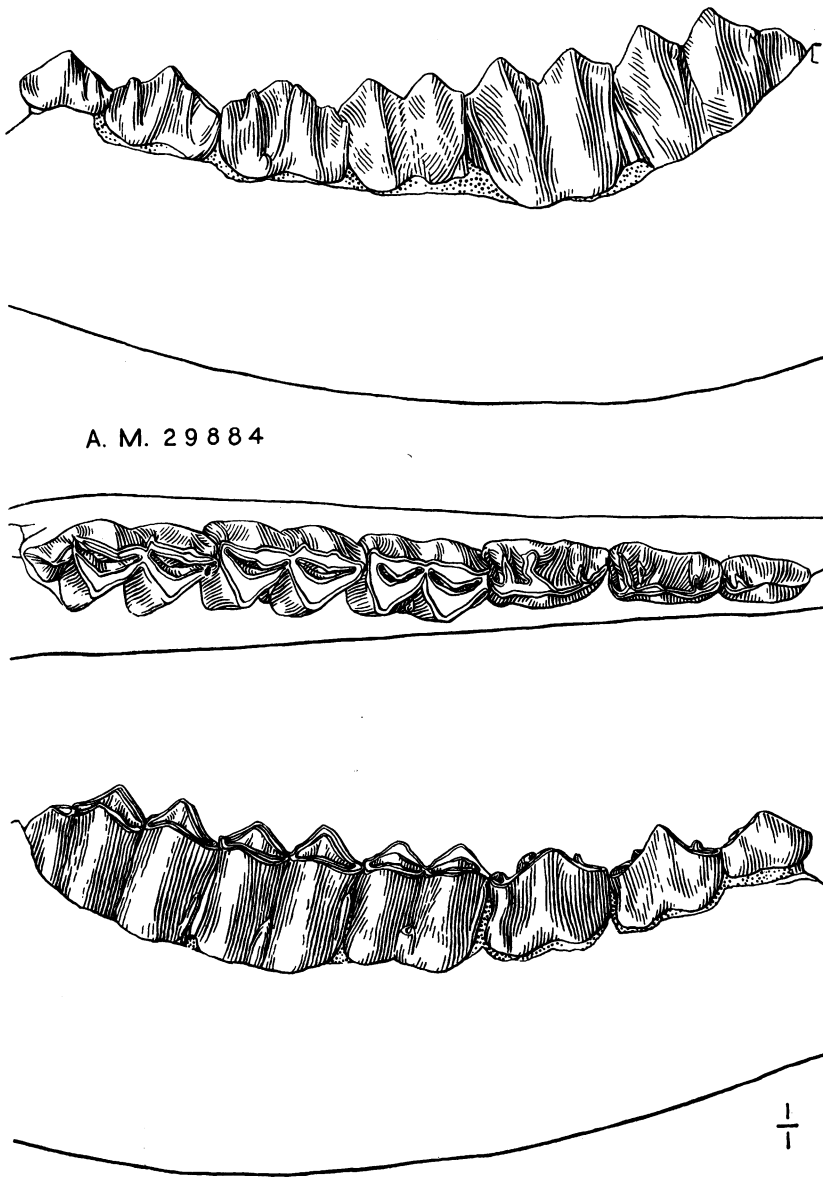


Fig. 29. *Tragocerus browni*, new species. Referred right mandibular ramus, Amer. Mus. No. 29884. From 1/2 mile south of Dhok Pathan. Inner, crown and outer views. Natural size.

for 30 mm. from the base and some sections of the right horn-core not connected with the base.

The horn-cores have the same amount of curvature and backward tilt as in the holotype, but are not quite so long and the antero-posterior diameter at the base is less. The keels do not approach each other so nearly as in the holotype nor is the frontal elevation so great. The posterior keel of the horn-core is somewhat more pronounced than in the holotype and the horn-core twists slightly. Apparently the width at the mastoid is more than in the holotype, but this may be due to distortion, as is also the fact that the width between the external edges of the occipital condyles is less. These differences are such as are often noticeable in specimens of *Tragocerus amalthea*, and probably depend on the individual or its sex.

COMPARISONS.—Another species of *Tragocerus* from the same horizon in India has for holotype a skull (Geol. Surv. Ind. No. B486) collected from a quarry on the Soan River, two and one-half miles west of Dhok Pathan. This was briefly described by me (1910, p. 70) under the name of *Tragocerus punjabicus*, but its full description with figures will be published at a later date. Meanwhile the differences between it and the present species, which in my opinion make it impossible to unite the two, will be included in the comparisons which follow. A third Indian species of *Tragocerus* was proposed by me (1910, p. 71) for the frontlet described and figured by Lydekker (1878, p. 170, Pl. XXVIII, figs. 1, 2) under the name of *Capra perimensis*. This is very imperfectly known but seems to differ from both the others.

The degree to which the face is bent down on the cranial axis is very much less in *T. browni* than in *T. punjabicus* or *T. perimensis*, the angle being only 10° as against 30° in *T. punjabicus*. In most European species of *Tragocerus* the angle is also larger than in *T. browni;* 25° to 30° in *T. amalthea;* 40° in *T. curvicornis;* 30° in *T. recticornis;* 20° in *T. parvidens*. On the contrary in *T. rugosifrons* it is 10° or less.

Tragocerus browni and *T. punjabicus* are approximately equal in size both being somewhat smaller than *T. curvicornis*, *T. recticornis*, *T. rugosifrons* and the larger races of *T. amalthea*. They are but little larger than *T. parvidens*.

In regard to the length of the cranium in relation to that of the face the Indian species do not seem to agree with *T. parvidens* and *T. recticornis* which have a rather short cranium, but rather with the other European species of *Tragocerus*. The brain-case, is, however, much more slender in the Indian species than in any European species except possibly *T. rugosifrons*. The Indian species differ from one another in the relative width at the orbits and at the occipital. While in *T. browni* the width at the orbits is greater than in *T. punjabicus* and equal between the horn-

cores, yet the width at the mastoid process is only 87 mm. as against 93 mm. in *T. punjabicus*. The relative width at the mastoid process is least in the species *T. parvidens* and greatest in *T. recticornis; T. browni* occupies an intermediate position between *T. parvidens* and the remaining species of *Tragocerus*.

The occipital is rather differently shaped in the Indian species from what is the case in *T. amalthea*. In the latter it is semicircular; in the former almost sub-triangular with concave sides.

The position of the orbit seems to be characteristic in different species. In *T. browni, T. punjabicus, T. perimemsis, T. amalthea* and *T. curvicornis* the orbit is only just in advance of the base of the horn-core. On the contrary in *T. rugosifrons, T. recticornis* and *T. parvidens* the anterior margin of the orbit lies a considerable distance in front of the base of the horn-core.

Although the horn-core in the holotype of *T. punjabicus* is broken off about 100 mm. above the base, yet a comparison with the corresponding 100 mm. of the horn-core in *T. browni* shows that the horns of the latter are tilted backward considerably more than those of the former, the angle between the hinder margin of the horn-core and the parietal surface being 45° in *T. browni* and as much as 60° in *T. punjabicus*. Most of the European species seem to have horns as upright as in *T. punjabicus, T. parvidens* more so, while those of *T. rugosifrons* seem to be tilted back more than in *T. browni*. The great curvature of the horn-cores of *T. browni* distinguishes them from those of all other species of *Tragocerus*. Even in *T. curvicornis* the curvature is less. The horn-cores of *T. amalthea,* though variable, seem to be always slightly curved, as also those of *T. frolovi* and *T. perimensis*. On the contrary in *T. recticornis* and *T. parvidens* they are straight almost throughout their length. The horn-cores of *T. punjabicus* are equally straight in their lower part, although it cannot be denied that they may have curved to some extent in the portion above which is missing. The length and cross-section of the horn-core vary no doubt with the age of the individual. In the holotype of *T. browni* they are 330 mm. long, a length which is equalled by many specimens of *T. amalthea,* though often much in defect of that. On the other hand, in an American Museum specimen of *T. curvicornis* from Samos No. 20566 they are 370 mm. long and equally large dimensions seem to obtain in *T. recticornis*. In *T. frolovi* and *T. perimensis* the horn-cores are very short. The small antero-posterior diameter of the horn-core in *T. browni* may be a specific character, as no doubt it is in *T. rugosifrons* and in the third race of *T. amalthea*. At any rate the

difference in regard to this between *T. browni* and *T. punjabicus* seems to be inherent, for in spite of the youth of the holotype of *T. punjabicus* and the probably inferior length of the horn-core, its antero-posterior diameter exceeds that of the horn-core of *T. browni*. The divergence of the horn-cores differs in the holotypes of the three Indian species but hardly beyond the limits of individual variation.

Any comparison with the four species from China, *T. gregarius*, *T. spectabilis*, *T.*(?) *sylvaticos* and *T.*(?) *kokeni*, which Schlosser (1903, pp. 142–145) established on teeth only, seems unprofitable, since the dentition appears to be very variable. Whether the Chinese material now being studied by Bohlin will shed any light on the affinities of these species is at present unknown to me.

The preceding comparisons will have demonstrated that *T. browni* can be distinguished without difficulty from all other well-defined species of *Tragocerus*. Its affinities are perhaps nearest to *T. rugosifrons*, so far as can be judged from the rather incomplete material on which that species has been founded. It differs by its inferior size, by the more backward position of the orbit, by the greater breadth between the orbits and by the greater diameter of the horn-cores.

Tragocerus punjabicus Pilgrim

PILGRIM, 1910, Rec. Geol. Surv. Ind., XL, p. 70.
TYPE.—Geol. Surv. Ind. No. B486, a skull.

REFERRED SPECIMENS

Amer. Mus. No. 19480—lower jaw, 1 mi. S. Dhok Pathan.
" " " 19655—upper and lower jaws, 1/2 mi. S. Dhok Pathan.
" " " 19658—lower jaw, 1/2 mi. S. Dhok Pathan.
" " " 19665—lower jaw, 1/2 mi. S. Dhok Pathan.
" " " 19754—lower jaws, 1 1/2 mi. N. Hasnot.
" " " 19970—palate, 1/2 mi. S. W. Dhok Pathan.
" " " 19978—lower jaw, 1/2 mi. S. Dhok Pathan.
" " " 19979—lower jaw, 1/2 mi. S. Dhok Pathan.
" " " 29883—palate fragment, 1 mi. N. E. Hasnot.
" " " 29890—palate fragment, 1/2 mi. S. Dhok Pathan.
" " " 29957—palate fragment, near Dhok Pathan.

HORIZON AND LOCALITY.—Middle Siwaliks, Dhok Pathan Zone near Dhok Pathan, Punjab.

DIAGNOSIS.—A *Tragocerus* of about the same size as *T. browni;* face bent down on the cranial axis at an angle of about 30°; skull rather narrow at the frontals; horn-cores with a large antero-posterior diameter, rather upright and but little curved; premolar series rather short.

Tragocerus browni or punjabicus

REFERRED SPECIMENS

Amer. Mus. No. 19672—jaws, teeth, 1/2 mi. S. Dhok Pathan.
" " " 29870—pelvis, vertebrae, 1/2 mi. S. W. Dhok Pathan.
" " " 29958—vertebra, 1/2 mi. S. Dhok Pathan.
Amer. Mus. No. 19293—jaw fragments, 4 mi. E. Dhok Pathan.
" " " 19316—vertebrae, 1/2 mi. S. W. Dhok Pathan.
" " " 19660—jaw fragments and teeth, 1/2 mi. S. Dhok Pathan.
" " " 19697—limb bones, 1/2 mi. S. Dhok Pathan.
" " " 19714—teeth, 4 mi. W. Dhok Pathan.
" " " 29833—lower jaw, 2 mi. E. Dhok Pathan.
" " " 29881—lower jaw, 4 mi. W. Dhok Pathan.
" " " 29922—lower jaw, 4 mi. W. Dhok Pathan.
" " " 29948—molar, 1/2 mi. N. Hasnot.

SIVACEROS, NEW GENUS

GENOTYPE.—*Sivaceros gradiens*, new species.

DIAGNOSIS.—Boselaphinae of small size; skull wide at the frontals but narrow at the occipital; face but little bent down on the cranial axis; occiput moderately short, the distance between the mid-point of the orbits and the occipital crest being to the width of the brain-case in the ratio of about 1.44 to 1; horn-cores slender, not very long, straight, situated immediately above the orbits and far apart on the frontals, with very slight anterior and an even fainter posterior keel; keel axis only slightly oblique to skull axis; horn-cores moderately tilted backward, slightly divergent; cross section at base narrowly elliptical; temporal ridges not very distinct; frontals and parietals somewhat roughened; lachrymal fossa shallow; basioccipital short, subtriangular, surface broadly rounded, anterior tuberosities not prominent, supraoccipital exposed as a long narrow area on the surface of the skull; foramen magnum large and condyles rather broad and prominent, slightly projecting in rear of the occipital crest; auditory bulla small and not greatly inflated.

REMARKS.—Although I have chosen *Sivaceros gradiens*, belonging to the Chinji stage, as the type of the genus *Sivaceros*, yet there is a better preserved skull of another species in Calcutta (Geol. Surv. Ind. No. B796). Like the holotype of *Sivaceros gradiens*, it also lacks the dentition. This was collected from the Dhok Pathan stage of Nila. It is as yet undescribed, but there seems little doubt that it may be assigned to *Sivaceros*, although the horn-cores are much smaller and somewhat more tilted than in the genotype. Some of the characters in the above diagnosis which are connected with the face and the basicranial region are taken from that specimen.

COMPARISONS.—The genus *Sivaceros* seems to be closely allied to the species *Tragocerus valenciennesi* Gaudry (1865, p. 288), which Pilgrim and Hopwood (1928, p. 54) separated from the genus *Tragocerus* under the name of *Graecoryx*. Unfortunately *Graecoryx valenciennesi* is only

known by fragmentary specimens, so that a comparison between it and *Sivaceros* is only possible in respect of a few of the skull characters.

Graecoryx valenciennesi is much larger than either of the Indian species. Its horn-cores are rather shorter in proportion to the width of the skull at the orbits than those of *Sivaceros gradiens* but longer than those of the Calcutta skull from Nila mentioned above. They are set much more obliquely on the frontals than is the case in the Indian species, the angle between their long axis and the skull axis being about 25° as against 5° at most in the two latter. Their distance apart is practically the same relative to the width of the skull at the orbits. Whereas in the Pikermi species they are slightly curved backward; in both species of *Sivaceros* they are perfectly straight. The cross-section is not very different in the three species; that of *G. valenciennesi* is less compressed laterally than in *Sivaceros gradiens* and more compressed than in the Calcutta skull, the ratio between the longitudinal and transverse diameters at the base being 1.32 for the Calcutta skull; 1.44 for *G. valenciennesi;* 1.66 for *S. gradiens.* Both anterior and posterior keels are distinctly visible in the Indian species, especially the former, the outline being a symmetric oval. In *G. valenciennesi* the horn-core is narrower in front than behind, although there is practically no trace of keels. There is very little difference in the backward tilt of the horns in *G. valenciennesi* and the skull from Nila, but since in the latter the face is slightly more bent down on the cranial axis, it causes the horns to be almost in the same plane as the face, instead of at a slight angle to it as in the Pikermi species. In *S. gradiens* the horns are obviously more upright in relation to the plane of the occiput than in either of the other two, but as the face is missing the angle between it and the occiput is unknown. The greater uprightness of the horns is probably a primitive character corresponding to its earlier horizon. The divergence of the horns is inconsiderable in all three species. Their apparently slightly greater parallelism in *G. valenciennesi* may be partly due either to their oblique position, to their curvature or to deformity. The supraorbital pits are certainly farther forward in *G. valenciennesi* than in the skull from Nila. In the former they seem to be on a level with the anterior border of the orbit; in the latter they lie distinctly behind this point. The ratio between the width of the brain-case and the breadth between the orbits, according to the actual measurements, is 0.65 in *G. valenciennesi* and 0.67 in *S. gradiens,* so that one cannot claim any definite difference between them in the size of the occiput, especially as there is a possibility that on account of crushing the measurements in *G. valenciennesi* are not quite

accurate. Neither skull shows the strong temporal ridges of the Boselaphinae, though there is a faint trace of a ridge in *S. gradiens*, which also has a distinct granulation behind the horn-cores, absent in the Pikermi species, and less marked in the skull from Nila on account of its defective preservation. A skull fragment from Pikermi in the British Museum (Br. Mus. No. M12985) which has been referred to *Graecoryx valenciennesi* exhibits the hinder region of the occiput. This agrees with the corresponding part of the Indian species, at any rate as to the structure of the occipital and basioccipital; the condyles project to the rear in about an equal degree.

Although the two Indian skulls cannot in my opinion be separated generically, it does not seem feasible to regard them as congeneric with *Graecoryx valenciennesi*, having regard to the differences detailed above.

The characters which were relied on to distinguish *Graecoryx valenciennesi* from *Tragocerus* apply equally in the case of *Sivaceros*. The cross-section of the horn-core bears no resemblance to that of *Tragocerus*, since it shows not the faintest tendency to the triangular outline which is characteristic of the Boselaphinae. On the other hand the abrupt diminution of the antero-posterior diameter near the tip of the horn-core is similar to what is often found in *Tragocerus* (see page 781). In the basicranial region the bulla is shorter than in *Tragocerus*, and the basioccipital is short and rounded and lacks the median furrow which is generally found in *Tragocerus*, *Tragoportax* and *Boselaphus*. The resemblance is closer to the condition that exists in other Middle and Lower Siwalik genera which are here placed in the Boselaphinae. On the other hand, the shape and narrowness of the occipital reminds one of *Tragocerus* and somewhat less of *Tragoportax*, rather than of other boselaphines. In estimating the likelihood that *Graecoryx* and *Sivaceros* may prove to be allied to *Tragocerus* and the Boselaphinae we should not, perhaps, lay too great stress on the horn-cores. For example we recognize that *Tetraceros*, though in most respects a highly specialized boselaphine, retains a primitive type of horn-core with an almost circular cross-section. In the same way we may provisionally regard *Graecoryx* and *Sivaceros* as descended from an early member of the same group, in which the triangular section of the horn-core and the temporal ridges had not developed but in which lateral compression had taken place, so as to produce a symmetric instead of an asymmetric oval in cross-section. At any rate there is no other group to which a greater affinity can be traced.

Strong support to this view comes from a study which Bohlin (1935A)

has recently published on *Tragocerus*. He has shown, as mentioned above (page, 781) that the horn-core of *Tragocerus* only developed the strong anterior keel as it approached maturity. He considers that the skulls described under the name of *Graecoryx valenciennesi* (Gaudry, 1865, p. 288; Pilgrim and Hopwood, 1928, p. 55) are those of immature or female animals and that their horn-cores represent a young stage of *Tragocerus*. Whether the keel of these horn-cores would ever have attained the strength of that of *Tragocerus amalthea* is, I think, open to doubt, but at any rate Bohlin's observations supply a very strong argument in favour of the relationship of *Graecoryx*, and still more of *Sivaceros*, to *Tragocerus*. We may therefore regard all three genera as members of an extremely specialized branch of the Boselaphinae, *Sivaceros* being the most primitive of the three and possibly even ancestral to *Tragocerus*.

Sivaceros gradiens, new species

Figures 30 to 34

HOLOTYPE.—Amer. Mus. No. 19448, a fragmentary skull, lacking the face and the dentition.

REFERRED SPECIMENS

Amer. Mus. No. 29861—lower jaw, near Chinji Bungalow.
" " " 29910—maxilla, near Chinji Bungalow.
" " " 29962—molar, 3 mi. W. Chinji Bungalow.
" " " 22975—molars, 3 mi. W. Chinji Bungalow.
" " " 29979—molar, 1 mi. S. Nathot.

HORIZON AND LOCALITY.—12 miles east of Chinji Bungalow, from the Chinji stage, Lower Siwaliks.

DIAGNOSIS.—The diagnosis is the same as that for the genus.

DESCRIPTION.—The entire face is missing, and with it the front half of the base of both horn-cores and the adjacent portion of the frontals, as well as the dentition. Except for the front of the base, the right horn-core is perfect throughout most of its length and the hinder part of the base is still attached to the frontal immediately above the orbit. The greater portion of the orbital rim has been broken away with the missing part of the base of the horn-core. The left horn-core is missing except for the uppermost 65 mm. and a fragment nearer the base. The whole of the left orbit is also absent. The brain-case is moderately well preserved, and the sutures are well shown. The basicranium lacks the auditory bulla and the tips of the paroccipital processes. The zygomatic arches are also broken. The horn-cores are situated far apart on the wide frontals. They are situated immediately above the orbits and are moderately tilted backward, the angle between the horn-core and the surface of the occiput being about 63°. They are almost parallel, diverging at an angle of only about 13°. They are practically without curvature either backward or laterally. One peculiar feature is, however, noticeable on the anterior edge. This edge is straight up to within 65 mm. of the tip, above which it forms a sharp angle and runs back to a point within 50 mm. of the tip, above which its course is again straight and so tapers

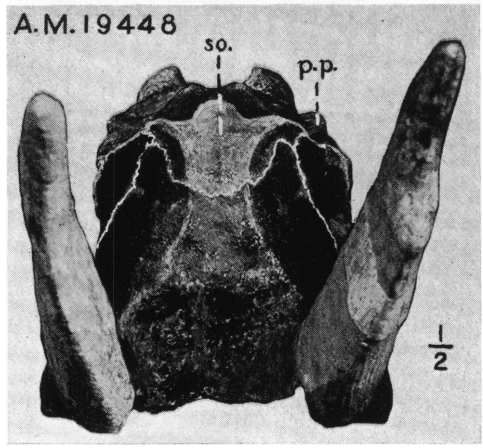


Fig. 30. *Sivaceros gradiens*, new genus and species. Type, Amer. Mus. No. 19448. Partial skull, from twelve miles east of Chinji Bungalow. Top view. One-half natural size. *p. p.*, paroccipital process; *s. o.*, supraoccipital.

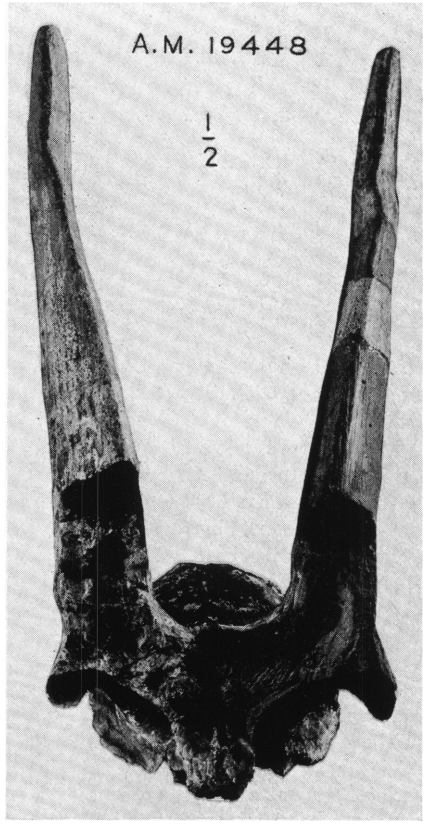


Fig. 31. *Sivaceros gradiens*, new genus and species. Type, Amer. Mus. No. 19448. Partial skull, from twelve miles east of Chinji Bungalow. Front view. One-half natural size.

to the summit, giving the appearance of a small horn set upon the end of a larger one. This character is a regular feature of the horn-cores of *Antilocapra* and I have seen a similar appearance in horn-cores of *Tragocerus*. Gaudry has figured horn-cores of

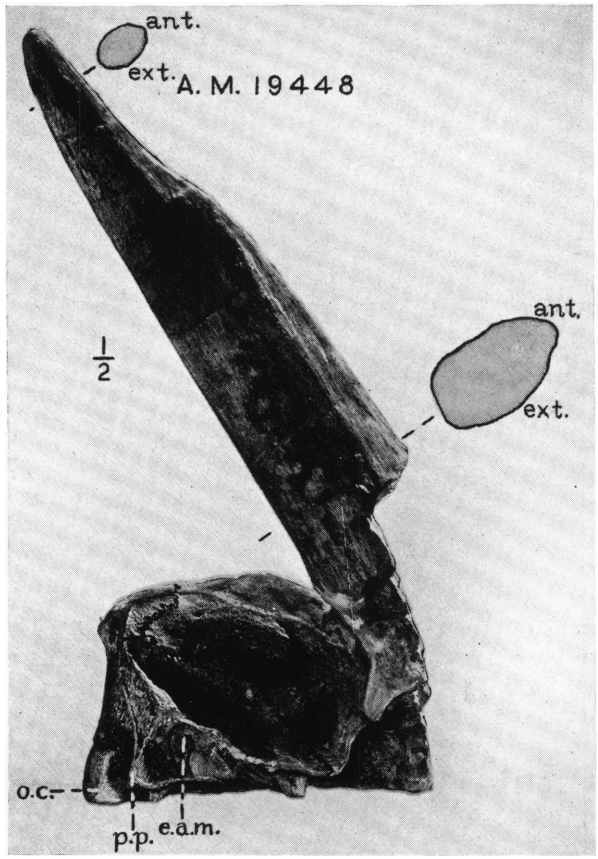


Fig. 32. *Sivaceros gradiens*, new genus and species. Type, Amer. Mus. No. 19448. Partial skull, from twelve miles east of Chinji Bungalow. Lateral view. One-half natural size. *e. a. m.*, external auditory meatus; *o. c.*, occipital condyle; *p. p.*, paroccipital process. Cross-section of right horn-core near base; *ant.*, anterior; *ext.*, external.

Tragocerus amalthea from Pikermi (1865, Pl. XLVIII, fig. 7) which show it. This structure in *Antilocapra* is correlated with forked horns and it is not impossible that such a specialization may have occurred in *Sivaceros*, *Graecoryx* and *Tragocerus*, even though their lineage is very remote from that of the Antilocaprines. The horn-core

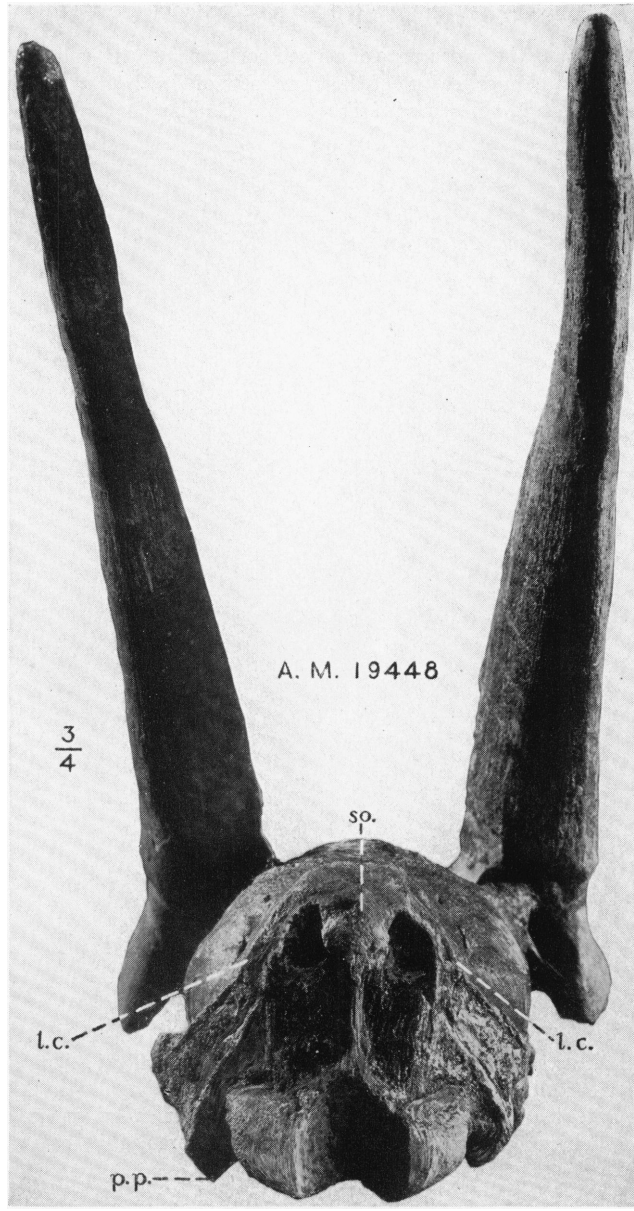


Fig. 33. *Sivaceros gradiens*, new genus and species. Type, Amer. Mus. No. 19448. Partial skull, from twelve miles east of Chinji Bungalow. Occipital view. Three-quarters natural size. *l. c.*, lambdoid crest; *p. p.*, paroccipital process; *s. o.*, supraoccipital.

is strongly compressed laterally; there is a fairly distinct anterior keel and a faint posterior one, the axis joining the two keels being but little oblique to the skull axis. The cross-section is thus an almost regular elongate oval, narrowing very slightly

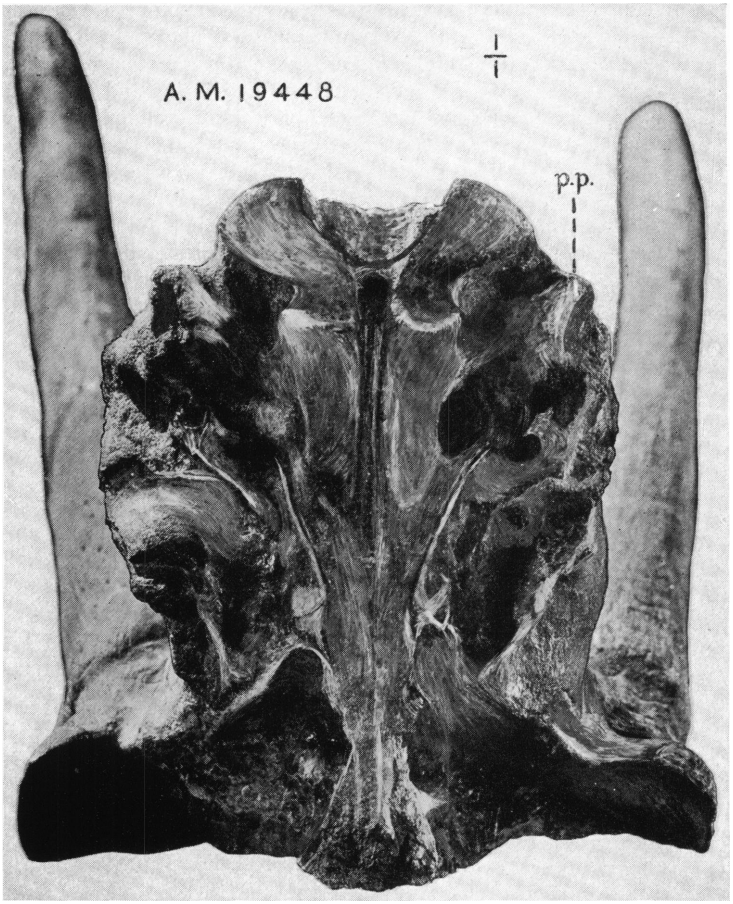


Fig. 34. *Sivaceros gradiens*, new genus and species. Type, Amer. Mus. No. 19448. Partial skull, from twelve miles east of Chinji Bungalow. Basicranial view. Natural size. *p. p.*, paroccipital process.

towards the front. The surface of the horn-cores is ornamented with very fine reticulate striae. The orbits project moderately prominently beyond the horn base. There are very slight temporal ridges, much less strong than is usual in *Tragocerus* and the Boselaphinae. The fronto-parietal suture forms a curved line with the convexity in front between the hinder ends of the horn-cores. The surface of the

frontal in front of and behind this is somewhat roughened, but less so than in many of the Boselaphinae. There is a roughened eminence on the parietal, about midway between the frontals and the supraoccipital, and at right angles to the skull axis, which unites the temporal crests. The brain-case widens out considerably behind the horns. The supraoccipital occupies a rather long area on the upper surface of the skull, and also laterally where it can be seen in side view above the upper posterior corner of the parietal. The occipital is rather high, and narrow above, widening out somewhat below as in *Tragocerus*, but unlike the other Lower and Middle Siwalik Boselaphinae. A flat area occupies the central part of the occipital 29 mm. across, with a faint median keel widening out into the prominent knob-like summit of the occipital crest. Slightly depressed areas occupy the lateral portions of the occipital from which the paroccipital processes proceed. The foramen magnum is larger than in *Tragocerus*. The occipital condyles are broad and prominent and project slightly behind the summit of the occipital crest. The lambdoid crest and the mastoid process are less prominent than is usual in the Boselaphinae. The basioccipital is short and constructed much as in *Helicoportax*, *Pachyportax* and *Strepsiportax*. The posterior tuberosities are somewhat expanded laterally and the shallow groove between them is not continued forward to form a furrow as in *Tragocerus*, *Tragoportax* and *Boselaphus*, but the surface is broadly rounded. The anterior pair of tuberosities is weak.

Sivaceros sp.

REFERRED SPECIMENS

Amer. Mus. No. 19900—jaw, $1^1/_2$ mi. N. Hasnot.
" " " 19426—jaw, 12 mi. E. Chinji Bungalow.
" " " 19996—maxilla, 3 mi. W. Chinji Bungalow.
" " " 20000—molars, 1 mi. S. Nathot.
" " " 29941—molars, 3 mi. N. W. Chinji Bungalow.
" " " 29957—palate, near Dhok Pathan.
" " " 29868—lower jaw, 13 mi. E. Chinji Bungalow.
" " " 29938—teeth, 3 mi. N. W. Chinji Bungalow.

SUBFAMILY **GAZELLINAE**

GAZELLA BLAINVILLE

BLAINVILLE, 1816, Bull. Soc. Philom. Paris, p. 75.
GENOTYPE.—*Capra dorcas* Linn., 'Syst. Nat.,' 10th Ed., I, p. 69.

Gazella lydekkeri, new species

Figures 35 to 41

(?)LYDEKKER, 1886, *Gazella* sp., Pal. Ind., (10) IV, p. 12, Pl. IV, fig. 6.

HOLOTYPE.—Amer. Mus. No. 19663, skull, and conjoined mandible.

PARATYPES.—A hornless skull, Amer. Mus. No. 19664, and a left mandibular ramus, Amer. Mus. No. 19665, which probably belong to the same individual and were excavated from the same quarry as the holotype. The frontlet, Geol. Surv. Ind. No. 228a, briefly described and figured by Lydekker under the name of *Gazella* sp., came from a quarry at Niki north of the Salt Range and also belongs to the Dhok Pathan stage of the Middle Siwaliks. It may or may not belong to the same species

as the holotype of *G. lydekkeri*, but since the only differences observable are its smaller size and the smaller size of P_2 (on the assumption that a few mandibles found in a quarry at Dhok Pathan in the Calcutta collection belong to the frontlet) it seems hardly feasible to separate it. It is worthy of note that equally small or smaller horn-cores of a similar type occur in the Chinji stage, which shows that primitive gazelles were in existence at that period.

REFERRED SPECIMENS

Amer. Mus. No. 19854—jaw fragments, 4 mi. W. Dhok Pathan.
" " " 29882—lower jaw, 4 mi. W. Dhok Pathan.
" " " 29895—lower jaws, 1/2 mi. S. Dhok Pathan.
" " " 29956—brain case and horns, 1/2 mi. S. W. Dhok Pathan.
" " " 29985—lower jaw, 1/2 mi. S. Dhok Pathan.

HORIZON AND LOCALITY.—Quarry one-half mile south of Dhok Pathan, from the Dhok Pathan stage of the Middle Siwaliks.

DIAGNOSIS.—A *Gazella* of the size and type of the living *G. bennetti*, but females hornless; skull long and slender; face bent down on cranial axis at about 35°; occipital rather high; horn-cores moderately long, only about 18 mm. apart, subparallel, slightly curved and tilted back at an angle of about 60° with the occiput, of a broadly elliptical cross-section, with about thirty fine ribs which die out before reaching the tip and one deep furrow posteriorly; teeth moderately hypsodont, molars approaching a quadrate shape; premolar series rather long; P_4 not very progressive, its inner cusp almost unfused with anterior wing, but fusing earlier with posterior wing.

DESCRIPTION.—The holotype is almost perfect. The right orbit lacks a small part of its front margin, which comprises a portion of the lachrymal. The nasal and premaxillary region of the face have been somewhat crushed laterally, so that the tooth rows are much closer together than was the case in life, as may be seen by comparison with the female skull (Amer. Mus. No. 19664). The skull belonged to a mature animal, as all the teeth are worn in some degree, but the wear of M^3 is not very advanced and the height of its unworn crown can hardly have been much more than 3 mm. in excess of what it now is (see table on page 855). Its actual height is 12 mm.

The female skull differs in certain small details from the holotype, in addition to the absence of horns, but in view of the fact that it was found in the same quarry, I do not think these can be attributed to more than sexual or individual variation.

The skull agrees sufficiently closely with those of *Gazella bennetti* and *subgutturosa* as to leave no doubt as to its position in the genus *Gazella*. The hornless skull which may be referred with a strong degree of probability to the same species as the holotype proves that, unlike what is the case in *Gazella bennetti* and *fuscifrons*, the females were hornless. The face is bent down on the cranial axis at an angle of about 35°, which is somewhat less than in *G. bennetti* and *subgutturosa* and about the same as in *G. capricornis* Wagner (olim *G. brevicornis* Wagner) and *G. pilgrimi* Bohlin (olim *G. gaudryi* Schlosser; see Schlosser, 1904, p. 66 and Bohlin, 1935B, p. 103). In size the skull is rather smaller than is usual in *G. subgutturosa* and is relatively more slightly built, with a higher occipital. In these respects it is closer to *G. bennetti*. The horn-cores arise immediately above the orbits and stand about 18 mm. apart on the frontals. They are of a moderate length, though shorter than in the two living

species with which I have compared it, without keels, and with a broadly elliptical cross-section. Their surface is covered with about thirty rather fine longitudinal ribs, which tend to anastomose and die out before reaching the tip of the horn-core. This is much the same as in *G. bennetti, subgutturosa* and *capricornis*. A single deep furrow exists on the posterior side. They diverge very slightly, rather less than in

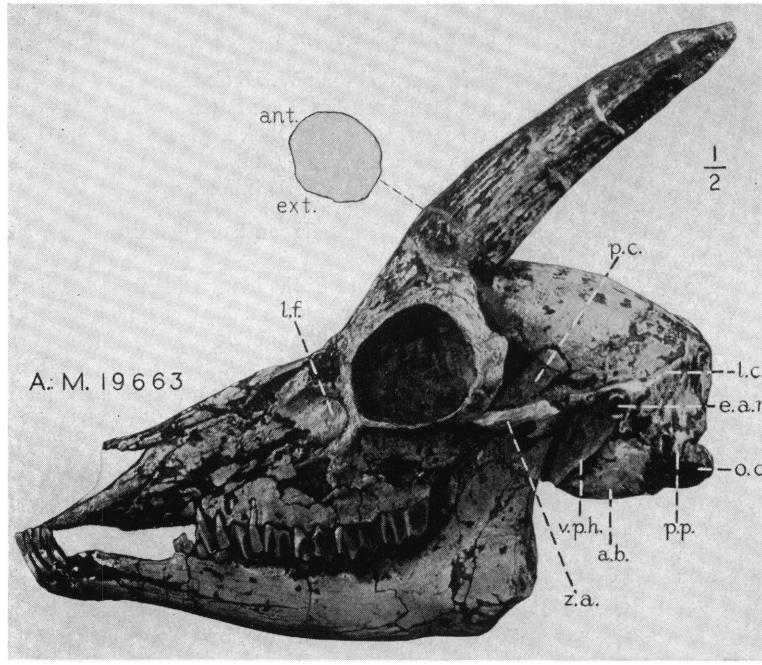


Fig. 35. *Gazella lydekkeri*, new species. Type, Amer. Mus. No. 19663. Skull, from a quarry half a mile south of Dhok Pathan. Lateral view. One-half natural size. *a. b.*, auditory bulla; *e. a. m.*, external auditory meatus; *l. c.*, lambdoid crest; *l. f.*, lachrymal fossa; *p. c.*, postorbital crest; *p. p.*, paroccipital process; *o. c.*, occipital condyle; *v. p. h.*, vagina processus hyoidei; *z. a.*, zygomatic arch. Cross-section of left horn-core near base; *ant.*, anterior; *ext.*, external.

G. subgutturosa but to much the same extent as in *G. bennetti*. They are tilted backward at an angle of about 60° between their lower portion and the occiput, and curve regularly but slightly as they run back, their tips falling short of the occipital surface when the occiput is placed in a horizontal position. In both *G. bennetti* and *subgutturosa* they are more upright. The face is less deep than in the two living species, the distance between M^3 and the summit of the frontal being 45 mm. as against 63 mm. in *G. subgutturosa* and 55 mm. in *G. bennetti*. The nasals are crushed but are obviously much narrower and longer than in either of the living species (their length being about 65 mm.). An ethmoidal fissure, similar in size and shape to that of *G. bennetti* is plainly

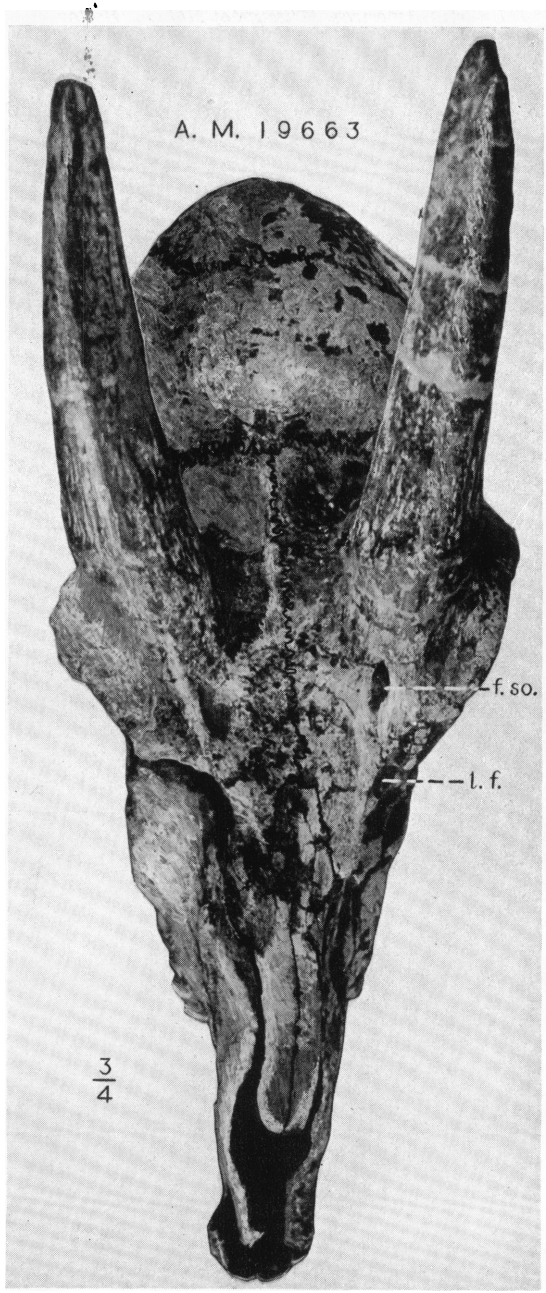


Fig. 36. *Gazella lydekkeri*, new species. Type, Amer. Mus. No. 19663. Skull, from a quarry half a mile south of Dhok Pathan. Top view. Three-quarters natural size. *f. so.*, supraorbital foramen; *l. f.*, lachrymal fossa.

visible on the right side. The supraorbital foramina are lodged in narrow pits, situated on the anterior base of the horn-cores. They are shorter and less deep than in *G. subgutturosa*. The frontals are depressed between the supraorbital foramina, but

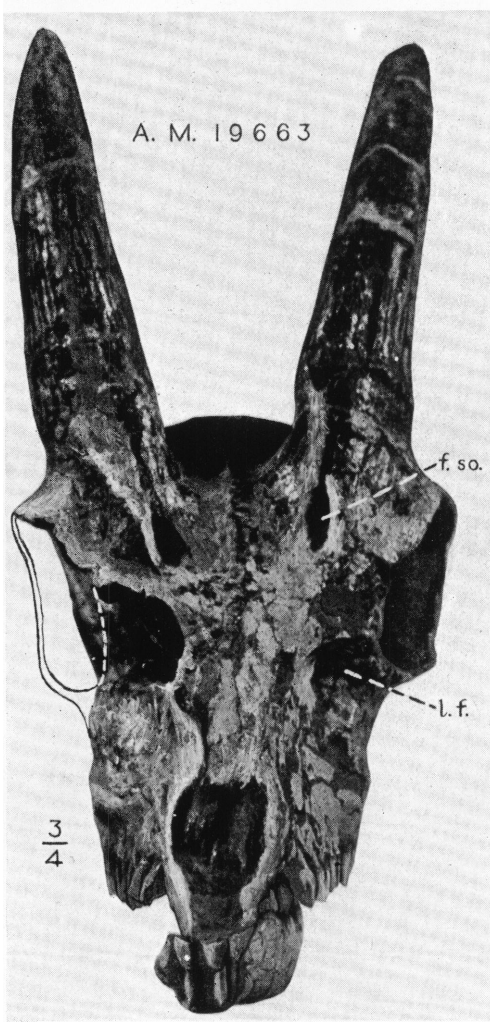


Fig. 37. *Gazella lydekkeri*, new species. Type, Amer. Mus. No. 19663. Skull, from a quarry half a mile south of Dhok Pathan. Front view. Three-quarters natural size. *f. so.*, supraorbital foramen; *l. f.*, lachrymal fossa.

their suture forms a low ridge between the horn-cores, which extends back as far as the fronto-parietal suture. The orbits project laterally about 10 mm. on the outer side of the horn-cores. Their antero-posterior exceeds their vertical diameter, a difference which does not seem to be due to crushing. There is a well marked lachrymal

fossa, somewhat less deep than in *G. subgutturosa*, but extending over as wide an area. The upper profile of the occiput is slightly convex, the curve continuing regularly over the frontals, the parietals and the supraoccipital. The general structure of the occipital is like that of *G. bennetti*, but relatively higher and narrower than in *G. subgutturosa*. Its surface is almost at right angles to the upper surface of the occiput and is not hollowed in the vertical plane. There is a prominent median occipital crest, terminating above in a knob-like swelling with flattened depressions on either side of it. The occipital condyles project but little to the rear of this swelling. The lambdoid

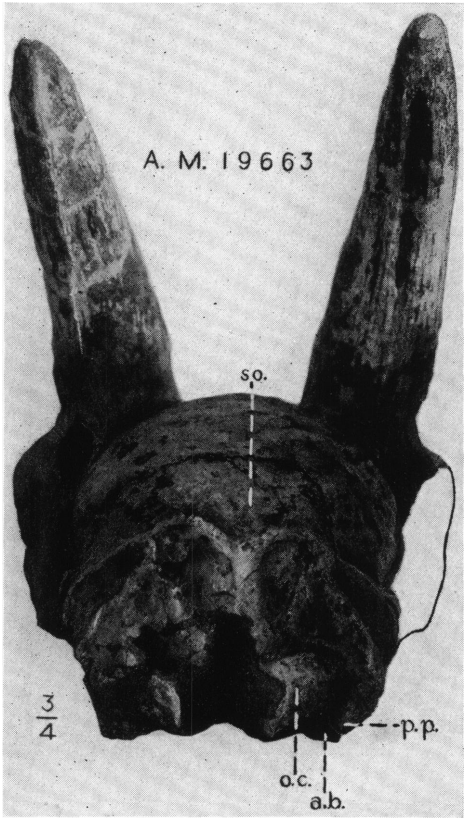


Fig. 38. *Gazella lydekkeri*, new species. Type, Amer. Mus. No. 19663. Skull, from a quarry half a mile south of Dhok Pathan. Occipital view. Three-fourths natural size. *a. b.*, auditory bulla; *p. p.*, paroccipital process; *o. c.*, occipital condyle; *s. o.*, supraoccipital.

crest is feebly developed. The mastoid process is no stronger than in *G. bennetti* and *subgutturosa*. The paroccipital processes are broken off but seem to be similar in size and outline to those of the two living species. The surface of the basioccipital is rather different from that of *G. bennetti*, and still more from that of *G. subgutturosa*. Whereas in the latter it is almost flat, with a pair of sharp-edged, transversely ridged posterior tuberosities running forward into a low narrow median crest, and with

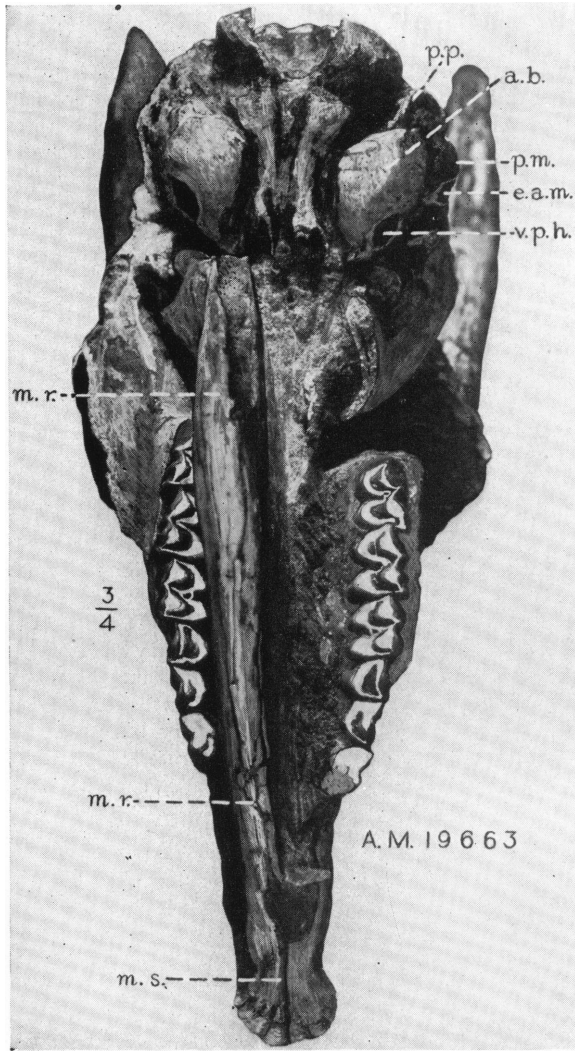


Fig. 39. *Gazella lydekkeri*, new species. Type, Amer. Mus. No. 19663. Skull, from a quarry half a mile south of Dhok Pathan. Ventral view. Three-quarters natural size. *a. b.*, auditory bulla; *e. a. m.*, external auditory meatus; *m. r.*, mandibular ramus; *m. s.*, mandibular symphysis; *p. m.*, mastoid process; *p. p.*, paroccipital process; *v. p. h.*, vagina processus hyoidei.

feebly developed anterior tuberosities, in *G. lydekkeri* the posterior tuberosities form rounded obtuse knobs, each of which runs forward into a narrow rounded ridge, there being a deep median furrow between these ridges. The anterior tuberosities are fairly prominent. On a smaller scale the structure resembles that of *Boselaphus*. In the female skull (Amer. Mus. No. 19664) the ridges of the basioccipital are narrower and sharper. The auditory bulla is smaller in every dimension than in *G. bennetti* and

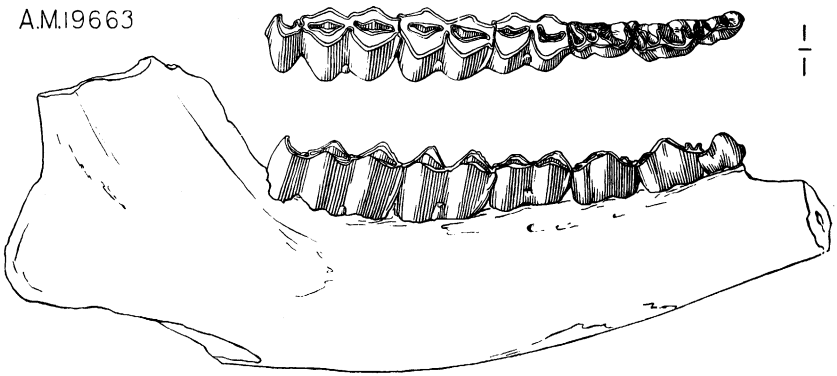


Fig. 40. *Gazella lydekkeri*, new species. Type, Amer. Mus. No. 19663. Right mandibular ramus, disassociated from the skull. Crown and outer views of lower cheek dentition. Natural size.

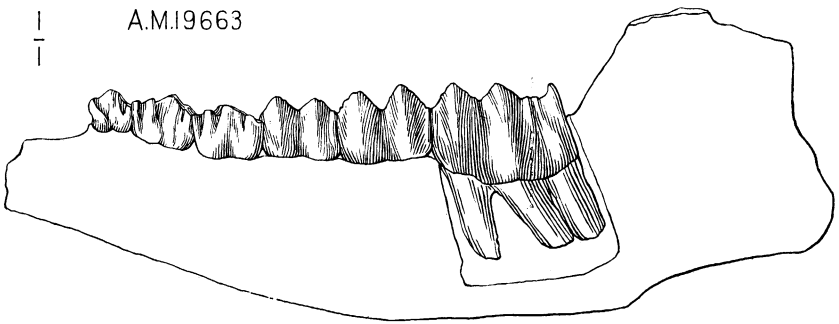


Fig. 41. *Gazella lydekkeri*, new species. Type, Amer. Mus. No. 19663. Right mandibular ramus, disassociated from the skull. Inner view of lower cheek dentition. Natural size.

subgutturosa, and in particular much less inflated. The small process at the forward end of the bulla in *G. subgutturosa* is here represented by a very much larger projection which is connected with the vagina processus hyoidei at the antero-external end of the bulla; this does not seem to be the case in *G. subgutturosa*. The bullae are much closer together than in *G. subgutturosa*, being only 16 mm. apart against 22 mm. in the living species.

Upper Dentition.—The antero-posterior is decidedly greater than the trans-

verse diameter in the case of the last two upper molars, but M^1 is more nearly quadrate. Compared to living species they are much more brachyodont. Thus the respective height of crown in molars of *G. subgutturosa* and of *G. lydekkeri* which have approximately the same amount of wear is 25 and 14. The lower molars appear to have slightly higher crowns than the upper ones. The height of M^3 is about equal to the antero-posterior diameter of the crown. On the outer side of the molars the anterior and median folds are of about equal strength and rather prominent; the posterior fold is weak. The median rib of the anterior fold is strongly developed; that of the posterior lobe is weaker, but both are visible to the base of the crown. Median basal pillars are not visible on the inner side of any of the molars. Small spurs of enamel project into the crescentic cavities in each lobe. In the centrum of M^1 a small transversely elliptical enamel island has been formed. The last two molars are not sufficiently advanced in wear to show this.

The relative length of the premolar series much exceeds what is the case in living species like *Gazella bennetti* and *subgutturosa*. Of the upper premolars P^2 is the longest and P^4 the shortest. The premolars are all very broad; in the case of P^4 the transverse exceeds the antero-posterior diameter. The premolars show on their outer side a strong but narrow anterior fold, an equally strong but broader median fold, and a much weaker posterior fold. The furrow between these last two folds diminishes in intensity from P^2 to P^4.

Mandible and Lower Dentition.—The anterior pair of mental foramina are situated rather far forward, being only from 10 mm. to 12 mm. behind the canines as against 17 mm. in *G. subgutturosa*. The same condition as in *G. lydekkeri* seems to obtain in the fossil gazelles from Pikermi and Samos. I cannot see the posterior mental foramen which should be situated beneath P_2. The inner walls of all the molars have well marked broad ribs in each lobe. Both these and the corresponding furrows extend to the base of the crown. At the anterior end, both on the inner as well as on the outer side, each molar has a strong fold, more prominent on the outer than on the inner side. At the posterior end there is only a weak fold on the inner side and none at all on the outer side. Median basal pillars are present in all the molars, diminishing in strength from M_1 to M_3, that in M_3 being extremely small. M_3 has an extremely long and narrow third lobe, which has strong anterior and posterior folds on the inner side enclosing a deep furrow. P_4 has a slightly elongate inner cusp which is connected from an early stage of wear with the principal outer cusp. There are two wings in front of the inner cusp and two wings behind it, of which the foremost and the rearmost form respectively the front and hind walls of the tooth. The inner cusp remains unfused with the anterior wing for a considerable way towards the base; on the other hand the fusion with the posterior wing occurs much earlier. Situated one-third of the length of the tooth from the hinder end on the outer side is a deep narrow furrow. P_3 is precisely similar in structure to P_4. P_2 is a long tooth with two roots. It is longer and more complicated than is usual in most species of *Gazella*. Remnants of the same five wings are present on the inner side which we find in the two succeeding molars, but they project much less and are less independent of the main body of the tooth. The inner cusp is closely united to the principal cusp and has little antero-posterior expansion. The anterior fold is almost entirely obliterated, so that in effect there is only a single wing anterior to the inner cusp, which merely shows a faint furrow on the inner side, as indicating a potential division into two distinct wings. The furrow on the external side is very slight.

COMPARISONS.—The differences of *Gazella lydekkeri* from *G. bennetti* and *G. subgutturosa*, the two living species which lend themselves most readily to comparison with it, are for the most part stated in the course of the description of the holotype. Except only for the absence of horns in the female, *G. lydekkeri* is much more like the former of these two species, both in respect to its longer and more slender skull, the higher occipital and the shape and direction of its horn-cores. The main distinctions concern changes which one would expect to occur in the course of the evolution of a gazelle from the Pontian period up to the present day, such as acquisition of horns in the female sex, lengthening of the horn-cores, greater bending down of the facial on the cranial axis, shortening of the nasals, increase in hypsodonty, reduction of the premolar series and enlargement of the bullae. In fact it is not difficult to regard *G. lydekkeri* as ancestral to the living *G. bennetti.*

G. capricornis (= *G. brevicornis* Wagner), the best known of the European Pontian species, differs in many ways from *G. lydekkeri.* Though its skull is somewhat larger and more robust than the holotype of the latter, especially in regard to the width at the orbits, yet the dental series is actually shorter. The teeth are more brachyodont. The folds and ribs on the external side of the upper molars and on the inner side of the lower molars, though strong are finer and sharper than in *G. lydekkeri.* The premolars are broader and somewhat less reduced. In P_4 there is less tendency towards the backward growth of the inner cusp, so that fusion with the posterior wings occurs much nearer the base of the crown. The horn-cores are almost circular in cross-section, more divergent and somewhat more curved. The basioccipital is broader, shorter and much flatter. Whereas in *G. lydekkeri* the posterior tuberosities are but little expanded transversely and have a deep groove between them which continues up to the anterior tuberosities, in *G. capricornis* the posterior tuberosities are extremely flat, laterally expanded ridges, which are hardly more prominent than the space between them, while the anterior tuberosities, though as strong as in *G. lydekkeri*, are not, as in that species, connected with the posterior tuberosities by prominent ridges.

G. pilgrimi Bohlin (formerly known as *G. gaudryi* Schlosser, 1904, p. 66) from Samos is rather incompletely known. If a skull in New York (Amer. Mus. No. 20570) from Samos is correctly referred to *G. pilgrimi*, then the length of the nasals is in excess of what obtains in *G. lydekkeri*, although the width at the orbits is less. The horn-cores are farther apart. smaller, rather more compressed laterally, almost straight and with but

a trifling divergence. The longitudinal ribs are fewer in number and stronger and persist to the tip of the horn-core. The dentition is not unlike that of *G. lydekkeri* in regard to the length of the individual molars and premolars and their degree of hypsodonty. The folds and ribs on the external walls of the upper molars are little weaker than in the Indian species, but those of the upper premolars are less prominent and the internal surface of the lower molars is almost flat. The posterior valley in P_4 is more blocked than in *G. lydekkeri*.

G. deperdita, perhaps only a variety of *G. capricornis*, has narrower and more curved horn-cores. *G. mytilinii* Pilgrim has a slender skull but is a much larger species than *G. lydekkeri* with more narrowly elliptical, almost parallel, and little curved horn-cores. The horn-cores of *G. schlosseri* Pavlow are more slender and upright and the ribs extend to the tip. *G. longicornis* Andree has exceptionally long horn-cores which diverge more than in *G. lydekkeri* and have a more narrowly elliptical cross-section and stronger ribs. In *Gazella* n. sp. Andree (1926, p. 168) the horn-cores are more divergent and their tips are turned inward. *Gazella* n. sp. Andree (1926, p. 169) resembles *G. pilgrimi* but the horn-cores are more obliquely set and lie more behind the orbit than in other species of *Gazella*. *G. rodleri* Pilgrim and Hopwood has spirally twisted horns. *G. anglica* Newton and *G. daviesii* Hinton are smaller species with much more compressed horn-cores than in *G. lydekkeri*.

Several well-defined species of *Gazella* seem to have existed in the Pontian of China. Bohlin (1935B, pp. 75–106[1]), who has recently studied the Pontian Gazelles of that country, considers as valid species of *Gazella* the following species founded by Schlosser (1903): *G. gaudryi* (described and figured by Schlosser under the name of *Protetraceros gaudryi*, p. 136), *G. dorcadoides* and *G. altidens*. He has removed *Gazella palaeosinensis* Schlosser to the genus *Tragoreas* (?). Of the species of *Gazella* founded by Teilhard and Young (1931, pp. 35–40) Bohlin has referred some skulls and dentitions to *G. paotehensis* but does not mention *G. blacki*. In all the Chinese species the skull seems to be less slender than in *G. lydekkeri* although the width at the orbits is as great. The horn-cores seem to be in general agreement with those of the Indian species. The nasals are probably somewhat shorter. *G. gaudryi* differs little from *G. capricornis* with regard to the brachyodonty of the molars and the nature of the folds and ribs on the external side of the upper molars, so that *G. lydekkeri* is more hypsodont and has coarser and

[1] Unfortunately the publication of this work is too far advanced to permit me to make the fullest use of Bohlin's detailed account of the Pontian Bovidae of China, but so far as possible his main conclusions are incorporated here.

broader folds and ribs. In *G. dorcadoides* and *G. altidens* the teeth are still more hypsodont than in *G. lydekkeri*. In *G. dorcadoides* the hinder lobe of the upper molars has a concave external wall, while the lower molars have an almost flat inner surface. Perhaps *G. paohetensis* is on the whole nearer to *G. lydekkeri* in regard to the height of the teeth and the length of the face and nasals, but shows itself to be more progressive both as regards the reduction in length of P^2 and P_3. Teilhard and Young also state that the inner cusp of P_4 is completely fused with the posterior wing which is by no means the case in *G. lydekkeri*. The same progressive type of P_4 occurs in *G. blacki*, but the teeth are extremely hypsodont. In most of the Chinese species the occipital condyles are almost in the same plane as the occipital and the angle between the occipital and parietal surfaces is obtuse as in most living species of *Gazella* but not in *G. bennetti*. *G. lydekkeri* differs from the fossil species of China in both these characters and agrees with *G. capricornis*. On the other hand the narrow and concave basioccipital of *G. lydekkeri* seems to resemble that of the Chinese species, at any rate *G. gaudryi*, rather than that of *G. capricornis*. *G. lydekkeri*, in fact, differs from each one of the Pontian species either in few or many characters and undoubtedly represents a distinct type. *G. sinensis* Teilhard and Piveteau (1930, p. 64) from the upper Pliocene of Nihowan in China has much more massive frontals and horn-cores and a much smaller skull length, while the face is more bent down on the cranial axis and P_4 is more progressive. Apparently it is allied to the *Procapra* Gazelline type.

The various species of *Gazella* described by Pomel (1895) from the Pleistocene of Algeria seem to be allied to *G. dorcas*, *G. cuvieri* and *G. rufifrons* and so differ from *G. lydekkeri* by the greater compression of their horn-cores. In any case they are distinguished by their greater degree of hypsodonty.

Gazella sp.

REFERRED SPECIMENS

Amer. Mus. No. 19549—teeth and bones, near Hasnot.
" " " 19854—jaws, 4 mi. W. Dhok Pathan.
" " " 29845—cranium, 1/2 mi. S. Dhok Pathan.
" " " 29865—horn-cores, 1 mi. W. Chinji Bungalow.
" " " 29908—maxilla, 4 mi. W. Chinji Bungalow.
" " " 29963—horn-cores and lower jaw, 1/2 mi. S. Dhok Pathan.
" " " 29971—horn-cores, 2 mi. W. Chinji Bungalow.
" " " 29976—horn-core, 1/2 mi. N. Chinji Bungalow.
" " " 29978—horn-core, 1 1/2 mi. W. Chinji Bungalow.
" " " 29880—upper and lower jaws, 1 1/2 mi. N. E. Hasnot.

ANTILOPE PALLAS

PALLAS, 1776, 'Miscellanea Zoologica,' pp. 1–15, tab. I, IV, fig. 3.

GENOTYPE.—*Capra cervicapra* Linn., 1758, 'Syst. Nat.,' 10th Ed., I, p. 69.

Antilope subtorta, new species

Figures 42 to 44

HOLOTYPE.—Amer. Mus. No. 19989, a fragment of a horn-core.

PARATYPES.—Amer. Mus. No. 19985, a specimen of M_3 from near Tatrot, probably belonging to the Tatrot stage of the Upper Siwaliks. Amer. Mus. No. 19990, a specimen of M_2 from the upper variegated beds below the boulder conglomerate, six miles east of Chandigarh, Siwalik Hills, from the Pinjor Stage of the Upper Siwaliks.

HORIZON AND LOCALITY.—Near Siswan, Siwalik Hills, from the Upper Siwaliks (?) Pinjor Stage.

DIAGNOSIS.—An *Antilope* which may have been approximately equal in size to *Antilope cervicapra;* horn-cores much less twisted, the torsion being in the ratio of about one-third of a revolution as against a whole revolution in *A. cervicapra;* practically without any trace of a keel. On the assumption that the paratype teeth belong to this species, the lower molars are broader and less hypsodont than in *A. cervicapra,* and have median basal pillars, abent in *A. cervicapra.*

DESCRIPTION.—The resemblance of the holotype to the horn-core of the Indian species *Antilope cervicapra* in respect to its method of torsion, its circular cross-section, the practical absence of keels and the character of the surface, renders it highly probable that it should be referred to the same genus. The most important distinction of the horn-core from that of the living species is the smaller degree of torsion. A comparison with a specimen of *Antilope cervicapra,* in which the horn-core has the same basal diameter and is mature, shows that for the same length as that of the fossil fragment the diameter is the same as that of the fossil in every part, but while in that length the recent horn-core has made a complete revolution, the fossil horn-core has only made about one-third of a revolution. A keel is sometimes distinguishable on the antero-internal side of the horn-core of *Antilope cervicapra,* but in the fossil, there is no trace of one on the surface and only a faint indication of one in the cross-section. On the outside of the horn-core in the holotype a prominent groove is present. This dies away near the top of the fragment. The remainder of the surface is adorned with a series of small pittings or reticulate and anastomosing striae, which precisely resembles the ornamentation of the living *Antilope cervicapra.* The concave parts of the horn-core in the living species are almost smooth. A difference between the concave and convex parts of the fossil is also noticeable but is less marked than in the living species.

It is unknown how far from the base the horn-core was fractured, so that in size this species may have equalled the largest individuals of *A. cervicapra.*

Additional evidence as to the probable existence of the genus in India in the Middle and Upper Pliocene is afforded by two lower molars, one of which is almost certainly from the same horizon as the horn-core, Pinjor Stage. The other is likely to have been somewhat earlier, Tatrot

Stage. These teeth by their narrowness and height as compared with contemporary species of antelope agree most nearly with those of *Antilope cervicapra*, and the enamel is equally smooth. They possess a strong fold anteriorly both on the inner and outer side, which is characteristic of the living species.

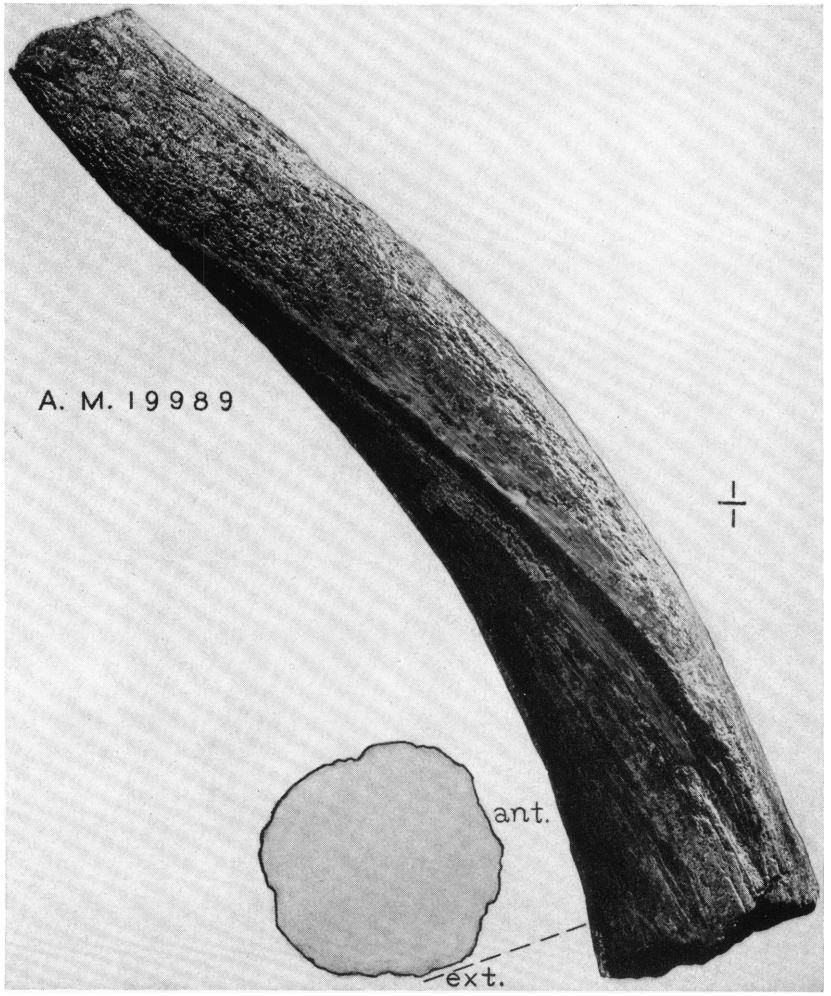


Fig. 42. *Antilope subtorta*, new species. Type, Amer. Mus. No. 19989. Fragment of horn-core, from near Siswan, Siwalik Hills. Lateral view and cross-section. Natural size. *Ant.*, anterior; *ext.*, external.

In the Pinjor as well as in the Tatrot specimen, the lower molars are somewhat broader than in *Antilope cervicapra*, but in the latter particularly so. In both there are median basal pillars in the external valleys. These are absent in the living form. The teeth in both the fossil speci-

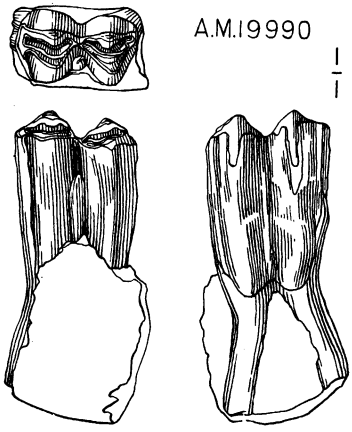


Fig. 43

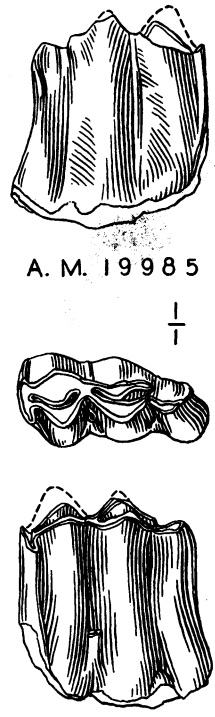


Fig. 44

Fig. 43. *Antilope subtorta*, new species. Amer. Mus. No. 19990. Referred M_2, from the upper variegated beds below the Boulder conglomerate, six miles east of Chandigarh, Siwalik Hills. Crown, outer and inner views. Natural size.

Fig. 44. *Antilope subtorta*, new species. Amer. Mus. No. 19985. Referred M_3, from near Tatrot. Inner, crown and outer views. Natural size.

mens are somewhat advanced in wear, so that the height as given in the table of measurements is less than would be the case in unworn teeth. It is, however, apparent that the recent teeth are considerably more hypsodont than the fossil ones.

The broader teeth of the Tatrot M_3 combined with its occurrence in an earlier deposit suggests that it may belong to a different species from

the other two specimens. In any case the smaller degree of torsion and hypsodonty as compared with *A. cervicapra* obviously point to all three fossil specimens being in an earlier stage of evolution.

Measurements of *Antilope subtorta*, new species

Holotype: horn-core Amer. Mus. No. 19989.

Length of fragment measured along convex curve on antero-internal side	160	mm.
Diameter of fragment at bottom end	31	mm.

Referred M_3, Amer. Mus. No. 19985.

Antero-posterior diameter	24.5	mm.
Transverse diameter	11.5	mm.
Height of crown	26	mm.

Referred M_2, Amer. Mus. No. 19990.

Antero-posterior diameter	16	mm.
Transverse diameter	9.5	mm.
Height of crown	22.5	mm.

SUBFAMILY BOVINAE

LEPTOBOS RÜTIMEYER

RÜTIMEYER, 1878, Abh. Schweiz. Paläont. Ges., V, p. 157.

GENOTYPE.—*Leptobos falconeri* Rütimeyer, 1878, Abh. Schweiz. Paläont. Ges., V, p. 157.

DIAGNOSIS.—Bovinae with low, relatively narrow skull and long, slender limbs; females hornless; face but little bent down on cranial axis; parietals reduced, but taking a considerable part in the roof of the brain-case; temporal crests very prominent and overhanging the temporal fossa; hinder ends of temporal fossae approximating to one another, curving inward, narrowed and opening on to the supraoccipital only; supraoccipital more or less deflected out of the plane of the parietal towards that of the occipital; horn-cores long and slender, subcylindrical, widely spaced, not far behind the orbits, situated far below the occipital plane, considerably tilted backward, divergence variable; large ethmoidal vacuity; molar teeth rather elongate.

Leptobos falconeri Rütimeyer

Figures 45 and 46

RÜTIMEYER, 1878, Abh. Schweiz. Paläont. Ges., V, p. 157, Pl. I, figs. 7, 8; Pl. IV, figs. 3, 4, 5, 6; Pl. VI, fig. 9.

COTYPES.—Brit. Mus. Nos. 40887, a skull; 39567, a cranium.

REFERRED SPECIMEN.—Amer. Mus. No. 19816, a skull.

HORIZON AND LOCALITY.—Upper Siwaliks of the Siwalik Hills.

DIAGNOSIS.—A *Leptobos* with horns diverging at about 65° to 80° but little curved; relatively broad frontals; supraorbital pits opposite the orbits; parietals about one-quarter the length of the frontals; supraoccipital much deflected towards the plane of the occipital; hinder extremities of temporal fossae very pointed and close together.

DISCUSSION.—The skull here figured (Amer. Mus. No. 19816) was collected by Dr. Barnum Brown two miles west of Chandigarh, Siwalik

Fig. 45. *Leptobos falconeri* Rütimeyer. Amer. Mus. No. 19816. Skull, partially restored, from two miles west of Chandigarh, Siwalik Hills, below the Boulder conglomerate. Top view. One-sixth natural size.

Hills below the Boulder conglomerate. It is moderately well preserved and lacks only the upper portions of the horn-cores, the left orbit and the front of the muzzle. These have been restored with a reasonable approach to accuracy. This is a larger skull than the one in the British Museum (Br. Mus. No. 40887) figured by Rütimeyer, but differs from it in no essential respect. More of the horn-cores are preserved than in

Fig. 46. *Leptobos falconeri* Rütimeyer. Amer. Mus. No. 19816. Skull, partially restored, from two miles west of Chandigarh, Siwalik Hills, below the Boulder conglomerate. Lateral view. One-sixth natural size.

any previously known specimen, which circumstance affords us a better idea of their structure. They are coarsely ribbed, circular in cross-section with a faint trace of an antero-internal and a postero-external keel. They curve outward and backward considerably, the backward curvature diminishing in the upper half, with a very slight indication of a spiral which is counter-clockwise in the right horn-core. The measurements of this skull are tabulated on page 818.

Measurements of American Museum Bovine Skulls from the Upper Siwaliks

	Leptobos falconeri A. M. No. 19816	*Hemibos acuticornis* A. M. No. 19963	*Bubalus platyceros* A. M. No. 19872
Width of skull at mastoid	217	app. 190	269
Width of skull at orbits	227	app. 200	265
Width of skull at constriction above orbits	213	app. 185	240
Width of skull between temporal fossae	124	app. 132	143
Distance from occipital crest to highest point of frontals	127	app. 97	113
Distance from highest point of frontal to apex of nasals	app. 117	app. 118	242
Distance from apex of nasals to end of premaxilla (estimated)	app. 240		app. 250
Length of temporal fossa	134	app. 200	190
Interval between supraorbital foramina	92	app. 95	141
Length of horn-core measured from pedicle along convex curve (estimated)	590	400	880
Antero-posterior diameter of horn-core at base	77	55	98
Lateral diameter of horn-core at base	85	75	146
Interval between orbit and base of horn-core	100	64	50

HEMIBOS RÜTIMEYER EX FALCONER MS.

FALCONER, quoted by Rütimeyer, 1866, Verhandl. Naturf. Ges. Basel, IV, Heft 2, p. 330.

GENOTYPE.—*Hemibos triquetricornis* Rütimeyer, ex Falconer MS., 1866, Verhandl. Naturf. Ges. Basel, IV, Heft 2, p. 330.

DIAGNOSIS.—Bovinae with relatively broad skull; face bent down on cranial axis at an angle of about 55°; frontals arched longitudinally, flat or concave between the horn-cores; parietals but little reduced, about half the length of the frontals, taking a considerable part in the roof of the brain-case; temporal crests weakened; temporal fossae opening widely on to the parietal and supraoccipital surface; horn-cores large, triangular in cross-section, inner keel prominent, relatively close to one another, situated below the occipital plane, moderately divergent, considerably tilted backward; no ethmoidal vacuity.

Hemibos acuticornis (Falconer and Cautley)

Figure 47

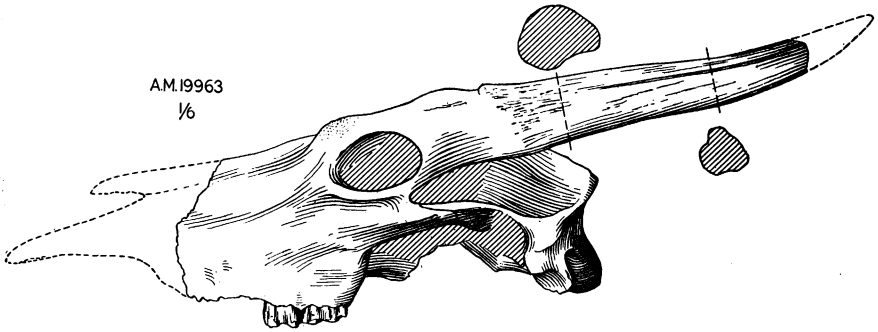
Amphibos acuticornis RÜTIMEYER, 1866, Verhandl. Naturf. Ges. Basel, IV, Heft 2, p. 331, *nomen nudum*.

Bos(Amphibos) acuticornis FALCONER AND CAUTLEY, 1868, Palaeont. Mem., I, pp. 23, 280, 547, 554; RÜTIMEYER, 1878, Abh. Schweiz. Paläont. Ges., V, p. 147 Pl. III, figs. 1–7.

Hemibos acuticornis LYDEKKER, 1880, Pal. Ind., (10) I, p. 176.

COTYPES.—Brit. Mus. Nos. 39560, a cranium; 39564, a cranium.

47*a*



47*b*

Fig. 47. *Hemibos acuticornis* Falconer and Cautley. Amer. Mus. No. 19963. Partial skull, from three miles west of Chandigarh, Siwalik Hills, below the Boulder conglomerate. *a*. Front view; *b*. Lateral view; *c*. Dorsal view (page 820); *d*. Ventral view (page 821). One-sixth natural size.

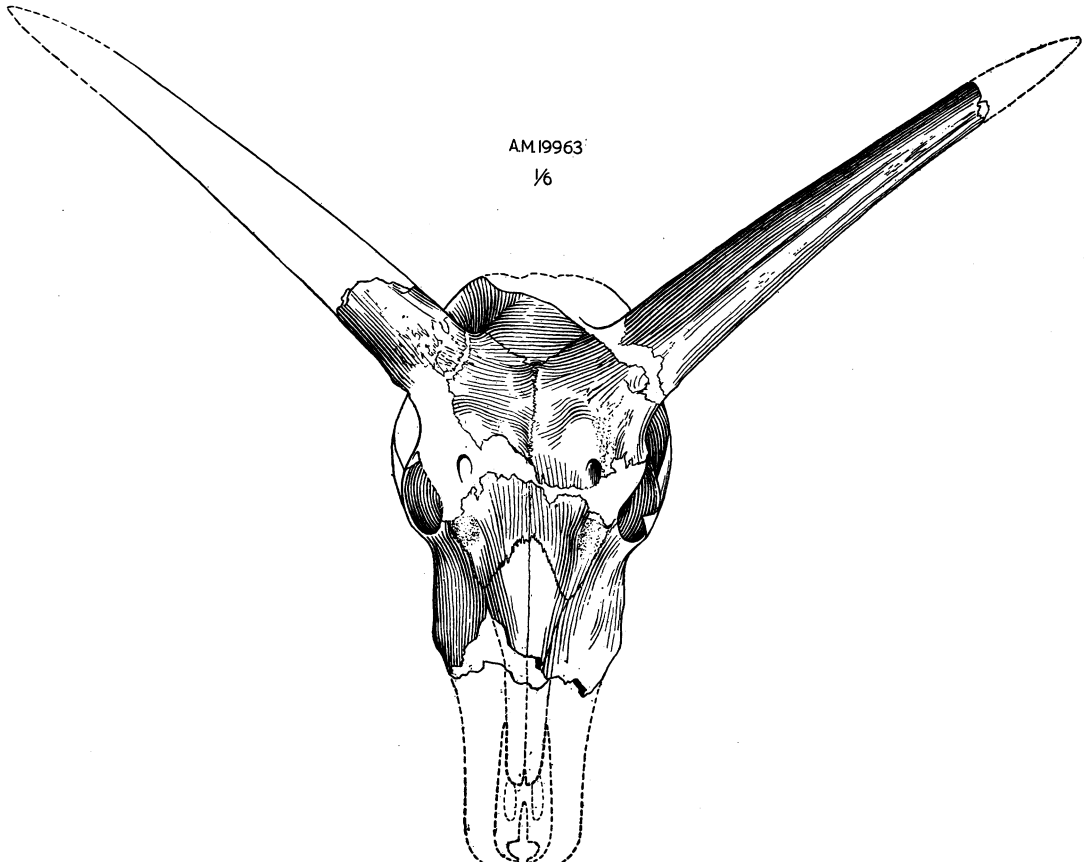


Fig. 47c. *Hemibos acuticornis* Falconer and Cautley. Amer. Mus. No. 19963. Partial skull, dorsal view. One-sixth natural size. (See caption for Fig. 47 on page 819.)

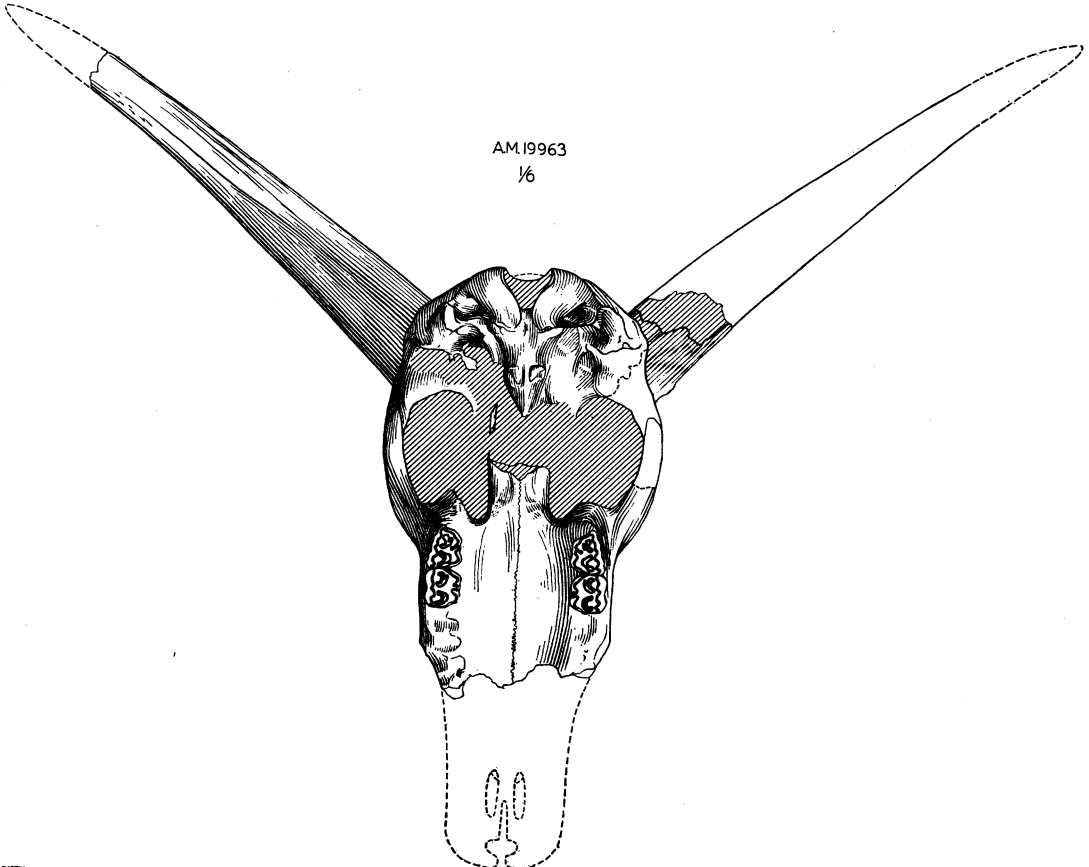


Fig. 47*d*. *Hemibos acuticornis* Falconer and Cautley. Amer. Mus. No. 19963. Partial skull, ventral view. One-sixth natural size. (See caption for Fig. 47 on page 819.)

REFERRED SPECIMENS.—Amer. Mus. No. 19963, a skull.

HORIZON AND LOCALITY.—From the Upper Siwaliks of the Siwalik Hills.

DIAGNOSIS.—A *Hemibos* with horn-cores slightly curved, with an almost equilaterally triangular cross-section, less expanded internally than in *H. triquetricornis*, so that the diameter between the inner keel and the center of the outer face does not much exceed that between the antero-internal and the postero-external keels; horn cores diverging at about a right angle, less tilted backward than in *H. triquetricornis;* supraorbital pits situated farther from the margin of the skull than in *H. triquetricornis;* orbits funnel-shaped, with thin walls, not projecting far beyond the profile of the face.

DISCUSSION.—The skull (Amer. Mus. 19963) here figured was collected three miles west of Chandigarh, Siwalik Hills, below the Boulder conglomerate. It is poorly preserved and considerably crushed, and the measurements given in the table on page 818 are only approximate. It is an aged male skull, and exceeds in size any specimen of the species hitherto known. The horn-cores are straight and diverge somewhat more than usual. Their cross-section is subtriangular, with well marked antero-internal and postero-external keels. The small width at the mastoid is typical of the species, but the shortening of the parietal region as compared with some other skulls of *Hemibos acuticornis*, conforms with Rütimeyer's opinion that this feature is a character of age in the male sex, and causes such individuals as show it to approach the appearance of *Hemibos triquetricornis*.

BUBALUS H. SMITH EX FRISCH *nom. non bin.*

FRISCH, 1775, 'Das Natur-System vierfüss Thiere,' Tabellen, 2.

H. SMITH, 1827, in Griffith's 'Animal Kingdom,' V, p. 371.

GENOTYPE.—*Bos bubalis* Linnaeus, 'Syst. Nat.,' 10th Ed., p. 72, 1757.

DIAGNOSIS.—Bovinae with broad skull; face much bent down on cranial axis; frontals considerably arched longitudinally, rather elongate; parietals much reduced from one-third to one-quarter the length of the frontals, but still taking a distinct part in the roof of the brain-case; horn-cores large, triangular and compressed in cross section, much expanded internally and inner keel very prominent, so that the diameter between the inner keel and the center of the outer face is at least twice as great as that between the antero-internal and the postero-external keels, horn-cores situated below the occipital plane, very divergent and tilted backward.

Bubalus cf. **platyceros** Lydekker

Figures 48 to 50

LYDEKKER, 1878, Pal. Ind., (10) I, p. 127, Pl. XVIII.

TYPE.—Geol. Surv. India, No. B237, a skull.

REFERRED SPECIMENS.—Amer. Mus. No. 19872, a skull.

HORIZON AND LOCALITY.—Upper Siwaliks of the Siwalik Hills.

DIAGNOSIS.—A *Bubalus* of large size with frontals flat or slightly swollen between

Fig. 48. *Bubalus* cf. *platyceros* Lydekker. Amer. Mus. No. 19872. Skull, from half a mile west of Siswan, Siwalik Hills, at the top of the Boulder conglomerate. Front view. One-tenth natural size.

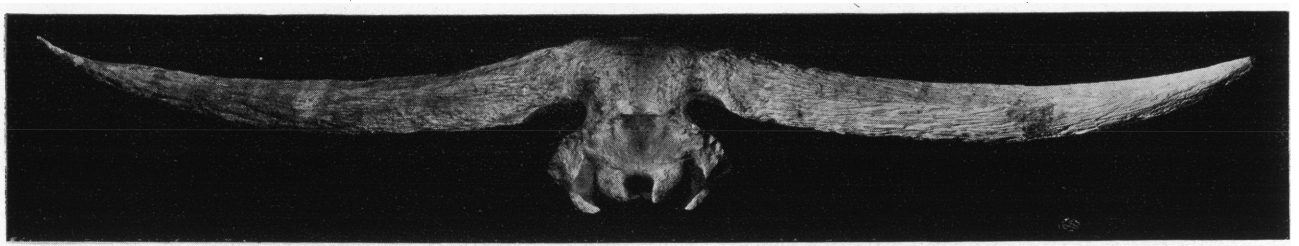


Fig. 49. *Bubalus* cf. *platyceros* Lydekker. Amer. Mus. No. 19872. Skull, from half a mile west of Siswan, Siwalik Hills, at the top of the Boulder conglomerate. Occipital view. One-tenth natural size.

Fig. 50. *Bubalus* cf. *platyceros* Lydekker. Amer. Mus. No. 19872. Skull, from half a mile west of Siswan, Siwalik Hills, at the top of the Boulder conglomerate. Lateral view. One-tenth natural size.

the horn-cores; parietals less reduced and farther out of the plane of the occipital than in most other species; horn-cores moderately spaced, widely divergent, but curving gradually inward towards the tips.

DISCUSSION.—The skull (Amer. Mus. No. 19872) figured on p. 823–4 was collected half a mile west of Siswan, Siwalik Hills, from the top of the Boulder conglomerate, being the highest fossil found by Dr. Barnum Brown. Another skull (Amer. Mus. No. 19782) of the same species came from the upper clays below the Boulder conglomerate, three miles northeast of Mirzapur, Siwalik Hills.

This skull is much larger than the holotype (Geol. Surv. Ind. No. B237) or than Br. Mus. No. 16431, the type of *Bubalus sivalensis* Rütimeyer which is a synonym of *B. platyceros* Lydekker. Both by its size as well as certain other details of structure it differs from the other two, and thereby makes a very decided approach to *Bubalus palaeindicus* as well as to the living Arni, *Bubalus bubalis*. These differences are: (1) the curve made by the horn-cores and the frontals is much more open so that the tips of the horn-cores do not rise so far above the forehead; (2) the frontal area between the horn-cores is slightly more swollen than in the holotype of *B. platyceros*. Thus it forms almost a connecting link between the typical *B. platyceros* and *B. palaeindicus*.

ANTELOPINE TEETH OF THE MIDDLE SIWALIKS

The attribution of the Bovid teeth found in the Siwalik series of India to the various genera is attended with considerable uncertainty because of the general lack of association between the skulls and upper dentitions as well as mandibles. This uncertainty is much greater in the case of the Lower than of the Middle Siwaliks. In both, however, it will be as well to devote a special section to the consideration of the teeth only, and to deal first with those of the Middle Siwaliks, about the identification of which there is less doubt. To some extent this may help us to identify the Lower Siwalik dentitions, when we come to deal with them in turn.

Teeth Referred to *Pachyportax*

Figure 51

It has already been stated (page 768) that one of the two largest Middle Siwalik skulls known, that of *Pachyportax latidens* var. *dhokpathanensis* was found at Nila in a much decayed condition, but with two of the molars either in contact or almost so with the remnants of the palate. These teeth are identical in size and structure with those in the maxilla de-

scribed and figured by Lydekker (1884, p. 111, Pl. XIII, figs. 12, 13) under the name of *Oreas* (?) *latidens*. Lydekker identified this with an upper molar similar in structure but larger, which he had previously described as *Cervus latidens* (Lydekker, 1876, p. 65, Pl. VIII, figs. 7, 10). To the second large Middle Siwalik skull, that of *Selenoportax vexillarius*, can be attributed with little hesitation numerous dentitions which are identical in structure with, but smaller than, those described and figured by Lydekker (1884, p. 114, Pl. XIII, figs. 1–4, 7, 8, 11) under the name of *Boselaphus* sp. The mandible of Lydekker's figure 5 and the upper and lower molars figured on page 828 and probably belonging to one individual may be taken as typical of these. As has been explained above (page 740), no other teeth so far found in the Middle Siwaliks are large enough for the skull in question.

From Lydekker's failure to institute any comparisons between the two types of dentition mentioned above, merely contenting himself with observing that "the teeth of *Boselaphus* are of a different type from those of '*Oreas*' (?) *latidens*," one would not gather that there was any similarity between them. It is, however, often difficult to distinguish the worn upper molars of *Pachyportax* from similarly worn upper molars of *Selenoportax*. The resemblances of both to bovine teeth, especially to those of *Hemibos* and *Leptobos*, as shown by their hypsodonty, by the large size of the median basal pillar, by the strongly convex even rib-like internal surface of the external lobes (paracone and metacone) which produces in wear a deep U-shaped enamel island, and the quadrate outline of the crown, are shared but in much less pronounced degree by *Boselaphus*, but not by *Taurotragus* or the Tragelaphinae. *Pachyportax* even possesses the bovine feature of cement. I have not noticed this on teeth of *Selenoportax*, but it so generally disappears from weathered teeth that failure to find it does not necessarily prove its absence in reality. The rugosity of the enamel equally is often unnoticeable on weathered specimens, but I have reason to believe that the enamel on the teeth of *Pachyportax* was somewhat less rugose than on those of *Selenoportax*. At the base of the crown, the upper molars of *Pachyportax* are often but not invariably somewhat broader than those of *Selenoportax*. The main differences between the upper molars of the two genera are: (1) those of *Pachyportax* are less hypsodont, as may be realized by the table on page 851, and are also less hypsodont than in the case of *Boselaphus;* (2) in the case of *Pachyportax* the antero-posterior diameter increases but little from the base to the summit of the crown, whereas the rapid increase of this dimension, particularly near the summit, is one of the most striking

features of *Selenoportax*, more so even than in *Boselaphus;* (3) although the bending over of the summit of the external lobes towards the inside is often observable in both genera, as in *Boselaphus*, yet it is less pronounced in *Pachyportax;* (4) the external folds and ribs of both molars and premolars, and particularly the median fold of the molars, are decidedly stronger and broader in *Selenoportax* and reach to the base of the crown. In *Pachyportax* the weakness of the posterior fold and of the median rib of the posterior lobe and their absence near the base give the lower quarter of the posterior lobe a flattened appearance which is very

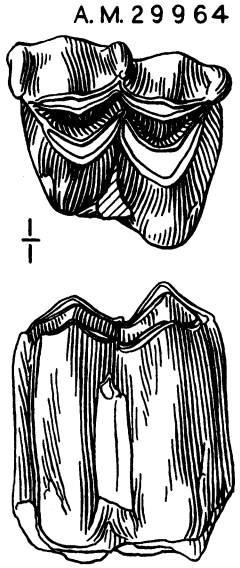


Fig. 51. (?)*Pachyportax latidens* (Lydekker), var. *dhokpathanensis*, new variety. Amer. Mus. No. 29964. One of two referred isolated upper molars, in an early stage of wear, from two miles northeast of Hasnot. Crown and inner views. Natural size.

characteristic. The strength of the median basal pillar in *Pachyportax* is intermediate between that of *Selenoportax lydekkeri* and *S. vexillarius.* Both genera show variable spurs projecting into the central cavity.

Beyond the features already mentioned, the more elongate crown of the upper molars of *Taurotragus*, the weakness of the external folds and ribs, the absence of a median basal pillar and the smooth enamel give the teeth of that genus an altogether different appearance from those of *Pachyportax.*

Mandibles referable to *Pachyportax latidens* are less common; they are generally larger and come from the neighborhood of Hasnot. I have seen no immature specimen, nor one containing P_4. Amongst

these is the Calcutta ramus (Geol. Surv. Ind. No. B268) said to be associated with a fore limb (page 859). The molars differ from the ones described below as *Selenoportax* by their smaller degree of hypsodonty, flatter median ribs and by the weaker and more parallel folds internally.

Teeth Referred to *Selenoportax*

Figures 52 to 59

As usual, the identification of the mandibles presents more difficulty than that of the upper dentition. The immature ramus (Amer. Mus.

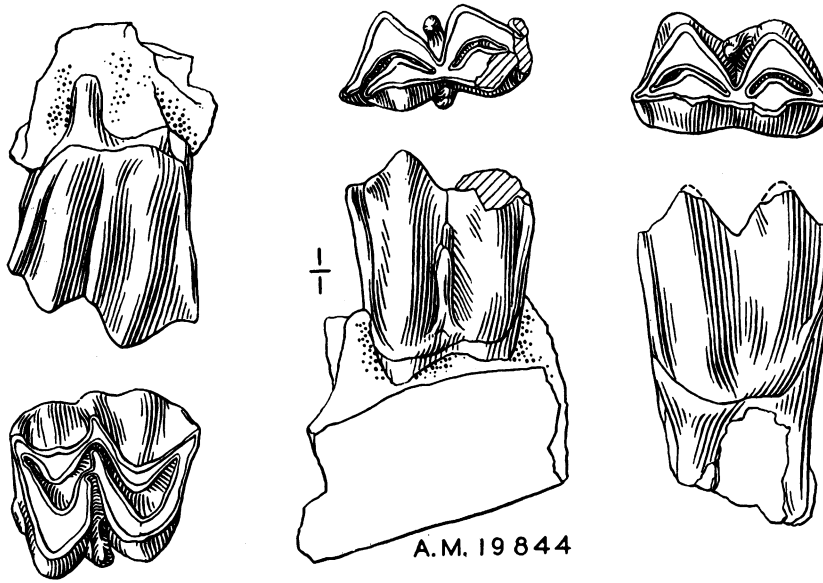


Fig. 52. *Selenoportax vexillarius*, new genus and species. Amer. Mus. No. 19844. Associated upper and lower molars, from three miles east of Dhok Pathan. Outer and crown views of upper molar. Crown and inner views of lower molars. Natural size.

No. 19514) from one mile west of Hasnot, figure 54, may be referred with some degree of confidence to *Selenoportax vexillarius*, on account of the hypsodonty of the molars, the pronounced neck and the increased antero-posterior diameter near the summit of the crown, and the strong internal folds and ribs. The embryo P_4 in this ramus has a primitive structure, with a long open valley separating the two short anterior

wings from the inner cusp. The inner cusp slopes considerably backward and near the base of the crown is united with the foremost of the two rather long posterior wings. Calcutta specimens from Hasnot, which are of the size of *Selenoportax lydekkeri*, show a similar structure of P_4. P_3 in these rami is similar, but the union of the inner cusp with the posterior wings takes place rather earlier. Their greater length—as compared with those of *Boselaphus*—is noteworthy, but in both P_4 has a comparatively simple structure unlike the Tragelaphinae. An isolated P_4 rather advanced in wear (Amer. Mus. No. 29946; Fig. 56), from four

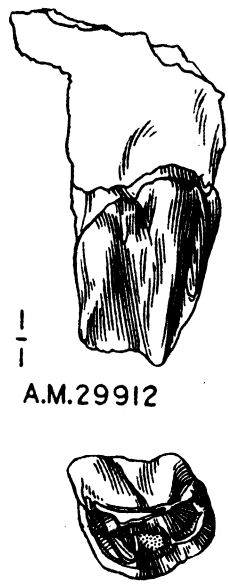


Fig. 53. (?)*Selenoportax vexillarius*, new genus and species. Amer. Mus. No. 29912. A referred P^3, from four miles west of Dhok Pathan. Outer and crown views. Natural size.

miles northeast of Chinji Bungalow, by its size and horizon is likely to belong to *Selenoportax vexillarius*. The backward growth of the inner cusp in this is very remarkable, but the union with the posterior wing does not occur until near the base of the crown.

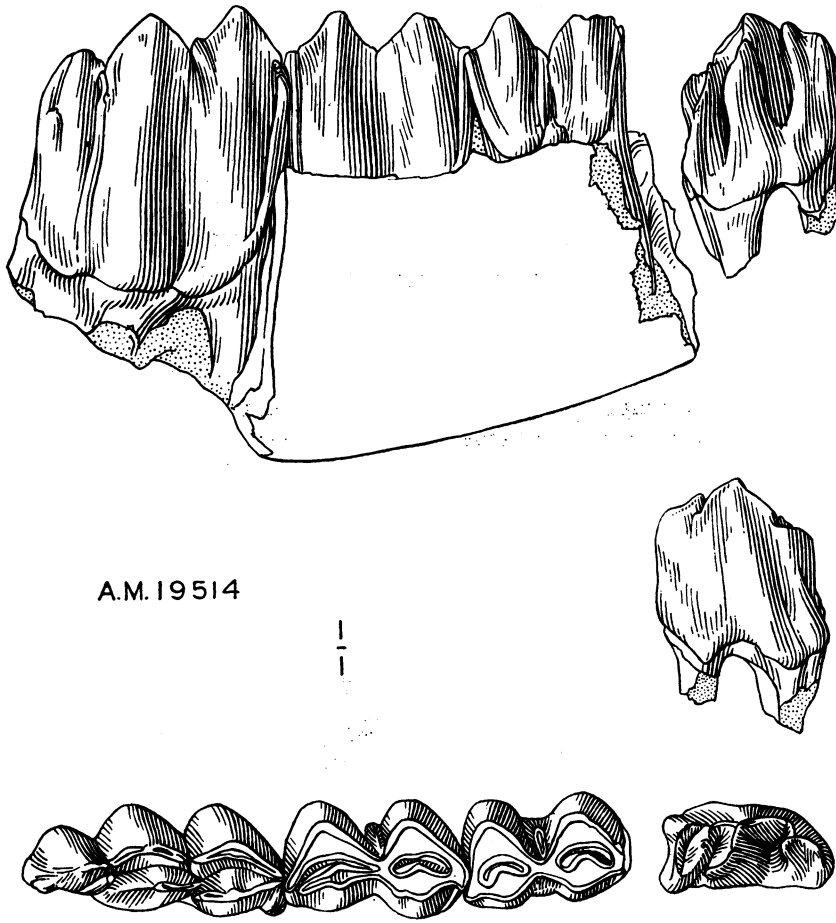


Fig. 54. *Selenoportax vexillarius*, new genus and species. Amer. Mus. No. 19514. Left mandibular ramus of a young individual with M_{1-3} and P_4 in embryo, from one mile west of Hasnot. Outer, crown and inner views. Natural size.

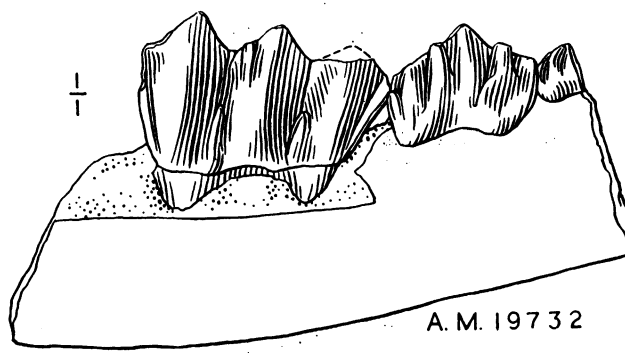


Fig. 55. *Selenoportax lydekkeri* (Pilgrim). Amer. Mus. No. 19732. Right ramus of a young individual, with MM_{3-4} from half a mile southeast of Hasnot. Inner view. Natural size.

Fig. 56

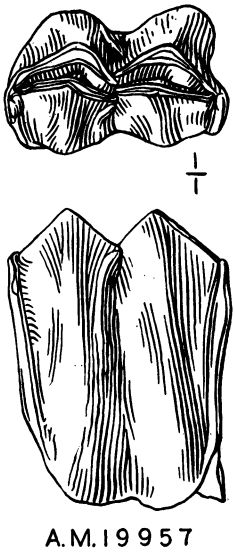


Fig. 57

Fig. 56. (?)*Selenoportax vexillarius*, new genus and species. Amer. Mus. No. 29946: A referred P_4, from four miles northeast of Chinji Bungalow. Crown and inner views. Natural size.

Fig. 57. *Selenoportax lydekkeri* (Pilgrim). Amer. Mus. No. 19957. A referred M_1, from two miles west of Hasnot. Crown and inner views. Natural size.

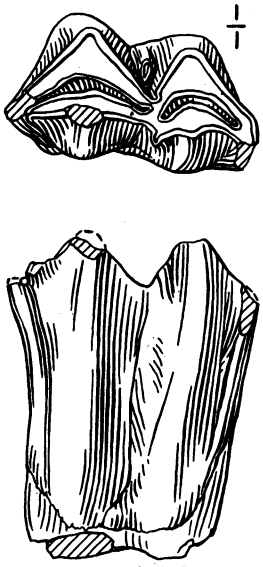


Fig. 58

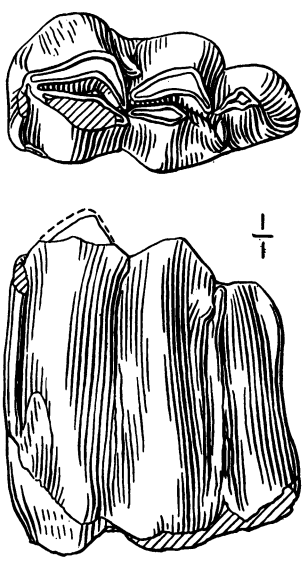


Fig. 59

Fig. 58. *Selenoportax lydekkeri* (Pilgrim). Amer. Mus. No. 19981. A referred M_3, from two and one-half miles north of Hasnot. Crown and inner views. Natural size.

Fig. 59. *Selenoportax lydekkeri* (Pilgrim). Amer. Mus. No. 19908. A referred M_3, from two and one-half miles north of Hasnot. Crown and outer views. Natural size.

Teeth Referred to *Tragocerus*

Two species of *Tragocerus* and one of *Tragoportax* are represented by skulls containing the upper dentition. That of *Tragocerus punjabicus* is in perfect condition, and that of *Tragocerus browni* is satisfactory. Both in the American Museum and in the Calcutta collections are several upper and lower dentitions of *Tragocerus*. Examples of these are figured on pages 787 and 788, figs. 28, 29. The former for the most part came from the same quarry, or from quarries adjacent to the one in which the holotype skull of *Tragocerus browni* was found. These quarries are to the south of Dhok Pathan. The latter were mainly excavated from the quarry on the Soan River three miles west of Dhok Pathan, which has yielded two or three skulls of *Tragocerus punjabicus*. All of them may be distinguished at a glance from teeth of *Pachyportax* and *Selenoportax* by their smaller size, their more brachyodont character, and the weaker basal pillars. My study of all this material as well as of that of *Tragocerus* from Pikermi and other European localities contained in London and Paris leads me to confirm the opinion expressed by Gaudry (1865, pp. 282, 284) and emphasized still more categorically by Arambourg and Piveteau (1929, pp. 109, 110) that the variation in the structure of the teeth is considerable. Whether these variations show any tendency to group themselves in foci of correlated characters I have not discovered. If at a later date, when I come to review the whole mass of Indian antelope material, I find it possible to add any facts of value, I may discuss the question in greater detail. Suffice it for the present to say that the relative length of the premolar series seems to provide a character which separates at any rate the two Indian species mentioned from one another. What position the third Indian species, *Tragocerus perimensis*, takes with regard to this character as compared with the two others, I am unable to say as it is only known by a unique frontlet from an area some distance removed from the Salt Range, and may not even have existed in the latter region. Most of the American Museum dentitions, so far as my memory serves me, agree with the holotype of *T. browni* in having a relatively longer premolar series than *T. punjabicus*. The material in Calcutta obtained from the Soan quarry near Dhok Pathan with few exceptions belongs to the latter type. In both these types similar variations in regard to other dental characters seem to occur indiscriminately, one of the most noteworthy being that connected with the structure of P_4. While there are many specimens of

P_4 which display quite as simple an inner cusp and quite as open internal valleys as in *Boselaphus*, *Selenoportax* or more primitive boselaphines, on the other hand quite as high and continuous an inner wall may exist as we find in any tragelaphine genus. I cannot resist the conclusion that in the Pontian genus *Tragocerus*, we have just happened to encounter an instance of a form at the most critical stage of a change from a primitive to a progressive type of P_4. The tragelaphines for the most part have passed this stage and the structure of their P_4 has become stereotyped, while most of the Boselaphinae have not yet reached it. Thus, while in certain ways more primitive than other Boselaphinae, yet in this character at any rate *Tragocerus* is more advanced than any of them.

Teeth Referred to *Tragoportax*

Figures 60, 61

Unfortunately the teeth in the holotype of *Tragoportax salmontanus* are so worn down that, beyond their size and the suggestion of similarity to those of *Tragocerus*, no details of their structure are visible. No other specimens in the American Museum help at all. In the Calcutta collections, however, are a few isolated dentitions which may possibly supply the want. These came from the same quarry in which the remains of *Tragocerus punjabicus* have been found. In these the upper molars and in a less degree the upper premolars show certain features which definitely distinguish them from those of *Tragocerus punjabicus* and *browni*. These are: (1) increased hypsodonty; (2) greater strength of the external folds and ribs; (3) fairly rapid increase in antero-posterior diameter from base to summit of crown, correlated with a divergence of the external folds in contrast with *Tragocerus* in which they are parallel along most of the crown and converge only at the very base where they form a kind of cingulum. In these specimens we further observe a greater elongation of the premolar series than in *T. punjabicus*, so as nearly to approach what is the case in *T. browni*. These are points which Borissiak (1914, pp. 129, 131, 134) has emphasized in the case of *Tragocerus leskewitschi*, so that there is some probability that these dentitions may be generically related to the skull of *Tragoportax salmontanus*, which as we have seen is closely allied to the Sebastopol species. As may be seen from the measurements on page 854, they are larger than the teeth in the holo-

type of *Tragoportax salmontanus*, but may reasonably be associated with the numerous skulls and horn-cores in the Calcutta collection, which are certainly larger than the holotype and may represent another race or even species. It is true that the quarry yielded, so far as I am aware, no horn-cores of *Tragoportax*, but horn-cores generally seem for some

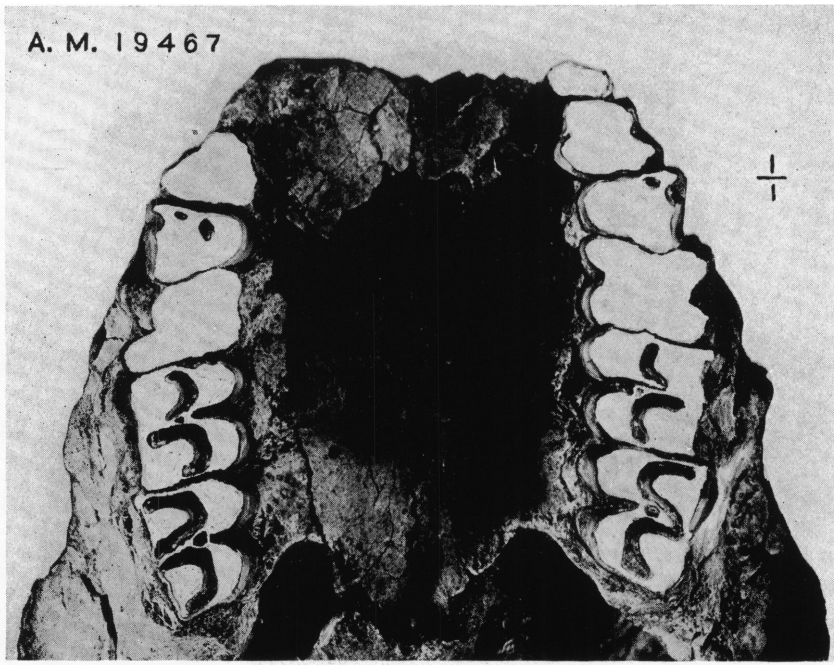


Fig. 60. *Tragoportax salmontanus*, new genus and species. Type, Amer. Mus. No. 19467. Partial skull, from one mile south of Dhok Pathan. Palatal view, showing crowns of cheek teeth. Natural size.

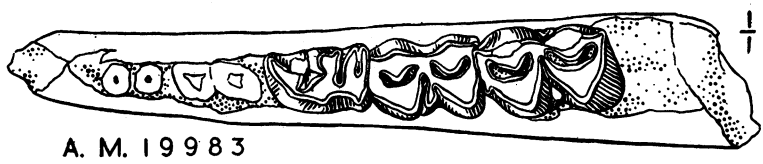


Fig. 61. *Tragoportax* cf. *salmontanus*, new genus and species. Referred left mandibular ramus. Amer. Mus. No. 19983, from four miles east of Dhok Pathan. Crown view. Natural size.

reason to have been very scarce at this site. Nor have I found any specimen of the upper dentition of *Tragoportax salmontanus* amongst the American Museum collection, except that in the holotype skull. The only mandible which agrees at all in size with the upper dentition of the species is a left ramus (Amer. Mus. No. 19983) figure 61, page 834, which came from four miles east of Dhok Pathan. This is rather large for the holotype and might belong to the same species as the upper dentitions mentioned above. It may be observed that the relative length of the premolar series in this is intermediate between that of *Tragocerus browni* and *T. punjabicus*. Further, the P_4 is of a decidedly primitive type, there being open valleys in front of and behind the inner cusp almost to the base of the crown. On the contrary in most if not all of the American Museum rami of *Tragocerus browni*, the inner wall of P_4 is complete up to within a short distance of the summit of the crown.

Teeth Referred to *Gazella*

The American Museum collection contains a few dentitions of *Gazella*, recognized by their small size and resemblance to the mandible of the holotype of *G. lydekkeri*. These are described on pages 806–8.

With the exception of one or two isolated specimens there are no undoubted Middle Siwalik bovid teeth in the American Museum which cannot be referred to one or other of the forms mentioned above.

ANTELOPINE TEETH OF THE LOWER SIWALIKS

The identification of the bovid teeth of the Chinji stage presents a much more difficult problem than in the case of those of the Dhok Pathan stage. The reason for this is easily understandable. There is definite evidence for the association of skulls and upper dentition in the case of no less than five different species of Dhok Pathan antelopes. These dentitions are generally both perfect and well preserved, or at any rate possess characters which render it possible to identify with them the numerous isolated teeth found in the same beds. Moreover the great difference in size between most of the species facilitates the task of identification very considerably, at least in the case of the American Museum collection; there are in Calcutta other species not represented by skulls or horn-cores in the collection with which I am now dealing, to which the above observation does not so strictly apply.

On the other hand there are but two skulls in the Chinji stage which show the dentition, one in New York and one in Calcutta. In the former the teeth are in an advanced stage of wear, and the latter

belongs to a female and does not possess horns. Further it is rare to find complete dentitions either in the upper or the lower series, the teeth though very abundant occurring either singly or united only by twos or threes. Finally there is so little difference in size between the various species of Chinji antelope that we receive no help from this quarter towards the identification of the unassociated teeth or dentitions, of which the bulk of the American Museum collection consists. In these regrettable circumstances I am forced to content myself with figuring and describing, as far as possible, what I consider to be different types of dentition, and at most suggesting the species or genus to which they are, in my opinion, most likely to belong. The difficulty is enhanced by the fact that there are other types of skulls and horn-cores in Calcutta which are not represented in New York, but it cannot be by any means claimed that teeth of these particular species may not occur in the latter collection side by side with those which belong to the skulls which have actually been found by Dr. Barnum Brown. Any names which I have attached to the figured teeth must therefore be regarded as in the highest degree provisional.

Teeth Referred to *Helicoportax*

Figures 62 to 70

The only Chinji skull in the American Museum collection which has the dentition preserved is the holotype of *Helicoportax praecox* (Amer. Mus. No. 19476). Bovid dentitions of this type are apparently the most abundant in the collections from the Chinji stage both in New York and Calcutta. They exist in every stage of wear and every state of preservation. In the holotype of *H. praecox* M^3 is worn down to within 8 mm. of the base of the crown and the other teeth to a proportionately greater extent, while the striae on the enamel are barely distinguishable. In the female skull (Geol. Surv. Ind. No. B576) mentioned on page 747, the teeth are in an earlier stage of wear. A left maxilla (Geol. Surv. Ind. No. B803) belongs to a still younger animal and has the striae on the enamel well preserved. There are numerous immature dentitions, both upper and lower, which may be referred with some degree of probability to *Helicoportax*. These are represented amongst others by a left maxilla with M^1 and MM^4 (Amer. Mus. No. 29909; Fig. 63, page 838); two right rami with M_1 and MM_{3-4} (Amer. Mus. Nos. 19617 and 29995; Fig. 69, page 840); a right maxilla with M^1 and MM^4 and a left ramus with M_1 and MM_{3-4} (Amer. Mus. Nos. 29945 and 29900), which were collected from the same spot three miles west of Chinji Bungalow and probably belong to the same individual.

Of somewhat smaller size than the preceding four are a left maxilla with M^1 and MM^{3-4} (Amer. Mus. No. 29867; Fig. 64, page 838); a left maxilla with M^{1-2}, MM^{3-4} and an isolated P^3–P^4 (Amer. Mus. Nos. 19998

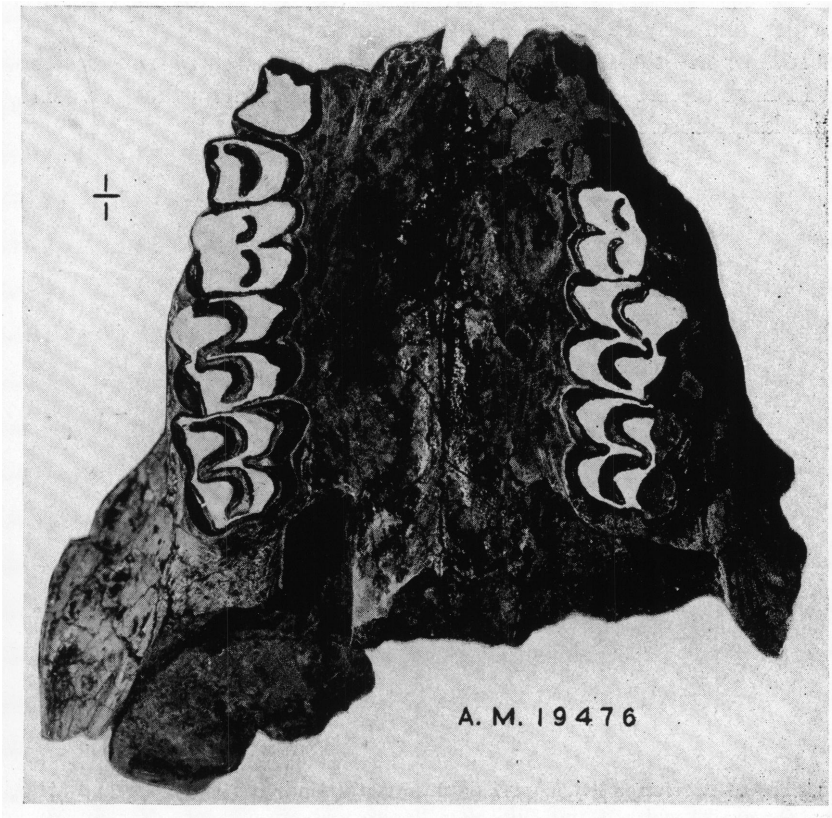


Fig. 62. *Helicoportax praecox*, new genus and species. Type, Amer. Mus. No. 19476. Partial skull from four miles west of Hasnot. Palatal view, showing crowns of cheek teeth. Natural size.

and 19997; Figs. 65 and 66) from the same locality three miles northwest of Chinji Bungalow; a right maxilla with M^1 and MM^4, a defective M^2 and a broken MM^3 (Amer. Mus. No. 29961); a left ramus with M_1 and MM_4 (Amer. Mus. No. 19995; Fig. 67, page 840). Finally a right ramus with M_{1-3} and P_{3-4} (Amer. Mus. No. 29858; Fig. 70, page 841) is referred to *Helicoportax*, since it agrees in size and in the slenderness

of its teeth with the immature teeth of the smaller series, while the advanced structure of its P_4 may be correlated with a type of MM_3 such as we find in them. The smaller series agrees in size with the teeth in the holotype skull of *Helicoportax praecox* as well as the female skull and the left maxilla (Geol. Surv. Ind. No. B803), or are very slightly smaller, and may be referred to that species. The larger series slightly exceeds in size the teeth in the holotype skull of *Helicoportax praecox*, and I have therefore referred them to *H. tragelaphoides*, which is a somewhat larger species than *H. praecox*.

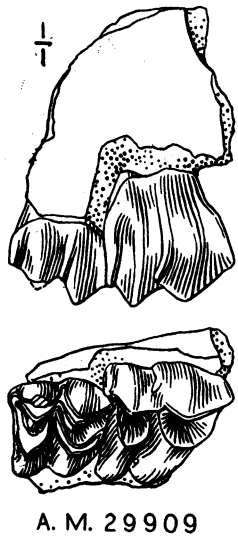


Fig. 63

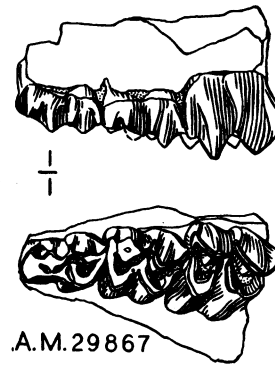


Fig. 64

Fig. 63. (?)*Helicoportax tragelaphoides*, new genus and species. Amer. Mus. No. 29909. A referred left maxilla of an immature individual with M^1 and MM^4, from three miles west of Chinji Bungalow. Outer and crown views. Natural size.

Fig. 64. (?)*Helicoportax praecox*, new genus and species. Amer. Mus. No. 29867. Referred left maxilla of an immature individual with M^1 and MM^{3-4}, from five miles east of Chinji Bungalow. Outer and crown views. Natural size.

The characters of the teeth are far better observed in the immature maxillae and mandibles. The upper molars remind one strikingly of those of *Selenoportax vexillarius* and *lydekkeri*, and in a somewhat less degree of *Boselaphus*, in respect to their structure, though vastly inferior in size. They have the same pronounced neck at the base of the crown, the antero-posterior diameter increasing enormously in the upper two-

thirds of the height. On the other hand, near the summit the outer wall curves over to the inner side, so that the transverse diameter diminishes rapidly. The inner wall of the tooth is straight and not concave, so that the transverse diameter does not decrease rapidly until the uppermost quarter of the height, though the decrease is more than in *Boselaphus* and *Selenoportax lydekkeri*, the resemblance being closer to *Selenoportax vexillarius*. Considering their geological horizon the hypsodonty of the molars is remarkable, as may be seen from the table on page 850. The outer folds and ribs are very strong, the median rib of the posterior

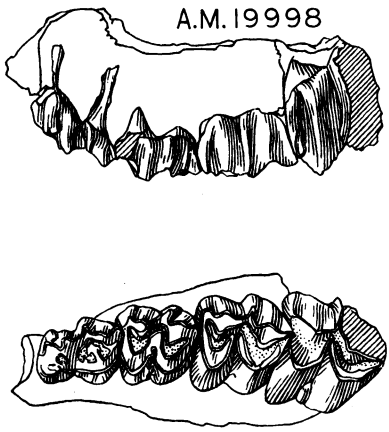


Fig. 65

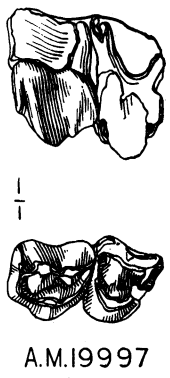


Fig. 66

Fig. 65. (?)*Helicoportax praecox*, new genus, new species. Amer. Mus. No. 19998. A referred left maxilla with M^2–MM^3, from three miles northwest of Chinji Bungalow. Outer and crown views. Natural size.

Fig. 66. (?)*Helicoportax praecox*, new genus, new species. Amer. Mus. No. 19997. Left P^{3-4}, from three miles northwest of Chinji Bungalow. Outer and crown views. Natural size.

lobe being weaker than that on the anterior lobe. Neither of them, however, reaches the base of the crown; nor do the anterior and posterior folds reach the base, the posterior fold particularly ceasing a considerable distance above the base. Median basal pillars are present in M^1 and M^2 of the smaller species, provisionally referred to *H. praecox*. They do not seem to be present in any of the molars of the larger species provisionally referred to *H. tragelaphoides*. The enamel is rather strongly rugose, as is the case in *Boselaphus* and *Selenoportax*. The upper premolars are very similar in structure to those of *Tragocerus* and *Tragoportax*. The anterior and posterior folds are weaker than in

Boselaphus. P^2 is no longer than P^3 but is rather narrower. There are no spurs projecting into the central cavity.

The lower like the upper dentition is exceedingly like that of *Selenoportax*. The lower molars are very hypsodont. There is a decided neck at the base of the crown; above this the antero-posterior diameter increases markedly; on the contrary the transverse diameter is very little greater at the base than in the upper part of the crown, though at the extreme summit there is the same tendency as in the upper molars for the inner wall to curve over towards the outer side. The anterior and

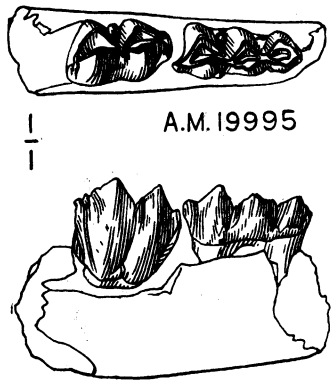


Fig. 67

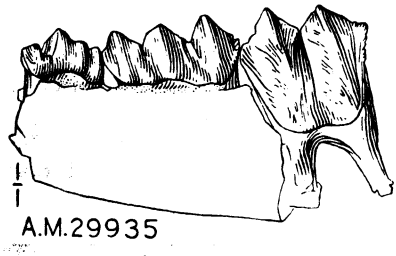


Fig. 68

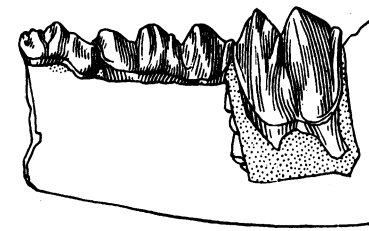


Fig. 69

Fig. 67. (?)*Helicoportax praecox*, new genus and species. Referred left ramus of a young animal, with M_1 and MM_4, Amer. Mus. No. 19995. From one mile west of Chinji Bungalow. Crown and inner views. Natural size.

Fig. 68. (?)*Helicoportax tragelaphoides*, new genus and species, Amer. Mus. No. 29935. Referred right mandibular ramus of a young individual with M_1 and MM_{3-4}, from one and one-half miles northwest of Chinji Bungalow. Inner view. Natural size.

Fig. 69. (?)*Helicoportax tragelaphoides*, new genus and species, Amer. Mus. No. 19617. Referred right mandibular ramus with M_1 and MM_{3-4}, from one and one-half miles west of Chinji Bungalow. Crown and inner views. Natural size.

posterior folds on the inner side are strong and diverge from the base, though they are less prominent than in *Selenoportax*. The center of each lobe is convex with a slight indication of a median rib. There are median basal pillars. The talon of M_3 as seen in Amer. Mus. No. 29858 is broader than in the ramus Amer. Mus. No. 29878 provisionally referred to *Strepsiportax*. In MM_3 as in the corresponding tooth of *Selenoportax* a process runs back from the inner cusp which joins the posterior wing some way above the base. The tooth is, however, more compli-

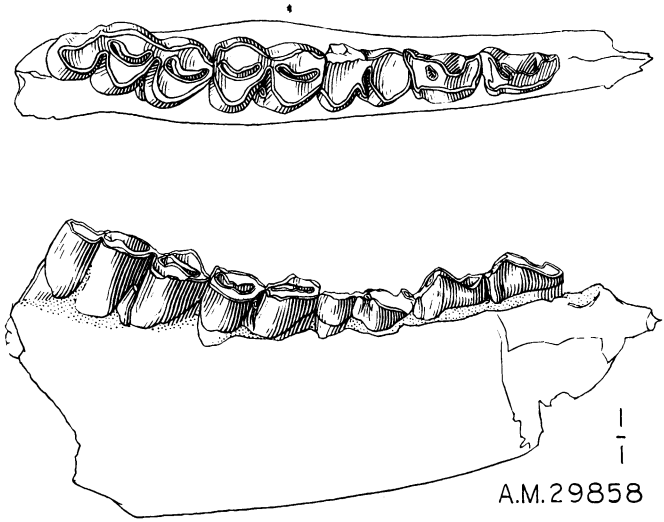


Fig. 70. (?)*Helicoportax praecox*, new genus and species. Amer. Mus. No. 29858. Referred right mandibular ramus with M_{1-3} and P_{3-4}, from one and one-half miles west of Chinji Bungalow. Crown and outer views. Natural size.

cated in *Selenoportax*, since there are two anterior and posterior wings instead of only one as in *Helicoportax*. The same structure is seen in P_4 of the ramus Amer. Mus. No. 29858, Fig. 70, except that the union between the inner cusp and the posterior wing takes place earlier. In any case there is an open valley in the anterior part of P_4 unlike what is the case in the living Tragelaphinae.

Teeth Referred to *Sivaceros*

Figure 71

Several isolated upper molars in Calcutta and a few in New York are about the same size as those referred to *Helicoportax*, and have equally strong outer folds and ribs, but are much more brachyodont.

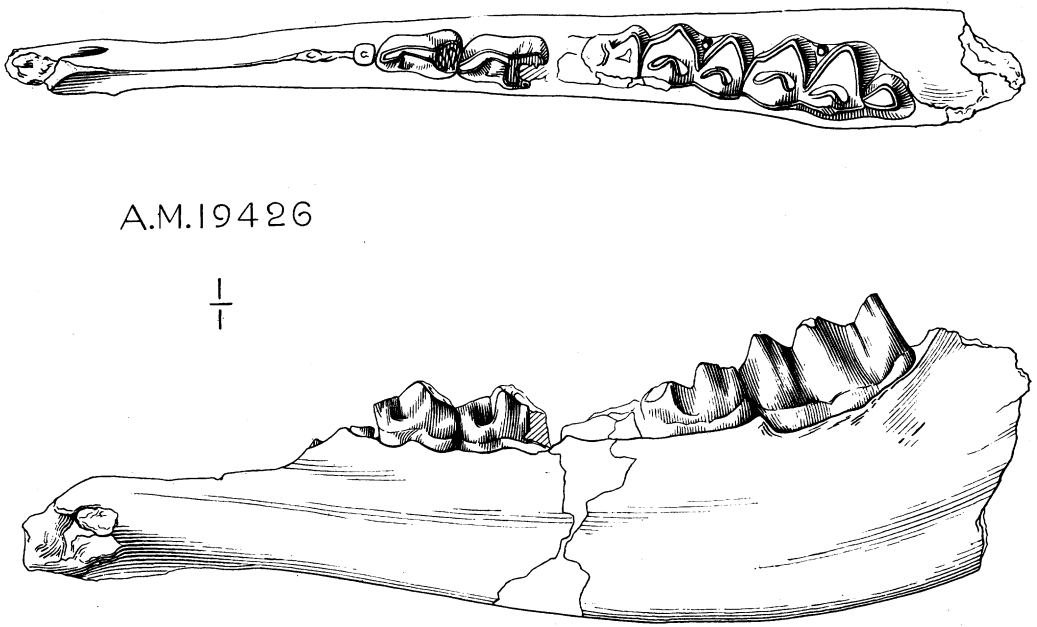


Fig. 71. *Sivaceros gradiens*, new genus and species. Amer. Mus. No. 19426. A referred right mandibular ramus with M_3–P_3, from twelve miles east of Chinji Bungalow. Crown and inner views. Natural size.

On the analogy of the upper molars of *Graecoryx valenciennesi*, a genus which is probably allied to *Sivaceros*, it is suggested that these teeth may belong to the latter genus, since these are the characters found in the upper molars of *Graecoryx*. It is also possible that a ramus (Amer. Mus. No. 19426) with the cheek dentition complete except for P_2, which is only known by the roots, also belongs here. The great length of P_2 and of the premolar series generally, relative to that of the molar

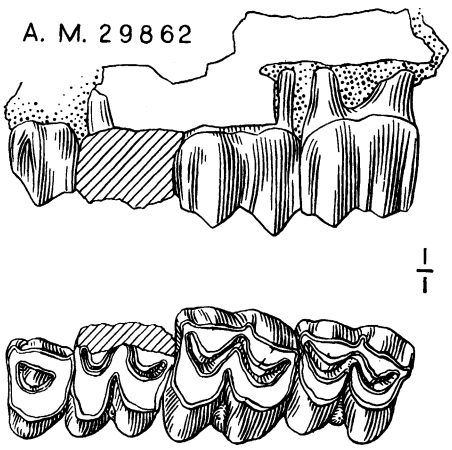


Fig. 72. (?)*Strepsiportax* sp. Amer. Mus. No. 29862. Referred left maxilla with M^{1-3} and P^4, from three miles northwest of Chinji Bungalow. Outer and crown views. Natural size.

series, suggests a resemblance to *Graecoryx*. Damage to the wall of P_4 does not permit of exact observation as to how far down the posterior valley extended, but in any case the backward extension of the inner cusp was obviously greater than in Amer. Mus. No. 19578 referred to *Strepsiportax*. In P_3 it is united to the two posterior wings. The talon of M_3 is rather long. There are median pillars in the valleys of all the molars.

Teeth Referred to *Strepsiportax*

Figures 72 to 75

A left maxilla with M^{1-3} and P^4 (Amer. Mus. No. 29862), from three miles northwest of Chinji Bungalow, probably at the upper Chinji level, shows a different type of dentition from what has been described above. This is figured above as figure 72. The upper molars are distinguished from those referred to *Helicoportax* by their somewhat shorter crowns, a less pronounced neck, weaker and more parallel outer folds, which

persist to the base of the crown. There are well defined median basal pillars on the inner side. The enamel is rugose. In P^4 the median rib and the anterior outer fold are stronger than in the molars. These are in some degree the characters of the teeth of *Pachyportax latidens*, except that in the latter the outer folds and the median rib of the anterior lobe are very much stronger. The present maxilla might conceivably belong

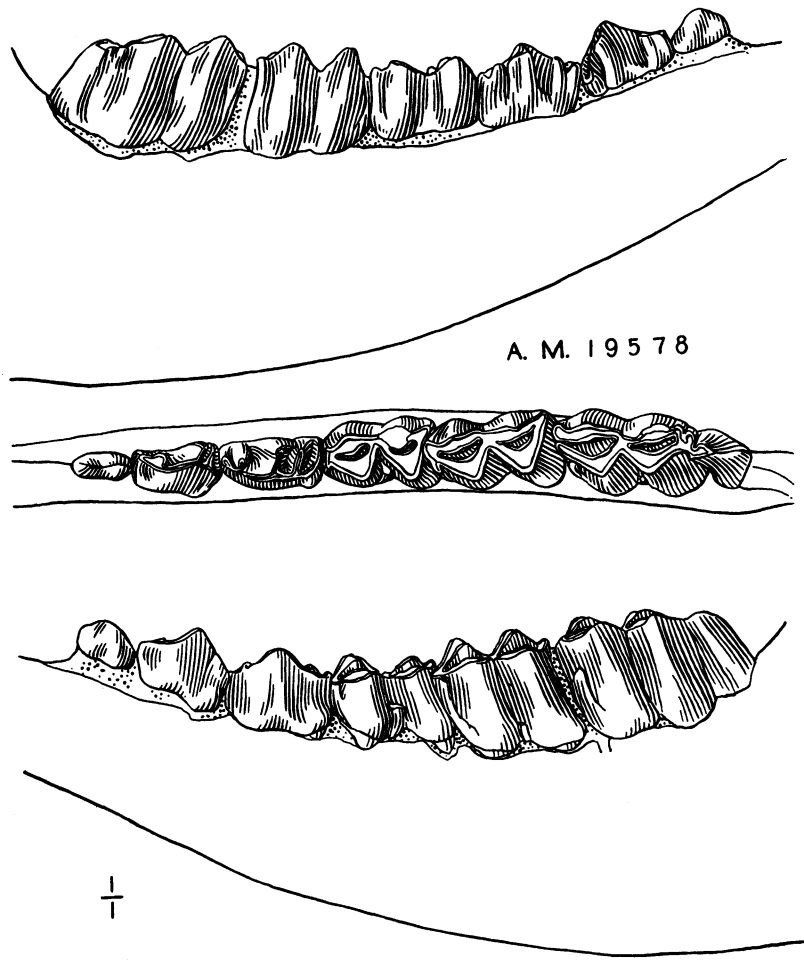


Fig. 73. (?)*Strepsiportax* sp. indet. Amer. Mus. No. 19578. A referred left mandibular ramus, with M_{1-3}–P_{2-4}, from one and one-half miles northwest of Chinji Bungalow. Inner, crown and outer views. Natural size.

to a smaller species of *Pachyportax* in which the teeth are in a more primitive stage of development. It happens, however, that there is a maxilla in Calcutta from the Nagri stage (Geol. Surv. Ind. No. B808), which is much larger than Amer. Mus. No. 29862, in fact almost intermediate in size between it and *Pachyportax latidens* var. *dhokpathanensis*,

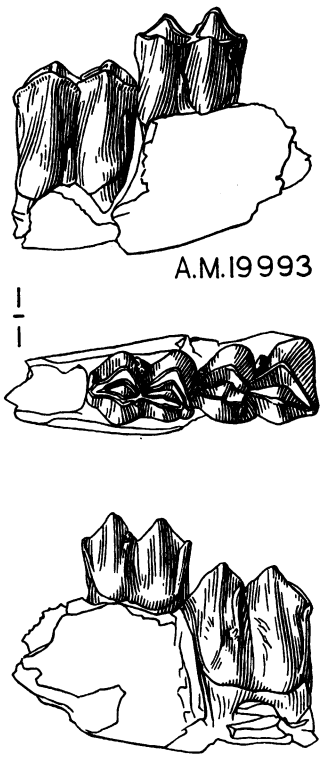


Fig. 74. (?)*Strepsiportax* sp. indet. Amer. Mus. No. 19993. A referred right mandibular ramus of a young individual, with M_{1-2}, from thirteen miles east of Chinji Bungalow. Outer, crown and inner views. Natural size.

though the molars are almost a replica in miniature of those of the Dhok Pathan species, in particular with regard to the strength of the outer folds and of the fold on the inner side of the outer crescents, and to the large size of the median inner basal pillars. There is also an occiput in Calcutta from the Nagri stage (Geol. Surv. Ind. No. B560) which in some ways reproduces the characters of *Pachyportax latidens* and corresponds in size with the maxilla (Geol. Surv. Ind. No. B808). This seems to make it more likely that the Chinji maxilla belongs to *Strepsiportax*, the affinity of which to *Pachyportax* is undoubtedly close. It is perhaps rather

large for the holotype of *Strepsiportax gluten*, but an occiput in Calcutta from the Chinji stage (Geol. Surv. Ind. No. B562) differs only in minor details from *Strepsiportax gluten* and might without difficulty be referred to the same species as the maxilla Amer. Mus. No. 29862. It is worth noting that the molars of the American Museum maxilla resemble more closely those of *Tragocerus* than those of *Helicoportax*, *Selenoportax* and *Boselaphus* though the folds are less prominent. This fact equally tells in favor of the reference suggested, since as has been mentioned above (pages 757 and 772–3), both *Protragocerus* and "*Tragocerus*" *lati-*

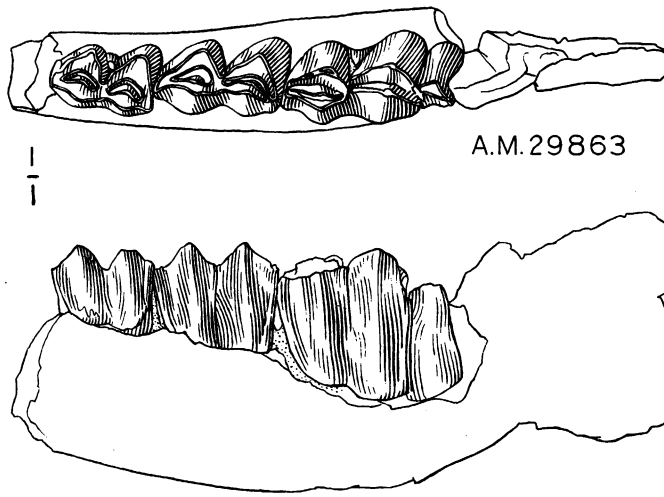


Fig. 75. (?)*Strepsiportax* sp. indet. Amer. Mus. No. 29863. A referred right mandibular ramus with M_{1-3}, from one and one-half miles west of Chinji Bungalow. Crown and inner views. Natural size.

frons show a closer affinity to *Strepsiportax* than to the other three genera named. There are at any rate no other boselaphine upper teeth from the Chinji stage, which differ sufficiently from those of *Helicoportax* to enable me definitely to refer them to another genus, nor are there any small teeth of a tragocerine type which we might suppose to be those of *Strepsiportax*, although several worn and isolated upper molars might belong here rather than to *Helicoportax*. In the circumstances the provisional reference of the maxilla Amer. Mus. No. 29862 to *Strepsiportax* seems to be justified.

A left ramus with the complete but rather worn down cheek dentition

(Amer. Mus. No. 19578; figure 73), may be provisionally referred to *Strepsiportax*, since it seems to differ in certain particulars from mandibles of *Helicoportax*. The molars are quite hypsodont and slender, but are longer. M_3 has a narrower talon. P_4 is longer, with a strong inner cusp which does not possess the backward process of the P_4 referred to *Helicoportax*, so that the posterior valley is more open. The anterior valley is very long. There are two anterior and two posterior wings. Certain other lower dentitions, of which Amer. Mus. Nos. 19993 and 29863, figures 74 and 75, may be taken as examples, seem to agree with Amer. Mus. No. 19578 and may equally be referred to *Strepsiportax*.

Teeth Referred to *Gazella*

Figure 76

Another type of upper molar represented by a left maxilla with two molars, probably M^1 and M^2 (Amer. Mus. No. 29908), is figured on page 848, figure 76. The appearance of the teeth is quite gazelline, but in size they vastly exceed those of *Gazella lydekkeri*, or of any species which may have possessed the small gazelline horn-cores from the Chinji stage, which occur in the American Museum collection. They are quite as large as those of the large living African gazelles *G. sommeringi* and *G. granti*. There are, however, gazelline frontlets in Calcutta, which are large enough to belong to the teeth in question, so that consideration of size need not deter us from assigning the maxilla to some gazelline genus. The teeth are quite as hypsodont as those of *Helicoportax*, but differ from them in several particulars. Their transverse diameter is large at the base but diminishes rapidly, so that it is small at the summit, and the inner wall is concave instead of straight as in *Helicoportax*. The neck is much less pronounced, so that the folds do not diverge so much, nor does the antero-posterior diameter increase suddenly in the upper half of the crown as is so markedly the case in *Helicoportax*, *Selenoportax* and *Boselaphus*. The folds and ribs on the outer side are much weaker than in *Helicoportax* the median rib of the posterior lobe being practically absent, while the folds at the two ends of the tooth are also very weak, as in *Gazella*. The enamel is rugose, and basal pillars are present in the median valleys of both molars.

There is a maxilla (Geol. Surv. Ind. B805) of a somewhat larger species from the Middle Siwaliks in Calcutta, which shows the same characters, only there are no basal median pillars. In this specimen the median external rib of the anterior lobe of the molars and that in the

anterior portion of P^4 are remarkably strong, and probably the same is the case in Amer. Mus. No. 29908, if its rather defective state of preservation allowed the surface of the molars to be clearly defined.

This latter character is unlike the large living African gazelles, but agrees with the smaller Asiatic species. The transverse broadening of the molars near the base distinguishes *Gazella* from *Antilope* and *Aepyceros*, and the character is more marked in the earlier than in the later species of *Gazella*. The tragocerines have more brachyodont teeth than the

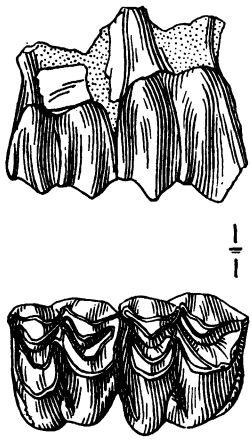


Fig. 76. Gazelline, genus and species indet. Amer. Mus. No. 29908. A left maxilla with M^{1-2}, from four miles west of Chinji Bungalow. Crown, inner and outer views. Natural size.

ones we are now considering, and in both of them as well as in *Pachyportax* the folds and ribs of the molars are stronger.

Both the Indian maxillae probably represent one or more rather precocious gazelline lineages, which ended in the Pontian, and which, though doubtless more closely related to the Asiatic than to the African gazelles, are yet generically distinct from both. The question will be more fully considered when I come to deal with the gazelline frontlets in the Calcutta collection.

Teeth of Questionable Reference

Figure 77

There are several mandibular rami from the Chinji stage, of which the one in figure 60 is typical, which do not seem to find a place in any of the genera so far described. The original of figure 77 is a right ramus with M_{2-3} and P_4 (Amer. Mus. No. 29905) from four miles west of Chinji Bungalow. This is smaller than any of the other mandibles described above and is too large for *Gazella*. It is characterized by the small length

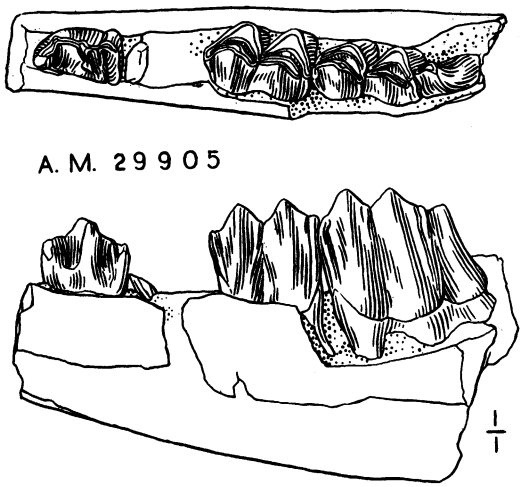


Fig. 77. (?)Tragelaphine, genus and sp. indet. Amer. Mus. No. 29905. A right mandibular ramus with M_{2-3}–P_4, from four miles west of Chinji Bungalow. Crown and inner views. Natural size.

of M_3 relative to the front molars. This is especially noticeable in the talon which is extremely short and slender. The lower molars are narrow, rather brachyodont, but with a neck and distinctly divergent lateral folds. The median ribs on the internal side of the lobes are weak. There are median basal pillars in the external valleys. P_4 is extremely simply constructed with one anterior wing and two posterior wings—separate at the summit of the crown but fused into one a considerable distance above the base; the inner cusp slopes backward as in *Helicoportax* and *Selenoportax*, but is not united to the posterior wing, so that there are both anterior and posterior open valleys. This structure distinguishes it from the known Tragelaphinae, and from *Palaeoreas lindermayeri*,

to which the narrow molars and the short talon of M_3 give it a resemblance. The teeth of *Palaeoreas* are also more hypsodont. All the same these rami might be those of a primitive tragelaphine, of which skulls undoubtedly exist in the Calcutta collection. They might also conceivably belong to the genus *Sivaceros*, representing a smaller species than *Sivaceros gradiens*.

TABLES OF MEASUREMENTS

Ratio of Height of Crown to Antero-Posterior Diameter of Upper Molars of Siwalik and Other Antelopes

	Selenoportax lydekkeri M^2 of type, G. S. I., B213	*Selenoportax vexillarius* M^1 G. S. I., B569	*Pachyportax latidens* M^3 G. S. I., B801	*Boselaphus tragocamelus* M^3	*Helicoportax* cf. *tragelaphoides* M^1 A. M. 29909	*Tragoportax* aff. *salmontanus* M^2 G. S. I., B795	*Tragocerus* cf. *punjabicus* M^3 G. S. I., B800	*Graecoryx valenciennesi* M^3 Br. Mus. M12995	*Gazella lydekkeri* M^3 A. M. 19663
Antero - posterior diameter (measured halfway up the crown)	29	22	27.5	26	14	16	21	17.5	15
Height of unworn crown	45	30	36.5	37	17	18	20	16	app. 15
Ratio $\frac{\text{Height of crown}}{\text{Ant.-post. diam.}} \times 100$	155	136	133	142	121	112	105	91	100

Measurements of Upper Teeth of *Selenoportax* and *Pachyportax* (transverse diam. measured at the maximum; ant.-post. diam. measured about halfway up the height of unworn crown)

		Selenoportax lydekkeri							*Selenoportax vexillarius*		*Pachyportax latidens*					*Pachyportax latidens* var. *dhokpathanensis*	
		G. S. I. B213	A. M. 19933	A. M. 29846	A. M. 19986	A. M. 29911	A. M. 19714	A. M. 29912	A. M. 19844	G. S. I. B569	G. S. I. B219	A. M. 29914	A. M. 29964	A. M. 29913	A. M. 19730	G. S. I. B218	A. M. 19841
M^3	Ant.-post. diam.		31								34.5	36		31	29.5	28.5	27.5
	Trans. diam.		28								28	34		29	27	27.5	25
M^2	Ant.-post. diam.	29	30	28	29				25.7		26.5		28		28.5	25	25
	Trans. diam.	27.5	30.5	28.5	27				24				25		28.5	26	26
M^1	Ant.-post. diam.	28		27						22						21	21?
	Trans. diam.	25?		27.5						23						23	24
P^4	Ant.-post. diam.					18										16	
	Trans. diam.					20										19.5	
P^3	Ant.-post. diam.						19.5	20.5								19	
	Trans. diam.						16	16.5								19	
MM^4	Ant.-post. diam.	23	20.5							18.5							
	Trans. diam.	22	21.5							19							
MM^3	Ant.-post. diam.	24															
	Trans. diam.	18.5															
MM^2	Ant.-post. diam.	21.5															
	Trans. diam.	13															

Measurements of Lower Teeth of *Selenoportax* and *Pachyportax*

		Selenoportax lydekkeri							*Selenoportax vexillarius*					*Pachyportax latidens*
		G. S. I. B211	A. M. 19908	A. M. 19981	A. M. 19957	A. M. 29916	A. M. 29966	A. M. 19732	G. S. I. B793	A. M. 19844	A. M. 19514	A. M. 29946	A. M. 29917	G. S. I. B268
M_3	Ant.-post. diam.		37.5			37.5	39		38		33			
	Trans. diam.		19.5			20.5	18		19		?15			
M_2	Ant.-post. diam.			32.5					28	25.9	24		21	29
	Trans. diam.			19					18	16.5	?15		15	18
M_1	Ant.-post. diam.	25			28.5				21	24.5	21		18	24
	Trans. diam.	17			18.5				17	14	14		13	10
P_4	Ant.-post. diam.								21		21.5	21	?17	
	Trans. diam.								13		11	11	10	
P_3	Ant.-post. diam.								21.5					
	Trans. diam.								12.5					
P_2	Ant.-post. diam.								?18					
	Trans. diam.													
MM_4	Ant.-post. diam.	30.5						32.5						
	Trans. diam.	14						14.5						
MM_3	Ant.-post. diam.	20.5						19.5						
	Trans. diam.	10						9.5						

Localities of the Specimens Mentioned Above

Upper Teeth

A. M. 19933.	2 m. E. of Hasnot.
A. M. 29846.	2 m. N. E. of Hasnot.
A. M. 19986.	3 m. E. of Dhok Pathan.
A. M. 29911.	1 m. N. of Hasnot.
A. M. 19714.	4 m. W. of Dhok Pathan.
A. M. 29912.	4 m. W. of Dhok Pathan.
A. M. 19844.	3 m. E. of Dhok Pathan.
A. M. 29914.	1 1/2 m. N. E. of Hasnot.
A. M. 29964.	2 m. N. E. of Hasnot.
A. M. 29913.	1 m. N. of Hasnot.
A. M. 19730.	1 m. S. of Padhri nr. top of Mid. Siwalik.
A. M. 19841.	4 m. W. of Dhok Pathan.

Lower Teeth

A. M. 19908.	2 1/2 m. N. of Hasnot.
A. M. 19981.	2 1/2 m. W. of Hasnot.
A. M. 19957.	2 m. W. of Hasnot.
A. M. 29916.	4 m. E. of Dhok Pathan.
A. M. 29966.	3 m. N. of Hasnot.
A. M. 19732.	1/2 m. S. E. of Hasnot.
G. S. I. B793.	Hasnot.
A. M. 19514.	1 m. W. of Hasnot.
A. M. 29946.	4 m. N. E. of Chinji Bungalow.
A. M. 29917.	1 1/2 m. E. of Hasnot.
A. M. 29913.	1 m. N. of Hasnot.
G. S. I. B268.	Niki.

Measurements of Upper and Lower Teeth of *Tragocerus* and *Tragoportax*

		Tragocerus browni		*Tragocerus punjabicus*		*Tragoportax salmontanus*				
		Type skull, A. M. 19662	Referred mandible, A. M. 29884	Type skull, G. S. I. B486	Referred mandible, G. S. I. B820	Type skull, A. M. 19467	Referred mandible, A. M. 19983	*Tragoportax* sp., maxilla, G. S. I. B792	"*Tragocerus*" *leskewitschi* upper teeth	*Tragocerus amalthea*, upper teeth
M_3^3	Ant.-post. diam.	21	25.5	20	25	18			16.5–19	20
	Trans. diam.	20	12	18.5	12	19			17 –18	20
M_2^2	Ant.-post. diam.	20	19	20	20	15	17.5	19	15 –18	21
	Trans. diam.	20	12	20	14		11.5	19.5		
M_1^1	Ant.-post. diam.	18	16	18	17	12	13.5	15	13.5–16.5	18
	Trans. diam.	18	11	18	11		11	17		20
P_4	Ant.-post. diam.	12.5	15.5	11	16	11	13.5	12	11 –12	13
	Trans. diam.	17	9	15.5	9.5	14.5	8.5	15.5	12.5–14	17
P_3	Ant.-post. diam.	15	15	14.5	15	14.5	app. 11	13	13 –13.5	16
	Trans. diam.	17	8	12	9	14.5		12	11 –13.5	
P_2	Ant.-post. diam.	15.5	11.5	17	10.5		app. 8.5	14	13 –14	16
	Trans. diam.	12.5	6	11	7			10.5	10 –11	12
Length of molar series		54	?61	57	62	47.5				
Length of premolar series		46	?42	44	40	36				
Ratio of molar length to premolar length		1.17	?1.45	1.29	1.55	1.32				

Measurements of Upper and Lower Teeth and Mandible of *Gazella lydekkeri*

Holotype (Amer. Mus. No. 19663)

		Upper Dentition	Lower Dentition
M_3	Ant.-post. diam.	15	17.5
	Trans. diam.	11	7
M_2	Ant.-post. diam.	13.5	13
	Trans. diam.	11.5	7.5
M_1	Ant.-post. diam.	11	10
	Trans. diam.	11	6.5
P_4	Ant.-post. diam.	7	9.5
	Trans. diam.	9	5
P_3	Ant.-post. diam.	8	8.5
	Trans. diam.	7	5
P_2	Ant.-post. diam.	10	6
	Trans. diam.	7	3.7

Length of upper molar series 36. Length of upper premolar series 26.
Ratio: 72
Length of lower molar series 41. Length of lower premolar series 23.
Ratio: 56
Length of mandible from front edge of incisors to hinder border of angle 140.
Distance between hinder edge of M_3 to anterior mental foramen 86.
Depth of ramus below M_3 (inside) 23; below M_1 (inside) 19.
Diastema between P_2 and canine 32.

Skull Measurements of Middle and Lower Siwalik Antelopes

	Gazella lydekkeri ♂ type A. M. 19663	*Gazella lydekkeri* ♀ A. M. 19664	*Sivaceros gradiens* type A. M. 19448	*Sivaceros* sp. G. S. I. B796	*Tragocerus browni* type A. M. 19662	*Tragocerus punjabicus* type G. S. I. B486	*Tragoportax salmontanus* type A. M. 19467	*Tragoportax* aff. *salmontanus* G. S. I. B565 and 802	*"Tragocerus" latifrons* Sickenberg	*Strepsiportax gluten* type A. M. 19746	*Strepsiportax chinjiensis* type A. M. 19450	*Pachyportax latidens* var. *dhokpathanensis* type G. S. I. B489	*Helicoportax praecox* ♂ type A. M. 19476	*Helicoportax* cf. *praecox* ♀ G. S. I. B576	*Helicoportax tragelaphoides* ♂ type G. S. I. B797	*Helicoportax* cf. *tragelaphoide* ♀ A. M. 19654	*Selenoportax vexillarius* type A. M. 19748
1. Length from occipital condyles to front edge of premaxillae	185																
2. Distance from a point level with middle of orbit to summit of occipital crest	78		89	85	129	127		?115	114	97		144		75		?77	107
3. Distance from fronto-parietal suture to summit of occipital crest	53			66	75	81			77	61		89		57		59	?65
4. Distance from parietal-supra-occipital suture to summit of occipital crest	17		24	25	25	24			26	20		32		20		?20	?26
5. Distance from fronto-nasal suture to level of anterior edge of orbit				?22	?33	?32			22	?12	?6						
6. Distance from fronto-nasal suture to fronto-parietal suture						116				72				56			

7. Breadth of skull at mastoid ..	60		?69	67	87	93		?106	91	79		143		65		66	120	
8. Breadth of brain case.....	58		63	58	70	70	78	65	74	62		91		55		60	93	
9. Breadth of skull at orbits	79	?65	94	84	117	108	123		122	106	108	157	?113	?72		92	?139	
10. Breadth of palate at M^3.....		27			42.5	44	43						38+					
11. Height of occipital from bottom of condyles to summit of occipital crest.....	60		53	50	82	65		?65	56	49		97		39		45	?75	
12. Height of face at M^3.....	45				81	88												
13. Distance between outer edges of occipital condyles.....	35		42	43	60	57		67	49	46		82		39		39		
14. Distance between supraorbital pits.....	27			?31	36	35	46		46	42	40	60	53	?38			54	
15. Vertical diameter of orbit....	28				35	41				36								
16. Horizontal diameter of orbit.	34			?41	46	46	?44			35								
17. Estimated length of horn-core, measured along posterior edge	100		170	?150	265		150	210	160	180			200		225		315	
18. Longitudinal diam. of horn-core at base.....	26		40	29	65	71	43	51	55	37	33	56	34		43		51	
19. Transverse diam. of horn-core at base.....	21		24	22	36	36	33	38	28	24.5	26	42	28		29		34	
20. Minimum distance apart of horn-cores, just above the frontal swelling.....	18		41	31	28	13	50	?23	53	68	55	68	56				76	
21. Angle between frontal and parietal planes.....	35°			38°	28°	40°	40°		33°	15°		25°		20°			20°	
22. Angle between direction of horn-core near base and plane of occiput.....	60°		63°	47°	45°	70°	40°		70°	35°		45°					73°	
23. Diverging angle of horn-cores near base.....	15°		13°	10°	50°	45°	36°		43°	50°		60°	45°		?100°		105°	
24. Length of upper molar series.	36	34			54	57	47.5						42	43				
25. Length of upper premolar series.....	26	22.5			46	44	36							34				
Ratio No. 2: No. 8 × 100.....	134		141	146	184	181		177	154	156		158		136		128	115	
Ratio No. 7: No. 11 × 100....	100		130	134	106	143		?162	162	161		147		166		147	?160	
Ratio No. 9: No. 8 × 100.....	136			150	167	154	158		165	171		172	?174	?131		153	?149	

Measurements of Upper and Lower Teeth of Antelopes from the Lower Siwaliks

		Upper Dentition								Lower Dentition						
		A. M. 19476 type skull	A. M. 19998	*Helicoportax* cf. *praecox* A. M. 19997	A. M. 29867	*Helicoportax* cf. *tragelaphoides* A. M. 29909	A. M. 29945	(?) *Strepsiportax* sp. A. M. 29862	Gazelline gen. and sp. indet. A. M. 29908	A. M. 19995	*Helicoportax* cf. *praecox* A. M. 29858	*Helicoportax* cf. *tragelaphoides* A. M. 29935	A. M. 19578	(?) *Strepsiportax* sp. A. M. 19993	A. M. 29863	(?) *Sivaceros* cf. *gradiens* A. M. 19426
M_3^3	Ant.-post. diam.	16.8						16	16		22		23		23	21
	Trans. diam.	17.2						16?	16.5		9.5		10.5		10	11
M_2^2	Ant.-post. diam.	15.6	14.5					16	15		14	15	15.5	16.5	15	13.5
	Trans. diam.	17.2	14.5					18	15.5		10	9	11	11	10.5	10.5
M_1^1	Ant.-post. diam.	12.5	13		13	17	15	13		13.5	11.5		14	14.5	13	?13.5
	Trans. diam.	15.5	13		13	17	15	15		8.5			9.5	9	10	8.5
P_4^4	Ant.-post. diam.	9.5		?9.5				9.5			10.5		13.5			13
	Trans. diam.	13						13			7.5		8			7.5
P_3^3	Ant.-post. diam.	12?		10.5							9.5		12			1
	Trans. diam.	11.5		10							6.5		7.5			71
P_2^2	Ant.-post. diam.												8			?8
	Trans. diam.												4			
MM^4	Ant.-post. diam.		10.5		11	14	12			16						
	Trans. diam.		10.5		10.5	14	13			7.5						
MM^3	Ant.-post. diam.		12		11.5											
	Trans. diam.		9		8.5											

ANTELOPINE SKELETAL PARTS FROM THE SIWALIKS

Entire bones of the skeleton of antelopes are of as rare occurrence in the Siwaliks as complete skulls and maxillae. There is absolutely no evidence of association, and we have even less to guide us in identifying them than in the case of dentitions. It may, however, be of some use, in view of future finds, to place on record descriptions and figures of the most perfect ones which have been collected. It will be readily understood that the identifications suggested are only provisional.

(?) **Pachyportax latidens dhokpathanensis,** new subspecies

The only specimen of a limb of an antelope from the Siwaliks which at all approaches completeness is that mentioned by Lydekker (1884, p. 116; 1885, p. 19) as contained in the Calcutta collection of the Geological Survey of India registered No. B268. He referred it to *Boselaphus* sp., without either figure or description other than that it was the nearly complete right forelimb and that associated with it were a mandibular ramus and an axis vertebra. The association of the two last-named parts with the limb bones must be viewed with suspicion, since the vertebra is too small to have belonged to the same individual as the limb, and the proximity of the ramus may have been equally fortuitous, although it corresponds in size with the limb. The forelimb, as it exists at present, lacks all the carpal bones, the proximal half of the humerus and the phalanges of the inner side. The specimen came from the Dhok Pathan stage of Niki in the Salt Range area. I propose to figure and describe it fully in a subsequent memoir, so that it will suffice to say at present that all these bones are relatively more robust even than in *Taurotragus* and very much more so than in *Boselaphus*. Further, the metacarpals are very much longer proportionately to the length of the radius than in *Boselaphus* or any of the tragelaphines, and are only approached by *Tetraceros*. In *Cephalophus* and *Gazella* they are even longer. The latter character precludes an identification with a primitive buffalo. The only two Middle Siwalik antelopine species to which on account of their size the forelimb might be attached are *Selenoportax vexillarius* and *Pachyportax latidens dhokpathanensis*. The latter species on account of its massive skull is more likely than the former to have had such stout limbs. Another line of reasoning possibly gives a similar indication. We gather from Borissiak's measurements of *Tragocerus leskewitschi* that the metacarpals of that species were equally long as contrasted with the normal *Tragocerus*, in which they are even shorter than in *Boselaphus*. Since *Tragocerus leskewitschi* appears to be allied to *Trago-*

portax salmontanus, while the latter species in its turn affords a passage into *Pachyportax*, I am inclined to infer that the metacarpals of *Pachyportax* were probably also long. On the contrary the closer affinity of *Selenoportax* to *Boselaphus* suggests that its metacarpals were shorter than is the case in Geol. Surv. Ind. B268.

Assuming that the upper molar series is approximately of the same length in *Selenoportax vexillarius* and *Pachyportax latidens* var. *dhokpathanensis*, we may draw a comparison between the radius of *Boselaphus* and the fossil one, adopting as a standard the length of the upper molar series. On this basis of calculation the fossil radius is relatively longer than that of *Boselaphus*, and since this difference from *Boselaphus* is more likely to exist in *Pachyportax* than in *Selenoportax*, we may infer that there is a greater chance that the radius of Geol. Surv. Ind. B268 belongs to the former of these two genera. In conclusion we may say that probably *Pachyportax* possessed long, stoutly built limbs and particularly long metacarpals and metatarsals, while *Selenoportax* possessed shorter, slenderer limbs and more normal metacarpals and metatarsals. This assumption will be used in the provisional identification of certain bones in the American Museum collection.

(?) **Tragoportax salmontanus,** new genus and species

Figure 78

The right metatarsals (Amer. Mus. No. 29821) from the Dhok Pathan stage one-half mile southwest of Dhok Pathan (figure 78).

DIMENSIONS

Length	219.9 mm.
Diameter at middle of shaft	21 mm.
Diameter at distal end	34.5 mm.

This bone belonged to an adult individual, so that its absolute size enables us to narrow down very considerably the Dhok Pathan species of antelope with which an identification is possible. Not only is it far too small for the Dhok Pathan species of *Selenoportax* and *Pachyportax*, but it is also too small for *Tragocerus punjabicus* and *browni*, judging by the length of the metatarsals of *Tragocerus amalthea* as given by Gaudry (1865, p. 283), i.e., 270 mm. It is too large for *Gazella lydekkeri* and its stouter build precludes our assigning it to any species allied to *Gazella*, even the much larger *G. porrecticornis*. Of the Middle Siwalik antelopes so far known, *Tragoportax salmontanus* or a larger species of *Tragoportax* represented by numerous skulls and horn-cores in the Calcutta collection

agrees very nearly with it in size. If we suppose that the metatarsal length in *Tragoportax salmontanus* is the same as in *Tragocerus amalthea* relative to the lengths of the upper molars, we obtain a length of 217

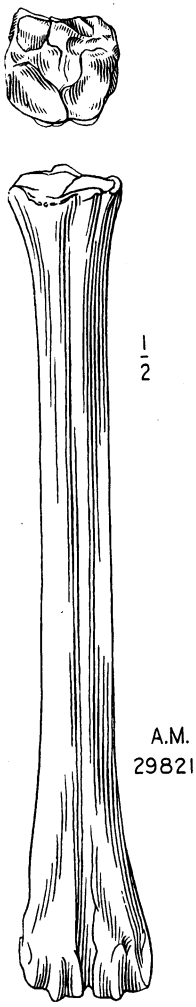


Fig. 78. (?)*Tragoportax salmontanus*, new genus and species. Amer. Mus. No. 29821. Referred right metatarsal bones, from half a mile southwest of Dhok Pathan. Proximal and dorsal views. One-half natural size.

mm. for *Tragoportax salmontanus*. This is 3 mm. less than the length of Amer. Mus. No. 29821, but since this may have belonged to a larger individual or species than the holotype of *T. salmontanus*, and since in addition we have reason to believe that the metatarsals of *Tragoportax* on the

analogy of *T. leskewitschi* were probably longer than in *Tragocerus amalthea*, the agreement is close enough to justify us in provisionally assigning this bone to *Tragoportax salmontanus*.

From the ratios of length to diameter at middle of shaft given in the table for certain species, it will be seen that the metatarsals are more robust than in *Tragocerus amalthea* and *Boselaphus*, but apparently less robust than in *Taurotragus* and *Pachyportax*, on the assumption that the right forelimb (Geol. Surv. Ind. No. B268) belongs to the latter genus, while they agree closely with those of *Tragocerus leskewitschi*.

	Tragocerus leskewitschi	*Tragocerus amalthea*	*Taurotragus*	*Tragelaphus buxtoni*	*Boselaphus*	*Pachyportax* (metacarpals)	Amer Mus. No. 29821
Length of shaft	209	270	307	...	257	...	220
Diameter at middle of shaft	20	23	32	...	22	...	21
Ratio	10.4	11.7	9.6	...	11.7	8.7	10.5

There seem to be no special features about the conformation of the metatarsals except the presence of a furrow on the dorsal side, which *Tragocerus amalthea* does not possess but which Borissiak mentions in *Tragocerus leskewitschi*.

(?) **Helicoportax praecox,** new genus and species

Figure 79

A left tibia (Amer. Mus. No. 19729) is from four and one-half miles west of Hasnot. This locality seems to be almost on the boundary between the Chinji and Nagri stages but may perhaps be considered as uppermost Chinji, since it can hardly be put into the Middle Siwaliks, judging from the boundaries as indicated on the geological map (Pilgrim, 1913, Pl. XXVIII). It is the same locality from which the holotype skull of *Strepsiportax gluten* was collected and not far below the level at which the holotype skulls of *Selenoportax vexillarius* and *Helicoportax praecox* occurred. It is figured on page 863, figure 79.

DIMENSIONS

Length	217.5	mm.
Dorso-plantar diam. of proximal end	55.5	"
Lateral diameter of proximal end	48	" approx.
Diameter at middle of shaft	21	"
Lateral diameter of distal end	30	"

This tibia belonged to an adult individual. The proximal articulation is somewhat defective, but otherwise the bone is in good condition.

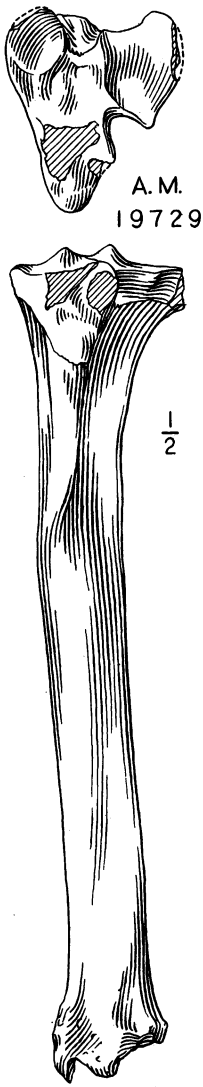


Fig. 79. (?)*Helicoportax praecox*, new genus and species. Amer. Mus. No. 19729. Referred left tibia, from four and one-half miles west of Hasnot. Proximal and dorsal views. One-half natural size.

The following table shows the ratio, *Length of tibia: Diameter at middle of shaft*, as compared with that of some other antelopine genera. Of the antelopine species known to occur at or near this horizon the

Pachyportax mentioned above (pages 770 and 845) as being smaller than *P. latidens* var. *dhokpathanensis* and corresponding to the skull from Nagri which is in Calcutta is too large to have possessed a tibia of such a length as this. Much more does this apply to *Selenoportax vexillarius*. On the other hand, the small-horned *Gazella* is far too small, and in any case the Gazellinae as a group, including the larger species of *Gazella* (page 847), may be excluded because their tibia is of a much more slender type than this. There remain the two species of *Strepsiportax*, the two species of *Helicoportax* or a species of *Sivaceros*.

	A. M. 19729	*Tragocerus amalthea*	*Boselaphus tragocamelus*	*Tetraceros quadricornis*	*Tragelaphus buxtoni*	*Strepsiceros*	*Taurotragus oryx*	*Boocercus eurycerus*	*Gazella granti*
Length of tibia	217.5	347	344	220	347	331	461	331	304
Diameter at middle of shaft	21	30	30.5	14	30.5	27	46	27	24
Ratio	10.4	11.6	11.3	15.5	11.4	12.3	10.0	12.2	12.7

The ratios tabulated above indicate that this tibia is either of proportionately the same thickness but shorter than most of the genera mentioned above, or that it is of the same length but thicker. If it were possible to determine the ratio which each of these characters bears to a third—for example, the length of the upper molar series—we should have more data for deciding which of the two alternatives mentioned above is correct. Unfortunately the only one of the Siwalik species named of which the upper molar series is definitely known is *Helicoportax praecox*. We may, however, regard the length of the upper molar series as approximately the same in *Helicoportax praecox*, *Strepsiportax gluten* and *Sivaceros* sp. A comparison on this basis with the four species *Boselaphus tragocamelus*, *Tetraceros quadricornis*, *Taurotragus oryx* and *Tragocerus amalthea* shows that agreement with each one in turn would give for the diameter of the tibia at the middle respectively 21.6 mm., 18 mm., 21.0 mm. and 21.3 mm. On the other hand, the length of the tibia should on a similar basis be 228 mm., 281 mm., 210 mm. and 247 mm. It follows, therefore, that this tibia is far too short for *Tetraceros* and *Tragocerus* and too long for *Taurotragus* but that it is only slightly too long for *Boselaphus*. We seem to have some grounds for the belief that *Helicoportax* is allied to *Selenoportax* and *Boselaphus*, while *Strepsiportax*, *Pachyportax*, *Tragoportax* and *Tragocerus* and presumably *Sivaceros* form another group. Further, if the forelimb mentioned above is correctly referred to

Pachyportax, then it is probable that the limb bones of that genus are long, and on the analogy of *Tragocerus leskewitschi* the radius and probably the tibia of *Tragoportax* are also long. Both lines of reasoning lead to the conclusion that the present tibia is more likely to belong to *Helicoportax* than to any of the other Siwalik genera mentioned. The smaller-sized immature dentitions described above (pages 838), are smaller than the teeth in the holotype of *Helicoportax praecox*, so that it would seem that there were individuals of a smaller size than the holotype, and to one of these the tibia might have belonged.

Certain other features in this tibia are suggestive of affinity to *Boselaphus* rather than to the tragelaphines or *Tragocerus*. The proximal head is extremely narrow as may be seen by the tabulated ratios of the dorso-plantar diameter to the lateral diameter. It will be seen that in this

	A. M. 19729	*Boselaphus tragocamelus*	*Tetraceros quadricornis*	*Taurotragus oryx*	*Boocercus eurycerus*
Dorso-plantar diameter of proximal head	55.5	82	41	110	67.5
Lateral diameter of proximal head	48	81	36	126	72
Ratio	1.15	1.01	1.14	0.87	0.94

feature it agrees closely with *Tetraceros*, and next closely to *Boselaphus*. The tragelaphines except *Tragelaphus* have a much broader proximal head. A feature of difference from *Tragelaphus* is the development of the anterior crest, which in *Tragelaphus* extends the whole length of the bone, in *Taurotragus* half way down, and in the present tibia only one-third. In *Tragocerus amalthea* the crest also extends about halfway down. The anterior half of the bone is much more convex than in the other genera named, but the Nilghai approaches it somewhat. In *Tragelaphus* the concave outer surface passes into a flat upper surface. The shape and depth of the popliteal notch is similar both to *Tragelaphus* and *Boselaphus*.

This tibia is, therefore, more likely to belong to *Helicoportax* than to *Strepsiportax* and may be provisionally referred to *Helicoportax praecox*.

(?) **Selenoportax vexillarius,** new genus and species

Figure 80

A left cuboid-navicular is now considered (Amer. Mus. No. 29977; figure 80, page 867), from one mile south of Nathot (Lat. 32° 50′; Long.

73° 13′, about six and one-half miles west northwest of Hasnot). This locality is described as "Lower Middle Siwalik, 1000 feet below the Bhandar bone bed," so that at any rate it cannot be below the very top of the Chinji stage and may belong to the Nagri stage.

Its dimensions as measured by Dr. E. H. Colbert are stated below alongside of the corresponding ones for certain other species of antelope and ox:

	A. M. 29977	A. M. 29984	*Boselaphus tragocamelus*	*Tetraceros quadricornis*	*Taurotragus oryx*	*Tragelaphus buxtoni*	*Tragocerus amalthea*	*Bos banteng*
Max. dorso-plantar diameter	50.5	54 ?	43	18	63	45	..	52
Max. lateral diam.	47.5	54	48	22	68	43	42	59
Max. height (anterior)	28	28 ?	25	16	27	24	..	24
Max. height (posterior)	41	..	35	17	46	32	..	38
Height of cuneiform (approx.)	10	10	9	5	11	..	..	8

The only two Lower or Middle Siwalik species of bovid known with which the size of this cuboid-navicular makes an identification possible are *Selenoportax vexillarius* and *Pachyportax latidens dhokpathanensis*. Being far too large to correspond with the tibia and metatarsals, which have been described above, it cannot be referred to the genera *Helicoportax*, *Strepsiportax* or *Tragoportax*. It is equally too large for *Tragocerus*. It is somewhat too small for the forelimb (Geol. Surv. Ind. No. B268) mentioned above (page 859) and referred to *Pachyportax latidens* var. *dhokpathanensis*, although it is not impossible that it might belong to a smaller individual of the same species or a smaller variety or species of the genus *Pachyportax*.

It seems to be completely adult. Its most striking feature is the excess of the dorso-plantar over the lateral diameter, as may be seen from a comparison with the other species of which the corresponding dimensions are tabulated above. This is only in small part due to the prominence of the process at the internal plantar angle. *Boselaphus* approaches it more closely in this respect than the other species, but even here the lateral diameter exceeds the dorso-plantar diameter. From this character of the cuboid-navicular we may infer the possession of slender limbs, and on the assumption (page 860) that *Selenoportax* had slenderer limbs than *Pachyportax*, it seems more likely that this bone should be-

long to the former genus. Considering also the horizon at which it occurred, which is almost the same as that of the holotype of *Selenoportax vexillarius*, but at which, so far as we are aware, the only species of *Pachyportax* known is one considerably smaller than *P. latidens dhokpathanensis*, we may say that the balance of probability is in favor of an identification of this cuboid-navicular as that of *Selenoportax vexillarius*.

Certain structural features are worthy of note. On the inner side the articulation with the astragalus overhangs that with the cuneiform considerably, so as to form a kind of groove. This is not particularly marked in *Taurotragus*, but is fairly conspicuous in *Boselaphus* and still more so in *Tetraceros*. It does not exist in the oxen.

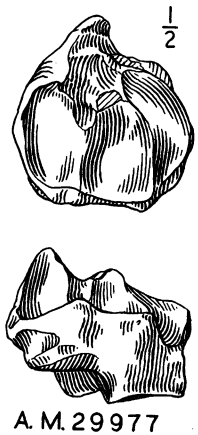


Fig. 80. (?)*Selenoportax vexillarius*, new genus and species. Amer. Mus. No. 29977. Referred left cuboid-navicular, from one mile south of Nathot. Proximal and dorsal views. One-half natural size.

The dorsal boundary runs more obliquely than in *Taurotragus*, *Boselaphus* and the oxen, because the internal articulating facet with the astragalus is larger, so that the bone juts out more on the dorsal side than in the other genera. The internal boundary is convex instead of almost in one plane as in *Boselaphus*. In consequence of these two features the outline of the bone is less quadrate than in the other genera named.

The external articulation with the calcaneum terminates farther from the lower side of the bone than in any of the genera named above. It also overhangs the base, which is not the case in *Boselaphus* and *Taurotragus*, but is equally noticeable in *Tetraceros*. This is correlated with the greater height of the cuneiform as estimated by the depth of the step on the cuboid-navicular. This is a marked distinction from the

oxen, and less so from *Taurotragus*. In *Boocercus* and *Boselaphus* the cuneiform is deeper, while in *Tetraceros* this difference from the present cuboid-navicular hardly exists. In fact both as regards general outline, the nature of the articulation with the calcaneum and the depth of the cuneiform, this tarsus is closer to that of *Tetraceros*. In the latter genus, however, the internal articulation with the astragalus does not overhang, nor is the process on the inner side of the plantar boundary at all prominent, which accounts for the small dorso-plantar diameter of the cuboid-navicular in *Tetraceros*.

Another cuboid-navicular (Amer. Nus. No. 29984) from one mile west of Chinji Bungalow, is larger than the one just described, but is on the whole in agreement with it. The lateral diameter is, however, somewhat greater, though still much less so than in *Boselaphus*, *Taurotragus* and *Tetraceros*. From its size it might well have belonged to the possessor of the forelimb (Geol. Surv. Ind. No. B268; page 859) and it cannot be denied that there is a possibility that it is the same species, but its older horizon militates against this, while its differences from the cuboid-navicular just described are not so great as to prohibit its reference to a larger individual of *Selenoportax vexillarius*.

(?) Tragocerus browni or punjabicus

Figure 81

The first eight cervical and dorsal vertebrae lacking the axis (Amer. Mus. No. 29870), from half a mile southwest of Dhok Pathan, were associated with parts of a pelvis. An axis vertebra (Amer. Mus. No. 19672) corresponding with the others in size came from half a mile south of Dhok Pathan. These agree both in shape and size with the corresponding vertebrae of *Tragocerus amalthea*, figured by Gaudry (1865, p. 280, Pl. L, fig. 2). Unfortunately they are at present not available for examination in Paris, as their whereabouts is unknown, so that my comparison is based merely on Gaudry's figures. The most interesting of the vertebrae is the sixth. This seems to possess a very significant feature, which is more plainly seen in another sixth cervical vertebra from half a mile south of Dhok Pathan (Amer. Mus. No. 29958; page 859, Fig. 81). This concerns the caudal articulation and the transverse process. The former is exceedingly oblique to the sagittal plane of the centrum, while the latter is considerably prolonged backward, so as to be almost a continuation of and in the same plane as the general plane of the caudal articulation. In no antelope have I seen this feature in such a marked degree; but somewhat the same obliquity of the caudal

facet and backward prolongation of the transverse process is found in *Boselaphus tragocamelus*. Gaudry's figure of the sixth cervical of *Tragocerus amalthea* seems to be similar to Amer. Mus. No. 29958, and the vertebrae in the American Museum may be referred to *Tragocerus browni*

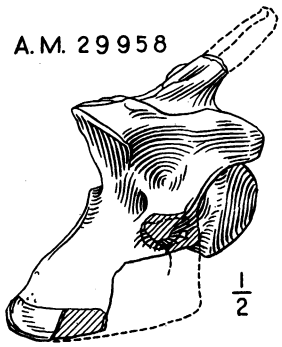


Fig. 81. (?)*Tragocerus browni*, new species, or *punjabicus* Pilgrim. Amer. Mus. No. 29958. 6th cervical vertebra, from half a mile southwest of Dhok Pathan. Lateral view. One-half natural size.

or *punjabicus*. The similarity between them and those of *Boselaphus tragocamelus*, however, suggests a closer affinity between *Tragocerus* and the Boselaphinae than has been hitherto suspected and is in accord with the conclusions at which I have arrived from a study of the skull and horn cores. The spine of the axis (Amer. Mus. No. 19672) is not so high as in *Tragocerus amalthea*.

APPENDIX

Bovid Remains of Uncertain Identification in the American Museum Siwalik Collection:

Antelopine gen. et. sp. indet.

Amer. Mus. No. 19490—Part of skull and lower jaw, 1/2 mile south of Dhok Pathan.
" " " 19493—Miscellaneous bones, 1/2 mile south of Dhok Pathan.
" " " 19535—Miscellaneous bones and teeth, 1 mile south of Nathot.
" " " 19551—Lower jaw, 1 1/2 mile northeast of Hasnot.
" " " 19556—Miscellaneous teeth and jaws, 2 miles west of Chinji Bungalow.
" " " 19566—Jaws, near Chinji Bungalow.
" " " 19634—Miscellaneous bones and teeth, 1 1/2 miles northwest of Chinji Bungalow.
" " " 19636—Jaw, 1 mile northwest of Chinji Bungalow.
" " " 19654—Brain-case, 6 miles west of Chinji Bungalow.
" " " 19666—Limb bone, 1/2 mile south of Dhok Pathan.
" " " 19715—Jaw fragments and teeth, 4 miles west of Dhok Pathan.
" " " 19745—Brain-case, 4 1/2 miles northwest of Hasnot.
" " " 19760—Teeth and jaw fragments, 1 1/2 miles east of Hasnot.
" " " 19763—Jaw, 18 miles west of Bilaspur.
" " " 19848—Teeth and lower jaw, 4 miles east of Dhok Pathan.
" " " 19889—Jaw, 1 mile west of Tatrot (3 1/2 miles north of Hasnot).
" " " 19919—Foot, 2 miles east of Ramnagar, Kashmir.
" " " 19923—Jaw fragment, 2 miles west of Hasnot.
" " " 19928—Teeth, 3 miles east of Ramnagar.
" " " 19931—Metapodial, 4 1/2 miles west of Hasnot.
" " " 29849—Teeth and jaw, 1 1/2 mile northeast of Hasnot.
" " " 29869—Lower jaw, 1/2 mile south Dhok Pathan.
" " " 29871—Lower jaw, 1/2 mile south of Dhok Pathan.
" " " 29874—Upper and lower jaws, 12 miles east of Chinji Bungalow.
" " " 29876—Lower jaw, 4 1/2 miles west of Hasnot.
" " " 29878—Lower jaw, 2 miles northeast of Hasnot.
" " " 29886—Two lower jaws, 1 mile north of Hasnot.
" " " 29891—Jaws and teeth, 1 mile west of Dhok Pathan.
" " " 29894—Jaws and teeth, 2 1/2 miles south of Chandigarh.
" " " 29896—Jaws, 1/2 mile south of Dhok Pathan.
" " " 29944—Molar, 1 mile northwest of Chinji Bungalow.
" " " 29947—Jaws and teeth, 5 miles east of Chinji Bungalow.
" " " 29950—Molar, 3 miles south of Hasnot?
" " " 29951—Molars, 1 mile east of Hasnot.
" " " 29952—Molar, 1 mile northeast of Hasnot.
" " " 29954—Molar, 1 mile south Nathot.
" " " 29969—Cuboid-navicular, 3 miles west of Chandigarh.
" " " 29970—Lower jaw, 1 1/2 miles northeast Chinji Bungalow.
" " " 29972—Molar, 4 miles west of Dhok Pathan.
" " " 29982—Jaw fragment and teeth, 2 miles west of Chinji Bungalow.
" " " 29988—Molar, 1/2 mile southwest of Hasnot.

Bos or *Bison* sp. indet.

Amer. Mus. No. 19877—Teeth, 4 miles west of Mirzapur.

Bovid gen. et sp. indet.

Amer. Mus. No. 19438—Limb bones, 12 miles east Chinji Bungalow.
" " " 19463—Skull and skeletal parts, 1/2 mile southwest of Dhok Pathan.
" " " 19570—Teeth, jaw, etc., 5 miles west of Chinji Bungalow.
" " " 19601—Teeth, jaw, etc., 3 miles northwest of Chinji Bungalow.
" " " 19678—Lower jaw, 1/2 mile south Dhok Pathan.
" " " 19788—Skull, 3 miles west of Chandigarh.
" " " 19816—Skull, 2 miles west of Chandigarh.
" " " 19872—Skull, 1/2 mile west of Siswan.
" " " 19891—Phalanges, 6 miles south of Hasnot?
" " " 19892—Jaw, foot bones, 4 1/2 miles west of Hasnot?
" " " 19906—Femur, 4 1/2 miles west of Hasnot?
" " " 19971—Brain-case and horn, 6 miles west of Kalka.
" " " 19974—Maxilla, 1 1/2 miles north of Hasnot.
" " " 29804—Foot bones, 1/2 mile southwest of Dhok Pathan.
" " " 29864—Lower jaw and teeth, 1 1/2 miles east of Chinji Bungalow.
" " " 29872—Lower jaw, 1/2 mile south Dhok Pathan.
" " " 29879—Lower jaw and teeth, 12 miles east of Chinji Bungalow.
" " " 29889—Maxilla, 1 1/2 miles north of Hasnot.
" " " 29892—Lower jaw, 1/2 mile south of Dhok Pathan.
" " " 29980—Horn-core, 2 miles west of Chinji Bungalow.
" " " 29986—Horn-core, near Ramnagar.
" " " 29987—Vertebrae, Bhandar.
" " " 29989—Molar, 4 miles west of Chinji Bungalow.
" " " 29993—Molar, 1 mile northeast of Hasnot.
" " " 29996—Molar, 5 miles east of Chinji Bungalow.
" " " 19721—Brain-case, 1/2 mile south of Dhok Pathan.
" " " 19549—Fragmentary skeleton, 4 1/2 miles west of Hasnot.

Boselaphine gen. et sp. indet.

Amer. Mus. No. 19991—Molar, 3 miles west of Chandigarh.

Tragelaphine gen. et sp. indet.

Amer. Mus. No. 19992—Lower jaw, 1/2 mile north of Chinji Bungalow.
" " " 19999—Molar, 2 miles northeast of (?)Phadial.
" " " 29897—Jaw fragments, 4 miles northeast of Chinji Bungalow.
" " " 29949—Lower jaw, 1 mile north of Hasnot.
" " " 29981—Lower jaw, 5 miles east of Chinji Bungalow.
" " " 29885—Lower jaw and teeth, 1 mile south of Nathot.
" " " 29939—Molars, 4 miles northeast of Chinji Bungalow.

Hemibos sp. or *Bos* sp. indet.

Amer. Mus. No. 19780—Palate, 3 miles northeast of Mirzapur.
" " " 19787—Tooth, 3 miles west of Chandigarh.
" " " 19790—Lower jaws, 25 miles east of Chandigarh.
" " " 19791—Lower jaws, 12 miles east of Chandigarh.
" " " 19792—Lower jaws, 6 miles east of Chandigarh.
" " " 19800—Palate, 3 miles northeast of Siswan.
" " " 19801—Jaws, near Siswan.
" " " 19805—Skull and jaws, 8 miles west of Kalka.
" " " 19808—Tooth and phalange, near Chandigarh.
" " " 19810—Teeth, near Siswan.
" " " 19812—Teeth and jaws, near Mirzapur.
" " " 19813—Jaw, near Siswan.
" " " 19876—Teeth and jaws, 4 miles west of Mirzapur.
" " " 19885—Teeth and jaws, near Siswan.
" " " 29848—Lower jaw, 3 miles west of Chandigarh.
" " " 29851—Jaw fragments, 3 miles west of Chandigarh.
" " " 29893—Jaw fragments and teeth, 7 miles west of Kalka.
" " " 29894—Jaw fragments and teeth, $2^1/_2$ miles south of Chandigarh.

REFERENCES

ANDREE, J. 1926. 'Neue Cavicornier aus dem Pliocän von Samos.' Palaeontographica, LXVII, Heft 6, pp. 135–175, Pls. X–XVI.

BOHLIN, BIRGER. 1935A. 'Kritische Bemerkungen über die Gattung Tragocerus.' Nov. Act. Reg.-Soc. Sci. Upsaliensis, (4), IX, pp. 1–19, Pls. I–V.

1935B. 'Cavicornier der Hipparion-Fauna Nord Chinas.' Palaeont. Sinica, Ser. C, IX, fasc. 4, pp. 1–166, 20 Pls., 142 text figs.

BORISSIAK, A. 1914. 'Mammifères fossiles de Sebastopol.' Mem. Com. Geol. St. Petersburg, (N. S.) Livr. 87, pp. xii, 154, Pls. I–X.

BOULE, M., BREUIL, H., LICENT, E. AND TEILHARD DE CHARDIN, P. 1928. 'Le Paléolithique de la Chine.' Arch. Inst. Paléont. Humaine, Mem. 4, pp. i–viii, 1–138, Pls. I–XXX.

DÉPÉRET, C. 1887. 'Recherches sur la Succession des Faunes de Vertébrés Miocénes de la Vallée du Rhône.' Arch. Mus. Hist. Nat. Lyon, IV, pp. 45–313, Pls. XII–XXV.

GAUDRY, A. 1862–67. 'Animaux Fossiles et Géologie de l'Attique.' 476 pp. Atlas of 75 pls. and map. Large 4to. Paris.

HINTON, M. A. C. 1908. 'Note on *Gazella daviesi*, an antelope from the Norwich Crag.' Geol. Mag. London, (5) V, p. 445, Pl. XXIII.

JOLEAUD, L. 1917. 'Les Gazelles Pliocénes et Quaternaires de l'Algérie.' Bull. Soc. Geol. France, (4) XVII, pp. 208–225.

LYDEKKER, R. 1876. 'Molar teeth and other remains of Mammalia.' Palaeont. Indica, (10) I, 2, pp. 19–87, Pls. I–VIII.

1878. 'Crania of Ruminants from the Indian Tertiaries, and Supplement.' Palaeont. Indica, (10) I, 3, 4, pp. 88–181, Pls. XI–XXVIII.

1884. 'Rodents and new Ruminants from the Siwaliks.' Palaeont. Indica, (10) III, 3, pp. 105–134, Pl. XIII.

1886. 'Siwalik Mammalia.' Palaeont. Indica, (10) IV, 1, pp. 1–21, Pls. I–VI.

LYDEKKER, R., AND BLAINE, G. 1914. 'Catalogue of the Ungulate Mammals in the British Museum.' II, pp. vi, 295, 8vo. London.

MATSUMOTO, H. 1915. 'On some fossil Mammals from Sze-chuan, China.' Sci. Rep. Imp. Univ. Tôhoku, 2nd ser. (Geology), III, pp. 1–28, Pls. I–X.

NEWTON, E. T. 1884. 'On the occurrence of Antelope remains in newer Pliocene beds in Britain, with the description of a new Species, *Gazella anglica*.' Quart. Jour. Geol. Soc. London, XL, pp. 280–293, Pl. XIV.

PAVLOW, M. 1913. 'Mammifères Tertiaires de la Nouvelle Russie.' N. Mem. Soc. Nat. Moscou, XVII, livr. 3, pp. 1–72, Pls. I–IV.

1914. 'Apercu sur la nouvelle Faune des Mammifères Tertiaires de la Russie Meridionale.' Annu. Geol. Min. Russ., XVI, pp. 181–191, Pl. VIII.

PILGRIM, G. E. 1910. 'Notices of new mammalian genera and species from the Tertiaries of India.' Rec. Geol. Surv. Ind., XL, pp. 63–71.

1913. 'The correlation of the Siwaliks with the Mammal horizons of Europe.' Rec. Geol. Surv. Ind., XLIII, pp. 264–326, Pls. XXVI–XXVIII.

1925. 'The migrations of Indian Mammals.' Proc. 12th. Indian Sci. Congr., pp. 200–218.

1932. 'The fossil Carnivora of India.' Palaeont. Indica, (N. S.) XVIII, pp. 1–232, Pls. I–X.

PILGRIM, G. E., AND HOPWOOD, A. T. 1928. 'Catalogue of the Pontian Bovidae of Europe.' Br. Mus. Cat., pp. viii, 106, Pls. I–IX.

POCOCK, R. I. 1910. 'On the specialized cutaneous glands of Ruminants.' Proc. Zool. Soc. London, pp. 840–986.

1918. 'On some external characters of Ruminant Artiodactyla—The Tragelaphinae.' Ann. Mag. Nat. Hist., (9) II, pp. 440–448.

POMEL, N. A. 1895. 'Les Antilopes.' Carte Geol. Algérie (Paléont.), Monogr. 5.

RÜTIMEYER, L. 1877–1878. 'Die Rinder der Tertiär-Epoche nebst Vorstudien zu einer natürlichen Geschichte der Antilopinen.' Abh. Schweiz. Paläont. Ges., IV, 208 pp., 7 pls.

SCHLOSSER, MAX. 1903. 'Die fossilen Säugetiere Chinas nebst einer Odontographie der recenten Antilopen.' Abh. Bayer. Akad. Wiss., XII, pp. 1–221, Pls. I–XIV.

1904. 'Die fossilen Cavicornier von Samos.' Beitr. Paläont. Geol. Oest.-Ung., XVII, pp. 28–118, Pls. IV–XIII.

1923. See Zittel, K. A.

1924. 'Tertiary Vertebrates from Mongolia.' Palaeont. Sinica, Ser. C, I, 1, pp. 1–120, Pls. I–VI.

SICKENBERG, O. 1929. 'Eine neue Antilope und andere Säugetierreste aus dem Obermiozän Niederosterreichs.' Palaeobiologica, II, pp. 62–86, Pls. VII, VIII.

STREMME, H. 1911. 'Die Säugethiere mit Ausnahme der Proboscidier. M. L. Selenka and M. Blanckenhorn, Die Pithecanthropus-Schichten auf Java.' 4to Leipzig, pp. 82–150, Pls. XVI–XX.

STROMER, E. 1928. 'Wirbeltiere im obermiocänen Flinz Münchens.' Abh. Bayer. Akad. Wiss., XXXII, pp. 1–71, Pls. I–III.

TEILHARD DE CHARDIN, P. 1928. See Boule, M., Breuil, H., Licent, E. and Teilhard de Chardin, P.

TEILHARD DE CHARDIN, P., AND PIVETEAU, J. 1930. 'Les Mammifères fossiles de Nihowan.' Ann. Pal., XIX, pp. 1–134, Pls. I–XXIII.

TEILHARD DE CHARDIN, P., AND YOUNG, C. C. 1931. 'Fossil Mammals from the late Cenozoic of Northern China.' Palaeont. Sinica, Ser. C, IX, 1, pp. 1–66, Pls. I–X.

WEBER, MAX. 1928. (Unter mitwerkung von O. Abel) 'Die Säugetiere, II, 2nd. edition, pp. xxiv, 898, 8vo. Jena.

ZITTEL, K. A. VON. 1923. 'Grundzüge der Paläontologie,' pp. v, 706, 4th Ed., 8vo. München (Klasse Säugetiere bearbeitet von Max Schlosser).

INDEX TO VOLUME LXXII

New taxonomic names are printed in heavy-faced type.