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Ser. X.

INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

Vol. III.

By R. LYDEKKER, B.A., F.G.S., etc.

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PREFACE.

The present volume completes the description of the Siwalik and Narbada Vertebrata as at present known, although one or more supplemental memoirs on particular groups may probably be published; while materials for others may, it is hoped, be afforded by future 'finds.'

My own share in the work commenced in 1876, and its completion has therefore taken upwards of ten years. The general advance in vertebrate zoology and palæontology during that period, coupled with the disadvantage of my not having had access to the British Museum collections when writing the first and part of the second volumes, and my own inexperience when I commenced the work, has entailed many changes both in systematic arrangement, and in the determination of particular specimens; but the Synopsis of Mammalia given in this volume, together with the Introductory Observations, will, it is hoped, render all such emendations apparent to the reader.[1] The publication of Prof. W. H. Flower's 'Catalogue of Mammalia in the Museum of the Royal College of Surgeons' (1884) marks an epoch in the history of the Mammalia, as being one of the first attempts to introduce a thoroughly dependable nomenclature, and the generic terms employed in the synopsis in the present volume have been brought in the main into accord with those used in that work. The lines laid down in that Catalogue have been followed in my own 'Catalogue of the Fossil Mammalia in the British Museum', now in course of publication; and the writing of that work has enabled me to make numerous emen dations in regard to the species and range of the non-Indian mammals referred to in the course of this and the preceding volumes. Some of these emendations are noticed in the Introductory Observations to the present volume, but the reader who desires to quote any observations in regard to such mammals is referred to the original work. In both the above-mentioned Catalogues generic terms have been

1 See also "Catalogue of Siwalik Vertebrata in the Indian Museum," pt. I. *Calcutta* (1885).

employed in a very wide sense, and I am more and more convinced that this view is the preferable one, as the multiplication of such terms can but encumber the science without giving any adequate advantage in return.

I may mention that the references to non-Siwalik vertebrates do not usually refer to the first publication of the names, but merely to good descriptions or figures.

I have again to express my thanks to many of the Officers of the Zoological and Geological Departments of the British Museum (Natural History) for much valuable assistance; and thanks are also due to the Director of the British Museum, and to Professor Boyd-Dawkins, of Owens College, for some of the woodcuts illustrating this volume. The readers of this and the preceding volume are deeply indebted to Miss G. M. Woodward and the other artists for the accuracy and excellent execution of the figures of the specimens.

RICHARD LYDEKKER.

THE LODGE,
HARPENDEN,
HERTFORDSHIRE.

March 1st, 1886.

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CORRIGENDA.

Page 37, *line* 16 *from bottom*, *for* 1839 *read* 1836.

,, 91, ,, 10 ,, ,, *and* 104 *line* 16 *from top*, the date of publication of Pomel's memoir on *Palæochoerus* is 1847, the paper having been read in 1846.

,, 93, ,, 18 *from top*, *for* typus *read* majus.

,, 104, ,, 9 *and* 10 *from top*, the memoir on *Hyotherium* is by Meyer, and not Osborn.

,, 109, *top line*, *for* miocene *read* pliocene.

,, 117, *line* 22 *from top*, *for* Kow. *read* Aym.

,, 129, *for* Chæromeryx *read* Chœromeryx.

,, 130, *note* 2, *and* 131 *note* 1, *for* 1884 *read* 1885.

,, 145, ,, ,, *for* XI. *read* XII.

,, 153, *line* 14 *from top*, *before* conclusion *add* same.

,, 182, *note* 6, *for* 395 *read* 295.

,, 196, ,, 5, *read* "Synopsis Reptilium," p. 49 (1831).

,, 224-5. Transpose the sentence at the end of the second paragraph on p. 224 with the two sentences at the end of the first paragraph on p. 225.

In description of plate II. *fig.* 2 *for* third, *read* first true molar.

INTRODUCTORY OBSERVATIONS.

ADDENDA TO SYNOPSIS OF SIWALIK & NARBADA MAMMALIA.

General.—Since the publication of the Synopsis of Siwalik and Narbada Mammalia in the third part of the present volume several new upper Siwalik species have been added to the list, and some emendations made in regard to certain genera and species; while there is one provisional new species to be added. All these additions are noticed in the sequel; the genera being taken in the same order as in the Synopsis. It may be premised that the division of the Artiodactyla into the sections Ruminantia and Suina, and of the latter into the subsections Selenodontia and Bunodontia has been abandoned.[1]

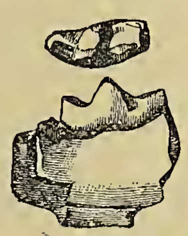

Fig. 1. *Mustela*, sp Fragment of the left ramus of the mandible; from the Siwalik Hills. British Museum (No. 15914).

Mustela, *sp.* – This form (*infra.* p. 125) is determined from a fragment of the left ramus of the mandible (woodcut fig. 1), which is described and figured on page 177 of part I. of the "Cat. Foss. Mamm. Brit. Mus." It indicates a species as large as *M. flavigula.*

Nesokia, *sp.*—The specimen alluded to in the synopsis (*infra.* p. 126) as *Mus.* (?), sp. is referred in the "Cat. Foss. Mamm. Brit. Mus.' part I. p. 226 to *Nesokia*; it presents no characters by which it can be distinguished from *N. hardwickei,* Gray.

Lepus, *sp.*—The fragment of the mandible of a *Lepus* mentioned in the synopsis (*infra.* p. 126) is described in the "Cat. Foss. Mamm. Brit. Mus." pt. I. p. 262.

Bubalus buffelus.—The so-called *B. palæindicus* (which occurs only in the topmost Siwaliks and the Narbadas) is referred to a variety of this species (*vide* "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 28).

Hemibos.—This genus (including three species) is now merged in *Bubalus* (*vide* "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 28).

Strepsiceros (?) falconeri, *Lyd.*[2]—This is a new species founded on part of a cranium from Perim Island (*vide* "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 47).

Hippotragus sivalensis, *Lyd.*—The so-called *Antilope sivalensis* (*vide infra.* p. 128) is referred to *Hippotragus* (*vide* "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 49).

Cobus.—Two species have been referred to this genus, *viz.* the so-called *Antilope* (?) *patulicornis,* Lyd. (*vide infra.* p. 128); and a new species named *C. palæindicus,* Lyd.[3]

1 See part II of the writer's "Catalogue of Fossil Mammalia in the British Museum" (1885) and part I. of "Catalogue of Siwalik Vertebrata in the Indian Museum" (Calcutta, 1885). A few emendations in the references to the original descriptions of Siwalik mammals have been made in these works.

2 'Geol. Mag.' dec. 3. vol. II. p. 170 (1885).

3 "Cat. Foss. Mamm. Brit. Mus. pt. II. p. 53 (1885).

Alcelaphus bakeri, *Lyd.*[1]—A new species founded upon a portion of a cranium in the British Museum (*vide* "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 56). The occurrence of the large number of existing African genera of antelopes confirms the conclusion that the higher mammalian fauna of Africa has immigrated from the Oriental region.

Propalæomeryx.—This genus is merged in *Palæomeryx* (*vide* "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 119).

Camelus antiquus, *Lyd.*[2] (*ex Falc. & Caut. MS.*)—The chief characters by which this species is distinguished from *C. sivalensis* are its inferior size, the smooth enamel of the teeth, the concavity and vertical ridge in the middle of the inner surface of the lower true molars (the ridge being only observable in little-worn teeth), and the short deep mandible. The type remains are noticed in the "Cat. Foss. Mamm. Brit. Mus." pt. II. pp. 145-147.

Cervus aristotelis and C. porcinus.—These existing Indian species have been provisionally added to the fauna of the Narbadas (see "Cat. Foss. Mamm. Brit. Mus." pt. II. pp. 103, 104).

Merycopotamus nanus, *Lyd.*[3] (*ex Falc. MS.*)—This species is distinguished from *M. dissimilis* by its somewhat inferior dimensions, the relatively narrower mandibular symphysis, shorter jaws, convex cranial profile, the absence of a fossa on the outer side of the mandible behind the canine, and the great concavity of the inner surface of the third lower true molar. The writer has not been able at present to distinguish between the upper true molars of this species and *M. dissimilis*; a detached tooth belonging to one of the two is represented in fig. 2. The type remains are noticed in the "Cat. Foss. Mamm. Brit. Mus." pt. II. pp. 211-213.

Fig. 2. *Merycopotamus*, sp.—A right upper true molar; from the Siwaliks of the Punjab. $\frac{1}{1}$. Indian Museum (No. B. 116).

Merycopotamus pusillus, *Lyd.*[4]—This species is founded on a fragment of the right maxilla containing the third true molar, which is represented in fig. 3. The specimen was collected from the Siwaliks of Kushálgarh, below Attock, by Lieuts. Garnett and Trotter sometime previously to 1865, and was submitted by the late Dr. Oldham to Dr. Falconer, on whose death it was presented by his brother, Charles Falconer, to the British Museum. Being identified by the present writer as the specimen noticed in "Falconer's Palæontological Memoirs," vol. I. p. 416 under the name of *Merycopotamus nanus*[5], it was transferred in 1885 to

Fig. 3. *Merycopotamus pusillus.*—The third right upper true molar; from the Siwaliks of Kushálgarh. $\frac{1}{1}$. Indian Museum (No. B. 324).

1 "Geol. Mag.' dec. 3. vol. II. pt II. p. 170 (1885).

2 'Rec. Geol. Surv. Ind.' vol. XVIII. p. 78 (1885).

3 'Geol Mag' dec. 3. vol. I. p. 545 (1884).

4 'Rec. Geol. Surv. Ind' vol. XVIII. p. 146 (1885).

5 The name *M. nanus* had been applied by Falconer in MS (*vide Pal. Mem.* vol. II. p. 407) to the last species, before he applied it to the Kushálgarh specimen, which he evidently regarded as distinct. When the collection of Kushálgarh specimens were returned to India, a label bearing the name *M. nanus* was attached to a tooth referred to *Dorcatherium* (*vide* 'Palæontologia Indica,' ser. 10. vol. I. p. 62 [44]), which led the present writer to consider that Falconer had made a wrong generic identification.

the Indian Museum. The tooth differs from the corresponding molar of *M. dissimilis* or *M. nanus* (fig. 2) both in its inferior size, and in structure. Its length is 0·75, and its width 0·8 inch; and the external surface of the outer columns is less inwardly inclined, thus causing the tooth to assume a character more approaching that of *Chœromeryx*, which is now provisionally referred to the *Dichodontidæ*. Additional specimens are required before anything more definite can be said as to the affinities of the present species, which may indicate the identity of *Hemimeryx* with *Merycopotamus*.

Sivameryx.—This genus has been merged in *Chœromeryx*, and the latter provisionally placed in the *Dichodontidæ* (*vide* "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 165). The type species is probably identical with *C. silistrense*.

Anthracotherium, *sp.*—Two specimens in the British Museum (*vide* "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 244) appear to indicate the existence of two additional Siwalik species of *Anthracotherium*, but are not sufficiently perfect to afford good grounds for specific determination. The large lower Siwalik species noticed in vol. II. p. 176 of this work is omitted from the synopsis.

Tetraconodon.—This genus, together with *Elotherium* (*Entelodon*) is now included in the *Chœropotamidæ* (*vide* "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 249).

Sus, *sp.* (? *nov.*).—In the accompanying woodcut there is represented the last right lower true molar of a species of *Sus* which is implanted in a fragment of a mandible collected by Mr. Theobald from the Siwaliks of the Punjab, and apparently indicates a species distinct from any of those described in the second part of the present volume.[1] The tooth is in a partially worn condition, and has a comparatively simple talon. It is larger and somewhat more complex than the corresponding tooth of *S. hysudricus* (pl. VIII. figs. 2, 3); and is smaller and has a rather less complex talon than $\overline{\text{m. 3}}$ of *S. falconeri* (pl. VII. fig. 1): it agrees, however, with the latter in the lateral compression of the columns. It is very nearly equal in size to $\overline{\text{m. 3}}$ of *S. cristatus*, but has a less complex talon, while the main columns are rather more compressed, and the accessory ones smaller and more detached. The extreme length is 1·55, and the width anteriorly 0·7 inch. The greater part of an immature cranium of a species of *Sus* from the Siwaliks in the British Museum (No. M. 2403—"Cat. Foss. Mamm. Brit. Mus." pt. II. p. 266) agrees so exactly in size with the present specimen that there is a great probability that the two are specifically identical; but the immature and imperfect condition of the British Museum cranium renders it insufficient to afford good diagnostic characters, and it is therefore unadvisable to assign to this form a distinct specific name, although it is probably different from all the named Siwalik species.

Fig. 4. *Sus*, sp. The third right lower true molar; from the Siwaliks of the Punjab. $\frac{1}{1}$. Indian Museum (No. B. 438).

Hipparion.—An examination of the Siwalik specimens of *Hipparion* in the British Museum (*vide* "Cat. Foss. Mamm. Brit. Mus." pt. III.[2]) has led to the con-

[1] The specimen is noticed in the "Cat. Siwalik Vert. Ind. Mus." pt. I. p. 109 (1885).

[2] In preparation.

clusion that *H. antilopinus* was probably monodactylate; and also that the remains from the Punjab described and figured in the second volume of this work under that specific heading not improbably belong to a distinct species.

Rhinoceros and Aceratherium.—The writer has come to the conclusion that there is no logical reason for generically separating *Aceratherium* from *Rhinoceros* (*vide* "Cat. Foss. Mamm. Brit. Mus." pt. III.[1]), since the American forms ranged by Cope under the names *Aphelops*, *Cænopus*, and *Peraceras* (*vide supra* vol. II. p. ix.) indicate a complete transition between the two.

Mastodon cautleyi, *n. sp. Lyd.*—The difficulty of referring detached teeth of the genus *Mastodon* to their proper species in cases where several allied forms occur in the same formation is so great, that errors in such determinations are almost inevitable unless a very extensive series of perfect specimens is forthcoming. In recently describing a molar of *Mastodon latidens* from Borneo, the present writer[2] referred to certain Siwalik specimens in the British and Indian Museums which appeared to indicate a more or less complete transition between typical molars of that species on the one hand and those of *M. perimensis* on the other. A subsequent examination of the specimens in question has however led to the conclusion that they cannot apparently be satisfactorily referred to either one of those species; and as there can be no question as to the strongly marked distinction between typical molars of those two species, it has been thought, after considerable hesitation, advisable to provisionally apply a distinct specific name to the aberrant form, which may be called *M. cautleyi.* The alternative would be to consider this form as a variety of one of the previously named species, but the difficulty then arises of saying with which it should be associated, since its upper molars present resemblances not only to those of the Siwalik *M. latidens* and *M. perimensis*, but also to those of the European *M. longirostris*.

The specimens on which this provisional species is founded are five in number, and are all cheek-teeth of the upper jaw; four of them being in an unworn condition. Three of these teeth, which are all from Perim Island, are in the British Museum, and are figured in the "Fauna Antiqua Sivalensis," under the name of *M. latidens*: the first (pl. XL. figs. 2, 2a) is the right $\underline{\text{mm. 4}}$; the second (pl. XL. figs. 3, 3a) is the left $\underline{\text{m. 1}}$, and is refigured of the natural size in woodcut fig. 5; while the third (pl. XXXI. figs. 6, 6a) is the left $\underline{\text{m. 3}}$, and is refigured on a larger scale in woodcut fig. 6. The other two specimens are in the Indian Museum, and are figured in the present work under the name of *M. perimensis*; the first[3] (vol. I. pl. XL.) being the partially-worn left $\underline{\text{m. 1}}$, with the associated $\underline{\text{pm. 4}}$, the former[4] of which apparently agrees precisely with the homologous British Museum specimen, and the other[5] (vol. III. pl. XVI. fig. 2) the imperfect right $\underline{\text{m. 2}}$, in an unworn condition. All these

1 In preparation. 2 'Proc. Zool. Soc.' 1885, pl. XLVIII.

3 "Cat. Siwalik Vert. Ind. Mus." pt. I. p. 97. No. A. 48. (1885). *M. perimensis.*

4 When describing this specimen in Calcutta the writer could not identify it with the one figured in the "F.A.S." pl. XL. fig. 3, owing to the small size of the figures in that work, which renders them almost useless for comparison.

5 "Cat. Siwalik Vert. Ind. Mus." pt. I. p. 97. No A. 437. (1885). *M. perimensis.*

five specimens agree so exactly with one another that there can be little or no hesitation in referring them to one and the same species. Their essential characters are that the ridges are moderately tall, and inclined forwards; the valleys partially

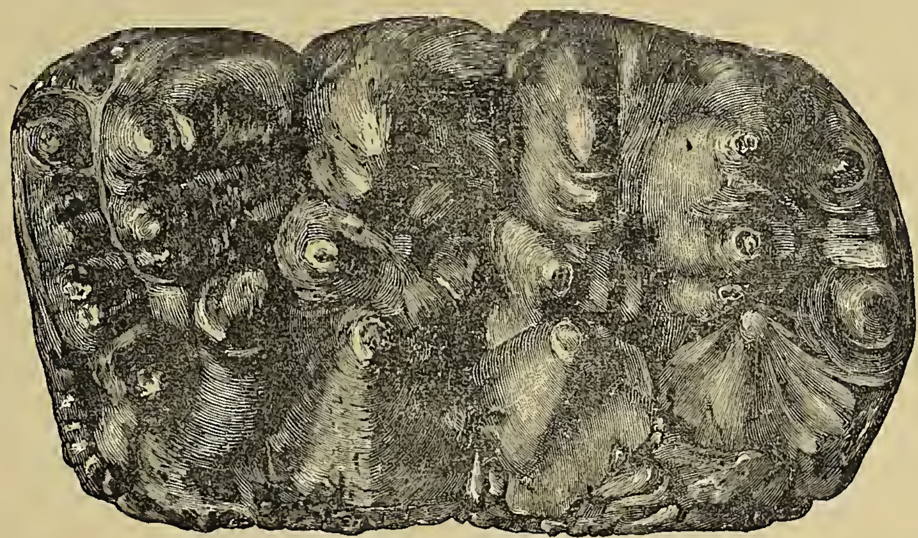

Fig. 5. *Mastodon cautleyi.* The first left upper true molar in an unworn condition; from Perim Island. ⅟. British Museum (No. M. 2817). The lower border of the figure is the inner border of the specimen.

blocked by accessory tubercles, of which there are none on the outer side of the median longitudinal cleft. The first inner column always has accessory tubercles on both sides, and there are similar tubercles on the hinder side of both the second and third inner columns; the hind talon of the 'intermediate' molars (woodcut fig. 5) is relatively small; while in unworn examples the hinder aspect of the outer column of the first ridge is deeply concave, and the arrangement of the tubercles on the inner column of the same ridge forms a V. The third true molar (woodcut fig. 6)

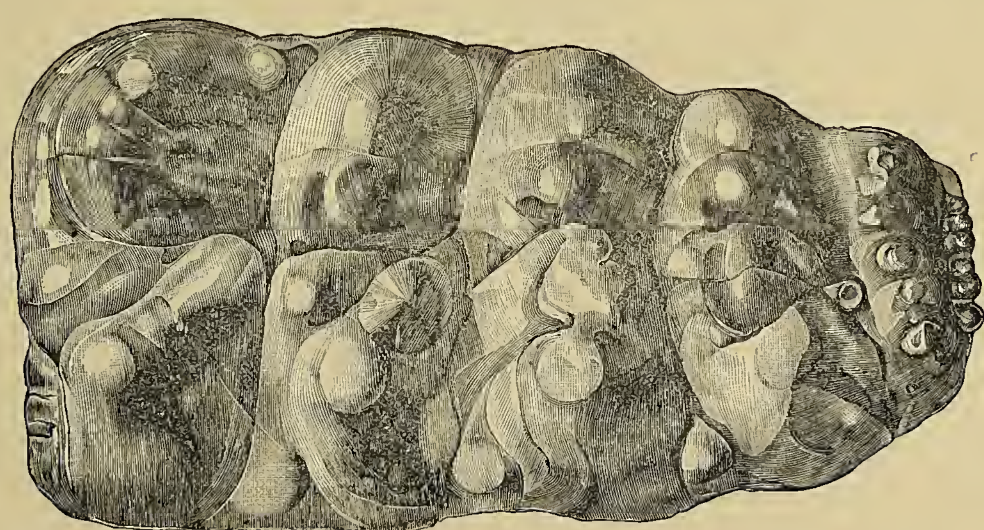

Fig. 6. *Mastodon cautleyi.* The third left upper true molar, in an unworn condition; from the Siwaliks of Perim Island. ½. British Museum (No. M. 2705). The lower border of the figure is the inner border of the specimen.

is very wide, tapers but little posteriorly, and carries five ridges and a simple hind talon, the latter consisting of a narrow ridge with six small tubercles. All the teeth are relatively wide, with a well-marked median longitudinal cleft; they appear to have no appreciable quantity of cement in the valleys, and when worn (*supra* vol. I. pl. XL.) present trefoils on their inner columns.

Contrasting these teeth with those of *M. latidens*, of which species typical examples of the milk-molars are figured in vol. I. pl. XXXVII. of the present work[1], while typical true molars are figured in pls. XXXVIII. and XXXIX. of the same volume, in pl. XXXI. figs. 3[2], 4, 5 of the "Fauna Antiqua Sivalensis," and in pl. XLVIII. of the 'Proc. Zool. Soc.' for 1885 (the latter figure being reproduced on a smaller scale in woodcut fig. 7), it will be seen that the ridges in the latter species are much lower, placed closer together, and have a less distinct median longitudinal cleft; while there are no distinct accessory tubercles, and the valleys are consequently almost completely open: when worn (*supra* vol. I. pl. XXXVIII. fig. 2) the inner columns present very imperfect trefoils, and the dentine surfaces of the inner and outer columns soon unite to form a single transversely elongated surface. The third true molar (woodcut fig. 7; see also "F.A.S." pl. XXXI. figs. 3, 3a, *supra* vol. I.

Fig. 7. *Mastodon latidens*. The third left upper true molar of a small individual in a partially-worn condition; from the Pliocene (?) of Borneo. $\frac{2}{3}$. The lower border of the figure is the inner border of the specimen. (Reduced from the figure in the 'Proc. Zool. Soc.' 1885, pl. XLVIII.)

pl. XXXIX. 'Proc. Zool. Soc.' 1885, pl. XLVIII.) is very wide, tapers but little posteriorly, and carries five ridges and a hind talon, the latter being always large and frequently very wide (compare woodcut fig. 6). All the teeth are of great relative width; and $\underline{\text{pm.4}}$ (*supra* vol. I. pl. XXXVII. fig. 6) differs markedly from the homologous tooth of *M. cautleyi* (*supra* vol. I. pl. XL.)

Turning now to *M. perimensis* (with which the writer previously associated two of the type molars of the new species) it will be seen that here also decided distinctions obtain. A typical example of the second left upper true molar[3] of this species in an unworn condition is represented in woodcut fig. 8, in which the summits of the columns of the first ridge are broken off; while other typical upper molars are represented in the "F.A.S." pl. XXXI. figs. 9, 9a, in Falconer's "Palæontological Memoirs," vol. I. pl. IX. figs. 3-6 (the one represented in figs. 5, 6 is the right $\underline{\text{m.2}}$, which agrees precisely with the one figured in the accompanying woodcut

1 In the first volume the normal three milk molars of the Proboscidea are termed mm. 1, mm. 2, and mm. 3.

2 The teeth in this (the type) specimen are $\underline{\text{m.2}}$ and $\underline{\text{m.3}}$, but are wrongly described in the index to the plate.

3 See 'Cat. Siwalik Vert. Ind. Mus.' pt. I. p. 97. No. A. 355. (1885). The specimen is there referred to the right side.

[fig. 8].), and in plate XLII. of the first volume of the present work.[1] In the unworn m.2 (woodcut fig. 8) accessory tubercles (*a*) are present on the outer side of

Fig. 8. *Mastodon perimensis.* The second left upper true molar, in an unworn condition; from the Siwaliks of Perim Island. $\frac{2}{3}$. Indian Museum (No A. 355). *a.* external accessory tubercles. The lower border of the figure is the inner border of the specimen.

the median longitudinal cleft, which are attached to the hinder side of each ridge, and gradually diminish in size from the first to the fourth ridge: these tubercles are also observable in m.3 (*supra* vol. I. pl. XLII.), but are absent in *M. latidens* and *M. cautleyi.* The inner column of each ridge has no distinct accessory tubercle on its posterior aspect in the specimen figured in woodcut fig. 8, but a large one is present to each ridge in the one figured in the "F.A.S." pl. XXXI. figs. 9, 9a. In all the above-mentioned teeth the ridges are still higher, and more nearly vertical than in *M. cautleyi,* while the posterior surface of the outer column of the first ridge is less hollowed, and the summit of the unworn inner column of the same frequently does not form a complete V (woodcut fig. 8): the hind talon of the 'intermediate' molars is relatively larger (compare woodcut fig. 8 and Falconer's "Palæontological Memoirs," vol. I. pl. IX. fig. 6 with woodcut fig. 5 and vol. I. pl. XL. of the present work); the main columns of the ridges have a more decided tendency to an alternate arrangement, and the valleys are generally blocked to a greater extent by accessory tubercles; cement is, moreover, present in much greater quantity.[2] The third true molar figured in vol. I. pl. XLII. is long, narrow, and tapering posteriorly, and carries five ridges and a complex hind talon, but a specimen in the British Museum (M. 256) is wider posteriorly. All the teeth agree with those of *M. cautleyi* in presenting trefoils on their earlier inner columns, but their crowns are relatively narrower.

Having now pointed out the characters in which the present form differs from *M. latidens* and *M. perimensis,* it remains to indicate how close is the resemblance between the molars of certain examples of the three forms. In some molars of *M.*

[1] The specimen figured in vol. I. pl. XLI. fig. 4 of the present work as m.2 of *M. perimensis* has been shown in vol. III. p. 151 to belong to *M. sivalensis.*

[2] In some specimens (*e. g.* the one represented in woodcut fig. 8) the cement has fallen out.

latidens, as in the two figured in pl. XXXI. figs. 4, 4a of the "F.A.S." there is a tendency in the ridges to become somewhat higher, and to the development of distinct accessory tubercles; and there is thus effected an almost complete transition to *M. cautleyi*. On the other hand, it is but a step from the structure of the 'intermediate' molars of the latter to those of *M. perimensis*, although there is somewhat less probability of a complete transition existing between these two species.

The 'intermediate' molars of the present form very closely resemble those of *M. longirostris*, but the hind talon and fourth ridge are longer and narrower, the cusps on the columns more numerous, and the accessory tubercle of the second inner column less developed: the third molar (judging by the one example) also differs by its long, straight, and narrow fourth ridge and talon. There can, however, be but little doubt that the two forms are allied.

As the result of the foregoing comparisons it appears that the form here known as *M. cautleyi* (whether it is really entitled to rank as a species or merely as a variety) probably passed imperceptibly into *M. latidens*, and connects that species in one direction with *M. longirostris*, and in another with *M. perimensis*,[1] which is itself allied to the *M. sivalensis* and *M. arvernensis* group. It has been shown (*infra.* p. 143) to be not improbable that the tetralophodont *M. perimensis* (in which *M. cautleyi*[2] was then included) is a more specialised form derived from the stock of the trilophodont *M. pandionis*, and it appears that starting from the generalized *M. angustidens* (*infra.* p. 18) two branches of more specialized forms may be traced, the one (in which there is a tendency of the valleys of the molars to be much blocked and their columns to be ranged alternately) passing through *M. pandionis* and *M. perimensis* to *M. sivalensis* and *M. arvernensis*; and the other (in which the valleys remain more open and the columns of the ridges run straight across the crowns) passing through *M. longirostris*, *M. cautleyi*, and *M. latidens* to *Elephas clifti*, and then through the higher stegodont forms to the true elephants. There are, however, signs that some of the middle forms of these two branches were mutually connected; but the nature of this connection cannot be at present indicated, although it may be suggested that in regions like India where several species inhabited the same area there may possibly have been interbreeding between the different forms. The relationship apparently existing between *M. cautleyi* and *M. longirostris* may help to explain some of the difficulties alluded to on page 18 of this volume, and may indicate that the transition from the trilophodont to the tetralophodont type in this branch took place in the regions to the westward of India.[3]

As regards distribution, *M. cautleyi* apparently occurs only in Perim Island and the western Punjab; while *M. latidens* occurs not only in these regions and Sind, but extends through the typical Siwalik Hills, and thence to Burma and Borneo.

[1] In the first volume from not having distinguished *M. cautleyi* from *M. perimensis* the writer regarded the latter as more nearly allied to *M. longirostris* than to *M. arvernensis*.

[2] In its short and wide m.3 *M. cautleyi* comes nearer to *M. pandionis* than does *M. perimensis*: the latter, however, agrees with the trilophodont species in its more abundant cement.

[3] Note 4 on page 18 should be confined to *M. arvernensis*.

This distribution is of peculiar interest in regard to the apparent relationship of *M. cautleyi* to the European *M. longirostris*, and of its cousin *M. latidens* to *Elephs clifti*, and thus to the higher stegodonts, which are especially characteristic of the typical Siwalik Hills and the countries to the eastward (*vide infra.* p. 18).

With regard to the milk-molars figured in plate XVII. of the present volume under the name of *M. perimensis*, it is very difficult to determine whether they belong to that species as now restricted, or to *M. cautleyi.* The small hind talon of the specimen represented in figs. 3, 3a (which Falconer had labelled *M. latidens*[1]), coupled with the comparative clearness of its valleys, and the absence of any distinctly alternate arrangement of its columns, render it, however, not improbable that this specimen should be referred to *M. cautleyi.* The writer has at present been unable to refer any lower teeth to the latter form.[2]

Mastodon angustidens.—On page 32 of the present volume two teeth were described and provisionally regarded as upper milk-molars of *M. falconeri*; the more perfect example being figured in the woodcut on the same page (reproduced in fig. 9). A re-examination of these specimens has, however, convinced the writer that he was mistaken in regarding them as complete teeth, and that they are really imperfect examples of the first right lower true molar of *M. angustidens* var. *palæindicus.* The figured specimen comprises the first and second ridges, and its identity with $\overline{\text{m. 1}}$ of that species may be seen by comparing the woodcut with the specimen represented in plate IV. fig. 8, which belongs to the opposite side of the jaw, and is in a somewhat more worn condition. The second specimen (British Museum. No. 32503) consists of the second and third ridges of the homologous tooth, in a somewhat earlier stage of wear. It is not improbable that both specimens were obtained from the Búgti Hills or Dera Búgti (*vide infra* page 1).

Fig. 9. *Mastodon angustidens* var. *palæindicus.* The first and second ridges of the first right lower true molar, in a half-worn condition; from the Lower Siwaliks of Sind or the regions to the north or west. $\frac{1}{1}$. British Museum. (No. 40788).

Mastodon pandionis.—It may be advisable to note here that the tooth figured in vol. I. pl. XXXII. fig. 4 under the name of *M. falconeri* has been referred on page 30 of the present volume to *M. pandionis.*

A penultimate lower milk-molar of a *Mastodon* from Perim Island in the collection of the British Museum which has recently come under the writer's notice affords some clue to the vexed question of the specific determination of the milk-molars figured in vol. I. pls. XXXII. figs. 2, 3, and XXXIII. fig. 2, of which

1 *Vide infrà.* p. 151.

2 It is not improbable that one of the specimens of mandibular symphyses figured in vol. 1. pl. XLIII. under the name of *M. perimensis* may belong to *M. cautleyi*, as both differ somewhat from the mandible of the former described on p. 245 of the same volume.

the affinities are discussed on pp. 32 and 154 of the present volume.[1] This tooth, which is figured in the woodcut fig. 10, agrees precisely with the homologous tooth

Fig. 10. (?) *Mastodon pandionis.* The third (penultimate) left lower milk-molar; from Perim Island. Viewed from the grinding and outer lateral aspects. $\frac{1}{1}$. British Museum. (No 40779).

figured in vol. I. pl. XXXIII. fig. 2, and exhibits the vertically grooved enamel characteristic of the true molars of *M. pandionis.* This shows that both in Perim Island and the Punjab the true molars of that species are accompanied by trilophodont milk-molars exhibiting a similar structure of the enamel; and the *primâ facie* presumption therefore is that both types of teeth belong to the same species. If this be so the milk-molars figured in vol. I. apparently indicate a variety of *M. pandionis* in which the valleys of the earlier 'intermediate' molars are less blocked than usual, and thereby approximate to the corresponding teeth of *M. pentelici*; with which species the penultimate milk-molars agree in their tendency towards a tetralophodont type of structure.[2] The present specimen agrees very closely with $\overline{\text{mm. 3}}$ of the last-named species,[3] but $\underline{\text{mm. 3}}$ of the Indian form is relatively shorter and wider. In its laterally compressed form the young Punjab mandible described in vol. I. p. 205 of the present work agrees with the adult mandible of *M. pandionis.*

The apparent absence of premolars in the skull to which the specimens figured in the first volume belong may perhaps be due either to an individual peculiarity, or to their late development. If this identification be correct the specimens figured in vol. I. pls. XXXV. fig. 3, and XXXVII. fig. 3, and provisionally regarded respectively as the upper and lower penultimate milk-molars of *M. pandionis* are not rightly determined. The occurrence of *M. pentelici* in Persia (*vide infra.*) is especially interesting in view of the affinity to that species presented by *M. pandionis* (*infra.* p. 154); an affinity which will be rendered still closer if the milk-molars under discussion are rightly referred to that species.

RANGE OF SIWALIK MAMMALIA.

General.—Our knowledge of the range of many of the Siwalik Mammalia into the regions to the eastward of Burma[4] has been considerably increased by recent discoveries.

1 The redetermination of the specimens noticed in the preceding paragraph removes one obstacle to the reference of the specimens in question to *M. falconeri*; but their intrinsic characters (now that the specimen represented in vol. I. pl. XXXII. fig. 4 has been shown to belong to *M. pandionis*) forbid that view.

2 See Gaudry "Les Enchainements, etc.—Mammifères Tertiaries," pp. 180, 181, fig. 211. (1878).

3 Gaudry "Animaux Fossiles et Géologie de l' Attique," pl. XXII. fig. 3.

4 *Vide supra* vol. II. pp. 65, 66.

Java.—Herr. K. Martin[1] has described some fragments of molars of a stegodont elephant from Java, which it is suggested may not improbably belong either to *Elephas insignis* or *E. bombifrons.*

Borneo.—The present writer[2] has described and figured a last upper true molar of *Mastodon latidens* from Borneo, which indicates the occurrence of a small race of this species in that island; a small-sized figure of this tooth is given in woodcut fig. 7 (page xvi.).

China.—From China a lower molar of a species of *Hyænarctos* (fig. 11) has been described and figured by the present writer,[3] which may perhaps be identical with one of the Siwalik species. Part of the left maxilla of a species of *Sus* from a cave in Sechuen, N. W. China has been provisionally identified by the writer[4] with *Sus giganteus.* Dr. Ernst Koken[5] has recently described and figured a considerable series of Mammalian teeth collected by Baron von. Richthofen from caves in the province of Yunnan, which lies immediately south of Sechuen (Szechuen), whence the greater number of the original specimens described by Sir Richard Owen[6] were obtained. Including the forms previously identified by the present writer (indicated by an asterisk), Dr. Koken gives the following list of Siwalik species which range into China, viz.

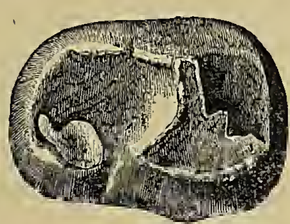

Fig. 11. *Hyænarctos*, sp Second right lower true molar; from the Pliocene (?) of S. China. ½. British Museum (No. 28588).

Mastodon perimensis, *var.* sinensis.[7]	Elephas (*cf.*) bombifrons.
,, (*cf.*) pandionis.	Rhinoceros blanfordi,[8] *var.* hipparionum.
*Elephas clifti.	,, sivalensis.
* ,, insignis.	

A species of *Hipparion* is described under the name of *H. richthofeni* and is considered to be very close to *H. antilopinus.* Additional teeth of *Hyæna sinensis*, Owen, are described; and that species is considered distinct from *H. felina*, but extremely near to an unnamed Siwalik maxilla figured in vol. II. pl. XXXVA. fig. 4 of this work.[9] In regard to *Rhinoceros sivalensis* it may be mentioned that the last true molar figured by Owen in the 'Quart. Journ. Geol. Soc.' vol. XXVI. pl. XXIX. figs. 1, 2 under the name of *R. sinensis* is identified with that species; but that the outer lamina of an upper premolar represented in fig. 3 of the same plate is considered distinct, and the name *R. sinensis* retained for it: under the latter name Dr. Koken figures (pl. VI. fig. 1) a perfect upper premolar, which precisely resembles Owen's specimen. Now since it is most probable that the two specimens figured by

1 'Beitr. Geol. Ost. Asiens u. Australiens,' vol. IV. pt. I. (1884).

2 'Proc. Zool. Soc.' 1885, pl. XLVIII.

3 "Cat. Foss. Mamm. Brit. Mus." pt. I. pp. 156, 157 (1885).

4 *Ibid.* pt. II. p. 270. No. M. 2462 (1885).

5 'Palæontologische Abhandlungen,' vol. III. pt. 2 (1885).

6 'Quart. Journ. Geol. Soc.' vol. XXVI. (1870).

7 The writer is by no means sure that the specimen on which this determination rests (Koken, *op. cit.* pl. VII. fig. 1, erroneously described in the description of the plate as belonging to the left side) is not the imperfect $\overline{m.3}$ of a trilophodont species.

8 Syn. *Aceratherium blanfordi.*

9 Dr. Koken misquotes the plate as XXVIA.

Owen belong to the same individual, while Koken's upper premolar apparently agrees precisely with the homologous tooth of *R. sivalensis* figured in vol. II. pl. V. fig. 6 of this work, there seems no reason for separating the Chinese premolars from the true molars, and assuming that Dr. Koken is correct in identifying the latter with *R. sivalensis* the name *R. sinensis* should be abolished.

Persia.—On page xv. of the preceding volume the occurrence of fossil mammals at Maragha in north-western Persia was briefly noticed. Further observations on this fauna have been published by Messrs Pohlig,[1] and Rodler,[2] and the present writer has recently communicated a paper to the Geological Society[3] recording the species and genera mentioned by those palæontologists and Herr Grewingk,[4] and adding some others. The majority of the mammals (with the exception of some later forms) appear identical with Pikermi species; but the French *Felis brevirostris* and *Rhinoceros blanfordi* of the north-west frontier of India and China are also met with, as well as a *Rhinoceros* apparently connecting *R. antiquitatis*[5] with *R. platyrhinus*. It is suggested that the Maragha beds may be somewhat newer that the lower pliocene, but the relations of the newer types to those characteristic of the Pikermi beds are not yet determined. The apparent almost total absence of eastern Siwalik forms is noticed, and the suggestion made that there appears a decided distinction as regards species between the pliocene faunas of the Palæarctic and Oriental regions.

LISTS OF NON-INDIAN MAMMALIA.

General.—The writer's examination of the non-Indian fossil Mammalia in the British Museum during his preparation of the Catalogue of that collection has enabled him to make several emendations in the lists given in this and the preceding volumes of the same series; the most important of which may be noticed.

Elephantidæ (*supra* vol. I. p. 283).—The name *M. americanus* (Cuvier) is the correct one for *M. maximus*. All the specimens figured in the "F.A.S." pls. XXXV., XL., and XLII. (some of which are refigured in Falconer's "Palæontological Memoirs," vol. I. pl. VIII. and vol. II. pls. I. and II.) with the exception of the one in pl. XL. fig. 15 under the name of *M. andium*, and so referred to in the first volume of this work, really belong to *M. humboldti*. The mandible of *M. andium* (the preferable name for which appears to be *M. cordillerum*) has a long symphysis with tusks.[6]

Ursidæ.—*Amphicyon brevirostris* (*supra* vol. II. p. 247) is referred to *Cephalogale* (*vide* "Cat. Foss. Mamm. Brit. Mus." pt. I. p. 147).

Anthracotheriidæ.—In reference to the list of species of *Anthracotherium* given in vol. II. pp. 148, 149 it may be mentioned that a more complete one is given by Teller in the 'Beitr. Pal. Ost. Ung.' vol. IV. pt. I. (1884). The so-called *Hyopotamus gresslyi* (*supra* vol. II. p. 157) has been referred to *Anthracotherium* (*vide* "Cat. Foss.

1 'Verh. k. k. geol. Reichs,' 1884, pp. 281–284. 2 *Ibid* 1886. No. 14. 3 Read January 27th, 1886.

4 *Vide supra*, vol. I. p. xv. 5 Syn. *R. tichorhinus*.

6 *Vide* Cope, 'Proc. Amer. Phil. Soc.' vol. XXII. (No. 117) pp. 5, 6 (1884). A list of the American species is given in this paper, and in another published in the 'Amer. Nat.' vol. XVIII. pp. 524-526 (1884).

Mamm. Brit. Mus." pt. II. p. 244). The fragment of a maxilla with two molars of an *Anthracotherium* from Piedmont in the British Museum noticed in vol. II. pp. 151, 153 as *A. cuvieri* has been provisionally referred to *A. alsaticum* (*vide* "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 240.—No. M. 75).

Suidæ.—In the list of species of *Hyotherium* given on pp. 92-94 of this volume, it appears probable that both *H. meissneri* and *H. suillum* are synonyms of *H. typum*; *H. majus* is probably equivalent to *H. sœmmeringi*; while the so-called *Chœromorus simplex* is apparently entitled to rank as a distinct species, and may be known as *H. simplex* (*vide* "Cat. Foss. Mamm. Brit. Mus." pt. II. pp. 254, 257, 258). The species mentioned on page 52 of this volume (on the authority of Prof. Gaudry) under the name of *Sus steinheimensis* apparently belongs to *Hyotherium*. *Sus chœroides* (*infra.* p. 51) is a middle miocene form.

Since the second part of this volume was published a new existing species of *Sus* from Borneo has been described by Dr. A. Nehring[1] as *S. longirostris*, who regards it as allied to *S. verrucosus*. In the same paper that writer does not accept Prof. Forsyth-Major's limitation in the number of the existing species (*vide infra.* p. 50). The pliocene north African form noticed on page 77 has been referred by M. P. Thomas[2] to another new species under the name of *S. phacochœroides*. Species of *Cynocephalus*, *Hipparion*, *Equus*, etc., are recorded from the same region.

Hippopotamidæ.—The specimens in the British Museum indicate that *Hippopotamus pentlandi* (*infra.* p. 37) is decidedly smaller than the existing race of *H. amphibius*, and also show differences in the form of some of the limb-bones (*vide* "Cat. Foss. Mamm. Brit. Mus." pt. II. p. 287).

Equidæ.—In the list given in vol. II. pp. 71, 72 *Equus devillei*, *E. micrognathus*, and *E. piscenensis* are American forms distinct from *E. caballus*. *E. arcidens*, Owen, appears indistinguishable from *E. principalis*, Lund. (*vide* "Cat. Foss. Mamm. Brit. Mus." part III.[3]).

Rhinocerotidæ.—As mentioned above, the writer now proposes to include *Aceratherium* in *Rhinoceros*. In the list of species[4] given in vol. II. pp. 3-7 *Rhinoceros cimogorrhensis* is equivalent to *R. simorrensis* (the former name having the priority); *R. mercki* and *R. kirkbergensis*, Jäger, are synonyms of *R. megarhinus*, Christol, and not of *R. leptorhinus*, Owen; while *R. lunelensis*, Gervais, is probably equivalent to the latter, instead of the former. Apparently all the specimens on which *R. sinensis* was founded belong to *R. sivalensis*. The formula of the cutting-teeth of the so-called *Peraceras* (*vide* vol. II. p. ix.[5]) according to a later memoir of Prof. Cope[6] is $I\,\frac{0}{2}\,C\,\frac{0}{0}$ (or $I\,\frac{0}{1}\,C\,\frac{0}{1}$) instead of $I\,\frac{0}{0}\,C\,\frac{0}{0}$.

1 'Zoologischen Anzeiger," vol. VIII. pp. 347-353 (1885).

2 'Mem. Soc. Géol. France,' ser. 3. vol. III. art. 2. (1884).

3 In preparation.

4 The specimens from Quercy originally referred to *R. minutus* were subsequently shown by Filhol (Ann. Sci. Géol.' vol. XI. art. I. p. 4) to belong to *R. croizeti*.

5 In note 1 on that page the volume and date (XIV-1880) are inadvertently omitted.

6 'Proc. Amer. Phil. Soc.' 1881, p. 393.

SIWALIK BIRDS.

Distribution of Struthio.—In reference to the distribution of *S. camelus* and *S. asiaticus* (*infra.* pp. 144-5) it may be observed that Professor A. Newton[1] mentions that the existing species formerly occurred in Assyria, and that it may still exist in the Kirwan district of eastern Persia, whence it may stray into Turkestan; it is also stated that there are assertions of its former occurrence in Sind and Baluchistan, but these are insufficiently authenticated. This evidence is extremely important as connecting the distributional areas of the recent and fossil species.

Dromæus.—Among the Siwalik collection in the British Museum the writer has found specimens which have convinced him that the phalangeals described on pp. 145-6, and figured[2] in pl. XIV. figs. 2, 4, 5, 6, under the name of *Dromæus* (?) *sivalensis* really belong to an ungulate mammal allied to *Hippopotamus*.

SIWALIK AND NARBADA CHELONIA.

Species of Batagur.—It may be mentioned that the so-called *B. iravadicus*, Anderson[3] is omitted from the lists of *Batagur* given on pp. 187 and 195, since it presents no characters by which it can be palæontologically distinguished from *B. trivittatus*, with which Mr. Theobald[4] thinks it may be identified.[5] For the smaller species referred by Dr. Anderson to *Batagur*, Mr. Theobald retains the genus *Morenia*.

Trionyx, *sp.*—Attention may be directed to the redetermination on page 255 of the specimens described and figured on page 206.

SIWALIK CHELONIA, OPHIDIA, AND LACERTILIA.

The name Gharialis.—The writer follows Mr. Theobald[6] in adopting the name *Gharialis* in place of *Gavialis*, which was founded on a misspelling of the native name gharial: the retention of the *h* in the first syllable cannot, however, be defended in strict Latinity.

Eocene pythons.—On account of differences in the vertebræ *Python cadurcensis* (*infra.* p. 237) has been made the type of the new genus *Palæopython*, Rochebrune[7]; a second species from Quercy being described in the same memoir under the name of *P. filholi.* Pictet's Swiss forms are referred to the same genus.

March 1st, 1886.

1 "Encyclopædia Britannica," 9th ed. vol. XVIII. p. 62 (1885)—'Ostrich.'

2 The description of the plate has been revised.

3 "Expedition to Western Yunnan," p. 736 (1878).

4 "Mason's Burma," vol. I. p. 339 (1882).

5 Dr. Anderson adopts the name *B. duvaucelli* for *B. dhongoka*, and *B. lineatus* for *B. kachuga*.

6 "Catalogue of Reptiles of British India," p. 37. (1876). This amended name is also adopted by Mr. Blanford in the "Manual of the Geology of India," pt. 2. p. 580. (1879), and in his address to the Geological section of the British Association, 1884, p. 5.

7 'Nouv. Arch. d. Muséum,' ser. 2, vol. III. pp. 276-277 (1880).

PLATE XIV.

Aves (and, *errorim*, Ungulata).

Fig. 1. LEPTOPTILUS FALCONERI (M. Edws.). Distal extremity of the left humerus, viewed from the palmar aspect; from the Siwalik Hills. British Museum, (No, 48,435).

,, 2, 2a, 2b, 2c, 4, 4a, 4b, 5, 6. First and second phalangeals of Ungulate Mammals described on pp. 145-146 as Avian, under the name of *Dromæus* (?) *sivalensis* (see introduction to volume); from the Siwaliks. Indian Museum (Nos. E. 1-4).

,, 3, 3a, 3b. MERGUS (?) sp. Early cervical vertebra; from the Siwaliks of the Punjab. Indian Museum (No. E. 212). 3 from the hæmal, 3a from the anterior, 3b from the neural aspect.

,, 7, 7a, 7b, 7c, 7d. CICONIOID, gen. *non. det.* Fourth cervical vertebra; from the Siwaliks of the Punjab Indian Museum (No. E. 8). 7 from the right lateral, 7a from the anterior, 7b from the posterior, 7c from the neural, 7d from the hæmal aspect.

,, 8. STRUTHIOID, gen. *non. det.* Second phalangeal of the middle (third) digit of the foot; from the Siwalik Hills. British Museum (No. 39,733). From the anterior aspect.

,, 9, 9a, 9b. LEPTOPTILUS FALCONERI (M. Edws.). Distal extremity of the right tibia; from the Siwaliks of the Punjab. Indian Museum (No. E. 10). 9 from the anterior, 9a from the posterior, 9b from the distal aspect.

,, 10, 10a. PHALACROCORAX (?) sp. Proximal half of the tarso-metatarsus; from the Siwalik Hills. British Museum (No. 39,742). 10 from the anterior, 10a from the posterior aspect.

,, 11, 11a. PELECANUS CAUTLEYI, Davies. Distal extremity of the left ulna; from the Siwalik Hills. British Museum (No. 39,740). 11 from the external, 11a from the palmar aspect.

,, 12. LEPTOPTILUS FALCONERI (M. Edws.). First phalangeal of the outer (fourth) digit of the right foot; from the Siwaliks of the Punjab. Indian Museum (No. E. 9). From the anterior aspect.

,, 13. Gen. *non. det.* First phalangeal of the median (third) digit of the foot; from the Siwaliks of the Punjab. Indian Museum. From the anterior aspect.

,, 14 LEPTOPTILUS FALCONERI (M. Edws.). Distal extremity of the left tarso-metatarsus; Siwalik Hills. British Museum (No. 39,736). From the anterior aspect.

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* *All the figures natural size.*

INDIAN TERTIARY & POST-TERTIARY VERTEBRATA.

ADDITIONAL SIWALIK PERISSODACTYLA & PROBOSCIDIA.

By R. LYDEKKER, B.A., F.G.S., F.Z.S.

(WITH PLATES I. TO V.)

INTRODUCTORY.

Since the publication of the supplementary memoir on Siwalik Proboscidia, and the memoirs on the *Rhinocerotidæ* and *Equidæ* in the preceding volume of this work, other remains of these groups from the Siwaliks have been acquired by, or lent to, the Indian Museum. Some of these later acquisitions belong to one or more new species; others to a species new to India; while others illustrate more fully than heretofore a previously known Indian species.

In the present memoir the most important of these new specimens are described and figured; and in order to illustrate their affinities more fully, the figures of certain specimens from the earlier volumes have been reproduced by the side of those of the new specimens.[1]

Since lists of species, together with the chief dental characters of the genera treated of in this memoir, have been already given in the two preceding volumes, the description of the species may be undertaken without preliminary matter.

It will save space to mention here that, with the exception of the remains of *Hippotherium*, the whole of the specimens[2] forming the subject of the present memoir were collected in 1882 by Mr. W. T. Blanford from the lower Siwaliks, or Manchhars, of the extreme western side of India; the two most important localities being Gandoi, in the Búgti Hills, north of Jacobabad, in Sind; and Dera Búgti, on the north-eastern frontier of Balúchistán.

1 An additional reason for reproducing some of these figures was their unsatisfactory execution.

2 These do not of course include the specimens from the tertiaries of other districts figured to illustrate more fully the affinities of Mr. Blanford's specimens.

ORDER: UNGULATA.[1] SUB-ORDER: PERISSODACTYLA.

FAMILY: *RHINOCEROTIDÆ.*

GENUS: ACERATHERIUM, Kaup.

Species: ACERATHERIUM BLANFORDI, n. sp., *nobis.*

History.—In the preceding volume of this work a much battered left maxilla of a small rhinoceros from the Siwaliks of the Punjab, containing pm. 4, m. 1, and m. 2, is figured[2] and briefly described.[3] It was there pointed out that the specimen apparently came nearest to *R. palæindicus*, among the Siwalik rhinoceroses; and that if not the same, it indicated a new Siwalik species: it was, however, added that there did not seem "any evidence at present to warrant us in separating the two," and the Punjab specimen was, therefore, provisionally referred to *R. palæindicus.*

The evidence for the specific distinctness of the form to which this imperfect specimen belonged has been afforded by the more perfect specimens forming the subject of the present notice.[4]

Upper molars of larger race.—In plate I., fig. 1, there are represented the three left upper true molars of a rhinoceros from Dera Búgti; in which the well-worn condition of the masticating surface indicates that they belonged to a fully adult animal: the first and third teeth are somewhat damaged, but the middle tooth is perfect.

The latter tooth (of which another specimen from Gandoi, in a less worn condition, is represented in fig. 2 of the same plate) is characterized by the comparatively small development of the buttress[5] at the antero-external angle; so that the second costa (*c*) projects but slightly above the plane of the external surface (*dorsum*) of the crown; while the external surface of the first costa (*d*) is placed very nearly in the same plane. Behind the second costa the dorsum is distinctly concave, especially near the free edge, but this concavity is much less marked than in many species.[6] The crown is worn into an irregular concavity, as in most rhinoceroses. The anterior collis (*a*) is relatively large; and at a short distance from its inner extremity is constricted by a deep groove on either side. On the outer side of the hindmost of these grooves there is a bold ante-crochet (*f*), projecting into the median valley; the bottom of which is thus completely obstructed in the middle. Externally to this obstruction the median valley again expands and deepens; the form of the terminal portion being rounded in all early stages of wear.

1 In accordance with the classification recently proposed by Prof. Flower ('*Pro. Zool. Soc.*,' 1883, pp. 184-5) the Proboscidia will be reckoned as a sub-order of the Ungulata.

2 Plate VI., fig. 1.

3 Pages 44-45.

4 These specimens have been briefly noticed in the "Records" (vol. XVI., p. 72), when it was thought the mandible resembled that of the African species, which turns out not to be the case.

5 For these terms see vol. II., p. 8.

6 This concavity is most marked in the specimen represented in fig. 2.

At the entrance to the same valley there is a large, blunt tubercle (*g*) attached exclusively to the posterior collis (*b*). The latter gives off a blunt projection into the median valley, placed a short distance internally to the ante-crochet (*f*), and more externally a distinct, though small crochet (*e*): there is no combing-plate at the extremity of the median valley. The posterior valley (*i*) is elongated antero-posteriorly, and is much less deep than the median valley; the descent from its outer wall being gradual. The cingulum forming the anterior valley (*left of a*) does not extend beyond the inner half of the tooth; and in one specimen (fig. 2) stops short of the inner surface of the anterior collis, but in the other extends a short distance on to this part.

In the last molar (m. 3, fig. 1) the general characters are the same as in the preceding tooth: the anterior cingulum extends, however, still more on to the inner face of the anterior collis (*a*), and the tubercle at the entrance to the median valley is larger. The much worn first molar (m. 1, fig. 1) shows the median valley all but divided by the above-mentioned obstruction into two distinct portions, the inner of which is triangular, and the outer sub-elliptical in shape. An equally worn $\underline{\text{m. 1}}$ from Gandoi represented in plate II., fig. 2, exhibits these characters still more clearly.

Upper cheek-teeth of smaller race.—In plate II., fig. 4, there is represented the left maxilla of a smaller rhinoceros from Gandoi, containing all the permanent cheek-teeth, with the exception of $\underline{\text{pm. 1}}$, in a medium condition of wear; the first and last of the series being somewhat damaged. With the exception of their considerably smaller size the true molars of this specimen agree precisely with the teeth described above; and since there is a considerable variation in the size of different races of some of the existing species of rhinoceros, there appears no good reason for regarding the Gandoi specimen otherwise than as belonging to a small race of the species to which the larger teeth belong.

The premolars of this specimen have their inner halves surrounded by a complete, sharp-edged cingulum; whose free edge extends much higher up on the crown of the posterior (*b*) than on that of the anterior collis (*a*). The latter extends considerably more inwardly than the former; which is, so to speak, buried in the cingulum. With the exception that the ante-crochet is less developed, the other general characters of the premolars are similar to those of the true molars. In $\underline{\text{pm. 4}}$ there is a small combing-plate.[1]

Comparisons with other Siwalik rhinoceroses.—A comparison of the figures of the specimens described above with the small maxilla represented in vol. II., pl. VI., fig. 1, will show pretty clearly that all belong to the same species, the Punjab specimen being intermediate in point of size between those figured in this volume. Accepting this identification, it remains to show in what respects these specimens differ from *Rhinoceros palæindicus*, with which, in the perhaps over anxiety to avoid making unnecessary species, the first specimen was provisionally classed. In the

1 There is another specimen of the same size from Gandoi in the Indian Museum (No. C. 266), exhibiting the three true molars of the right side in a much damaged condition.

true molars of the typical *R. palæindicus* (woodcut fig. 1[1]) the external surface is still flatter than in the present specimens; the buttress being entirely absent and the costæ (*c*, *d*) but faintly developed. The bases of the two colles (*a*, *b*) are, moreover, in contact, and there is no tubercle at the entrance to the median valley (*g*): nor is there any ante-crochet. In more worn teeth[2] the median valley becomes separated into two isolated fossettes[3]; the entrance to the valley becoming obliterated, instead of having the triangular, imperfectly isolated fossette which occupies that place in the teeth under consideration (pl. II., fig. 2). The tooth regarded as a premolar of *R. palæindicus* (vol. II., pl. VII., fig. 2) is quite different from the premolars of the specimen represented in pl. II., fig. 4, of this volume.

Fig. 1. *Rhinoceros palæindicus*, Falc. and Caut. 2nd upper true molar, from the Siwaliks: British Museum (No. 39,648): the tooth really belongs to the right side, but the figure has been reversed, so as to make it correspond with the teeth figured in plate I. 1/1.

In the preceding volume[4] a skull of a small Siwalik rhinoceros in the British Museum (No. 48,932) was provisionally referred to *R. palæindicus*. The inner halves of the molars (which are alone preserved) differ, however, from those of that species by the separation of the bases of the colles, and the partial development of an ante-crochet: pm. 4 has, moreover, a distinct cingulum. Now that the specimen represented in vol. II., pl. VI., fig. 1, has been shown to be distinct from *R. palæindicus*: it seems pretty certain that the above-mentioned skull is likewise distinct. The last premolar of the latter is very like the corresponding tooth of the specimens under consideration; but the true molars have not such a marked ante-crochet and constriction of the anterior collis; and it, therefore, seems not improbable that this skull is likewise specifically distinct from the specimens under consideration, although the broken condition of its teeth does not admit of certain specific determination. Apart from the question as to the species of this skull it may be taken as pretty certain that the specimens under consideration do not belong to *R. palæindicus*; which is also distinguished by its greatly superior size.

Turning to *R. sivalensis*, it will be seen from the typical upper molar refigured

1 This specimen is also figured (½) in volume I., pl. IV., fig. 3, and in the "F.A.S.," pl. LXXV., fig. 4, as a premolar: it has been shown in vol. II. (p. 44) to be a true molar. The position in which this specimen is figured shows scarcely any of the external surface, which is well displayed in the specimens figured in the plates.

2 "F.A.S.," pls. LXXIV., fig. 1: LXXV., fig. 1.

3 In the previous volume (p. 44), from the inclusion of other specimens with this species, it was doubted whether this was invariably the case.

4 Page 45.

in plate I., fig. 7, that the buttress is much more strongly developed; the second costa (*c*) standing out more prominently, and the first costa (*d*) being placed more internally to the plane of the external surface of the crown, and more prominently developed. Again, the anterior collis (*a*) has no vertical groove on its posterior side, and the ante-crochet (*f*) is absent: the crochet (*e*) is also relatively larger, and the outer termination of the median valley in an early stage of wear[1] is triangular, instead of rounded. The posterior valley (*i*) of *R. sivalensis* forms a deep, round pit, instead of a shallow, elongated pit; while there is no tubercle at the entrance to the median valley (*g*). The figures of the more worn teeth of *R. sivalensis* given in the 'F.A.S.'[2] show that the fossettes formed on their crowns are quite different from those of the Búgti specimens. The premolars of the former species[3] are, moreover, quite distinct from those of the latter, having no cingulum on the inner side, and a well-developed second costa.

These comparisons leave no doubt of the well-marked distinctness of the present specimens from the typical race of *R. sivalensis*. In the second volume,[4] however, a right upper molar from Sind was described, presenting certain differences from the typical teeth of the last-named species; but apparently not such as, in the absence of other evidence, could be taken to justify specific distinction. This specimen is refigured in plate I., fig. 3. In the general contour of the crown, especially in the well-developed buttress and costæ, this tooth agrees with the typical molar of *R. sivalensis*. It differs, however, in that there is a groove on both sides of the anterior collis (*a*), with the consequent formation of a small ante-crochet; by the elongated and shallow form of the posterior valley (*i*); and by the presence of a rudimentary tubercle at the entrance to the median valley (*g*). In the same volume[5] another upper molar, of considerably smaller size, but presenting the same external contour of the crown, was described, and provisionally referred to *R. sivalensis* under the separate varietal name of *gajensis* (so named from the Gáj beds, in which it was found). This specimen is refigured in plate I., fig. 4. In this tooth the characters in which the last specimen differed from the typical molar of *R. sivalensis* are exaggerated; the ante-crochet being very distinct; the posterior valley (*i*) much elongated; and the tubercle at the entrance to the median valley (*g*) distinctly developed.

If the tooth represented in pl. I., fig. 3, had not been known, the Gáj tooth would have been certainly referred to a distinct species: but as the former, which in future it may be convenient to refer to as *R. sivalensis*, var *intermedius*, is precisely intermediate between the latter and typical teeth of *R. sivalensis*, it was found advisable to provisionally regard the three as races, or varieties, of the same species: this conclusion being strongly confirmed by the circumstance that the teeth regarded as the milk-molars of *R. sivalensis*[6] closely resembled the Gàj tooth.

It will be observed that the molars of *v. intermedius* and *v. gajensis* resemble the

1 Compare pl. I., fig. 2, with fig. 7; these specimens being in nearly the same stage of wear.

2 Plates LXXIV., fig. 5; LXXV., fig. 5. 3 *Supra.*, vol. II., pl. V., fig. 6. 4 Page 30. 5 Page 40.

6 Vol. II., pl. VI., fig. 2.

Búgti teeth much more closely than do those of the typical *R. sivalensis*. They are, however, at once distinguished by the greater development of the buttress and costæ; which stamp them as of the *R. sivalensis* type. The premolars of *v. intermedius* and *v. gajensis* are unfortunately unknown. The further consideration of the mutual relations of all these forms will come more conveniently in the sequel.

The molars of *Aceratherium perimense*, of which a specimen is represented in plate I., fig. 5 in nearly the same stage of wear as m. 2 in fig. 1 of the same plate, are distinguished from the Búgti teeth by the much greater development of the buttress and costæ (*c*, *d*), and the more marked sinuosity of the external surface of the crown. The ante-crochet (*f*) is less developed, and does not so completely block the median valley; while the posterior valley (*i*) forms a deep funnel-shaped pit, in place of a slit. The tubercle (*g*) at the entrance of the same valley is, moreover, attached to both colles (*a*, *b*); and in some instances[1] is crenulated; while there is no vertical groove on the anterior face of the posterior collis (*b*). The premolars of *A. perimense*[2] resemble the Búgti teeth in the presence of a cingulum; but are distinguished by the circumstance that this cingulum, which is frequently crenulated, does not extend across the inner face of the posterior collis; by the larger development of the second costa (*c*); and by the greater proportionate increase in the size of the later teeth of this series. *A. perimense* is also distinguished by its much larger size.

To the molars of *R. platyrhinus*[3] the Búgti teeth present no resemblance; and it is therefore apparent that they cannot be referred to any of the previously described species of Siwalik rhinoceroses. Further comparisons will be instituted in the sequel.

Mandible.—In figure 5 of plate II. there is represented a fragment of the left ramus of the mandible belonging to the same individual as the upper molars represented in fig. 4. The inner side shows the commencement of the symphysis immediately in advance of the socket of $\overline{\text{pm. 3}}$. Another specimen from Gandoi (woodcut fig. 2); which from its resemblance to the last specimen, and the locality

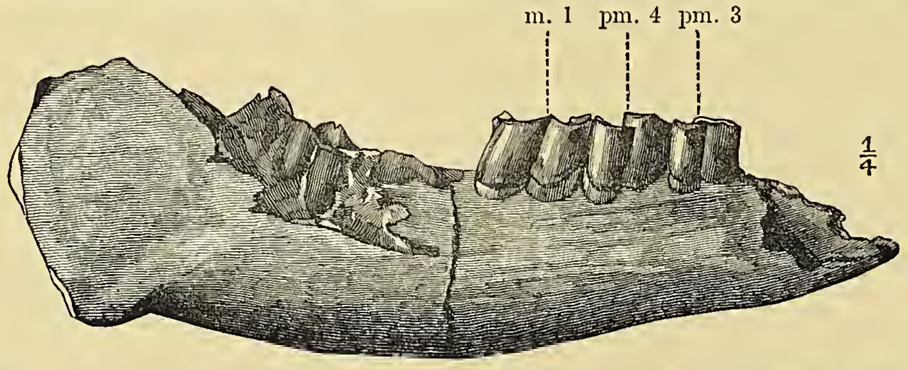

Fig. 2. *Aceratherium blanfordi*, Lyd. The right ramus of the mandible; from the lower Siwaliks of Gandoi: Indian Museum (No. C. 271).

from which it was obtained should almost certainly be referred to the larger race of the same species, shows a considerable part of the symphysis, and the alveolus of the right canine: while a third specimen from Gandoi (*Ind. Mus.*, *No.* C. 272) shows the hinder part of the symphysis, and the rami of both sides: the teeth and their alveoli and the extremity of the symphysis are, however, wanting. A fragment of

1 *Supra.*, vol. II., pl. II. 2 *Ibid.*, pls. II., IIA. 3 *Ibid.*, pl. VIII.

the right ramus of a calf, with one milk-molar remaining, is represented in plate II., fig. 3. The lower molars have a faint trace of an external cingulum. The inferior border of the horizontal ramus is markedly convex : and the ramus itself diminishes rapidly in vertical height towards, and at the symphysis,[1] indicating that the form of this part was very similar to that prevailing in the existing Javan rhinoceros, and that the canines[2] were of moderate size ;—an inference rendered certain by the size of their alveoli in the specimen in which these are preserved. In the specimen figured in the woodcut the crown of $\overline{\text{m. }2}$ has been hammered off ; while $\overline{\text{m. }3}$ is only partially protruded.

Upper milk-molars.—In figure 6 of plate I. there are represented the first and second right upper milk-molars of a rhinoceros from Gandoi, which may in all probability be referred to the present species. These teeth are of considerable importance in confirming the conclusions already arrived at as to the distinctness of the latter, since four other different types of upper milk-molars have been already described and referred to the four other Siwalik rhinoceroses.[3] The present specimens may be at once compared with the others, without preliminary description. In *R. palæindicus*[4] $\underline{\text{mm. }1}$ is more squared, and the anterior collis (*a*) is not distinctly developed : $\underline{\text{mm. }2}$ has no obstruction at the entrance to the median valley ; and the extremity of the latter is cut off as an isolated fossette, which is not the case with the present specimen : minor differences will be detected by a comparison of the figures. In *R. sivalensis*[5] the external surface of $\underline{\text{mm. }2}$ is more convex, and wants the distinct costa which occurs opposite the median valley in $\underline{\text{mm. }2}$ of the present specimen[6] : the tooth which is probably $\underline{\text{mm. }1}$ of *R. sivalensis*[7] has a square crown, without any anterior prolongation. To $\underline{\text{mm. }2}$ of *R. platyrhinus*[8] the corresponding tooth of the present specimen has no resemblance. In *Aceratherium perimense*[9] $\underline{\text{mm. }2}$ has a squarer crown, with the two colles shaped more like those of the succeeding teeth : the median costa is also more strongly developed.

In figure 1 of plate II. there is represented the unworn germ of a right upper molar of a rhinoceros from Gandoi, which may possibly be the last milk-molar of the present species. It has lost the enamel of the anterior surface, and the first costa. The buttress was apparently more developed than in the true molars, giving the tooth a great resemblance to the molar of *R. sivalensis*, var. *gajensis* ; from which it is, however, distinguished by its higher crown. The tooth has also a strong resemblance to $\underline{\text{mm. }4}$ of *R. sivalensis*, but has likewise a higher crown. If the serial and specific determination of this tooth be correct it indicates a resemblance between the milk-teeth of the typical *R. sivalensis*, of *var. gajensis*, and the present species, not existing in the true molars.

1 Seen even in the specimen represented in plate II., fig. 5, which is associated with the upper teeth of fig. 4.

2 Since it is now pretty clearly proved that the outer mandibular cutting teeth of the rhinoceroses are canines, and not incisors, they will in future be so termed.

3 Even if any of these milk-molars be wrongly assigned, this will not interfere with the inference drawn from the present specimens as to the existence of a fifth Siwalik rhinoceros.

4 *Supra.*, vol. II., pl. VII., fig. 3. 5 *Ibid.*, pl. VI., fig. 2. 6 Not clearly shown in the figure.

7 *Supra.*, vol. II., p. 34. 8 *Ibid.*, pl. VII., fig. 4. 9 *Ibid.*, pl. III., fig. 2 : vol. I., pl. V., fig. 4.

Further comparisons.—Having now described all the known dental and mandibular remains of the present species; and its distinctness from the other named Siwalik species having been indicated; it remains to institute a wider range of comparisons. Commencing with the non-Siwalik Asiatic species, *R. deccanensis*[1] is distinguished by the absence of mandibular cutting teeth, and of an ante-crochet to the upper true molars, which are furnished with combing-plates. The upper premolars are, however, strikingly like those of the present species, but are distinguished by the greater development of the crochet, and the shape of the cingulum; which forms an inverted V, instead of an oblique line on the inner surface of the crown. The molars of *R. namadicus* are unknown. The last upper molar of the doubtfully distinct *R. sinensis*[2] has no ante-crochet.

Of the existing species, the large unicorn Indian rhinoceros is distinguished by its complex upper molars; while those of the Javan and Sumatran species[3] are of the *R. sivalensis* type. The two African species are distinguished by the absence of permanent cutting mandibular teeth; the same character also obtaining in *R. pachygnathus* of the Pikermi beds. The four species of the higher pliocene and pleistocene of Europe are likewise distinguished by the same character; as well as by the absence of pm. 1, which is shown by the specimen represented in plate II., fig. 4, to have been present in the Búgti species. It may be added that *R. tichorhinus* is widely distinguished by the complex structure of its upper molars[4]; while in *R. megarhinus*[5] (woodcut fig. 3), and *R. leptorhinus*,[6] Ow., the upper cheek-teeth have not such a distinct ante-crochet, such a stout cingulum to the premolars, or such a distinct tubercle at the entrance to the median valley; the crochet is moreover always larger. In *R. etruscus*,[8] which Prof. Boyd Dawkins considers to be allied to the miocene forms, the upper premolars have a well-developed cingulum, and a distinct ante-crochet exists in the true molars. This species is, however, readily distinguished by the cingulum of the premolars being less prominent, and running straight across the colles; both of which have the same inward extent. The

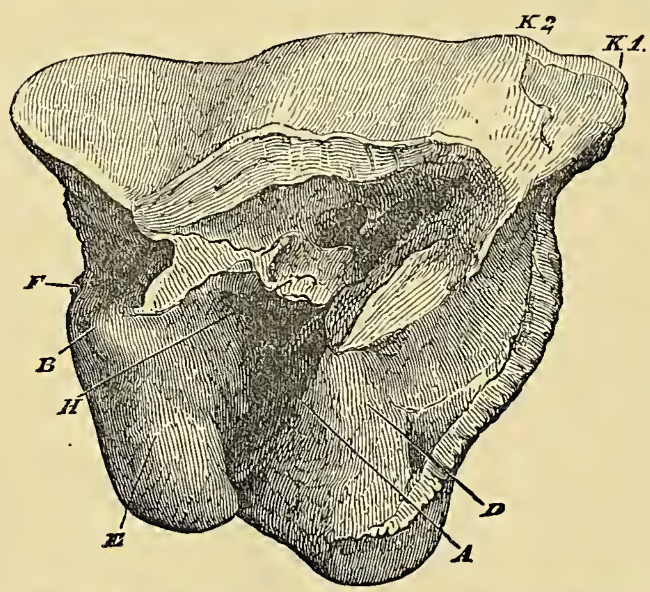

Fig. 3. *Rhinoceros megarhinus*,[7] Christol. Second right upper true molar, slightly worn. 1/1. *A*, median valley; *D*, anterior collis; *E*, posterior do.; *F*, posterior valley; *H*, crochet; *K* 1, *K* 2, first and second costæ. Pleistocene, England.

1 *Supra.*, vol. I., p. 1, pls. I.—III.
2 Owen, 'Quart. Journ. Geol. Soc.,' vol. XXVI., pl. XXIX., fig. 1.
3 The so-called *R. lasiotis* and *R. inermis* are not distinguishable by dental characters from the Sumatran and Javan species.
4 Owen, "Brit. Foss. Mamm. and Birds," fig. 122, p. 329.
5 Lortet and Chantre, 'Arch. d. Mus. d'Hist. Nat. d. Lyon,' vol. II., pl. XVII.
6 Owen, *op. cit.*, fig. 141, p. 373.
7 The writer is indebted to Prof. Boyd Dawkins for this figure.
8 Boyd Dawkins, 'Quart. Journ. Geol. Soc.,' vol. XXIV., pl. VII.

ante-crochet of the true molars is also smaller; and the crochet of m. 3 extends nearly, or completely, across the median valley.

As it will be shown below that the Búgti teeth almost certainly belong to an *Aceratherium*, it will be unnecessary to point out the differences between them and the molars of the other species of *Rhinoceros*; none of which resemble them very closely: and further comparisons may accordingly be confined to *Aceratherium*. In *A. incisivum*[1] the upper molars very closely resemble the larger Búgti teeth; the general plan of structure being precisely the same: the buttress is, however, somewhat more developed, the first costa placed more internally, the crochet larger, the tubercle at the entrance to the median valley generally less conspicuous, and the ante-crochet rather smaller in the European form; these differences being most conspicuous in an early stage of wear.[2] The premolars of the two are almost indistinguishable; and the fossettes formed on the well-worn molars are likewise precisely similar. The mandible presents, however, considerable differences in the two forms; the inferior border of the horizontal ramus of the European species[3] being straight, and the ramus itself preserving nearly the same vertical thickness throughout its length. The lower canines are much larger, and the cheek-teeth have a more distinct cingulum. Although these differences are in all probability of sufficient importance to indicate the specific distinctness of the two forms, yet the resemblances are so strong as to render it certain that they were extremely closely allied; and it may, therefore, be inferred that the Búgti rhinoceros was in all probability an *Aceratherium*.

It does not appear that the upper molars of any other European species of that genus approach as closely to the Búgti teeth: those of *A. lemanense*,[4] and *A. croizeti*[5] being distinguished by the larger buttress, and the absence of the crochet; and the lower molars of the former[6] having a strongly developed cingulum. In *A. goldfussi*[7] the upper molars have a conspicuous buttress, as in *A. perimense*: the ante-crochet is very slightly developed, and there is no tubercle at the entrance to the median valley of m. 3. *A. velaunum*[8] is readily distinguished by its shortened mandible, and the peculiar form of its lower molars. The upper molars of *A. minutum*[9] have a large buttress, and apparently no distinct tubercle at the entrance to the median valley.

In the so-called *R. austriacus*, Peters,[10] of the middle miocene of Styria, which

1 Kaup, "Beiträge," pt. I., pl. IV. (the figure is very small, but being a photograph permits of enlargement with a lens: a cast of the original is in the British Museum). Blainville, "Ostéographie," Genus Rhinoceros, pl. XII. (*R. incisivus* de Sansan). The teeth in Kaup's specimen are slightly less worn than in the specimen represented in pl. I., fig, 1.

2 Compare pl. I., fig. 2, with fig. 62 (p. 58) of "Les Enchainements du Monde Animal—Mamm. Tert.": the two teeth are in about the same stage of wear.

3 Kaup, *op. cit.*, pl. 6.

4 Blainville, "Ostéographie," Genus Rhinoceros, pl. XII. (*R. incisivus* d'Auvergne).

5 Filhol, 'Ann. d. Sci. Geol.,' vol. XI., pp. 78-9.

6 Gaudry, *op. cit.*, fig. 59.

7 Kaup, *op. cit.*, pl. II. Gaudry, *op. cit.*, fig. 64 (*R. brachypus*).

8 Filhol, "Mammifères Fossiles de Ronzon," pl. XII.

9 Kaup, *loc. cit.*

10 'Denks. k. Ak. Wiss.,' vol. XXX., 1870, p. 46, pl. II. In the second volume of the present work this species is referred to *Rhinoceros*.

from the structure of its upper cheek-teeth probably belongs to *Aceratherium*, the upper premolars are readily distinguished from those of the Búgti species by the absence of an ante-crochet, the larger crochet, the more prominent second costa, the less complete cingulum, and the larger tubercle at the entrance to the median valley.

With regard to the American acerotheroids,[1] there is considerable difficulty in being perfectly sure that none of them are specifically the same as the Búgti form, owing to the circumstance that many of them have been only described in a preliminary manner, and that in many cases where figures have been given they are on such a small scale as to be useless for the detection of minute points of difference. It is, however, improbable that any one of the American forms should be specifically the same as an Indian species. Of those that have been figured the one that apparently comes nearest to the latter is *A. (Aphelops) fossiger*,[2] in which, as far as can be seen from the small figure, the upper molars have a very small buttress, and a large ante-crochet: but apparently no tubercle at the entrance to the median valley.

Specific distinctness and affinities.—As the result of the foregoing comparisons, it seems impossible to identify the Búgti rhinoceros with any described species; and it accordingly appears entitled to a separate specific name. The strong presumption that this species belonged to *Aceratherium* has been already indicated; and it is proposed that it should be known as *A. blanfordi.* The larger race may be distinguished as variety *majus*, and the smaller as variety *minus.* The remains of the former race indicate an animal somewhat exceeding in size full grown individuals of the typical Sumatran rhinoceros; while those of the latter are not larger than the small race of that form, which was named *R. niger* by Gray. As there is such an amount of variation in the size of the Búgti species, it has been thought that nothing would be gained by giving measurements. In the absence of the cranium it is impossible to say whether *A. blanfordi* was really hornless, but such was not improbably the case; although it is necessary to assume that those forms of the genus which come nearest to *Rhinoceros* were most probably furnished with a rudimentary nasal horn.[3] That the species was closely allied to *A. incisivum*[4] there can be no reasonable doubt; and there are also strong indications of its relation to the earlier races of the *R. sivalensis* type; a relationship of which traces are retained in the milk-molars of the later race of that type. It is, moreover, not impossible that the pleistocene *R. deccanensis* may have been a descendant from the same stock as *A. blanfordi*, since there is such a remarkable resemblance in the structure of their upper premolars. It is also conceivable that the small undetermined skull in the British Museum from the upper Siwaliks alluded to on page 4, may indicate a species connecting *A. blanfordi* with *R. deccanensis*, since there is a great similarity in the structure of their molars. The suppression of the buttress of the upper molars

1 *Supra*, vol. II., pp. 20, 21.

2 Cope, 'Amer. Nat.,' Dec., 1879, fig. 3, p. 771*e*.

3 The writer is convinced that it is almost or quite impossible to draw any real distinction between *Aceratherium* and *Rhinoceros.*

4 This species occurs in the Eppelsheim beds; and possibly in those of Pikermi and Mont Léberon.

which occurs in some of the most specialized recent and later tertiary rhinoceroses probably indicates that the stock of *A. perimense* (in which this buttress is strongly developed) diverged at an early stage from that of *A. blanfordi* (in which the buttress is small). It may be mentioned that the ante-crochet of the upper molars of the rhinoceroses is another feature which disappears in the later forms; being quite unknown in all those of the present day.

It thus seems probable that *A. incisivum*, *A. blanfordi*, and *R. sivalensis*, var. *gajensis* had a common ancestry in some part of the miocene; and that the latter form gave origin to var. *intermedius* of the lower Siwaliks, which overlie the Gáj beds, and that again to the typical *R. sivalensis* of the upper Siwaliks, from which the living Javan rhinoceros may have descended. The exact relationship of *A. blanfordi* to *A. incisivum* cannot yet be determined; neither is it certain in which direction the migration of the connecting forms took place. From the occurrence of the Gáj variety of *R. sivalensis* in the upper miocene of India, and that of *A. incisivum* in the upper miocene, and possibly in the lower pliocene, of Europe, and from the distribution of *A. blanfordi* (as noticed below), it seems, however, not improbable that the common ancestral form originated in the countries between India and Europe, and that the Styrian *A. austriacum* may be another branch of the same stock.

Distribution.—Remains of *A. blanfordi* have been obtained from the Punjab and the Búgti districts; and whereas the species appears to have been very rare in the former, it appears to have been as common in the latter area. This is noteworthy, since it would be expected that an Indian species exhibiting affinity with a European form would occur most abundantly on the western side of the Indian area.

A considerable part of the skeleton of the smaller race of the present species has been obtained and may perhaps form the subject of a future memoir.

Family: *EQUIDÆ.*

Genus: HIPPOTHERIUM, Kaup.

Species: Hippotherium antilopinum, Falc. and Caut.

Object of present notice.—A large series of the remains of this species (together with those of *H. theobaldi*) have been described in the third part of the second volume of the present work; but at that time no specimen of the cranium was known. This desideratum has been supplied by the specimen forming the subject of the present notice; which has been already briefly alluded to in the 'Records'[1] for 1883.

Cranium.—The cranium mentioned above is the property of Mr. Theodore Cooke, LL.D., F.G.S., of Poona, India, who has kindly lent it for description. It was obtained from the Siwaliks of Perim Island; and is represented, of half the natural size, in figures 1 and 2 of plate III.: the cheek-dentition of the left side

[1] Vol. XVI., p. 94.

being represented of the full size in fig. 3 of the same plate. The specimen has lost its two extremities, the crowns of the cheek-teeth of the right side, and the outer walls of some of those of the opposite side, but is otherwise in excellent preservation; many of the cranal sutures being distinctly visible. The condition of the teeth shows that the skull belonged to a fully adult, though not an old individual.

The grinding surfaces of the teeth cannot be completely cleaned from matrix; although this has been accomplished sufficiently to exhibit the complete isolation of the anterior pillar (*e*),[1] characteristic of *Hippotherium*; as well as the complex plication of the dentine and enamel in the central part of the crown, which is especially well-marked in both the Indian species described in the second volume. The anterior pillar (*e*) is less prominent and less elongated in cross-section than in the teeth of *H. theobaldi* figured in the same volume[2]; while the posterior pillar (*f*) is not constricted at its junction with the inner column, as is the case in little-worn teeth of that species,[3] and is larger than in well-worn teeth of the same.[4] In all these respects the teeth of the Perim skull agree with those of *H. antilopinum*[5]; as well as with the isolated tooth from the Punjab of which a polished transverse section is represented in plate III., fig. 4, of this volume. In the following table the dimensions of the Perim skull are compared with those of the three maxillæ referred to *H. antilopinum* in the second volume[6]; *viz.:*

	Previous specimens.			Perim skull.
Width of palate posteriorly			2·0	2·8
,, ,, ,, between pm. 4			1·9	2·6
Length of series of cheek-teeth	5·3			5·8
,, ,, three true molars	2·36		2·5	2·67
,, ,, pm. 2	1·25			1·25
Width ,, ,, ,,	0·83			
Length ,, ,, 3	0·96	0·96		0·96
Width ,, ,, ,,	0·95	0·95		1·04
Length ,, ,, 4	0·93	0·9	0·9	0·92
Width ,, ,, ,,	0·86	0·91	0·9	
Length ,, m. 1	0·8	0·81	0·8	0·88
Width ,, ,, ,,	0·85	0·88	0·9	
Length ,, ,, 2	0·85	0·82	0·8	0·87
Width ,, ,, ,,	0·76	0·72	0·85	0·93
Length ,, ,, 3	0·8		0·85	0·98
Width ,, ,, ,,	0·55		0·75	0·83

It will be observed that the teeth and palate of the Perim skull are somewhat larger than those of either of the other specimens, although the teeth are still considerably smaller than those of *H. theobaldi* figured in the second volume. It will also be observed that in the Perim skull the length of pm. 3 is less than its width, the reverse being the case in the other three specimens. Analogous differences prevail, however, in the latter, since the length of pm. 4 of the specimen in the first column exceeds its width, the reverse prevailing in the other two specimens: these differences need not,

1 For the terms employed in the description of the cheek-teeth of the horses, see vol. II., p. 73.
2 Plate XI., fig. 3. 3 *Ibid.* 4 Vol. II., pl. XIII., fig. 2.
5 *Ibid.*, pl. XI., fig. 1. "F.A·S.," pl. LXXXIII., fig. 18. 6 Page 76.

therefore, be of more than individual value, if all the three first specimens are correctly referred to the same species.

It appears from the foregoing comparisons and measurements that the Perim skull agrees so nearly with *H. antilopinum* that there seems no reason for assigning it to another species[1]; although its large size tends to remove one of the distinctions between that species and *H. theobaldi*.

Accepting the provisional reference of the skull under consideration to *H. antilopinum*, its distinctive characters will be exhibited in the best way, by at once comparing it with the skull of *H. gracile*. Regarding the teeth, no more need be said except that there are no signs of the presence of $\underline{\text{pm. 1}}$; which exists as a small tooth in some specimens of *H. gracile*: this absence is the more remarkable since this tooth persists in both the Siwalik species of *Equus*. The Perim skull agrees with that of its European congener[2] in its comparatively small size; as well as in its general contour, and absolute size. The two skulls also agree in the presence of two cavities in the outer surface of the maxilla, one of which (*a*) may conveniently be termed the anterior, and the other (*b*) the posterior maxillary cavity. There is, however, a very great difference in the shape and position of the former cavity in the two skulls. In *H. gracile* the posterior, or so-called larmial, cavity is very large, extending backwards as far as the anterior border of the lachrymal, or within less than an inch from the anterior border of the orbit, and having a long diameter of more than three inches. The infra-orbital foramen (*trous sous-orbitaire*) is described by Prof. Gaudry[3] as "*situé, soit a la partie antérieure du larmier, soit en dehors et un peu en avant.*" In the Perim skull, on the other hand, the corresponding cavity (*b*) is comparatively small, and separated by a considerable interval from the anterior border of the lachrymal (*la*), and by a space of two-and-a-half inches from the orbit, its longer diameter being about one-and-a-half inches. The infra-orbital foramen commences at the hinder extremity of the posterior cavity; the latter having merely the appearance of a much dilated aperture of the foramen. The same cavity extends some distance on to the outer surface of the nasal. In advance of the posterior cavity there is a broad, shallow, groove on the surface of the maxilla, conducting to the anterior maxillary cavity (*a*), which is a deep spherical depression immediately in advance of $\underline{\text{pm. 2}}$. The corresponding cavity[4] in *H. gracile* is considerably longer and shallower; but was apparently connected with the posterior cavity by a similar groove, which the crushed condition of the Pikermi skull has to a great extent obliterated. According to Prof. Gaudry[5] distinct traces of this anterior cavity may be seen in the skulls of *E. burchelli* and

1 Seeing that if the broken maxillæ of the existing species of African horses were mingled together it would probably be quite impossible to refer them to more than one species, it is highly probable that the teeth and maxillæ referred to *H. antilopinum* really belong to more than one closely allied species. In the absence, however, of any certain points of specific distinction, the only course at present is to refer them provisionally to the same species, or group, if the latter term be preferred.

2 Gaudry, "Ann. Foss. et Géol. de l'Attique," pl. XXXV.: by the courtesy of Prof. Gaudry the writer has been enabled to compare the Perim skull with a cast of the Pikermi specimen.

3 *Op. cit.*, p. 222.

4 Marked *d* in Prof. Gaudry's figure.

5 *Op. cit.*, p. 222.

E. quagga; and they may also be detected in some skulls of *E. caballus*, where the groove occurring in advance of the infra-orbital foramen not unfrequently terminates above $\underline{\text{pm. }2}$ in a very shallow, but distinct depression.

The smooth form of these cavities in the Perim skull leaves little or no doubt that they once contained a sebaceous gland, like the 'larmier' of the deer and antelopes. In all deer and in most antelopes the larmier is single, and placed almost entirely in the lachrymal; having of course no connection with the infra-orbital foramen. In some antelopes, however (e.g., *Cephalopus maxwelli*, and *C. pygmæa*)[1] a similar cavity is present in the maxilla, which sometimes coexists with the lachrymal cavity, and sometimes replaces it. "In the African water-hogs [*Potamochœrus*] a naso-maxillary pit opens between the eye and snout, rather nearer the eye."[2] In *Oreodon*[3] there is a single cavity which is confined to the lachrymal.

These observations indicate pretty clearly that the maxillary cavities of *Hippotherium* are homologous with those of the Artiodactyla; and are very noteworthy as being one of the very few evidences among the later forms of an original connection between the artiodactyle and perissodactyle modifications of the Ungulata.

The differences in the form of the posterior maxillary cavity in *H. antilopinum*, and *H. gracile* are so great as to leave no question of the specific distinctness of those forms, of which, from the study of the remains then available, some doubt was entertained in the second volume. The diminished size and more advanced position of the same cavity in *H. antilopinum* indicates that this species should be regarded as a form between the European species, and the modern horses; of which the African species retain most traces of their connection with the hippotheres. If the writer's memory serves him correctly, the posterior larmial cavity in the young maxilla of *H. theobaldi* from the Punjab, briefly mentioned in the second volume,[4] is of much larger size, and placed considerably nearer to the orbit than in the Perim skull.

The latter does not appear to differ in any other important points from the European species.

Distribution.—The specimen under consideration extends the range of the species to Perim Island; of which there was only some doubtful evidence at the time of publication of the second volume.

Species: *non. det.* (*? nov.*)

Upper molars.—In the accompanying woodcut (fig. 4) there are represented three associated right upper cheek-teeth of a species of *Hippotherium* lately obtained

1 See Owen, "Anatomy of Vertebrates," vol. III., p. 633.

2 Owen, *op. cit.*, p. 634.

3 Gaudry, "Les Enchainements—Mam. Tert.," fig. 90, p. 81.

4 Page 83. The specimen is No. C. 153, Indian Museum; and the present writer would be obliged to any officer of the G. S. I. who would compare it with the figure of the Perim skull, and communicate the result to the "Records."

by Mr. F. Fedden from the Siwaliks of Perim Island. The crowns of the molars were so encrusted with matrix that it was found impossible to cleanse them, and the specimen has accordingly been ground and polished. The structure of the teeth shows that they undoubtedly belong to a *Hippotherium*; and from the two first teeth being larger than the third, and less fully protruded, it is evident that the former are the two last premolars, and the latter the first true molar.

Fig 4. *Hippotherium* sp. (? *nov.*). Polished section of three right upper cheek-teeth, in a fragment of the maxilla; from the Siwaliks of Perim Island, Gulf of Cambay: Indian Museum (No. C. 273).

In the following table the dimensions of these three teeth are compared with those of the corresponding teeth of *H. theobaldi* figured in the second volume,[1] *viz.*:—

	H. theobaldi.	Specimen.
Length of three teeth	3·3	3·03
,, ,, pm. 3	1·24	1·06
Width ,, ,, ,,	1·12	1·0
Length ,, ,, 4	1·13	1·05
Width ,, ,, ,,	1·15	1·01
Length ,, m. 1	1·0	0·94
Width ,, ,, ,,	1·05	0·95

The united length of the corresponding teeth of the Perim skull of *H. antilopinum* described above is 2·23 inches; and the present specimen is, therefore, nearer in point of size to *H. theobaldi*. Compared with the slightly worn teeth of that species represented in vol. II., pl. XI., fig. 3, the present teeth differ by the section of the anterior pillar (*e*) being sub-circular, instead of markedly ellipsoidal, this character being most marked in the premolars: but agree in having the posterior pillar (*f*) connected with the adjacent inner crescent (*d*) by a constricted neck: the shape of this pillar differs, however, considerably, being elongated in *H. theobaldi* and rounded in the present specimen. In more worn teeth of *H. theobaldi*[1] this pillar becomes almost completely merged with the first inner crescent (*c*); which would apparently never be the case with the present teeth.

In *H. antilopinum*[2] (as in *H. gracile*) the posterior pillar of the upper cheek-teeth is always well developed, and never shows a constricted junction with the adjacent crescent, except in a very early stage of wear: the anterior pillar has much the same shape and position as in the specimen under consideration. In none of the known examples of *H. antilopinum*[3] does the length of pm. 3 exceed its width by so much as in the present specimen. Finally, the teeth of the latter are considerably larger than those of *H. antilopinum*. In the detached tooth represented in plate III., fig. 4, of this volume, which exhibits all the characters of *H. antilopinum*, the line of section is taken at precisely the same level as in the specimen under consideration; and as

1 Vol. II., pl. XIII., fig. 1.

2 Vol. II., pl. XI., fig. 1: 'F.A.S.,' pl. LXXXII., figs. 13, 16, 18: and pl. III., fig. 3, of the present volume.

3 See table on page 12.

the two specimens are from the same side of the jaw, they are excellently adapted for exhibiting the characteristic differences.

As the result of the foregoing comparisons, the present writer (although fully aware of the difficulty of distinguishing the horses solely by means of their dentition) is very strongly of opinion that the teeth under consideration indicate a third Siwalik *Hippotherium*, intermediate in size between the other two species. It was shown in the second volume[1] that a lower jaw from the Punjab provisionally referred to *H. theobaldi* differed in some respects from the type specimen, and it is possible that it may belong to the same form as the upper molars from Perim.

The latter are distinguished from the upper teeth of *H. gracile* in much the same respects as from those of *H. antilopinum*. It appears, moreover, that in all the Indian species the plications of the dentine and enamel are decidedly more complex than in the European species; this character being especially noticeable in well-worn teeth.[2]

The writer has been unable to identify the Perim teeth with any of the American species. They are markedly distinct from *H. calamarium*,[3] in which the hinder pillar of the upper cheek-teeth is remarkably large; and they differ from *H. speciosum*[4] by their superior size, by the more cylindrical anterior pillar, and the greater complexity of the plications of the enamel.

Specific distinctness.—If further discoveries confirm the conclusion that the Perim teeth probably belong to a new species, the name *H. feddeni* may be appropriately applied.

Affinities of the Siwalik species.—The extreme complexity of structure of the molars of the Siwalik hippotheres, coupled with the absence of $\frac{\text{pm. 1}}{}$ in at least one species, points to the conclusion that none of these species were on the direct ancestral line of *Equus*.

Sub-Order: PROBOSCIDIA.

Nomenclature of the milk and premolar series.—In the first volume of this work,[5] owing to the general absence in the Proboscidia of the first deciduous cheek-tooth of the typical eutherian series, the three teeth of this series which are normally developed in the elephantine family of that sub-order were, following Dr. Falconer, respectively termed antepenultimate, penultimate, and last, or more generally, first, second, and third. Although this nomenclature is convenient for the Proboscidia when considered by themselves, it is apt to lead to confusion when treating of the other sub-orders of the Ungulata,[6] and the rest of the Mammalia; and it, therefore, seems best to adopt the nomenclature of the typical eutherian series. In this

1 Page 20, pl. XII., fig. 4.

2 Compare the specimens figured in Gaudry's "Ann. Foss. et Géol. de l'Attique," pl. XXXIV., fig. 7.

3 Cope, "Rep. U. S. Geog. Surv. W. of 100th Meridian," vol. IV., pt. II., pl. LXXV., fig. 1. This species is distinguished from the European and both the other Indian species by the want of the anterior projection of pm. 2.

4 *Ibid*, fig 3.

5 Pp. 198-201.

6 The discrepancy was not so marked when the Proboscidia were regarded as a group of equivalent value with the Ungulata.

memoir, therefore, the three milk-molars of the elephantine Proboscidia will be respectively termed the second, third, and fourth. The same rule will be applied to the premolars; the two teeth of that series usually present being respectively termed the third and fourth. This explanation will, it is hoped, obviate any confusion that might arise from this change of nomenclature.

Family: *ELEPHANTIDÆ.*

Genus: MASTODON, Cuvier.

Number of Siwalik species.—In the first volume of this work[1] five species of Siwalik mastodons were described; two belonging to the trilophodont, and three to the tetralophodont section of the genus. The specimens described in the present memoir indicate a third species of the former section; and illustrate rather more fully the dentition of the other Siwalik species of the same section.

Additional American species.—It may be mentioned that to the list of species of mastodons given in the first volume[2] there should be added the two following undescribed species, *viz.*:

Mastodon (Tetralophodon) campester, Cope.[3] Miocene; N. America.

Mastodon proavus, Cope.[4] Pliocene; N. America.

New proboscidian genus.—Since the publication of the same volume the tusk of a fossil proboscidian from the tertiaries of Australia has been described by Sir R. Owen,[5] under the name of *Notelephas australis.*[6]

Distribution of Indian mastodons.—A very remarkable circumstance in connection with the distribution of Indian mastodons is revealed by the specimens described in the sequel, and those already described in the first volume of this work. This circumstance is that tetralophodont forms are alone found in the typical eastern Siwalik Hills, and Burma, while on the extreme north-western side of India, trilophodont are the dominant, or sole, forms.[7] It is worthy of remark that *Dinotherium* occurs in the region occupied by the trilophodons, while the true elephants are confined to the tetralophodont region, where the intermediate stegodons also occur.

As the dinotheres are essentially European forms, and as there is an Indian species (*D. sindiense*) connecting these with the trilophodons, while it will be shown in the sequel that there are good reasons for regarding at least two of the Siwalik trilophodons as immigrants into India from the west, it is not impossible that the

1 Pp. 202-256. 2 P. 283.

3 'Pro. Amer. Phil. Soc.,' vol. XVII., p. 225, 1877: this species is said to be allied to *M. longirostris.*

4 'Rep. U.S. Geol. Surv.,' 1873, p. 531: this species is known only by one perfect tooth, and some broken teeth, and an astragalus: it is not stated whether it is a *Tetra-* or *Trilophodon.*

5 'Phil. Trans.,' 1882, p. 772.

6 The present writer is fain to confess that he can see no reason for assigning the tusk in question to a new genus.

7 *M. latidens* ranges into Sind: in Dera Búgti and the Búgti Hills no remains of tetralophodons have been found.

dinotheres and trilophodons of the lower Siwaliks of the west of India were, if not the actual progenitors, at least closely connected with the ancestors, of the tetralophodons, stegodons, and true elephants of the upper Siwaliks of the eastern side of that country, although from the existence of *M. latidens* in the lower Siwaliks of Sind some of these transitions may have taken place in the regions to the west of India; the higher forms alone having migrated eastward.[1] It is quite possible to imagine that the tetralophodont *M. latidens*, with its short mandibular symphysis, may have taken origin from the trilophodont *M. angustidens*,[2] with its long symphysis; and the transition from the former to the stegodons and higher elephants has been shown in the first volume to be so extremely gradual and complete, that it is highly probable that the one may be the ancestor of the other.

If then, the true elephants took their origin from the stegodons characteristic of Eastern Asia there must either have been a subsequent western migration towards Europe; or, which is equally possible, the stream went continuously eastward *viâ* China, Japan, and America.[3] That there should be difficulties in some of the above-mentioned views (which are put forth merely in the light of suggestions for further thought) is but natural. Thus if the tetralophodons of India took their origin in that country from the trilophodons, how did the upper miocene tetralophodon of Europe (*M. longirostris*)[4] arise? Could the different tetralophodons have had separate origins from the trilophodons? If moreover true elephants originated in India during some part of the Siwalik period, there is some difficulty in seeing how they should have reached Europe by the time of the upper pliocene. These difficulties, however, though great, are not insurmountable; but before these views can be put into definite shape it requires a further knowledge of the proboscidians of China and Japan; and some information regarding those of Persia and Asia Minor.

Genealogy of the elephants.—A few observations on the genealogy of the elephantine Proboscidia arising from the study of the specimens described in the sequel may be here recorded. The presence in some of the mastodons of simple tetraconodont premolars like those represented in pl. V., figs. 2 and 6, suggests the probability of the descent of these animals from some primal ungulate, furnished with teeth of this simple structure, in which the premolars were as fully developed as the molars. The replacement of the three-ridged last lower milk-molar of the pigs by a much simpler premolar, is very similar to the replacement of the corresponding upper tooth in the trilophodont mastodons by a tetraconodont

1 The stegodons are known to extend to China and Japan ; *Elephas namadicus* also occurring in that country.

2 The ridges and valleys in this species are not quite so simple as in *M. latidens* ; but there seems no reason why the modification in one direction may not have tended to simple, and in another to complex ridges.

3 The association of *E. primigenius* with *E. namadicus* in Japan and the occurrence of the former in N. America is in favour of this view : and it has been shown in the previous volume that the migration of the machærodonts not improbably followed a similar course.

4 The European tetralophodons (*M. longirostris*, *M. arvernensis*), from the very irregular ridges of their molars, cannot be looked upon as on the direct ancestral line of the true elephants.

premolar; and it is merely necessary to assume the addition of an extra pair of columns to each of the true molars of the bunodont Artiodactyla to produce a dentition analogous to that of the simple-toothed mastodons. What the primal ungulate may have been that gave origin to the Proboscidia is at present unknown; that it was intimately related to some of the eocene ungulates of America is almost certain, from the resemblance of their foot-structure to that of the elephants: the dentition of the former indicates, however, that they are probably a branch which diverged at an early date from the proboscidian stock, and are more intimately connected in this respect with the modern Perissodactyla.

The mastodons, and still more the true elephants, may be regarded as animals retaining a very primitive type of skeleton, but whose dentition has reached a very high degree of specialization. The want of specialization in the skeleton may not improbably be due to the huge size of these animals, whereby they have obviated the necessity of modifications on the primitive type of skeleton, which are necessary to produce a limb capable of the rapid flight of animals like the horse and the antelope. Their dentition has been gradually increasing in specialization in order to make the utmost possible use of the diet on which these animals subsist.

The survival of the elephant in India, after so many highly specialized ungulates (*e.g.*, *Sivatherium*) have entirely disappeared, seems to indicate the inherent vitality of a primitive form when once it has attained an amount of specialization in any direction (in this case in dentition, and corporeal bulk) to enable it to hold its own among other animals.

Species 1: Mastodon (Trilophodon) angustidens, Cuv.

Var. palæindicus, *nobis.*

First record of occurrence in India.—It has been stated in the first volume[1] that some of the first-found mastodon remains from the Siwaliks were originally referred to *M. angustidens*, but were subsequently separated under the name of *M. sivalensis.* The only other notice referring to the occurrence of *M. angustidens* in India is one published in 1883[2] referring to some of the specimens forming the subject of the present description. All these specimens, with one exception, which will be noticed in the sequel, were obtained from Dera Búgti.

Third lower true molar.—In order to determine the serial position of the different teeth described in the sequel it has been found necessary to commence with the last teeth of the series; of which a specimen from the right side of the lower jaw is represented in plate IV., fig. 3. This tooth, which is in an intermediate stage of wear, was associated with the second upper true molar represented in figure 2 of the same plate: it carries four transverse ridges and a talon (*ta*); from which circumstance, together with the shape of the crown, and the concave form of the worn masticating surface, it is evidently the last lower molar of a trilophodont mastodon.

[1] Page 248. [2] 'Records,' vol. XVI., pp. 161-2.

The transverse ridges are divided by a fissure traversing the long axis of the crown into inner and outer columns, which have a tendency to an alternate arrangement. Each of the valleys dividing the ridges is blocked by a large accessory column (*a*), placed on the posterior aspect of the transverse ridges, and extending across the median longitudinal fissure. When slightly more worn the dentine surface of each of these accessory columns would coalesce with that of the outer column immediately in front of it, and produce rudely trefoil-shaped dentine islets; and it is evident that in a somewhat earlier stage of wear the antero-internal angle of each of the outer columns (*b*) would have formed a separate smaller anterior accessory column. At the outer extremity of each of the transverse valleys there is a low, blunt tubercle; the separate tubercles being connected by a cingulum. The transverse valleys are comparatively wide at their extremities so that the ridges are not in contact. There is no trace of any cement.

Compared with the corresponding tooth of the Siwalik *M. pandionis*,[1] the present specimen will be found to differ very widely. In the first place, it is of considerably smaller size; while the ridges are lower, and the hind talon is single in place of double: the anterior talon seems also to have been smaller. The accessory columns of *M. pandionis* are much more numerous, being wedged in between the main columns of the ridges, and blocking the transverse valleys to a much greater extent than in the present specimen. The columns composing the transverse ridges in *M. pandionis* are moreover in close contact at their bases, so that the valleys become extremely narrow. The blunt tubercles occurring at the outer extremities of the transverse valleys of the present specimen are not distinctly developed in *M. pandionis*; and the worn dentine surfaces of the latter have no tendency to assume a trefoil shape. Finally, cement is present in large quantities in the molar of *M. pandionis.*

The corresponding molar of *M. falconeri*, the other Siwalik trilophodon, is unknown, but as it will be shown below that the other teeth of the Búgti mastodon are different, the present specimen cannot be referred to that species.

Compared with the last lower molar of *M. angustidens* the present specimen agrees very closely. A tooth of that species figured by H. von Meyer[2] is of precisely the same size, and has the same general contour of the crown, with the exception that the borders of the crown are less curved: and in other European specimens[3] these borders are still less curved. The arrangement of the ridges, and the form of the transverse valleys is exactly the same in the two; and there are the same blunt tubercles at the outer extremities of the transverse valleys. The hind talon of the European tooth is, however, more detached; and consists of only one column. The most important difference between the two teeth consists in the

1 Vol. I., pl. XXXIV., fig. 2; XXXV., fig. 4: the second of these specimens agrees exactly in its degree of wear with the specimen under consideration, and from belonging to the same side, is very favourable for comparison.

2 "Paläontographica," vol. XVII., pl. VII., figs. 3 and 4.

3 Vacek, 'Abhand. k. k. geol. Reich.,' vol. VII., pt. 4, pl. IV., fig. 2.

greater development of the posterior accessory columns (*a*) in the Indian tooth. In the European tooth these are not larger than the anterior accessory columns (*b*), and do not extend on the outer side of the median longitudinal fissure; this causes the blocking of the middle of the transverse valleys to be less complete than in the Indian tooth. In some European specimens[1] the development of the posterior accessory columns is still less; but in others again[2] it is greater, although perhaps never quite so large as in the Indian tooth. There is a considerable degree of variation in the size of the hind talon in European specimens.

It appears, therefore, that the differences between the present specimen and the last lower molar of *M. angustidens* are scarcely, if at all, greater than those occurring between different European specimens of the latter; and it thus seems probable that at the most they should be reckoned merely as of varietal value. The greater development of the accessory columns in the Indian tooth is a step from the typical form of *M. angustidens* towards the more complex tooth of *M. pandionis.*

In the following table the dimensions of the present specimen are compared with those of the corresponding teeth of *M. pandionis*[3] and *M. angustidens*[4]; the specimens of the teeth of the two latter being in the same condition of wear as the Búgti tooth.

	Specimen.	M. angustidens.	M. pandionis.
Total length	5·65	5.85	8·4
Greatest width of first ridge . . .	2·38	2·5	3·3
Height of first ridge	1·0	1·0	1·8
,, ,, hind talon	1·35	0·8	2·6

A smaller tooth of *M. pandionis* has a length of 7·4 inches. The European molar of *M. angustidens* is an unusually small one.

Second upper true molar.—The tooth represented in plate IV., fig. 2, belonged to the same individual as the last specimen.[5] The regular oblong form of the crown shows that it belongs to the upper jaw; while the presence of but three ridges, which are more worn than those of the last lower tooth, shows that it must be the second true molar: it belongs to the left side of the skull. The tooth exhibits a large concavity on its anterior surface, caused by the pressure of the preceding tooth: the crown is so worn that the dentine surfaces of the outer and inner columns of the two first ridges have coalesced; and have also united with those of the accessory columns. In the last ridge the internal column is still separate, and the position of the large anterior accessory column[6] (*a*) can still be detected: the hind talon (*ta*) was evidently well developed; and the large tubercles can be seen at the inner extremities of the transverse valleys.

This tooth agrees in all general characters with the corresponding molar of *M. angustidens*; but is intermediate in size between European specimens of m. 1 and

1 Vacek, 'Abhand. k. k. geol. Reich,' vol. VII, pt. 4, pl. IV, fig 2

2 Compare a specimen figured by De Blainville—"Ostéographie," Genus Elephas, pl. XV.

3 *Supra.*, vol. I., pl. XXV., fig. 4.

4 Meyer, *op. cit.*

5 Inferred from the precise similarity in the mineral condition of the two specimens; and from their agreement in size, and their relative condition of wear.

6 This corresponds to the larger, or posterior, accessory column in the lower teeth.

m. 2.[1] In the Indian tooth, however, the anterior accessory column seems to have been relatively larger; and extended across the median antero-posterior fissure, instead of being confined to its inner side. There appears a certain amount of variation in the degree of development of the accessory tubercles in European specimens of m. 2 of *M. angustidens*[2]; a specimen figured by Kaup[3] being apparently very close to the Indian tooth.

The molar represented in plate IV., fig. 1, is a still more worn specimen of the same tooth: it is slightly wider than the last; but as similar variations obtain among European specimens this difference cannot be considered as of more than individual value. In this much-worn tooth, not only have the dentine surfaces of the separate columns united, but those of the first and second ridges have likewise coalesced; the extremely worn dentine surfaces assuming a regular elliptical shape. Traces of the outer column of the last ridge still persist.[4] Precisely similar conditions of wear obtain in European teeth of *M. angustidens*.[5]

If the two teeth described above be compared with the corresponding tooth of the Siwalik *M. falconeri*,[6] they will be found to differ by their greatly inferior size. They also differ by their smaller hind talon, and the greater development of the anterior accessory column (*a*), and the consequently less regular trefoils formed by the dentine surfaces of the inner columns. The difference in size is indeed so great that the teeth under consideration correspond in this respect with m. 1 rather than m. 2 of *M. falconeri*. An almost unworn molar of that species is represented in vol. I., pl. XXXIII., fig. 3, where it is regarded as m. 1: from its regularly oblong form this tooth is, however, more probably m. 1, of the right side. It exhibits equally well the differences from the teeth under consideration, pointed out in comparing them with m. 2 of the same species. The large fore-and-aft talons are well displayed. From the second true molar of *M. pandionis*[7] the present specimens are likewise distinguished by their greatly inferior size. The crown of the latter (although the different degree of wear of the specimens is not very favourable for comparison) is of a more complex structure, owing to the greater number of accessory columns, and the fine plications into which the enamel is thrown. The form of the worn dentine surfaces is not very unlike in the two; although those of the present species have a greater tendency to a trefoil shape: the tooth of *M. pandionis* is further distinguished by the presence of a large amount of cement. The Búgti teeth agree more nearly in size with m. 1 of *M. pandionis* of which an unworn specimen is represented in plate V., fig. 5: exhibiting well the highly complex crown, with its tall columns. This tooth

1 Specimens of these teeth in nearly the same condition of wear are figured by Herr Vacek (*op. cit.*, pl. V., figs. 3, 4): they are viewed from the outer side.

2 Compare Meyer, *op. cit.*, pl. I., fig. 5: pl. III., fig. 7.

3 "Beiträge," pt. 3, pl. III.

4 As this tooth might be mistaken for m. 1 of *Dinotherium*, it may be well to point out that it is distinguished from that tooth in *D. indicum* (vol. I., pl. XXXI., fig. 2), by the circumstances that in the latter the dentine surfaces of the ridges assume an irregular shape when *most worn*: the reverse obtaining in the present teeth. The molar of *Dinotherium* is also distinguished by its much thicker enamel.

5 Compare Vacek, *op. cit.*, pl. V., fig. 4.

6 *Supra*, vol. I., pl. XXXII., fig. 1.

7 *Ibid*, pl. XXXVA.

is, however, still less favourable for comparison with the present specimens. A much worn left $\underline{\text{m. 1}}$ figured in the first volume (pl. XXXII., fig. 4), as belonging to *M. falconeri*, but which will be shown in the sequel to belong to *M. pandionis*, differs very markedly from the specimens under consideration, with which, from its state of wear, it is very favourable for comparison. In the first place, the crown surface is much more convex antero-posteriorly; while the anterior borders of the worn dentine surfaces are highly convex, instead of nearly straight: and, in the second place, the dentine surfaces of the inner and outer columns coalesce completely in the third ridge before they do in the second; the reverse condition obtaining in the present teeth. Again, the dentine surface of the third ridge of *M. pandionis*, by the absorption of the large double hind talon, becomes much larger than that of either of the others.

In the following table the dimensions of the two specimens under consideration are compared with those of $\underline{\text{m. 2}}$ of *M. falconeri*, *M. pandionis*, and *M. angustidens*[1] from Europe :—

	Present specimens.		M. angustidens.		M. falconeri.	M. pandionis.
Extreme length . .	3·63	3·52	4·52	4·65	5·2	5·1
Width at first ridge .	2·2	2·42	2·8	2·9	3·5	3·6

A specimen of $\underline{\text{m. 2}}$ of *M. angustidens* from Simorre, figured by MM. Lortet and Chantre,[2] has almost precisely the same dimensions as the second Búgti specimen.

Second lower true molar.—The tooth represented in pl. IV., fig. 7, and in pl. V., fig. 3, was obtained from Gandoi. It has been scarcely worn; and from its diminishing rapidly in width towards the anterior extremity must be referred to the lower jaw; and belongs to the left side. From its general resemblance to the teeth already described, it must be referred to the same species; while from its agreeing in size with the upper tooth represented in fig. 2 of the same plate, it must in all probability be regarded as the homologous tooth of the lower jaw; or $\overline{\text{m. 2}}$. The crown carries three transverse ridges, a small anterior, and a large posterior talon (*ta*); the latter carrying two columns. The median longitudinal fissure is distinct; and the transverse valleys are broad; the first of these having a low, blunt tubercle (*tu*) at its outer extremity; the posterior accessory columns (*a*) are larger than the anterior (*b*); and in the first valley the former extends slightly on the inner side of the median longitudinal fissure.

In structure this tooth agrees precisely with $\overline{\text{m. 2}}$ of *M. angustidens*,[3] although it is possible that the posterior accessory column may be slightly larger. In the form of the hind talon, in which there is a certain amount of variation, it is nearest to a specimen figured by Kaup.[4] In size it is somewhat smaller than European specimens of the corresponding tooth.

From the corresponding tooth of *M. falconeri*[5] the present specimen is

1 The specimens figured by Meyer.

2 'Arch. Mus. Hist. Nat. Lyon,' vol. II, pl. XV., fig. 9a.

3 Meyer, *op. cit*, pl. IV., fig. 6: Vacek, *op. cit.*, pl. IV., fig. 2.

4 "Beiträge," pt. 3, pl. III.

5 *Supra.*, vol. I., pl. XXXIII., figs. 1, 4.

distinguished by its greatly inferior size, and by the lesser development of the hind talon, which consists of only one row of columns, and is considerably lower than the last ridge. In *M. falconeri*, moreover, the anterior and posterior accessory columns are more equal in size; and the inner column of each ridge shows a tendency to divide into separate cusps, which is not the case in the tooth under consideration.

The corresponding tooth of a small individual of *M. pandionis*[1] is somewhat larger than the present specimen; and is readily distinguished by its more complex hind talon, and accessory columns; of which the anterior and posterior have coalesced to form two large columns situated in the same transverse line, and extending far on either side of the median longitudinal fissure. The transverse valleys are much narrower, and have no tubercles at their outer extremities; and in consequence of this arrangement are blocked to a much greater degree. There is no tendency to the formation of trefoil-shaped dentine islets in *M. pandionis*, and the section of the enamel displays a crenulated arrangement. The first lower molar of *M. pandionis* represented in pl. V., figs. 1, 1a, of this volume, exhibits the much higher and stouter transverse ridges characteristic of that species; as well as the more complex crown, though the latter character is somewhat less marked than in $\overline{\text{m. 2}}$ of that species.

The dimensions of the specimen represented in pl. IV., fig. 7, are compared below with those of $\overline{\text{m. 2}}$ of *M. angustidens*,[2] *M. falconeri*, and *M. pandionis*.

	Specimen.	M. angustidens.	M. falconeri.	M. pandionis.
Extreme length	3·73	4·4	6·4	4·1
Width at first ridge	1·82	2·17	3·05	
,, ,, third ,, ...	2·2	2·68	3·7	2·6
Height of outer column of do. . .	1·5			

An homologous tooth of *M. angustidens* from Simorre, figured by MM. Lortet and Chantre,[3] has almost precisely the same dimensions as the Gandoi specimen.

First lower true molar.—The specimen represented in pl. IV., fig. 8, is the anterior part of a well-worn left lower true molar; which from its narrower anterior extremity may probably be regarded as the tooth preceding the last specimen, or, the first true molar: if this reference be correct (and it is confirmed by the relative size of $\overline{\text{mm. 4}}$ described below) it must have belonged to a somewhat larger individual than that to which the last specimen belonged. A comparison of the figures will show that this specimen agrees in all essential details with the latter: the space occupied by the first and second ridges is, however, rather greater, indicating the more elongated type of the present tooth: the posterior accessory tubercle (*a*) in the first valley is, moreover, relatively larger, its base extending outwards as far as the tubercle at the entrance of the valley: analogous variations occur in *M. angustidens*. The posterior accessory column is rather larger than in any European teeth of *M. angustidens*, which have come under the writer's notice; and the specimen agrees, therefore, in this respect with the last lower molar already described. The points in

1 *Supra.*, vol. I., pl. XXXIV., fig. 1: the specimen belongs to the opposite side of the jaw.

2 Vacek, *op. cit.*, pl. IV., fig. 2.

3 *Op. cit.*, pl. XV., fig. 15.

which this tooth differs from $\overline{\text{m. 1}}$ of *M. pandionis* will be alluded to under the head of that species.

The still more worn hinder portion of a right lower molar represented in pl. V., fig. 7, from its being narrower and somewhat smaller than the second true molar described above, may in all probability be likewise regarded as a first true molar. This tooth is of a shorter type than the last specimen; but otherwise agrees with it. It is of very nearly the same size as an homologous upper tooth figured by H. von Meyer[1]; and might have belonged to an individual of the same size as that to which the tooth represented in pl. IV., fig. 1 belonged.

Fourth lower milk-molar.—The perfect tooth represented in pl. IV., fig. 5, evidently belongs to the same species as the preceding specimens; and from its small size must be the last milk-molar, probably belonging to an individual of the size of that to which the first true molar represented in fig. 8 of the same plate belonged. It is of nearly the same size as a last milk-molar of *M. angustidens* figured by Kaup,[2] but rather smaller than one figured by MM. Lortet and Chantre.[3] The specimen is in a middle stage of wear; and is almost a miniature facsimile of the tooth represented in fig. 7 of the same plate. It agrees with European specimens of $\overline{\text{mm. 4}}$ of *M. angustidens*, with the exception of the somewhat larger size of the posterior accessory columns (*a*). The cingulum and the tubercles at the outer extremities of the transverse valleys (*tu*) are particularly well displayed. The length of this tooth is 2·4; its greatest width 1·37; and the height of the worn inner column of the third ridge 0·78 inch. The last lower milk-molar of *M. pandionis*[4] has a higher crown; and a length of 3·4, with a width of 2·3 inches. The corresponding tooth of *M. falconeri* is unknown.

Last upper premolar.—At least two types of last upper premolars of trilophodont mastodons are known from the Siwaliks; but as these have never been found associated with the true molars there is very great difficulty in assigning them to their respective species; and their reference must accordingly be considered more or less provisional. In pl. V., figs. 2, 2a, there is represented a tooth from Dera Búgti, which, from certain reasons noted below,[5] and from its resemblance to $\underline{\text{pm. 4}}$ of *M. angustidens*, is provisionally referred to the present form. The tooth is in germ; the crown not having become attached to the root. The sub-quadrate shape of the crown indicates that it should be referred to the upper premolar series, of which it must be the last; and the forward inclination of the columns indicates that it

1 *Op. cit.*, pl. III., fig. 5: the specimen is called the last milk-molar, but is evidently $\overline{\text{m. 1}}$: many of the earlier teeth figured by Meyer are classed one place too early in the series

2 *Op. cit.*, pt. 3, pl. I., fig. 2. 3 *Op. cit.*, pl XV., fig. 4. 4 *Supra*, vol. I, p 220.

5 Since describing the remains of mastodons in the first volume the writer has found out that worn teeth of the premolar series may generally be distinguished from those of the milk-molar series by the fact of the hinder ridge being more worn than the front one; the reverse condition generally prevailing in the milk-molars. Thus the specimen represented in pl. V., fig. 6, from the forward inclination of the ridges is referred to the right side; and consequently from the hind ridge being the most worn, is probably a premolar: the squared form of the crown shows that it belongs to the upper jaw. The cause of the earlier wear of the hind ridge in the premolars is that this part of the tooth comes in contact with the already fully protruded milk, or true molar immediately behind it in the dental series of the opposing jaw.

belongs to the right side of the jaw. The transverse valley is fairly open, but is blocked for a short distance between the two inner columns; the hindmost of which (*a*) consists of three distinct tubercles: there is a well-marked cingulum surrounding the greater part of the crown, but this does not extend across the inner face of the hindmost inner column: a distinct tubercle (*c*) occurs behind the second outer column. The columns are relatively high, and the enamel is comparatively smooth. The form of the crown is very close to that of a European specimen of pm. 4 of *M. angustidens* figured by H. von Meyer[1]; both specimens showing the stoppage of the cingulum on the hinder inner column, and the detached posterior tubercle (*c*). The variations between the two specimens are, indeed, not greater than those between different European specimens of pm. 4 of *M. angustidens*[2]; and from this resemblance, and the circumstance that the enamel is smooth, instead of corrugated, the present specimen is provisionally referred to the same species as the molars already described, rather than to *M. pandionis*, to which from its larger size it might at first sight be referred. As *M. falconeri* is not known to occur in Dera Búgti, it is improbable that the present specimen belongs to that species.[3] The characters distinguishing it from the homologous tooth provisionally referred to *M. pandionis* will be noticed under the head of that species: it presents no resemblance to pm. 4 of the Siwalik tetralophodons.[4] The length of the specimen is 1·96; its greatest width 1·5, and the height of the first outer column 1·24 inches: the outline of the crown of the corresponding detached tooth figured by H. von Meyer more nearly approaches a square.

Third upper premolar.—The small germ of a right third upper premolar represented in figs. 4, 4a of pl. V., agrees well in relative size with the last specimen, and may, therefore, not improbably be referred to the same species. This reference is confirmed by the almost complete similarity of the tooth to European specimens of pm. 3 of *M. angustidens*[5]; the difference between the Indian tooth and one of the European specimens figured by H. von Meyer, being not greater than those between the two European specimens figured by the same writer. The Indian and European teeth agree precisely in size.

Last lower premolar.—The difficulty experienced in referring the last upper premolars to their respective species is so enhanced in the case of the corresponding lower teeth, that it has been found impossible to arrive at any satisfactory conclusion. In the first volume of this work[6] two small teeth from Sind were provisionally regarded as being the last lower premolars of *M. pandionis*; while a similar tooth, said to have been obtained from the Deccan,[7] was also mentioned; and the three

1 *Op. cit.*, pl. III., fig. 12.

2 *Ibid*, fig. 1: for the serial homology of the teeth of that specimen, see vol. I., p. 200.

3 For the earlier teeth of this species see below.

4 *Vide supra*, vol. I, pl. XXXVII, fig. 6, and XL.

5 Von Meyer, *op. cit*, pl. III., figs. 1, 8, 9, 10.

6 Pl. XXXV., fig. 2: p. 221.

7 This tooth is now in the British Museum (No. 40,787): some remarks on its probable place of origin will be made under the head of the next species.

were shown to be practically indistinguishable from $\overline{\text{pm. 4}}$ of *M. angustidens*. The more worn condition of the second ridge in some of these teeth seems to indicate that the serial determination is in those cases correct: but it is quite possible that other similar teeth may be milk-molars. Among the specimens obtained by Mr. Blanford from Dera Búgti are two very similar teeth of the left side; one of which is well worn, and is represented in pl. IV., fig. 6; while the other is almost unworn, and is represented in figure 4 of the same plate. The unworn specimen shows the two accessory cusps (*a*, *b*) in the transverse valley; which form a worn disc in the other specimen. In the latter the plane of wear of the last ridge is horizontal; while in the specimen figured in the first volume, and in the one in the British Museum, this plane inclines towards the anterior ridge: a similar inclination existing in the specimen figured in pl. V., fig. 4. It is just possible that this variation may indicate specific or serial differences. The transverse valley in the unworn specimen appears rather narrower than in the others; but none of the five teeth present any characters by which they can be referred to the present, rather than to the next species, or *vice versâ*. There is a certain amount of probability that some of these or nearly similar teeth may belong to *M. falconeri*; in which case they may be milk-molars. The dimensions of the two specimens represented in plate IV. are as follows, *viz.*:—

	A 430.	A 431.
Extreme length	1·6	1·6
,, width	1·34	1·35
Height of inner column of first ridge		1·09

Mandible.—Among Mr. Blanford's Dera Búgti specimens there is a fragment of the right ramus of the mandible of a mastodon,[1] containing $\overline{\text{m. 2}}$ and $\overline{\text{m. 3}}$, with their crowns hammered off. The base of the crown of the latter tooth precisely resembles the last lower molar represented in plate IV., fig. 3, so that there is no doubt that the two should be referred to the same species. The length of the tooth in this jaw must, however, have been slightly greater than that of the detached specimen. The fangs of $\overline{\text{m. 2}}$ indicate a tooth similar to the specimen represented in pl. IV., fig. 7, but of rather larger size. Below the roots of the molars there is a long cavity, filled with matrix, indicating the presence of large incisors.

From its imperfect condition the mandible, which is broken off a short distance in front of $\overline{\text{m. 2}}$, has not been figured, but it is of considerable importance in completing the evidence connecting the specimens already described with *M. angustidens*. As far as its imperfect condition admits of comparison, the Búgti mandible agrees precisely with a specimen of the mandible of the latter species figured by Kaup,[2] and was evidently furnished with a similarly produced symphysis: its characteristic points are the straightness of the inferior border, the increase of vertical depth at $\overline{\text{m. 2}}$ as compared with $\overline{\text{m. 3}}$, and the great lateral compression. The vertical depth at $\overline{\text{m. 3}}$ is 5·85, and at $\overline{\text{m. 2}}$ 6·65 inches: the transverse diameter is 4·1 inches.

[1] Ind. Mus., No. A. 435.

[2] Kaup, "Beiträge," pt. 3, pl I., fig. 1.

The Búgti jaw is distinguished from the mandible of *M. pandionis*[1] by its inferior size, and by the outer surface being convex, in place of concave[2]: as the symphysis of the former is wanting, it is not possible to make comparisons between that part; but it is probable that the Búgti jaw closely resembled in this respect European specimens of *M. angustidens*. The mandible of *M. falconeri*[3] presents no resemblance to the Búgti specimen.

Summary.—As the result of the foregoing comparisons it appears that the present species of mastodon is specifically distinct from both the other Siwalik trilophodons; but that it agrees so closely with the European *M. angustidens* that there seems no alternative but to refer it to the same species. Since, however, there appears a tendency in the Indian form to a slightly more complex structure of the molars, and to a greater curvature of the borders of the crown of $\overline{\text{m. 3}}$, it may be advisable to mark this local variation by distinguishing the Indian race under the name of *M. angustidens*, var. *palæindicus*.[4] It is noteworthy that in both the above-mentioned respects the Indian race makes a step in the direction of *M. pandionis*.

Distribution of M. angustidens.—The species has a wide geographical distribution in Europe; thus it has been found in Gers (Simorre and Sansan), in the south of France; in Switzerland; in Bavaria (Munich); in Styria (Eibiswald); in Bohemia (Franzensbad); and in Austria-Hungary, where it has been recorded from Buda-Pest, from near Staatz, and elsewhere.[5] The specimens from Buda-Pest were obtained from the Sarmatian stage; those from Gers and Styria coming from the so-called mid-miocene. In India the species has been obtained solely on the extreme western side of the continent, where no other Siwalik mastodons, with the exception of *M. pandionis*, are yet known to occur. This probably indicates that the species ranged over the whole of the countries between Europe and the western side of northern India, but did not extend far into that continent. Remains of a mastodon have been recorded from Persia,[6] and it is not impossible that these may eventually turn out to belong to the present species.

From the later tertiaries of N. America a species of trilophodont mastodon has been described under the name of *M. obscurus*,[7] which is considered both by its original describer, and by Herr Vacek,[8] as closely allied to *M. angustidens*: of which it is possible that it may be merely a local race. There appears to be some doubt whether the American species is of miocene, or pliocene age, but it is not improbably the latter.[9] It is noteworthy that the last lower molar of this form has

1 *Supra.*, vol. I., pp. 216-7.

2 The writer has not had the opportunity of putting the two specimens in juxta-position: if this were done it is probable that other differences would be detected.

3 *Supra*, vol. I., pp. 207-8, pl. XXXIII., fig. 1.

4 The term *indicus* would have been preferable, but as the writer is persuaded that the elephants and mastodons will eventually have to be united in one genus, it might lead to confusion.

5 This distribution has been mainly taken from Herr Vacek's memoir, already cited.

6 Introduction to vol. II.

7 Leidy, "Extinct Vertebrate Fauna of the Western Territories," pls XXI -XXII.

8 *Op. cit.*, p 24.

9 Herr Vacek alludes to it as undoubtedly of pliocene age: in the first volume of the present work it is doubtfully referred to the miocene.

the accessory columns relatively small, and the lateral borders nearly straight; indicating that while farthest removed in space, it is likewise farthest removed in structure from the Indian race.

The circumstance that the Indian race apparently marks the extreme eastern range of the species, and the occurrence of an allied form in America, seem to lead to the conclusion that the original home of the group was in Europe or Western Asia: from whence it migrated east and west.

Species 2: MASTODON (TRILOPHODON) PANDIONIS, Falconer.

Introductory.—In the first volume of this work[1] a considerable series of the teeth and jaws of the present species are described and figured. Many of these specimens were obtained from the Siwaliks of the Punjab, and others from Sind; but all the type specimens were said to have been obtained from the Deccan, by Col. Sykes. An examination of these specimens, which are now in the British Museum,[2] has, however, shown that in mineralogical condition they correspond precisely with the Siwalik fossils of Sind; exhibiting the characteristic gray weathered surface of the enamel. Among Col. Sykes' specimens having the same reputed origin there is the small tooth[3] represented in woodcut fig. 6, provisionally referred to *M. falconeri*, which precisely agrees with another specimen presented by Col. Sykes to the British Museum (No. 32,503), and obtained from Sind. The only region in the Deccan where mammalian remains have been obtained, is the valley of the Krishna, and it has been suggested[4] that Col. Sykes' specimens were obtained from the upper part of that valley. The Krishna valley fossils are, however, in an extremely fragile and unmineralized condition; whereas Col. Sykes' specimens are very hard and stony. There are the additional circumstances that the Krishna deposits are of pleistocene age, while in Sind the remains of *M. pandionis* occur in the lower Siwaliks; and that no strata equivalent to the Siwaliks are known in southern India. For these reasons, and especially since it is certain that one mastodon molar, precisely similar to one of the reputed Deccan specimens, was obtained by Col. Sykes from Sind, it appears to the present writer to be highly probable that the whole of his specimens were obtained from the latter region.[5]

First upper true molar.—The specimen represented in pl. V., fig. 5, is the one alluded to in the first volume (p. 214) as being a first upper molar of which the locality is unknown. At that time it was thought to be distinct from the specimen described in the note by Dr. Falconer quoted on pp. 213, 214 of the same volume as

[1] Pp. 213, 292: pls. XXXIV.-XXXVI.

[2] One of these specimens is represented in plate V., fig. 5. All the specimens are stated in the "Palæontological Memoirs" to have been presented to the India House by Col. Sykes: the figured specimen was, however, found in Falconer's private collection.

[3] B. M., No. 40,788.

[4] "Manual," pt. I., p. 390.

[5] It is just possible that the confusion may have arisen in the following manner:—It was known that Col. Sykes obtained a large collection of mesozoic fossils from the Deccan, and if the mastodon remains were not fully labelled, nothing is more likely than that they should have been assigned to the same locality.

the penultimate upper molar, but a subsequent comparison with that description has shown that it is really the same.[1] A comparison with the figure of m. 2 given in plate XXXVA. of the first volume, will show that it is really the first upper true molar of the left side. Nothing need be added to Falconer's description, except that traces of cement are to be seen in the transverse valleys; and that the columns are relatively higher than in *M. angustidens*, and the enamel is thrown into vertical corrugations. The length of the specimen is 4, and its extreme width 2·5 inches.

In pl. XXXII., fig. 4, of the first volume of this work a much-worn upper true molar of a trilophodont mastodon from the Punjab, is figured as m. 1 of *M. falconeri*, although it was noticed[2] that it differed from the other true molars of that species in having irregular, instead of trefoil-shaped, dentine islets. It now appears from a comparison with the figure of m. 2 of *M. pandionis* given in plate XXXVA.[3] of the same volume, as well as from the crenulated edges of the enamel, the obliquity of the valleys, and the forward inclination of the ridges in the much-worn molar, that the latter should likewise be referred to *M. pandionis*; of which it is m. 1. It differs widely from the specimen now regarded as m. 1 of *M. falconeri*[4]; in which species the enamel of the true molars is smooth,[5] the columns of the ridges nearly upright, and the valleys run straight across the crown.

First lower true molar.—The specimen represented in plate V., figs. 1, 1a, was obtained by Mr. Blanford from Dera Búgti; and from its narrow shape and the three ridges borne on the crown is evidently the lower molar of a trilophodon, belonging to the left side of the jaw. The crown is still in germ, being untouched by wear; and has lost a small portion of its postero-external angle. The columns of the ridges and talons are taller than in the first and second lower molars of *M. angustidens* (pl. IV., figs. 7, 8: pl. V., figs. 3, 7); and the transverse valleys are narrower and more blocked. The accessory columns are, moreover, much more numerous; and consist of a confused agglomeration in each transverse valley, instead of a pair only: there is also an extra one of these columns wedged in between the hind talon (*ta*) and the outer column of the last ridge. The enamel, instead of being smooth as in *M. angustidens*, is thrown into vertical corrugations; which in a worn condition would give a crenulated appearance to the rings of enamel surrounding the dentine islets. From the appearance of the enamel in the valleys it seems probable that cement was originally present in considerable quantities. The length of this specimen is 4·1, the extreme width 2·25, and the height of the inner column 2·0 inches.

1 The identification was not easy to make without a comparison of the actual specimen with Falconer's description.

2 *Supra*, vol. I., p. 208, note.

3 This specimen was obtained after the smaller tooth had been described and figured: and exhibits more clearly than previous specimens the corrugated enamel as a well-marked specific character. In describing it at the end of the first volume the writer was on the point of departure for the field, and had not time to make a full comparison with other specimens; which would have shown that the smaller tooth belonged to the same species.

4 Vol. I., pl. XXXIII., fig. 3.

5 The milk-molars with rough enamel figured in vol. I., pl. XXXII., and referred to *M. falconeri* will be alluded to under the head of that species.

In all the above-mentioned characters this specimen agrees with the teeth of *M. pandionis*; and as it has precisely the same dimensions as the right $\overline{\text{m. 1}}$ of that species represented in plate XXXV., fig. 1, of the first volume, it may safely be regarded as the homologous tooth of the opposite side.[1]

Upper premolar.—The tooth represented in figs. 6, 6a of plate V., and the one in the woodcut (fig. 5), are two of three similar specimens from Dera Búgti. The former has lost the greater part of the cingulum, and the inner face of the first inner column, and is less worn than the latter specimen. The sub-quadrate form of the crown shows that the specimens belong to the upper jaw; while the forward inclination of the larger columns (fig. 6a) indicates that they are from the right side. The absence of a disc of pressure on the anterior side, the rounded angles of the crown, and the more worn condition of the hinder as compared with the front columns, indicates that the teeth belong to the premolar series, of which they are the last. From the strongly-marked vertical corrugations in the enamel, the forward inclination of the columns, and the obstructed transverse valleys, it is inferred that these specimens probably belong to the present species. Their distinction from the corresponding tooth referred to *M. angustidens* (pl. V., figs. 2, 2a) will be sufficiently apparent from a comparison of the figures: and from their complex crowns, as well as from the absence of *M. falconeri* from Dera Búgti, it is improbable that they belong to that species. The present teeth are of relatively smaller size when compared with the true molars of *M. pandionis*, than is the case with the corresponding teeth of *M. angustidens.*

Fig. 5. (?) *Mastodon pandionis*, Falc. Last right upper premolar, from Dera Búgti: Indian Museum (No. A. 432). $\frac{1}{1}$.

Affinities.—The affinities of the present species have been already alluded to in the first volume,[2] but a few remarks may be added. That the species is allied to *M. angustidens* is pretty evident from the general form of the mandible, and the structure of the molars. The greater complexity of the latter, and the addition of cement, indicates, however, that the present species is a more specialized form, and may possibly have sprung from the progenitors of the Indian race of *M. angustidens*, which has been shown to diverge somewhat from the typical race in the direction of the present species. The absence of *M. pandionis* from the Eastern Siwaliks indicates the probability of its being an immigrant into India from the west; which confirms its relationship to *M. angustidens.* From the coexistence of the two forms in the lower Siwaliks of Dera Búgti their genetic connection probably took place in the regions to the westward of India. *M. pandionis* appears to have survived longer, and penetrated further into India than *M. angustidens*, since its remains occur abundantly in the upper Siwaliks of the Punjab to the westward of the river Jhelam.

The circumstance that the last molars of the upper Siwalik *M. sivalensis* have a

1 The specimen figured in the first volume is narrower posteriorly, but this is probably due to its imperfect protrusion.

2 P. 225, *et. seq.*

great resemblance to those of the lower Siwalik *M. pandionis*,[1] coupled with the fact of the former having a short, and the latter a long mandibular symphysis,[2] might lead to the inference that the one is the more specialized descendant of the other; but the absence of cement in *M. sivalensis* seems to forbid this view. From the extreme complexity of the structure of its molars, *Mastodon pandionis* can have no direct ancestral connection with the true elephants.

Species 3: MASTODON (TRILOPHODON) FALCONERI, *nobis*.

Upper milk-molars.—In figs. 2, 3 of plate XXXII. of the first volume an associated penultimate and last upper milk-molar of a trilophodont mastodon were referred to *M. falconeri*: the specimens belonged to a young cranium, associated with a part of the mandible containing $\overline{\text{mm. 3}}$.[3] It was not noticed that these teeth differed from the true molars of that species by the enamel being thrown into vertical corrugations.[4]

In the accompanying woodcut (fig. 6) there is represented a right upper tooth of a trilophodont mastodon, said to have been obtained by Col. Sykes from the Deccan, but which is more probably from Sind[5]; there being a precisely similar specimen from that district presented by Col. Sykes to the British Museum (No. 32,503.) The figured specimen carries two transverse ridges, both of which are nearly equally worn: the columns of the ridges are nearly vertical; and there are accessory columns on either side of the inner main columns, causing the worn dentine surfaces of the latter to assume a trefoil shape. The enamel is smooth, and the transverse valleys are fairly open. From the columns of the first ridge being more worn than those of the second, and the elongated and angular shape of the crown, the tooth under consideration is inferred to be $\underline{\text{mm. 3}}$, rather than $\underline{\text{pm. 4}}$. It is unlike $\underline{\text{mm. 3}}$ of *M. angustidens*,[6] and is of too large a size to have belonged to the Indian race of that species. It differs from the teeth of *M. pandionis* in its smooth enamel, low vertical ridges, wide transverse valley, and trefoil-shaped dentine islets. A tooth of quite a different type, represented in vol. I., pl. XXXV., fig. 3, is, from the presence of cement in its valleys, considered with great probability to be the homologous milk-molar of the last-named species.

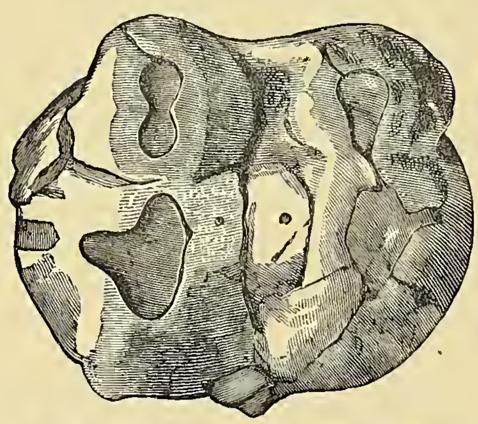

Fig. 6. (?) *Mastodon falconeri*, *nobis*. Third right upper milk-molar (?): British Museum (No. 40,788). ½.

With the true molars of *M. falconeri*[7] the present tooth agrees in all respects, and there is accordingly a great probability of its belonging to that species. If this

1 *Vide supra*, vol. I., p. 226.

2 From the occurrence of a short symphysis in all the true elephants, and stegodons, and in the pleistocene mastodons, it may be taken as certain that this form of jaw is the most specialized.

3 *Supra.*, vol. I., pl. XXXIII., fig. 2.

4 The specimen represented in vol. I., pl. XXXII., fig. 4, being referred to *M. falconeri* (instead of *M. pandionis*) rendered this character inconstant.

5 *Vide supra.*, p. 29.

6 Gaudry "Enchainements - Mam. Tert.," fig. 239 ($\underline{\text{2m.}}$).

7 *Supra.*, vol. I., pl. XXXIII., fig, 4.

be so, the milk-molars mentioned above, and figured in plate XXXII. of the first volume, cannot belong to that species. Those teeth do not, moreover, belong to *M. angustidens*; and, for the reason mentioned above, it is improbable that they belong to *M. pandionis*. This is confirmed by the valleys of $\underline{\text{mm. 4}}$ (vol. I., pl. XXXII., fig. 3) having no cement, being straight and very open, and the ridges low and nearly vertical. The cranium in which these milk-molars, together with $\underline{\text{m. 1}}$, are contained, shows, moreover, no signs of the presence of premolars,[1] which there is every reason to believe were developed in *M. pandionis*, as in *M. angustidens*. On this view it seems highly probable that the milk-molars referred in the first volume to *M. falconeri*, really belong to a fourth Siwalik species of trilophodont mastodon.[2]

The only other interpretation of the serial homology of the tooth represented in woodcut fig. 6, would be to consider it as $\underline{\text{pm. 4}}$. In that case it could not belong to either *M. angustidens* or *M. pandionis*, of which the corresponding teeth are known (pl. V.): and if it belonged to *M. falconeri*, then the milk-molars referred to that species in the first volume would have been succeeded by premolars, which was apparently not the case. It is, moreover, improbable, even if they were so succeeded, that they should be replaced by a tooth furnished with an entirely different kind of enamel: and on this view it thus seems probable that the above-mentioned milk-molars belong to a new species.

From the resemblance of the tooth represented in woodcut fig. 6 to the lower teeth of the type of those represented in plate V., figs. 4 and 6, it is not impossible that some of those in which the first ridge is the most worn may be the homologous lower milk-molars of *M. falconeri*.

Number of teeth known.—As the serial position of one of the teeth of this species figured in the first volume has been changed; and as other teeth there referred to the same species have been shown to be either probably or certainly specifically distinct, it may be well to give a revised list of the known teeth; *viz.*:—

(?) $\underline{\text{Mm. 3}}$—Woodcut fig. 6, p. 32. $\underline{\text{M. 2}}$—*Ibid*, pl. XXXII., fig. 1.
$\underline{\text{M. 1}}$ —Vol. I., pl. XXXIII., fig. 3. $\overline{\text{M. 2}}$—*Ibid*, pl. XXXIII., fig. 4.

It may be observed that some confusion has arisen on pp. 209-10 of vol. I. in comparing the teeth of the present species with those of *M. angustidens* figured in pl. XL. of the "F.A.S.," owing to the circumstance that the latter are figured and described as upper teeth, when it appears that they belong to the lower jaw. The molars, as now restricted, of the present species appear to be very similar to those of *M. angustidens*; the main distinction between the two species being the difference in the form of the mandible, the superior size of *M. falconeri*, and the larger and taller talons of its lower molars. The Indian teeth of *M. angustidens* show that no distinction can be drawn as to the relative height of the crowns of the molars of the two species.

1 *Ibid*, p. 208.

2 The talons of the tooth represented in vol. I., pl. XXXII., fig. 3, are smaller than those of the tooth now regarded as $\underline{\text{m. 1}}$ of *M. falconeri* (*Ibid*, pl. XXXIII., fig. 3).

Distribution.—Unless the specimen represented in woodcut fig. 6 really came from the Deccan, the present species is confined to the Siwaliks of the western Punjab and the lower Siwaliks of Sind.

FAMILY: *DINOTHERIIDÆ.*

GENUS: DINOTHERIUM, Kaup.

Alleged identity of Indian and European forms.—In a recently published memoir[1] Dr. O. Weinsheimer has come to the conclusion not only that all the European remains of *Dinotherium* should be referred to *D. giganteum*, but that the Indian forms[2] described under the names of *D. indicum*, *D. pentapotamiæ*, and *D. sindiense* should likewise be regarded as belonging to the same species. Dr. Weinsheimer has had the advantage of a far larger series of specimens of the European form than were accessible to the present writer,[3] and has shown pretty conclusively that the variation in size of the European form is so great as to include within its limits the two forms referred to *D. indicum* and *D. pentapotamiæ*. Measurements are also given showing that the peculiar dimensions of the jaws of *D. sindiense* are paralleled by European specimens, and indicating that the present writer's suggestion that this form was unprovided with mandibular incisors is not improbably incorrect.

In India the mandibles of the forms known as *D. sindiense* and *D. pentapotamiæ* are so perfectly distinct from one another[4] (no specimens exhibiting any signs of a transition from the one to the other) that even if (as is highly probable) they both sprang from the same European stock, they may be regarded at the least as very well-marked local races; and the same may be said in a less marked degree of *D. indicum* and *D. pentapotamiæ*. The present writer has not seen any last lower molar of *D. giganteum* presenting such a relatively large talon as the tooth of *D. pentapotamiæ*[5] figured in vol. I., pl. IX., fig. 5.

Although in view of the occurrence of *M. angustidens* on the western side of India it is by no means improbable that some of the Indian dinotheres (which are in the main found on the western side of that country) should be identical with a European form, yet in view of the great number of species of other Proboscidian genera in which the molars afford ample distinctive characters, it seems difficult to believe that *Dinotherium*, in which alone the simple structure of the molars does not admit of such distinctive characters, should be represented only by a single species ranging over the greater part of the Old World. On these grounds the writer is disinclined to admit at present the specific identity of the whole of the Indian dinotheres, which present a very remarkable amount of variation in size and the form of the mandible, with *D. giganteum.*

1 "Ueber *Dinotherium giganteum*, Kaup," in Dames and Kayser's 'Palæontologische Abhandlungen,' vol. I., pt. 3 (Berlin, 1883).

2 *Supra*, vol. I., pp. 72-5, 183-97, 292, pls. IX., XXIX.-XXXI.; and vol. II., pp. 63-4.

3 Many works cited by Dr. Weinsheimer were inaccessible to the present writer.

4 The figures do not exhibit these distinctions at all clearly.

5 Described at first as m. 1.

INDIAN TERTIARY & POST-TERTIARY VERTEBRATA.

SIWALIK AND NARBADA BUNODONT SUINA.

By R. LYDEKKER, B.A., F.G.S., F.Z.S.

(WITH PLATES VI. TO XII.)

INTRODUCTORY.

In the fifth part of the preceding volume of the present work the remains of a large number of animals whose nearest existing allies are to be found in the pigs and hippopotami were described, and referred to a group termed the Suina Selenodontia. It was then shown that this group connects the living, or bunodont, Suina with the modern Ruminants; and that such a complete transition is thus effected between the three groups that it is impossible to draw any real distinction between them; although their retention for the purposes of classification is convenient. It is the group of Suina Bunodontia which forms the subject of the present memoir.

The fossil Indian representatives of this group may be referred to the four following families; *viz.*, *Hippopotamidæ*, *Suidæ*, *Entelodontidæ*, and *Listriodontidæ*; which will be treated of in this order. A large series of the remains of the two first families are figured in the "Fauna Antiqua Sivalensis"; although in most cases they have never been described. These figures, although generally of a smaller size than is altogether desirable, are so good in execution as to render their reproduction in the present volume unnecessary.

The comparatively simple structure of the molars of nearly all the members of the group indicates that these animals are more nearly related to the primitive ungulates than any other living artiodactyle group. The structure of their feet, and especially the form of the astragalus, indicates, however, that at all events the modern representatives of the group are very far removed from the primitive stock: and it is noteworthy that the hippopotamus, in which the dentition is more specialized than in the pig, has retained more of the primal foot-structure than the latter. The cheek-teeth of the pigs are remarkable for the circumstance that the first true molar becomes worn to a smooth surface of dentine before the last molar comes into use; and this remarkable inequality in wear, together with the elongation of the latter tooth, which is very markedly developed in some forms, shows how easily a transition might have taken place from the teeth of a pig-like animal to those of a trilophodont mastodon: and from this, and other circumstances, the writer is strongly inclined to believe that the pigs and proboscidians were connected at no very distant (geological) date.

A noteworthy circumstance is the disappearance at the present day of all the selenodont Suina; this being accompanied by the disappearance of a Siwalik pig (*Hippohyus*), in which the dentition is of a more complex type than in any of its kindred. This disappearance may perhaps be explained by the probability that the more specialized selenodont Suina entered into competition with the still more specialized ruminants, to which they had probably given origin, but were unable to stand against the advantages gained by the higher organization of that group; while the less specialized group of Suina confined themselves more or less exclusively to swamps, and, therefore, did not enter into competition with the ruminants, and thus survived.

Order: UNGULATA. Sub-Order: ARTIODACTYLA.
Section: SUINA. Sub-Section: BUNODONTIA.
Family I.: *HIPPOPOTAMIDÆ.*
Genus: HIPPOPOTAMUS, Linn.

Syn. *Chœropsis*, Leidy; *Hexaprotodon* and *Tetraprotodon*, Falc.

Affinities.—The present genus, in which, as will be shown in the sequel, it appears desirable to include all the hippopotami, is apparently the only representative of the family, and is remarkably isolated, both in the present and past time. In respect of the form of the skull and mandible the genus comes nearest to *Merycopotamus*, and is thus intimately connected with the *Anthracotheridæ*[1]: in the structure of its molar teeth it is, however, widely different, and in this respect seems to be nearest to the Siwalik genus *Hippohyus* (described in the sequel), whose molar dentition, as remarked above, is of a peculiarly specialized structure. The molars of the hippopotamus also present a very remarkable resemblance to those of some of the Sirenia; from which circumstance, together with certain resemblances in the structure of their brains, it has lately been suggested[2] that these animals are very closely allied. It is, however, just possible that this resemblance may be due to the somewhat similar mode of life of the hippopotamus and the Sirenia.

1 It is in great part owing to this relationship that the writer divides the Artiodactyla into the Suina and the Ruminantia, instead of into the Bunodontia and the Selenodontia. In the latter arrangement the hippopotamus and *Merycopotamus* would be widely separated.

2 Chapman, 'Pro. Acad. Philadel.,' 1881, p. 126.

Number of species.—The following list comprises the non-Indian species of the genus; and indicates the variation in the number of incisors :—

1. Hippopotamus amphibius, Linn. Up. pliocene to recent, Europe and Africa.

H. abyssinicus, Less. *H. major*, Cuv.
H. annectans, Falc. *H. senegalensis*, Desm.
H. capensis, Desm. *Tetraprotodon amphibius*, Falc.
Tetraprotodon major, Falc.

I. $\frac{2}{2}$: the inner pair much larger than the outer: one instance is recorded of three incisors in one ramus of the mandible.[1]

2. Hippopotamus hipponensis, Gaudry.[2] Pleistocene (?), Algeria.

Hexaprotodon hipponensis, Gaud.

I. $\frac{?}{3}$. A small species, distinguished by the smooth enamel of the lower incisors; which tend to expand at their extremities, and thus indicate affinity with the pigs.

3. Hippopotamus liberiensis, Morton. Recent, W. Africa.

Chæropsis liberiensis, Leidy.[3] *Tetraprotodon liberiensis*, Falc.

I. $\frac{2}{1}$. Much smaller than *H. amphibius*.

4. Hippopotamus minutus, Cuv.

Tetraprotodon minutus, Falc.

I. $\frac{2}{2}$. Considered by Gervais[4] to be closely allied to *H. liberiensis*.

5* Hippopotamus pentlandi, H. von Meyer. Pleistocene, S. Europe.

Tetraprotodon pentlandi, Falc.

I. $\frac{2}{2}$. As large as *H. amphibius*, with which Prof. Gaudry[5] thinks it may be identified.

H. medius, Cuv.=*Halitherium*.

Distribution.—The genus is confined to the Old World, where it formerly had a wide distribution: its earliest appearance in Europe is in the upper pliocene.

Species 1: Hippopotamus sivalensis, Falc. and Caut.

Syn. *Hexaprotodon sivalensis*, F. and C.

History.—This species was originally described by Falconer and Cautley[6] in 1839 on the evidence of a very perfect specimen of the cranium from the Siwaliks; which, with numerous other specimens, was subsequently figured in the "F.A.S."[7] At a later date the species was subdivided by M'Clelland,[8] but apparently on insufficient grounds. The name *Hexaprotodon* was originally applied by Falconer and Cautley in a sub-generic sense, but was adopted as a generic term by Sir R. Owen.[9]

1 Gaudry, 'Bul. Soc. Géol.,' ser. 3, vol. 4, p. 504. Falconer ("Pal. Mem.," vol. II., p. 406) records another so-called instance of hexaprotodontism. The specimen on which this statement rests is in the Museum of Trinity College, Dublin, where the present writer has examined it: the extra tooth is malformed and very small, and situated on the alveolus of the canine. It can be in no sense regarded as a reversion, but is merely a redundancy: the additional incisor of the hexaprotodont form should occur between the two incisors of the living hippopotamus.

2 *Op. cit.*, p. 501, pl. XVII.

3 'Journ. Acad. Philadel.,' vol. II., 1853, p. 207.

4 "Zool. et Pal. Gen.," 1st ser., p. 250.

5 *Op. cit.*, p. 504.

6 'Asiatic Researches,' vol. XIX., p. 39. "Pal. Mem.," vol. I., p. 130, pls. XI., XII.

7 Plate LIX., *et. seq.*

8 'Journ. As. Soc. Beng.,' vol. VII., p. 1038: it is unnecessary to quote M'Clelland's names.

9 "Odontography," p. 566, pl. CXLIII.

Typical crania.—The type cranium is in the British Museum and is figured in plate LIX., figs. 1, 1a, 1b of the "F.A.S.," and is also represented in the accompanying woodcut (fig. 1). It has lost the canines[1]; but shows the alveoli of three sub-equal incisors on either side. The cheek-teeth are much worn, m. 1 being almost obliterated: the true molars are broader than long. An almost identical skull represented in figs. 2, 2a of the same plate shows the base of the canines, which are readily distinguished from those of *H. amphibius* by the much deeper channelling of their posterior surface.[2] The same specimen shows that pm. 1, as in the existing species, was separated by a considerable interval from pm. 2. In both skulls m. 3 is placed a considerable distance in advance of the posterior border of the palate; in the first specimen this tooth does not extend behind the posterior border of the anterior zygomatic root; but it does so to a small extent in the second. Precisely similar dental characters are exhibited by two other crania in the British Museum (Nos. 16,380 and 40,889): the dentition of the latter is in excellent preservation, and exhibits the large inner cingulum, which appears characteristic of this form. According to Falconer and Cautley's description, the type skull differs from *H. amphibius* in the less prominent orbit; the longer post-orbital portion; the shorter and deeper pre-orbital constriction; the more concave frontals; the higher occipital surface and crest; the larger lachrymal; the shorter diastema, and the more curved line of the cheek-teeth. The whole skull indicates an animal rather smaller than *H. amphibius*. The dimensions of the type specimen are given in Falconer and Cautley's memoir.

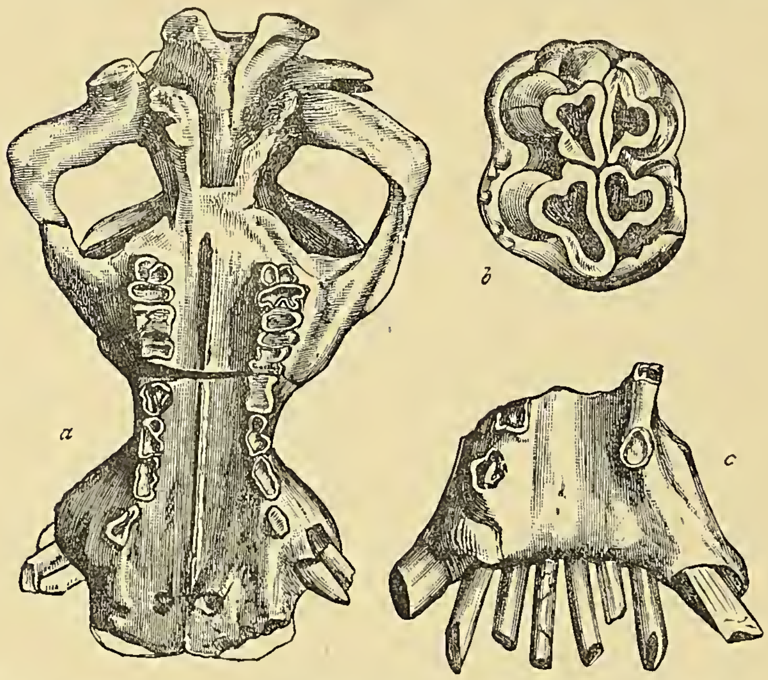

Fig. 1. *Hippopotamus sivalensis*, F. and C.: *a*, palatal view of type cranium, with the teeth much worn, $\frac{1}{8}$; *b*, third right upper true molar in an early stage of wear, $\frac{1}{2}$; *c*, upper view of anterior portion of mandibular symphysis, $\frac{1}{8}$. All the specimens are in the British Museum; and came from the Siwaliks.

Aberrant crania.—In plate LIX., figs. 3, 3a of the "F.A.S." there is figured the cranium of another Siwalik hippopotamus in the British Museum, which differs considerably from either of those described above: there is another precisely similar specimen in the same collection (No. 17,469), in which m. 3 is not fully protruded, and mm. 4 has not been shed. The figured specimen has lost the extremity of the muzzle, and a considerable portion of both zygomatic arches, but is otherwise fairly perfect. The whole of the four premolars are present; and as m. 3 is fully protruded the cranium evidently belonged to an adult individual. These two crania

1 These are restored in the woodcut.

2 Compare "F.A.S.," pl. LXII.

differ from the typical specimens by the relative position of the molar series : thus m. 3 is placed entirely behind the posterior border of the zygomatic root, and extends backwards as far as the line of the posterior border of the palate. The line of the cheek-teeth is straighter ; the true molars are of a more elongated form, their length exceeding their breadth ; pm. 1 is placed closer to pm. 2 ; while pm. 4 is of nearly the same size as pm. 3 instead of being considerably smaller. The following table exhibits the difference in the dimensions of the true molars of these specimens, and those of the two typical skulls figured in the "F.A.S."; *viz.* :—

	Type form.		Aberrant form.	
Length of m. 1		1·35	1·8	1·78
Width ,, ,, ,, ...		1·75	1·5	1·62
Length ,, ,, 2	1·85	1·65	2·1	2·14
Width ,, ,, ,, ...	2·11	2·08	1·75	1·85
Length ,, ,, 3	1·8	1·9	2·1	
Width ,, ,, ,, ...	2·05	1·95		

There are several other crania in the British Museum (*e.g.* Nos. M. 491 ; 16,381 ; 16,378) exhibiting precisely similar characters ; and it appears from these that the cingulum on the inner side of the true molars is less developed than in the type cranium. These crania are on the whole rather smaller than those of the type form.

Intermediate crania.—Were it not for the two specimens to be now mentioned, it would appear that the crania last described belonged to a distinct species from *H. sivalensis* ; but the former exhibit such transitional characters that it appears impossible to accept this view. The two crania in question are in the British Museum (Nos. 16,379, 16,382): in the first m. 3, although entirely behind the zygomatic root, is in advance of the posterior border of the palate, and pm. 4 is of the small size characteristic of the typical skulls : while in the second m. 3 is partly behind the posterior border of the zygomatic root, and considerably in advance of the posterior border of the palate : in both the true molars are of the elongated type.

It thus seems that the wide-toothed Siwalik hippopotamus is so closely connected in certain respects by these two skulls with the narrow-toothed form, that, in the absence of other well-marked differences, it appears impossible to consider them as more than varieties, or races : it may be convenient to designate the former, or typical race as var. *latidens*, and the latter as var. *angustidens*. In provisionally regarding these two forms as races of one species it must, however, be borne in mind that no sufficient distinction can be drawn between any of the different species of the genus from the pattern of their molars, and that thus a character of much value among other genera as a means of specific distinction is lost ; and it may, therefore, still be possible that there may be more than one species necessarily included in *H. sivalensis*. The large number of species by which the other genera of large Ungulata were represented in the Siwaliks renders this supposition the more probable.

In the crania represented in plate LX. of the "F.A.S." the orbit is more prominent, and the post-orbital portion of the skull relatively shorter : these characters being most marked in the specimen represented in figs. 2, 2a, 2b, where they are accompanied by a lower occipital surface (*fig.* 2b). The transition from the typical skulls to this specimen is, however, so gradual that, in the absence of other differences, it appears impossible to draw any specific distinction on this score; but the specimens with more prominent orbits undoubtedly exhibit a marked step from the type in the direction of the Narbada and existing hippopotami.

Mandible.—Several specimens of the mandible are represented in plates LX., LXI. of the "F.A.S.": those in figs. 3 and 6 of the former showing the milk-dentition: a specimen of the anterior portion of the symphysis represented in plate LXI., fig. 7, is refigured on a smaller scale in the woodcut on page 38. The three incisors are sub-equal in size; the median pair being rather larger than either of the others: at the free edge of the mandible[1] the six teeth form an even line, but the lower part of the alveolus of $\overline{\text{i. 2}}$ is placed above the level of the other two alveoli.[2] These teeth are placed more obliquely than in *H. amphibius*, and the abraded surface is more confined to their extremities, indicating affinity to the pigs; the canines are relatively shorter and larger; and $\overline{\text{pm. 1}}$ is retained longer. The descending plate at the angle[3] is considerably larger and deeper than in *H. amphibius*, and its anterior border is blunt and rounded, instead of curved and pointed anteriorly. The mandible of the Siwalik species is also distinguished by its longer symphysis, of which the superior surface is more deeply channelled. The line of the lower cheek-teeth and the horizontal ramus of the mandible, is markedly concave externally, instead of nearly straight.[4] It does not appear that the lower cheek-teeth of the two forms present any characteristic points of distinction. The following table exhibits the dimensions of the mandible[5] of *H. sivalensis* represented in plate LXI., fig. 5, of the "F.A.S.," compared with those of a very large fossil mandible of *H. amphibius* in the British Museum from Auvergne,[6] *viz.*:—

	H. sivalensis.	H. amphibius.
Length of symphysis	7·1	6·8
Interval between canines	8·0	11·0
Depth at pm. 1	4·6	5·1
Longer diameter of canine	2·4	2·5
,, ,, ,, i. 1	1·35	1·4
,, ,, ,, ,, 2	1·0	
,, ,, ,, ,, 3	1·3	0·8

Mandible of small variety.—In fig. 1 of plate VI. of this volume there is represented the left ramus of the mandible of a hippopotamus collected by Mr. Theobald in the Siwaliks of the Punjab, which differs somewhat from the typical mandibles of *H. sivalensis*, as is shown by the following dimensions, *viz.*:—

1 "F.A.S.," pl. LXI., fig. 4. 2 *Ibid*, fig. 4a. 3 *Ibid*, pl. LX., figs. 8, 9.

4 Compare "F.A.S.," pl. LXI., fig. 5, with Blainville's "Ostéographie," Gen. Hippopotamus, pl. II.

5 B.M., No. 17,085.

6 The homology of the lower incisors of *H. amphibius* will be discussed in the sequel.

	Specimen.	Typical form.[1]
Depth of ramus at m. 2	4·2	4·4
Length of five last cheek-teeth	7·7	8·5
" " m. 1	1·21	1·5
Width " " "	0·95	1·3
Length " " 2	1·68	1·9
Width " " "	1·22	1·55
Length " " 3	2·2	2·82
Width " " "	1·3	1·6

These dimensions show that while the depth of the ramus is practically the same in the two specimens, there is a great difference in the absolute size of the teeth: the hinder border of the symphysis is also placed farther forward in the smaller jaw, and the true molars are proportionately slightly narrower. In the first notice of this specimen[2] it was thought that it might belong to *H. iravaticus*,[3] but an examination of the original specimens on which that species was founded has shown that the present specimen is too large, and has too short a symphysis to belong to that form. It is not, however, improbable that it should be referred to the form which is here provisionally termed *H. sivalensis*, var. *angustidens*.

Vertebræ and limb-bones.—An extensive series of these bones are contained in the British and Indian Museums, but have never been compared with those of other species, although a large number from the former collection are figured in the "F.A.S."[4] The following points in which some of the Siwalik bones differ from those of *H. amphibius* may be recorded:—The spinous process of the axis is higher vertically and shorter antero-posteriorly, and the odontoid process blunter and directed more upwardly. The scapula has its long diameter shorter, and its fore-and-aft borders more curved. Of the femur there are two forms, in one of which the head is very similar to that of *H. amphibius*, while in the other it is more prominent, and approaches that of the same bone in one of the Narbada species: in the former the trochlear surface for the patella is less deeply excavated, and its superior border less sinuous than in *H. amphibius*, thus indicating a lesser degree of specialization: the shaft is apparently stouter. These differences confirm the suggestion that *H. sivalensis* may really include more than one species. The astragalus (of which also there seems to be more than one form) is decidedly longer than the corresponding bone of *H. amphibius*, and thereby makes a marked step in the direction of the pigs.

Affinities.—The long mandibular symphysis, the three pairs of incisors in each jaw, the small prominence of the orbits, and the elongated astragalus, are all characters clearly indicating that this species is of a less specialized type than the living members of the genus.

Distribution.—This species occurs in the typical Siwalik Hills, where its remains are extremely common, and continues into the western Punjab, where it is equally rare. It is unknown from Sind and Perim Island. Remains of the genus occur in Burma, but have all been referred to the next species.

1 Taken from a specimen in the Indian Museum.
2 'Records,' vol. XV., p. 32.
3 *Vide infra.*
4 Plates LXIII., *et. seq.*

Species 2: HIPPOPOTAMUS IRAVATICUS, Falc. and Caut.

Syn. *Hexaprotodon iravaticus*, F. and C.

History.—In plate LVII., figs. 11, 11a, 10, 10a, 10b, 10c, of the "F.A.S." there are figured two specimens of the symphysis of a small hexaprotodont hippopotamus, under the name of *H. iravaticus*; the first specimen[1] being nearly complete. In plate LXXXIII., fig. 12, of the same work, the lower end of a small radius is figured under the same name: and in Falconer's "Catalogue of the Fossils of the Asiatic Society of Bengal" the lower ends of a radius, and a femur are referred to the same species.[2] All these specimens came from Burma. With the exception of a note published in the "Palæontological Memoirs,"[3] in which it is stated that "*H. iravaticus* is a size larger than *H. liberiensis*," this is the whole of the information left by Falconer in regard to this species. In 1882 a note on this species was published by the present writer,[4] wherein it was suggested that a mandible from the Punjab might perhaps be referred to it: subsequent comparisons have, however, indicated that this specimen, as already mentioned, belongs to *H. sivalensis*.

Mandible.—The type mandible, to which the reference has been already given, is a sub-adult specimen, with $\overline{\text{pm. 2}}$ half protruded. It is distinguished from the mandible of *H. sivalensis* by its inferior size, proportionately longer symphysis, laterally compressed $\overline{\text{i. 3}}$, as well as by the circumstance that the six incisors, instead of forming a straight line between the canines,[5] are placed irregularly; the second being above the first, and the third below both the others. The alveoli of the three first premolars also show that $\overline{\text{pm. 1}}$ and $\overline{\text{pm. 2}}$ were separated by proportionately longer intervals.[6] The more important of these differences are exhibited by the following measurements, *viz.* :—

	H. iravaticus.	H. sivalensis.[7]
Length of symphysis	5·1	7·1
Interval between canines	4·45	8·0
Depth at pm. 1	2·9	4·6
Longer diameter of canine	1·48	2·4

These differences are of such importance as to leave little doubt of the specific distinctness of the small Irawadi hippopotamus[8] from *H. sivalensis.* The only other described species with which the former could be identical would be the subsequently named *H. hipponensis*; but the known remains of that species do not permit of exact comparison with *H. iravaticus*.

The extremely long mandibular symphysis of the latter, and the relatively

1 B. M., No. 14,771.
2 *Vide* "Pal. Mem.," vol. I., p. 142.
3 Vol. II., p. 406.
4 'Records,' vol. XV., p. 31.
5 Compare "F.A.S.," pl. LXII , fig. 4.
6 *Ibid*, pl. LXI., figs. 4, 5.
7 *Ibid*, pl. LXI., fig. 5 (B. M., No. 17,085).
8 There are several specimens of the symphysis of the mandible of small hippopotami from Burma in the collection of the Indian Museum (*e.g.* No. B. 304), which may very probably belong to the present species. The present writer's attention was not directed to the specific characters of these specimens during his service on the Geological Survey.

small interval between the canines, undoubtedly indicates a nearer approximation to the pigs than is exhibited by any other species of the genus, in which the complete symphysis is known. The mandible indicates a species about one-third smaller than *H. sivalensis*.

Limb-bones.—In plate LXXXIII., figs. 12, 12a, 12b, of the "F.A.S." there is represented the distal extremity of the radius of a small hippopotamus from Burma, which is referred to *H. iravaticus*. Its dimensions are compared below with those of the corresponding bone of *H. sivalensis*,[1] *viz.*:—

	H. iravaticus.	H. sivalensis.
Transverse diameter of articulating surface . . .	2·8	4·0
Ant.-post. ,, ,, ,, ,, . . .	1·7	2·15

A similar specimen in the Indian Museum is catalogued by Falconer,[2] and there is also the lower end of a femur in the same collection. The distal articular surface of the radius of *H. iravaticus* is less expanded laterally than in *H. sivalensis*; and thereby exhibits more affinity to the pigs. There are one or two other bones in the British Museum, which may not improbably be referred to the present species.

Distribution.—With the exception of a few bones in the Indian Museum from the Siwaliks of Burma, the above-mentioned remains are all that can be referred to the present species, which has hitherto been certainly determined only from Burma.

Species 3: Hippopotamus namadicus, Falc. and Caut.

Syn. *Hexaprotodon namadicus*, F. and C.

History.[3]—In plate LVII., figs. 12, 12a, and in plate LVIII., figs. 1, 1a, 2, 2a, 3, 3a, of the "F.A.S." there are figured four specimens of the mandible of a hexaprotodont hippopotamus from the Narbadas, under the name of *H. namadicus*. The species was, however, never described; but Falconer[4] mentioned that it was larger than *H. amphibius*, or *H. sivalensis*, and had well-marked specific characters. The present writer[5] has suggested that this species might possibly be the same as *H. palæindicus*, but later observations disprove this view.

Mandible.—The mandibles figured in the "F.A.S." show a considerable variation in size, the largest (pl. LVIII., fig. 1) exceeding the largest mandible of *H. sivalensis*. The incisors are three in number on either side; the second being smaller than either of the others, and its alveolus placed slightly above the level of those of the other two: this character is more marked in some specimens than in others, and is especially noticeable in a mandible from the Narbadas in the Indian Museum (No. F. 147). These mandibles are readily distinguished from the mandible of

1 "F.A.S.," pl. LXV., fig. 18.

2 *Vide* "Pal. Mem.," vol. I., p. 142. In this passage the specimen is compared to the radius of *H. sivalensis* figured in pl. LXV., fig. 18, of the "F.A.S." The numbers were, however, left blank in Falconer's Catalogue, and were evidently filled up by the editor of the "Pal. Mem": they should have been pl. LXXXIII., fig. 12.

3 Numerous remains of hippopotami from the Narbadas were described by Dr. Spilsbury in the 'Journ. As. Soc. Beng.': but these descriptions need not be quoted on this occasion.

4 "Pal. Mem.," vol. II., p. 406.

5 'Records,' vol. XV., pp. 102-3.

H. sivalensis by the more abrupt angle at the inferior border of the anterior extremity, and by the relatively shorter symphysis; the latter character being shown in the following table of measurements; *viz.*:—

	H. namadicus [1]				H. sivalensis.
	Ind. Mus.	Brit. Mus.			
	F. 147.	1.	2.	3.	
Length of symphysis		4·1	5·2	5·85	7·1
Interval between canines		7·2	9·3	9·9	8·0
Depth at pm. 1		4·3	4·65	5·2	4·6
Longer diameter of canine		1·67	1·86	2·14	2·4
,, ,, ,, i. 1	1·2	1·23	1·26	1·3	1·35
,, ,, ,, ,, 2	0·9	0·97	0·9	0·92	1·0
,, ,, ,, ,, 3	1·33	1·24	1·43	1·5	1·3

The complete horizontal ramus of this species is not exhibited by any of the British Museum specimens, but the highly curved outer surface of the portion remaining indicates that the ramus was relatively shorter than in *H. sivalensis*, and probably not dissimilar to that of the next species. The short symphysis distinguishes the present jaws still more markedly from *H. iravaticus*. The incisors exhibit none of the peculiarities of those of *H. hipponensis*. The distinction of the present specimens from the mandible of the succeeding species (*H. palæindicus*) will be indicated in the sequel.

The foregoing comparisons sufficiently indicate the specific distinctness of *H. namadicus* from all other known hexaprotodont forms.

Cranium.—In the "F.A.S." (pl. LVII., fig. 1, LVIII., fig. 4) two crania of Narbada hippopotami, wanting the premaxillæ, are referred to *H. palæindicus*; and a third specimen in Calcutta[2] was also assigned by Falconer to the same species. There is apparently, however, not the slightest reason for assigning any of these specimens to *H. palæindicus* rather than to *H. namadicus*; and it is quite probable that some, or all of them may belong to the latter. It will be better to allude to the distinctive characters of these crania under the head of *H. palæindicus*.

Distribution.—Remains which can be certainly referred to the present species have been obtained only from the Narbadas; but the old alluvium of the Jamna, and the pleistocene of the Pemganga and other rivers, have yielded remains of hippopotami, which may probably be referred either to one or other, or to both of the Narbada species.

Species 4: Hippopotamus palæindicus, Falc. and Caut.

Syn. *Tetraprotodon palæindicus*, F. and C.

History.—With the exception of the mandibles noted above as belonging to *H. namadicus*, the whole of the remains of hippopotami from the Narbadas figured in the "F.A.S." are referred to the present species; of which no description was

[1] The British Museum specimens of which the measurements are given are those figured in the "F.A.S.," pl. LVIII.: 1, fig. 2 (No. 36,840): 2, fig. 3 (No. 36,838): 3, fig. 2 (No. 36,839).

[2] *Vide* "Pal. Mem.," vol. I., p. 147.

ever published by Falconer. The only one among all those specimens exhibiting the incisors is the symphysis of the mandible represented in plate LVII., figs. 5, 5a of the "F.A.S."; which must consequently be taken as the type specimen. The only important note[1] of Falconer's in reference to the species is to the effect that it differed from *H. amphibius*, in the proportions of the lower incisors. A note was published in 1882 by the present writer[2] showing that *H. palæindicus* was at all events in some instances hexaprotodont.

Mandible.—The type mandible[3] consists only of the symphysis, showing the complete alveoli of a central pair of incisors, and the lower halves of the alveoli of an outer pair, together with the section of the left canine. The alveoli of the outer incisors are larger than those of the inner; and in the figure the specimen has been restored as simply tetraprotodont, but it will be shown below that this restoration is most probably incorrect. A similar mandible from the Narbadas, now in the Indian Museum, was referred to this species by Falconer[4]: it comprises only a portion of the symphysis, exhibiting the lower halves of the alveoli of two pairs of incisors and of the canines.

In figure 2 of plate VI. of the present volume there is represented the symphysis of the mandible of a hippopotamus collected by Mr. C. Hackett in the Narbadas.[5] In this specimen there remain the sections of two pairs of large and closely approximated incisors; and in the upper triangular spaces between the first and second pair there are wedged another pair of very minute teeth, evidently corresponding to the second pair of incisors ($\overline{\text{i. 2}}$) in *H. namadicus.* The whole form of the jaw, and the relative size of the two pairs of large incisors leaves no doubt that the specimen belongs to *H. palæindicus.* In the British Museum there are two specimens of similar mandibles (Nos. 40,893 and 41,663) from the Narbadas,[6] acquired since Falconer's death, exhibiting a precisely similar arrangement of the incisors. The former specimen shows the symphysis, and the complete left ramus: the descending process is smaller than in *H. sivalensis,* and more like the same part in *H. amphibius*; the horizontal ramus is, however, much shorter than in either, the total length from the descending process to the extremity being only $11\frac{1}{2}$ inches, in place of 15 in an equal-sized specimen of *H. amphibius.*[7] In the second specimen $\overline{\text{i. 2}}$ is smaller on the left than on the right side. In the following table the dimensions of the four specimens mentioned above are compared with those of *H. namadicus* and *H. sivalensis*; *viz.*:—

1 "Pal. Mem.," vol. I., p. 147.

2 'Records,' vol. XV., p. 102.

3 "F.A.S.," pl. LVII., fig. 5. The place where this specimen is preserved is unknown.

4 "Pal. Mem.," vol. I., p. 147.

5 The specimen mentioned in the passage of the 'Records,' already cited.

6 The second specimen (41,663), which was bought at Toulmin-Smith's sale, is labelled Siwaliks: its general condition, and especially its imperfect state of mineralization, leaves, however, not the slightest doubt of its Narbada origin.

7 A specimen from Auvergne in the British Museum.

	H. palæindicus.				H. namadicus.				H. sivalensis.
	Type sp.	I. M. F. 149.	B. M. 40,893.	B. M. 41,663.					
Length of symphysis .			5 0	5·39		4·1	5·2	5·85	7·1
Interval between canine .			8·2	9·3		7·2	9·3	9 9	8·0
Depth at pm. 1 . . .			4·9	5·2		4·3	4 65	5·2	4 6
Longer diameter of canine			2·26	2·35		1·67	1·86	2·14	2·4
,, ,, ,, i. 1 .	1·5	1·96	1·80	1·8	1·2	1·23	1·26	1·3	1·35
,, ,, ,, ,, 2 .		0·59	0·62	0·72	0·9	0·97	0·9	0·92	1·0
,, ,, ,, ,, 3 .	1·85	2·0	1·84	1·81	1·33	1·24	1·43	1·5	1 3

From the occurrence of the small i. 2 in all the three specimens in which the superior surface of the symphysis is preserved, it seems probable that this tooth was originally present in the two specimens noticed by Falconer, in which that part is wanting. The table of measurements shows that in specimens in which the depth of the mandible is the same, the symphysis is shorter in *H. palæindicus* than *H. namadicus*; and this, coupled with the larger size of the first and third pairs of incisors, and the smaller size of the second pair, indicates the specific distinctness of the two forms.[1] This is confirmed by the difference in the position of the canines, which are placed more nearly on a level with the incisors in *H. namadicus* than in *H. palæindicus*.

Besides the shorter mandibular ramus, the latter species is distinguished from *H. amphibius* by the shorter symphysis; by the equality in size of i. 1 and i. 3; and by the presence of the minute i. 2.

Cranium.—The impossibility of deciding as to whether the crania figured in the "F.A.S.,"[2] under the name of *H. palæindicus*, and the similar cranium in the Indian Museum so named by Falconer,[3] really belong to that species, or to *H. namadicus*, or to both, has been already alluded to under the head of the latter species. The chief characters of these crania may now be briefly mentioned. They indicate an animal somewhat larger than the existing race of *H. amphibius*; and are characterised by their prominent orbits, and their general shortness: the latter feature being shown by the small interval between the posterior border of the palate and the anterior zygomatic root, as well as by the extreme shortness of the pre-orbital constriction, and the backward position of the maxillary expansion. The last molar has its posterior border placed slightly behind the free border of the palatines; which at once distinguishes these crania from those of all other species except one variety of *H. sivalensis*. In that form, however, m. 3 does not extend in advance of the posterior border of the anterior zygomatic root; whereas this is largely the case in the Narbada skulls; the Siwalik skulls are also distinguished by their considerably longer shape, and longer pre-orbital constriction; and by their narrower molars. The nasals of the Narbada skulls seem to have been shorter and wider than those of *H. amphibius*. The shortness of the Narbada skulls is a character which accords equally well with both the forms of lower jaws from that formation.

1 Before he had an opportunity of comparing all the specimens the present writer thought they might be identical.

2 Plate LVII., figs. 1, 16; LVIII., figs. 4, 46.

3 "Pal. Mem.," vol. I., p. 147.

Vertebræ and limb-bones.—Two vertebræ and several limb-bones of Narbada hippopotami are figured in the "F.A.S." under the name of *H. palæindicus*; but it is quite impossible to say whether they belong to that species or to *H. namadicus*. A very large collection of similar bones from the Narbadas is contained in the Indian Museum, but has never been described. The femur[1] has a larger great trochanter and a more prominent head than in *H. amphibius*, and the shaft of the bone is apparently longer and more slender.

Distribution.—Like *H. namadicus*, this species is only certainly known from the Narbadas; but it probably also occurs in the corresponding deposits of the other large rivers. The association of hippopotamus remains with stone implements in the Narbadas proves the coexistence of man in India with these animals, and hence Falconer's conjecture that the so-called 'water-elephant' of the early writings of India refers to a tradition of the existence of that animal may not improbably be correct.[2]

General Remarks on the genus Hippopotamus.

Generic unity of hexa- and tetraprotodont forms.—The case of *H. palæindicus*, which in its lower jaw is really a *Hexaprotodon* in process of conversion into a *Tetraprotodon*, coupled with the instance of unilateral hexaprotodontism in *H. amphibius*,[3] indicates that Falconer's two subgenera should be abolished. This point being admitted there are but slight grounds for retaining the subgenus, or genus, *Chœropsis*; and accordingly all the species of hippopotamus may be referred to a single genus.

Lines of specialization.—The Indian species of the genus indicate that the specialization of the genus has advanced on two main lines; *firstly*, in the shortening and widening of the mandibular symphysis, frequently accompanied by a general shortening of the cranium and mandible; and, *secondly*, in the reduction of the number of incisors, this reduction probably occurring first in the lower jaw, and being accompanied by the largely increased size of one or more of the remaining pairs of teeth. These features are apparently also accompanied by an increase in the size of the canines.

The most primitive form of mandible is exhibited by *H. iravaticus*, in which the long narrow symphysis, the six small incisors, and the small canines, indicate an animal much closer to the pig than any other species of which the mandible is known. The next step is *H. sivalensis*, in which the symphysis is considerably shorter, although the incisors still preserve their small size. The third step is *H. namadicus*, in which the symphysis has still more decreased in length, while $\overline{\text{i. 2}}$ has become slightly smaller, and is thrown more or less above the line of the other two. The fourth step is exhibited by *H. palæindicus*, in which the symphysis is shorter than in any other form, while $\overline{\text{i. 1}}$ and $\overline{\text{i. 3}}$ have increased enormously in size at the expense of $\overline{\text{i. 2}}$, which becomes wedged in between the other two. It is highly

1 "F.A.S.," pl. LVIII.

2 *Vide* "Pal. Mem.," vol. II., pp. 613-4.

3 *Vide supra*, p. 37.

probable that these four species represent the actual line of descent in which these modifications have been accomplished.

Another branch, which may have taken origin from the same hexaprotodont stock, is represented by *H. amphibius*, in which the symphysis is shorter than in *H. sivalensis*, although longer than in the Narbada hippopotami: in this form the lower incisors are reduced to two, of which the inner is very large, and the outer very small. Finally in *H. liberiensis* another tooth, probably corresponding to the small outer incisor of *H. amphibius*, has likewise disappeared. The longer symphysis of *H. amphibius* indicates that this species should not be regarded as the direct descendant of either of the Narbada hippopotami: the large size of $\overline{\text{i. 3}}$ in *H. palæindicus* still more strongly confirms this view in respect of that species.

Homology of incisors.—In the case of *H. palæindicus* it is proved that $\overline{\text{i. 2}}$ is the tooth which is about to disappear; and from the constancy of the order in which the terminal cheek-teeth tend to disappear among the more specialized mammals, it may be assumed with a high degree of probability that it is the same tooth which is wanting in the mandible of *H. amphibius*. It is unfortunate that the upper incisive series of *H. palæindicus* is unknown, but from the disappearance of homologous cheek-teeth in the upper and lower jaws of mammals generally, it is probable that it is $\underline{\text{i. 2}}$ which has disappeared in *H. amphibius* and the other tetraprotodont forms. This inference is confirmed by certain observations recorded by Prof. P. Albrecht,[1] which lead to the conclusion that it is the same tooth which has disappeared in man, and, therefore, in other mammals.[2]

The small size of $\overline{\text{i. 3}}$ in *H. amphibius* renders it probable that it is this tooth which has disappeared in *H. liberiensis*; and it would, therefore, seem that in those mammals where the incisors are reduced to a single pair, that pair corresponds to the first of the typical series. From the instance of *H. liberiensis* it also seems that the disappearance of each pair of incisors commences in the lower, sooner than in the upper jaw; this arrangement corresponding with that which obtains in the case of the cheek-teeth among mammals generally.

If these conclusions hold good the two upper incisors which are occasionally developed in *Rhinoceros*[3] will be respectively the first and third of the eutherian series; the single tooth that is normally present being the first. It will also be evident that the two pairs of lower cutting teeth which are frequently present in that genus, will be respectively the inner incisor and the canine; since if they were both incisors, as was formerly considered to be the case, the number of lower incisors would exceed the upper; which is apparently never the case among the eutherian

1 "Sur les 4 Os Intermaxillaires, le Bec-de-Lièvre, et la Valeur Morphologique des Dents Supérieures de l'Homme," Brussels, 1883.

2 The instances of *Ursus labiatus* in which $\underline{\text{i. 1}}$ is wanting, and *Babirussa* in which $\underline{\text{i. 3}}$ has disappeared, are exceptions; but as the space for this tooth persists in the former, and the dentition of the species is altogether abnormal, while in the latter the disappearance of $\underline{\text{i. 3}}$ is clearly due to the large canine, these exceptions need not invalidate the rule.

3 *Vide* 'Journ. As. Soc. Beng.," vol. XLIX., pt. II., p. 135, pl. VII., fig. 1: these teeth are numbered $\underline{\text{i. 1}}$ and $\underline{\text{i. 2}}$ in the figure.

mammals, except in special instances like those noticed above. From the presence of four incisors in some Metatheria Prof. Albrecht comes to the further conclusion that $\underline{\text{i. }3}$ of the eutherian series really corresponds to $\underline{\text{i. }4}$ of the metatherian series; the first reduction in number taking place by the suppression of $\underline{\text{i. }3}$ of the metatherian series.

FAMILY II.: *SUIDÆ.*

Extent.—For palæontological purposes it seems best that the present family should be taken to include the recent family *Dicotylidæ.*[1] It is abundantly represented in the fossil state both in the New and Old Worlds: all the species found in the former are, however, more or less closely related to *Dicotyles*; the typical swine having apparently been always confined to the Old World. The Siwalik representatives of the family comprehend the genera *Sus*, *Hippohyus*, *Sanitherium*, and *Hyotherium*; which will be treated of in this order.

GENUS I.: SUS, Linn.

Including[2] *Porcula*, Hodgs.; and *Potamochœrus*, Gray.

Extent, dentition, etc.—The dentition of the existing species of *Sus* is so well known that it is unnecessary to describe it. It comprehends the full eutherian series; but in some fossil forms the first premolar in both jaws is usually or always absent. In the African river-hogs (*Potamochœrus*) the anterior premolar is also absent in both jaws, the talon of the last molars is smaller than in the more typical pigs, and the structure of all the cheek-teeth is somewhat less complex.[3] In some of the miocene and pliocene forms the latter features are still more pronounced, and it thus becomes very difficult to draw any distinction between *Sus* and *Hyotherium*, and impossible to draw any between *Sus* and *Potamochœrus*; so that for palæontological purposes the two living species of the latter may be included in the former. It has recently been shown[4] that the genus *Porcula*, Hodgs., should be merged in *Sus*. *Babirussa*, besides its enormously developed canines, is readily distinguished by the early loss of the outer upper incisors, and the two first premolars in each jaw: the talons of the last molars are also smaller, and the four main columns of the molars more distinct than in existing species of *Sus*; these teeth being, moreover, relatively narrower. In cases where only the hinder cheek-teeth of some of the more generalized fossil forms are known it would, however, be difficult to distinguish between *Sus* and *Babirussa*.

Recent species.—There is still a great amount of uncertainty as to the number of

1 In vol. II. of this work (p. 146) the two families are still maintained. The genus *Heterohyus*, Gerv. ("*Zool. et Pal. Franç.*," pl. XXXV., fig. 14), was then included in the *Suidæ*: from its resemblance to *Aphelotherium* it should, however, very probably be referred to the Pachysimia.

2 It is needless to allude to the numerous genera into which *Sus* was divided by Gray.

3 There is, however, an almost complete transition in this respect among living pigs from *S. scrofa* to *Potamochœrus*

4 Garson, 'Proc. Zool. Soc.,' 1883, p. 413, *et. seq.*

existing Asiatic species of the genus. Rolleston[1] regards *S. cristatus*, *S. vittatus*, and *S. leucomystax* as forming a closely allied group, and thinks it highly probable that the two last may be all but identical; he also considers *S. andamanensis*, *S. papuensis*, and *S. timorensis* as another group intimately related to the first. Prof. Rütimeyer[2] unites *S. leucomystax* and *S. vittatus*, and regards the *S. andamanensis* group as smaller races of the same. Prof. Forsyth-Major[3] thinks that (excluding *Potamochœrus* and *Porcula* (*S. salvanius*)) there are but four existing species, *viz.*, *S. scrofa*, *S. barbatus*, *S. verrucosus*, and *S. vittatus*; the latter including *S. cristatus*, *S. leucomystax*, the *S. andamanensis* group, and some other forms. All are agreed in regarding *S. celebensis* as intimately related to, or identical with, *S. verrucosus*.

S. barbatus is readily distinguished by its elongated cranium, and the extremely short m. 3. *S. scrofa*, according to Rolleston, is distinguished from *S. verrucosus* and the *S. vittatus* and *S. andamanensis* groups, by the form of the lachrymal, and the relatively long facial portion of the cranium. In males of *S. cristatus* the talon of m. 3 is more complex than in *S. scrofa*, and in most instances the length of $\underline{\text{m. 3}}$ exceeds that of $\underline{\text{m. 1}}$, $\underline{\text{m. 2}}$, and in all examples that the writer has seen the length of $\overline{\text{m. 3}}$ exceeds that of $\overline{\text{m. 1}}$ and $\overline{\text{m. 2}}$.[4] In *S. vittatus* m. 3 is normally shorter than in *S. cristatus*; its length, especially in the lower jaw, in all typical examples[5] that have come under the writer's notice being less than that of m. 1, m. 2. There may be exceptions, but these points are generally characteristic of the two forms. In *S. andamanensis*[6] m. 3 has a still smaller talon, and its length is still less in proportion to that of m. 1, m. 2. On these grounds the present writer is inclined to continue to apply separate names to the Indian *S. cristatus*, the Javan (etc.) *S. vittatus*, and the smaller *S. andamanensis*, even if certain forms indicate a more or less complete transition between them.[7] In *S. verrucosus* the length of m. 3 is usually about the same as that of m. 1, m. 2. *S. salvanius* is distinguished from all by its diminutive size. The river-hogs comprise *S. africanus* of S., and *S. porcus* of W. Africa: the skulls of these species are readily distinguished by the great development of the protuberance above the canine.

Fossil species.—There is great difficulty in deciding on the number of European fossil species; and the following list[8] which comprehends the best-defined forms must, therefore, be regarded as purely provisional. The confusion in the synonomy is, indeed, so great, that the only way to arrive at a thoroughly satisfactory conclusion

1 'Trans. Linn. Soc.' Zool., ser. 2, vol. I., pp. 251-286 (1877). 2 'Verh. nat. Ges. Basel,' vol. VI., pt. 3 (1877).

3 Carus' 'Zoologischer Anzeiger,' vol. VI., pp. 295-300 (1883).

4 In one specimen in the Brit. Mus. (No 1716 S.) $\underline{\text{m. 3}}$ is abnormally short, its length being less than that of $\underline{\text{m. 1}}$, $\underline{\text{m. 2}}$: $\overline{\text{m. 3}}$ is, however, longer than $\overline{\text{m. 1}}$, $\overline{\text{m. 2}}$. The same seems to be the case with the male skull figured by Rolleston. These specimens are, therefore, exceptions to the general rule given on page 56.

5 No. 1362 B., British Museum., is an exception, but this specimen not improbably belongs to *S. verrucosus*.

6 Rolleston, *op. cit.*, p. 262, pl. XLIII., fig 8.

7 The writer would not be deterred from applying distinct names to two well-marked forms which are more or less connected by other forms, for it is evident that if such connections be wanting this is merely due to their extinction.

8 It should be observed that here, as elsewhere, the references do not always refer to the original descriptions of the different species, but merely to memoirs where good figures or descriptions may be found.

would be to compare all the type specimens. The most doubtful species are indicated by an asterisk. The living *S. scrofa* occurs in the Forest-bed of the Eastern Counties;[1] and *S. antiquus* and *S. palæochœrus* have been recorded from the Red Crag.

1. Sus antiquus, Kaup.[2] Up. miocene, Eppelsheim.

A species frequently larger than *S. erymanthius*, and with relatively larger canines, and thicker lower premolars: pm. 1 is present in some instances.

*2. Sus arvernensis[3] (Cr. and Job.). Up. pliocene, France.

Aper arvernensis, Cr. and Job.

An imperfectly determined species, smaller than *S. scrofa*.

*3. Sus chæroides,[4] Pom. Up. miocene, Europe.

S. africanus (*larvatus*) ? Blain. ? *S. antediluvianus*, Kaup (*in parte*).

A species smaller than *S. scrofa*; said to resemble *S. africanus*; it is suggested by Gervais[5] that it may be the same as *S. antediluvianus*[6] or *S. palæochœrus*: the former species as being an extremely uncertain one is provisionally included, although Kaup's name has the priority. The last molars are relatively short.

4. Sus chærotherium, Blain.[7] Mid. miocene, France.

S. (?) *doati*, Lart. *S. simorrensis*, Lart. (*teste* Gervais).

A species varying in size, according to Gervais, from that of *S. scrofa* to *S. erymanthius*: its canines are relatively large, and its molars approach those of *Hyotherium*.

5. Sus erymanthius,[8] Roth. and Wagn. Pikermi group.

A species considerably larger than *S. scrofa*, with extremely small canines: pm. 1 generally absent in both jaws.

*6. Sus lockharti,[9] Pom. Mid. miocene, France.

? *S. belsiacus*, Gerv.

An ill-defined species of about the same size as *S. palæochœrus*, with which its molars agree in general characters: these, according to Prof. Gaudry, approach those of *Hyotherium*. It is considered probable by Gervais[10] that the so-called *S. belsiacus* is the young of this species.

*7. Sus major,[11] Gerv. Mt. Lebéron group.

A species at least as large as *S. erymanthius*; from which it is only distinguished by the absence of the protuberance over the upper canine: pm. 1 absent in both jaws: it is regarded by Prof. Gaudry as being probably merely a race of *S. erymanthius*.

8. Sus palæochœrus,[12] Kaup. Up. miocene, Eppelsheim.

An imperfectly determined species, with which *S. chœroides* should possibly be united. The molars are smaller than those of *S. scrofa*: in the small talons of the last of the series, and in the stout premolars it approaches *S. porcus*.

1 It should be observed that here and elsewhere the present writer follows Prof. Boyd-Dawkins ('*Quart. Journ. Geol. Soc.*,' vol. XXXVI., p. 395) in regarding the Forest-bed as pleistocene.

2 "Beiträge," pt. IV., pls. IV., V. "Oss. Foss. d. Mus. d Darmstadt," p. 8, pl. VIII.

3 Blainville, "Ostéographie," Genus Sus, pl. IX.

4 *Ibid*, and Pom., cited below.

5 "Zool. et Pal. Franç.," p. 180.

6 This species was identified by Kaup ("Beiträge," pt. IV., p. 12, pl. VI., figs. 4, 5) with *Hyotherium sœmmeringi*; and this identification is accepted in part by Peters: the lower jaw figured by Kaup (*op. cit.*) is quite different from that of *H. sœmmeringi* figured by Peters (pm. 1 being small in the former and large in the latter), and seems to belong to *Sus*.

7 *Op. cit.* *Chærotherium dupui*, Lart., is identified by Gervais in one place (*op. cit.*, p. 179) with this species, and in another (p. 185) with *Chœromorus mammilatus*.

8 Gaudry, "Animaux Foss. et Géol. de l'Attique," p. 235, pls. XXXVII.-IX.

9 Pomel, 'Bibl. univ. d. Genève Archiv.,' vol. VIII., p. 159.

10 *Op. cit.*, p. 180, pl. XXXIII., fig 7.

11 Gaudry, "Animaux Foss. du Mt. Leberon," p. 42, pls. VII., VIII.

12 "Beiträge," pt. IV., pl. VI.

9. SUS PRISCUS, M. de Ser.[1] Pleistocene, France.

A species about the size of *S. scrofa*, with which it agrees in dentition; its skull is, however, more like that of *S. africanus*.

10. SUS PROVINCIALIS, Gerv.[2] Low. pliocene, Montpellier.

Larger than *S. scrofa*, with $\underline{\text{m. 3}}$ like that of *S. africanus*, with which it was identified by De Blainville: it has small canines, and four lower premolars.

11. SUS STEINHEIMENSIS (Fraas[3]). Mid. miocene, Germany.

Chœropotamus steinheimensis, Fraas.

A species considerably smaller than *S. scrofa*, referred to the present genus on the authority of Prof. Gaudry[4]: the molars are apparently not unlike those of living swine.

12. SUS STROZZI,[5] Menegh. Up. pliocene, Italy.

A species stated by Prof. Forsyth-Major to present affinities to *S. verrucosus*.

13. SUS VALENTINI, Filhol.[6] Miocene, France.

Characterized by the extremely short talon of $\underline{\text{m. 3}}$; the whole length of this tooth being less than that of $\underline{\text{m. 2}}$. The species is apparently somewhat smaller than *S. andamanensis*.

Sus (?) *mastodontoides*, Blain., is probably a Sirenian, while *S.* (?) *lemuroides*, Blain., may belong to the Pachysimia. Most of the other forms which have been referred to *Sus* belong to *Hyotherium*, or allied genera.

Distribution.—The genus, both in the recent and fossil condition, is entirely confined to the Old World, over which it appears to be pretty generally distributed. In time, according to Prof. Gaudry,[7] it made its first appearance in the middle miocene (stage of Montabuzard).

Species 1: SUS GIGANTEUS, Falc. and Caut.

History of fossil Indian species.—The earliest notice of the occurrence of fossil swine in the Siwaliks seems to be one published in 1835 by the late General (then Lieut.) Sir W. E. Baker[8]; in which the lower jaw of a species considerably larger than the existing Indian wild-boar was described and figured. In the following year a fuller notice was published by Messrs. Baker and Durand,[9] in which a nearly complete skull of a female and several upper and lower jaws were described and figured. It was therein stated that the authors had evidence of the existence of two species of Siwalik swine; one considerably larger, and the other smaller than

1 "Récherches dans les Cavernes de Lunel-Viel," p. 134, pl. XI. (Montpellier, 1839).

2 *Op. cit.*, p. 177, pls. III., XXII. Rütimeyer, 'Verhand. nat. Ges. Basel,' vol. I., p. 517, *et. seq.* (1857).

3 "Die Fauna von Steinheim,' p. 22, pl. V. (Stuttgart, 1870).

4 "Animaux Foss. du Mt. Lebéron," pp. 45-6.

5 Forsyth-Major, 'Proc. Verb. Soc. Tosc. Sci. Nat.,' vol, II., 1881, p. 22: the writer has not seen a full description of this species.

6 'Bull. Soc. Philom.,' vol. VI., 1882, p. 123.

7 "Les Enchainements—Mam. Tert.," p. 5. It is possible that the subsequently described *S. valentini* may belong to a lower stage.

8 'Journ. As. Soc. Beng.,' vol. IV., p. 568, pl. XLVII., fig. 20.

9 *Ibid*, vol. V., p. 661., pls. XXXV. and XLIV.

S. cristatus. No specific name was, however, assigned to either form, although both were considered specifically distinct from the living swine of India. A large number of the remains of Siwalik swine were subsequently figured by Falconer and Cautley in the "Fauna Antiqua Sivalensis";[1] and were referred to three species, namely, *S. giganteus*, *S. hysudricus*, and *S.* (*Hippohyus*) *sivalensis*. No descriptions of these species were, however, ever published, and their identification accordingly rests solely on the figures. The remains figured in that work under the first name belong to at least two species; and it appears that the first published occurrence of the name is in that work. A skull of a large pig from the Siwaliks was briefly mentioned at a later date by the present writer under the first name, but is referred below to a new species.

Type cranium.—The specimen which the writer thinks it best to take as the type of the present species is the very perfect cranium from the Siwalik Hills represented ($\frac{1}{3}$) in plate LXIX., figs. 1, 1a, 1b, 1c, of the "F.A.S.," and now preserved in the British Museum (No. 15,385). It is noticed in the description of the plate in the following words, *viz.*:—"The zygomatic arches are perfect. There are three molars on either side, and also the last premolar. The specimen is broken off in front of the last premolar. The extreme distance between the zygomata is much greater than in *S. cristatus*. The sub-orbital foramina are large, and the bone is deeply channelled in front." The most striking feature in the skull, which is considerably larger than that of *S. cristatus*, is the excessive width of the zygomatic arches; the anterior root of which bends out very suddenly from the maxilla. The vertical height above $\underline{\text{m. 3}}$, and at the occiput, is considerably greater than in *S. cristatus* and *S. scrofa*; and the facial profile is straighter than in the former, and ascends more rapidly towards the occiput than in either. The temporal fossæ encroach much more extensively on the parietals, making the superior surface of those bones at the pre-occipital contraction much narrower. The orbits are relatively smaller; and the palate extends much farther behind $\underline{\text{m. 3}}$ than in either of the two living species. The fronto-parietal region is markedly convex, the concavity in front of the orbit being deep and broad behind: and the complete skull must evidently have been relatively short, and, therefore, very different from that of *S. scrofa*. The molars of this specimen are much worn; and their distinctive characters will be noticed below. The great zygomatic width of this specimen indicates that it probably belonged to a male; while the worn condition of the molars shows that it belonged to a very old individual. It probably indicates a full-sized example of the species.

Second specimen.—In figs. 2, 2a of the same plate of the "F.A.S." there is represented ($\frac{1}{3}$) the anterior portion of another Siwalik cranium in the British Museum (No. 16,166), showing the last five cheek-teeth in a less worn condition. This specimen agrees very closely in general contour with the last: the zygomatic arches are, however, slightly less prominent, and the molar series somewhat longer: the latter point causing the prolongation of the palate behind $\underline{\text{m. 3}}$ to be somewhat less.

[1] Plates LXIX.-LXXI.

These slight variations are not, however, more than those due to differences in the age or sex of the specimens. This specimen, although the tip of the nasals is wanting, shows that the facial portion was relatively shorter in comparison with the fronto-parietal portion than is the case with *S. scrofa*; thereby indicating affinity with *S. cristatus* and its allies, and showing that the cranium is of quite a different type from that of *S. barbatus.*

In the following table the dimensions of the two specimens[1] described above are compared with those of a male skull of *S. cristatus* in the writer's possession; *viz.*:—

	S. giganteus.		S cristatus.
	No. 15,385.	No. 16,166.	
Extreme zygomatic width	8·5		6·2
Width at post-orbital processes	5·1		4·25
,, ,, infra-orbital foramina		2·2	2·2
,, ,, narrowest part of parietals	1·08		1·8
Height of occiput	6·55		5·1
,, ,, foramen magnum	0·9		0·77
Width ,, ,, ,,	1·0		0·8
Long diameter of condyle	1·6		1·2
Interval between foramen magnum and palate	3·8		3·25
Height at infra-orbital foramen	5·4	5·0	3·9
Width of palate posteriorly	1·7	1·6	1·3
,, ,, ,, anteriorly	1·5	1·4	1·35
Greatest diameter of orbit	1·35		1·6
Length of three true molars	3·2	3·7	2·9
,, ,, four last cheek-teeth	3·8	4·25	3·42
,, ,, five ,, ,, ,,		5·1	3·95
Width of intermolar space at m. 2	1·4		1·41

The remarkable narrowness of the intermolar space in the fossil form is well exhibited by these dimensions.

Upper dentition.—The right upper cheek-dentition of the second of the two skulls is represented of the natural size in plate XI., fig. 2 of the present volume.[2] It is in a well-worn condition, and, therefore, indicates a fully adult animal; and agrees precisely with the dentition of the type cranium. The talon of $\underline{\text{m. 3}}$ is comparatively short; and is more like the corresponding part of the tooth of *S. barbatus* and *S. vittatus* than that of *S. cristatus* and *S. scrofa.* The crowns of the molars are relatively low, and the pattern formed on their worn surfaces is comparatively simple: the length of $\underline{\text{m. 3}}$ slightly exceeds the united lengths of the two preceding teeth; and the whole of the molars are relatively wider than in *S. cristatus*, and other Asiatic pigs. The last premolar ($\underline{\text{pm 4}}$) is relatively short antero-posteriorly, but this may be an accidental character: both its inner and outer halves are relatively largely developed. The penultimate premolar ($\underline{\text{pm. 3}}$) is relatively a much wider and stouter tooth than in existing pigs; the width of its anterior portion being nearly the same as that of $\underline{\text{m. 1}}$, instead of very much less. This unusual width is caused by the great development of the outer moiety (*a*) of

1 The dimensions of these specimens are taken, with some corrections, from those given in the "Palæontological Memoirs."

2 Also represented of half the natural size in pl. LXIX., fig. 2b of the "F.A.S."

the tooth, which forms a stout elongated cone, instead of a flattened ridge as in existing Asiatic pigs.

In plate LXXI., fig. 12 of the "F.A.S." there is represented a fragment of a maxilla of a large Siwalik pig, now in the British Museum, containing the three true molars in a rather earlier stage of wear than those of the last specimen. The characters of these teeth are precisely similar to those of the latter, although their size is slightly less: the length of m. 3 being very nearly equal to that of the two preceding teeth. There can be no hesitation in referring this specimen to the present species. A fragment of another maxilla, containing pm. 4 and m. 1, represented in fig. 16 of the same plate, and likewise in the British Museum, may in all probability be referred to the same species: pm. 4 is here of average length, but has its inner moiety much more developed than in existing Asiatic pigs.

The following table exhibits the dimensions of the cheek-teeth of the two crania, and the first of the two maxillæ: the figures in the first column refer to the type cranium, those in the second to the cranium of which the dentition is represented in plate XI., fig. 2, and those in the third to the detached maxilla. The fourth column gives the corresponding dimensions of the cheek-teeth of *S. cristatus*; *viz.*:—

	S. giganteus.			S. cristatus.
Length of three true molars . . .	3·2	3·75	3·2	2·9
,, ,, m. 1 and m. 2		1·72		1·45
,, ,, pm. 4	0·7	0·7		0·52
Width ,, ,, ,, ...	0·9	0·8		0·55
Length ,, m. 1	0·62	0·7		0·62
Width ,, ,, ,, ...	0·82	0·92	0·76	0·6
Length ,, ,, 2	0·91	1·16	1·0	0·84
Width ,, ,, ,, ...	1·08	1·0	0·9	0·7
Length ,, ,, 3	1·7	1·9	1·6	1·58
Width ,, ,, ,, ...	1·21	1·22	1·0	0·82

These dimensions clearly show the proportionately greater width of the molars of the fossil, when compared with those of the living form. As there is another palate specimen in the British Museum, in which the teeth are similar to those of the type cranium, it may be safely assumed that the dimensions given represent the average size of the cheek-teeth of the species.

Mandible.—As is always the case where there are several allied species of a genus to deal with, there is some difficulty in assigning its proper mandible to the present species. Several Siwalik mandibles are figured in the "F.A.S." under the name of *S. giganteus*, but they will all be shown in the sequel to belong to other species. It may be observed that the following points occur in the upper and lower dentition of existing species of pigs, which may be taken as guides in associating fossil specimens of the upper and lower dentition:—*Firstly*, the pattern on the worn surface of the upper and lower teeth is the same in the same species; *secondly*, the relative degree of development of the talon of the last molar is the same in the upper and lower jaws, although this part is actually larger in the latter; *thirdly*, m. 2 is slightly longer and considerably wider than m. 2; and, *fourthly*, that where the length of m. 3 exceeds, or is equal to, the united lengths of the two preceding teeth, the same holds good with regard to the proportionate length of m. 3 and the united lengths of the two preceding teeth. Similarly where the length of m. 3 is less than that of the two preceding teeth, the same relation, although sometimes in a less marked degree, prevails in regard to the length of the corresponding lower teeth.[1]

The mandible represented in plate XI., fig. 1 of the present volume was collected by Mr. Theobald in the Siwaliks of the village of Asnot, in the Punjab; and from the structure of the cheek-teeth and the section of the canine evidently belongs to a species of *Sus* of large size. The extremity of the symphysis has been broken away, but the section of the incisors and canine still remains: the latter indicates a tooth of large size, with the characteristic ridge on the external surface; and from the large size of this tooth the specimen may be safely referred to a male individual. The whole of the four premolars were originally present, but have been much damaged; only a portion of the crowns of the two last teeth of this series now remaining: pm. 1 is separated by a considerable interval from pm. 2. The true molars of the left side are well preserved; and are in a medium condition of wear. In the following table the dimensions of this specimen are compared with those of a male mandible of *S. cristatus*; *viz.*:—

	Specimen.	S. cristatus.
Height of ramus at m. 2	3·4	2·0
Vertical height of symphysis at canine	3·0	2·1
Width of intermolar space at m. 2	1·45	1·55
Length of three molars	3·72	3·1
,, ,, six last cheek-teeth	6·6	4·6
,, ,, m. 1 and m. 2	1·85	1·45
Interval between pm. 1 and pm. 2	0·9	0·5
Length of pm. 1	0·54	0·29
,, ,, ,, 2	0·77	0·51
Width ,, ,, ,,	0·31	0·28
Length ,, ,, 3	1·19	0·57
Width ,, ,, ,,	0·79	0·3
Length ,, ,, 4	0·99	0·6
Width ,, ,, ,,	0·9	0·4
Length ,, m. 1	0·72	0·65
Width ,, ,, ,,	0·7	0·59
Length ,, ,, 2	1·1	0·88
Width ,, ,, ,,	0·9	0·6
Length ,, ,, 3	1·9	1·65
Width ,, ,, ,,	1·09	0·7
Longer diameter of canine	1·22	0·91

It will be seen from these dimensions that m. 1 and m. 2 of the fossil are relatively wider than in the recent jaw; and that although the length of m. 3 in the former exceeds the united lengths of the two preceding teeth, yet that such excess is relatively less than in the latter. The same points distinguish the upper jaw of *S. giganteus*; and if the dimensions of the two series of lower teeth given above be compared with those of the upper molars of *S. giganteus* figured in plate XI., and those of *S. cristatus* given in the last column of the table on page 55, it will be

[1] These comparisons, as is noted below, should always be made between teeth in nearly the same stage of detrition.

found that the upper and lower teeth of the two fossil jaws bear the same proportion to one another, as obtains between the corresponding teeth of the existing species. The molar teeth of the mandible under consideration agree, moreover, in absolute size with those of *S. giganteus* figured in plate XI., the length of m. 2 being almost exactly the same size in both (1·16, 1·1); while in the lower jaws the pattern formed on the worn surfaces of the molars is as simple, and the crowns of the molars are as low as in the upper jaw: the length of $\overline{\text{m. 3}}$ also exceeds to a small extent the united lengths of the two preceding teeth; and the talon of the former tooth is of relatively simple structure. The fossil lower jaw also agrees with the cranium of *S. giganteus* in having the intermolar space absolutely less than in the smaller jaws of *S. cristatus*. All these points indicate very strongly that the mandible under consideration belongs to the same species as the crania described above; and when to these is added the peculiar structure of the premolars of the former the probability that this association is correct is rendered very strong indeed. An inspection of fig. 2 of plate XI. will show that the mandible under consideration exhibits some very remarkable features in the structure of its premolars, which are unknown in any other species of the genus. Thus the first and second of these teeth, judging from their broken bases, appear to have been similar to those of other pigs: $\overline{\text{pm. 3}}$, however, in place of being a narrow cutting-tooth inserted only by two fangs, as is the case in existing pigs, has a stout triangular crown with the apex situated anteriorly, inserted by three distinct fangs, as is well seen in the left ramus. The fourth premolar ($\overline{\text{pm. 4}}$) is also a much wider tooth than in existing pigs; the width of its posterior half considerably exceeding that of $\overline{\text{m. 1}}$, instead of being narrower: it is probable that the two hind fangs of this tooth were more distinctly separated than in existing pigs. Now since it has been shown that $\underline{\text{pm. 3}}$ and $\underline{\text{pm. 4}}$ of *S. giganteus* are wider and stouter than the corresponding teeth of most existing pigs, it is pretty certain that the homologous lower teeth of that species would likewise have been abnormally large. It is true that the two upper premolars of *S. giganteus* represented in plate XI. are proportionately rather too short to correspond exactly with the homologous teeth of the present specimen; but it is probable that $\underline{\text{pm. 4}}$ is abnormally short in that cranium, and it is quite possible that the specimen may belong to a female individual. The rami of the present mandible indicate an animal of great strength of jaw; which is also a character in harmony with the characters of the type cranium: the inferior border of the symphysis of the mandible seems to have been much elongated. Should future discoveries eventually prove that the provisional reference of the mandible under consideration to *S. giganteus* is incorrect, it will then follow that that specimen belongs to a new species.

The structure of the two last premolars of the present specimen is precisely similar to that of the corresponding teeth of *Tetraconodon*[1]; the only difference being that their size in relation to that of the true molars is proportionately much less.

[1] *Vide supra*, vol. I., pl. X.

The simple structure of the true molars of the present specimen is also but one step in advance on *Tetraconodon*, where the columns form completely distinct cones.

Specific distinctness and affinities.—The foregoing comparisons and measurements have sufficiently indicated the specific distinctness of the present form from *S. scrofa*, *S. cristatus*, and *S. barbatus*; and it cannot be identified with any other existing Asiatic species; from all of which, putting aside mandibular characters, it is distinguished by its superior size, and the relatively large development of $\underline{\text{pm. 3}}$ and $\underline{\text{pm. 4}}$. In the African *S. porcus* the hinder premolars are stouter than in *S. scrofa* and existing Asiatic pigs, but $\underline{\text{pm. 3}}$ is narrower than in the crania under consideration; and the last molar shorter in proportion to the preceding teeth. In the form of the cranium the fossil has been shown to be nearer to *S. cristatus* and its allies than to *S. scrofa*: the species coming nearest to it in this respect being *S. vittatus*,[1] in which the shortness and height of the cranium are especially well marked, the palate extending a considerable distance behind $\underline{\text{m. 3}}$, and that tooth having a rather shorter talon than in *S. cristatus*. In both the recent and fossil crania the form of the pre-orbital concavity is very similar, and the anterior border of the orbit extends as far forwards as the middle of $\underline{\text{m. 3}}$. The recent cranium, besides its inferior size, is readily distinguished by its less prominent zygomatic arches, smaller occipital height, and smaller $\underline{\text{pm. 3}}$ and $\underline{\text{pm. 4}}$.[2] In *S. verrucosus* and *S. celebensis* the cranium is somewhat similar in shape to that of *S. vittatus*, but the length is generally proportionately greater to the height, and the talons of the last molars are of rather more complex structure.[3] The characters of the inferior premolars of the mandible provisionally referred to the present species are quite distinct from those of any existing species.

Of the fossil species given on the list on pages 51, 52, the only ones which can compare in size with the present form are *S. chœrotherium*, *S. provincialis*, *S. antiquus*, *S. erymanthius*, and *S. major*. The two latter,[4] which Prof. Gaudry thinks are probably merely varieties of the same species, are readily distinguished by the form of the cranium,[5] which is of an elongated type somewhat like that of *S. barbatus*,[6] with the orbit entirely behind $\underline{\text{m. 3}}$, and with a very slight parietal constriction. The upper molars of the Siwalik species are, as Prof. Gaudry remarks,[7] relatively wider; while in the European species the length of $\underline{\text{m. 3}}$ is considerably less than the united lengths of the two preceding teeth: $\underline{\text{pm. 3}}$ of the latter is also much narrower than in the Siwalik species. The mandible provisionally referred to the latter is distinguished from the mandibles of the European forms by its much larger canine, the presence of $\overline{\text{pm. 1}}$, and the peculiar form of $\overline{\text{pm. 3}}$ and $\overline{\text{pm. 4}}$; as well as by the length of $\overline{\text{m. 3}}$ exceeding the united lengths of the two preceding teeth, the reverse condition prevailing in the European mandibles, although less markedly in the specimen figured under the name of

1 Skull figured by Gray, "Hand-List of Edentate, Thick-skinned, and Ruminant Mammals in the British Museum," pl. XXIV., fig. 3 (*Aulochœrus vittatus*).

2 In *S. vittatus* the length of $\underline{\text{m. 3}}$ is usually less than that of $\underline{\text{m. 1}}$ and $\underline{\text{m. 2}}$.

3 Rolleston, *op. cit.*, pp. 267, 274.

4 *Vide* Gaudry, "Animaux Foss. et Géol. de l'Attique," p. 235, pls. XXXVII.-IX.; and "Animaux Foss. du Mt. Lebéron," p. 42, pl. VIII.

5 Compare "F.A.S.," pl. LXIX., figs. 1, 16, with Prof. Gaudry's figures.

6 Rolleston, *op. cit.*, pl. XLIII., fig. 7.

7 "Animaux Foss. et Géol. de l'Attique," p. 242.

S. erymanthius than in that named *S. major*. In *S. antiquus*,[1] which is apparently only known by the mandible, the length of $\overline{\text{m. 3}}$ is less than the united lengths of the two preceding teeth, and it is, therefore, to be presumed that the same relation held good in the upper jaw: the lower molars are of the elongated form of those of *S. erymanthius*. The hinder lower premolars of *S. antiquus* are quite different from those of the mandible figured in plate XI.; and it is probable, as will be shown under the head of the next species, that the canine was relatively smaller. *S. provincialis*[2] is of smaller size, and is readily distinguished by the extreme smallness of the talon of $\underline{\text{m. 3}}$: in the lower jaw the united length of $\overline{\text{m. 1}}$ and $\overline{\text{m. 2}}$ exceeds that of $\overline{\text{m. 3}}$, and the last premolars are not of the peculiar form of those figured in plate XI. The molars of *S. chœrotherium*[3] are frequently of much smaller size, and the columns are of more simple structure.

It thus appears, irrespective of the question whether the mandible be rightly associated with the crania, that the present large Siwalik pig cannot be identified with any other named form, and is, therefore, entitled to specific distinction. The remarkable resemblance existing between its cranium and that of the Javan *S. vittatus*, coupled with the fact that the talon of the last molar of the latter is rather less complex than in *S. cristatus*, and that, according to Prof. Rütimeyer, its molars are relatively wider, and its hinder premolars decidedly stouter than in *S. scrofa*, renders it not improbable that the Javan species may be the lineal descendant of the larger Siwalik species. The existing species has lost the wide $\underline{\text{pm. 3}}$ characteristic of the latter; as well as, if the fossil mandible be rightly determined, the large and wide last lower premolars. Force is added to this suggestion from the circumstance that other Siwalik mammals find their existing representatives in the Malayan region: thus *Hemibos* is represented by the living anoa of Celebes, *Palæopithecus* by the orangs of Borneo, and *Rhinoceros sivalensis* by the small one-horned rhinoceros of Java and the eastern side of the Indian region.

The cheek-dentition of the mandible figured in plate XI. indicates very clearly that the species of *Sus* to which it belonged was intimately related to *Tetraconodon*; and that the two had a common origin at a comparatively recent geological epoch.

Distribution.—If the specimens described above be rightly associated, the range of the present species extended from the typical Siwalik Hills to the Punjab.[4]

Species 2: Sus titan, n. sp., *nobis*.

History.—The name of this species is mentioned here for the first time; the specimens on which it is founded having been hitherto referred to the last species.[5]

1 Kaup, "Beiträge," pt. IV., pls. IV., V.

2 Gervais, "Zool. et Pal. Franç.," 2nd ed., pl. III., figs. 1-6, pl. XXII., fig. 8.

3 Blainville, "Ostéographie," Genus *Sus*, pl. IX.

4 It has been elsewhere stated that the species occurs in the Narbadas: the mandible on which that statement rests belongs, however, to another species.

5 On page 81 of the Xth volume of the 'Records' a portion of the left maxilla of a large bunodont artiodactyle was described by the present writer under the name of *Hippopotamodon sivalense*. It contains two teeth which were assumed to be $\underline{\text{m. 2}}$ and $\underline{\text{m. 3}}$. Subsequent examination has shown that the specimen really belongs to the present species of *Sus*, $\underline{\text{m. 3}}$ being absent by an abnormality: the teeth at first regarded as $\underline{\text{m. 2}}$ and $\underline{\text{m. 3}}$ are really $\underline{\text{m. 1}}$ and $\underline{\text{m. 2}}$. The specimen is now in the Indian Museum (No. B. 7).

Mandible.—As it is to great extent on the characters of the mandible that the present species is distinguished from the last, it will be well to commence with the description of that part. It is unfortunate that there is such an element of uncertainty as to whether the mandible figured in plate XI. really belongs to *S. giganteus*, since there is no doubt of the distinctness of the mandible of the present form from that specimen. Putting, however, that specimen on one side, there are characters in the mandible, and other remains of the present form, which appear to leave but little doubt of its specific distinctness from *S. giganteus*, assuming that species to be founded on characters of the cranium alone.

In figure 4 of plate VII. there is represented the cheek-dentition of a portion of the right ramus of the mandible of a large-sized pig collected by Mr. Theobald in the Siwaliks of the Potwār district of the Punjab. The four last teeth are still remaining, and are in beautiful preservation. In advance of $\overline{\text{pm. 4}}$ there remain the fangs of $\overline{\text{pm. 3}}$: the last molar is unworn, the two preceding teeth being in an intermediate condition of wear. It will, perhaps, be simplest to commence by contrasting this mandible with the one figured in plate XI. In the first place, the molar teeth of the two have a somewhat similar general structure, the pattern formed on their worn surfaces being a simple one; but the proportionate size of the three teeth is very different in the two. Thus in the present jaw the united length of the three molars exceeds that of the corresponding teeth of the other jaw; the length of $\overline{\text{m. 3}}$ is, however, nearly the same in the two, though the width of that tooth is greater in the present specimen: the smaller proportionate length of $\overline{\text{m. 3}}$ in the latter is caused by its smaller talon, the portion behind *a* being shorter than that between *a* and *e*, while the reverse is the case in the other specimen. The first and second molars ($\overline{\text{m. 1}}$ and $\overline{\text{m 2}}$) of the present jaw are much longer than in the other jaw; their united length being greater, instead of less, than that of $\overline{\text{m. 3}}$: the former teeth are also proportionately narrower in the present specimen, as is well seen in $\overline{\text{m. 1}}$ which is an elongated tooth, with its length considerably exceeding the width of $\overline{\text{m. 2}}$, as in existing pigs; whereas in the other jaw the length of this tooth is less than the width of $\overline{\text{m. 2}}$. Precisely similar relations obtain between the length of $\overline{\text{m. 2}}$ and the width of the last molar.[1] As far as can be judged from the slightly different stages of wear of the two specimens, it appears that the columns of $\overline{\text{m. 3}}$ are relatively higher in the present specimen (*a view of the inner surface of this tooth is given in plate* VII., *fig.* 10), Coming to the premolars, it will be seen that $\overline{\text{pm. 4}}$ is a relatively smaller tooth than in the jaw figured in plate XI., and has not the great lateral expansion at its posterior extremity so characteristic of the latter: this tooth in the jaw under consideration exhibits, however, a large column (*a*) on the inner side, which is not present in existing pigs. The broken base of $\overline{\text{pm. 3}}$ shows

[1] It may be observed that in many species of *Sus*, especially those with taller and more complex molars, the first and second molars when very much worn become abnormally short, owing to the pressure of the adjacent teeth. As, however, the lower teeth represented in pl. XI., and the upper teeth of *S. giganteus* represented in fig. 12 of pl. LXXI. of the "F.A.S." (which have the same proportions as those in pl. XI. of this volume) are in the same stage of wear, which is only a degree beyond that of the lower teeth represented in pl. XI., no vitiation of the comparisons can occur from this source. The molars of all these specimens retain their original length.

that this tooth was inserted only by two fangs, and was, therefore, quite unlike the corresponding tooth of the mandible figured in plate XI. The vertical height of the present specimen, as well as its width, is considerably less than that of the latter. The sex of the specimen under consideration cannot be certainly determined, but from the characters of a specimen described below it not improbably belongs to a female.

In figure 1 of plate VIII. there is represented a fragment of the right ramus of a similar mandible, collected by Mr. Theobald in the Punjab, containing $\overline{\text{pm. }4}$, $\overline{\text{m. }1}$, and $\overline{\text{m. }2}$, in a somewhat less worn condition than in the last specimen. The section of the root of the canine in this specimen indicates that it belonged to a male individual, like the jaw figured in plate XI.: the true molars are precisely the same as in the specimen represented in plate VII., fig. 4, but $\overline{\text{pm. }4}$ is rather wider: the roots of $\overline{\text{pm. }3}$ are not exhibited.

There is a third specimen in the Indian Museum (No. B. 358) precisely similar to the one represented in plate VII.; and a fourth in the Museum of the Royal College of Surgeons (No. 1805); both of which specimens were collected from the Siwaliks of the Punjab by Mr. Theobald.

From the foregoing comparisons (as well as from the dimensions given below) there seems no doubt of the specific distinction of the specimens under consideration from the mandible figured in plate XI., irrespective of the question to what species that specimen belongs.

With regard to the crania of *S. giganteus*, it is tolerably clear from the considerations advanced under the head of that species that the lower molars were probably of the proportions of those of the mandible represented in plate XI., and, therefore, that the mandibles under consideration do not belong to that species. The first and second molars of these mandibles are of the elongated type of those of *S. erymanthius* and *S. major*; and it may, therefore, be inferred that the corresponding upper molars were likewise of the type of those of the two last-named species, which have already been shown to be narrower than those of *S. giganteus*.[1] Since $\overline{\text{m. }2}$ of the present mandibles is about half as long again as $\underline{\text{m. }2}$ of *S. giganteus*, the former specimens indicate an animal of considerably larger size than the latter.

From these considerations it may be taken that the present form of mandible most probably indicates a second species of large Siwalik *Sus*, with molars of a simple structure. The talon of the last tooth of the specimen represented in plate VII., fig. 4, consists of a single median column (*a*), behind which there is a semicircular portion comprising a large outer (*b*), and a smaller and lower inner column (*c*). In the talon of the corresponding tooth of *S. cristatus* and *S. scrofa* there is another column behind *b* and *c*; and even in the simpler tooth of *S. andamanensis*[2] the talon is of a more complex structure.

The figures in the first column of the following table give the dimensions of the mandible represented in plate VII., fig. 4; those in the second of the one in

[1] Compare Prof. Gaudry's figures (*op. cit.*) with plate XI., fig. 2, and with pl. LXXI., fig. 12, of the "F.A.S."

[2] *Vide* Rolleston, *op. cit.*, pl. XLIII., fig. 8.

plate VIII., fig. 1; and those in the third the corresponding dimensions of *S. cristatus*:—

	Present species.		S. cristatus.
Height of ramus at m. 2	3·0	3·1	2·0
Thickness of ditto	2·0	2·2	1·2
Length of three true molars	4·45		3·1
,, ,, pm. 4	1·0	1·0	0·6
Width ,, ,, ,,	0·76	0·84	0·4
Length ,, m. 1	0·97	1·1	0 65
Width ,, ,, ,,	0·74	0·8	0·59
Length ,, ,, 2	1·42	1·49	0·88
Width ,, ,, ,,	1·0	1·05	0·6
Length ,, ,, 3	2·16		1·65
Width ,, ,, ,,	1·2		0·7

It seems from a broken fragment of a mandible of a male from the Punjab in the Indian Museum (No. B. 8), with the crowns of the teeth hammered off, that $\overline{\text{pm. 3}}$, though a small and narrow tooth when compared with that of the mandible figured in plate XI., apparently had the hinder root divided into two. This seems to indicate that the jaw represented in plate VII., fig. 4, is probably that of a female. The vertical diameter of the canine in the male jaw is 1·22 inches.

Cranium.—In plate IX. there is figured ($\frac{1}{2}$) the skull of a gigantic pig obtained by Mr. Theobald from the Siwaliks of the village of Niki, in the Punjab, which has been previously alluded to by the present writer under the name of *S. giganteus*.[1] This specimen is in such frail condition that its transport to England was deemed inadvisable, and the writer has consequently been unable to compare it with the crania of *S. giganteus*, and cannot give such full measurements as he would desire. The mandible is *in situ*; and the chief damage that the specimen has sustained consists in the loss of the angle of the mandible, the occipital condyles, a portion of the exoccipitals, and the tip of the nasals. The whole of the teeth are in beautiful preservation; but from the apposition of the upper and lower series they cannot be fully examined.

The mandible and lower molars agree exactly in general characters with the specimen represented in plate VII., fig. 4; and the skull may, therefore, be safely referred to the same species. The present specimen shows that $\overline{\text{pm. 1}}$ was present, and was separated by a considerable interval from $\overline{\text{pm. 2}}$, as in existing pigs. The mandibular symphysis is relatively short, with a rapidly ascending inferior border. The canines are of fairly large size, and indicate that the specimen probably belonged to a male. The upper molars have the same length as the lower; and the length of $\underline{\text{m. 1}}$ and $\underline{\text{m. 2}}$ apparently exceeds that of $\underline{\text{m. 3}}$: $\underline{\text{pm. 1}}$ is present.

Although the naso-frontal suture is not visible, yet it can be easily seen that the nasals when complete must have been shorter than the fronto-parietal portion of the cranium; thus showing that the species was in this respect allied to *S. giganteus* and the *S. cristatus* group, and quite different from *S. scrofa* and *S. barbatus*. The protuberance above the upper canine is of about the same proportionate size as in *S. cristatus*. Comparing the figure with that of the cranium of *S. giganteus*,[2] it

1 'Records,' vol. X., pp. 81-2.

2 "F.A.S.," plate LXIX., fig. 16. The two figures are not drawn in the same position.

appears that the proportionate height at the orbit is somewhat less ; the orbit smaller, and placed less below the frontal profile ; and the interval between the zygoma and the molar alveoli much smaller. The anterior border of the orbit extends still farther over $\underline{\text{m. 3}}$ in the present specimen than in *S. giganteus.* Although the occipital regions of both specimens are more or less damaged, and comparison is, therefore, difficult, it seems that the condylar region was decidedly more prominent in the present specimen. It is also not improbable that the pre-orbital concavity of the latter was smaller and shallower, although this cannot be certainly determined. The general form of the two crania is, however, very similar. The palate of the present specimen is unfortunately invisible. The dimensions of the Niki skull are as follows, *viz.*:—

Length from supra-occipital to incisors	23·0
Interval between ditto and angle of mandible	8 0
Width above orbits	5·4
Length of series of upper cheek-teeth	7·3
,, ,, exposed portion of lower canine	2·5
,, ,, ,, ,, ,, ,, incisors	1·4
Long diameter of upper canine	1·25
Depth of mandible at m. 3	3·3
Width of mandibular symphysis	2·6
Length of three true lower molars	4·4 (?)
,, ,, $\overline{\text{m. 1}}$	1.08
,, ,, $\overline{\text{m. 2}}$	1·4
Interval between $\overline{\text{pm. 1}}$ and $\overline{\text{pm. 2}}$	1·1

Detached molars.—In plate VII., fig. 6, there is represented the unworn crown of a third right upper true molar of a large pig, collected by Mr. Theobald in the Siwaliks of Asnot, Punjab, which from its large size and comparatively simple structure may probably be referred to the same species as the specimens described above. The length of this tooth is 2·43 and its greatest width 1·7 inches ; and, judging from the length of $\overline{\text{m. 3}}$, it indicates an individual somewhat larger than the one to which the mandible represented in plate VII., fig. 4, belonged. The four main columns of the crown are bold and distinct, and separated by very wide open valleys : the accessory columns (*a*, *g*, *h*) are also large, and are restricted to the median line. The talon is very short, its whole length being less than the interval between *a* and *g* : it consists of a central accessory lobe (*a*), and of a short semi-circular portion (*b*) immediately behind the latter. A very distinct cingulum, raised into a number of cusps, surrounds the anterior and inner sides of the crown, and coalesces posteriorly with the talon. The extreme shortness of the talon of this tooth is in harmony with the corresponding part of $\overline{\text{m. 3}}$, and indicates that the united length of $\underline{\text{m. 1}}$ and $\underline{\text{m. 2}}$ exceeded the length of the present tooth.

Compared with $\underline{\text{m. 3}}$ of *S. giganteus*[1] this specimen is distinguished by its vastly superior size ; its shorter and wider talon, the portion *b*, *c* being more developed laterally ; the wider and more open valleys, with the restriction of the accessory columns to the median line ; and lastly by the presence of the conspicuous cingulum,

1 Plate XI , fig. 2, and "F.A.S.," pl. LXXI., fig. 12.

of which there is no trace in the little-worn tooth of *S. giganteus* figured in the "F.A.S."

In plate VII., fig. 3, there is represented a slightly worn and partially broken last right lower true molar, collected by Mr. Theobald in the Potwár district, which agrees so closely with $\overline{\mathrm{m.\,3}}$ of the specimen represented in fig. 4 of the same plate, that there seems every reason for referring it to the same species. This tooth has a length of 2·65, and a maximum width of 1·5 inches; and it apparently indicates an animal still larger than that to which the specimen last described belonged: its size is indeed scarcely inferior to that of the corresponding tooth of *Hippopotamus amphibius*. This tooth differs from $\overline{\mathrm{m.\,3}}$ of the mandible represented in fig. 4 of the same plate merely by the outer portion (*b*) of the talon extending somewhat behind the inner portion (*c*); thus causing the whole talon to be somewhat longer.

Limb-bones.—In figures 1 and 2 of plate XII. of this volume there are figured the distal half of the left radius (fig. 1), and the third and fourth left metacarpals (fig. 2) which were obtained, in company with some broken bones, by Mr. Theobald from the Siwaliks of the village of Niki in association with the cranium figured in plate IX. From the circumstance that the fracture of the radius is quite recent, and that the articular surfaces of the metacarpals and radius are perfectly uninjured, with their ridges sharp and distinct, there is no doubt that the whole skeleton was originally in juxta-position, and was broken up in the process of extraction. In the following table the dimensions of the figured bones are compared with those of the corresponding bones of a skeleton of a male of *S. scrofa* in the Museum of the Royal College of Surgeons (No. 1765); *viz.*,

	Fossil.	Recent.
Length of third metacarpal	4·5	3·46
Transverse diameter of ditto distally	1·19	0·86
,, ,, ,, distal end of radius . . .	2·5	1·6

The fossil bones agree so closely in general form with those of the existing species, that they do not afford any characters of specific value. The skeleton of *S. scrofa* has a height of 31 inches at the shoulder; and taking the length of the third metacarpal as a modulus, the calculated height of the skeleton of the fossil would be 40 inches, or ten 'hands';—the height of a good-sized pony. The molars of the skull of the Niki pig (pl. IX.) are, however, by no means the largest which may probably be referred to that species, being about the size of those of the mandible represented in plate VII., fig. 4, in which the length of $\overline{\mathrm{m.\,1}}$ is 2·16 inches. The larger corresponding tooth represented in fig. 3 of the same plate has a length of 2·65 inches, and the calculated height of the skeleton of the individual to which that specimen belonged would be upwards of 49 inches, or 12¼ 'hands';—the height of a small horse.

Specific distinctness and affinities.—As the result of the foregoing comparisons it appears that there is a very strong probability that the specimens described above are specifically distinct from *S. giganteus*—a probability which will be almost a certainty if the mandible figured in plate XI. be correctly referred to that species.

The species to which the present specimens belong is certainly distinct from all existing forms of the genus; and the only fossil species mentioned in the list on pages 51-2 with which it can compare in size, and the structure of the molars, are *S. antiquus*, *S. erymanthius*, *S. major*, *S. provincialis*, and *S. chœrotherium*. The first is apparently mainly known by two specimens of the mandible figured by Kaup.[1] In one of these[2] the canine is relatively small, and the specimen is consequently referred by Kaup to a female: in the other,[3] which is regarded by Kaup as a male, the middle incisors are present; then there is an empty alveolus on each side, behind which there is a slender upwardly-directed tooth which Kaup regards as $\overline{\text{i. 3}}$, the canines of both sides being, on Kaup's view, absent through malformation. In the present writer's opinion it is far more probable that these up-curving teeth are really the canines (the second and third incisors having belonged to the empty alveoli), and that the jaw really belonged to a female; the specimen referred by Kaup to a female belonging to a male. If this view be correct, *S. antiquus* will be distinguished from the present species by its very small canines. It is also distinguished by the more horizontal direction of the lower incisors; while its $\overline{\text{pm. 4}}$ is not wider than $\overline{\text{m. 1}}$, and the inner column (*a*) of the former, although present, is not so strongly developed. The two species agree in the proportionate size of the true molars, and in having the united length of $\overline{\text{m. 1}}$ and $\overline{\text{m. 2}}$ greater than that of $\overline{\text{m. 3}}$. In *S. erymanthius* and *S. major*, which, as already said, are regarded by Prof. Gaudry as being probably races of the same species, the form of the cranium is very different from that of the specimen represented in plate IX.: the European species are also distinguished by their small canines, by the small size, or absence, of the protuberance over the upper canine, and by the general absence of pm. 1 in both jaws. The cheek-teeth of the European species present a striking resemblance to those of the present species; the lower molars having the same simple structure, and the length of $\overline{\text{m. 1}}$ and $\overline{\text{m. 2}}$ exceeding that of $\overline{\text{m. 3}}$ (this character being most marked in *S. major*): $\overline{\text{pm. 4}}$ is, however, relatively narrower, and has but an indistinct trace of the accessory inner column (*a*); $\overline{\text{pm. 3}}$ is a very narrow tooth, and shows no indications of having had three roots, which appears to have been the case in at least some male individuals of the present species. The last upper molar has no trace of the conspicuous cingulum of the tooth represented in plate VII., fig. 6; and in the European molars the valleys seem slightly less open, and the accessory columns less strictly confined to the median line. Both the figured specimens of the dentition of the European species are smaller than that represented in plate VII., fig. 4; and no individuals are known to have attained anything like the size of those to which the teeth represented in figs. 3 and 6 of the same plate belonged. The molars of *S. provincialis*[4] present a certain resemblance to those of the present form, but are of considerably smaller size: the talon of $\underline{\text{m. 3}}$ is, however, much narrower, and that tooth has not the cingulum on the inner side which is so conspicuously developed in the tooth figured in plate VII., fig. 6: the last

1 "Beiträge," pt. IV., pls. IV. V. 2 *Ibid*, pl. IV., figs. 1, 1c. 3 *Ibid*, pl. IV., fig. 2, pl. V.
4 Gervais, "Zool. et Pal. Franç.," pl. III., figs. 1-6, pl. XXII., fig. 8.

lower premolar is apparently proportionately narrower. The molars of *S. chœrotherium*,[1] besides their inferior size, are readily distinguished by the extremely simple structure of the columns on their crowns.

From the foregoing evidence it appears that there is every probability of the present species being distinct from every described form ; and it is therefore allowable to assign to it at least a provisionally distinct name : from the very large size of the species the name *S. titan* may be appropriately applied. This species in the structure of its true molars was evidently allied to the above-named fossil species from Eppelsheim, Pikermi, and Mont Lebéron ; but was much more specialized in the development of its canines than the species from the two latter localities, and apparently also, although to a less extent, than the Eppelsheim species. This large development of the canines is a well-marked instance of the specialization, and consequently late geological age, of the Siwalik fauna. In the structure of its lower premolars *S. titan* is intermediate between the mandible referred to *S. giganteus* and the fossil European pigs ; $\overline{\text{pm. 4}}$ being a wider tooth than in the latter, and $\overline{\text{pm. 3}}$ in some instances retaining evidences of the relationship of its owner to a *Tetraconodon*-like form by the retention of three distinct roots. Although it is probable that *S. titan* and the large European fossil pigs are nearly connected, it is at present impossible to indicate the home of the common ancestral stock.

Distribution.—All the specimens described above were obtained from the Siwaliks of the Punjab.

Species 3 : SUS FALCONERI, n. sp., *nobis*.

Syn. *Sus giganteus*, F. and C., *in parte*.
Sus sivalensis, Blain. (*non* Falc. and Caut.)
Sus, sp. nov., Baker and Durand.

History.—The name of the present species is mentioned here for the first time ; the specimens on which it is founded having been previously either referred by Falconer and Cautley to *S. giganteus*, by De Blainville to *S. sivalensis*, or not specifically named.

Cranium of male.—In figures 3, 3a, 3b of plate LXIX. of the "F.A.S." there are given three small-sized views of the cranium of a Siwalik pig in the collection of the British Museum (No. 16,386), under the name of *S. giganteus*. The specimen has lost the extremity of the muzzle, but is otherwise nearly complete anteriorly : posteriorly it is broken off in the middle of the temporal fossa, and has lost a portion of the fronto-parietal region : the teeth are all well worn, and indicate an aged animal.

In describing this specimen it will be simplest to indicate in what respects it differs from the crania of *Sus giganteus* and *S. titan*, which have been shown to be of the same general type, and may therefore be considered together. In the first place, the size of the cheek-teeth indicates an animal nearly or quite as large as the British

[1] Blainville, "Ostéographie," Genus *Sus*, pl. IX.

Museum type skull of the first of those species; but the proportions of the two skulls are very different. Thus while in *S. giganteus* the vertical height of the cranium at the infra-orbital foramen is 5·4, and at pm. 4 4·3 inches, in the present specimen these dimensions are only 4·3 and 2·9 inches: the width across the parietals between the temporal fossæ in the present specimen is, moreover, nearly twice that of *S. giganteus*. The protuberance above the canine in the present specimen is also extremely large and elongated, whereas it is comparatively small and short in the cranium of *S. titan* (pl. IX.), which is probably that of a male: the large size of this protuberance and of the alveolus of the canines indicates that the present specimen likewise belongs to the male sex. The present specimen also differs from the cranium of *S. giganteus* by the narrower and less prominent zygomatic arches, as well as by the more anterior direction of the axis of the orbit.

The present cranium is indeed of a longer and lower form than that of *S. cristatus*, and comes nearest in this respect to the cranium of the existing *S. barbatus*[1] of Borneo; in which the facial portion is very long and low, with a marked rise above the orbit towards the occiput. The fossil and recent crania also agree in possessing a long protuberance above the canine, extending backwards as far as m. 1, instead of stopping at pm. 2 as in other living pigs, *S. titan*, and probably *S. giganteus*; and in having the extremity of the muzzle much elongated and deflected considerably below the plane of the grinding surface of the cheek-teeth; this character being, however, most marked in the fossil. The two crania also resemble one another in the form of the pre-orbital concavity, and in having the anterior border of the orbit placed considerably behind m. 3; although this character also is most strongly developed in the fossil. In all these respects the latter differs very widely from *S. giganteus*; in which the infra-orbital sulci are shallower and less curved; their form being unknown in *S. titan*. Other comparisons will be made in the description of the next specimen; but it may be mentioned here that the skull of *S. barbatus* is readily distinguished from the present specimen by the much greater production of the palate behind m. 3. In the following table the teeth of the present specimen are compared with those of *S. cristatus*, *viz.*:—

	Specimen.	S. cristatus.
Length of three true molars	3·55	2·9
,, ,, pm. 4	0 54	0·52
Width ,, ,, ,,	0·65	0·55
Length ,, m. 1	0·68	0·62
,, ,, ,, 2	0·94	0·84
Width ,, ,, ,,	0·9	0·7
Length ,, ,, 3	1·94	1·51
Width ,, ,, ,,	1·14	0·82
Long diameter of canine	1·1	1·0

In the present specimen the length of m. 3 considerably exceeds the united length of the two preceding teeth: but this appears to be in great part due to the much worn condition of the latter, as it is not the case with little worn specimens

1 The skull of this species is figured by Rolleston, 'Trans. Linn. Soc.,' Zool., ser. 2, vol. I., pl. XLIII., fig. 7.

described below. The structure of the molars of the present specimen is much more complex than in *S. giganteus* or *S. titan*; but these characters are better exhibited by less worn specimens described in the sequel. The last upper molar of *S. barbatus* is much simpler than that of *S. cristatus*, and is, therefore, quite unlike the corresponding tooth of the fossil.

Cranium of female.—In plate X. of the present volume there is represented ($\frac{1}{2}$) the skull of a female pig from the Siwaliks, which from its general agreement with the last specimen may be referred to the same species: the right upper cheek-dentition of this cranium is represented of the full size in plate VII., fig. 7. This specimen is preserved in the Science and Art Museum, Dublin (No. C. 27), and is one of those figured and described by Baker and Durand.[1] It is nearly complete and has suffered but slightly from crush: all the teeth, with the exception of the canines and outer incisors, are in position; all the true molars are very much worn; and the alveoli of the canines and outer incisors are filled with matrix. In general form this skull agrees very closely with the male specimen; being distinguished only by the small size of the canines, and the absence of the overhanging protuberance. These two characters clearly indicate the female sex of the present specimen.

The more perfect preservation of the present specimen permits of fuller comparisons than were possible with the male skull. Thus it is seen that the length of the nasals[2] considerably exceeds the length of the fronto-parietal region; and it is, therefore, evident that the present species has no affinity with *S. titan*, *S. giganteus*, and the *S. cristatus* group, in which the reverse is the case. The present specimen also shows the wide and flattened fronto-parietal region, the narrow nasals, and the deflected muzzle; as well as the advanced position of $\underline{\text{m. 3}}$ in regard to the orbit; in all of which characters it differs from *S. giganteus* and *S. titan*.[3] The extension of the palate behind the last-named tooth is intermediate between the condition prevailing in *S. giganteus* and *S. cristatus*. The zygomatic arches are wider in the middle than posteriorly; which is a character given by Rolleston[4] as distinctive of *S. barbatus*: the pre-orbital concavity is also deep as in that species, instead of wide and shallow as in *S. scrofa*.

As it is apparently only in *S. scrofa* and *S. barbatus* among living pigs that the length of the nasals largely exceeds the length of the fronto-parietal portion of the skull,[5] it is evidently only with those two that the fossil is allied. It is distinguished from the former by the greater deflection of the muzzle, the flattened frontals, the form of the pre-orbital concavity and of the zygomata, and the large protuberance over the canine of the male. It agrees, however, with that species in the fact that

1 Two views ($\frac{1}{3}$ nat. size) are given on plate XXXV. of Baker and Durand's memoir; while the dentition of the left side is represented of the full size on plate XLIV., fig. 3, of the same memoir. The latter figure is reproduced on a smaller scale by De Blainville ("Ostéographie," Genus *Sus*, pl. IX.) under the name of *S. sivalensis*.

2 The length of these bones can be estimated from that of the premaxillæ.

3 The width of the parietals at the temporal fossæ has not been determined in this species.

4 *Op. cit.*, p. 265.

5 *Vide* Rolleston, *op. cit.*

the summit of the occipital crest forms the highest point of the skull[1]; and thereby differs from *S. barbatus*, in which "the highest point is some way in front of the occipital squama, and occupies a level far above the plane occupied by the anterior half of the frontal."[2]

In the following table the dimensions of the specimen under consideration are compared with those of the type skull of *S. giganteus*, with one of *S. barbatus*, of which the dimensions are given by Rolleston, and with one of *S. cristatus*:—

	S. giganteus.	Specimen.	S. barbatus.	S. cristatus.
Extreme length		15·8	19·7	14·5
Base line		13·5	16·7	1·2
Extreme zygomatic width	8·5	6·62	6·8	6·2
Length of nasals		8·0	10·5	6·6
,, ,, fronto-parietals		7·2	9·0	7·2
Width of nasals		1·5	1·5	1·7
,, ,, post-orbital processes	5·1	4·3	4·5	4·25
Height of occiput	6·55	4·62		5·1
Long diameter of condyle	1·6	1·13		1·2
Interval between foramen magnum and palate . .	3·8	4·1		3·25
Height at infra-orbital foramen	5·4	4·4		3·9
Width of palate posteriorly	1·7	1·2	1·1	1·3
,, ,, ,, anteriorly	1·5	1·34		1·35
Greatest diameter of orbit	1·35	1·75		1·6
Length of palate		9·2		8.6

In the next table the dimensions of the teeth of the present and the last specimen are compared with those of the two British Museum crania of *S. giganteus*, *viz.*:—

	Present species.		S. giganteus.	
	male.	female.		
Length of three true molars	3·55	3·48	3·2	3·7
,, ,, four last cheek-teeth	4·28	3·74	3·8	4·22
,, ,, series of ,, ,, ...	5·5	5·1		
Diameter of canine	1·1	0·58		
Length of pm. 4	0·54	0·45	0·7	0·7
Width ,, ,, ,, ...	0·65	0·55	0·9	0·82
Length ,, m. 1	0·68	0·52	0·62	0·75
Width ,, ,, ,, ...		0·68	0·82	0·92
Length ,, ,, 2	0·94	0·87	0·91	1·16
Width ,, ,, ,, ...	0·9	0·85	1·08	1·08
Length ,, ,, 3	1·94	2·1	1·7	1·85
Width ,, ,, ,, ...	1·14	1·0	1·2	1·22

In regard to the cheek-dentition it will be observed that, as in the male cranium, the length of $\underline{\text{m. 3}}$ considerably exceeds the united length of the two preceding teeth, but this character is largely due to mutual pressure, and the worn condition of the teeth; $\overline{\text{m. 1}}$ and $\overline{\text{m. 2}}$ having lost their enamel on both their anterior and posterior borders. The third premolar is of the normal shape, and therefore quite distinct from the corresponding tooth of *S. giganteus* (plate XI., fig. 2): the first premolar is remarkably small, but is rather larger in the male cranium. The last true molar (plate VII., fig. 7) exhibits an extremely complex structure on its worn surface, the talon being much produced, and the portion behind *a* relatively more developed than in the corresponding teeth of *S. giganteus* (plate XI., fig. 2) and *S. titan* (plate VII., fig. 6):

1 *Vide* Rolleston, *op. cit.*, pl. XLII., fig. 5.

2 *Ibid*, p. 265, pl. XLIII., fig. 7.

the whole talon indeed exceeding the length of the hinder main columns. The complexity of the pattern on the worn surface is produced by the number and large size of the accessory columns (which completely block the lateral valleys) and by the vertical grooving of the enamel; the latter character causing the section of the enamel in certain stages of wear to present a folded, or crenulated, appearance. This structure is present to a certain extent in the molars of most pigs, but is never so strongly developed as in the present form. In the elongated m. 3, and the complex pattern on its crown, the cranium is widely different from *S. barbatus*.

Other specimens.—In the memoir cited Baker and Durand described an imperfect cranium of a male of which they figured the left dentition[1]: that specimen seems to agree in all respects with those described above, and belonged to an old individual, the first and second molars being completely worn down, and their united length much less than that of m. 3: the latter tooth is rather larger in all its dimensions than that of the female skull, but exhibits the same complexity of structure. The subsequent history of this specimen is unknown. In the Science and Art Museum, Dublin, there is the middle portion of a crushed skull (No. C. 31), of which the dentition of the left side is represented in plate XLIV., fig. 4, of Baker and Durand's memoir. This specimen appears to agree exactly with the typical male skull, although the crush to which it has been subjected makes it appear relatively higher: the teeth are well worn. The dimensions of its cheek-teeth are as follows, *viz.*:—

Length of three true molars	3·6	Length of m. 3	2·0
,, ,, m. 2	1·0	Width ,, ,, ,,	1·1
Width ,, ,, ,,	0·9		

In the British Museum there is the palate of a younger individual in which m. 3 has not come into wear: the left dentition of this specimen is represented in plate XLIV., fig. 2, of Baker and Durand's memoir. From its little-worn condition, and consequent absence of pressure by m. 3, the second true molar is much longer in this specimen than in any of those previously described; the united length of this and the preceding tooth equalling that of m. 3: m. 2 very clearly exhibits the characteristic complex pattern of the masticating surface. The dimensions of the teeth of this specimen are as follows, *viz.*:—

Length of pm. 4	0·49	Length of m. 2	1·29
Width ,, ,, ,,	0·6	Width ,, ,, ,,	0·84
Length ,, m. 1	0·74	Length ,, ,, 3	2·03
Width ,, ,, ,,	0·66	Width ,, ,, ,,	0·97

The palate of a still younger individual in the British Museum (represented in "F.A.S.," pl. LXXI., fig. 14, and in pl. XLIV., fig. 1, of Baker and Durand's memoir[2]), in which m. 3 is still *in alveolo*, exhibits precisely similar characters, but the dimensions of m. 2 are only 1·2 and 0·83. The greater portion of a young skull in the same collection, represented in plate LXX., figs. 4, 4a, 4b, of the "F.A.S.,"

1 Plate XLIV., fig. 5.

2 This figure is reproduced on a reduced scale by De Blainville ("Ostéographie," Genus *Sus*, pl. IX.), under the name of *S. sivalensis*.

agrees in contour with the type skulls, and shows the elongated m. 2 characteristic of young individuals.

In figure 5 of plate VII. of the present volume there are represented the cheek-teeth of one side of the hinder part of a palate of a Siwalik pig in the British Museum[1]; in which there is seen a fragment of the well-worn m. 1, and the complete m 2 and m. 3: the last is untouched by wear, while m. 2 is in a middle stage of detrition. The dimensions of this specimen are as follows, *viz.*:—

Length of m. 2	1·4	Length of m. 3	2·2
Width „ „ „	0·83	Width „ „ „	1·1

In this specimen m. 2 exhibits very perfectly the extreme complexity of pattern characteristic of the present species, and is more elongated than in any other jaw. The last molar is also unusually complex; its length being greater in proportion to its breadth than is normally the case with the corresponding tooth of any described species of the genus. Although the molars of this specimen are slightly longer than those of any of the specimens yet described, the jaw may be safely referred to the same species. In figure 8 of the same plate there is represented a fragment of the right maxilla of a pig in the Siwalik collection of the Indian Museum, containing m. 2 and m. 3, which present similar characters to the foregoing, although of somewhat smaller dimensions[2]: both teeth are more worn than in the specimen last described, and m. 2 is imperfect anteriorly. Their dimensions are as follows, *viz.*:—

Length of m. 2	0·92 (?)	Length of m. 3	1·7
Width „ „ „	0·79	Width „ „ „	0·91

From their little worn and perfect condition the teeth of these two specimens exhibit in the most marked degree the points distinguishing the molars of the present species from those of *S. giganteus* and *S. titan*. Thus, if the perfect m. 2 in figure 5 be compared with the slightly more worn homologous tooth of the former in the jaw represented in fig. 12 of plate LXXI. of the "F.A.S.," and with the more worn one in plate XI., fig. 2, of this volume, the contrast between the elongated crown, with the complex pattern on its worn surface, of the one, and the square crown, with its simple pattern, of the other, will be at once perceived. The corresponding upper tooth of *S. titan*, although probably more elongated than that of *S. giganteus*, must have been much wider than the corresponding tooth in fig. 5, since the dimensions of the latter are almost the same as those of the lower tooth of *S. titan* represented in fig. 4, and upper molars are always much wider than their corresponding lower teeth. Similarly if the last molars of the two specimens under consideration be compared with the corresponding tooth of *S. giganteus*, and that of *S. titan* represented in fig. 6 of the same plate, analogous differences will be observed. Thus the hindmost teeth of the present species are much longer and narrower; and their talon, instead of consisting simply of one median column (*a*) with a horseshoe-shaped portion (*b*) behind it, consists of the same median column (*a*) with a pair of columns (*b*) behind,

[1] This specimen is also figured in pl. LXXI., fig. 13, of the "F.A.S.," under the name of *S. giganteus*.

[2] This specimen is the one mentioned under the number 318 in the note on page 513 of the first volume of the "Palæontological Memoirs"; where it is referred simply to *Sus*.

beyond which again there is a mass of agglomerated columns (*c*). The last tooth of the present specimens is further distinguished by the inner surfaces of the main inner columns being flatter, and by the valleys between the main columns being almost entirely blocked by the development of a number of small columns on either side of the median accessory columns (*f. g.*). The tooth of *S. titan* is still more markedly different in these respects than that of *S. giganteus.* Compared with $\underline{\text{m. 3}}$ of *S. cristatus*, which according to Rolleston is more complex than in any existing species of the genus, the corresponding tooth of the present specimens differs by the greater complexity of the portion *b*′ and *c*, causing the whole tooth to be relatively longer; and by the columns on the median line (*a*, *f*, *g*) being more distinct from the four main columns; as well as by the greater development of accessory columns in the terminations of the transverse valleys. The simple molars of *S. barbatus* present no resemblance to the present specimens.

In the Dublin Museum there is a detached right $\underline{\text{m. 3}}$ of a Siwalik pig (No. C. 30), agreeing in all essential characters with the corresponding tooth of the female skull represented in plate X., although of smaller size; its dimensions being 1·73x0·94.

Mandible of male.—In plate LXX., fig. 5, of the "F.A.S." there is represented the mandible of a large Siwalik pig, which from the great size of the canines evidently belonged to a male. This specimen is in the British Museum, and exhibits all the cheek-teeth in a well-worn condition: the inferior aspect of the symphysial portion is still obscured by matrix and the incisors are incomplete. From the circumstance that the last molar of this specimen is of a very elongated form (exceeding the length of the two preceding teeth) and exhibits an extremely complex pattern on the worn masticating surface, it may be inferred that it belongs to the present species. The symphysis extends backwards as far as $\overline{\text{pm. 3}}$, and there is a longer interval between $\overline{\text{pm. 2}}$ and the canine than in the mandible of *S. titan* figured in plate IX.; the canine is also relatively larger than in that specimen. The premolars are not well preserved, but they show that $\overline{\text{pm. 3}}$ was of the same form as in existing pigs. A comparison of the figures will at once show that this specimen is specifically distinct from the mandible of *S. titan* (plate VII., fig. 4) and from that provisionally referred to *S. giganteus* (plate XI., fig. 1).

A very similar specimen is represented in plate XXXV., fig. 4, of Baker and Durand's memoir. The dimensions of these specimens will be given after the description of the mandible of the female.

Mandible of female.—In plate LXIX., fig. 4, of the "F.A.S." there is given a reduced lateral view of the left ramus of a nearly complete mandible of a Siwalik pig now in the Dublin Museum of Science and Art, being one of the specimens collected by Baker and Durand. The right dentition of this specimen is figured of the full size in plate VII., fig. 1, of the present volume. The specimen shows all the teeth, which are in a well-worn condition; but the crowns of $\overline{\text{i. 3}}$, the canine, $\overline{\text{pm. 1}}$, and $\overline{\text{pm. 2}}$ have been broken off: the small size of the canine indicates that the jaw belonged to a female. In the following table the dimensions of this specimen and of the two mandibles of males are compared with those of the mandible of a male of *S. cristatus*; *viz.*:—

	Specimens.			S. cristatus.
	Male.[1]		Female.	
Length of three true molars	3·8		3·5	3·1
,, ,, five last cheek-teeth	5·0		4·7	4·08
Width of symphysis between external borders of alveoli of canines	3·4		2·42	2·7
Interval between canine and pm. 2	1·9		1·2	1·26
Length of symphysis	3·9	3·47	3·2	3·1
Height to summit of m. 3			2·66	2·67
,, ,, alveolus of i. 2			1·18	1·6
Length of m. 1		0·5		0·65
Width ,, ,, ,,		0·57		0·59
Length ,, ,, 2	1·08	1·05	1·1	0 88
Width ,, ,, ,,	0·72	0·69	0·7	0·6
Length ,, ,, 3	2·04	1·94	1·95	1·65
Width ,, ,, ,,	0·86	0·76	0·76	0·7
Long diameter of canine	1·2		0·6	0·93
Intermolar space at m. 3	1·6		1·12	1·4

The complex pattern on its worn surface, and the elongated shape of $\overline{\text{m. 3}}$ of the female jaw, clearly indicate that this specimen should be referred to the present form. It will be seen from the measurements that the superior surface of the extremity of the symphysis is much lower in the present specimen relatively to the detrital plane of the cheek-teeth than in the jaw of *S. cristatus*; the inferior border of the symphysis also forms a much less marked angle with the inferior border of the horizontal ramus, although this feature is somewhat exaggerated in the figure in the "F.A.S." These features are evidently in correlation with the deflection of the premaxillary region of the cranium of the present species. The cheek-teeth of the female jaw are relatively rather longer than in that of the male, and the intermolar space is somewhat less; both these characters corresponding with those prevailing in the crania. It will be seen that $\overline{\text{pm. 3}}$ and $\overline{\text{pm. 4}}$ are narrow teeth like those of existing pigs; the latter wanting the distinct inner column which occurs in the corresponding tooth of *S. titan* (*a*, fig. 4), and being widely different from the same tooth in the jaw referred to *S. giganteus* (plate XI., fig. 1): $\overline{\text{pm. 3}}$ is inserted by two roots only, and is therefore quite different from the same tooth in the latter jaw. The characters of the true molars will be best gathered from the specimens described below.

Lower molars.—In plate VII., fig. 2, of the present volume there is represented from the masticating aspect a fragment of the right ramus of the mandible of a pig formerly in the collection of the Asiatic Society of Bengal, which was obtained by the late Sergeant Dawe from the Siwaliks of the neighbourhood of Náhan. It is described by Falconer[2] in the following words:—"*Sus*; Fragment of lower jaw, right side, comprising posterior part of horizontal ramus, broken across horizontally near the base of the teeth, and containing the last two molars, the penultimate well worn, with very flexuous enamel; the last molar in germ and of very large size."

1 The specimen in the first column is the British Museum, and that in the second Baker and Durand's specimen.

2 *Vide* "Pal. Mem.," vol. I., p. 513, note (No. 319).

Since Falconer's notice the anterior wall of $\overline{m. 2}$ has been broken way. The inner aspect of $\overline{m. 3}$ is represented in fig. 9 of the same plate. A larger fragment of the corresponding ramus of another mandible, from the Siwalik Hills, containing the three true molars, is represented in plate LXXI., fig. 15, of the "F.A.S." under the name of *S. giganteus*, and is preserved in the British Museum (No. 16,612). In that specimen the cheek-teeth are in nearly the same condition of wear as the mandible represented in plate VII., fig. 1, of the present volume, and the length of $\overline{m. 3}$ exceeds that of the two preceding teeth. Since the molars of all three specimens agree exactly in the complex pattern formed on their masticating surfaces, in their elongated shape, and in the long talon of the last tooth; while the teeth of the British Museum specimen agree almost exactly in size with those of fig. 1, those of fig. 2 being somewhat larger, the whole of the three specimens evidently belong to the same, or a closely allied, species.

Comparing the molars of the specimen represented in fig. 2 with those of *S. titan* represented in fig. 4 of the same plate (the degree of wear of the latter being very slightly less than that of the former), it will be seen that the pattern of the worn surface of $\overline{m. 2}$ is much more complex in the present specimen; the transverse valley on the outer side being entirely obliterated by the detrition of the outlying columns situated therein: the whole crown is moreover relatively longer and narrower. In $\overline{m. 3}$ the distinctive characters of the two forms are, if possible, still more distinctly displayed. Thus the talon of that tooth in the present specimen has the median column (*a*) corresponding to that of *S. titan*; in the portion *b* and *c* the inner column is, however, more developed, being as large as the outer column; while behind these there is the portion *d* which is entirely wanting in *S. titan*. The main columns in the present species are flattened on their lateral surfaces; and the lateral accessory columns are so developed as to almost completely block the outer terminations of the transverse valleys; this being especially noticeable in the first valley. On the inner lateral surface (figs. 9, 10) it will be seen that the columns of the present species are relatively taller and wider, with their summits inclining forwards in place of being nearly vertical, and with much narrower spaces between them: the talon (*the portion to the right of ta*) is equal in length to the whole length of the rest of the crown, instead of only to half, and its first column is as high as the column immediately anterior to it: finally the whole crown is relatively higher. In the following table the dimensions of the specimen represented in fig. 2 are compared with those of the British Museum specimen, and with those of the corresponding teeth of *S. titan*, *viz.*:—

	Present species.		S. titan.
	Ind. Mus.	Brit. Mus.	
Length of m. 2		0·95	1·42
Width ,, ,, ,, ...	0·71	0·7	1·0
Length ,, ,, 3	2·4	1·8	2·16
Width ,, ,, ,, ...	0·85	0·7	1·2
Height of first inner column of talon of ditto	1·05		0·7

These dimensions and comparisons, coupled with the totally different form of the last premolar of the female jaw already described from that of *S. titan*, leave no doubt of the specific distinctness of the specimens under consideration from that species.

Compared with the jaw provisionally referred to *S. giganteus* (plate XI., fig. 1), still more striking differences obtain, since the crowns of the molars of that specimen are even lower than in *S. titan*, and the crowns of $\overline{\mathrm{m.\,1}}$ and $\overline{\mathrm{m.\,2}}$ are of remarkable shortness ; while the latter tooth exhibits no trace of the complex pattern formed on the worn surface of the present specimens. These differences, together with the simple premolars of the female lower jaw of the present form, leave no doubt of the specific distinctness of the latter from the lower jaw figured in plate XI.: and since it has been shown even if that specimen do not belong to *S. giganteus* that the lower molars of that species must have been of very similar structure, there is no doubt of the specific distinctness of the present form from that species.

Compared with *S. cristatus*, the molars of the present specimens present a much greater resemblance than they do with those of *S. titan* or *S. giganteus*. In $\overline{\mathrm{m.\,3}}$ of the living species the whole crown, and more especially the talon, is relatively lower ; and the hindmost portion of the talon (*d*) comprises only a single column : the inner lateral surfaces of the main columns are less flattened and elongated, the accessory columns less fully developed, and the pattern on the worn masticating surfaces of all the molars less complex. With the simple molars of *S. barbatus* the present specimens have no resemblance.

Other mandibles.—In figs. 7, 7a of plate LXX. of the "F.A.S." there is represented, under the name of *S. giganteus*, the mandible of an immature Siwalik pig, now in the collection of the British Museum (No. 16,599), which, judging from the elongated form of $\overline{\mathrm{m.\,2}}$ and the complex pattern of the worn surface of the same, as well as from the general contour of the jaw, should apparently be referred to the present species. The last molar is not fully protruded ; and the small size of the canines indicates that the specimen probably belonged to a female. The side view shows the depression of the extremity of the symphysis below the alveoli of the cheek-teeth characteristic of this species. Another specimen in the same collection, represented in plate LXX., fig. 6, of the "F.A.S.," in which the molars are very much worn down and battered, probably belongs to the same species. The dimensions of these two specimens, taken in the same order, are as follows, *viz.*:—

Height of ramus at m. 3	2·0	2·1	Width of m. 1	0·55
Thickness ,, ,, ,, ,,	1·4	1·4	Length ,, ,, 2	1·21
Length of symphysis	2·8	2·8	Width ,, ,, ,,	0·7
Interval between canine and pm. 1	0·5		Width ,, ,, 3	0·78
Length of m. 1	0·72			

A fragment of the right ramus of a mandible in the same collection (No. 16,609) probably belongs to a young individual of the same species. This specimen shows very clearly the elongated form of the little worn $\overline{\mathrm{m.\,1}}$.

Distinctness and affinities.—The foregoing comparisons leave no doubt of the specific distinctness of the specimens under consideration from *S. giganteus* and

S. titan; and the resemblance of the different specimens to one another is so close that they may, at all events provisionally, be referred to a single species. That species is indeed a much smaller form than *S. titan*, and many of its individuals do not greatly exceed in size the existing *S. cristatus*. The fossil species is distinguished from all living species of the genus (including *Potamochœrus*) by the extreme complexity of the structure of its cheek-dentition, as well as by the form of the skull. In the latter respect it makes a very marked approach to *S. barbatus*, but the simple molar dentition of that species removes it very widely from the fossil. The only way of explaining the resemblance existing between the crania of these two forms seems to be that they may both be diverging branches from a common stock having a cranium of similar form, and with molars of the simple structure of the existing species.

With regard to the fossil species in the list on pages 51-2 the present form is at once distinguished from *S. antiquus*, *S. erymanthius*, and *S. major*, by the structure of its molars; those of the three fossil species being of the *S. titan* type. *S. arvernensis* is a much smaller form, with apparently simpler molars. The molars of *S. chœroides*, *S. chœrotherium*, *S. lockharti*, and *S. palœochœrus*, are all of a comparatively simple structure, and approach more or less closely those of *S. africanus* and *Hyotherium*; while none of the other species in the list appear to present any close resemblance to the present form. The distinctness of the latter from the Siwalik *S. hysudricus* and *Hippohyus* will be indicated in the sequel.

Seeing, therefore, that the specimens under consideration cannot be identified with any named species with which the writer is acquainted, they are entitled to rank as a distinct species, for which the name of *Sus falconeri* is proposed. There appears to be a certain amount of variation in the structure of the hinder molars, but not more than might be expected in different individuals of such a complex-toothed species. The high specialization of the species is indicated not only by the complex structure of the molars, but also by their extremely elongated form.

Resemblance to Phacochœrus and Hippohyus.—Although there is no doubt that *S. falconeri* is a true *Sus*, yet in the structure of its molars it makes a decided approach to *Phacochœrus*; this character being most marked in last lower molars, like the one represented in plate VII., figs. 2, 9. This tooth approaches $\overline{\text{m. }3}$ of *Phacochœrus* in its extremely elongated form, in the flattened lateral walls of the main columns, in the distinctness and large size of the numerous accessory lateral columns filling the valleys, and in the relatively great height of the crown. To convert such a tooth into the lower molar of *Phacochœrus*, it merely requires that the main columns should be reduced to the size of the accessory ones, and that each one should be completely isolated from the others, while the height of the crown should be still more increased. The last lower molar of *S. falconeri* is indeed almost exactly intermediate between the corresponding tooth of *S. titan* and *Phacochœrus*; and it is thus easy to see how a transition may have taken place from a simple tooth like that of *S. titan* to the extremely complex one of *Phacochœrus*. In the "Enchainements"[1] Prof. Gaudry remarks:—"*Le genre phacochère a pu, comme celui des hippopotames, être cité parmi les formes qui sont isolées dans la nature actuelle, mais M. Tournouër m'a montré dernièrement des molaires d'un sanglier fossile recueilli en Afrique dans la province de Constantine, où les denticules se multiplient et se séparant les uns des autres, de manière a indiquer une tendance vers la forme singulière des phacochères.*" This African form, which the writer believes to be still undescribed, would thus seem to be allied in the structure of its molars to *S. falconeri*; and it is interesting to find indications that the African wart-hogs were probably connected through an extinct North African form with a highly specialized true pig from the Siwaliks of India.

The complex structure of the molars of *Sus falconeri* leads on in another direction by an easy transition to the still more complex molars of *Hippohyus*, and it is thus, as will be shown in the sequel, easy to see how a transition may have been effected from the simpler forms of bunodont molars to those of the Selenodonts.

Distribution.—Remains of *S. falconeri* have hitherto been obtained only from the typical Siwalik Hills (unless some undetermined mandibles noticed in the sequel belong to this species). This is another instance of the more or less complete restriction of the more specialized forms to the eastern side of India: the more generalized forms usually characterizing the western side, although sometimes ranging to the eastward.

Species 4: Sus hysudricus, Falc. and Caut.

Syn. *Sus*, sp., Baker and Durand.

History.—At the conclusion of their memoir on the fossil Siwalik swine Baker and Durand[2] observed that an imperfect cranium, of which they gave a figure,[3] indicated a species of Siwalik pig specifically distinct from the one they had first described (*S. falconeri*). They observed that this second species was of smaller size than the existing *S. cristatus*; and differed also, among other characters, by the more simple structure of the talon of $\underline{\text{m. 3}}$. In the "F.A.S."[4] a large number of specimens of the teeth and jaws of a small Siwalik pig were figured by Falconer and Cautley under the name of *S. hysudricus*; although no description of the species was ever published. A comparison of the figures shows that the species so designated is the same as the smaller *Sus* described by Baker and Durand.

Upper dentition and cranium.—In plate LXX., figs. 2, 2a, of the "F.A.S." there is represented the middle portion of a cranium of this species from the Siwalik Hills, in which $\underline{\text{m. 3}}$ is not protruded, and the canine is of extremely small size; the latter character indicating that the specimen belonged to a female. A full-sized view of the dentition of this specimen is given in plate LXXI., fig. 9, of the same work. The pre-orbital concavity is narrow behind, as in *S. verrucosus*; and the form of the cranium appears to be relatively short and tall, as in the majority of existing

[1] "Mammifères Tertiaries," pp. 73-4.
[2] 'Journ. As. Soc. Beng.,' vol. V., p. 668.
[3] *Ibid*, pl. XLIV., fig. 6.
[4] Part VIII., plates LXX., LXXI. (1847).

Asiatic pigs. In the specimen figured by Baker and Durand the canine is of large size, indicating a male individual: and from the width of the nasals it is inferred that this cranium was relatively shorter than that of *S. cristatus*. There is an imperfect cranium in the British Museum (No. 37,267) from the Siwaliks of Perim Island, in which the crowns of the teeth are broken off, exhibiting very similar characters.

In plate LXXI., fig. 5, of the "F.A.S." there is represented the left half of a palate of the same species, now in the British Museum, from Perim Island, showing the two last premolars and the three true molars, the last of which is unworn. A specimen of a fragment of the right maxilla, from the Siwalik Hills, represented in fig. 7 of the same plate, shows m. 2 and m. 3 in a well-worn condition. The specimen of a portion of the right maxilla represented in plate VIII., fig. 10, of the present volume was collected by Mr. Theobald in the Siwaliks of the Punjab, and exhibits the hinder portion of m. 1, and the complete m. 2 and m. 3; the latter being in an unworn condition. In fig. 11 of the same plate there is represented a fragment of the left maxilla, from the same region, showing the last premolar, and the first and second true molars; all in a well-worn condition. In the following table the dimensions of the four specimens mentioned above, taken in the same order, are compared with those of the corresponding teeth of a male of *S. andamanensis*, *viz.*:—

	S. hysudricus.				S. andamanensis.
Length of pm. 3	0·5				0·4
Width ,, ,, ,, ...	0·35				0·33
Length ,, ,, 4	0·5			0·5	0·44
Width ,, ,, ,, ...	0·53			0·56	0·45
Length ,, m. 1	0·6			0·64	0·57
Width ,, ,, ,, ...	0·58			0·6	0·48
Length ,, ,, 2	0·8	0·68	0·8	0·84	0·7
Width ,, ,, ,, ...	0·71	0·7	0·72	0·73	0·58
Length ,, ,, 3	1·1	0·85	1·2		0·95
Width ,, ,, ,, ...	0·71	0·7	0·72		0·61

As the dimensions of the specimen figured by Baker and Durand, and those of the one represented in plate LXXI., fig. 9, of the "F.A.S.," are comprised within the same limits, it may be taken for granted that the foregoing dimensions indicate the average size of the species. The length of m. 1 in the third and fourth columns is practically the same as that of the corresponding tooth of the cranium of *S. cristatus* measured on page 55, but its width is greater. The last molar of the fossil is, however, very much shorter than in the last-named species; its length being less than that of the two preceding teeth. These two specimens indicate, therefore, an animal nearly as large as *S. cristatus*; but the specimen in the second column is more nearly the size of *S. andamanensis*. The extreme shortness of m. 3 distinguishes the fossil species from typical examples of *S. scrofa*, *S. verrucosus*, and *S. cristatus*; and allies it with *S. barbatus*, the typical form of *S. vittatus*, the *S. andamanensis* group, and the African river-hogs. The form of the cranium indicates that the fossil has no affinity with *S. barbatus*. In view of the uncertainty existing as to the relations of *S. vittatus* to the *S. andamanensis* group, it is almost impossible, when dealing with fossil forms of intermediate size, to indicate any characters by which the one can be satisfactorily distinguished from the other; and comparisons will, therefore, be mainly confined to the *S. andamanensis* group. It may be observed, however, that the talon of the third molar of *S. andamanensis* is generally still simpler than that of *S. vittatus*; and the length of that tooth usually still less in proportion to that of the two preceding teeth; and that in this respect the fossil appears to be nearer to the former species. Compared with the cranium of *S. andamanensis*, the fossil form agrees with that species in the proportionate length of the true molars; the united length of $\underline{\text{m. 1}}$ and $\underline{\text{m. 2}}$ considerably exceeding that of $\underline{\text{m. 3}}$, and the talon of the latter being relatively short: the true molars of the fossil are, however, relatively wider than those of the existing species. Both forms agree in the relatively early appearance[1] of $\underline{\text{m. 3}}$; but the crown of that tooth is lower in the fossil, and the talon wider, with its hinder portion (*b*) more distinctly separated from the hinder pair of main columns: the last tooth of the existing species has not the conspicuous cingulum of the fossil. The upper molars of *S. timorensis* and *S. papuensis* (the other members of the *S. andamanensis* group) are also very similar to those of the fossil, but have likewise slightly narrower and higher crowns. The crania of the three existing species have the pre-orbital concavity wide posteriorly. The last upper premolar of the fossil has its inner moiety longer antero-posteriorly, and its inner column (*a*) decidedly larger than in either of the three species mentioned, or indeed than in any existing Asiatic pig; and the preceding tooth[2] likewise appears to be relatively larger. In these respects the fossil is nearer to the African *S. porcus*[3]; which is, however, distinguished by the smaller relative size of $\underline{\text{m. 3}}$, and the absence of $\underline{\text{pm. 1}}$; the latter being well developed in the fossil.

Lower dentition and mandible.—In plates LXX., LXXI., of the "F.A.S." there are represented five specimens of the mandible of a small species of Siwalik pig, which from their size and the structure of their teeth may be referred to the present species. The first specimen (plate LXX., figs. 3, 3a) shows the entire cheek-dentition of both sides, in an early stage of wear: the second (pl. LXXI., fig. 6) the cheek-dentition of the left side, the earlier premolars and $\overline{\text{m. 3}}$ being imperfect, and $\overline{\text{m. 1}}$ in a half-worn condition: the third (*ibid*, fig. 10) the last five teeth of the right side in a rather more worn condition: the fourth (*ibid*, fig. 8) $\overline{\text{m. 2}}$ and $\overline{\text{m. 3}}$ of the left side, in a well-worn condition; and the fifth (*ibid*, fig. 11) the symphysis, showing the four premolars. In plate VIII., figs. 3, 3a, of the present volume there is represented the dentition of the right ramus of a similar mandible collected by Mr. Theobald in the Siwaliks of the Potwár district of the Punjab, showing the last five cheek-teeth in a well-worn condition. In figure 2 of the same plate there is represented a fragment of the right ramus showing $\overline{\text{m. 3}}$ and the greater part of $\overline{\text{m. 2}}$, both in a still

1 The specimen represented in pl. LXXI., fig. 9, of the "F.A.S." is abnormal in this respect.

2 "F.A.S.," pl. LXXI., fig. 9.

3 The upper and lower dentition of this form is figured by Rütimeyer in 'Verhand. nat. Ges. Basel,' vol. IV., p. 517, *et. seq*, under the name of *S. penicillatus*.

more worn condition, obtained by Mr. Theobald from the Siwaliks of Lehri, Punjab. The corresponding portion of the opposite ramus of the same specimen was also obtained, but is not figured.

In the following table the dimensions of these seven specimens, taken in the same order, are compared with those of the mandible of *S. andamanensis*, *viz.*:—

	S. hysudricus.							S. andamanensis.
Height at m. 2	2·0					2·1	2·3	1·4
Length of three molars	3·0		2·2			2·75		2·3
,, ,, 6 cheek-teeth	4·88							3·5
,, ,, pm. 2		0·45			0·45			0·4
,, ,, ,, 3	0·59	0·45			0·5	0·65		0·42
Width ,, ,, ,,	0·3					0·44		0·21
Length ,, ,, 4	0·69	0·5	0·5		0·5	0·62		0·46
Width ,, ,, ,,	0·43	0·35	0·35			0·5		0·32
Length ,, m. 1	0·8	0·55	0·5			0·64		0·54
Width ,, ,, ,,		0·43	0·4			0·48		0·37
Length ,, ,, 2	0·92	0·7	0·66	0·73		0·84		0·65
Width ,, ,, ,,		0·53	0·5	0·6		0·65	0·66	0·46
Length ,, ,, 3	1·4		1·0	1·4		1·35	1·28	1·1
Width ,, ,, ,,			0·5	0·65		0·7	0·71	0·53
,, ,, intermolar space at pm. 2					1·3			0·96

The differences in these dimensions are not greater than those which might occur in different individuals of the same species: the excessive length of $\overline{\text{m. 1}}$ and $\overline{\text{m. 2}}$ in the first specimen is due to the large talons and early stage of wear of those teeth. In all the specimens the united length of $\overline{\text{m. 1}}$ and $\overline{\text{m. 2}}$ largely exceeds that of $\overline{\text{m. 3}}$. The specimen in the sixth column (pl. VIII., fig. 3) may, from the large size of the premolars, be pretty safely referred to a male. It will be seen from the dimensions that in this specimen $\overline{\text{pm. 3}}$ and $\overline{\text{pm. 4}}$ are much larger in proportion to $\overline{\text{m. 1}}$ than in *S. andamanensis*; this being especially marked in the case of $\overline{\text{pm. 3}}$, whose length exceeds that of $\overline{\text{m. 1}}$, instead of being considerably less: both premolars are relatively much wider than in the existing species; but $\overline{\text{pm. 3}}$ appears to have been inserted by two roots only. It seems that the accessory inner column (*a*) found in $\overline{\text{pm. 4}}$ of *S. titan* (pl. VII., fig. 4) is developed in the corresponding tooth of the present species. In some of the specimens figured in the "F.A.S." the premolars are relatively smaller; whence it is not improbable that those specimens belonged to females. The true molars are very similar in structure and proportionate size to those of *S. andamanensis*, but the crowns are somewhat lower; and the talon[1] of $\overline{\text{m. 3}}$ has its posterior portion (*b*, *c*) more distinctly separated from the middle accessory column (*a*). In the jaw referred to a male the molars are relatively rather wider; but this is not the case with some of the specimens figured in the "F.A.S.," which may belong to females. Very similar differences obtain between the fossils and the lower molars of *S. papuensis*.

In the specimen represented in plate VIII., fig. 3, the depth of the jaw and the length of $\overline{\text{m. 1}}$ and $\overline{\text{m. 2}}$ is almost exactly the same as in the jaw of *S. cristatus* measured on page 73; but the width of these two teeth is considerably greater in the fossil; while the length of $\overline{\text{m. 3}}$ is much less, and that of $\overline{\text{pm. 3}}$ and $\overline{\text{pm. 4}}$ as much

1 A last lower molar of *S. andamanensis* is figured on an enlarged scale by Rolleston, *op. cit.*, pl. XLIII., fig. 8.

greater. This specimen, therefore, indicates an animal as large as *S. cristatus*; but other specimens scarcely exceed the size of *S. andamanensis.*

In its relatively large hinder premolars the mandible represented in plate VIII., fig. 3, is like that of *S. porcus*[1]; but $\overline{\text{pm. 3}}$ is longer, instead of shorter, than $\overline{\text{pm. 4}}$ in the fossil; and the two preceding teeth are well developed. In the large size of the hinder premolars in both jaws the fossil is distinguished from *S. vittatus* as markedly as from the *S. andamanensis* group.

In plate VIII., fig. 5, there is represented a fragment of the right ramus of the mandible of a young pig, collected by Mr. Theobald in the Siwaliks of the Punjab, containing the last milk-molar ($\overline{\text{mm. 4}}$) in a half worn condition, and $\overline{\text{m. 1}}$ in an early stage of wear: from the size of the latter tooth the specimen may be referred to the present species. The milk-molar agrees very closely with the same tooth in a young English domestic pig. In fig. 6 of the same plate there is represented the corresponding portion of a left ramus, obtained by Mr. Theobald from the Siwaliks of Kúshalghar, below Attock, containing the homologous teeth. The milk-molar is broken and very much worn: $\overline{\text{m. 1}}$ is slightly smaller than in the last specimen, and indicates a small individual of the species. In fig. 8 of the same plate there is represented a fragment of the right ramus of the mandible of an extremely young individual, also from the Siwaliks of the Punjab, containing the third and fourth milk-molars in an unworn condition. The dimensions of the teeth of the three specimens described above (taken in the same order) are given in the following table, *viz.*:—

Length of mm. 3			0·46
,, ,, ,, 4	0·68		0·72
Width ,, ,, ,, ...	0·34	0·32	0·36
Length ,, m. 1	0·61	0·58	
Width ,, ,, ,, ...	0·44	0·41	

Specific distinctness and affinities.—The foregoing comparisons indicate that the present form is specifically distinct from any existing pig, and that it appears to be most nearly allied to the *S. andamanensis* group; but is distinguished from the living representatives of that group, among other characters, by the proportionately larger and stouter premolars, and the wider and lower-crowned molars of the male sex; most individuals of which were of larger size than the existing species. In the form of the premolars it shows some affinity to the African river-hogs.

Turning to the previously described Siwalik species, the present form is at once sufficiently distinguished from *S. falconeri* by its much simpler last molars. In the structure of its cheek-teeth it is much nearer to *S. titan*, but is sufficiently distinguished by its greatly inferior size. The last upper molar (pl. VIII., fig. 10) is of the same general form as that of *S. titan* (pl. VII., fig. 6), but the hinder part of the talon (*b*) is narrower, the valleys are less open, the accessory columns in the neighbourhood of the talon more numerous, and the enamel thrown into a greater number of corrugations. The lower molars of the two are likewise very similar

1 *Vide* Rütimeyer, *op. cit.*

(pl. VIII., fig. 3, and pl. VII., fig. 4), but it is difficult to compare them exactly, owing to their different degrees of wear. The talon of $\overline{\text{m. 3}}$ of the present form seems to have had lower columns, less distinctly separated from one another, than in *S. titan*. In no individuals of the latter were the hinder lower premolars relatively as narrow as in some (female) individuals of the present form. From *S. giganteus* the present form is equally well distinguished by its inferior size. The last upper molar of that species (pl. XI., fig. 2) has no sign of the cingulum which is so conspicuously developed in the corresponding tooth of the present form: and the first and second molars are usually still wider in proportion to their length. Finally the teeth of the lower jaw provisionally assigned to that species (pl. XI., fig. 1) are of a totally different type from those of the present form.

It may accordingly be taken as pretty evident that the present form is specifically distinct from either of the three species of Siwalik pigs already described, and it now remains to compare it with the fossil species of Europe. It will probably suffice to state that the forms coming nearest to the Siwalik fossil are those grouped in the table on pp. 51-2 under the names of *S. chœroides*, *S. lockharti*, and *S. palæochœrus*. The lower jaw figured by Kaup[1] under the latter name in having relatively large premolars is very similar to the specimen represented in plate VIII., fig. 3: its $\overline{\text{m. 1}}$ and $\overline{\text{m. 2}}$ are, however, rather more elongated, but as this character is not constant in the specimens referred to the present species it cannot be regarded as of specific value. The last upper molar of the same species figured by Kaup[2] is also very similar to the corresponding tooth of the specimen in plate VIII., fig. 10, although its talon is placed directly in the median line. The above-mentioned specimens come nearer to the Siwalik form than any others which have come under the present writer's notice; and the resemblance is indeed so close that it appears quite possible that the two may be specifically identical. Bearing in mind, however, the extreme difficulty of distinguishing allied species of the genus from the characters of their molars, it would be rash to say that the European and Indian forms are the same; and it, therefore, seems best that the name of *S. hysudricus*[3] should be, at least provisionally, retained for the latter.

Distribution.—Remains referable to *S. hysudricus* have been obtained from the typical Siwalik Hills, from the Siwaliks of the Punjab and Perim Island, and from the lower Siwaliks of Sind. The latter circumstance is of importance, since it is from the western side of India that species closely connected with European forms usually occur.

Species 5: Sus punjabiensis, *nobis*.

History.—In 1878 the present writer[4] gave a preliminary description of a fragment of the mandible[5] of a small Siwalik pig, which was referred to a new species under the above name.

1 "Beiträge," pt. IV., pl. VI., figs. 1, 1a. 2 *Ibid*, fig. 2.

3 The name *S. palæochœrus* was published in 1833, and *S. hysudricus* in 1847. 4 'Records,' vol. XI., p. 81.

5 In the original notice two specimens are mentioned: the second (pl. VIII, fig. 6) belongs, however, to a young individual of *S. hysudricus*.

Mandible.—The dentition of the above-mentioned mandible is represented in plate VIII., figs. 9, 9a. The specimen, which was obtained by Mr. Theobald from the Siwaliks of Asnot, consists of the hinder dental portion of the left ramus, and contains the three true molars; of which the first is well-worn, and the third only touched on its anterior columns. The dimensions of the specimen are as follows, *viz.*:—

Length of three molars	1·46	Width of m. 2	0·35
,, ,, m. 1	0·32	Length ,, ,, 3	0·61
Width ,, ,, ,,	0·29	Width ,, ,, ,,	0·38
Length ,, ,, 2	0·49	Depth of jaw at ditto	0·69

The condition of the teeth shows that the specimen belonged to an adult animal; and if the foregoing dimensions be compared with those of the mandible of *S. hysudricus* given on page 80, it will be seen that the present specimen is so much smaller than the smallest individual of that species, that on this ground alone there would be every reason for referring the former to a distinct species. There are, however, such differences in the last molars as to render the distinctness of the two beyond reasonable doubt. In $\overline{\mathrm{m.\,3}}$ of the present form the talon is relatively much shorter and higher than in *S. hysudricus* (*compare* plate VIII., figs. 9a, 3a); its length being less, instead of exceeding, that of the second main column; and its height being nearly equal to the latter. All the columns of the tooth are, moreover, relatively higher in the present specimen, and they are more closely squeezed together. These differences in form and size are of such importance as to leave no reasonable doubt of the specific distinctness of the present minute form from *S. hysudricus*; and it is quite evident that it cannot belong to either of the other larger Siwalik species.[1]

The present specimen agrees very closely in size with the mandible of *S. salvanius*[2]; but is distinguished by the earlier protrusion of $\overline{\mathrm{m.\,3}}$ (which is exceptionally late in the pigmy-hog), and by $\overline{\mathrm{m.\,1}}$ and $\overline{\mathrm{m.\,2}}$ being relatively wider[3]: the pattern on the worn crowns is very similar in the two forms. All other existing species are of far larger size. Of the fossil species mentioned on pp. 51-2 apparently the only one approaching in size to the present form is *S. valentini*, which is, however, still larger. The lower jaw of that species is unknown; but judging from the description of the upper teeth it is unlikely that it should be specifically the same as the present form.

Distinctness and affinities.—It appears, therefore, that the present specimen indicates the existence in the Siwaliks of a diminutive species of pig, not larger than the existing pigmy-hog of the Nepal terai. As it cannot be identified with that species, and is apparently smaller than any other described form, it may be regarded as specifically distinct, and may be known as *S. punjabiensis*.

1 The distinction between the specimen and *Sanitherium schlagintweiti* (*Sus pusillus*, Falc.) will be noticed under the head of that species.

2 Brit. Mus., No. B. 1077a.

3 The second molar of the fossil is both shorter and wider than $\overline{\mathrm{m.\,2}}$ of the existing species.

That *S. punjabiensis* may be regarded as the ancestor of *S. salvanius* is highly probable, both from its occurrence in the same country, from its size, and from the circumstance that in its lower molars it presents evidence of being a somewhat more generalized form.

The existence of the present pig, which was not larger than a hare, side by side with the larger race of the colossal *S. titan* (*compare* pl. VII., fig. 3, *with* m. 3 *of* plate VIII., fig. 9), which rivalled the hippopotamus in size, is very noteworthy, and indicates very clearly the luxuriance of the mammalian life of the Siwalik epoch.

Undetermined Specimens.

Part of mandible from the Punjab.—In figs. 4, 4a of plate VIII. of this volume there are given two views of the symphysial extremity of the left ramus of the mandible of a large pig collected by Mr. Theobald in the Siwaliks of the village of Asnot, Punjab, which does not agree with any of the specimens described above. The fragment shows the broken canine, the bases of $\overline{\text{pm. 1}}$ and $\overline{\text{pm. 2}}$, and the complete $\overline{\text{pm. 3}}$ and $\overline{\text{pm. 4}}$: the last tooth alone is slightly worn. The triangular section, and comparatively large size of the canine indicates that the specimen belonged to a male. The first premolar is nearly as long as the second, and is closely approximated both to the latter and to the canine, so that there is scarcely any diastema. The dimensions of the specimen are as follows, *viz.*:—

Interval between canine aud pm. 2	0·86	Width of pm. 3	0 5
,, ,, pm. 1 and pm. 2	0·2	Height ,, ,, ,,	0·91
Length of pm. 1 (alveolus)	0·55	Length ,, ,, ,,	0·81
,, ,, ,, 2 (ditto)	0·61	Width ,, ,, ,,	0·75
,, ,, ,, 3	0·92	Long diameter of canine	0·85

This jaw differs from the mandible of *S. titan* figured in plate IX. by the large size of $\overline{\text{pm. 1}}$ and by the shortness of the interval between that tooth and $\overline{\text{pm. 2}}$; and from the mandibles of the same species represented in plates VII., fig. 4, and VIII., fig. 1, by the absence of the inner column (*a*) in $\overline{\text{pm. 4}}$, which is constantly present in all the known jaws of that species. The two last premolars are very different from the corresponding teeth of the mandible figured in plate XI., fig. 1, under the name of *S. giganteus*; this difference being especially marked in the case of $\overline{\text{pm. 3}}$. These differences are so great that it may be pretty safely concluded that the specimen does not belong to either of the two species mentioned. The above-mentioned teeth are of the same general form as those of the female mandible of *S. falconeri* represented in plate VII., fig. 1, but are of very much larger size: in that specimen $\overline{\text{pm. 1}}$ is of relatively smaller size than in the present jaw, and is separated by a considerable interval from $\overline{\text{pm. 2}}$. In the male lower jaw of that species figured by Baker and Durand,[1] the dimensions of the premolars are as follows, *viz.*:—

First premolar	0·35X0·2	Third premolar	0·62X0·36
Second ditto	0·5 X0·27	Fourth ditto	0·7 X0·51

It appears from these dimensions that the teeth are considerably smaller than

1 *Op, cit.*, plate XXXV., fig. 3.

those of the present specimen; $\overline{\text{pm. 1}}$ being also smaller as compared with $\overline{\text{pm. 2}}$, and, judging from the figure, being separated by a considerable interval from that tooth.

The present specimen is of far too large a size to have belonged to either of the other two species of Siwalik pigs. It requires, however, the evidence of the true molars before it can certainly be determined that it does not belong to a large race of *S. falconeri*, but it is highly probable that it does not. Should, however, later discoveries indicate that it does belong to that species, then there will be good evidence that a few individuals of the latter ranged into the Punjab. If, as seems probable, it is specifically distinct from *S. falconeri*, the present specimen indicates a sixth species of Siwalik pig.

Mandible from the Narbadas.—In plate LXX., figs. 8, 8a, of the "F.A.S." there is represented under the name of *S. giganteus* the nearly complete mandible of a pig from the Narbadas, which is now in the British Museum (No. 36,843). The whole of the teeth are preserved, $\overline{\text{m. 3}}$ being in an early stage of wear, although fully protruded: the small size of the canines probably indicates that the specimen belonged to a female. Its dimensions are as follows, *viz.*:—

Length of last five teeth	4·6	Length of m. 2	1·0
,, ,, three true molars . . .	3·4	Width ,, ,, ,, ...	0·72
,, ,, pm. 3	0·64	Length ,, ,, 3	1·7
,, ,, m. 1	0·69	Width ,, ,, ,, ...	0·89
Width ,, ,, ,, ...	0·53	Long diameter of canine	0·75
Length of symphysis	1·0		

These dimensions indicate an animal of about the size of the female of *S. falconeri*, and it is evident from the structure of the cheek-teeth that it is only with that species among the Siwalik forms that the specimen can be compared. In specimens of *S. falconeri* with the teeth in about the same stage of wear $\overline{\text{m. 2}}$ and $\overline{\text{m 3}}$ are usually longer and narrower; and the complexity of the pattern on their worn surface appears decidedly greater. The inner columns of the molars of the Narbada jaw apparently have their inner surfaces less flattened; but the talon of $\overline{\text{m. 3}}$ seems to have the same number of columns, although these are relatively smaller. The incisive alveoli of the specimen are less depressed below the level of the molar series than in *S. falconeri*, and the inferior border of the symphysis is inclined more rapidly upwards. Although these differences appear comparatively slight, yet it is not improbable that they may be of specific value; and it is highly likely that the fossil pig of the Narbadas may have been more closely related than any of its Siwalik congeners to existing Asiatic species like *S. cristatus*.

Genus II.: HIPPOHYUS, Falc. and Caut.[1]

The history of the genus is given under the head of the species.

Species: Hippohyus sivalensis, Falc. and Caut.

Synonym. *Sus (Hippohyus) sivalensis*, Falc. and Caut.

History.—Apparently the first published mention of this genus and species occurs in Sir R. Owen's "Odontography"[2] (1840-5), where an upper molar is

[1] In Owen's "Odontography," p. 562 (1840-5). It seems best on the whole, as in the analogous case of *Hyænarctos*, to authenticate the genus as above: it might, however, be given as 'Owen (*ex* Falc. and Caut.),' in which case the same would have to be done with *Hyænarctos*. [2] *Loc cit.*

figured[1] under the name of *Hippohyus sivalensis,* which was probably at that time a manuscript name of Falconer and Cautley's; and it is stated that the structure of the upper molars makes an approach to that of the same teeth in the hippopotamus.[2] In the 8th part of the "Fauna Antiqua Sivalensis"[3] (1847) a skull and three fragments of the mandible are figured under the name of *Sus* (*Hippohyus*) *sivalensis*; while in the notice of the Siwalik fauna in the "Palæontological Memoirs,"[4] compiled from Falconer's notes and letters, *Hippohyus* is alluded to as a distinct genus. It thus seems doubtful whether this name was intended by its founders to be used in a generic or subgeneric sense: the peculiar character of the dentition leads, however, to the conclusion that it should be used in the latter sense, although there are not wanting signs of a transition from this genus to *Sus.* Beyond the brief notice by Sir R. Owen no description of the type species has ever been published. The present writer has recorded[5] the occurrence of the genus in the Siwaliks of the Punjab, and indicated the possibility of some of these remains belonging to a second species.

Cranium and upper dentition.—Three views ($\frac{1}{2}$) of the type cranium, which is in the British Museum, are given on plate LXX. of the "F.A.S.," and the dentition of the right side (reversed) is represented of the full size in fig. 1 of the succeeding plate. With the exception of the loss of the zygomatic arches, the extremity of the premaxillæ, and a portion of the occiput, the specimen is in excellent preservation: it shows the alveoli of three incisors, of the canine, and of the first and second premolars; the remaining five teeth are in position, but $\underline{\text{m. 3}}$ is not fully protruded, which indicates the sub-adult condition of the specimen. In the following table its dimensions are compared with those of a male skull of *Sus andamanensis, viz.*:—

	Hippohyus.	Sus.
From occipital condyle to anterior border of incisive alveolus	9·0	8 9
,, lower border of foramen magnum to posterior border of palate	2·3	2·4
,, posterior border of palate to posterior border of incisive foramen	5·4	5·16
Transverse diameter of both condyles	1·88	1·56
Length of palate	6·3	6·2
,, ,, series of cheek-teeth	4·3	3·54
,, ,, palate in front of pm. 1	1·9	2·61
Width of intermolar space at m. 2	1·2	0·88
,, ,, palate at canines	1·05	1·0
,, ,, ,, ,, i. 2	0 7	0·6
Length of three true molars	2·7	2·2
Interval between pm. 1 and pm. 2	0·2	0·0
Length of pm. 3	0·5	0·4
Width ,, ,, ,,	0·4	0·33
Length ,, ,, 4	0·5	0·44
Width ,, ,, ,,	0·5	0·45
Length ,, m. 1	0·6	0·57
Width ,, ,, ,,	0·6	0·48
Length ,, ,, 2	0·9	0·7
Width ,, ,, ,,	0·8	0·58
Length ,, ,, 3	1·15	0·95
Width ,, ,, ,,	0·8	0·61
Interval between i. 3 and pm. 3	0·6	1·30

1 Plate CXL., fig. 7.

2 It is very doubtful whether the name *Hippohyus* was intended to indicate affinity with the hippopotamus, or with the horse; to the molars of the latter of which those of this Siwalik pig present a distant resemblance in the pattern of their grinding surface.

3 Pls. LXX., LXXI.

4 Vol. I., p. 22.

5 'Records,' vol. XI., p. 82.

The general form of the skull is essentially that of a pig: the frontals are, however, unusually flat, and the nasals wide; while the contour of the masticating surface of the series of cheek-teeth is more convex than in any pig: the palate extends a considerable distance behind $\underline{\text{m. 3}}$. The foregoing dimensions show that in general size the Siwalik skull belonged to an animal considerably larger than the Andamanese pig; although in some of its dimensions it is smaller than the latter. Thus the portion of the palate in front of $\underline{\text{pm. 1}}$ is very considerably smaller than in *S. andamanensis*; indicating that this part of the skull is considerably shorter in proportion to the portion behind $\underline{\text{pm. 1}}$ than in that species of *Sus*, which is one of those having relatively short nasals. This shortness is caused by the small size of the canine (the alveolus[1] of which is not larger than that of $\underline{\text{i. 2}}$), and the absence of any diastema between it and $\underline{\text{i. 3}}$; the presence of which forms such a marked feature in all species of *Sus*. The canine was evidently a small incisor-like tooth, which did not project outwardly beyond the incisors. The third incisor (i. 3) is larger than in *Sus*, and is in close apposition to the preceding tooth: $\underline{\text{i. 1}}$ is larger than either of the other teeth of that series. In all these distinctive points the Siwalik skull agrees precisely with *Hyotherium*.[2] The anterior portion of the palate is vaulted, as in that genus and *Sus*; but the anterior palatine foramina are apparently somewhat smaller than in either of those genera, and thereby make some approach to *Dicotyles*.

In the Indian Museum there are two imperfect crania (Nos. B. 62, 63), collected by Mr. Theobald in the Siwaliks of the Punjab, agreeing in all essential points with the type specimen. The second of these specimens shows the excessive width of the nasals, and the extremely small size of the alveolus of the canine: the length of the series of cheek-teeth is only 3·9 inches; and it is possible that these specimens may indicate a smaller race, or even species.

The upper cheek-dentition is described by Sir R. Owen[3] in the following words: "Each upper true molar has its crown cleft by the common or crucial valleys, the transverse one passing from within forwards and outwards. Each of the four principal lobes is subdivided, not by a vertical central depression, but by a fold penetrating its anterior and posterior margins: the enamel at first shows additional minor plications; but is worn down progressively to the simpler pattern above described: the outer lobes are convex externally. The first premolar is very small and simple, separated by an interval of its own breadth from the second: both this and the third have transversely compressed crowns, the fourth has a sub-trihedral crown."

In plate XII., fig. 17, there is represented a fragment of the right maxilla, collected by Mr. Theobald in the Siwaliks of Asnot, showing $\underline{\text{m. 2}}$ and $\underline{\text{m. 3}}$, and belonging to an older individual than the type specimen. The last molar is fully protruded and partially worn; and $\underline{\text{m. 2}}$ about half worn. In fig. 21 of the same plate there are represented the corresponding teeth from a palate specimen, also

1 This alveolus is the hollow immediately in advance of pm. 1 in the figure in plate LXXI., fig. 1, of the "F.A S."

2 *E.g. H. waterhousi, vide* Filhol. 'Ann. Sci. Géol.,' vol. XI., pl. VI.

3 *Op. cit.*, p. 562.

collected by Mr. Theobald in the Punjab. In this specimen the teeth are still more worn; m. 2 being reduced to a plain surface of dentine, and m. 3 about half worn. There is another very similar specimen in the Indian Museum (No. B. 67), from the same locality. The following table gives the dimensions of these three specimens, taken in the same order:—

Length of m. 2	0·9	0·88	0·77
Width ,, ,, ,,	0·89	0·86	0·74
Length ,, ,, 3	1·48	1·43	1·22
Width ,, ,, ,,	0·99	0·93	0·79
,, ,, intermolar space at m. 2		1·36	1·34

These dimensions are so near to one another that all the specimens may be provisionally classed together, although it is not impossible that they may belong to more than one species. It will be seen from the figures that the talon of m. 3 is relatively short, and corresponds with that of the homologous tooth of *S. titan* (pl. VII., fig. 6); consisting in an early stage of wear (pl. XII., fig. 17) of a hinder portion (*b*), and a median column (*a*). The same figure shows the correspondence between the other portions of the tooth and the molar of *S. titan*. Thus there are in each tooth four main columns with three accessory columns (*a*, *g*, *h*) in the median line: at a later stage of wear (pl. XII., fig. 21) the accessory median columns unite with the inner main columns (as is the case in *Sus*), and produce the complicated pattern characteristic of the genus. The difference between the molars of *Hippohyus* and *Sus titan* consists in the columns of the former being taller, more elongated antero-posteriorly, with their outer walls more flattened, and the foldings of the enamel much deeper; by which means the valleys are made very deep, narrow, and sinuous. The molars of *S. falconeri* (pl. VII., fig. 5)[1] are in some respects intermediate between the two, and easily show the manner in which the transition has taken place. The third molar of the last-named species is widely distinguished by its very complex talon; and the columns of all the molar teeth have been more squeezed together, so that the valleys are to a great extent obliterated.

Mandible and lower dentition.—In plate LXXI., figs. 2, 3, 4, of the "F.A.S." there are represented three fragments of the mandible and lower dentition of a pig-like animal, which from the structure of the teeth undoubtedly belongs to the present form. The first specimen shows m. 3 and a part of m. 2; the second m. 1 and m. 2, the former much worn; and the third the same teeth in a less worn condition: all three specimens came from the Siwalik Hills, and are now in the British Museum. The following table shows the dimensions of their teeth, *viz.*:—

Length of m. 1		0·5	0·55
Width ,, ,, ,,		0·45	
Length ,, ,, 2		1·0	0·85
Width ,, ,, ,,		0·63	
Length ,, ,, 3	1·45		
Width ,, ,, ,,	0·73		

In plate XII., fig. 3, of the present volume there are represented the hinder cheek-teeth of the right ramus of a mandible collected by Mr. Theobald in the Siwaliks of

1 In the upper molars of *S. falconeri* the letters *f*, *g* correspond to *g*, *h* in those of the present species.

Kolsa, Punjab: the corresponding fragment of the left ramus was obtained at the same time, as well as the extremity of the symphysis, one half of which is represented in fig. 19 of the same plate. The first and second molars are much worn, and $\overline{\text{m. 3}}$ is about half worn down, showing that the specimen belonged to an aged animal. The structure of $\overline{\text{m. 3}}$ shows that the specimen belonged to the present form; and the dimensions of the teeth indicate an individual of about the same size as that to which the upper molars represented in fig. 17 belonged: the great width of the teeth probably indicates that the specimen belonged to a male. In fig. 18 of the same plate there is represented a fragment of the left ramus of a somewhat similar mandible, from the Punjab, containing a fragment of $\overline{\text{m. 2}}$, and $\overline{\text{m. 3}}$ imperfect on the outer side: this tooth is almost unworn, and from being slightly smaller and relatively rather narrower than the corresponding tooth of the last specimen it is probable that the present specimen belonged to a female individual. In figs. 20 and 4 of the same plate there are represented two fragments of the left ramus of mandibles of a species of the present genus; also from the Siwaliks of the Punjab. The second of these specimens contains the three true molars, and a fragment of $\overline{\text{pm. 4}}$; whilst the first contains $\overline{\text{m. 3}}$ and a part of $\overline{\text{m. 2}}$, these teeth being rather more worn than in the first specimen. The teeth of the specimen represented in fig. 4 agree in relative size with those of one of the small crania in the Indian Museum noticed on page 87 (No. B. 63), and from the great difference in size between them and the teeth of the specimen represented in fig. 3 it is quite possible that the present specimen and the crania belong to a small form, which may be specifically distinct from *H. sivalensis*. There is, however, such an amount of variation in the size of the different specimens, which apparently present no distinctive structural points, that nothing would be gained by attempting to separate them. The dimensions of the teeth of the four specimens described above (taken in the same order) are as follows, *viz.*:—

Length of m. 2	0·86			0·71
Width ,, ,, ,, ...	0·7	0·59		0·5
Length ,, ,, 3	1·77	1·6	1·35	1·25
Width ,, ,, ,, ...	0·8	0·68	0·6	0·53

In structure the lower molars are precisely analogous to the upper; but the talon of $\overline{\text{m. 3}}$ is perhaps rather larger in proportion to that of $\underline{\text{m. 3}}$ than is usually the case in true pigs. In the number of the columns composing its talon $\overline{\text{m. 3}}$ (pl. XII., fig. 18) corresponds with *Sus titan* (pl. VII., fig. 4) rather than with *S. falconeri* (*ibid*, fig. 2). A comparison of the figures will show how $\overline{\text{m. 3}}$ is formed by an amplification of the plan of that of the corresponding tooth of *S. titan*, in the same way as has been shown to be the case with $\underline{\text{m. 3}}$; the tooth of *S. falconeri* being in some respects intermediate.

The symphysis belonging to the first of the foregoing specimens, of which the left side is represented in fig. 19, shows the three incisors, and the broken bases of the canine and $\overline{\text{pm. 1}}$. The latter was inserted by a compressed conjoint fang, and was evidently relatively larger than in *Sus*; it is separated by a very short interval both from $\overline{\text{pm. 2}}$ and the canine. The canine (*c*) is not of larger diameter than the second incisor, and its crown was in all probability not produced much above the level of the incisors: it is in immediate contact with i. 3, the base of the latter being indented by the canine. The incisors are all much worn; and are directed considerably more upwardly than in *Sus*. The first incisor (i. 1) is a narrow compressed tooth, of much the same form as in that genus. The second incisor is much larger than the first, and its crown is greatly expanded laterally towards the summit: in general form it is more like the corresponding tooth of a ruminant than of *Sus*. The third incisor is considerably smaller than the second, but had a similarly expanded crown, and is likewise more like the corresponding tooth of a ruminant than a pig. In the absence of any diastema the present specimen resembles *Hyotherium*[1]; as it does in the expanded crown of i. 3, and the curved form and upward direction of all the incisors. The large size of i. 2 and its expanded crown are, however, characters not found in *Hyotherium*; and are very decided ruminant characters. The form and direction of the incisors clearly indicates that *Hippohyus* was an animal more adapted for grazing than the true pigs:—a conclusion fully borne out by the characters of the molars.

Affinities.—The foregoing comparisons indicate pretty conclusively that the present form is generically distinct from *Sus*. In certain cranial characters, and in the arrangement of the teeth the genus shows strong indications of affinity with *Hyotherium*. In the structure of its molars it is, however, widely different from that genus; species of *Sus* with comparatively simple molars, like *S. titan*, occupying in this respect a middle position between *Hyotherium* and *Hippohyus*. The true molars present a very considerable resemblance to those of *Hippopotamus*, but are widely distinguished by the equal development of the longitudinal and transverse valleys, in place of the diminution of the former and the enlargement of the latter. There is a distant resemblance to the molars of the horse in those of the present genus, which cannot, however, be taken to indicate any affinity between the two: if the generic name was assigned from this resemblance it is a highly objectionable one.

In another direction the molars of *Hippohyus* make a decided approach to those of some of the selenodont Artiodactyla. Thus if the upper molars of simple selenodonts like *Hemimeryx* or *Hyopotamus*[2] be compared with those represented in plate XII., fig. 17, it will be seen that the plan of structure is essentially the same in the two; the median columns *a*, *g*, *h*, in the *Hippohyus* molar corresponding to the extremities of the crescents of the selenodont tooth. The molars of *Hippohyus* are, however, less like those of the ruminants than are those of *Hemimeryx*, and are of far too complex structure to be on the ancestral line of that genus; whence it is probable that *Hippohyus* may be regarded as an offshoot from a pig-like stock which has died out without descendants.

Distribution.—Remains of *Hippohyus* have been obtained from the typical Siwalik Hills and from the Punjab. The smaller form comes solely from the Punjab.

1 *Vide* Filhol, 'Ann. Sci. Géol.,' vol. XI., pp. 21-3, pl. VII.

2 *Supra*, vol. II., pl. XXIII.

Genus III.: SANITHERIUM, H. von Meyer.

Species: Sanitherium schlagintweiti, H. von Meyer.

Syn. *Sus pusillus*, Falconer.

Mandible.—This genus and species are founded on some fragments of the mandible and lower molars of a small pig-like animal, obtained from the Siwaliks of Kúshalghar, Punjab, which have been already described and figured in the first volume.[1] One of these specimens (the original of *Sus pusillus* of Falconer) has, however, been refigured in plate VIII., fig. 7, of this volume in order to show its distinctness from the mandible of *Sus punjabiensis* (*ibid*, fig. 9), with which it agrees very closely in size. The specimen consists of a fragment of the right ramus, containing the third true molar in an early stage of wear, of which the anterior columns have been broken off. It will be seen that this tooth differs from the last molar of *Sus punjabiensis* by the presence of a distinct cingulum on the outer side of the second main outer column; and by the very large development of the two hind columns (*b*, *e*) of the talon, as well as by the union of the median accessory column (*a*) with the outer main column of the tooth; the other median accessory column (*e*) being likewise united with the same main column. A comparison of the *Sanitherium* molar with the corresponding teeth of *Hippohyus* figured in plate XII. will show that in all these respects, as well as in the compression of the main inner columns, there is a much closer resemblance between the two than there is between *Sanitherium* and *Sus*. The tooth of *Hippohyus* is, however, unprovided with the cingulum which forms such a marked feature in *Sanitherium*.

These comparisons indicate that the latter genus (as far as the very slight materials on which it is founded admit of its characters being defined) is more nearly allied to *Hippohyus* than to *Sus*.

Genus IV.: HYOTHERIUM, H. von Meyer.

Syn. *Amphichœrus*, Brav. (?) MSS.; *Chœromorus*, Gervais, *ex* Lartet, MSS.; *Chœrotherium*, Lart.; *Palæochœrus*, Pom.

Synonomy.—The name *Hyotherium* was applied in 1834 by H. von Meyer[2] to *H. sœmmeringi*. In 1846 Pomel[3] founded the genus *Palæochœrus*, with the two species *P. typus* and *P. major*. In 1851 the name *Chœrotherium* was applied by Lartet[4] to several species, one of which was named *C. sansaniense*; and apparently about the same time Lartet's manuscript name *Chœromorus* was employed by Gervais[5] for two forms which he named *C. simplex* and *C. mammilatus*. The name *Amphichœrus*, Bravard, is applied to certain specimens in the British Museum. In 1859 Gervais[6]

[1] Page 76 (58), pl. IX., figs. 6-9.
[2] "Die fossile Zahne und Knochen von Georgensmünd," p. 43, pl. II.
[3] 'Bull. Soc. Géol. France,' 2nd ser., vol. IV., p. 381, pl. IV.
[4] "Notice sur la Colline de Sansan," p. 32.
[5] "Zool. et Pal. Franç.,' 1st ed. (1848-52), p. 198, note 1; and explanation of plate XXXIII., p. 7.
[6] *Ibid*, 2nd ed., p. 182.

came to the conclusion that all the above-mentioned names were really synonymous; and adopted the name *Hyotherium*, which has the priority. The same view was subsequently adopted by Peters[1]; but Prof. Gaudry[2] retains the two genera *Hyotherium* and *Palæochœrus*; although admitting that there is practically no distinction between them.[3] The former view will be adopted in this memoir.

Number of species.—There is such utter confusion in the species of the genus that without an actual comparison of all the types it is impossible to arrive at any satisfactory conclusion; and the following list of the non-Indian forms must be regarded as purely provisional: the most doubtful species are indicated by an asterisk.

*1. Hyotherium medium, H. Meyer.[4] Miocene, Germany.

An insufficiently described species, whose claim to distinction is considered very doubtful by Peters.[5]

2. Hyotherium meissneri, H. Meyer.[6] Miocene, Germany.

Chœropotamus meissneri, Meyer[7] (1834). *Sus meissneri*, Kaup.[8]

A species nearly equal in size to *H. typus* (with which it is identified by Peters[9]); but apparently distinguished by its more elongated upper true molars, in which the cusps are less distinct than in that species.[10] The lower jaw figured by Gervais[11] under the name of *Chœromorus simplex*, and referred by Peters to the present species, is apparently distinct from the type mandible of *H. meissneri*. If *H. meissneri* and *H. typus* are really synonymous the former name has the priority.[12]

*3. Hyotherium minimum[13] (Cuv.). Miocene, France.

Sus leptodon, Pom. (*teste* Gastaldi).

(?) *H. cuvieri*, Pet. *Anthracotherium minimum*, Cuv.

This species is referred to *Hyotherium* on the authority of Gervais,[14] who figured a lower jaw belonging to an animal rather larger than a peccary: the molars seem to have a tendency to a selenodont structure which is wanting in other forms. It appears that Peters[15] confused this species with *Anthracotherium minutum*, Blain.[16]; since when mentioning that name he refers to Gervais' figure of *H.* (*A.*) *minimum*. In the mandible figured by Gastaldi the columns appear more conical.

1 'Denschr. k. Ak. Wiss.,' vol. XXIX., p. 195, *et. seq.*, 1869. 2 "Les Enchainements—Mam. Tert.," p. 71.

3 It is somewhat difficult to ascertain Dr. Filhol's views: in one memoir ('Ann. Sci. Géol.,' vol. XI.) he apparently uses the name *Hyotherium* in its widest sense; but in another ("Phosphorites du Quercy") he employs both *Palæochœrus* and *Chœromorus*.

4 'N. Jahrb.,' 1841, p. 104. 5 *Op. cit.*, p. 196. 6 'Jahrb. Nassau Ver. Nat.,' vol. VI., p. 116, pl. IV. (1850).

7 "Georgensmünd," p. 51. 8 "Beiträge," pt. IV., pl. VI. 9 *Op. cit.*

10 The specimens figured by Kaup have distinct columns. 11 "Zool. et Pal. Franç.,' 2nd ed., pl. XXXIII., fig. 5.

12 Gervais (*op. cit.*, p. 182) suggested the possibility of the unity of these two forms.

13 *Vide* Gastaldi, 'Mem. Ac. Real. Torino,' ser. 2, vol. XIX., p. 22, pl. VIII., fig. 38.

14 "Zool. et Pal. Franç.," 2nd ed., p. 187, pl. XXXIII., fig. 6.

15 *Op. cit.*, pp. 196, 214. Peters objects to the name *minutum*, and substitutes *cuvieri*; but it would seem that the latter name is really a synonym of *minimum*.

16 Referred in vol. II. of the present work (p. 149, where it is wrongly authenticated as Cuv.) to *Amphitragulus* or *Dichodon*: it is identified by Dr. Filhol ("*Mam. Foss. de Ronzon*," [reprint] p. 240) with *Gelocus communis*, which is the same as *Amphitragulus communis*: the same view having been previously taken by Gastaldi (*op. cit.*, p. 23).

4. Hyotherium platyops (Cope[1]). Miocene, N. America.

Palæochœrus platyops, Cope.

Said to be the largest species of the genus. but is yet unfigured: pm. 4 is remarkably elongated; and m. 1 narrows internally.

5. Hyotherium sœmmeringi, H. von Meyer.[2] Mid. miocene, Europe.

Chœromorus mammilatus, Gerv. (*teste* Peters).
(?) *Chœrotherium dupuii*,[3] Lart. (?) *in parte*.
Chœrotherium sansaniense, Lart. (*teste* Peters).
Sus antediluvianus, Kaup (*apud* Blain).
Sus chœrotherium, Blain., *in parte*.
Sus sœmmeringi, Blain.

The largest European species; of which the molars are of a complex structure, approaching those of *Sus*.

6. Hyotherium subæquans (Cope[4]). Miocene, N. America.

Palæochœrus subæquans, Cope.

An unfigured species, said to be about the size of *Dicotyles tajacu*: a distinct cingulum on outer side of upper molars.

*7. Hyotherium suillum (Pom.). Low. miocene, Europe.

Palæochœrus suillus, Pom. (?) *Amphichœrus typus*, Brav.

This species was formed by Pomel on the evidence of a skull in the British Museum (No. 34,961),[5] and is said to be one-third smaller than *H. typus*. Dr. Filhol,[6] however, provisionally refers this specimen to the latter species; but he regards the lower jaw figured by Gervais under the name of *H. typus*, as really belonging to that species, whereas Peters has shown that it is probably distinct,[7] and smaller than the proper jaw of that species. Both the former specimen and the British Museum specimen may, therefore, possibly belong to the same species, which will then be distinct from *H. typus* and may retain the name *H. suillum*.

8. Hyotherium typus (Pom.). Up. eocene to low. miocene, France.

Chœromorus simplex, Gerv.[8] (*teste* Peters). *Palæochœrus typus*, Pom.[9]

A species of about the same size as *H. meissneri*. The crowns of the upper true molars[10] are nearly square, with very simple columns. The lower jaw figured by Gervais[11] under the name of *Chœromorus simplex* has been shown by Peters to probably belong to this species.[12] A mandible from Quercy figured by Filhol[13] under the latter name may likewise be referred to this species.

1 'Bull. U. S. Geol. Surv.,' vol. VI., p. 174.

2 "Georgensmünd," *loc. cit.*; Peters, *op. cit.*, p. 196, pls. I., II. The synonomy is mainly taken from the latter memoir. *Palæochœrus major*, which Peters refers to this species, is, however, on the authority of Dr. Filhol, referred to *H. waterhousi*.

3 Identified by Gervais both wih his *C. mammilatus* and *Sus chœrotherium*.

4 'Pro. Amer Phil. Soc.," vol. XVIII., p. 374, 1879.

5 A canine of *Amphitragulus* or *Dremotherium* is inserted in this skull.

6 'Ann. Sci. Géol.,' vol. XI., p. 14.

7 Peters proposed to restrict the term *H. typus* to this jaw, which only adds to the confusion. If *H. meissneri* and *H. typus* are identical, the latter name should be at once abolished.

8 *Op. cit.*, pl. XXXIII., fig. 5.

9 'Bull. Soc. Géol. France," 2nd ser., vol. IV., p. 381, pl. IV., fig. 1 (1846):

10 Gervais, *op. cit.*, pl. XXXIII , fig. 1. Gaudry, "Les Enchainements—Mam. Tert.," fig. 83.

11 *Op. cit.*, pl. XXXIII., fig. 5.

12 That the lower jaw referred by Gervais to *H. typus* is too small for the upper teeth of that species may be seen by comparing the relative dimensions of these teeth with those of *H. waterhousi* figured by Dr. Filhol, and referred to below.

13 "Phosphorites du Quercy" (reprint), p. 391, fig. 292.

9. Hyotherium waterhousi[1] (Pom.). Low. miocene, France.

Amphichœrus major, Brav. *Palæochœrus major*,[2] Pom.
Hyotherium majus, Filh. *Palæochœrus waterhousi*, Pom.

A species coming next in size to *H. sœmmeringi*, but with molars of the simple structure of *H. typus*; which it considerably exceeds in size. The inner pair of upper incisors are unusually large.

Affinities.—If the above-mentioned European species be referred to two genera, it appears that *H. sœmmeringi* is the only one which should belong to *Hyotherium*; all the rest belonging to *Palæochœrus*. The former species, by the more complex structure of its molars, serves to connect the other species with the less specialized forms of *Sus*.[3] From the phosphorites of Quercy Dr. H. Filhol[4] is about to describe the cranium of an allied form under the new generic name of *Doliochœrus*. In that genus the molars are of very simple structure, the last upper molar having no distinct talon, and the parietal portion of the cranium being extremely unlike that of *Sus*; from which it may be concluded that the genus belongs to a very primitive type. In the tertiaries of North America remains of numerous pig-like animals have been discovered apparently connecting *Hyotherium* with *Dicotyles*: several of these species have been referred to the two new genera *Chænohyus* and *Thinohyus*,[5] whose relation to the other genera is exhibited in the following table, *viz.*:—

Dicotyles. Pm. $\frac{3}{3}$ ($\underline{\text{pm. 2}}$ in contact with $\underline{\text{pm. 3}}$).
Chænohyus. Pm. $\frac{3}{3}$ ($\underline{\text{pm. 2}}$ isolated).
Thinohyus. Pm. $\frac{4}{4}$ ($\underline{\text{pm. 1}}$ isolated).
Hyotherium. Pm. $\frac{4}{4}$ ($\underline{\text{pm. 1}}$ in contact with $\underline{\text{pm. 2}}$).

The four genera are considered by Prof. Cope to be closely allied; and the fossil forms connect *Dicotyles* so closely with *Sus*, that in a palæontological classification it seems impossible to refer those two genera to distinct families. From the study of the skull of *H. waterhousi* Dr. Filhol[6] has been led to the conclusion that it is improbable that *Hyotherium* is the direct ancestor either of *Dicotyles* or *Sus*; but it is most probable from the structure of its molars that it must have been intimately related with such ancestral stock. The later premolars are relatively stouter than in existing species of *Sus*. The canines are small, and in *H. sœmmeringi* the root of the upper one is double: there is no distinct diastema, and (at least in several species) the lower canines had not attained the peculiar form of those of *Sus*.

Distribution.—It is only recently that the genus has been recorded from

1 *Vide* Filhol, 'Ann. Sci. Géol.,' vol. XI., pls. IV.-IX.

2 Identified with this species on the authority of Dr. Filhol (*op. cit.*, p. 19): it is identified by Peters (*op. cit.*, p. 136) with *H. sœmmeringi*.

3 Gaudry, "Les Enchainements—Mam. Tert.," p. 71.

4 The present writer is indebted to Dr. Filhol for early information concerning this undescribed genus, and also for proofs of the illustrations to accompany his forthcoming memoir upon the same.

5 Cope, 'Pro. Amer. Phil. Soc.,' vol. XVIII., p. 373, 1879. *Palæochœrus condoni*, Marsh, should be referred to *Platygonus* or *Thinohyus*, according to Prof. Cope.

6 'Ann. Sci. Géol.,' vol. XI., p. 81.

America,[1] where it occurs in the miocene. In Europe it ranges from the upper eocene (Quercy phosphorites) to the middle miocene (Sansan stage); and is found from France to Styria. Its distribution in India will be mentioned in the sequel.

Species: Hyotherium sindiense, *nobis*.

History.—In 1878 the present writer briefly mentioned[2] some detached molar teeth of a suilline animal obtained by Messrs. W. T. Blanford and F. Fedden from the lower Siwaliks of Sind, which were referred to *Hyotherium*, with the provisional name of *H. sindiense.* It is these and other specimens from the same region which form the subject of the present notice.

Upper cheek-teeth.—In plate XII., fig. 6, there is represented a fragment of the left maxilla containing the second and third true molars of a suilline animal, which from the form and structure of these teeth may probably be referred to the present genus. Both teeth are well-worn, but are unfortunately much decayed, so that the characters of their worn surfaces cannot be determined. In size and contour they agree almost exactly with the corresponding teeth of *H. sœmmeringi* figured by Peters.[3] In figure 12 of the same plate there is represented an unworn molar of the right side, which from its agreeing in size with $\underline{\text{m. 2}}$ of the last specimen may be regarded as the homologous tooth of the same species. This tooth agrees very closely with $\underline{\text{m. 2}}$ of *H. sœmmeringi*, with the exception of having no cingulum on the outer surface: the accessory columns (*a*, *g*, *h*) are more strongly developed and have a more complete union with the inner main columns than is the case with *H. waterhousi*,[4] or *H. typus*; the molars of which are also distinguished by the more square form of the summit of their crowns.[5] The present tooth is distinguished from $\underline{\text{m. 2}}$ of a true pig like *Sus hysudricus* (pl. VIII., fig. 10) by its relatively wider crown, and by the columns being lower, and somewhat more distinctly defined: it is, however, almost exactly intermediate between the corresponding tooth of *H. typus* and *S. hysudricus.* In fig. 11 of the same plate there is represented a half worn right upper molar which might well be $\underline{\text{m. 1}}$ of the same species as the last specimen: a tooth described in the sequel indicates, however, that it might be $\underline{\text{m 2}}$ of a smaller form. In this specimen there is a distinct crenulated cingulum on the outer side of the posterior outer main column;—a similar cingulum girding both columns in *H. sœmmeringi.* In fig. 10 of the same plate there is represented a still more worn (probably) left molar agreeing in size with the last specimen. In figures 13 and 14 of the same plate there are represented two similar right upper molars of smaller size than any of those described above. These teeth are of too small a size to have been $\underline{\text{m. 1}}$ of an individual of the size of those to which figs. 6 and 12 belonged; but if the specimen represented in fig. 11 were a second molar they

1 The correctness of Prof. Cope's generic determination is of course assumed.

2 "Records," vol. XI., p. 77.

3 *Op. cit.*, pl. I., fig. 1.

4 Filhol, *op. cit.*, pl. VI.

5 It is somewhat difficult to give a correct estimate of the relative proportions of the crowns of the molars of many species, owing to the circumstance that the outer walls of the base of the crown are very sloping.

might have been $\underline{\text{m. 1}}$ of the same form. As these teeth do not appear to present any characters, except that of size, by which they can be distinguished from fig. 12, it is obvious that it is impossible to say whether fig. 11 be $\underline{\text{m. 2}}$ of the smaller or $\underline{\text{m. 1}}$ of the larger form. The small teeth are almost indistinguishable from specimens in the Indian Museum from Germany, which, on the authority of Klipstein, are referred to the ill-defined *H. medium.*

In figures 9 and 15 of the same plate there are represented two last upper premolars of a pig-like animal, belonging to opposite sides of the jaw, which may probably be referred to the present genus. The smaller specimen agrees in relative size with fig. 13, and the larger with fig. 6. The two teeth agree very closely in structure, although the smaller one has a more distinctly developed cingulum: they resemble to a great extent the corresponding tooth of *H. sœmmeringi*; but are distinguished by the two outer columns being less equal in size, as well as by the greater development of the transverse ridges connecting the inner columns with the two outer columns. In *H. waterhousi*, *H. typus*, and most other species, these connecting ridges are scarcely developed at all.

Lower molars.—In figures 7, 8, of plate XII. there are represented two right lower true molars in a well-worn condition, which agree with those of the present genus. The one represented in fig. 8 may from its size be regarded as $\overline{\text{m. 1}}$, and agrees in relative size with the small upper teeth represented in figs. 13, 14. The second specimen may be regarded either as $\overline{\text{m. 2}}$ of the same form, or as $\overline{\text{m. 1}}$ of the larger form represented in figs. 6 and 12. Both these teeth agree in general proportions, and, as far as can be seen, in structure, with the lower molars of *H. sœmmeringi*: the smaller specimen agreeing with $\overline{\text{m. 1}}$ of a small individual of that species figured by Peters[1]; and the larger with $\overline{\text{m. 2}}$ of the same specimen, and also with $\overline{\text{m. 1}}$ of a larger individual figured by the same writer.[2] In figure 16 of the same plate there is represented a fragment of the right ramus of a mandible containing $\overline{\text{mm. 4}}$ and $\overline{\text{m. 1}}$; both in an unworn condition. The true molar is of the same size as the specimen represented in fig. 8: it is of smaller size, and the columns are of a more simple structure than in the corresponding tooth of *Sus hysudricus* (pl. VIII., fig. 8).

Distinctness and affinities.—With the materials at present available it is impossible to say whether the larger and smaller teeth noticed above belong to one or two species. Their similarity in structure, coupled with the variation in the size of the teeth referred to *H. sœmmeringi* (assuming all of them to be rightly associated), seems, however, to be in favour of the former alternative. It is also impossible to say whether such species belonged to *Hyotherium* or to one of the allied American genera; but in the absence of any evidence to the contrary it may, from the resemblance of the teeth to those of *H. sœmmeringi* be, at least provisionally, referred to that genus. The larger specimens indicate a species of the size of the larger

1 *Op. cit.*, pl. II., fig. 6.   2 *Ibid*, fig. 7.

form of *H. sœmmeringi*, and therefore larger than all other forms except *H. waterhousi*, and the unfigured American *H. platyops*. From *H. waterhousi* (and *H. typus*) the Sind form is distinguished by the structure of its molars, but it cannot be compared with *H. platyops*. That it was closely allied to *H. sœmmeringi* is pretty evident, but the materials at hand are insufficient to determine definitely whether the two are distinct or not. To mark its place of origin the Sind form may retain the provisional name of *H. sindiense*. Should it be eventually found that the larger and smaller teeth belong to more than one species the foregoing name may be restricted to the larger form.

Distribution.—As already mentioned, all the specimens described above were obtained from the lower Siwaliks of Sind.

Hyotherium, sp.

Lower molar.—In plate XII., fig. 5, there is represented a second left lower true molar of a pig-like animal, which probably belongs to the present genus. The tooth is implanted in a fragment of the mandible, showing a part of the alveolus of $\overline{\text{m. 3}}$, so that there can be no doubt as to its serial position. The specimen was among the collection of the Asiatic Society of Bengal transferred to the Indian Museum, and was obtained from the Siwaliks of Perim Island. The tooth is but very slightly worn, and the columns are comparatively simple and distinct: the crown is relatively wider than the lower molars of *Hyotherium sœmmeringi* and the corresponding teeth from Sind, and it is therefore probable that the present specimen belongs to a large species distinct from either. The lower molars of the large *H. waterhousi*[1] are also of a more elongated type than the specimen under consideration; and as the writer has been unable to identify the latter with any described form it appears highly probable that it indicates a new species; although it is necessary to await further specimens before this can be definitely determined.

Evolution of the Suidæ and their Allies.

At the close of the foregoing descriptions it may be well to record a few observations deduced therefrom as to the probable line of evolution of the *Suidæ* and their allies. The observations of M. Filhol have shown that in *Hyotherium*, which is one of the oldest forms of the family, the canines and lower incisors had not attained the specialized structure of those of the existing pigs; while the absence of a diastema and the simple structure of the molars are also characters indicating a primitive type. Although, as M. Filhol suggests, it is quite probable that this genus is not on the direct ancestral line of the modern pigs; yet it was evidently closely connected with such primitive stock. The undescribed genus *Doliochœrus* apparently indicates a form still closer to the same primitive stock. The remarkable agreement in cranial characters and the structure of the cutting-teeth existing between *Hyotherium* and *Hippohyus* indicates that the latter should in all

1 Filhol, *op. cit.*, pl. VII.

probability be regarded as a highly specialized branch of the *Hyotherium* stock. The structure of the molars of *Sanitherium* likewise suggests that this genus may be another offshoot from the same branch. In some forms of *Hyotherium* (*H. typus*) the crowns of the true molars are nearly square, and the premolars are usually stouter than those of existing pigs; and these forms may be regarded as the most primitive.

Turning to the genus *Sus*, it has been shown that the crowns of the molars of several of the earlier forms were relatively short, and that the premolars, especially those of the lower jaw, were larger in proportion to the true molars than is the case among most existing species; the latter character culminating in the mandible provisionally referred to *S. giganteus*. The resemblance of the teeth of that jaw to those of *Tetraconodon* indicates that the group (entelodonts) to which that genus belongs and *Sus* are diverging branches of one stock, which was probably closely connected with the primitive hyotheroid stock. In the entelodont branch the premolars appear to have gone on increasing in relative size, till they attained their greatest development in *Tetraconodon* itself; and it is not improbable that some of the anthracotheroids may have taken origin from an early branch of the same stock. The extreme simplicity of the structure of the molars of *Tetraconodon* indicates that this genus has not descended from *Sus*.

In the true pigs, on the other hand, the premolars having attained in the lower jaw of one form (? *S. giganteus*) a comparatively large development, ever afterwards began to diminish in relative size, and subsequently in number; while progressive development, both as regards size and complexity of structure, was transferred to the true molars, and especially to the last tooth of that series. Thus while in the mandible provisionally referred to *S. giganteus* $\overline{\text{m. 1}}$ and $\overline{\text{m. 2}}$ are remarkably short, and the talon of $\overline{\text{m. 3}}$ is comparatively long, the premolars being of great size; in the form here called *S. titan* the first two molars have increased in relative length, although the last tooth still retains its simple talon; the lower premolars being still relatively larger than in existing pigs. In *S. falconeri* the early molars have become still more elongated and complex, and the last tooth of some individuals has attained a length and a complexity of structure unknown among any existing members of the genus; the lower premolars being much narrower than in any of the previous forms. This branch appears to have culminated in the existing African genus *Phacochœrus*, where the last molar has become extremely narrow and complex, and in its tall crown, and in its persistence after all the earlier teeth have disappeared foreshadows, or parallels, a proboscidian type. In this genus the gradual diminution in the size of the premolars has culminated in the non-development of the first in the upper, and of the first and second in the lower jaw, and in the relatively small size and early disappearance of the remaining teeth.

Of the existing species of true pigs, the African river-hogs exhibit traces of a primitive type in their relatively large premolars, short m. 1 and m. 2 and small talon of m. 3; although the absence of the first premolar is a more specialized character, albeit one found in some tertiary species (*S. erymanthius*, etc.). The stout premolars and the short m. 3 of some of the tertiary forms like *S. palæochœrus* and *S. hysudricus* indicate that it is not improbable that the river-hogs may have descended from some such form. *S. barbatus* in its small m. 3 almost certainly shows signs of a direct descent from a primitive stock; and the writer is inclined to think that the same may be said of *S. vittatus* and the *S. andamanensis* group. The resemblance of the teeth of the latter to those of *S. hysudricus* renders it by no means improbable that the one may be the descendant of the other; and if the writer is at all correct in supposing that *S. vittatus* is descended from *S. giganteus* this would indicate that the *S. vittatus* and the *S. andamanensis* groups are not specifically the same. The first and second molars of *S. vittatus* are relatively longer than in *S. giganteus*, which is a character that might be expected to occur in the newer form. The longer m. 3 of *S. cristatus* indicates that it may well be a more specialized form of the *S. vittatus* stock. The proportions of the molar teeth of *S. verrucosus* are not unlike those of the form here named *S. titan* (assuming that to be distinct from *S. giganteus*), with the exception that m. 3 is generally longer in proportion to the two preceding teeth[1]; and the writer would suggest the possibility of the one being the degenerate descendant of the other. In any case it is highly probable that the *S. verrucosus*, *S. vittatus* (including *S. cristatus*), and *S. andamanensis* groups are descendants of some of the three medium or large forms of Siwalik pigs with simple molars; and the undoubted existence of the three fossil forms[2] renders it, *primâ facie*, probable that the existing Asiatic species (exclusive of *S. barbatus* and *S. salvanius*) are more than two in number. The probability of the descent of *S. salvanius* from *S. punjabiensis* has been already noticed.

Babirussa in its simple molars shows evidence of affinity with some of the primitive forms; and the same may be said still more decidedly with respect to *Dicotyles*. The connection of the latter genus with *Hyotherium* and its allies cannot be determined till the affinities of the extinct America genera noticed above have been fully worked out.

Family III.: *ENTELODONTIDÆ*.[3]

Genus: TETRACONODON, Falc.

Species: Tetraconodon magnus,[4] Falc.

This genus and species, which are both peculiar to the Siwaliks are only known

1 The dimensions of the upper molars of three specimens of *S. verrucosus* are as follows:—

		m. 1 m. 2	m. 3
1.	Borneo	1·24	1·24
2.	Java	1·53	1·49
3.	Ceram	1·54	1·47

2 Even if *S. titan* should be eventually proved to be only a large variety of *S. giganteus*, the lower jaw provisionally assigned to the latter will indicate another species.

3 Prof. Flower ("Catalogue of Osteological Specimens in Mus. Roy. Coll. Surgeons," pt. II., p. 341, 1884) refers the present group to the family *Chæropotamidæ*. He also adopts the generic term *Elotherium*, Pom. (1847), in place of *Entelodon*, Aym. (1848); the very general acceptation of the latter by continental palæontologists induces the present writer to retain it. *Archæotherium*, Leidy, is a later synonym.

4 *Olim*, *magnum*, *errorim*.

by some molars and an imperfect mandible; the latter being figured and described in the first volume of this work.[1] The mandible is distinguished from that of *Entelodon* by the absolutely and relatively larger premolars, and the more regularly oblong form of the crowns of the true molars. The genus is considered by Mr. F. Osborn[2] to be closely allied to the American *Achænodon*[3]; being, as far as is at present known, distinguished only "by the presence of a few minor tubercles upon the slopes of the molar cusps," and by the larger size of the lower premolars in proportion to that of the true molars. It is quite possible that these distinctions may be only of specific, rather than of generic value.

Family IV.: *LISTRIODONTIDÆ.*

Genus: LISTRIODON, H. von. Meyer.[4]

Syn. *Lophiochœrus*,[5] Bayle, after Lart., MSS.; *Tapirotherium*, Blainville and Lartet; (?) *Calydonius*, H. von Meyer.

Position of the genus.—There has been much discussion as to the systematic position of this genus, which apparently forms a family of itself; some writers, like De Blainville[6] and Gervais,[7] being inclined to refer it to the Perissodactyla; while Lartet (who also at first considered it allied to the tapirs[8]) finally classed it among the bunodont Suina.[9] The latter view has been adopted by Kowalevsky and other writers; but Prof. Cope[10] in a memoir published 1881 reverted to the original view, and classed *Listriodon* in the *Tapiridæ*. The present writer considering that this view was probably supported by good evidence, adopted it in his own papers; but since no evidence in favour of it has been subsequently published, and as Prof. Cope has given indications of retracting the same,[11] it appears advisable to adopt the more general view. That view is confirmed by the presence of a distinct talon to $\underline{\text{m. 3}}$, and by the form of the upper incisors, as well as by the secant character of the earlier premolars.

In Europe the genus apparently contains only the single species *L. splendens*,[12] H. Meyer, of the middle miocene, which has been found in France, Switzerland, and Styria.

1 Page 78 (60), pl. X.

2 "Contributions from E. M. Mus. Geol. and Archæol. Princeton Coll. U.S.A.," Bull. No. 3, p. 23, 1883.

3 The same as *Parahyus*, Marsh, according to Mr. Osborn: the present writer was unacquainted with this synonymy when writing "Siwalik Selenodont Suina" in the second volume of the present work.

4 'Neues Jahrb.,' 1846, p. 466.

5 The genus *Lophiodochœrus* (at first *Lophiochœrus*), Lemoine, is apparently distinct.

6 "Ostéographie," Genus Tapirus, p. 52, pl. VI. (*Tapirotherium* and *Lophiodon* de Sansan): the writer believes that this part of the Ostéographie was published subsequently to 1846, so that *Listriodon* has the priority over *Tapirotherium*; but in any case the former name has met with pretty general acceptation.

7 "Zool. et Pal. Franç.," 2nd ed., p. 201: Gervais states that in his own opinion the genus is allied to the tapirs, but in deference to Lartet's opinion he places it among the Artiodactyla.

8 "Notice sur la Colline de Sansan," p. 31.

9 *Vide* Gervais, *op. cit.*, p. 201.

10 'Pro. Amer. Phil. Soc.,' 1881, pp. 374, 325.

11 In a presentation copy of this memoir sent to the present writer, Prof. Cope has erased *Listriodon* from the *Tapiridæ*.

12 Syn. *Tapirotherium larteti*, Gerv.; *Listriodon larteti*, Gerv.; *Lophiochœrus blainvillei*, Bayle; *Lophiochœrus splendens*, (?) Jourd.; *Tapirotherium blainvillei*, Lart.; *Sus tapirotherium*, Blain.; (?) *Calydonius trux*, and *C. tener*, H. von Meyer.

Species 1: Listriodon pentapotamiæ (Falconer).

Syn. *Tapirus pentapotamiæ*, Falconer.

History.—The history of the species has been already given in the first volume.[1]

Upper molars.—In figures 13 and 17 of plate VIII. the two original specimens on which this species is founded are refigured[2]: both teeth belong to the right true molar series; and the first (fig. 13), which was obtained by Mr. Theobald from the Siwaliks of the Punjab, is almost unworn, and, from its size, may be regarded as m. 1. The second (fig. 17), which was obtained by Messrs. Garnett and Trotter from the Siwaliks of Kúshalghar, below Attock, is partially worn, and may be regarded as m. 2. In fig. 15 there is represented a much worn and partly broken second left upper molar, which is slightly wider than the specimen represented in fig. 17: this tooth belonged to the same individual as the specimens represented in figs. 14 and 16, and, together with the corresponding tooth of the opposite side, was collected by Mr. Theobald in the Siwaliks of Niki, Punjab: it is in a well-worn condition. The tooth represented in fig. 16 is the third left upper true molar, in a well-worn condition, wanting the postero-internal angle. In fig. 15a there is represented the hinder portion of the third right upper true molar, in an unworn condition, probably belonging to the same individual as the specimen represented in fig. 17. In fig. 14 there is represented the much-worn first right upper incisor belonging to the same individuals as figs. 15, 16. In the following table the dimensions of the above-mentioned teeth are compared with those of a specimen of the right maxilla of *Listriodon splendens* in the Lyons Museum, the measurements being taken from a plaster cast in the British Museum (No. 40,959):—

	L. pentapotamiæ.					L. splendens.
	fig. 13	fig. 17	fig. 15	fig. 16	fig. 15a	
Length of m. 1	0·81					0·73
Width ,, ,, ,, at first ridge . . .	0·75					0·7
,, ,, ,, ,, ,, second ,, . . .	0·74					0·69
Length ,, ,, 2		0·81	0·8			0·8
Width ,, ,, ,, ,, first ,, . . .		0·83	0·85			0·78
,, ,, ,, ,, ,, second ,, . . .		0·8	0·75			0·74
Length ,, ,, 3						1·0
,, ,, hind-ridge and talon of ditto .					0·64	0·5
Width ,, ditto at first ridge . . .				0·88		0·83
,, ,, ,, ,, second ,, ...					0·81	0·73

The dimensions of the Indian teeth are such that all the specimens may, at least provisionally, be referred to the same species; and their resemblance to the European form is so close that there can be no doubt of their belonging to the genus *Listriodon*. In size the Indian teeth are rather larger than those of *L. splendens*, but the difference in this respect is so slight that it cannot be regarded as of any specific value. In the upper molar of *L. splendens* figured by Gervais[3] the cingulum is more distinctly developed on the outer surface than in the Indian teeth; and the same

[1] Page 70 (52).
[2] The original figures are in vol. I., pl. VIII., figs. 8, 9.
[3] "Zool. et Pal. Franç.," 2nd ed., pl. XX., fig. 4 (*L. larteti*).

character, judging from the cast, seems to obtain in the Lyons specimen. The most distinctive character of the Indian teeth is, however, the relatively larger talon of m. 3 (fig. 15a), which forms a wide flat ledge, almost entirely wanting in the Lyons specimen. No other distinctions can be detected between the Indian and European molars.

Incisor.—The first upper incisor (fig. 14) is very similar to an homologous tooth of *L. splendens* in the British Museum, and also closely resembles the same tooth in *Hyotherium*: it is much longer antero-posteriorly than i. 1 of *Sus*. On the inner side of this tooth there is a small ledge or cingulum.

Distinctness and affinities.—The foregoing comparisons indicate that the Indian and European forms of *Listriodon* are very closely allied: without additional remains of the former it is, however, impossible to say whether the distinctive points noticed above are of specific value or not; although it is probable that they are. For the present at least the Indian species may retain the specific name of *L. pentapotamiæ*.

Distribution.—The specimens described above are all the known remains of the species, and, as already mentioned, were all obtained from the Siwaliks of the Punjab.

Species 2: LISTRIODON THEOBALDI, *nobis*.

History.—The only previous notice of this provisional species is a preliminary one in the "Records" for 1878,[1] referring to the one molar on which it is founded.

Upper molar.—The above-mentioned tooth, which is the only specimen known, was obtained by Mr. Theobald from the Siwaliks of the village of Jabi, in the Punjab, and is represented in plate VIII., fig. 12. From the width of its crown this molar seems to belong to the upper jaw, and is of the right side: it is in an early condition of wear, and, if belonging to the permanent series, is either m. 1 or m. 2. The tooth differs from the molars of *L. pentapotamiæ* by its greatly inferior size, and by the transverse valley being wider and more open, as well as by the absence of the oblique ridges running from the fore-and-aft cingula to the summits of the two main ridges.

Assuming this tooth to belong to the permanent series, its greatly inferior size would leave no reasonable doubt of its being specifically distinct from *L. pentapotamiæ* and *L. splendens*. There is, however, no certain reason why this tooth should not be the last upper milk-molar (which in the pigs has the same form as the permanent molars), in which case it might at first sight be regarded as belonging to *L. pentapotamiæ*. In the pigs, however, no difference in structure can be detected between mm. 4 and m. 1, and the difference in the size of those teeth is considerably less than that between the specimen under consideration and the first molar of *L. pentapotamiæ* represented in plate VIII., fig. 13. On these grounds it is unlikely that the present specimen is mm. 4 of that species; and it is accordingly probable that it indicates a second Siwalik species of *Listriodon*, which may retain the provisional name of *L. theobaldi*.

1 Vol. XI., p. 98.

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INDIAN TERTIARY & POST-TERTIARY VERTEBRATA.

RODENTS & NEW RUMINANTS FROM THE SIWALIKS,

AND

SYNOPSIS OF MAMMALIA.

By R. LYDEKKER, B.A., F.G.S., F.Z.S.

(WITH PLATE XIII.)

Order: RODENTIA.

Rarity of remains.—The remains of rodents from the Indian tertiaries are of rare occurrence; this being probably due to the small size of most members of the order. No remains of rodents are figured in the "F.A.S.;" neither were any described by Falconer, although more than one genus was known to him from the Siwaliks. A species of *Siphneus (S. arvicolinus)* has recently been described by Herr Nehring[1] from the deposits of the upper Hwangho river in China, which probably correspond either to the Siwaliks or Narbadas.[2] The living species of that genus occur in North China and the Altai; and the fossil form is said to connect the living species with *Arvicola.*

Sub-Order: Simplicidentata.

Family I: *MURIDÆ.*

In a memoir by the late Gen. Sir W. E. Baker,[3] it is stated that remains of *Mus* had been obtained from the Siwaliks; and the same statement is made in Falconer's notes.[4] In the Indian Museum there is a fragment of breccia from the Narbadas containing the incisors of a murine rodent, of which the generic determination seems impossible.

1 "Sitz. Ges. nat. Freunde, Berlin." 1883. p. 19

2 *Vide supra*, vol. II. p. 289.

3 "On the Fossil Remains presented to the Museum at Ludlow" (Ludlow, 1850) p. 16.

4 "Palæontological Memoirs," vol. I., p. 23. See also 'Journ. As. Soc. Beng.' vol. IV., p. 706; V., p. 296.

Family II.: *SPALACIDÆ.*

Genus: RHIZOMYS, Gray.

Distribution and number of species.—According to Dr. G. E. Dobson,[1] the genus occurs in China, Tibet, the Malay Peninsula, and Eastern Africa; and Dr. J. Anderson[2] gives the following list of species from India, China, etc., *viz.:*

Rhizomys badius, Hodgson. India and Burma.
,, erythrogenys, Anderson. Burma and Tenasserim.
,, minor, Gray. Burma, Martaban, etc.
,, pruinosus, Blyth. Eastern Asia.
,, sinensis, Gray. China.
,, sumatrensis (Raffles). Sumatra.

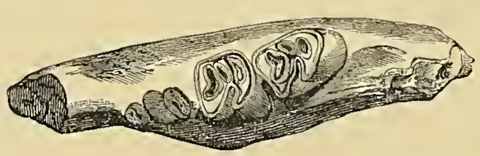
The form described below is the only known fossil species.

Species: Rhizomys sivalensis, *nobis.*

Syn (?) *Typhlodon*, Falconer.

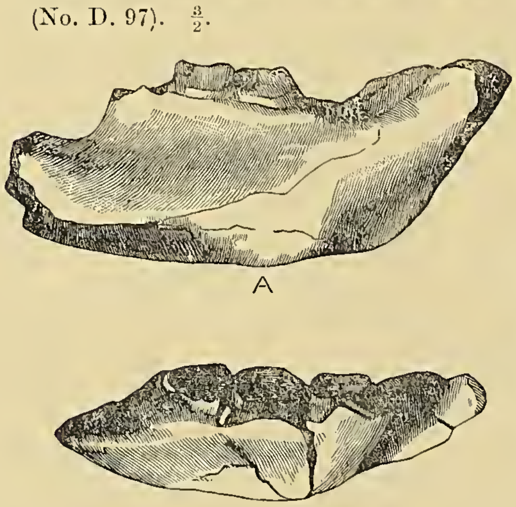
History.—This species was briefly described by the present writer[3] in 1878 on the evidence of two rami of the mandible, one of which was subsequently figured.[4] It was suggested that the generic name *Typhlodon*, Falconer,[5] might probably have been assigned to the present form; its derivation from the allied *Spalax typhlus* being so obvious. This suggestion is confirmed by the fact that Siwalik specimens of the present form are preserved in the British Museum.

Mandible.—In the accompanying woodcut (fig. 1) there is given an enlarged view of the dental aspect of the left ramus of a mandible, collected by Mr. Theobald in the Siwaliks of the Punjab. Only the two last molars remain, the crown of $\overline{\text{m. 1}}$ having been broken off. A portion of the incisor still remains on the lower border; and the two molars are in an early stage of wear. In woodcut fig. 2, there are represented two portions of the right ramus of the mandible of a species of the same genus. The first specimen (A) is viewed from the inner aspect, and shows the second and third molars, the crown of $\overline{\text{m. 1}}$ having been broken off. The second (C) is viewed obliquely from the outer and upper aspects, and shows the three molars in a well-worn condition. Both were obtained by Mr. Theobald from the Siwaliks of the Punjab. The molars of these two specimens are rather smaller than those of the specimen represented in fig. 1, and the depth of the



m1. m2. m3.

Fig. 1. *Rhizomys sivalensis.* Part of the left ramus of the mandible, from the Siwaliks of the Punjab. Indian Museum (No. D. 97). $\frac{3}{2}$.



A

C

Fig. 2. *Rhizomys*, sp. Two specimens of part of the right ramus of the mandible, from the Siwaliks of the Punjab. Indian Museum (Nos. D 97a, 97b.) $\frac{3}{2}$.

1 "Encyclopædia Britannica," 9th ed., Art "Mammalia," p. 419.

2 "Anatomical and Zoological Results of the two Expeditions to Yunnan, p. 322 (1878).

3 'Records,' vol. XI., p 100.

4 *Ibid.*, vol, XII., p. 52.

5 "Palæontological Memoirs," vol. I., p. 23.

jaw is somewhat less; but as the three specimens are otherwise very similar, it seems best to regard them as belonging to the same species. In the British Museum there are two rami of the mandible of a fossil rodent from the typical Siwaliks, of slightly larger size than the largest Punjab specimen, but evidently belonging to the same genus. The general characters of those specimens are very similar to those of the Punjab specimens, and, although it is possible that their superior size may indicate specific distinction, they may be provisionally associated. The following table exhibits the dimensions of the molar series of three of the above-mentioned specimens, viz.:

	Ind. Mus.		Brit Mus.
Length of three molars	0·62	0·67 (?)	0.74
Width of m. 2	0·17	0·2	0·25
Vertical diameter of incisor	0 16	0·16	0 17

The number and structure of the cheek-teeth (fig. 1), which have a deep enamel-fold on the outer, and three minor folds on the inner side, two of which (fig. 2) persist as isolated fossettes on the crown of well-worn teeth, show that the specimens belong to the sub-family *Spalacinæ* of the *Spalacidæ*. This sub-family contains the three genera[2] *Spalax*, *Heterocephalus*, and *Rhizomys*. The lower molars of the first are distinguished by the enamel-folds being very shallow, and disappearing at an early stage of wear; while those of the second have only a single inner and outer fold. In *Rhizomys* the structure of the molars is precisely similar to that of the Siwalik specimens, and the latter may therefore be referred to that genus.

Fig. 3. *Rhizomys*. (?) sp. Left calcaneum; from the Siwaliks of the Punjab Indian Museum (No. D 98) $\frac{2}{1}$

Calcaneum.—In woodcut fig. 3 there is given an enlarged view of the left calcaneum, partially broken on the inner side, of a small mammal collected by Mr. Theobald in the Siwaliks of Asnot, which may not improbably belong to the present form. The bone is very similar to, but somewhat smaller than the calcaneum of *R. badius.*

Distinctness and Affinities.—Taking the specimen represented in fig. 1 as the type, the Siwalik form is distinguished from *R. sumatrensis* by the smaller size of the jaw and the incisor, although the length of the molar series is very nearly the same in the two; the individual teeth being wider in the living form. The fossil is nearer in size to *R. pruinosus*, but its molars are more elongated, the incisors much smaller, and the jaw more slender. It is considerably larger than *R. badius*, and still more so than *R. minor*; but the incisors are only a little larger than those of the former, although the molars are half as large again. *R. sinensis* and *R. erythrogenys* are both considerably smaller than the fossil. The writer has not had the opportunity of comparing the latter with the African form; but it is in all proba-

1 In the preliminary notice already quoted it has been conclusively shown that the specimens cannot belong to any other family. The memoir by E. R. Alston on the "Classification of the Order Glires" ('Proc. Zool Soc,' 1876, p. 61), exhibits the dental character of the different groups in a very clear manner.

2 *Myospalax*, Blyth (not Brandt, which=*Siphneus*), has been shown by Mr. W. T. Blanford ('*Journ. As. Soc. Beng.*,' vol. L, pt. 2, p. 118) to be probably identical with *Ellobius*, and does not, therefore, belong to the *Spalacidæ*.

bility distinct. In all the recent forms the molars are relatively wider than those of the fossil.

It appears, therefore, that the Siwalik *Rhizomys,* whether it comprehends one or more species, is probably distinct from any of the living forms ; and it may accordingly retain the provisional name, *R. sivalensis.* The relatively wider molars and the larger size of the incisors of the existing forms as compared with those of the fossil seem to indicate that specialization has tended to the production of these characters.

Distribution.—Remains of the Siwalik *Rhizomys* have been obtained from the typical Siwalik Hills and the Punjab.

FAMILY III.: *HYSTRICIDÆ.*

Dental Characters.—According to the late Mr. E. R. Alston[1] the living members of the *Hystricidæ* present the following dental characters, *viz.:*

A. SPHINGURINÆ. Cheek-teeth rooted. Nearctic and Neotropical.

- *Chætomys,* Gray. Upper cheek-teeth each divided into three lobes, of which the first and last have deep single enamel-folds; lower teeth with an external and two internal folds.
- *Synetheres*[2] F. Cuv. Cheek-teeth like *Chætomys,* but with two lobes only: equal in size.
- *Erethizon,* F. Cuv. Cheek-teeth like *Synetheres,* but anterior larger than posterior.

B. HYSTRICINÆ. Cheek-teeth, semi-rooted, Palæarctic, Indian, and Ethiopian.

- *Atherura,* Cuv. Upper cheek-teeth with one internal, and three or four external enamel-folds, the latter soon separated into enamel-loops: lower teeth similar but reversed.
- *Hystrix,* Linn. Teeth as in *Atherura.*

It thus appears that while the American porcupines can be distinguished palæontologically from those of the Old World, the genera *Atherura* and *Hystrix* cannot be distinguished by characters usually available in the case of fossils. The cheek-teeth of *Dasyproeta* are also very similar to those of the smaller porcupines; but none of the species of that genus, or *Atherura,* attain such a large size as some species of *Hystrix.*

GENUS: HYSTRIX, Linn.

Distribution, and number of fossil species.—The genus is confined to the Old World at the present day; but in former times it apparently ranged into America, if *Hystrix venusta* be rightly determined. It will be unnecessary to give a list of the existing species; but it may be mentioned that the South European and African *H. cristata,* Linn., and the Indian *H. hirsutirostris,*[3] Brandt, are the largest forms. The earliest recorded occurrence of a porcupine, or allied form, is in the "Quercy Phosphorites," from which deposits a fragment of a mandible has been described by Dr. Filhol[4] under the name of *H. (?) lamandini.* Besides this there is the so-called

1 *Op. cit.*

2 Syn. *Cercolabes,* Brandt. *Sphingurus,* F. Cuvier.

3 Syn. *H. leucura,* Sykes.

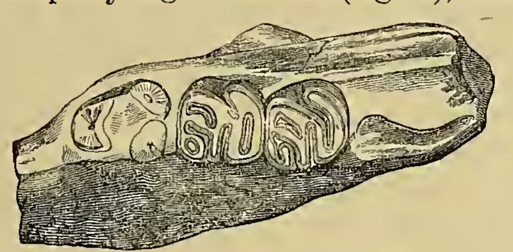
4 "Phosphorites du Quercy" (reprint) p. 49.

H. refossa, Gervais[1] from the miocene of Issoire; referred by Bravard[2] to *Dasyprocta*; *H. primigenia*[3] (Wagner) from the Pikermi group; and *H. venusta,* Leidy,[4] from the pliocene of North America. An unnamed form has also been obtained from the pliocene of the Val d'Arno; and another from Sicily.[5]

Species: HYSTRIX SIVALENSIS, *nobis.*

History.—The occurrence of a Siwalik porcupine is mentioned in the memoir by Sir. W. E. Baker already quoted, and in Falconer's notes.[6] A fragment of a mandible has been noticed by the present writer under the name of *H. sivalensis.*[7]

Mandible.—The above mentioned fragment of the mandible is represented in the accompanying woodcut (fig. 4), and was obtained by Mr. Theobald from the Siwaliks of the Punjab. It consists of the middle portion of the right ramus, and shows m. 1 and m. 2 in a middle stage of wear; the crown of pm. 4 has been broken off, and m. 3 has fallen from its alveolus, which is filled with matrix. The specimen is considerably larger than the jaw of *H. hirsutirostris,* and it is, therefore, evident that among the living forms it is only necessary to compare it with that species and *H. cristata.* The structure of the cheek-teeth is of the same complex nature as those of the living species. The broken base of pm. 4 shows, however, that this tooth was inserted by three distinct roots;[8] which from the state of wear of m. 1 must evidently have been situated only just below the lower extremity of the external enamel-fold. In the existing species the roots of this tooth are never so distinctly developed as in the fossil, and are situated at a distance of more than half-an-inch below the latter fold. The alveolus of pm. 4 in a jaw of the existing species in the same stage of wear, exhibits a large single cavity, without the slightest trace of any division. Precisely similar conditions prevail in the true molars, the roots being distinctly visible on the outer side of m. 1,[9] in which there is an interval of less than a quarter-of-an-inch between their commencement and the inferior extremity of the external enamel-fold, the same interval being more than half-an-inch in length in the smaller tooth of *H. hirsutirostris.* In consequence of the short crowns of the cheek-teeth the hinder part of the incisive alveolus is placed



pm. 4. m. 1. m. 2. m. 3.

Fig. 4. *Hystrix sivalensis.* Fragment of the right ramus of the mandible; from the Siwaliks of Asnot, Punjab. Indian Museum (No. D. 96). 1/1

1 "Zoologie et Paléontologie Françaises," 2nd ed., pp. 17, 18, pl. XLVIII., fig. 11.

2 *Vide* Pomel, "Cat. Meth. Vert. Foss.," p. 32.

3 *Vide* Gaudry, "Animaux Fossiles et Géologie de l'Attique," p. 122, pl. XVIII., fig. 2.

4 "Extinct Mammalian Fauna of Dakota and Nebraska," '*Journ. Ac. Nat. Sci. Philadel,*' ser. 2, vol. VII., p. 343, pl. XXVI., fig. 23 (1869).

5 *Vide,* Gaudry, *op. cit.* p. 126. 6 "Pal. Mem." vol. 1, p 23. 7 "Records," vol. XI., p. 100, (1878).

8 The large size of the alveolus of this tooth, and the well-worn condition of the true molars, shows that the former could not have been a milk-molar.

9 The crown of m. 1 accidentally broke off during description, when the roots were very distinctly exhibited.

nearer to the superior surface of the ramus than in the existing species. The mental foramen is placed nearer $\overline{\text{pm. 4}}$, the depression of the superior surface of the ramus in front of that tooth is less deep, and the ridge forming the anterior boundary of the masseteric fossa is more strongly developed.

In its large size, as well as in the position of the mental foramen, and the strong development of the masseteric ridge, the fossil agrees with the Pikermi *H. primigenia*. In all other respects that species appears to be very close to *H. cristata*, and differs, therefore, in the same characters from the Siwalik fossil. *H (?) lamandini* is named upon the evidence of a fragment without the teeth, and in the absence of a figure cannot be compared with the present specimen. *H. refossa* is apparently only known by a fragment of the mandible containing one molar, and the alveolus of another: it is said to be distinguished from *H. cristata* by the more numerous enamel-islands on the worn crowns of the molars. It apparently agrees with the Siwalik form in having very distinct roots and short crowns to the molars; but these teeth are of a more elongated form. *H. venusta* is founded on a single molar, which is said to resemble the corresponding tooth of *H. cristata*. It appears, however, to have had a short crown, with distinct fangs. It is impossible to say whether it is the same as the Siwalik fossil; although this is improbable. There are no means of comparing the Siwalik specimen with the unnamed fossils from the Val d'Arno and Sicily.

Young skull.—In the accompanying woodcut (fig. 5) there is represented the cranium of a young Siwalik porcupine in the British Museum which not improbably

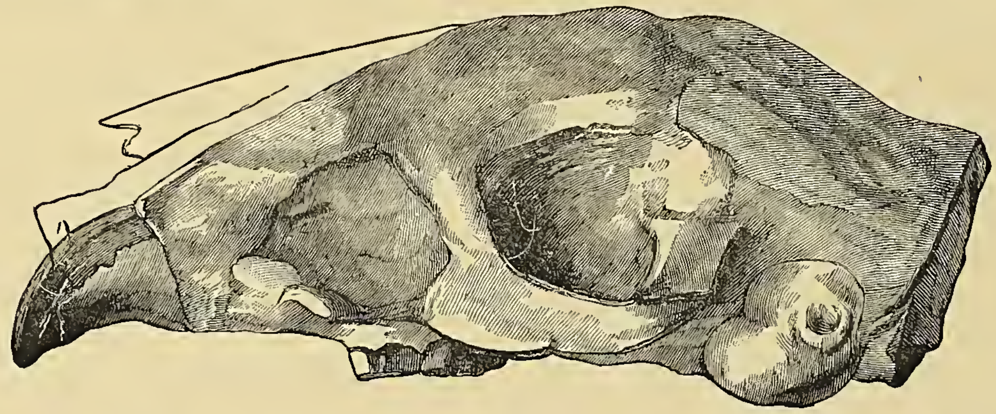


Fig. 5. *Hystrix* sp. Left lateral aspect of the cranium of a young individual from the Siwalik Hills, with the nasals restored. British Museum (No. 15,923). $\frac{1}{1}$.

belongs to the same species as the mandible. The specimen is believed to be one of those collected by Baker and Durand; and has the mandible (in a crushed condition) attached, which has been omitted from the figure. The cranium has suffered considerably from crush, and has lost the nasals and a part of the maxilla. In the upper jaw there are only two teeth, and but three in the lower; thus showing that the specimen is not adult. The first tooth in each jaw is the milk-molar, and the second the first true molar. On the left side of the mandible the whole length of the crown of $\overline{\text{m. 1}}$ is exposed; and it is thus seen that in its lower part the dimensions of this tooth are similar to those of the corresponding tooth of the specimen represented in fig. 4. In the same tooth the external enamel-fold extends as near down to the root as in the latter specimen; and there is accordingly a great probability that the two specimens belong to the same species. The young cranium is very similar in general contour to the cranium of *H. hirsutirostris* and *H. cristata*, having the characteristic convex profile; which is wanting in the smaller porcupines.

Distinctness and affinities.—The foregoing comparisons lead to the conclusion that the Siwalik porcupine is specifically distinct from all the living species of the genus, while it is probably also distinct from the described fossil forms, though apparently coming nearest, in one respect, to *H. refossa*, and perhaps to *H. venusta*. The characters in which the Siwalik form differs from the existing species are precisely those which might be expected to occur in an early, or generalized, form, and it is therefore quite possible that it may be the ancestor of the large existing Indian species. The provisional name *H. sivalensis* may be retained for the Siwalik species.

Distribution.—If both the specimens described above belong to the same species, the range of that species extended from the typical Siwalik Hills to the Punjab.

ORDER: UNGULATA. SUB-ORDER: ARTIODACTYLA.

SECTION: RUMINANTIA.

Introductory.—In the preceding volumes of this work[1] most of the Siwalik ruminants have been described and figured. The present part contains descriptions of a few new forms, and a revision of some of those previously described.

The retention of the generally discarded term Ruminantia, as comprehending the modern Pecora, Tylopoda, and Tragulina, is adopted in view of the difficulty of referring many of the fossil forms to one or other of those groups. That the term Ruminantia is incapable of definition the writer is fully aware; but as all divisions in palæontological zoology must be arbitrary in cases where a large number of forms belonging to allied groups are known, and as it is highly desirable to divide the Artiodactyla into a more specialized and a less specialized group, no valid objection to the use of the term can be drawn from this source.

FAMILY: *BOVIDÆ*.[2]

GENUS: OREAS, Desmarest.

Distribution.—The genus is confined at the present day to south and tropical Africa, and includes only two species. It has not hitherto been recorded in a fossil condition.

Species: OREAS (?) LATIDENS, *nobis*.

Syn. *Cervus latidens*, *nobis*.

History.—In the first volume of the present work,[3] an upper and lower molar

1 Vol. I., pts. 2, 3, 4. Vol. II., pts. 4, 5.

2 In accordance with Prof. Flower's classification this family is taken to include all the cavicorn ruminants except *Antilocapra*.

3 Page 65, plate VIII., figs. 4, 6, 7, 10 (1876).

of a large ruminant from the the Siwaliks of the Punjab were described and figured under the name of *Cervus latidens*, with a proviso as to the possible incorrectness of the generic name. In the preface to the same volume,[1] the doubtfulness of this point was again mentioned. The more extended means of comparison now available to the writer have pretty conclusively shown that these specimens do not belong to the *Cervidæ*.

Upper dentition.—In plate XIII., fig. 12, of the present volume, there is represented the external aspect of the left maxilla of a large ruminant collected by Mr. Theobald in the Siwaliks of the Punjab, containing the last two premolars and the three true molars, in an intermediate state of wear. Part of the outer surface of $\underline{\text{m. 2}}$ is somewhat damaged, and the masticating surfaces of this and the succeeding tooth are so injured that they could not be figured; but a figure (fig. 13) has been given of this aspect of the three preceding teeth. The true molars of this specimen correspond exactly in form with the type tooth represented in vol. I., pl. VIII., figs. 7, 10, but are of somewhat smaller size; this difference cannot, however, in all probability, be regarded as of more than individual, or sexual, value.

In no species of *Cervidæ* which has come under the writer's observation are the outer surfaces of the true molars so flat as in the specimens under consideration, or is the middle 'costa' of each lobe so faintly developed; neither are the hinder costæ on the outer surface of $\underline{\text{pm. 4}}$ so little prominent. These differences are so important as to indicate that the specimens do not belong to that family.

From *Bos* and its allies the specimens are readily distinguished by their more 'brachydont' character, the flatness of the outer surfaces of the molars, and the slight development of cement.

Turning to the larger antelopes, the teeth of the maxilla under consideration agree so closely with those of *Oreas canna* that there can be little or no doubt but that they indicate a closely allied form. The teeth of the specimen are about one-fourth smaller than those of a large male eland; but the single tooth figured in the first volume is very nearly the size of the latter. The fossil teeth can only be distinguished from these *O. canna* by the larger development of the accessory column in the median valley (which is very minute in the living species) and by $\underline{\text{pm. 3}}$ being relatively rather longer. The teeth of the kudu (*Strepsiceros*) present a strong resemblance to those of the eland, but are distinguished by their lower crowns, the total absence of the accessory columns in the median valley, the smaller development of the anterior costa of the first lobe, and of the costæ on the last two premolars. In all these respects they are unlike the fossil. All three agree in the smoothness of the enamel. The teeth of *Alcelaphus*, *Connochœtes*, and *Boselaphus* are of a different type, and those of no other existing antelopes come so near to the fossil as do those of *Oreas*.

Turning to other fossil forms, it may be stated that the present teeth are unlike

[1] Page xvii.

those of any other previously described Siwalik species. Of the European forms, those which come nearest to the present specimens are the Pikermi *Palæoryx pallasi* and *Tragoceros amaltheus*.[1] According to Prof. Gaudry[2] the molars of those two species are, in a long series, almost indistinguishable, although the figures appear to show considerable differences. The molars of *Palæoryx*, as far as can be judged from the figures, have lower crowns than those of the present specimen, with the costæ less strongly developed (especially the last costa[3] of m. 3), the middle of the outer surfaces of the lobes less perfectly flat, and the accessory columns less strongly developed, although, according to Prof. Gaudry, there is a considerable amount of variation in this respect. In *Tragoceros* the costæ appear slightly more developed than in *Palæoryx*, but not so strongly as in the present specimen; this smaller development never admitting of the worn surface of the first costa of the posterior lobe being directed forwards as in m. 1, fig. 13. In *Tragoceros*, as in *Palæoryx*, the costæ unite at the 'neck' of the crown to form a kind of cingulum. Finally the outer surface of pm. 4[4] in *Tragoceros*, and in a slightly less degree in *Palæoryx*, is apparently more symmetrical than in the present specimen; the middle costa being placed more nearly in the median line. Both the Pikermi genera resemble the Siwalik jaw in their elongated pm. 3.

Lower molar.—The lower molar represented in vol. I., pl. VIII., figs. 4, 6, so closely resembles the upper one figured in the same plate, that it may be safely referred to the same species. It closely resembles the corresponding tooth of the eland.

Distinctness and affinities.—The teeth of allied genera of ruminants are frequently so similar in general structure that it is a matter of extreme difficulty to deduce from them alone the generic affinities of their owners; and all determinations from such evidence must be made with extreme caution. The foregoing comparisons indicate, however, pretty conclusively that the teeth under consideration belonged to a large antelope, of which the largest individuals were nearly equal in size to the largest eland; and that this antelope was most nearly allied to *Oreas*, *Palæoryx*, and *Tragoceros*. On the whole, its relationship appears to be decidedly nearest to the first of these three genera (although it is quite possible that it may really be generically distinct); and it may, therefore, be perhaps admissible to refer it provisionally to that genus, until more complete remains shall be obtained.

Admitting the probability of the present form being very intimately related to *Oreas* and the larger Pikermi antelopes, its existence in the Siwaliks is a matter of much interest, as it is one more instance of the intimate union that formerly existed between the faunas of India, Africa, and southern Europe.

Distribution.—All the known remains belonging to the present form were obtained from the Siwaliks of the Punjab.

1 Gaudry, "Animaux Fossiles et Géologie de l'Attique," pls. XLVII.-IX.

2 *Op. cit.*

3 Compare pl. XLVII., fig. 3, of Prof. Gaudry's work.

4 Pm. 3 in Prof. Gaudry's figures.

GENUS: PALÆORYX, Gaudry.

Distribution.—Two species, *P. pallasi* and *P. parvidens*, have been determined from Pikermi,[1] and a third, *P. meneghinii*, has been recorded by Prof. Rütimeyer[2] from Italy.

PALÆORYX (?) sp.

History.—In the preface to the first volume of this work[3] it is stated that two molars from the Siwaliks may possibly belong to the present genus.

Upper molar.—One of the above-mentioned teeth (both of which came from the Punjab) is represented in pl. XIII., figs. 9, 10: it belongs to the left side, and is about one-third worn. It differs from the molars of *Oreas* (?) *latidens* (figs. 12, 13) by the crown being lower, which causes the outer surfaces of the lobes to be relatively wider; by the slighter development of the costæ (especially the last costa of the hinder lobe), and by their union at the 'neck' to form an imperfect cingulum (*not well shown in the figure*). It also differs by the more rugose enamel, the less perfect flatness of the outer surfaces of the lobes, and the compressed form of the accessory column in the median valley, which is attached entirely to the posterior 'crescent.' In all these respects this tooth agrees with the molars of *Palæoryx* and *Tragoceros*; but seems to come nearest to the figured specimens of the former, although having a larger accessory column: the size of this column is, however, so inconstant in the European form that it cannot be regarded as of generic value. Whether the present specimen really belongs to *Palæoryx* may be considered doubtful; but it pretty certainly indicates a closely allied form, and a second species of large Siwalik antelope.[4]

GENUS: BOSELAPHUS, Blainville.
Syn. *Portax*, H. Smith.

Number of species.—The genus is exclusively Indian; comprising the existing *B. tragocamelus*[5] (Pall.), the pleistocene *B. namadicus* (Rütimeyer), and the Siwalik form described below.

BOSELAPHUS, sp.

History.—In 1878 Prof. Rütimeyer[6] described two portions of the cranium of a ruminant from the Narbadas, under the name of *Portax namadicus*: that species being distinguished from the living form by the closer approximation of the horn-

[1] *Op. cit.*, pl. XLVII.

[2] "Die Rinder der Tertiär-Epoche," p. 87 ('Abh. schweiz. pal. Gesel,'—1877-8).

[3] Page xv. (1880).

[4] In the British Museum there is a part of the right maxilla of a ruminant (No. 16,657) from the Siwalik Hills, containing the last five cheek-teeth, which probably indicates a third species of large antelope. The last molar is nearly as large as in the figured jaw of *Oreas* (?) *latidens*, but the two preceding molars and the two premolars are very much smaller. The teeth come nearest to those of that form; but the first costa of the second lobe is less, and the last costa much more strongly developed: the accessory columns in the median valleys are somewhat larger.

[5] Syn. *B. pictus* (Pall.).

[6] "Die Rinder der Tertiär-Epoche," page 89, in 'Abh. schweiz. pal. Gesel,' vol. V.

cores to the orbits. The first notice of the occurrence of a species of this genus in the Siwaliks is in the first volume[1] of the present work, where some teeth and jaws are briefly mentioned under the name of *Portax.* In a subsequent notice[2] a fore-limb from the Siwaliks of the Punjab was also referred to the same genus; but no specific name was assigned in either case.

Upper dentition.—In plate XIII., fig. 1, there is represented the masticating and inner aspect of the cheek-teeth of the left maxilla of a ruminant collected by Mr. Theobald in the Siwaliks of the Punjab. The specimen belonged to a young individual and shows the three milk-molars (mm. 2, mm. 3, mm. 4) in a well-worn condition, and the first and second true molars (mm. 1, mm. 2) in an early condition of wear, and not fully protruded. In figure 2 there is represented the external aspect of the teeth of a precisely similar left maxilla, from the same locality, containing mm. 3, mm. 4, and m. 1.

It will suffice to say that the teeth of these specimens correspond so exactly with the homologous teeth of a young female individual of *Boselaphus tragocamelus* that there can be little hesitation in referring them to the same genus.[3] The only difference that can be detected between the recent and fossil teeth is that the latter are of considerably larger size, and that the central enamel-pits of the true molars are less deep, while the hinder wall of the posterior 'crescent' of m. 2 is somewhat lower, thus causing the union of the dentine surface of this 'crescent' with that of the corresponding 'lobe' to be somewhat later. The lesser depth of the middle enamel-pits causes the lip of the 'crescents' of the fossil teeth to be thicker than in those of the living species. In the following table the dimensions of the fossil teeth are compared with those of the above-mentioned skull of *B. tragocamelus*, *viz.*:—

	Fossil.		B. tragocamelus.
Length of five teeth	4·65		3·73
,, ,, mm. 2	0·83		0·67
,, ,, ,, 3	0·92	0·94	0·78
,, ,, ,, 4	0·9	0·92	0·72
,, ,, m. 1	1·1	1·11	0·97
,, ,, ,, 2	1·19		1·05

In figure 7 of the same plate there is represented a well-worn left upper true molar, from the Siwaliks of the Punjab, in which the greater part of the accessory column in the median valley has been broken away. The tooth of which two views are given in figures 8, 11 of the same plate is an almost unworn right upper true molar, from the same locality. In this specimen, as in m. 1 of fig. 2, the first costa of the anterior crescent is less strongly developed than in the true molars of fig. 1; but it is probable that this difference is merely of individual value.

Lower dentition.—In plate XIII., fig. 5, there is represented a fragment of the left ramus of the mandible of a large ruminant, collected by Mr. Theobald in the Siwaliks, which from its size and the resemblance of its teeth to those of the nilgai

1 Page xv. (1880). 2 "Records," vol. XVI., p. 76.

3 The molars of *Hippotragus* are very similar to those of *Boselaphus*, but have the borders of their outer surfaces more nearly parallel.

may be referred to the present species. This specimen contains the three true molars in a well-worn condition; and is distinguished from the mandible of the living species merely by its superior size, and the lesser depth of the median enamel-pits. The dimensions of this specimen are as follows, *viz.*:—

Length of three true molars	3·25	Length of m. 3	1·5
,, ,, m. 1	0·85	Depth of jaw at m. 3	1·87
,, ,, ,, 2	0·95		

There are numerous similar specimens in the Indian Museum from the Siwaliks of the Punjab, and one or two from the typical Siwalik Hills. In fig. 3 of the same plate there is represented part of the dentition of the right ramus of the mandible of a young individual, showing the well-worn $\overline{\text{mm. 3}}$ and $\overline{\text{mm. 4}}$, and $\overline{\text{m. 1}}$ very slightly worn: the inner portions of the lobes and parts of the crescents of the last two teeth have been broken away. In figure 4 of the same plate there is represented a portion of the left ramus of the mandible of a still younger individual, showing the three milk-molars in an early stage of wear, and the summit of the first lobe of $\overline{\text{m. 1}}$, which had not cut the gum. Both these specimens were obtained by Mr. Theobald from the Siwaliks of the Punjab; and so closely resemble young mandibles of *B. tragocamelus* that they may be referred to the present species. The only essential difference between the living and fossil form is the superior size of the latter.

Limb-bones.—From the Siwaliks of Niki in the Punjab Mr. Theobald, as already mentioned, obtained a nearly complete right fore-limb, and part of the associated ramus of the mandible, and axis vertebra of the present species, which are now in the Indian Museum (No. B. 268). The fragment of the mandible agrees precisely with the one represented in plate XIII., fig. 5; and the limb-bones are so like those of the nilgai that it has not been considered necessary to figure them. The radius is one inch longer than the corresponding bone of the skeleton of a male nilgai in the Museum of the Royal College of Surgeons (No. 1347).

Distinctness and affinities.—The foregoing comparisons indicate that the Siwalik nilgai was closely allied to the existing species, but that it exhibited slight differences which may be of specific value. With regard to *B. namadicus* (Rüt.[1]), it unfortunately happens that that species is described on the evidence of crania without the teeth, so that it is impossible to institute a comparison between the Siwalik and Narbada forms. There are in the Indian Museum some teeth of the genus from the pleistocene of the Pemganga valley, which probably belong to *B. namadicus*; but they have not been compared with those of the Siwalik form. Under these circumstances it is impossible to say whether the latter is specifically distinct from *B. namadicus*, and it is, therefore, inadvisable to give it a separate name.[2]

Distribution.—Remains of this species are of common occurrence in the Siwaliks of the Punjab; and one specimen has been obtained from the typical Siwalik Hills.

1 *Op. cit.*

2 It may be observed that the molars of the present species present a superficial resemblance to those of *Cervus triplidens* (vol. I., pl. VIII., figs. 1, 2); both forms being markedly hypsodont. The molars of *Boselaphus* are, however, readily distinguished by the lesser development of the costæ (especially the median costa of the hind lobe); and by the circumstance that on its outer surface the crown of each tooth is much wider near its summit than at its 'neck.'

Genus: ALCELAPHUS, Blainville.

Species: Alcelaphus palæindicus (Falc.).

Syn. *Antilope palæindica*, Falconer.

Generic determination.—Prof. Rütimeyer[1] has shown that the so-called *Antilope palæindica*,[2] Falc., is closely allied to the African bonte-bok and bless-bok, and may be referred to the same genus. Prof. Rütimeyer retains the genus *Damalis* for the living species; but in Prof. Flower's classification they are included in *Alcelaphus*, and the fossil form will accordingly be termed *Alcelaphus palæindicus*.

This identification affords another instance of the intimate connection between the Indian and African faunas.

Family: *TRAGULIDÆ.*

Genus: TRAGULUS, Pallas (*ex* Brisson).

Distribution, etc.—With the exception of the form described below this genus has not been recorded in the fossil condition[3]; although it is probable that the allied *Hyomoschus* is represented by *Dorcatherium* of the Eppelsheim beds and Siwaliks.[4] The living species are confined to Wallace's Oriental region, and comprise *T. javanicus* (Gmelin),[5] of Java, etc.; *T. kanchil* (Raffles), of Java, Tennasserim, etc.; *T. meminna* (Erxl.), of India; *T. napu* (F. Cuv.), of Sumatra, and *T. stanleyanus* (Gray), of Java. In the trenchant form of the earlier upper premolars[6] the genus is markedly distinct from the cervine ruminants Next to *Hyomoschus*, according to Prof. Rütimeyer, the nearest ally of *Tragulus* is *Prodremotherium*,[7] Filhol; and it is connected by the latter with *Gelocus*, Kow., and so with *Cœnotherium*. By many writers[8] the genera *Dremotherium*, E. Geoffr., and *Amphitragulus* are considered to be closely allied to the chevrotains; but they are placed by Prof. Rütimeyer nearer to *Cervus*.

Species: Tragulus sivalensis, *nobis.*

History.—In 1882 the present writer[9] gave a preliminary notice of an upper

1 "Die Rinder der Tertiär-Epoche" ('Abh. schweiz. pal. Gesel,' 1877-8), pp. 88-9.

2 "Pal. Mem.," vol. I., pl. XXIII.

3 Unless *Moschus meyeri*, Goldf., belong to it.

4 In a recent memoir, "Beiträge zu der Geschiete der Hirsch-familie" ('*Abhand. schweiz. pal. Ges.*,' 1883), pp. 70-78, Prof. Rütimeyer apparently comes to the conclusion that the genera *Dorcatherium* and *Hyomoschus* should be united. The former name (Kaup, 1836) has the priority over the latter (Gray, 1845); but it is doubtful if zoologists would accept the substitution of *Dorcatherium* as the name of the genus. For the so-called *Dorcatherium naui*, Kaup, Rütimeyer adopts the name *Hyomoschus crassus*, Lartet; but the specific name *naui* has the priority (1836), *crassus* having been applied in 1851 (*Dicrocerus crassus*, Lartet). The generic characters of *Dorcatherium* given in the first volume of the present work are incorrect.

5 Crania of several species are figured by Milne-Edwards in "Recherches sur la Famille des Chevrotains,"—'Ann. Sci. Nat.' Zool., 5th ser., vol. II., pls. VIII., IX., X. (1864); where the synonomy is also given.

6 Prof. Rütimeyer (*op. cit.*) employs the terms *heterodont* and *homœodont* for these two types of selenodont dentition; since, however, the same terms are applied in a much wider sense to the mammalian dentition their employment in the former sense is inadvisable.

7 For the characters of this and allied genera see Filhol, "Phosphorites du Quercy," p. 448, *et. seq.*, and "Mam. Foss. de Ronzon," p. 240, *et. seq.* (reprints).

8 See Milne-Edwards, *op. cit.*, pp. 148-9.

9 "Records," vol. XV., p. 30.

molar from the Siwaliks, which was referred to the present genus, with the provisional name *sivalensis*.

Upper molars.—The above-mentioned tooth is represented, of twice the natural size, in the two figures on the right side of the accompanying woodcut; the upper figure being taken from the masticating, and the lower from the outer aspect. The tooth belongs to the left side, and appears to be the last of the true molar series: the crown is about one-third worn down. It was obtained by Mr. Theobald from the Siwaliks of Asnot, Punjab.

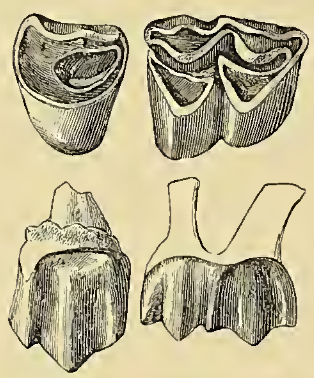


Fig. 6. *Tragulus sivalensis*, and *Moschus* (?) sp. The two figures on the right represent the third left upper true molar of the former; and those on the left the fourth right upper premolar provisionally referred to the latter. Indian Museum (Nos. B. 360, 437). $\frac{2}{1}$.

This tooth is of the same size and shape[1] as the corresponding molar of the existing *Tragulus meminna*; the only perceptible difference between the two being that the first costa of the anterior lobe of the fossil is rather more prominent than in the living species.[2] In this respect the fossil makes some approach to *Moschus*, but is distinguished by the later period at which the worn dentine surfaces of the inner crescents unite, and by the less elongated form of the crown.

The resemblance of the molar teeth of the different existing species of *Tragulus* is so close that it seems doubtful if any distinction beyond differences in size can be drawn between them. The resemblance existing between the fossil tooth and the molars of *T. meminna* renders it almost certain that the former belongs to the same genus; but additional remains are required before specific characters can be determined. In the meanwhile in order to record the probable occurrence of the genus in the fossil state the Siwalik form may retain the provisional name of *T. sivalensis*.

The occurrence of this essentially Oriental genus in the Siwaliks is only what might have been expected; and it is to be hoped that additional remains may be forthcoming, which will indicate the relationship of the fossil to the living species.

Family: *CERVIDÆ.*

Genus: MOSCHUS, Linn.

Distribution.—The genus is now represented by *M. moschiferus*, and is essentially Palæarctic, although ranging within the northern limits of the Oriental region. An allied genus *Amphimoschus* has been named from the miocene of Europe; but it does not appear that the genus *Moschus* has been certainly obtained in the fossil state, although certain remains have been so named. The earlier upper premolars are selenodont.

Moschus (?) sp.

Upper premolar.—On the left side of the woodcut figure 6 there are given

1 The foreshortening of the tooth in the woodcut makes the crown appear elongated, whereas it is really square.

2 Not well shown in the figure.

two views, twice the natural size, of the last right upper premolar of a small ruminant, obtained by Mr. Theobald from the Siwaliks of the Punjab; which is in a partially worn condition and is somewhat smaller than pm. 4 of the musk-deer. It agrees, however, essentially in form with that tooth; showing the prominent median costa, placed somewhat on the anterior side of the median line of the dorsum[1], and the equally prominent anterior and posterior costæ, which unite in a raised horizontal line along the base of the crown. The corresponding tooth of *Tragulus* is readily distinguished by the still more eccentric position of the median costa and the practically total absence of the lateral costæ. In the smaller true deer (*e.g. Cervulus muntjac*) pm. 4 is almost identical in form with that of *Moschus*, but is very much larger.

As it is impossible to distinguish the tooth under consideration from that of the musk-deer except by its inferior size, and as it is distinct from the corresponding tooth of *Tragulus*, while the premolars of the smaller true deer are of considerably larger size, it appears highly probable that the specimen belongs to a species of *Moschus*, although it would be hazardous to say that such was certainly the case.

If future discoveries should confirm this view, it would indicate that the original home of the race from which the existing musk-deer has sprung was probably in the Oriental region.

Genus: CERVUS, Linn.

This genus is taken to include *Axis*, *Rusa*, *Rucervus*, *Elaphurus*, *Panolia*, *Dama*, *Megaceros*, etc.

Species 1: Cervus simplicidens, *nobis*.

History.—This species was named in 1876 on the evidence of two left upper true molars described and figured in the first volume of this work[2]; although their affinities were not fully determined. In the preface to the volume[3] reference was made to a portion of a cranium belonging to the same species, which forms the subject of the present notice.

Upper dentition.—The above-mentioned portion of the cranium was obtained by Mr. Theobald from the Siwaliks of the Punjab; and the dentition of the left side is represented from the masticating aspect in plate XIII, fig. 6, and from the outer side in the woodcut (fig. 7). The cranium is too imperfect to afford a satisfactory figure: it comprises the portion between the middle of the orbit and the anterior limit of the series of cheek-teeth. It is of larger size than the corresponding portion of the cranium of the Indian *Cervus axis*, Erxleb, but agrees very closely in form: it shows the broad, flat frontals, the deep

Fig. 7. *Cervus simplicidens, nobis.* Outer view of the cheek-teeth of the left side. $\frac{2}{3}$. Indian Museum (No. B. 349).

[1] This is placed in the figure too near the median line.

[2] Page 69, plate VIII., fig. 3.

[3] Page xvii.

preorbital fossa, and the commencement of the larmial vacuity, characteristic of the deer; whence the specimen may be safely referred to that group. On the right side all the cheek-teeth are preserved, with the exception of pm. 2; a part of the outer side of pm. 3 and m. 3 is broken away; and the teeth are about one-third worn. The true molars agree with the little-worn type molars of *C. simplicidens* (vol. I., pl. VIII., fig. 3), with the exception that the accessory columns in the median valleys are more strongly developed; this cannot, however, in all probability be regarded as more than an individual variation, and the present specimen may accordingly be referred to that species.

In size the specimen agrees very closely with the Indian *C. duvaucelli*,[1] Cuv.; but is distinguished by its more 'hypsodont' character, and the less strongly developed costæ of the molars. In both these respects the fossil is exceedingly close to *C. axis*; which is more hypsodont than the majority of the family.[2] This hypsodont character is well shown in the woodcut, where the 'necks' of the crowns of the true molars occupy very different levels, as in *C. axis*.[3] With the exception of their considerably larger size, the only difference that can be detected between the teeth of the fossil and those of *C. axis* is that pm. 3 is relatively shorter in the latter, and the outer part of pm. 4 rather less symmetrical, and the true molars relatively wider. The following dimensions indicate the difference in the size and proportions of the fossil and recent forms:—

	C. sivalensis.	C. axis.
Width of intermolar space at m. 1	2·08	1·85
Interval between outer surfaces of second molars	3·76	3·15
Length of five cheek-teeth	3·48	2·74
,, ,, three true molars	2·4	2·04
,, ,, pm. 3	0·68	0·45
,, ,, m. 2	0·88	0·82
Width ,, ,, ,,	0·94	0·72

Distinctness and affinities.—It does not appear that there is any other species of deer of which the teeth approach so closely to *C. simplicidens* as do those of *C. axis*; and it, therefore, seems probable that the former should be regarded as an ancestral form of the latter. There seem no valid grounds for referring any of the mandibles or antlers of the Siwalik deer to the present species.

Distribution.—Both the specimens referred to this species were obtained from the Punjab.

Species 2: CERVUS TRIPLIDENS, *nobis*.

History.—This species was founded at the same time as the last.[4]

Upper molars.—The type second and third upper molars are figured in vol. I., pl. VIII., figs. 1, 2, and their dimensions are given on page 68. These teeth are but

1 In the original description the fossil species was considered to be allied to this species.

2 *Vide* Flower, Article "Mammalia," p. 432 in the 'Encyclopædia Britannica,' 9th ed.

3 In the more 'brachydont' forms (*e.g. Cervus duvaucelli*, and still more *C. kashmirianus*) the 'necks' of the true molars occupy nearly the same line (*vide* Flower, *loc. cit.*).

4 Vol. I., p. 67 (1876). The remark as to the shallowness of the median enamel pits is incorrect.

little worn; and from their general structure, and especially the strongly marked costæ on their outer surfaces, there seems no doubt but that the generic reference is correct. They are distinguished from those of *C. simplicidens* by their still higher crowns (the height of m. 3 exceeding its width), and the more strongly marked costæ on their outer surfaces; this hypsodont character being well exhibited by the extreme inequality in the degree of protrusion of m. 2 and m. 3.

The species of deer apparently nearest to the fossil is *C. davidianus* (A. Milne-Edwards[1]), of North China, which seems to be more hypsodont than any other living species, and whose molars have very strongly marked costæ. The remains of the Siwalik form are not sufficiently complete to indicate its exact relations to the living species, but there is every probability that the two were more or less intimately allied.

Distribution.—The type specimens and perhaps a part of a maxilla in the Indian and another in the British Museum are the only ones that can be referred to the species[2]; the former were obtained from the Punjab, and the latter from the Siwalik Hills.

Species 3: Cervus sivalensis, *nobis.*

History.—In the original description of *Cervus triplidens*[3] it was stated that two lower molars of a *Cervus* figured in vol. I., pl. VIII., fig. 5, might possibly belong to that species; but it was stated in the preface to the same volume[4] that this conjectural reference was incorrect, and the name *C. sivalensis* was proposed for the species to which the lower teeth belonged; this name having been subsequently quoted in a list of Siwalik mammals.[5]

Upper molars.—As the previous species have been determined from the characters of the upper molars, it is desirable that the same should be done with the present species, and accordingly two upper molars have been taken as the type, which are so similar to the above-mentioned lower molars that they evidently belonged to a closely allied, if not specifically identical form. These two teeth, the least worn of which is represented in the accompanying woodcut (fig. 8), are implanted in a fragment of the left maxilla, from the Siwalik Hills, presented to the British Museum by Mr. C. Falconer. The 'necks' of the two teeth are placed on the same line, which indicates a more 'brachydont' form than either of the two preceding species; but the much-worn condition of the present teeth forbids a more exact comparison in this respect. The present teeth are also distinguished by the more rugose character of their enamel, which approaches that of the giraffe; and by the presence of a distinct cingulum.

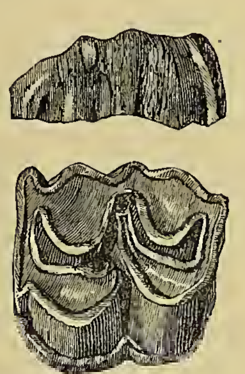


Fig. 8. *Cervus sivalensis*, *nobis*. Last left upper true molar; from the Siwalik Hills. British Museum (No 48,440).

1 'Nouv. Arch. d. Mus.,' Bulletin, vol II., p. 27 (1866). The teeth figured are very much worn: a skeleton in the British Museum shows them in an early condition of wear.

2 In the original description mention is made of part of a mandible: this, however, belongs to another species.

3 Vol. I, p. 68.

4 Page xvii.: the name *C. simplicidens* is erroneously given in place of *C. triplidens*.

5 "Records," vol. XVI., p. 83 (1883).

In size these teeth agree very closely with those of *C. duvaucelli*; and they also agree in the contour of their outer surface, and in the flatness of their masticating surface[1]; but differ by the more rugose enamel, the distinct cingulum, and the smaller size of the accessory inner column.

Lower molars.—The lower molars mentioned above are represented in vol. I., pl. VIII., fig. 5: they are the two last teeth of the right side, in a well-worn condition, and were obtained from the Siwaliks of the Punjab. They agree with the upper molars in their short crowns, rugose enamel, size, and the flatness of the masticating surface of the crown when well worn ($\overline{m.2}$).

Affinities.—The present specimens are insufficient to determine the full affinities of the species to which they belonged; and as the writer has not an opportunity of comparing them with the teeth of all species of the genus their specific distinctness cannot be insisted on; so that the name *C. sivalensis* must be regarded as provisional. Their interest lies in the fact of their proving the existence of a third species of Siwalik deer, and thus showing that the group was strongly represented in that period.[2]

Distribution.—The remains noticed above were obtained from the Siwalik Hills and the Punjab.

Synopsis of Siwalik and Narbada Mammalia.

Introductory.—The present synopsis includes all the specifically named mammals from the Siwaliks and Narbadas (together with *Rhinoceros deccanensis*), and the best defined of the unnamed forms.

The hope expressed in Prof. Flower's recently published Catalogue of the Mammalia in the Museum of the Royal College of Surgeons[3] that the generic and specific names therein employed might receive general adoption has induced the present writer to follow in the main that nomenclature; and it has accordingly been necessary to change some of the names employed in the earlier parts of this work. The use of subgeneric names has been entirely abolished; and the writer desires that the names given in the synopsis should be adopted for the future. The reference to each genus indicates the passage in which it was originally named; and in the case of species the first reference indicates the first publication of the name, and the second the place where a fuller description is given: in cases where the naming of a species is coincident with its description but one reference is given. The generic references are in many cases given on the authority of Prof. Flower.

1 The molars of the sambar (*C. aristotelis*, Cuv) are slightly larger, and are readily distinguished by the concavity of the middle part of the outer surface of each lobe. Those of *C. kashmirianus*, Falc. (which agree very closely with those of *C. elaphus* and *C. canadensis*) are of the same size, but have the costæ less deeply marked, and the worn masticating surface thrown into deep ridges and grooves.

2 An imperfect Siwalik cranium in the British Museum (No. 39,590) possibly indicates a fourth species of *Cervus*. The molars are brachydont, and are smaller than those of *C. sivalensis*. A fragment of a mandible in the same collection corresponds in size with this cranium.

3 London, 1884.

The approximate distribution in time of each species is given (as far as it can be determined); but for the distribution in space the reader must refer to the descriptions. In cases where the term 'Siwalik' is used it implies the upper Siwaliks; but in many cases it not improbably includes a part of the lower Siwaliks. The sequence of the orders is that adopted by Prof. Flower in the 'Proc. Zool. Soc.,' 1883[1], with the exception that the series is arranged from the highest to the lowest.

The dates have been gone through with great care, and in some cases amendments have been made on those previously given. Some emendations have also been made in the authorities for certain species.

CLASS **Mammalia.**

ORDER **Primates.**

SUB-ORDER ANTHROPOIDEA.

FAMILY *SIMIIDÆ.*

Genus PALÆOPITHECUS, Lyd.

'Rec. Geol. Surv. Ind.,' vol. XII., p. 33, (1879).

PALÆOPITHECUS SIVALENSIS, Lyd.

'Rec. Geol. Surv. Ind.,' vol. XII., p. 33, (1879).
Siwalik.

FAMILY *CERCOPITHECIDÆ.*

Genus SEMNOPITHECUS, F. Cuv.

"Hist. Nat. des Mammifères," (1821), (*Semnopithèque*).

SEMNOPITHECUS PALÆINDICUS, Lyd.[2]

The name is applied here for the first time.
"Palæontological Memoirs," vol. I., pl. XXIV., figs. 5, 6, 7, 8.
Siwalik.

Genus MACACUS, Desm.

"Mammalogie" p. 63 (1820).

MACACUS SIVALENSIS, Lyd.

'Rec. Geol. Surv. Ind.,' vol. XI., p. 70, (1878).
Siwalik.

Genus CYNOCEPHALUS, Lacépède.

"Nouv. Tab. Meth." (1799), in 'Mem. d. l'Institute,' vol. III., p. 490 (1801).

CYNOCEPHALUS SUBHIMALAYANUS, (H. Meyer).

Syn. *Semnopithecus subhimalayanus*, H. Meyer.

In Bronn's "Index Palæontologicus," p. 1133, (1848).
"Palæontological Memoirs," vol. I., pl. XXIV., figs. 1, 2
Siwalik.

CYNOCEPHALUS sp. Lyd.

"Palæontological Memoirs," vol. I., pl. XXIV. figs. 3, 4.
Siwalik.

ORDER **Carnivora.**

SUB-ORDER **Carnivora Vera.**

FAMILY *FELIDÆ.*

Genus MACHÆRODUS, Kaup.

"Oss. Foss. de Darmstadt," pt. 2, p. 24 (1833) (*Machairodus*).

MACHÆRODUS SIVALENSIS, (Falc. and Caut.)

Syn. *Drepanodon sivalensis*, Falc. and Caut.

"Palæontological Memoirs," vol. I., p. 550 (1868).
Supra. vol. II., p. 334.
Siwalik.

MACHÆRODUS PALÆINDICUS, Bose.

'Quart. Journ. Geol. Soc.,' vol. XXXVI., p. 125 (1880).
Supra, vol. II., p. 341.
Siwalik.

Genus FELIS,[3] Linn.

"Syst. Nat.," ed. 12, vol. I., p. 61 (1766).

1 Page 178.

2 The reasons for assigning this form to *Semnopitheeus*, and the two succeeding forms to *Cynocephalus* will be given in the forthcoming Catalogue of the Fossil Mammalia in the British Museum, by the present writer.

3 A large unnamed feline occurs in the Narbadas; *vide supra*, vol. II., p. 346.

FELIS CRISTATA, Falc. and Caut.

Syn. *F. grandicristata*, Bose.

"Asiatic Researches," vol. XIX., p. 135 (1836).
Supra, vol. II., p. 320.
Siwalik.

FELIS (? CYNÆLURUS) BRACHYGNATHUS, Lyd.

Supra, vol. II., p. 326, (1884).
Siwalik.

FELIS, sp. Lyd. (allied to *F. pardus*).

Supra, vol. II., p. 328 (1884).
Siwalik.

FELIS, sp., Lyd. (allied to *F. lynx*).

Supra, vol. II., p. 329 (1884).
Siwalik.

FELIS SUBHIMALAYANA, Bronn.

In Bronn's "Index Palæontologicus," p. 492 (1848).
Supra, vol. II., p. 330.
Siwalik.

Genus ÆLUROGALE, Filhol.

'Bibliothéque des Hautes Etudes,' vol. XVI., p. 39 (1877).

ÆLUROGALE SIVALENSIS, Lyd.

Syn. *Pseudœlurus sivalensis*, Lyd.

'Rec. Geol. Surv. Ind.,' vol. X., p. 83 (1877).
Supra, vol. II., p. 317.
Siwalik.

Genus ÆLUROPSIS, Lyd.

Supra, vol. II., p. 316 (1884).

ÆLUROPSIS ANNECTANS, Lyd.

Supra, vol. II., p. 316 (1884).
Siwalik.

FAMILY *HYÆNIDÆ*.

Genus HYÆNA, Zimm.[1]

"Specimen Zoologiœ Geographicæ," p. 365 (1777).

HYÆNA FELINA, Bose.

"Quart. Journ. Geol. Soc.,' vol. XXXVI., p. 130 (1880).
Supra, vol, II., p. 278.
Siwalik.

HYÆNA COLVINI, Lyd.

Supra, vol. II., p. 290 (1884).
Siwalik.

HYÆNA SIVALENSIS, Bose.[2]

'Quart. Journ. Geol. Soc.,' vol. XXXVI., p. 128 (1880).
Supra, vol. II., p. 303.
Siwalik.

HYÆNA MACROSTOMA, Lyd.

Supra, vol. II., p. 298 (1884).
Siwalik.

HYÆNA, sp., Lyd.

Supra, vol. II., p. 309.
Siwalik.

Genus LEPTHYÆNA, Lyd.

Supra, vol. II., p. 312 (1884).

LEPTHYÆNA SIVALENSIS, Lyd.

Syn. *Ictitherium sivalense*, Lyd.

'Rec. Geol. Surv. Ind.,' vol. X., p. 32 (1877).
Supra, vol. II., p. 312.
Siwalik.

FAMILY *VIVERRIDÆ*.

Genus VIVERRA, Linn.

"Syst. Nat.," ed. 12, vol. I., p. 63 (1766).

VIVERRA BAKERI, Bose.

"Quart. Journ. Geol. Soc.,' vol. XXXVI., p. 131 (1880.)
Supra, vol. II., p. 268.
Siwalik.

VIVERRA DURANDI, Lyd.

Supra, vol. II., p. 271 (1884).
Siwalik.

FAMILY *URSIDÆ*.

SUB-FAMILY *CANINÆ*.

Genus CANIS, Linn.

"Syst. Nat.," ed. 12, vol. I., p. 56, (1766).

CANIS CAUTLEYI, Bose.

'Quart. Journ. Geol. Soc.' vol. XXXVI., p. 135 (1880).
Supra, vol. II., p. 259.
Siwalik.

1 Given in vol. II. with the pre-Linnean authority of Brisson.

2 The name *H. sivalensis*, Falc. and Caut., also occurs; but it has been advisable that it should be dropped.

CANIS CURVIPALATUS, Bose.

'Quart. Journ. Geol. Soc.,' vol. XXXVI., p. 134 (1880).
Supra, vol. II., p. 253.
Siwalik.

Genus AMPHICYON, Lartet.

'Comptes Rendus,' vol. V., p. 424 (1837).

AMPHICYON PALÆINDICUS, Lyd.

Supra, vol. I., p. 84 (1876).
Ibid., vol. II., p. 248.
Low. (and ? up.) Siwalik.

SUB-FAMILY *URSINÆ.*

Genus HYÆNARCTOS, Falc. and Caut.

In Owen's "Odontography," p. 505 (1840-45).

HYÆNARCTOS PALÆINDICUS, Lyd.

'Rec. Geol. Surv. Ind.,' vol. XI., p. 104 (1878).
Supra, vol. II., p. 232.
Siwalik.

HYÆNARCTOS PUNJABIENSIS, Lyd.

Supra, vol. II., p. 226 (1884)
Siwalik.

HYÆNARCTOS SIVALENSIS, Falc. and Caut.

Syn. *Ursus sivalensis*, Falc. and Caut.

'Asiatic Researches,' vol. XIX., p. 193 (1836).
Siwalik.

Genus URSUS, Linn.

"Syst. Nat.," ed. 12, vol. I., p. 69 (1766).

URSUS NAMADICUS, Falc. and Caut.

"Palæontological Memoirs," vol. I., p. 552 (1868).
Supra, vol. II. p. 216.
Narbada.

URSUS THEOBALDI, Lyd.

Supra, vol. II., p. 211, (1884).
Siwalik.

FAMILY *MUSTELIDÆ.*

Genus MUSTELA, Linn.

"Syst. Nat.," ed. 12, vol. I p. 66 (1766).

MUSTELA, sp., Lyd.

"Catalogue of Fossil Mammalia in British Museum" (*in preparation*).
Siwalik.

Genus MELLIVORA, Storr.

"Prodromus Method Mam.," p. 34 (1780).

MELLIVORA SIVALENSIS, (Falc. and Caut.)

Syn. *Ursitaxus sivalensis*, Falc. and Caut.

"Palæontological Memoirs," vol. I., p. 553 (1868).
Supra, vol. II., p. 180.
Siwalik.

MELLIVORA PUNJABIENSIS, Lyd.

Supra, vol. II., p. 183 (1884).
Siwalik.

Genus MELLIVORODON, Lyd.

Supra, vol. II., p. 185 (1884).

MELLIVORODON PALÆINDICUS, Lyd.

Supra, vol. II., p. 185 (1884).
Siwalik

Genus LUTRA, Erxl. (*ex* Ray).

"Syst. Regn. Animal," p. 445 (1777).

LUTRA PALÆINDICA, Falc. and Caut.

"Palæontological Memoirs," vol. I., pl. XXVII (1868).
Supra, vol. II., p. 190.
Siwalik.

LUTRA BATHYGNATHUS, Lyd.

Supra. vol. II., p. 193 (1884).
Siwalik.

LUTRA SIVALENSIS, (Falc. and Caut.)

Syn. *Enhydriodon sivalensis*, Falc. and Caut.

"Palæontological Memoirs," vol. I., p. 552 (1868).
Supra, vol. II., pp. 195, 351.
Siwalik.

FAMILY *HYÆNODONTIDÆ.*

Genus HYÆNODON, Laizer and Parieu.

'Comptes Rendus,' vol. VII., p. 442 (1838).

HYÆNODON INDICUS, Lyd.

Supra, vol. II., p. 348 (1884).
Siwalik.

ORDER Rodentia.

SUB-ORDER Simplicidentata.

FAMILY *MURIDÆ.*

Genus MUS, Linn.

" Syst. Nat.," ed. 12, vol. I., p. 83 (1766).

MUS (?) sp., Falc. and Caut.

'Journ. As. Soc. Beng.,' vol. IV., p. 706 (1835).
A fragment of a mandible with $\overline{m.\ 1}$ in the British Museum[1] (No. 16,529a) belongs to this or an allied genus: it is about equal in size to the mandible of *Cricetus frumentarius*.
Siwalik.

FAMILY *SPALACIDÆ.*

Genus RHIZOMYS, Gray.

' Proc. Zool. Soc.,' 1831, p. 95.

RHIZOMYS SIVALENSIS, Lyd.

Syn. (?) *Typhlodon*, Falc.

'Rec. Geol. Surv. Ind.,' vol. XI., p. 101 (1878).
Supra, vol. III., p. 106.
Siwalik.

FAMILY *HYSTRICIDÆ.*

Genus HYSTRIX, Linn.

" Syst. Nat.,'" ed. 12, vol. I., p. 76 (1766).

HYSTRIX SIVALENSIS, Lyd.

' Rec. Geol. Surv. Ind.,' vol. XI., p. 100 (1878).
Supra, vol. III., p. 109.
Siwalik.

SUB-ORDER Duplicidentata.

FAMILY *LEPORIDÆ.*

Genus LEPUS, Linn.

" Syst. Nat.," ed. 12, vol. I., p. 77 (1766).

A minute fragment of a mandible in the British Museum (No. 16,529) belongs to this genus.
Siwalik.

ORDER Ungulata.

SUB-ORDER Artiodactyla.

Section RUMINANTIA.

FAMILY *BOVIDÆ.*

Genus BOS, Linn.

" Syst. Nat.,' ed. 12, vol. I., p. 98 (1766).

BOS NAMADICUS, Falc.

" Catalogue of Fossil Vertebrata of Asiatic Society of Bengal," p. 232 (1859).
Supra, vol. I., p. 95.
Narbada.

BOS ACUTIFRONS, Lyd.

' Rec. Geol. Surv. Ind.,' vol. X., p. 30 (1877).
Supra, vol. I., pp. 112, 173.
Siwalik.

BOS PLANIFRONS, Lyd.

' Rec. Geol. Surv. Ind.,. vol. X., p. 30 (1877).
Supra, vol. I., pp. 109, 173.
Siwalik.

BOS PLATYRHINUS, Lyd.

Supra, vol. I., p. 119 (1878).
Siwalik.
(The distinctness of this form is somewhat doubtful.)

Genus BISON, H. Smith.

In Griffith's "Animal Kingdom," vol. V., p. 373 (1827).

BISON SIVALENSIS (Falc.).

Syn. *Bos sivalensis*, Falc.

"Palæontological Memoirs," vol. I., p. 555 (1868)
Supra, vol. I., p. 122. (The specimen described is identified with Falconer's specimen on the evidence of a drawing in the British Museum.)
Siwalik.

Genus BUBALUS, Hamilton Smith.

In Griffith's "Animal Kingdom," vol. V., p. 371 (1827).

BUBALUS PALÆINDICUS (Falc.).

Bos palæindicus, Falc.

" Catalogue of Fossil Vertebrata of Asiatic Society of Bengal," p. 230 (1859).
Supra, vol. I., p. 132.
Narbada, and highest Siwalik.

BUBALUS PLATYCEROS, Lyd.

Syn. *Bubalus sivalensis*, Rüt.

' Rec. Geol. Surv. Ind.,' vol. X., p. 31 (1877).
Supra, vol. I., pp. 127, 173.
Siwalik.

[1] This specimen, as well as the one referred to *Lepus*, did not come under the writer's notice until the memoir on rodents was printed.

Genus HEMIBOS,[1] Falc. and Caut.

Syn. *Amphibos*, Falc. and Caut.; *Peribos*, Lyd.; *Probubalus*, Rüt.

"Palæontological Memoirs," vol. I., p. 546 (1868).
Supra, vol. I., pp. 145, 174.

Hemibos occipitalis (Falc.).

Syn. *Bos occipitalis*, Falc. *Hemibos, triquetriceros*, Falc. and Caut. *Peribos occipitalis*, Lyd. *Probubalus triquetricornis*, Rüt.

"Palæontological Memoirs," vol. I., p. 280 (1868).
Supra, vol. I., pp. 141, 174.
Siwalik.

Hemibos acuticornis (Falc. and Caut.).

Syn. *Amphibos acuticornis*, Falc. and Caut.

"Palæontological Memoirs," vol. I., p. 547 (1868).
Supra, vol. I., p. 176.
Siwalik.

Hemibos antilopinus (Falc. and Caut.).

Syn. *Amphibos antilopinus*, Falc. and Caut. *Probubalus antilopinus*, Rüt.

"Palæontological Memoirs," vol. I., p. 280 (1868).
"Die Rinder der Tertiär-Epoche," p. 135, in "Abh. Schweiz. pal. Gesel," vol. V. (1878).
Siwalik.

Genus LEPTOBOS, Rüt. (*ex* Falc., MSS.)

"Die Rinder der Tertiär-Epoche," p. 157, in 'Abh. Schweiz. pal. Gesel,' vol. V. (1878).

Leptobos falconeri, Rüt.

"Die Rinder der Tertiär-Epoche," p. 157, in 'Abh. Schweiz. pal. Gesel,' vol. V. (1878).
Siwalik.

Leptobos frazeri, Rüt.

"Die Rinder der Tertiär-Epoche," p. 165, in 'Abh. Schweiz. pal. Gesel,' vol. V. (1878).
Narbada.

Genus BUCAPRA, Rüt.

"Die Rinder der Tertiär-Epoche," p. 105, in 'Abh. Schweiz. pal. Gesel,' vol. V. (1878).

Bucapra daviesi, Rüt.

"Die Rinder der Tertiär-Epoche," p. 105, in 'Abh. Schweiz. pal. Gesel,' vol. V. (1878).
Siwalik.

Genus CAPRA, Linn.

"Syst. Nat.,' ed. 12, vol. I., p. 94 (1766).

Capra sivalensis, Lyd.

Supra, vol. I., p. 169 (1878).
Siwalik.

Capra perimensis, Lyd.

Supra, vol. I., p. 170 (1878).
Siwalik.

Capra, sp., Lyd.

Supra, vol. I., p. 171 (1878).
Siwalik.

Genus OREAS, Desmarest.

"Mammalogie," p. 471 (1822).

Oreas (?) latidens, Lyd.

Syn. *Cervus latidens*, Lyd.

Supra, vol. I., p. 65 (1876).
Ibid, vol. III., p. 111.
Siwalik.

Genus PALÆORYX, Gaudry.

'Comptes Rendus,' vol. LII., p. 238 (1861).

Palæoryx (?) sp., Lyd.

Supra, vol. III., p. 114 (1884).
Siwalik.

Genus BOSELAPHUS, Blainville.

Syn. *Portax*, H. Smith.

'Bull. Soc. Philom. Paris,' 1816, p. 75.

Boselaphus namadicus (Rüt.).

Syn. *Portax namadicus*, Rüt.

"Die Rinder der Tertiär-Epoche," p. 89 in 'Abh. Schweiz. pal. Gesel," vol. V. (1878).
Narbada.

Boselaphus, sp., Lyd.

Supra, vol. III., p. 114 (1884).
Siwalik.

Genus GAZELLA, Blainville.

'Bull. Soc. Philom. Paris,' 1816, p. 75,

[1] Rütimeyer considers the type species generically identical with the anoa, which Flower includes in *Bubalus*: it is, therefore, not improbable that *Hemibos* should be merged in that genus.

GAZELLA PORRECTICORNIS, Lyd.

Syn. *Antilope porrecticornis*, Lyd.

Supra. vol. I., p. 158 (1878).
Siwalik.

Genus ANTILOPE, Pallas.

"Spicilegia Zoologica," vol. I., p. 3 (1767).

ANTILOPE SIVALENSIS, Lyd.

Supra, vol. I., p. 154 (1878).
Siwalik.

ANTILOPE (?) PATULICORNIS, Lyd.

Supra, vol. I., p. 157 (1878).
Siwalik.

Genus ALCELAPHUS, Blainville.

'Bull. Soc. Philom. Paris,' 1816, p. 75.

ALCELAPHUS PALÆINDICUS (Falc.)

Syn. *Antilope palæindica*, Falc.

"Catalogue of Fossil Vertebrata of Asiatic Society of Bengal," p. 154 (1859).
"Palæontological Memors," vol. I., pl. XXIII.
Supra, vol. III., p. 117.
Siwalik.

FAMILY *GIRAFFIDÆ*.

Syn. *Camelopardalidæ*.

Genus SIVATHERIUM, Falc. and Caut.

'Asiatic Researches,' vol. XIX., p. 1 (1836).

SIVATHERIUM GIGANTEUM, Falc. and Caut.

'Asiatic Researches,' vol. XIX., p. 1 (1836).
Supra, vol. II., p. 131.
Siwalik.

Genus BRAMATHERIUM, Falc.

'Quart. Journ. Geol. Soc.,' vol. I., p. 363 (1845).

BRAMATHERIUM PERIMENSE, Falconer.

'Quart. Journ. Geol. Soc.,' vol. I., p. 365 (1845).
Supra, vol. II., p. 130.
Siwalik.

Genus HYDASPITHERIUM, Lyd.

'Rec. Geol. Surv. Ind.,' vol. IX., p. 154 (1876). (*Hydaspidotherium*).

HYDASPITHERIUM MEGACEPHALUM, Lyd.

'Rec. Geol. Surv. Ind.,' vol. IX., p. 154 (1876).
Supra, vol. I., p. 159, vol. II, p. 118.
Siwalik.

HYDASPITHERIUM GRANDE, Lyd.

'Rec. Geol. Surv. Ind.,' vol. XI., p. 91 (1878).
Supra, vol. II., p. 126.
Siwalik.

Genus HELLADOTHERIUM, Gaudry.

'Comptes Rendus,' vol. LI, p. 802 (1860).

HELLADOTHERIUM DUVERNOYI (Gaud. & Lart.)

Syn. *Camelopardalis duvernoyi*, Gaud. & Lart.

'Comptes Rendus,' vol. XLIII., p. 271 (1856).
Supra, vol. II., p. 116.
Siwalik, and Pikermi beds.

Genus VISHNUTHERIUM, Lyd.

'Rec. Geol. Surv. Ind.,' vol. IX., p. 103 (1876).

VISHNUTHERIUM IRAVADICUM, Lyd.

'Rec. Geol. Surv. Ind.,' vol. IX., p. 103 (1876).
Supra, vol. I., p. 55, vol. II., p. 112.
Siwalik.

Genus GIRAFFA, Zimmermann.

Syn. *Camelopardalis*,[1] Gmelin (1788).

"Geograph. Geschicte," vol. II., p. 125 (1780).

GIRAFFA SIVALENSIS (Falc. and Caut.).

Syn. *Camelopardalis sivalensis*, Falc. & Caut.
Camelopardalis affinis, Falc. & Caut.

'Proc. Geol. Soc.,' vol. IV., p. 244 (1843).
Supra, vol. II., p. 103.
Siwalik.

FAMILY *CERVIDÆ*.

Genus PROPALÆOMERYX, Lyd.

Supra, vol. II., p. 173 (1883).

PROPALÆOMERYX SIVALENSIS, Lyd.

Supra, vol. II., p. 173 (1883).
Siwalik.

1 Wrongly authenticated in vol. II.

Genus MOSCHUS, Linn.

" Syst. Nat.," ed. 12, vol. I., p. 91 (1766).

Moschus (?) sp., Lyd.

Supra, vol. III., p. 118 (1884).
Siwalik.

Genus CERVUS,[1] Linn.

" Syst. Nat.," ed. 12, vol. I., p. 92 (1766).

Cervus triplidens, Lyd.

Supra, vol. I., p. 67 (1876).
Ibid, vol. III., p. 120.
Siwalik.

Cervus simplicidens, Lyd.

Supra, vol. I., p. 69 (1876).
Ibid, vol. III., p. 119.
Siwalik.

Cervus sivalensis, Lyd.

Supra, vol. I., p. xvii. (1880).
Ibid, vol. III., p. 121.
Siwalik.

Cervus, sp.

'Rec. Geol. Surv. Ind.,' vol. XVI., p. 79 (1883).
(? *Cervus duvaucelli*, Cuv.)
Narbada.

Family *TRAGULIDÆ.*

Genus DORCATHERIUM, Kaup.

Syn. *Hyomoschus*, Gray (*teste* Rüt.).

" Oss. Foss. de Darmstadt," pt. 5, p. 92 (1836).

Dorcatherium majus, Lyd.

Supra, vol. I., p. 62 (1876).
Siwalik.

Dorcatherium minus, Lyd.

Supra, vol. I., p. 64 (1876).
Siwalik.

Genus TRAGULUS, Pallas (*ex* Brisson).

" Spicilegia Zoologica," vol. XIII., p. 27 (1779).

Tragulus sivalensis, Lyd.

'Rec. Geol. Surv. Ind.,' vol. XV., p. 30 (1882).
Supra, vol. III., p. 117.
Siwalik.

Family *CAMELIDÆ.*

Genus CAMELUS, Linn.

" Syst. Nat.," ed. 12, vol. I., p. 90 (1766).

Camelus sivalensis, Falc. and Caut.

'Asiatic Researches,'[2] vol. XIX., p. 120 (1836).
Supra, vol. I., p. 61.
Siwalik.

Section SUINA.

Sub-Section *SELENODONTIA.*

Family *MERYCOPOTAMIDÆ.*

Genus MERYCOPOTAMUS, Falc. & Caut.

" Fauna Antiqua Sivalensis," pt. 7, pl. LXII. (1847).

Merycopotamus dissimilis, Falc. & Caut.

Syn. *Hippopotamus dissimilis*, Falc. and Caut.
Merycopotamus sivalensis, Falc. and Caut.

'Asiatic Researches,' vol. XIX., p. 51 (1836).
Supra, vol. II., p. 164.
Siwalik.

Genus CHÆROMERYX, Pomel.

'Comptes Rendus,' vol. XXVI., p. 687 (1848).

Chæromeryx silistrensis (Pentland).

Syn. *Anthracotherium silistrense*, Pent. (*in parte*)

'Trans. Geol. Soc.,' ser. 2, vol. II., p. 394 (1828).
Supra, vol. II., p. 166.
Siwalik.

Genus HEMIMERYX, Lyd.

'Rec. Geol. Surv. Ind.,' vol. XI., p. 80 (1878).

Hemimeryx blanfordi, Lyd.

Supra, vol. II., p. 167 (1883).
Lower Siwalik.

Genus SIVAMERYX, Lyd.

'Rec. Geol. Surv. Ind.,' vol. XI., p. 80 (1878).

[1] This generic term is employed in a wide sense.
[2] A second species was named *C. antiquus* in this memoir, but cannot now be identified.

Sivameryx sindiensis, Lyd.

'Rec. Geol. Surv. Ind.,' vol. XI., p. 80 (1878).
Supra, vol. II., p. 169.
Lower Siwalik.

Family *OREODONTIDÆ.*

Genus AGRIOCHŒRUS, Leidy.

'Proc. Ac. Nat. Sci. Philad.,' vol. V., p. 121 (1850).

Agriochœrus (?) sp., Lyd.

Supra, vol. II., p. 171 (1883).
Lower Siwalik.

Family *ANTHRACOTHERIIDÆ*

Genus HYOPOTAMUS, Owen.

Syn. *Ancodus*, Pom. *Bothriodon*, Aymard. *Cyclognathus*, Croizet. *Tapinodon*, Meyer.

'Quart. Journ. Geol. Soc.,' vol. IV., p. 103 (1848).[1]

Hyopotamus palæindicus, Lyd.

'Rec. Geol. Surv. Ind.,' vol. X., p. 77 (1877).
Supra, vol. II., p. 158.
Lower Siwalik.

Hyopotamus giganteus, Lyd.

Supra, vol. II., p. 160 (1883).
Lower Siwalik.

Genus ANTHRACOTHERIUM, Cuv.

"Ossemens Fossiles," 2nd ed., vol. III., p. 396 (1822).

Anthracotherium hyopotamoides, Lyd.

Supra, vol. II., p. 152 (1883).
Lower Siwalik.

Anthracotherium silistrense, Pentland.

Syn. *A. punjabiense*, Lyd.

'Trans. Geol. Soc.,' ser. 2, vol. II., p. 394 (1828).
Supra, vol. II., p. 149.
Lower and (?) upper Siwalik.

Sub-Section *BUNODONTIA.*

Family *ENTELODONTIDÆ.*

Genus TETRACONODON, Falc.

"Palæontological Memoirs," vol. I., p. 156 (1868)

Tetraconodon magnus, Falc.

"Palæontological Memoirs," vol. I., p. 156 (1868).
Supra, vol. I., p. 79, vol. III., p. 99.
Siwalik.

Family *SUIDÆ.*

Genus HYOTHERIUM, H. von Meyer.

"Die fossile Zahne und Knochen von Georgensmünd," p. 43 (1834).

Hyotherium sindiense, Lyd.

'Rec. Geol. Surv. Ind.,' vol. XI., p. 77 (1878).
Supra, vol. III., p. 95.
Lower Siwalik.

Hyotherium, sp., Lyd.

Supra, vol. III., p. 97 (1884).
Siwalik.

Genus SANITHERIUM, H. von Meyer.

"Palæontographica," vol. XV., p. 15 (1865).

Sanitherium schlagintweiti, H. von Meyer.

Syn. *Sus pusillus*, Falc.

"Palæontographica," vol. XV., p. 15 (1865).
Supra, vol. I., p. 76, vol. III, p. 91.
Siwalik.

Genus HIPPOHYUS, Falc. and Caut.

In Owen's "Odontography," p. 562 (1840-5).

Hippohyus sivalensis, Falc. and Caut.

In Owen's "Odontography," p. 562 (1840-5).
Supra, vol. III., p. 85.
Siwalik.

Genus SUS, Linn.

"Syst. Nat.," ed. 12, vol. I., p. 102 (1766).

Sus giganteus,[2] Falc. and Caut.

"Fauna Antiqua Sivalensis," pt. 8, pl. LXIX. (1847).
Supra, vol. III.. p. 52.
Siwalik.

1 This paper was read November, 1847, which may stand as the date of the genus.

2 Prof. Forsyth-Major ('Quart. Journ. Geol. Soc.,' 1884) is inclined to unite *S. strozzi*, Meneghini, with this species. This identification was made before the publication of the writer's description of *S. giganteus*. The meagre description of *S. strozzi* available to the writer induced him to regard that species as smaller than *S. giganteus*. Should the two be identical, the latter name should stand; the first mention of *S. strozzi* being apparently by Forsyth-Major in 'Atti. Soc. Tosc. Sci. Nat.,' vol. I., p. 39 (1875).

Sus titan, Lyd.

Supra, vol. III., p. 59 (1884).
Siwalik.

Sus falconeri, Lyd.

Supra, vol. III., p. 66 (1884).
Siwalik.

Sus hysudricus, Falc. and Caut.

"Fauna Antiqua Sivalensis," pt. 8, pl. LXX. (1847).
Supra, vol. III., p. 77.
Upper and lower Siwalik.

Sus punjabiensis, Lyd.

'Rec. Geol. Surv. Ind.,. vol. XI., p. 81 (1878).
Supra, vol. III., p. 82.
Siwalik.

Sus, sp., Lyd.

Supra, vol. III., p. 85 (1884).
Narbada.

Family *HIPPOPOTAMIDÆ.*

Genus HIPPOPOTAMUS, Linn.

Including *Hexaprotodon* and *Tetraprotodon*, Falc. and Caut.

"Syst. Nat.," ed. 12, vol. I., p. 101 (1766).

Hippopotamus palæindicus, Falc. & Caut.

"Fauna Antiqua Sivalensis," pt. 7, pl. LVII. (1847).
Supra, vol. III., p. 44.
Narbada.

Hippopotamus namadicus, Falc. and Caut.

"Fauna Antiqua Sivalensis," pt. 7, pl. LVII. (1847).
Supra, vol. III., p. 43.
Narbada.

Hippopotamus sivalensis, Falc. and Caut.

'Asiatic Researches,' vol. XIX., p. 40 (1836).
Supra, vol. III., p. 37.
Siwalik.

Hippopotamus iravaticus, Falc. and Caut.

"Fauna Antiqua Sivalensis," pt. 7, pl. LVII. (1847).
Supra, vol. III., p. 42.
Siwalik.

Family *LISTRIODONTIDÆ.*

Genus LISTRIODON, H. von Meyer.

'Neues Jahrb.,' 1846, p. 466.

Listriodon pentapotamiæ (Falc.).

Syn. *Tapirus pentapotamiæ*, Falc.

"Palæontological Memoirs," vol. I., p. 415 (1868).
Supra, vol. III., p. 101.
Siwalik.

Listriodon theobaldi, Lyd.

'Rec. Geol. Surv. Ind.,' vol. XI., p. 98 (1878).
Supra, vol. III., p. 102.
Siwalik.

Sub-Order Perissodactyla.

Family *EQUIDÆ.*

Genus EQUUS, Linn.

"Syst. Nat.," ed. 12, vol. I., p. 100 (1766).

Equus sivalensis,[1] Falc. and Caut.

"Fauna Antiqua Sivalensis," pt. 9, pl. LXXXI. (1849).
Supra, vol. II., p. 87.
Siwalik.

Equus namadicus, Falc. and Caut.

Syn. *E. palæonus*, Falc. and Caut.

"Fauna Antiqua Sivalensis," pt. 9, pl. LXXXI. (1849).
Supra, vol. II., p. 92.
Siwalik and Narbada.

Genus HIPPARION,[2] Christol.

Syn. *Hippotherium*, Kaup.

'Ann. Sci. et Industrie d. Midi d. l. France,' vol. I., p. 180 (1832), *teste* Gervais.

[1] Prof. Forsyth Major ('Quart. Journ. Geol. Soc.,' 1884) is inclined to identify *E. stenonis*, Cocchi, with this species. Should this be correct, the name *E. stenonis* must be abolished, since it only dates from 1867 ('Mem. Soc. Ital. Sci. Nat.,' vol. II., art. 7, p. 14.)

[2] Prof. Flower places this genus in the family *Palæotheriidæ*.

HIPPARION ANTILOPINUM (Falc. and Caut.).
Syn. *Hippotherium antilopinum*, Falc. & Caut.

"Fauna Antiqua Sivalensis," pt. 9, pl. LXXXII. (1849).
Supra, vol. II., p. 75, vol. III., p. 11.
Siwalik.

HIPPARION THEOBALDI, Lyd.

Syn. *Sivalhippus theobaldi*, Lyd.
Hippotherium theobaldi, Lyd.

'Rec. Geol. Surv. Ind.,' vol. X., p. 31 (1877).
Supra, vol. II., p. 81.
Siwalik.

HIPPARION, sp., Lyd.

Syn. *Hippotherium*, sp., Lyd.
Supra, vol. III., p. 14 (1884).
Siwalik.

FAMILY *RHINOCEROTIDÆ.*

Genus RHINOCEROS, Linn.

"Syst. Nat.,' ed. 12, vol. I., p. 104 (1766).

A. Rhinoceros proper.

RHINOCEROS UNICORNIS, Linn.

Syn. *R. indicus*, Cuv. *R. namadicus*, Lyd. (*non.* F. and C.).

"Syst. Nat.,' ed. 12, vol. I., p. 104 (1766).
Supra, vol. I., pp. viii., 32.
Narbada and Recent.

RHINOCEROS SIVALENSIS, Falc. and Caut.
"Fauna Antiqua Sivalensis," pt. 7, pl. LXXIII. (1847).
Supra, vol. II., p. 28.
Upper and lower Siwalik.

Var. gajensis, Lyd.

Supra, vol. II., p. 40 (1881).
Lower Siwalik.

RHINOCEROS PALÆINDICUS, Falc. and Caut.
"Fauna Antiqua Sivalensis," pt. 7, pl. LXXIII. (1847).
Supra, vol. II., p. 42.
Siwalik.

B. Atelodus, Pomel.

RHINOCEROS DECCANENSIS, Foote.
Supra, vol. I., p. 1 (1874).
Krishna Valley.

RHINOCEROS PLATYRHINUS, Falc. and Caut.
"Fauna Antiqua Sivalensis," pt. 7, pl. LXXII. (1847).
Supra, vol. II., p. 48.
Siwalik.

C. Position uncertain.

RHINOCEROS NAMADICUS, Falc. and Caut.
"Palæontological Memoirs," vol. I., p. 21 (1868).
Supra, vol. I., p. ix.
Narbada.

Genus ACERATHERIUM, Kaup.

'Oken's Isis,' 1832 (*teste* Gervais[1]).

ACERATHERIUM PERIMENSE (Falc. and Caut.).

Syn. *Rhinoceros* (*A.* ?) *perimensis*, Falc. and Caut. *R. planidens*, and *R. iravadicus*, Lyd.

"Fauna Antiqua Sivalensis," pt. 7, pl. LXXV. (1847).
Supra. vol. II., p. 9.
Siwalik.

ACERATHERIUM BLANFORDI, Lyd.

Supra, vol. III., p. 2 (1884).
Lower Siwalik.

FAMILY *CHALICOTHERIIDÆ.*

Genus CHALICOTHERIUM, Kaup.

"Oss. Foss. de Darmstadt," pt. 2, p. 4 (1833).

CHALICOTHERIUM SIVALENSE, Falc. and Caut.
Syn. *Anoplotherium sivalense*, Falc. and Caut.

'Trans. Geol. Soc.,' ser. 2, vol. V., p. 502 (1837).
"Palæontological Memoirs," vol. I., p. 208.
Upper and lower Siwalik.

SUB-ORDER Proboscidea.

FAMILY *ELEPHANTIDÆ.*

Genus ELEPHAS, Linn.

"Syst. Nat.," ed. 12, vol. I. p. 48 (1766).

A. Elephas proper (*Euelephas*, Falc.)

ELEPHAS NAMADICUS,[2] Falc. and Caut.
"Fauna Antiqua Sivalensis," pt. 2, pl. XIII. (1846).
Supra, vol. I., p. 280.
Narbada.

[1] The writer has been unable to verify this reference.

[2] Leith Adams is inclined to identify this species with *E. antiquus*, Falc. and Caut. ("Fauna Antiqua Sivalensis, pt. 3, pl. XII. B. [1847]) : the name *E. namadicus* has the priority, and should, therefore, stand in any case.

ELEPHAS HYSUDRICUS, Falc. and Caut.

"Fauna Antiqua Sivalensis," pt. 1, p. 41, pl. I. (1846).
Supra, vol. I., p. 278.
Siwalik.

B. Loxodon, Falc.

ELEPHAS PLANIFRONS, Falc. and Caut.

"Fauna Antiqua Sivalensis," pt. 1, pl. II. (1846).
Supra, vol. I., p. 275.
Siwalik.

C. Stegodon, Falc.

ELEPHAS INSIGNIS, Falc. and Caut.

Syn. *Mastodon elephantoides*, Clift (*in parte*).
(?) *Stegodon orientalis*, Owen.

"Fauna Antiqua Sivalensis," pt. 1, p. 37, pl. II. (1846).
Supra, vol. I., p. 268.
Siwalik and (?) *Narbada.*

ELEPHAS GANESA, Falc. and Caut.

"Fauna Antiqua Sivalensis," pt. 1, pl. III. (1846).
Supra, vol. I., p. 273.
Siwalik and Narbada.

ELEPHAS BOMBIFRONS, Falc. and Caut.

"Fauna Antiqua Sivalensis," p. 46 (1846).
Supra, vol. I., p. 262.
Siwalik.

ELEPHAS CLIFTI, Falc. and Caut.

Syn. ? *Stegodon sinensis*, Owen.
Mastodon elephantoides, Clift (*in parte*).

"Fauna Antiqua Sivalensis," p. 47 (1846).
Supra, vol. I., p. 256.
Siwalik.

Genus MASTODON, Cuvier.

'Ann. du Mus.,' vol. VIII., p. 270 (1806).

A. Tetralophodont series.

MASTODON SIVALENSIS, Caut.

'Journ. As. Soc. Beng.,' vol. V., p. 294 (1836).
Supra, vol. I., p. 248.
Siwalik.

MASTODON PERIMENSIS, Falc. and Caut.

"Fauna Antiqua Sivalensis," pt. 4, pl. XXXIX. (1847).
Supra, vol. I., p. 239.
Siwalik.

MASTODON LATIDENS, Clift.

'Trans. Geol. Soc.,' ser. 2, vol. II., p. 371 (1828).[1]
Supra, vol. I., p. 227.
Upper and lower Siwalik.

B. Trilophodont series.

MASTODON PANDIONIS, Falc.

'Quart. Journ. Geol. Soc.,' vol. XIII. p. 319 (1857).
Supra, vol. I., pp. 213, 292, vol. III., p. 29.
Upper and lower Siwalik.

MASTODON ANGUSTIDENS, Cuv.

'Ann. du Mus.,' vol. VIII., p. 412 (1806).
(*Mastodonte à dents étroites.*)

Var. palæindicus, Lyd.

Supra, vol. III., p. 19 (1884).
Lower Siwalik.

MASTODON FALCONERI, Lyd.

'Rec. Geol. Surv. Ind.,' vol. X., p. 83 (1877).
Supra, vol. I., p. 202. vol. III., p. 32.
Upper and lower Siwalik.

FAMILY *DINOTHERIIDÆ.*

Genus DINOTHERIUM, Kaup.

'Oken's Isis,' vol. XXII., p. 401 (1829).

DINOTHERIUM INDICUM,[2] Falc.

'Quart. Journ. Geol. Soc.,' vol. I., p. 361 (1845).
Supra, vol. I., p. 192, vol. II., p. 63, vol. III., p. 34.
Upper (?) *and lower Siwalik.*

DINOTHERIUM PENTAPOTAMIÆ, Lyd. (*ex* Falc.).

Syn. *Antoletherium*, Falc.

Supra, vol. I., p. 72 (1876).
Ibid, p. 183, vol. III., p. 34.
Upper (?) *and lower Siwalik.*

DINOTHERIUM SINDIENSE, Lyd.

Supra, vol. II., pp. 196, 292 (1880).
Ibid., vol. III., p. 34.
Upper (?) *and lower Siwalik.*

ORDER Edentata.

SUB-ORDER Squamata.

FAMILY *MANIDÆ.*

Genus MANIS, Linn.

"Syst. Nat.," ed. 12, vol. I., p. 52 (1766).

MANIS SINDIENSIS, Lyd.

Supra, vol. I., p. 82 (1876).
Lower Siwalik.

1 The volume is dated 1829.

2 This and the two next species have been identified by Weinsheimer with *D. giganteum*, Kaup (*vide supra*, vol. III., p. 34). It is not impossible that *D. indicum* and *D. pentapotamiæ* may belong to one species.

NOTE.

A small collection of fossils from Perim Island has lately come into the writer's hands, among which are some teeth of *Mastodon pandionis* and *M. perimensis*, promising to be of considerable interest. They appear to show that the former (although apparently provided with premolars) exhibits signs of affinity with the Pikermi *M. pentelici*; and also that it is not improbable that the tetralophodont *M. perimensis* may have been a branch from the trilophodont stock of *M. pandionis*. There are already signs of the connection of the tetro-pentalophodont *M. sivalensis* with the same original stock.

The writer hopes to describe these specimens, and their bearing on the mutual relations of the Siwalik mastodons, in a later part; and in the meantime is extremely anxious to obtain any additional specimens of the teeth and jaws of the mastodons of Sind and Perim Island.

INDIAN TERTIARY & POST-TERTIARY VERTEBRATA.

SIWALIK BIRDS.

By R. LYDEKKER, B.A., F.G.S., F.Z.S.

(WITH PLATES XIV. AND XV.)

INTRODUCTORY.

Rarity of remains.—In the Siwaliks, as in most ossiferous formations, the remains of birds are extremely few as compared with those of mammals; and such bones as do occur are generally in a fragmentary condition. This rarity is doubtless due to the small size of many birds, and also to the frail structure of the bones themselves,[1] as well as to the circumstance that birds do not become 'mired.' The absence of teeth in ordinary birds is another important element in the case; since our knowledge of many tertiary mammals depends mainly, or entirely, on the evidence afforded by those organs.

Classification.—Considerable difficulty is found in regard to the classification of fossil birds, since the characters on which the recent orders are usually founded are to a great extent external, or are of such a nature as to be inapplicable to fossils; and the different orders do not consequently present the well-marked osteological differences of the Mammalia. Here again the want of the strong diagnostic characters afforded by the teeth of the latter is very strongly felt. In consequence of these wants it is frequently extremely difficult, or impossible, to say whether fossil birds belong to new orders or to those still existing; and it may perhaps be doubted whether it will be found ultimately advisable to retain for palæontological purposes many of the orders into which existing birds are divided. For the present, as a provisional arrangement, the writer has in the main adopted the classification given by Mr. Sclater in the "List of the Animals in the Gardens of the Zoological Society"[2]: the terms Carinatæ and Ratitæ, which are extremely convenient for

[1] This does not apply to the struthious birds.

[2] 8th ed., London, 1883.

palæontological purposes, have, however, been added as divisions of the value of a sub-class: and the orders of the struthious birds have been suppressed as being palæontologically inapplicable. The generic terms adopted by Mr. Sclater have been invariably employed in the present memoir.

Literature.—The literature relating to Siwalik birds is comparatively small. A brief allusion to the occurrence of birds in the Siwaliks is made in Falconer's notes,[1] and another occurs in a small pamphlet by the late Gen. Sir W. E. Baker.[2] Most of the remains collected by Falconer and Cautley are figured in unpublished plate R. of the "F.A.S.," but are not named in the description given in the "Palæontological Memoirs."[3] Several of these bones were subsequently named by M. Alphonse Milne-Edwards[4]; and a note on these and other remains was published in 1879 by the present writer.[5] A more important memoir by Mr. W. Davies,[6] of the British Museum, with a plate of illustrations, appeared in the following year.

In the present memoir all the remains of Siwalik birds which appear to admit of determination are more or less fully described; while those specimens which have been hitherto known merely by preliminary notices have been figured. Some of the more important figures from the "F.A.S." and Mr. Davies' memoir have been reproduced. There are a few broken specimens of Siwalik bird-bones in the British Museum whose affinities it has not yet been found possible to determine.

Sub-Class I.: CARINATÆ.

Order: STEGANOPODES.

Family: *PELECANIDÆ.*

Genus: PELECANUS, Linn.

Distribution.—The genus has now a world-wide distribution, and is represented by a large number of species.[7] It is represented in the miocene of Europe by *P. intermedius*, Fraas,[8] and *P. gracilis*, Milne-Edwards,[9] of Allier; both of which seem to be closely allied.[10] The so-called *P. miocænus*, Lartet, is considered by Milne-Edwards to be nearer *Sula.*[11] It is possible that *Pelecanus* was represented in the eocene of Paris.[12]

1 "Palæontological Memoirs," vol. I., p. 23.

2 "Memoir on the Fossil Remains presented by himself and Col. Colvin to the Museum at Ludlow," p. 16 (Ludlow, 1850).

3 Vol. I., p. 554.

4 "Recherches Anatomiques et Paléontologiques pour servir à l'histoire des Oiseaux Fossiles de la France." (Paris, 1867-77.)

5 "Notes on some Siwalik Birds." '*Records*,' vol. XII., p. 52.

6 "On some fossil Bird-Remains from the Siwalik Hills in the British Museum." '*Geol. Mag.*,' decade 2, vol. VII., p. 18, pl. II. (1880).

7 A list is given by A. Dubois, '*Bul. Mus. Roy. Hist. Nat. Belg.*,' vol. II., p. 1 (1883).

8 "Fauna von Steinheim," pl. X., fig. 3 (skull).

9 *Op. cit.*, vol. I., p. 250, pls. XXXVIII.-IX.

10 *Ibid*, vol. II., p. 576. 11 *Ibid*, vol. I., p. 250. 12 *Ibid*, vol. I., p. 249.

Species 1: PELECANUS CAUTLEYI, Davies.

History.—This species was founded by Mr. Davies in the memoir already quoted.[1]

Ulna.—The specimen on which this species is founded consists of the distal extremity of a left ulna, from the Siwaliks, in the British Museum, which is represented in pl. XIV., figs. 11, 11a. It is somewhat smaller than the ulna of the existing Indian and African *P. mitratus*; but agrees in the form of the trochlear articulation (*a*), and of the external tendinal pit and adjacent process (*b*). It differs, however, in the greater depth and elongation of the palmar trochlear depression (*c*), as well as in the more laterally compressed form of the shaft. In the size of the depression (*e*) it differs from all the species with which it has been compared. Its dimensions are compared below with those of *P. mitratus*, *viz.*:—

	P. cautleyi.	P. mitratus.
Transverse diameter, including radial tuberosity . . .	0·7	0·85
Ant.-post. ,, of ulna trochlear	0·75	0·95
Transverse ,, ,, shaft	0·45	0·58
Ant.-post. ,, ,, ,, ...	0·6	0·65

It is impossible to compare the Siwalik bone with *P. gracilis*, as the ulna of that species is not figured; but it is decidedly different from the ulna of *P. intermedius* (B. M., No. 48,164), although of very nearly the same dimensions.

Distinctness.—Although the comparisons that have been made indicate the distinctness of this Siwalik pelican from several species, yet the possibility of its identity with some of the existing species of which skeletons are not available must be borne in mind, and the name *P. cautleyi* must, therefore, be regarded as provisional.

PELECANUS SIVALENSIS, Davies.

History.—This species is named on page 26 of Mr. Davies' memoir.

Ulna.—This species also is founded on the distal extremity of an ulna from the Siwaliks in the British Museum (No. 39,745), which has not been figured. It differs from the corresponding bone of *P. cautleyi* by its inferior size, the shallowness and shortness of the palmar trochlear depression, and other minor points. It is of inferior size to the ulna of *P. mitratus* and *P. intermedius*, but agrees so closely in general characters that there seems no doubt of its belonging to the same genus. The dimensions of the specimen are as follows, *viz.*:—

Maximum transverse diameter . . .	0·52	Transverse diameter of shaft . . .	0·4
Ant.-post. diameter of ulna trochlear .	0·6	Ant.-post. ,, ,, ,, . . .	0·5

Distinctness.—There can be no question as to the distinctness of the present form from *P. cautleyi*; and the difference in size probably indicates specific distinctness from *P. mitratus* and *P. intermedius*. The specimen has not, however, been compared with *P. gracilis*, nor with most of the existing species, and its right to a distinct specific name must accordingly be regarded as provisional.

[1] Page 26.

Family: *PHALACROCORACIDÆ.*

Genus: PHALACROCORAX, Briss.

Syn. *Graculus*, Linn.

Distribution.—At the present day the genus has an almost world-wide distribution, and is represented by a large number of species. A coracoid in the British Museum from the pleistocene of Grays, Essex, indicates a species closely allied to, if not identical with *P. carbo*[1]; and a tarso-metatarsus in the same collection has been obtained from the prehistoric deposits of New Zealand.[2] *P. macropus* (Cope),[3] has been recorded from the pliocene of North America; and the tertiaries of the same country have also yielded *P. idahensis* (Marsh). From the French miocene three species have been determined[4] under the names of *P. miocænus*, *P. littoralis*, and *P. intermedius*.

Phalacrocorax, sp.

Syn. *Phäeton*? sp., Milne-Edwards; *Graculus*, sp., Davies.

History.—The proximal extremity of a small tarso-metatarsus[6] in the Cautley collection of the British Museum was considered by M. A. Milne-Edwards[5] to have possibly belonged to a species allied to the existing tropic-bird. The present writer[7] suggested that this provisional reference was an improbable one, and it was subsequently shown by Mr. Davies[8] that the specimen probably belonged to *Phalacrocorax* (*Graculus*), or a closely allied genus.

Metatarsus.—The above-mentioned specimen, which was obtained from the Siwalik Hills, is represented in plate XIV., figs. 10, 10a. It agrees with the corresponding bone of *P. carbo* in the form of the concave facets and tuberosity of the superior surface, in the depth of the median groove on the anterior surface, in the form of the tendinal canal on the same surface, and of the calcaneal process and grooves. It differs in having the anterior surface of the outer metatarsal less sharply ridged, and that of the inner less depressed below the articular cavity; as well as in the deeper depression on either side of the calcaneal process. It is almost indistinguishable from the above-mentioned bone from New Zealand.

Distinctness.—Other comparisons have not been made, and it is therefore uncertain whether the Siwalik cormorant is or is not identical with any of the other named species.

Order: HERODIONES.

Family: *CICONIIDÆ.*

Genus: LEPTOPTILUS, Lesson.

Syn. *Argala*, Hodgson; *Osterophea*, Hodgson.

Distribution.—This genus is confined at the present time to W. Africa (where it

1 A. Milne-Edwards, *op. cit.*, vol. I., p. 277.

2 Davies, *op. cit.*, p. 9.

3 'Bull. U. S. Geol. Survey,' vol. IV., p. 386.

4 A. Milne-Edwards, *op. cit.*, vol. I., p. 255, *et seq.*

5 *Op. cit.*, vol. I., p. 250.

6 This bone will in the sequel be simply termed the metatarsus: similarly the tibio-tarsus will be termed tibia.

7 *Op. cit.*, p. 57.

8 *Op. cit.*, pp. 8-9.

is represented by *L. crumeniferus* [Cuv.]) and the Indo-Malayan region (where it is represented by *L. argala* [Linn.], of India and Burma, and *L. javanicus* [Horsf.], of Java). From the Pikermi beds a humerus has been figured by Prof. Gaudry as *Ciconia* (?), which may possibly belong to the present genus[1]; and a species of the genus from the miocene of France has been named *Leptoptilus arvernensis* (Milne-Edwards[2]).

Species: LEPTOPTILUS FALCONERI (A. M.-Edw.)

Syn. *Argala falconeri*, A. M.-Edw.

History.—In the Introduction to the "F.A.S.," compiled in the "Palæontological Memoirs,"[3] it is stated that "among the Siwalik fossils there are also the remains of several species of birds, including *Grallæ*, greatly surpassing in size the gigantic crane [*sic.*] of Bengal (*Ciconia* [*Leptoptilus*] *argala*)." Subsequently M. A. Milne-Edwards,[4] who had some doubts whether the specimens might not indicate two species, described the proximal and distal extremities of the metatarsus, and two specimens of the distal extremity of the tibia of a large Siwalik stork in the collection of the British Museum under the name of *Argala falconeri.* At a later date the present writer[5] briefly recorded the discovery by Mr. Theobald in the Siwaliks of the Punjab of a cervical vertebra, the distal extremity of a tibia, and the first phalangeal of the outer digit of the foot of a large stork, which were provisionally referred to the same species.[6] Mr. Davies[7] afterwards described under the same name three other Siwalik specimens in the British Museum; *viz.*, a part of the first phalangeal of the wing, and the distal extremities of the femur and the humerus. A figure of the latter specimen is given in the plate in Mr. Davies' memoir; while the other two specimens mentioned by him, as well as those on which the species was founded, are figured, although unnamed, in unpublished plate R. of the "F.A.S."

Tibia.—The specimen which it may be convenient to take as the type of the species is the distal extremity of a right tibia in the British Museum (No. 39,735), figured in the "F.A.S.," pl. R., figs. 3, 3a, 3b, 3c. This specimen is rather larger than the tibia of an old *L. argala*, but presents no other points of distinction. The second specimen (B.M., No. 39,734) is also the distal extremity of the right side, but comprises rather more of the shaft: it is represented in figs. 5, 5a, 5b, 5c of the same plate, and is considerably smaller than the first specimen. The third specimen was obtained by Mr. Theobald from the Siwaliks of the Punjab, and is represented in plate XIV., figs. 9, 9a, 9b. It is the distal extremity of the right side, and is considerably smaller than the second specimen, and slightly smaller than the corresponding bone of a skeleton of *L. crumeniferus* in the Museum of the Royal College of Surgeons. It presents no distinctive characters from the latter bone,

1 "Animaux Fossiles et Géologie de l'Attique," p. 315, pl. LIX., fig. 12.

2 *Op. cit.*, vol. II., p. 572 (1871). The species is undescribed in that work.

3 Vol. I., p. 23 (1868).

4 *Op. cit.*, vol. I., p. 449 (1869-71).

5 "Records" vol. XII., p. 56 (1879).

6 The vertebra is now referred to another form.

7 *Op. cit.*, p. 6.

which seems to be distinguished from that of *L. argala* merely by its inferior size. The dimensions of the three Siwalik specimens are as follows :—

Antero-posterior diameter of inferior surface . .	1·32	1·2	0·93
Transverse ditto	1·05	0·93	0·71

There is a fourth imperfect specimen in the British Museum (No. 48,444) agreeing very closely with No. 39,734.

Metatarsus.—The distal extremity of the left metatarsus is represented in plate R., figs. 14, 14a, 14b, of the "F.A.S.," and in plate XIV., fig. 14 of this volume; and is in the British Museum. It is considerably larger than the corresponding bone of a large *L. argala* (the respective transverse diameters being 1·36 and 1·25), but presents no difference in form. The proximal extremity of a right metatarsus is represented in figs. 9, 9a of the same plate[1] of the "F.A.S." (B.M., No. 39,741); which is smaller than the corresponding bone of a full-sized *L. argala.*

Pedal phalangeal.—The bone represented in plate XIV., fig. 12, was obtained by Mr. Theobald from the Siwaliks of the Punjab: it is the first phalangeal of the outer (fourth) digit of the right foot; and is practically indistinguishable from the corresponding bone of *L. crumeniferus*, and agrees therefore in size with the smallest tibia.

Femur.—The distal extremity of the left femur is represented in plate R., figs. 4, 4a, 4b of the "F.A.S." (B.M., No. 39,737). This specimen is indistinguishable in form from the femur of *L. argala*, but is of rather larger size than a large specimen of that species; the respective transverse diameters of the two bones being 1·77 and 1·48.

Humerus.—The distal extremity of the left humerus is represented in pl. XIV., fig. 1, and is likewise in the British Museum: it is indistinguishable from the humerus of *L. argala*, except in its slightly superior size; the respective dimensions being as follows :—

	L. falconeri.	L. argala.
Transverse diameter at condylar tuberosities	2·3	2·1
,, ,, of condyles	1·75	1·5

Phalangeal of the manus.—The proximal third of the first phalangeal of the wing is in the Cautley collection of the British Museum (No. 39,738), and is represented in plate R., figs. 8, 8a, 8b, 8c, of the "F.A.S." It differs from *L. argala* merely by its slightly superior size, and by the circumstance that the lateral lamelliform expansion rises rather more abruptly.

Distinctness and affinities.—The foregoing specimens indicate the existence of one or more species of stork in the Siwaliks, some individuals of which were of considerably larger size than the largest specimens of *L. argala*, while others were not larger than *L. crumeniferus*. As there is a considerable amount of variation in the size of the former species, and as there appears to be no distinctive structural differences between the limb-bones of the fossil form and of the three living species, it seems impossible to say whether the former includes more than one species; and equally

[1] The figures show the posterior and superior aspects.

impossible to say whether the fossil form, or forms, be not respectively identical with one or more of the living species. In view of the impossibility of distinguishing several of the Siwalik reptiles from existing species, it is not improbable that there may be a similar specific identity between some of the birds of the two epochs; but our knowledge of the rate of specific evolution in the latter class is at present so imperfect that nothing can be advanced with any confidence. The writer has not seen a description of *L. arvernensis*; which name is, however, of later date than *L. falconeri*. Under these circumstances the name *Leptoptilus falconeri* must be regarded as a purely provisional one. The above-mentioned humerus from Pikermi indicates a bird considerably smaller than *L. argala*.

Distribution.—Remains of the present form have been obtained from the typical Siwalik Hills, and the Punjab.

Genus, *non. det.*

History.—The specimen forming the subject of the present notice was previously referred to *Leptoptilus falconeri*.[1]

Cervical vertebra.—In plate XIV., figs. 7, 7a, 7b, 7c, 7d, there are given five views of the cervical vertebra of a large bird collected by Mr. Theobald from the Siwaliks of Asnot, Punjab. The specimen is a fourth cervical; so determined from the large size and shortness of the neural spine (*ns.*, fig. 7c), and the shortness of the lateral carotid canal[2] (*cc.*, fig. 7). The summit of the neural spine and the processes surrounding the carotid canals have been broken away. The bone, although rather larger, has such a general agreement in structure with the corresponding vertebra of *Leptoptilus argala*, that it may be pretty safely referred either to the *Ciconiidæ* or the allied *Ardeidæ*.

Compared with the fourth cervical of *Leptoptilus argala* the specimen differs by being shorter and higher; by the more distinct hollow (*x*, fig. 7c) between the prezygapophyses (*prz.*); by the larger size of the neural spine (*ns.*), which extends backwards over the postzygapophyses (*ptz.*); by the closer approximation of the two latter; and by the absence of distinct surfaces for muscular attachment above the same. In its greater vertical height and longer neural spine the vertebra of *L. crumeniferus* comes nearer to the fossil; but is distinguished by the other characters of that of *L. argala*. In both the existing species the prezygapophyses (*prz.*) are separated by a distinct notch, extending as far backwards as their posterior border.

The fossil bone, although much larger, agrees more nearly in proportions with the fourth cervical of *Balæniceps* and *Mycteria*, but is distinguished by the neural spine extending farther backwards, and being higher posteriorly, as well as by the more distinct hollow (*x*) between the prezygapophyses. It is on the whole nearer to *Mycteria* than *Balæniceps*. Compared with the fourth cervical of *Cancroma* (*Ardeidæ*) the Siwalik bone is of very much larger size, but agrees in its relatively large height,

[1] 'Records,' vol. XII., p. 56.

[2] Two carotids are present in the *Ciconiidæ* and most of the *Ardeidæ*; *vide* Garrod, 'Proc. Zool Soc.,' 1873, p. 467.

and in the form of the neural spine; although differing by its shorter centrum, and the other characters in which it differs from *Leptoptilus*. The writer has not found any other birds whose vertebra approaches so nearly to the fossil as those mentioned above; and all the other genera have vertebræ very much smaller than the specimen under consideration.

Distinctness and affinities.—The foregoing comparisons show that the present specimen probably indicates a Siwalik stork (or allied form) exceeding in size the largest *Leptoptilus argala*, and specifically distinct from any living bird. The circumstance that the limb-bones of *L. falconeri* are practically indistinguishable from those of *L. argala* renders it almost certain that the present vertebra does not belong to the former. Whether the characters pointed out as distinguishing the fossil vertebra from the existing genera with which comparisons have been made should be regarded as of generic or of specific value appears extremely doubtful; and it, therefore, seems advisable not to attempt to give any name to the present large Siwalik bird. The distribution and relations of the genera *Leptoptilus*, *Mycteria*, and *Balænieeps* are such as to render it highly probable that an allied extinct genus should have formerly existed in India.

Order: ANSERES.

Family: *ANATIDÆ.*

Genus: MERGUS, Linn.

Distribution.—The genus has a wide distribution, being found in the Palæarctic, Nearctic, and Neotropical regions. It has apparently been hitherto unknown in the fossil state.[1]

Mergus (?) sp.

History.—The specimen on which this determination rests is noticed here for the first time.

Cervical vertebra.—In plate XIV., figs. 3, 3a, 3b, there are given three views of an early cervical vertebra of a bird obtained by Mr. Theobald from the Siwaliks of Asnot, Punjab. Fig. 3 represents the hæmal, fig. 3a the anterior, and fig. 3b the neural aspect. The specimen has lost both pairs of zygapophyses, a portion of the neural spine, and the posterior part of the lateral expansions of the centrum.

This vertebra is characterized by the extreme flatness and width of its hæmal surface (fig. 3); and in this respect comes nearer to *Mergus* than to any other genus with which the writer has been able to compare it. It is still shorter and wider than the corresponding vertebra of *M. serrator*, but indicates a bird of about the same size. The writer has been unable to compare the specimen with *M. merganser*, *M. albellus*, or *M. castor*.

Although the generic determination cannot be considered as certain, the present

1 The so-called *Mergus ronzoni*=*Sula ronzoni*.

specimen may be taken to indicate in all probability the occurrence in the Siwaliks of a bird closely allied to, if not identical with, *Mergus*.

GENUS, *non. det.*

Phalangeal of the foot.—In plate XIV., fig. 13, there is represented a bone obtained by Mr. Theobald from the Siwaliks of the Punjab, which is apparently the first phalangeal of the median (third) digit of the foot of some stout-limbed swimming or walking bird; the proximal extremity is somewhat worn, and the whole of the external surface is partially decayed. The specimen is very similar to the corresponding bone of the Australian *Cereopsis*, but it is insufficient to determine even the order to which its owner belonged.

SUB-CLASS II.: RATITÆ.

FAMILY: *STRUTHIONIDÆ.*

GENUS: STRUTHIO, Linn.

Number of species.—At the present day the genus is represented by the well-known *S. camelus.*[1] An ostrich has indeed been recently described from Somali Land under the name of *S. molybdophanes*, Reichenow,[2] but there is considerable doubt as to its claim to specific distinction[3]; and, in any case, it is distinguished at present merely by external characters, so that for palæontological purposes it may be grouped with *S. camelus.* The species described below is the only fossil representative.

Species: STRUTHIO ASIATICUS, A. M. Edwards.

Syn. *S. palæindicus*, Falc., MSS.; *Megaloscelornis sivalensis*, *nobis* (*in parte*).

History,—Apparently the first mention of a Siwalik ostrich is in a letter from Falconer to De Blainville, dated October 4th, 1847, in which certain remains were alluded to under the name of *S. palæindicus.*[4] In 1871 (or a little earlier) M. A. Milne-Edwards[5] proposed the name of *S. asiaticus* for the Siwalik species; and in 1880 Mr. Davies[6] described the remains on the evidence of which this name had been assigned, giving a figure of the most important specimen. It was mentioned at the same time that other remains had been figured in unpublished plate R. of the "F.A.S.," but had received no name. In the previous year the present writer[7] briefly described two bones from the Siwaliks (which had been found in juxtaposition and were labelled by Falconer as remarkable specimens) and referred them both to a bird, to which he applied the new generic and specific name of *Megaloscelornis sivalensis*. One of these bones, which was regarded as the sternum of this new bird, turns out to be a portion of the carapace and plastron of an emydine chelonian, which presents a most extraordinary resemblance to an avian sternum.[8] The other bone is a portion

1 *S. australis*, Gurney, seems to be merely a variety.

2 'Sonntags-Beiloge zur Norddeutschen Allgemeinen Zeitung,' September, 1883.

3 *Vide* 'Ibis,' 1884, pp. 116, 352.

4 *Vide* "Pal. Mem.," vol. I., p. xxi. (1868).

5 *Op. cit.*, vol. II., p. 587.

6 *Op. cit.*, p. 19.

7 'Records,' vol. XII., p. 55.

8 The writer is indebted to Prof. A. Newton, of Cambridge, for this correction.

of a tibia and belongs to the present species.[1] The genus *Megaloscelornis* must, therefore, be abolished.[2]

Metatarsus and phalangeal.—In plate XV., fig. 3, there is given a full-sized view of the distal half of the right metatarsus, with the proximal half of the first phalangeal of the inner digit; obtained from the Siwalik Hills. These bones are indistinguishable, both as regards form and size, from those of the existing ostrich.

Tibia and fibula.—In plate XV., figs. 2, 2a, there are two half-sized views of the distal half of a right tibia from the Siwalik Hills.[3] The articular portion of the bone is somewhat damaged; but allowing for this loss the specimen is indistinguishable in all respects from the tibia of *S. camelus.* In figures 1, 1a of the same plate there are two similarly reduced views of the greater portion of a right tibia and fibula[4] from the Siwalik Hills. The specimen is imperfect superiorly, the fibula (*f*) being broken off lower down than the tibia: a transverse section of the specimen at a fracture shows that the tibia and fibula are perfectly distinct, although cemented together by matrix. Distally the specimen has lost its articular extremity (astragalus); thus showing that it belonged to an adolescent individual. This specimen agrees precisely in every respect with the last, and with the corresponding bone of *S. camelus.*

Bones of the wing.—The metatarsus described above is associated with some of the wing-bones and some cervical vertebræ, doubtless belonging to the same individual. The wing-bones comprise the distal ends of the radius and ulna, the metacarpus, and a phalangeal; and the only difference than can be detected between these bones and those of *S. camelus* is that the metacarpals are slightly stouter.

Vertebræ.—The above-mentioned cervical vertebræ are twelve in number, five of which are figured in plate R., figs. 1, 1a of the "F.A.S.": they are fully described by Mr. Davies. The vertebræ resemble those of *S. camelus* in general size; but their larger anterior transverse diameter and greater vertical depth seem to indicate that the Siwalik ostrich had a stouter neck.

Distinctness and affinities.—The foregoing comparisons show that the Siwalik ostrich was extremely close to the existing species; and it seems doubtful whether the slight differences in their cervical vertebræ can be regarded as of more than individual, or varietal, value. Under these circumstances the name *S. asiaticus* must be regarded as provisional.

Distribution.—All the known remains have been obtained from the typical Siwalik Hills: it is, however, to be expected that the species will eventually be found

1 The tibia was referred to *Megaloscelornis* from the circumstance that it was associated with the supposed sternum. This example affords a warning against relying on the association of Siwalik bones as indicating individual identity. It seems from the labelling of the specimens that this association deceived Falconer. The writer considered that the tibia differed from that of struthioids by the anchylosis of the fibula, but a subsequently made section of the specimen has shown that the two bones are really distinct,

2 A portion of a humerus from Sind noticed in the 'Records,' vol. XVI., p. 68, which it was suggested might possibly belong to *Megaloscelornis*, seems to be probably crocodilian.

3 Figured in the "F.A.S.," pl. R., figs. 2, 2*a*, 2*b*, 2*c*, 2*d*.

4 This specimen is the one originally referred to *Megaloscelornis.*

in the Siwaliks of the Punjab, since it is pretty evident that the genus must once have ranged through Persia, and have thus connected its present habitat (Syria, and Africa) with its old Indian home.

FAMILY: *CASUARIIDÆ.*

GENUS: DROMÆUS, Vieill.

Number of species.—There is apparently only a single well-established existing emeu[1]—*D. novæ-hollandiæ*, Viell.; and the form described below is the only fossil that has been referred to the genus.

Species: DROMÆUS (?) SIVALENSIS, *nobis.*

History.—This species was named by the writer[2] in 1879 on the evidence of four phalangeal bones collected by Mr. Theobald in the Siwaliks of the Punjab, which form the subject of the present notice.

Phalangeals.—Of the first specimen three views are given in plate XIV, figs. 2, 2a, 2b. This bone is the first phalangeal of the outer (fourth) digit of the right foot of a tridactyle struthioid; and is in fair preservation, but has lost a small portion of the inner border of the proximal extremity (fig. 2b). In figure 6 of the same plate there is represented the corresponding bone of the opposite foot of a slightly smaller struthioid. This specimen has been considerably rolled; and its distal extremity, as well as the anterior aspect of the proximal extremity, are consequently imperfect. In general contour this bone is very similar to the last; but has the inner extremity of the proximal surface (*a*) somewhat more produced. It is somewhat doubtful whether these differences in size and form should be regarded as of individual or specific value; but it seems advisable in the absence of other evidence to regard them provisionally in the former light. These bones are very near indeed to the corresponding bone of *Dromæus novæ-hollandiæ*; being mainly distinguished by the slighter development of the pit on the inner aspect of the distal extremity, and their considerably larger size. They do not come so close to the corresponding bone of any other struthioid.

In figure 5 of the same plate there is represented the second phalangeal of the outer digit of the left foot of a tridactyle struthioid, agreeing in relative size with the larger first phalangeal (fig. 2). This bone is only distinguished from the corresponding phalangeal of the living emeu by its superior size and the somewhat greater expansion laterally and inferiorly of the outer articular trochlea (*a*). Both the recent and fossil bones are characterized by the presence of a pit on the outer side only of the distal extremity. There is every probability that the fossil belongs to the same species as the first phalangeal represented in fig. 2.

In figs. 4, 4a, 4b of the same plate there are given three views of a larger second phalangeal of the same digit and foot, which corresponds so exactly in form with the smaller specimen that it evidently belonged to the same kind of bird.

[1] *D. irrorata*, Bartl., is generally regarded as a variety.

[2] 'Records,' vol. XI., pp. 53-4.

In the following table the dimensions of the four specimens described above are compared with those of the corresponding bones of the living emeu. The two middle-sized fossil bones, which belonged to individuals of the same size, are placed in the second column :—

	Fossil.			D. novæ-hollandiæ.
Length of first phalangeal		2·4	2 3	1·8
Ant.-post. diam. of proximal surface of ditto .		1·36	1 15	0·75
Transverse ditto ditto		1·3	1·2	0·7
Ant.-post. diam. of distal ditto . . .		0 9	0·7	0·46
Transverse ditto ditto		1·0	0·8	0·6
Length of second phalangeal	1·51	1·3		0 8
Ant.-post. diam. of proximal surface of ditto .	1·0	0·85		0·55
Transverse ditto ditto	1·38	1·1		0·62
Ant.-post. diam. of distal ditto . . .	0·7	0·65		0·45
Transverse ditto ditto	1·35	1·08		0·54

Distinctness and affinities.—The resemblance of the bones described above to those of the living emeu is so close that there seems little doubt but that they indicate the existence of a nearly allied bird in the Siwaliks. Whether the fossil was generically identical with the recent form may perhaps on the whole be somewhat doubtful, but there is every probability that the one was the ancestral form of the other; and it may therefore be well to continue to refer the fossil to *Dromœus*, until such time as it shall be proved distinct. It is, however, by no means improbable that the Siwalik bird may belong to the pleistocene Australian genus *Dromornis*, of which the corresponding bones are at present unknown. That the Siwalik form was specifically distinct from the living emeu is evident, and the specific name *sivalensis* may therefore stand. Whether more than one species is at present comprehended under that name cannot be determined; but if such should eventually prove to be the case, the middle-sized bones whose measurements are given in the second column of the foregoing table may be regarded as the types.

Distribution.—As previously observed, the present form has hitherto been obtained only from the Siwaliks of the Punjab; but from its relationship to the Australian emeu it is to be expected that it will eventually be found in the typical Siwalik Hills.

The former occurrence in India of a large struthioid closely allied to the emeu is one more instance of the originally wide distribution of the struthioid birds; and it not improbably indicates that the home of the group of which the cassowaries, emeus, and moas are diverging branches was originally somewhere in the neighbourhood of the Indian region; from whence a migration took place during some part of the tertiary period towards the south-east, where the group, in regions more or less completely free from the larger mammals, subsequently attained its greatest development.

Genus, *non. det.*

Phalangeal.—In plate XIV., fig. 8, there is represented, from the anterior aspect, the second phalangeal of the middle (third) digit of the foot of a tridactyle struthioid from the Siwalik Hills; of which other views are given in the plate accompanying Mr. Davies' memoir. This specimen is but slightly larger than the corresponding bone of one of the species of *Casuarius*, and would, therefore, seem too small to have belonged to the last species. According to Mr. Davies[1] this bone differs from *Dromæus* and *Casuarius* so markedly that it seems to be generically distinct from both, although nearer the latter than the former. It cannot apparently be identified with any other described genus.

Additional specimens are required before the affinities of this bone can be fully determined, but it apparently indicates a third form of Siwalik struthioid.

[1] *Op. cit.*, pp. 22-3. Dimensions and a description are given in this notice.

INDIAN TERTIARY AND POST-TERTIARY VERTEBRATA.

MASTODON TEETH FROM PERIM ISLAND.

By R. LYDEKKER, B.A., F.G.S., F.Z.S.

(WITH PLATES XVI. AND XVII.)

INTRODUCTORY.

Since the publication of the description of various remains of *Mastodon pandonis* and *M. angustidens* in an earlier part of this volume[1] the present writer has been favoured with the loan of several teeth of mastodons from the Siwaliks of Perim Island, in the Gulf of Cambay, which were collected by Mr. Wajeshankar Gowreeshankar of Bhaonagar, Guzerat. As some of these teeth differ, either in form or in their degree of wear, from previously described specimens, and as it is only by describing a large series of specimens that we can hope to arrive at anything like a complete knowledge of the dentition of the Siwalik mastodons, the writer is glad to have the opportunity of describing these interesting specimens, and at the same time ventures to express the hope that they are not the last that he will receive from the same source. In addition to these specimens a tooth from Perim Island, now in the collection of the British Museum, and another collected by Mr. F. Fedden, of the Geological Survey, in the same locality, are also described and figured. It may be added that Mr. Gowreeshankar's specimens are those briefly noticed on page 134 of the present volume.

MASTODON PANDIONIS, Falconer.

First upper true molar.—In figures 2, 2a of plate XVII. there are given two views of the crown of a perfect germ molar of a trilophodont mastodon. The convexity of the crown, and its relative shortness indicates that the specimen probably belongs to the upper jaw, and the position of the columns proves that it belongs to the right side. The size of the tooth indicates that it is probably the first true molar.

1 Pages 17-32, plates IV.-V.

The crown carries three distinct ridges and a well-marked hind talon (*ta*). The ridges are divided by a median longitudinal cleft into an inner and outer moiety, which are not set in the same transverse line; the valleys are completely blocked by outlying, or accessory, columns, and there are four distinct cusps on the hindmost ridge. The columns (fig. 2a) have a considerable forward inclination; the enamel has deep vertical groovings; and there is a considerable amount of cement in all the valleys; while there is a distinct cingulum (*c*) on the inner side.

All the above characters are those of the molars of *Mastodon pandionis*, and if the figures of the present specimen be compared with the figure of the type upper molar given in plate V., fig. 5, of the present volume,[1] it will be seen that the two agree so closely with one another that they evidently belong to the same species. The type tooth is, however, less narrow anteriorly; but a much-worn specimen figured in plate XXXII., fig. 4, of the first volume, under the name of *M. falconeri*, but referred to the present species on page 30 of the present volume, agrees more nearly in this respect with the specimen under consideration. The three teeth taken together afford a good example of the variation to which an homologous tooth of the same species is liable. The length of the present specimen is 3·7; its greatest width 2·4; its width at the first ridge 1·7: and the height of the inner column of the last ridge 2·0 inches.

Last upper true molar.—The specimen represented in plate XVI., fig. 1, agrees so exactly with the last left upper true molar in the palate specimen of *M. pandionis* from the Punjab represented in plate XXXVA. of the first volume, that it may be certainly considered as the homologous tooth. The Perim specimen (of which the talon has been broken away) is important as exhibiting this tooth in a worn condition; the Punjab specimen being almost unworn. The figure shows the characteristic corrugated enamel, which presents a crenulated appearance in transverse section. The inner columns present irregularly shaped dentine islets, and not the distinct trefoils of *Mastodon falconeri*[2]; this being mainly due to the small development of the posterior accessory column (*b*). Cement is present in all the valleys.

Mastodon perimensis, Falconer and Cautley.

Second right upper true molar.—In plate XVI., fig. 2, there is represented the greater portion of a right upper true molar of a mastodon, collected by Mr. Fedden, which from reasons given below is considered to be the penultimate tooth of *M. perimensis*, which has lost the last ridge and talon: the three remaining ridges are in an unworn condition. The specimen agrees very closely with the much damaged homologous tooth figured in plate IX., figs. 5 and 6 of vol. I. of the "Palæontological Memoirs"; and also in general characters with the first and third upper true molars figured in plates XL. and XLII. of the first volume of the present work. All these four teeth agree in having tall columns, with deep and narrow transverse valleys,

1 A side view on a small scale is given in Falconer's "Palæontological Memoirs," vol. I., pl. XXXIV., fig. 7.

2 Vol. I., pl. XXXII., fig. 1.

partially blocked by accessory columns (*a*, *b*).[1] When worn it is quite evident that the first inner column of the present tooth would present a trefoil-shaped dentine islet as in the corresponding ridges of the partially worn teeth figured in the first volume. Owing to the absence in the second and third valleys of a distinct posterior accessory column (*b*), the second and third ridges would not present such perfect trefoils of dentine. The tooth is readily distinguished from the upper molars of *M. latidens* (vol. I., pl. XXXVIII.) by its higher columns and less open transverse valleys; and is also distinguished from those of *M. sivalensis* by the want of a completely alternate arrangement of the inner and outer columns of the ridges, as well as by the distinct trefoil which would be formed on the first inner column when worn down. The tooth is totally unlike the second upper true molar of the trilophodont *M. falconeri* (vol. I., pl. XXXII., fig. 1), and is readily distinguished from that of *M. pandionis* (*ibid*, pl. XXXVA.) by its comparatively smooth enamel, and the more distinct trefoil which would be formed on the first inner column when worn.

Seeing, therefore, that the specimen under consideration agrees in all general characters with the molars of *M. perimensis* and differs from those of all the other Siwalik species of mastodons, it may be pretty safely referred to the former species: its size shows that it is the penultimate tooth.

Assuming this reference to be correct, it would appear that the tooth figured in plate XLI., fig. 4 of the first volume as m. 1 of *M. perimensis* cannot really belong to that species[2]; its columns being arranged very alternately, the valleys completely blocked, and the whole tooth of a narrower type than the present specimen. In all these respects the former tooth agrees with *M. sivalensis* (compare mm. 4 of that species represented in fig. 2 of the same plate of the first volume), and may probably be referred to that species, being an example of a tooth in which the fifth ridge is not developed.

Upper milk-molars.[3]—With the exception of a tooth figured in plate XLI., fig. 3 of the first volume of this work, and provisionally considered as mm. 2,[4] the milk-molars of the present species have not hitherto been known. The tooth figured in plate XVII., figs. 3, 3a, of the present volume is in the collection of the British Museum, to which it was presented by the late Mr. C. Falconer, and its mineral condition leaves little doubt that it came from Perim Island: it is labelled by Dr. Falconer as the penultimate left upper milk-molar of *Mastodon latidens*. Of the correctness of the serial position there is no doubt, and the tooth, which is almost untouched by wear, evidently belongs to a tetralophodont species, as it contains three ridges and fore-and-aft talons, and is too small to be mm. 4 of a trilophodont species.

1 There are more minor accessory columns in the last molar figured in vol. I. than in the first; but this can only be regarded as an individual variation.

2 It was at first supposed that the present tooth belonged to the same species as the one represented in vol. I., pl. XLI., fig. 4, and the last ridge and talon (*ta*) were accordingly restored from that figure. This restoration is, therefore, erroneous.

3 The teeth of the milk-molar and premolar series are enumerated according to the typical series. Thus the ante-penultimate=mm. 2; the penultimate=mm. 3; the ultimate=mm. 4.

4 Termed mm. 1 in vol. I.

The ridges are relatively small, and are divided by a median longitudinal cleft, which is, however, less marked in the third ridge. The valleys are partially blocked by accessory columns (*a*, *a*), and there are traces of cement in all; the presence of the latter being a character of the molars of *M. perimensis*, although in many specimens the cement has fallen off.

If the present specimen be compared with the penultimate upper milk-molar[1] of *M. latidens* represented in plate XXXVII., fig. 4 of the first volume, it will be seen that it differs by its narrower form, its much higher and more completely divided ridges, and less open valleys. The tooth is quite different from the molars of *M. sivalensis*; and as it agrees precisely in general characters with the upper true molar of *M. perimensis* figured in plate XVI., fig. 2, it may be referred with great probability to that species. The length of this tooth is 2·3; the width at the first ridge 1·2, at the third 1·4; and the height of the middle ridge 0·95 inch.

In plate XVII., fig. 1, there is represented a fragment of the right maxilla of a young tetralophodont mastodon, containing the second and third milk-molars, in a much-worn and somewhat battered condition. Allowing for its different condition of wear the third milk-molar in this jaw agrees well with the last specimen; and this circumstance, taken with the place of origin of the present specimen, leads to the conclusion that it very probably belongs to the present species. From its worn and battered condition it is impossible to say whether the third milk-molar differed essentially from the homologous tooth of *M. latidens* represented in plate XXXVII., fig. 4 of the first volume; but it seems probable that the ridges when unworn were higher, and resembled those of the specimen represented in plate XVII., figs. 3, 3a. The second premolar is too much worn to permit of any comparisons. The length of the third milk-molar is 1·8, and its greatest width 1·38 inches; these measurements agreeing well with the dimensions of the last specimen.

Penultimate lower premolar.—The broken tooth represented in plate XVII., fig. 4, is contained in the fragment of the right ramus of the mandible, in that imperfect and battered condition which is frequently so provoking to the palæontologist. The figured tooth has had the anterior portion of its crown hammered off, and is but partly protruded: it is succeeded posteriorly in the jaw by a larger and fully protruded tooth, of which unfortunately the crown is now entirely wanting; the latter tooth being again succeeded by a fragment of a tooth still *in alveolo*. The broken tooth appears to have been the last milk-molar, and the figured tooth will accordingly be the penultimate premolar, as it evidently belongs to the second series. The latter has a smooth enamel, showing that the specimen does not belong to *M. pandionis*; and it is accordingly thought probable that it may belong to the common Perim species *M. perimensis*; which from the evidence of the fine specimen figured in plate XL. of the first volume is known to have developed premolars. The specimen under consideration shows the alveolus of a small mandibular tusk.

1 Termed $\frac{mm.\,2}{}$ in vol. I.

Relationship of M. perimensis and M. pandionis to one another and to other species.

It has been shown in the first volume of the present work that *M. perimensis* is a species provided with a comparatively short mandibular symphysis with small tusks (pl. XLIII.), while that of *M. pandionis* (pl. XXXVI.) is unusually elongated and often furnished with large tusks; and as it is known that all the early mastodons like *M. angustidens* and *M. longirostris* had long tusked mandibular symphyses, while the stegodont and more specialized elephants all have extremely short and tuskless ones, it is quite evident that evolution has tended to the shortening of the mandibular symphysis and the suppression of the mandibular tusks; and it is therefore also pretty evident that the tetralophodont *M. perimensis* is a more specialized form than the trilophodont *M. pandionis*, which is considered to be an offshoot from the stock of *M. angustidens*.[1] The circumstance that *M. pandionis* occurs in the lower Siwaliks where *M. perimensis* is not found is another circumstance pointing to the conclusion.

If now the tooth of *M. perimensis* represented in plate XVI., fig. 2, be compared with that of *M. pandionis* represented in figure 1 of the same plate, it will be seen that it merely requires the anterior accessory columns (*a*, *a*) of the latter to be somewhat less developed, which would render the valleys more open, and a fourth ridge to be developed in the 'intermediate' molars (vol. I., pl. XXXVA.), and a fifth ridge and double talon in the last molar (*ibid*) to transform the trilophodont molars of *M. pandionis* into teeth very like the tetralophodont ones of *M. perimensis*. Both species agree in the presence of cement in the valleys, and it is probable that both were furnished with premolars. Taking all these circumstances together, it is by no means improbable that *M. perimensis* may be a specialized descendant from the stock of *M. pandionis*.

It has also been shown in the first volume (pages 226-7) that the last lower molars of the upper Siwalik *M. sivalensis* present a remarkable resemblance to those of *M. pandionis*; and as the former is evidently a more specialized form—having a short mandibular symphysis and no lower tusks, with a tetro-pentalophodont ridge formula—it is quite possible that this species may likewise be a descendant from the *M. pandionis* stock; the development in this instance having tended to an increase in the alternate arrangement of the columns, and to the still more complete blocking of the transverse valleys; while the premolars and cement in the molars have disappeared. This line of development is entirely away from the direction of the stegodont elephants.

Mastodon pandionis also presents a strong resemblance to the Pikermi *M. pentelici*.[2] Thus both species are trilophodont forms, having a long and tusked mandibular symphysis, and teeth of the same general plan of structure, with a rugose enamel, and some cement in the valleys. The earlier upper teeth of *M. pentelici* appear,

[1] *Supra*, page 31.

[2] Gaudry, "Animaux Fossiles et Géologie de l'Attique," pls. XXII.-III.

however, to have rather more open valleys than those of *M. pandionis*, but the resemblance is greater between the lower teeth[1]: the Pikermi species has no premolars. Closer comparisons between the two cannot be made until some of the true molars of *M. pentelici* are known; but it seems probable that both the latter and *M. pandionis* are branches of the older *M. angustidens* stock.

The associated milk-molars from the cranium of a young Siwalik mastodon figured in plate XXII., figs. 2, 3, and XXXIII., fig. 2 of the first volume of this work, under the name of *M. falconeri*, but which have been shown on page 32 of the present volume to be distinct, differ from those of *M. pandionis* in the more open valleys of the intermediate molars, and in this respect agree more nearly with *M. pentelici*; which the Siwalik form also resembles in the absence of premolars. The resemblance between the penultimate milk-molars of the Siwalik and Pikermi forms[2] is indeed extremely close; and it appears by no means improbable that the two may really be specifically the same.

1 Compare Gaudry, *op. cit.*, pl. XXII., fig. 3, m. 3, with plate V., figs. 1, 1a of the present volume.

2 Compare *supra*, vol. I, pl. XXXII., fig. 2, and XXXIII., fig. 2, with m. 2 of figs. 2 and 3 of plate XXII. of Professor Gaudry's work.

INDIAN TERTIARY & POST-TERTIARY VERTEBRATA.

SIWALIK AND NARBADA CHELONIA.

By R. LYDEKKER, B.A., F.G.S., etc.

(WITH PLATES XVIII. TO XXVII.)

INTRODUCTORY.

Previous literature.—Hitherto our knowledge of the Chelonia of the Siwaliks has been extremely imperfect and crude; no systematic work on the subject having ever appeared, although there have been numerous disconnected papers. The earliest record of remains of the order in these deposits is by Clift,[1] who mentions and figures some fragments of shells of *Trionychidæ* from Burma. Several memoirs on two species by Falconer and Cautley, and Falconer alone, are given in "Falconer's Palæontological Memoirs,"[2] some of which were originally published at an early period of the palæontological career of Falconer, although one did not appear during his life. Mr. Theobald has noticed several species in the 'Records,'[3] while a brief summary of all the species then known to him has been given by the present writer in the 'Journal of the Asiatic Society of Bengal,'[4] and also in the 'Records.'[5] Remains of a few species of the fossil tortoises of the pleistocene Narbadas have been described and figured by Stoliczka.[6]

Definition of terms.—In the present memoir the various elements composing the epidermal horny coat are termed 'plates'; the term 'scutes'[7] being restricted to the

1 'Trans. Geol. Soc.' ser. 2. vol. II., pp. 374-375 (1828).

2 Vol. I., pp. 359-388. (1868).

3 'Rec. Geol. Surv. Ind.' vol. X. pp. 43-45 (1877), vol. XII. pp. 186-187 (1879).

4 Vol. XLIX. pt. II. pp. 16-18 (1880).

5 'Rec. Geol. Surv. Ind.' vol. XVI. pp. 67-68. (1883).

6 *Ibid.* vol. II. pp. 36-9 (1870).

7 The advantage of using the term scutes in this sense is that it agrees with the application of the same term to the dermal armour of the Crocodilia. The term 'shields' is sometimes employed in the sense in which the term plates is used here, but that is liable to lead to confusion since the whole plastron is frequently termed the ventral shield; that term being also employed in the same sense in the Labyrinthodonts.

elements of the underlying bony framework. The names applied to the individual plates are those employed in Günther's "Reptiles of British India,"[1] with the exception that the term 'pygal' is substituted for 'caudal.' The constituent scutes of the plastron are respectively termed epiplastron, xiphiplastron, etc., instead of episternum, xiphisternum, etc., as they are often called. The divisions separating both the plates and the scutes are termed sutures.

Difficulty of the subject.—As many specimens of the shells of fossil tortoises exhibit only the boundaries of the bony scutes and not those of the epidermal plates, and as in recent species as a rule the former are not described and are invisible without the removal of the overlying plates, it is in such cases almost impossible to determine the affinities of the fossils.[2] Owing to this difficulty the writer has considered it inadvisable to describe certain Siwalik specimens in which the boundaries of the plates are not visible.

The great similarity in the shells of many existing emydines, and the doubt still existing as to the number of species, likewise renders the specific determination of their fossil allies a matter of extreme difficulty, and specific names have therefore not been applied in several instances: for the same reason in the majority of cases only fairly perfect examples of such forms have been described at all. In the case of the larger land-tortoises, where only fragments of the shell are forthcoming, the epiplastral element, as the one most frequently preserved, has been selected as the one on which to found specific distinctions. It is of course obvious that unless some such restriction be observed several species might easily be made from the remains of one and the same form.

Relations of the fossil and existing Indian tortoises.—As far as our present very imperfect knowledge admits of generalization it appears that the pleistocene tortoises of the Narbadas all belong to existing Indian species. A considerable proportion of the medium and smaller sized forms of the pliocene Siwaliks appear closely allied to existing species now inhabiting India and the neighbouring regions, although in most instances they present more or less well-marked differences, which are in many cases regarded as of specific value. It is, however, very frequently a matter of extreme difficulty to decide whether the fossil forms should not rather be looked upon in the light of varieties of the existing species;—the course taken really depending to a considerable extent on the views of the individual describer as to what are specific and what are merely varietal differences. Some of the groups, however, like that of *Clemmys crassicollis* and the genus *Emyda* were much more strongly represented in the pliocene than in recent times. With regard to the larger land-tortoises the case is different; there being no question as to the specific distinctness of the large number of forms by which this group is represented from any existing Indian species. The nearest ally of this group is, however, apparently to be found in the existing Oriental *Manouria emys*, although there are strong

1 Page 2.

2 The writer is indebted to Mr. Theobald for numerous specimens of the shells of recent Indian tortoises, which have much facilitated his comparisons with their fossil allies.

indications that the recent gigantic tortoises of the far distant islands of the Indian Ocean are sprung from an allied branch. The inference may thus be drawn that while many of the smaller forms have clung to the continent of Asia with but a comparatively slight amount of change from the Siwalik epoch to the present day, the larger ones have entirely succumbed in the contest with the higher mammals of the continent, and are now only represented by distant cousins in regions entirely free from such forms of life, or by much smaller species on the Asiatic continent.

The comparatively small number of forms described in the following pages when taken in connection with the large number belonging to particular groups indicates that we are at present only acquainted with a small moiety of the whole Siwalik chelonian fauna; and from the extremely interesting nature of the species that are known to us the attention of collectors may be particularly directed to the acquisition of additional specimens.

Finally, it may be observed that the intimate affinity exhibited by the majority of the Siwalik tortoises with those now inhabiting India affords one of the strongest arguments for the late geological age of those deposits.

Family I.: *TESTUDINIDÆ.*

Shell convex, covered with horny plates; feet club-shaped and adapted for walking (hind-feet partially webbed in *Manouria*); pygal plates usually united, but separate in some recent and extinct Oriental forms. Plastron (in recent forms) concave in males, flat in females.

Genus I.: COLOSSOCHELYS, Falconer and Cautley.[1]

Shell as in *Testudo*,[2] but with the pygal plates not united, and the plastron produced anteriorly into a pair of cornua, supported on the ventral aspect by a strong triangular keel on which the gular plates are borne. Pectoral plates unknown.

The genus is exclusively Indian, and now extinct.

Species: Colossochelys atlas, Falconer and Cautley.[3]

Syn. *Megalochelys sivalensis*, Falconer and Cautley.[4]

(Twice the size of *Testudo elephantina.*)

History.—This species was originally named *Megalochelys sivalensis*, but the designation was subsequently changed to *Colossochelys atlas*; the term *Colossochelys* being employed as a subgenus of *Testudo*. As subgeneric terms are objectionable, and as the present species differs from *Testudo* by the non-union of the pygal plates, and from *Manouria* by the form of the epiplastron, the term *Colossochelys* is retained

1 'Proc. Zool. Soc.' 1844. p. 54. (As a subgenus.)

2 The definition of *Testudo* may be given as follows, *viz.*:—Shell usually solid, entirely bony and immovable, but sometimes of extreme tenuity; pygals united; gulars usually double, but sometimes (Mascarene tortoises) united; nuchal plate present or absent.

3 *Loc. cit.*

4 'Journ. As. Soc. Beng.' vol. VI. p. 358. (1837).

and employed in a generic sense. In a previous memoir[1] written before he was aware of the non-union of the pygals the present writer thought that the species might be referred to *Testudo.*

Epiplastron.—The most characteristic portion of the whole shell is the anterior part of the plastron, of which several specimens comprising the anchylosed epiplastral and parts of the contiguous scutes are preserved in the British and Indian Museums; all the specimens having been obtained from the Siwalik Hills. In plate XVIII. figs. 1, 1a, there are given dorsal and ventral views, one-sixth the natural size, of this portion of the epiplastron; the figures have been made by combining the two most perfect specimens in the British Museum, one of which shows the free extremities of the epiplastron, and is figured from the ventral aspect in "Falconer's Palæontological Memoirs," vol. I. pl. XXX. fig. 1, while the other shows their junction with the body of the plastron. The dorsal view (fig. 1) shows that the middle portion of the epiplastron, which carries the gular plates, is enormously thickened; the thickened portion being continued on either side as a curved rim covered by the postgular plates. The production of the gular far in advance of the postgular portion is a character in which the fossil agrees with *Manouria emys*[2] and differs from *Testudo horsfieldi* and the allied forms; but in the backward projection of the hinder portion of the gulars on the ventral aspect (fig. 1a) and the acute angle formed by the junction between the sutures separating the gulars and post-gulars it more resembles *T. horsfieldi* and its allies. The slight bifurcation occurring in the epiplastron of *Manouria emys* is enormously exaggerated in the fossil, the free extremities forming distinct cornua, while the remaining portion of the dorsal surface is deeply concave. On the ventral aspect (fig. 1a) the portion covered by the gulars, instead of being merely marked by the V-shaped suture bounding those plates as in tortoises like *T. horsfieldi*, forms a very distinct triangular keel, projecting beneath the portion covered by the postgulars, and expanding anteriorly into the cornua. The inferior aspect of the whole gular portion is strongly convex and distinctly impressed by the intergular suture. The extremely elongated epiplastron indicates that the whole plastron was long in proportion to the carapace, as in *Manouria emys.*

None of the gigantic recent land-tortoises have an epiplastron at all approaching that of the fossil; the gular portion of the epiplastron in *Testudo elephantina* and its allies[3] being very small and entirely in advance of the postgulars; and the intervening suture forming almost a straight line. No recent tortoise has the inferior keel of the fossil.

In the two large British Museum specimens of the epiplastron of the Siwalik fossil the thickness of the gular portion at its contracted juction with the postgular is 6·5, and its width 8·0 inches; while in the smaller Calcutta specimen (Indian

1 'Journ. As. Soc. Beng.' vol. XLIX. pt. II. p. 16. (1880).

2 *Vide* Gray, "Catalogue of Shield-Reptiles," pt. I. pl. III. (*M. fusca*).

3 *Vide* Günther, "Gigantic Land-Tortoises," pls. IV. VI. VII.

Museum, No. E 76) the corresponding dimensions are 5·1 and 6·5 inches. The interval between the cornua in the larger specimens is about 19, and in the small Indian Museum specimen 14 inches; the latter specimen therefore indicates an animal about one-fourth smaller than the larger specimens. These smaller but apparently adult individuals may perhaps have been females.[1]

Xiphiplastron.—There is a fine specimen of the posterior portion of the xiphiplastron of this species from the Siwalik Hills in the Cautley collection of the British Museum (No. 40629), which is figured of one-sixth the natural size from the dorsal aspect in vol. I. pl. XXX. fig. 2 of "Falconer's Palæontological Memoirs." The specimen terminates posteriorly in two very distinct cornua, separated by a deep notch shaped like a segment of a suboval. Near its line of fracture there is seen the impression formed by the anterior border of the anal plates, and the slight notch on the right side of the figure corresponds to the notch occurring in the existing *Testudo elongata* at the point where the suture between the postabdominal and anal plates reaches the margin of the xiphiplastron. The form of this portion of the shell is very like that occurring in the existing *T. elongata* and *Manouria emys*; and therefore confirms the conclusion drawn from the epiplastron as to the relative length of the plastron. The interval between the two cornua of the fossil xiphiplastron is about 22 inches. Taking this as a modulus and comparing it with the dimensions of a male *T. elongata* in which the corresponding interval measures 2·4 inches and the length of the carapace is 8·2 inches, the calculated length of the complete fossil carapace of the largest individuals would be about 8 feet in a straight line; the corresponding length of the smaller (female?) specimens being about 6 feet.

Carapace.—The British Museum possesses a large series of fragments of the carapace, from which, together with the portions of the plastron already noticed, a restoration in plaster of the entire shell was made under Falconer's superintendence, and is now exhibited in the Reptile Gallery. One fragment (No. R 326) consists of the posterior extremity of the carapace, and shows that the pygal plates are not united, as in the existing *Manouria emys*: this specimen (which probably belonged to a male animal) also shows that the pygal and adjacent marginal scutes are incurved inferiorly and situated nearly vertically, as in the males of *Testudo elongata*, and still more markedly in *Manouria emys*; so that when the shell is viewed directly from above very little of the pygal plates is visible. In other parts Falconer's restoration follows the lines of a typical land-tortoise,[2] with the exception that there is no nuchal plate; the original specimen giving the authority for the latter feature being unfortunately not forthcoming. The length in a straight line of the restored carapace is 8 feet 4 inches, and its height 3 feet 5 inches; the length of the plastron

1 The suggestion that another type of epiplastron belongs to this species will be discussed under the head of the next form.

2 In their first notice Falconer and Cautley (*vide* "Palæontological Memoirs," vol. I. p. 362) considered that some portion of the shell was cartilaginous, but this view seems to have been subsequently abandoned. From the evidence of the marginal scute noticed below under the name of *Cautleya annuliger* it is, however, not improbable that the sutures between some of the scutes in this or other Siwalik land-tortoises may have been cartilaginous.

measured between the bases of the epi- and xiphiplastral forks being 6 feet 2 inches.[1] As these dimensions accord very closely with those deduced from the proportions of the xiphiplastron and humerus,[2] they may be regarded as approximately correct. There are unfortunately no means of determining whether the pectoral plates of the male were separated by an interval, as in the males of *Manouria emys.*

Humerus.—In the Cautley collection of the British Museum there is the proximal half of the right humerus of a gigantic tortoise from the Siwaliks referred to the present species by Falconer,[3] and figured from the preaxial aspect[4] in plate XIX. fig. 2. of this volume, of one-fifth the natural size. Falconer[5] considered this specimen as comprising slightly less than half the complete bone, and such appears to be nearly the case. The length of the fragment is 14·4 inches; the larger diameter of the head being 5·1, and the smaller 4·5 inches. The shaft is more contracted than the humerus of *T. elephantina*[6]; and agrees more nearly with that of the Galapagos *T. elephantopus*[7]; from which bone the lower half of the figure is restored. The length of the recent bone is 8·4 inches; the longer diameter of the head 1·56, and the shorter 1·45. Taking the former as a modulus the calculated length of the fossil bone would be about 28 inches (2 feet 4 inches): this is equal to twice the length of the fragment (which was considered to be nearly half the bone), and is therefore probably not far from correct. Falconer[8] estimated its length at from 28 to 30 inches. In *T. elephantopus* the length of the carapace is slightly more than four times the length of the humerus; and in *T. elephantina* rather less than four times the same length (31 inches and 8·4 inches). This would indicate that the length of the carapace of the largest individuals of the fossil was somewhat short of nine feet: this estimate agreeing sufficiently well with that derived from the xiphiplastron. From comparing the fossil humerus with that of a small emydine Falconer[9] estimated the length of the fossil carapace at twelve feet. The radial tuberosity (*b*) of the fossil humerus is relatively longer transversely than in *T. elephantina*, and apparently agrees closely with that of *T. elephantopus.* The ulnar tuberosity (*a*) projects far above the level of the head. The British Museum also possesses a specimen of the proximal half of the left humerus (No. 39820), and the head of a right humerus (No. 39820a); and as both these specimens agree in size with the figured specimen they probably indicate the average size which the largest (? male) individuals of the species attained. The distal extremity of the right humerus of a large tortoise from the Siwalik Hills in the British Museum (No. 39825) is figured in plate XXXI. fig. 3. of the first volume of "Falconer's Palæontological

1 In all the published notices by Falconer and Cautley (*vide* "Palæontological Memoirs," vol. I. pp. 363, 374, 379) the length of the carapace in a straight line is given as 12 feet 3 inches, or 12 feet 6 inches, its height 6 feet, and the length of the plastron 9 feet 4 inches: these dimensions being generally quoted by subsequent writers. The restored shell indicates that Falconer subsequently abandoned the idea of the animal having reached such enormous dimensions.

2 *Vide infra.*

3 "Palæontological Memoirs," vol. I. p. 360.

4 It is figured in plate XXXI. figs. 4. 5. of the above work, but misnamed the femur.

5 *Op. cit.*, p. 361.

6 Günther, "Gigantic Land-Tortoises," pl. XVI.

7 *Ibid*, pl. LI. figs. A. A'.

8 *Op. cit.*, p. 381.

9 *Ibid*, p. 361.

Memoirs," and may not improbably be referred to a smaller individual of this species, although it may possibly belong to one of the generically undetermined species mentioned below. The trochlear portion is well developed, and indicates an animal adapted for progression on land. The ectepicondylar channel is not distinctly observable.[1]

Other bones.—Fragments of the femur and several of the foot-bones are preserved in the British Museum. The proximal extremity of the former is figured (as a humerus) in vol. I. pl. XXXI. fig. 2. of "Falconer's Palæontological Memoirs"; and a terminal phalangeal is figured in pl. XXX. figs. 3. 4. 5. of the same volume. The Museum also possesses the centrum of a vertebra. The foot-bones are like those of the large recent species of *Testudo.*

Cranium provisionally referred to this species.—Falconer[2] estimated the length of the cranium of this species at upwards of 2 feet, but judging from his miscalculation in the size of the carapace this length may be safely regarded as excessive. The cranium of which three views are given in plate XIX. figs. 3. 3a. 3b. was obtained from the Siwalik Hills, and is now in the Cautley collection of the British Museum: it is also figured from the parietal aspect in "Falconer's Palæontological Memoirs," vol. I. pl. XXXI. fig. 1. The specimen is broken off posteriorly close behind the quadrates, and has lost the anterior part of the prefrontals, but is in other respects fairly perfect. As no trace of sutures can be detected, it may be inferred that it belonged to an adult individual; and its general form and structure indicate that it belonged to a land-tortoise, which must have been of very large dimensions.

In general contour the specimen appears to agree to a considerable extent with the skull of *Manouria emys* figured by Gray[3]; the latter apparently having a decidedly concave palate and a broad postorbital bar, which are characteristic features of the fossil. The palatal concavity appears, however, less deep in the recent skull, and the whole skull is decidedly narrower than the fossil specimen; while frontal region of the latter is more elevated in front of the orbit; and from a character noted below it is probable that the nasal opening was directed more downwardly than in the living Indian species.

Compared with the crania of recent gigantic land-tortoises in the British Museum, the fossil agrees with that of *Testudo ponderosa*[4] of Aldabra in its deeply concave palate; this character being very strongly marked in that species,[5] but occurring in a lesser degree in all the species from the same island, which are thus distinguished from those of Mauritius,[6] and to a smaller extent from the Rodriquez tortoise.[7] This concavity is of moderate extent in the Galapagos tortoises.[8] Both

1 For the homology of this channel see Dollo, 'Bull. Mus. R. Hist. Nat. Belg.,' vol. III. p. 180 (1884).

2 "Palæontological Memoirs," vol. I. p. 374.

3 "Supplement to Catalogue of Shield-Reptiles," pt. 1, p. 7, woodcut fig 1: the specimen is figured under the name of *Scapia falconeri*; but it really belongs to *Manouria emys*; *vide* Theobald's "Catalogue of the Reptiles of British India," p. 4. The skull is now in Calcutta, and only the figure is therefore available for comparison.

4 *Vide* Günther's "Gigantic Land-Tortoises," pl. VIII.

5 *Ibid*, p 36.

6 *Ibid*, p. 44.

7 *Ibid*, p. 55.

8 *Ibid*, p. 62.

in the Siwalik fossil and *T. ponderosa* the impression in front of the occipital condyle is wide, shallow, and horse-shoe-shaped. It is unfortunate that the characteristic prefrontal of the fossil is broken; but enough remains to indicate that the nasal opening was probably higher than wide, and that the front margin of the premaxillæ projected so far in advance of the prefrontals as to cause the nasal opening to slope downwards as in the Aldabra tortoises; the upper surface of the premaxillæ being highly inclined as in those forms, instead of nearly horizontal as in the other recent gigantic forms. The orbit is placed relatively low down in the fossil, and there is a rudiment of a frontal convexity; although this makes no approach to that obtaining in the Aldabra forms. The postorbital bar of the latter is much narrower than in the Siwalik specimen. In the general contour of the palatal aspect the fossil is very like that of *T. ponderosa*,[1] and narrower than *T. elephantina*.[2] The following table shows the dimensions of the fossil and the male crania of *T. ponderosa* and *T. elephantina* figured by Dr. Günther[3]:—

	T. ponderosa.	T. elephantina.	Fossil.
Length from hinder border of quadrate to extremity of premaxilla	3·0	4·1	6·8
Interval between external surfaces of the quadrates . . .	2·8	3·9	6·3

The cranium of *T. elephantina* measures 5·5 inches from the occipital condyle to the premaxilla, and the corresponding length of the fossil would be 9·1 inches. As another male cranium of *T. elephantina* has a basal length of 6 inches, the fossil indicates an animal just one-and-a-half times the size of the largest males of the living species; and as the carapace of the largest male of that species measures 4 feet 1 inch in a straight line,[4] the calculated length of the carapace of the individual to which the fossil cranium belonged would be 6 feet;—or identical with the size calculated for the smaller (? female) form of the present species from the size of the smaller epiplastron. There is therefore no reason as regards size why the present specimen should not have belonged to a female of the species under consideration, although it cannot be affirmed that it may not have belonged to the species next described. It is probably too large to have belonged to either of the Punjab species of large tortoises described below, whose remains are not recorded from the Siwalik Hills. The calculated basal length of the cranium of the larger individuals of the present species would be twice the size of the cranium of *T. elephantina*, or 12 inches.

Affinities.—The foregoing observations indicate that the present species was a land-tortoise distinguished from all living forms except the Oriental *Manouria emys* by the non-union of the pygal plates. Assuming the right of that species to generic distinction,[5] it will be evident that the present form cannot be referred to *Testudo*; and since the relations of the pectoral plates of the males of the Siwalik species to one another are unknown, and the structure of the epiplastron is so very different from that of *Manouria emys*, it seems inadvisable to refer the fossil species to that

1 " Gigantic Land-Tortoises," pls. VIII., IX.
2 *Ibid*, pl. IX.
3 *Ibid*, pl. VIII.
4 *Ibid*, p. 25.
5 The generic characters of *Manouria* are the separation of the pectoral plates of the male, the non-union of the pygals, and the partially webbed character of the hind feet: the latter character indicating subaquatic habits.

genus, and accordingly, at least as a provisional measure, the name *Colossochelys* is retained. Whether the non-union of the pygals indicates that *Colossochelys* participated in the subaquatic habits of *Manouria* cannot be determined. In the form of the epiplastron *C. atlas* differs very widely from the Aldabra and other recent gigantic land-tortoises, and apparently comes nearest to *Manouria emys* and perhaps the Madagascar *Testudo radiata*; although in both cases the resemblance is a remote one. The xiphiplastron most resembles the corresponding part of *Manouria emys* and *Testudo horsfieldi*, and differs from all the gigantic recent tortoises. The cranium provisionally referred to this species seems to indicate a form intermediate between *Manouria emys* and the gigantic tortoises of Aldabra. In size the largest individuals of *C. atlas* were about double the size of the largest males of *T. elephantina*; while the smaller (? female) individuals were about one-half larger than the males of the latter, or about double the size of the females.

Some features in the structure of the present species suggest a few considerations of a somewhat wider import. In the first place the non-union of the pygal plates in this pliocene form, as well as the occurrence of the same feature in all the emydine tortoises, which are very probably the older forms, may suggest that the union of these plates in all recent land-tortoises, except *Manouria emys*, is a specialized character of late origin; in which case the last-named species will be the solitary survivor of a very ancient type—this being borne out by its subaquatic habits and wide distribution.

With regard to the epiplastron, there can be little or no doubt but that the form which the gular plates present in *Testudo horsfieldi*, *T. græca*, and numerous other species, is the most generalized, since it obtains in the majority of the emydine tortoises. In the prolongation of the gulars in front of the postgulars, with the retention of the V-shaped sutures between the two, the epiplastron of *Colossochelys atlas* and the other Siwalik species described below is evidently an advance on this generalized form. The next step is the epiplastron of *Manouria emys*, where the suture between the gulars and postgulars forms a very obtuse angle, and the former are almost entirely in advance of the latter; and from this to the epiplastra of the Aldabra *Testudo elephantina* and *T. ponderosa* is but one step more, where the gulars are very small, and the suture dividing them from the postgulars forms almost a straight line.

Bearing in mind this relation and taking into consideration the intermediate character of the cranium described above and provisionally referred to *Colossochelys atlas* between the crania of *Testudo ponderosa* and *Manouria emys*, it appears not improbable that the Aldabra tortoises are a branch which having taken origin from the old Indian stock of gigantic land-tortoises,[1] has developed very highly specialized characters in the cranium and plastron, and in common with other recent tortoises, has lost the divided pygals characteristic of at least one of the older Indian forms.

[1] *Vide infra.* The extreme specialization of the epiplastron of *Colossochelys atlas* probably indicates that this species forms a separate divergent branch.

What advantage to their owners has been the union of the pygals in nearly all land-tortoises, and how the advanced position and small size of the gular plates in the highly specialized Aldabra tortoises have helped them in the fight for supremacy, are questions which the writer cannot attempt to answer.

Distribution.—Remains of this species have been obtained from the typical Siwalik Hills, and Falconer[1] refers to it certain fragments of the shells of large tortoises from the Siwaliks of Burma and Perim Island. It has not been found in the Siwaliks of the Punjab, the lower Siwaliks of Sind, or the Narbadas.

At the conclusion of their most important memoir on this species Falconer and Cautley[2] observed "that there are fair grounds for entertaining the belief as probable that the *Colossochelys atlas* may have lived down to an early period of the human epoch and become extinct since:—1st. From the fact that other chelonian species and crocodiles, contemporaries of the *Colossochelys* in the Siwalik fauna, have survived. 2nd. From the indications of mythology in regard to a gigantic species of tortoise in India." Very little weight can be attached to any argument drawn from the first point; and against it there is the circumstance that no remains of the species have been obtained from the pleistocene Narbadas, although this absence may be explained by a restricted range in space. The distribution of gigantic tortoises in the recent and pleistocene epochs affords, moreover, another argument against Falconer's view, since all of them are found in islands where large mammals are entirely absent[3]; and it would, therefore, seem that these reptiles (which, from their distribution in time and space, evidently belong to an old group[4]), although they originally existed on the continents and for a time lived side by side with the larger mammals,[5] were eventually ousted by the latter, and only persisted in islands where they were not subject to such rivalry. Now the remains of *Colossochelys atlas* (as well as those of the somewhat smaller contemporary forms noticed below) are extremely rare as compared with the bones of elephants (and from the size and solidity of the epiplastron this part at least ought to be very frequently preserved), and it would thus appear that the species was one in course of extirpation by the struggle with the large Siwalik mammals, and it is therefore improbable that it persisted down to the human period.

With regard to the argument derived from mythology, Falconer and Cautley[6] base their conclusions on the improbability of the existing tortoises of India leading to the conception of an animal capable of supporting the world, or of holding its own in combat with an elephant. In the second of the two legends it is stated that

1 "Catalogue of Fossil Vertebrata in Mus. As. Soc. Bengal," pp. 32, 203 (1859).

2 "Palæontological Memoirs," vol. I., p. 369.

3 A small elephant and hippopotamus existed with the gigantic Maltese tortoise.

4 *Vide* Wallace, "Geographical Distribution of Animals," vol. I., p. 289 (1876).

5 The gigantic pliocene land-tortoise of Mont Lebéron, Vaucluse (*vide* Gaudry, "Animaux Fossiles du Mont Lebéron," p. 70 [1873]), coexisted with a large mammalian fauna.

6 *Op. cit.*, pp. 367-8.

both the elephant and the tortoise are carried off by a bird, in which Falconer and Cautley recognize the Indian *Leptoptilus argala*, and it hardly requires a much greater stretch of imagination to raise this bird to the required dimensions than to elevate the existing Indian *Manouria emys* (which attains a length of 20 inches) into an animal of the bulk of an elephant.

GENUS: *non. det.*

The imperfect remains on which the following species are founded do not admit of generic determination, although they are of considerable interest as indicating the great development which the group of gigantic land-tortoises attained in the pliocene of India.

SPECIES 1.

(About one-half larger than *Testudo elephantina.*)

History.—In 1859 Falconer[1] noticed the epiplastron of a large land-tortoise from the Siwalik Hills in the collection of the Asiatic Society of Bengal, and remarked that it was either specifically or sexually distinct from the type epiplastron of the preceding species. This specimen forms the subject of the present notice.

Epiplastron.—The specimen above-mentioned is figured of one-third the natural size in plate XVIII. fig. 4. from the ventral aspect. It comprehends the anterior portion of the epiplastron, showing nearly the whole of the space occupied by the gulars, and part of that by the postgulars. The anterior extremity is somewhat damaged, and when complete probably showed a slight bifurcation. Both the dorsal and ventral surfaces are convex along the median line. The sutures bounding the gular plates form an acute angle, and the portion of the bone in front of the anterior termination of these sutures, evidently projected in advance of the rim of the body of the plastron: the impressions formed by the sutures between the gulars and post-gulars are comparatively shallow. There is no trace of the inferior keel so characteristic of the epiplastron of *Colossochelys atlas*; and the bone is of medium thickness. As the specimen indicates an animal about the size of the smaller individuals of the latter species, the length of the carapace was probably about 6 feet in a straight line.

Distinctness and affinities.—The present specimen indicates a tortoise with an epiplastron about intermediate in character between that of *Colossochelys atlas* on the one hand and *Manouria emys* on the other, the production of the gular portion in advance of the postgular distinguishing it from *Testudo horsfieldi* and its allies; while it is widely distinguished from the gigantic tortoises of the Aldabra group by the acute angle formed by the suture between the gulars and postgulars, as well as by its greatly superior size. The specimen is so different from the epiplastron of *Colossochelys atlas* that in the absence of any such difference in the two sexes of recent tortoises, as well as from the circumstance that the female of that species is

[1] "Catalogue of Fossil Vertebrata in Mus. of the As. Soc. Beng.," p. 170, No. 673 (1859).

probably indicated by the small epiplastron described above, there seems every probability of its indicating a second gigantic species of land-tortoise from the Siwalik Hills.

In the absence of other remains it is impossible to arrive at any satisfactory conclusion as to the generic position of the present form ; but the probability is that the specimen indicates a species allied to *Colossochelys* and *Manouria*, and future discoveries may perhaps show that it will eventually be necessary to unite the two genera.

Species 2.

(? *Cautleya annuliger*, Theobald.[1])

(About one-fourth larger than *Testudo elephantina.*)

History.—The existence of this third gigantic species of Siwalik land-tortoise was indicated by the present writer in 1880[2] upon the evidence of the epiplastron noticed below.

Epiplastron.—The broken anterior extremity of the plastron represented of one-third the natural size in plate XVIII. figs. 3. 3a. from the dorsal and ventral aspects was collected by Mr. Theobald in 1879 from the Siwaliks of the Punjab: it comprises the greater part of the epiplastron, broken on the left side, and corroded ventrally. On the latter aspect the greater part of the intergular suture, and also the one between the gulars and postgulars, are preserved, and serve to indicate the form of the gular plates.

From its general resemblance to the corresponding portion of the plastron of *Colossochelys atlas* and the specimen represented in figure 4 of the same plate the fragment under consideration pretty evidently belonged to a large tortoise allied to the two preceding species. It indicates an animal considerably smaller than that to which the specimen represented in fig. 4 belonged, which was perhaps about one-fourth larger than the recent *Testudo elephantina.* The free extremity is bifurcate, but to a considerably smaller extent than in *Colossochelys atlas* ; probably resembling in this respect the specimen represented in fig. 4. The dorsal surface (fig. 3) is extremely convex; differing in this respect, as well as by the curvature of this surface towards the free extremities, from the latter. The ventral surface (fig. 3a) has not the strongly marked keel of *C. atlas*, but the gular portion is distinctly raised above the postgular, from which it is separated by a very deep channel; a similar channel dividing the two gular areas. The form of the ventral surface is therefore about intermediate between that of *C. atlas* and the specimen represented in fig. 4, in which the gular portion is not raised above the postgular, and the sutures do not form deep channels. The suture between the gulars and postgulars forms an acute angle, as in *C. atlas*, the specimen represented in fig. 4, and *Testudo horsfieldi*, etc.; the corresponding suture in *Manouria emys* forming an obtuse angle.

1 'Rec. Geol. Surv. Ind.,' vol. XII. p. 186 (1879). 2 'Journ. As. Soc. Beng.,' vol. XLIX. pt. II. p. 16.

The production of the gular far in advance of the postgular portion is, however, a character of the last-named species. The length of the upper thickened portion to the commencement of the bifurcation is 6·3 inches; the vertical thickness posteriorly being 4·2 inches.

Distinctness and affinities.—The specimen indicates beyond reasonable doubt the specific distinctness of the form to which it belonged both from *C. atlas*[1] (of which no specimens occur in the region whence the fossil was obtained) and the species to which the specimen represented in pl. XVIII. fig. 4. pertained. The present form is very considerably larger than any of the recent gigantic land-tortoises, none of which have an epiplastron presenting any close resemblance to the specimen under consideration. The writer has been unable to identify the latter with any described species of *Testudo*, and as in his opinion it affords good evidence of a very distinct species of gigantic land-tortoise, he considers that it indicates a new species, but for reasons mentioned below it is considered inadvisable to give it a specific name. Until the union or non-union of the pygal plates be known it cannot be determined how close is its affinity with *C. atlas* and *M. emys*, but the approach made in the structure of the epiplastron to that of both those forms indicates the probability of the three belonging to an allied group.

Cautleya annuliger, *Theobald.*[2]—In the passage cited Mr. Theobald has described and figured a free marginal scute of a large tortoise from the Siwaliks of Nila, in the Rawal-Pindi district of the Punjab, under the name of *Cautleya annuliger*. The specimen appears to be the last marginal of the right side (the one in contact with the pygal scute), and it agrees exactly in form with the corresponding scute of *Testudo græca*. The peculiarity of this specimen consists in the circumstance that its union with the last costal and vertebral scutes is a cartilaginous one[3]; from which Mr. Theobald is inclined to infer that the union of the whole of the marginal series of scutes with the costals was a cartilaginous one, and further that the species was a purely aquatic emydine. The evidence at our disposal only shows the cartilaginous union of the hinder free marginals, and as the specimen indicates an animal agreeing exactly in size with the epiplastron described above, and as there is no evidence of the existence of a true emydine of equal dimensions in the Siwaliks, it appears highly probable that the specimen belongs to the present form. If that be the case the specific name of this form will be *annuliger*; and since the peculiar union of the hinder marginals probably indicates generic distinctness the name *Cautleya* may also be retained; although the inexpedience of forming a species, and still less a genus, upon a specimen like the present has been already noticed in the Introduction, where it was shown that unless all the species of large Siwalik tortoises are founded upon homologous parts of the carapace there is practically no limit to the number of so-called species that may be based upon the remains of a few forms.

1 The great difference in the form of the specimens lends no countenance to the idea that the present specimen may belong to a young individual of *C. atlas*.

2 'Rec. Geol. Surv. Ind.," vol. XII. p. 186, and plate (1879).

3 This surface is the one above *a* in figure 1 of Mr. Theobald's plate, which shows the concave outer surface of the bone.

If the two specimens noticed above be specifically the same, and Mr. Theobald be right in regarding the second one as indicating an animal with aquatic habits, it may be that the present species was a tortoise allied to *Colossochelys atlas* and *Manouria emys*, having the subaquatic habits of the latter species still more strongly developed, and thus pointing to the origin of the whole group from an earlier purely aquatic form.

Species 3.

(About one-fourth larger than *T. elephantina.*)

Epiplastron.—The evidence of the existence of a fourth species of gigantic land-tortoise in the Siwaliks is afforded by the anterior portion of an epiplastron represented of one-third the natural size in pl. XVIII. fig. 2, which was collected by Mr. Theobald in the Siwaliks of the Punjab. The specimen, of which the dorsal aspect is represented in the figure, is in a much damaged condition, and does not exhibit the boundaries of the horny plates: it indicates an animal perhaps slightly larger than the preceding species. In general contour it presents a considerable resemblance to the epiplastron of the latter, but is distinguished by its relative shortness, and much greater thickness; the length of the dorsal thickened portion to the extremity of the bifurcation being 5·6, and the vertical thickness posteriorly something over 5 inches when complete. The anterior cornua are thicker, more upwardly recurved, and more widely separated than in the last form.

Distinctness and affinities.—The differences between the present specimen and the epiplastron of the last form are so marked as apparently to preclude the idea that they can belong to different sexes of the same species; and the observations recorded as to the specific distinctness of the latter will be equally applicable to the present form. The imperfect nature of the specimen under consideration, and the slight glimpse it affords of the affinity of the tortoise to which it pertained, renders it undesirable that it should receive a specific name; and it is described merely to illustrate the great development which the present group attained in the Siwalik period.

Species 4.

(Rather smaller than *Testudo elephantina.*)

History.—In 1879 Mr. Theobald[1] referred to some epiplastral and other portions of the shell of a species of land-tortoise obtained by himself from the Siwaliks near Nila in the Punjab, which indicated an animal considerably exceeding in size the existing *Manouria emys*: these and other specimens from the same district form the subject of the present notice.

Epiplastron.—Among Mr. Theobald's collection are the detached right and left epiplastral scutes evidently belonging to different individuals of the same species, and pertaining to a land-tortoise: these specimens are combined and figured of one-third the natural size in pl. XIX. figs. 1. 1a.; and show the entire form of the gular

[1] 'Rec. Geol. Surv. Ind.,' vol. XII. p. 187.

plates. In addition to its greater inferior size this form of epiplastron is distinguished from that of the four preceding types by the absence of any distinct bifurcation at the free extremity. In the rectangular termination and long anterior surface this type agrees with *Testudo horsfieldi* and *T. elongata*, and differs from *Manouria emys*[1]; but the angle formed by the junction of the sutures separating the gular and postgular plates is rather less acute than in the two former; while the gular portion is produced in advance of the postgular, as in *M. emys*. The recent Aldabra tortoises are distinguished from the present form by the smaller epiplastrals, and the nearly straight line formed by the sutures between the gulars and postgulars[2]; while the Mascarene forms are still more widely distinguished by the union of the gular plates.[3] In the figured specimen the length of the intergular suture is about 3·5 inches, and that of the one between the gulars and postgulars 3 inches: the corresponding dimensions in a male of *Testudo elongata*, in which the length of the carapace is 9·1 inches, being 1·0 and 0·9 inches. The fossil epiplastra indicate, therefore, a carapace of about 33 inches in length, or intermediate between the males and females of *T. elephantina*.[4] A pair of conjoint epiplastra from the Siwaliks of the Punjab in the Indian Museum (No. E 79) indicate a rather smaller individual not improbably belonging to the same species.

Nuchal scute.—The greater portion of the nuchal scute of a large land-tortoise represented of one-third the natural size in pl. XIX. fig. 4. agrees so well in relative size with the foregoing specimens that it not improbably belongs to the same species. It has a very large nuchal plate, which is widest anteriorly; and in the great width of this plate the specimen differs from *T. elongata* and *T. horsfieldi*, and approaches *Manouria emys*. The length of the nuchal plate is 2·3, and its width anteriorly 2·0 inches. The presence of the nuchal plate differentiates the species to which it belonged from the recent Mascarene and Galapagos gigantic tortoises.[5]

Xiphiplastron.—The left posterior half of the xiphiplastron[6] of a land-tortoise with the same history as the last specimen, may from its size be not improbably referred to the same species as the epiplastra: it shows the form of the whole of the postabdominal plate, which has a length of 9, and an extreme width of about 7 inches. The specimen is much curved, and apparently agrees to a great extent with the corresponding portion of the plastron of *M. emys* and *T. horsfieldi*: it differs widely from *T. elongata*, and likewise from the Aldabra and Mascarene tortoises.

Distinctness and affinities.—Apart from the question whether all the specimens noticed above belong to the same species, they indicate the existence of a land-tortoise of inferior size to *T. elephantina*, and exhibiting affinity with the existing land-tortoises of India and Burma, but largely exceeding all of them in size. The species is distinct from the recent Aldabra, Mascarene, and Galapagos tortoises, and the writer has been unable to identify it with any described fossil form. Its nearest

1 *Vide* Gray, "Catalogue of Shield-Reptiles," pt. I. pl. III.
2 *Vide* Günther, "Gigantic Land-Tortoises," pls. IV. VI. VII.
3 *Ibid*, p. 10.
4 *Ibid*, p. 25.
5 *Vide* Günther, *op. cit.*, p. 10.
6 Indian Museum, No. E 83.

ally on the whole appears to be *Manouria emys*, but in the absence of any evidence as to the relations of the pectoral and pygal plates it is impossible to refer it to its proper generic position, and nothing would therefore be gained by giving it a distinct specific name.

Family II. *EMYDIDÆ.*

Shell sometimes convex, generally more or less depressed, covered with horny plates: feet webbed, and adapted for swimming: pygal plates not united.

Genus I. CLEMMYS, Wagler.[1]

Including *Bellia*, *Damonia*, *Geoclemmys*, and *Melanochelys*, Gray.

Carapace and plastron united by a bony suture, and no transverse joint in the latter; 3rd and 4th vertebral plates connected by a broad suture; plastron flat in both sexes.

Unless the specimens were males showing their characteristic concave sternum it would seem very frequently impossible in the fossil condition to distinguish *Geoemyda* from the present genus; and as Mr. Theobald[2] is inclined to regard *Clemmys trijuga* as very close to *Geoemyda* it is probable that the two genera are intimately allied.

The term *Clemmys* corresponds nearly with the name *Emys* as employed by Gray in his earlier works; but the latter name is now applied to the European pond-tortoise (*E. europæa*), and corresponds to Gray's *Lutremys*.

Clemmys is found over a great part of the warmer regions of the habitable world at the present day except Australia; and it is probable that many of the European and N. American tertiary emydines described under the name of *Emys* belong to it: these range at least down to the eocene.[3] The number of recent and fossil species is so great that it would be very difficult to give a correct list.

A. No keel on the carapace of the adult.

Species 1. Clemmys sivalensis (Theobald[4]).

Syn. *Bellia sivalensis*, Theobald.[5]

(Allied to *Clemmys crassicollis* [Bell]).

History.—This Siwalik species was first described by Mr. Theobald in the passage cited upon the evidence of the shell noticed below, which is now for the first time figured.

Type shell.—The type shell, which was obtained by Mr. Theobald from the Siwaliks to the south of the village of Jhand in the Punjab, is figured in plate XX. figs. 1. 1a. 1b. of one-half the natural size; and shows the anterior two-thirds of the shell, as far back as the hinder edge of the 3rd vertebral plate. It has suffered

1 "Syst. Nat. Amphib. etc" p. 136 (1830).
2 "Catalogue of the Reptiles of British India," p. 5.
3 *Vide* Leidy, "Extinct Vertebrate Fauna of the Western Territories," p. 340 (1873).
4 'Rec. Geol. Surv. Ind.' vol. X. p. 44. (1877). *Bellia.*
5 *Loc. cit.*

somewhat from crushing, but not to such an extent as to mar the general contour. The plastron is preserved, but is crushed into the carapace, and is much obscured by matrix, except anteriorly (fig. 1b): it is united by bone with the carapace. The sutures between the bony scutes are nearly all invisible, which indicates that the specimen is adult. Mr. Theobald's description of this specimen may be paraphrased as follows:—" Shell oblong-ovate, depressed; very flat along the vertebral region, and without the trace of a keel; sides shelving; [anterior] margin simple. Nuchal plate absent. First vertebral plate five-sided, with an obtuse angle in front; anterior borders straight, lateral concave, posterior sinuated: this plate, like those which follow, is notched posteriorly to receive a corresponding projection from the succeeding one. Second and third vertebrals equal and similar, mushroom-shaped and six-sided: anterior and posterior borders equal; the former convex, the latter concave. First costal plate large, reaching to the centre of the fifth marginal. Marginals subequal, the first being the largest. When perfect the shell must have been close on nine inches long and six broad.

" The most obvious characters of this species are the great flatness of the top of the shell, the complete absence of any keel or nodosity, and the peculiar mushroom-shaped vertebrals. The latter very closely resemble those of *Clemmys crassicollis* (Gray), but that species, at present not known to range north of Tenasserim, has a small nuchal plate, which is certainly absent in the fossil. Still, however, the two are very similar; the fossil being rather larger than any specimen of the living species that I have seen." There are no traces of areolæ; and the anterior marginals are of considerable antero-posterior width: the anterior border of the plastron has an even contour.

The following are the dimensions of the more important plates:—

Length of 1st vertebral	1·97	Length of posterior border of 1st costal	2·15
Greatest width of ditto	1·65	Antero-posterior diameter of ditto	2·83
Length of posterior border of ditto	1·03	Length of gular	1·5
Length of 2nd vertebral	1·52	Width of ditto	0·84
Width of ,, ,,	1·97	Length of gular and postgular	1·7
Length of posterior border of ditto	1·04		

The height of the carapace is 2·6 inches, the width being about 6 inches.

Second specimen.—The anterior portion of the shell of a somewhat smaller but apparently adult emydine in the Indian Museum (No. E 91), collected by Mr. Theobald in the Siwaliks of the Punjab, agrees so exactly with the last specimen that it may be safely referred to the same species, of which it may be the female. It shows the anterior part of the carapace as far back as the middle of the 2nd vertebral, and the plastron as far back as the hinder part of the abdominal plate. The carapace has the same depressed form as in the type, with the shelving sides, and flattened, keelless vertebral region. There is no nuchal plate; the marginals are relatively wide, and the 1st and 2nd vertebrals agree precisely in form with those of the type; the gulars are likewise similar.

Third specimen.—A third specimen in the Indian Museum (No. E 90), also collected by Mr. Theobald in the Siwaliks of the Punjab, exhibits the nearly complete shell of a small (? female) individual, but unfortunately with the exception of the anterior marginals, and 1st and 5th vertebrals, the boundaries of the plates are invisible. The shell agrees exactly in form with the type specimen, exhibiting very clearly the characteristic flattened and keelless vertebral region. The width is 4·8 inches, and the height of the carapace 1·9 inches. The 5th vertebral is of moderate width; and the lateral edges of the carapace are nearly straight.

Distinctness and affinities.—The three specimens show clearly that the characters of the type are constant ones. Compared with the large series of shells of *C. crassicollis* in the British Museum, the fossil form differs in the characters mentioned by Mr. Theobald, and also by the wider posterior border of the 1st vertebral plate. The anterior portion of the plastron (fig. 1b) shows more marked differences, the gular plates being relatively longer, their posterior extremity forming a more acute angle, and the suture between the postgulars being only $\frac{1}{5}$ the length of the intergular suture, instead of about $\frac{1}{3}$, as in *C. crassicollis*. These differences, especially the absence of a nuchal plate, and the extremely flattened vertebral region, fully confirm Mr. Theobald's conclusions as to the distinctness of this form from *C. crassicollis*, and as it is totally different from any other species known to the writer it may rank as a distinct species. That it is intimately allied to *C. crassicollis* is quite evident, but the absence of the nuchal plate may render it doubtful whether it can be considered as the direct ancestor of that species. *C. crassicollis* occurs in India, Tenasserim, the Malay Peninsula, and probably in Sumatra and Java.

Species 2. CLEMMYS HYDASPICA, n. sp. *nobis*.

Shell.—The evidence for the existence of this species of *Clemmys* is afforded by a nearly complete shell collected by Mr. Theobald in the Siwaliks of the Jhelam district of the Punjab, which is figured of one-half the natural size in plate XX. figs. 4. 4a. The specimen has lost the anterior and some of the posterior marginal scutes, and the hinder half of the plastron, but is otherwise very perfect, and totally unaffected by crush. The boundaries of all the costal and vertebral plates, with the exception of the 4th vertebral[1] are distinctly defined; and some of those of the underlying bony scutes are also visible: the plastron is so damaged that only the form of the gular and postgular plates can be traced. As the plastron is united by bone with the carapace, while the pygal plates are separate, and the general resemblance of the vertebral plates to those of the last species is very close, the specimen may be referred to the present genus; and its affinities may be indicated by comparing it with *C. sivalensis*.

From that species the present form is at once distinguished by the more vaulted and regularly oval carapace, of which the lateral surfaces are highly arcuated, and the sides of the anterior portion instead of shelving rapidly are full and convex; the vertebral region is also highly convex, having no trace of the flatness so

[1] This is restored in the figure.

characteristic of *C. sivalensis.* The difference in the form of the shells is indicated by their respective dimensions; the width of the present specimen being 5·1 inches, and the height of the carapace 2·6 inches. The two forms agree in the absence of any trace of either vertebral or costal keels, and of areolæ. In profile (fig. 4a) the contour of the carapace of the present form is very similar at its two extremities.

It cannot, unfortunately, be determined whether the present form possessed a nuchal plate: the anterior marginals are relatively wide antero-posteriorly. The 1st vertebral plate closely resembles that of *C. sivalensis*, with the exception that its posterior border is entire. The 2nd and 3rd vertebrals also have a strong general resemblance; but their anterior borders in place of being sinuated with a median projection, are convex and continuous with the anterior lateral borders, so that these plates become more 'balloon-shaped,'[1] and are practically three-sided: their posterior borders are entire. The 5th vertebral is extremely wide; its inferior border equaling the united width of the pygal and last marginal plates. The gular and postgular plates are apparently very similar to those of *C. sivalensis.*

Distinctness and affinities.—The foregoing comparisons indicate pretty clearly the specific distinctness of the present form from *C. sivalensis*[2]; but the resemblance in the shape of their vertebral plates probably indicates their affinity. *C. crassicollis* is distinguished from the present form by its more depressed carapace, less 'balloon-shaped' middle vertebrals, much narrower 5th vertebral, shorter gular plates, and the straighter lateral edges of the carapace. Whether the two agreed in possessing a nuchal plate, and in having serrated posterior marginals cannot be determined from the present specimen. As no other species with which the writer is acquainted[3] presents any close resemblance to it, the fossil may be regarded as specifically distinct, and it is proposed to name it *Clemmys hydaspica*, from the classical name of the river Jhelam.

The writer does not think it probable that *C. hydaspica* is the direct ancestor of *C. crassicollis*, but in connection with the preceding and succeeding species it indicates the great richness in forms which the group of emydines to which that species belonged attained in the pliocene of India.

Species 3. CLEMMYS THEOBALDI, n. sp. *nobis.*

Shell.—This species is founded on the shell represented of one-half the natural size in plate XX. figs. 2. 2a. 2b.; which was obtained by Mr. Theobald from the Siwaliks of Jhand in the Punjab. It is perfect as far back as a short distance behind the 3rd vertebral plate, where it is broken off by a fracture extending through the carapace and plastron. The greater part of the plastron is preserved,

1 To Anglo-Indian readers an inverted 'gharra' would best convey the form of these plates.

2 In certain tortoises, *e.g. Testudo elongata*, considerable differences in the form of the carapace of the two sexes is observable, but nothing comparable to that existing between *C. sivalensis* and the present form. *C. crassicollis*, moreover, does not present such differences; and there is also the probability that the small specimens noticed above belong to females of *C. sivalensis.*

3 With regard to *Clemmys nuchalis*, see the next species.

but is crushed in along the middle line; the anterior extremity is represented in fig, 2b. A malformation exists in the hinder part of the carapace, the 4th vertebral and the 3rd costal plates having apparently been double. The sutures between the bony scutes are invisible, from which it may be inferred that the specimen is adult.

The carapace and plastron are united by bony sutures, from which circumstance, together with the general resemblance in the form of the vertebral plates to those of the two last species, the specimen may be referred to the present genus. The distinctive characters of the shell may be best exhibited by comparing it with that of *C. sivalensis.* In the first place the whole shell is still more depressed, and the vertebral region of the carapace flatter. The marginal plates, and more especially those of the anterior border, are remarkably narrow in an antero-posterior direction, instead of being relatively wide: thus the transverse diameter of the 1st marginal of the present specimen is 1·2 inches, and the antero-posterior 0·45; the corresponding dimensions in *C. sivalensis* being 1·2x0·94. The 1st vertebral is pentagonal, considerably wider in front than behind, with the lateral borders sinuated: at the junction of the two anterior borders an acute process is given off, which separates the 1st marginals of the two sides, there being no nuchal plate: the antero-external angles of the 1st vertebral are much produced and extend as far as the 1st marginal sutures, instead of being placed considerably nearer the median line as in *C. sivalensis* and *C. crassicollis.*[1] The 1st vertebral is much wider than in *C. sivalensis*, and its very different form may be seen by a comparison of the two figures. The 2nd and 3rd vertebral and the costal plates are so similar to those of *C. sivalensis* and *C. crassicollis* that they afford no distinctive characters. On the ventral aspect the anterior extremity of the plastron is slightly narrower, and the gular plates perhaps rather shorter. The extreme width of the specimen is 5·2, and the height of the carapace 1·5 inches. There is not the faintest trace of a vertebral keel, but there are indications of the existence of costal keels at an earlier age, although they are now practically obliterated. There are no traces of areolæ.

Distinctness and affinities.—The differences pointed out above indicate the specific distinctness of this form from *C. sivalensis*; and its distinctness from *C. hydaspica* is so evident as not to require special notice. It differs from *C. crassicollis* still more widely than is the case with *C. sivalensis.* As the only existing form closely allied to *C. crassicollis* mentioned by Gray[2] is *Clemmys nuchalis* (Blyth), from Java, which is apparently distinguished from *C. crassicollis* merely by difference in colouration, the form under consideration may be pretty certainly regarded as belonging to a new species, which it is proposed to term *C. theobaldi*, in honour of the collector of the type specimen of this and the allied Siwalik species.

Clemmys theobaldi appears to be a highly specialized form belonging to the *C. crassicollis* group which has entirely disappeared at the present day.

1 In one specimen in the British Museum (No. 47. 1. 13. 11) the antero-external angles of the 1st vertebral plate reach to within a short distance of the 1st marginal sutures.

2 "Supplement to Catalogue of Shield-Reptiles," pt. I. p. 41.

Species 4. CLEMMYS PUNJABIENSIS, n. sp. *nobis.*

Shell.—The fourth Siwalik species of this genus is also founded upon the greater portion of a shell collected by Mr. Theobald from the Siwaliks of the Punjab; and represented of one-half the natural size in plate XX. figs. 3. 3a. 3b. The specimen comprises the anterior half of the plastron (which is united by bone with the carapace), and the anterior part of the carapace as far back as the hinder border of the 3rd vertebral plate, wanting, however, the greater portion of the anterior marginals. A few traces of the sutures between the bony scutes can be detected here and there.

The general form of the vertebral plates and the bony union of the carapace and plastron indicate without much doubt the generic position of the specimen. The shell agrees with the three preceding species in the total absence of either vertebral or costal keels, and of areolæ, but is at once distinguished both from *C. sivalensis* and *C. theobaldi* by its much more vaulted carapace, and the consequent high angle of the plane of the anterior part of the 1st vertebral plate: from *C. hydaspica* it is distinguished by the latter character, and the great difference in the form of the vertebral plates. From the imperfect condition of the anterior margin of the carapace it cannot be determined whether a nuchal plate was present. The 1st vertebral plate is bell-shaped, considerably longer than broad, and entirely different from the corresponding plate in either of the three preceding species. The 2nd vertebral is hexagonal, and narrower behind than in front: it is less distinctly 'mushroom-shaped' than the corresponding plate of *C. sivalensis* and *C. theobaldi*, and has not the 'balloon-shape' of *C. hydaspica.* The 3rd vertebral is hexagonal, and nearly symmetrical; its width in front being not greater than behind: it is quite different from the corresponding plate in either of the three preceding species. The anterior marginal plates are intermediate in width between those of *C. sivalensis* and *C. theobaldi*: the costals do not offer any distinctive characters. On the ventral aspect (fig. 3b) the gulars are relatively shorter than in either of the three preceding species; the suture between the postgulars being one-half the length of that between the gulars. The portion of the plastron covered by the gular plates is, moreover, thickened, and projects in front of that covered by the postgulars, instead of forming a nearly continuous line, as in the three species last described. The extreme width of the specimen is 5·2, and the height of the carapace 2·3 inches.

Distinctness and affinities.—The foregoing comparisons leave no doubt of the specific distinctness of the form under consideration from *C. sivalensis*, *C. hydaspica*, and *C. theobaldi.* None of the Asiatic species of the genus described by Messrs. Gray, Günther, and Theobald have a bell-shaped 1st vertebral like that of the fossil[1]; although this feature is presented in numerous North American species,—

[1] The form of the plates in *Cyclemys oldhami* (*Vide* Günther, "Reptiles of British India," pl. V. fig. B'') is very similar to that of the present fossil; but that form is widely differentiated by the cartilaginous union of the plastron and carapace.

e.g., *C. ornata*,[1] *C. venusta*,[2] *C. callirostris*,[3] *C. rivulata*,[4] and *C. ventricosa*.[5] All these species agree with the Siwalik fossil in the absence of costal and (except in *C. callirostris*) vertebral keels. The last-named species comes nearest to the fossil in the form of the first three vertebral plates, but the second plate is not so much contracted posteriorly: in the contour of the shell *C. ventricosa* makes a nearer approach to the specimen under consideration, but all the American species are more depressed.

As there seems no doubt of the specific distinctness of the present form from any Old World species of *Clemmys*, and as it is apparently equally distinct from, although more nearly allied to, those of N. America, it may rank as a new species, to which the name of *C. punjabiensis* may be assigned.

The total distinctness of *C. punjabiensis* from the existing Indian emydines, and its apparent kinship to those of N. America, is a remarkable and unexpected fact in the distribution of this group of tortoises.

B. Carapace with three continuous keels.

Clemmys, sp. 5.

(Allied to *Clemmys trijuga* [Schweigg.])

Shell.—The evidence of the existence of this fifth species of Siwalik *Clemmys* is afforded by a shell from the Siwalik Hills preserved in the Cautley collection of the British Museum, and represented of one-half the natural size in plate XXI. figs. 4. 4a. 4b. It comprises the nearly entire carapace, and the anterior part of the plastron; the latter having been crushed in, but exhibiting the gular and postgular plates (fig. 4b), and a portion of the pectorals: on the right side a part of the suture between the abdominal and pectoral plates, and that between the former and the marginals is also preserved. The carapace has lost most of the nuchal and part of the 1st marginal plates, as well as the greater portion of the pygal and hinder marginals; but sufficient remains to show that the pygals were not united. The plastron is united by bone to the carapace, showing that the specimen cannot belong to *Terrapene*,[6] *Cyclemys*, or *Pyxidea*: the difference in the form of the gular plates distinguishes it from a female of *Geoemyda*, and as it is evidently not a *Pangshura* and almost certainly not a *Batagur*, it may be pretty safely referred to the present genus.

The gular plates (fig. 4b) are of rather small size, the length of the intergular suture being only about one-and-a-half times that of the one between the postgulars. The carapace is subovate, somewhat depressed, slightly flattened superiorly as far as the 5th vertebral plate (which is obliquely placed) and bears three indistinct, low, and approximated keels, which are continuous throughout the length of the shell. In profile (fig. 4a) the anterior portion presents a gentle upward inclination from the margin to the vertex, while posteriorly there is a sudden ascent from the margin.

1 *Vide* Gray, "Catalogue of Shield-Reptiles," pt. I. pl. XII.
2 *Ibid*, pl. XIIA.
3 *Ibid*, pl. XIIB.
4 *Ibid*, pl. XI.
5 *Ibid*, pl. XIV.
6 Including *Cuora*, Gray.

The 1st costal plate is considerably larger than either of the two succeeding ones,[1] and extends as far back as the middle of the 5th marginal. There are indications of the presence of a nuchal plate: and there are distinctly marked areolæ, although they are not shown in the figures. The first vertebral is wider than either of the three following, and is pentagonal, widest anteriorly, with a rounded posterior border; its antero-external angles reaching nearly up to the 1st marginal sutures. The 2nd, 3rd, and 4th vertebrals are hexagonal, narrower behind than in front, and have concave borders to their hinder lateral surfaces: in the middle of their anterior border each of these plates gives off a projection, which is received into a notch in the plate in front. The 5th vertebral is not wider than either of the three preceding ones; and the anterior marginal plates are relatively wide antero-posteriorly. The absence of any trace of the sutures between the bony scutes indicates the full age of the specimen. Its dimensions are as follows, *viz.*:—

Length (about)	6·8	Length of 3rd vertebral plate . .	1·4
Width	4·3	Width ,, ,, ,, ,, . .	1·55
Height of carapace	2·5	Length ,, 4th ,, ,, . .	1·25
Length of 1st vertebral plate . . .	1·55	Width ,, ,, ,, ,, . .	1·6
Width ,, ,, ,, ,, . . .	1·85	Length ,, 5th ,, ,, . .	1·35
Length ,, 2nd ,, ,, . . .	1·4	Width ,, ,, ,, ,, . .	1·6
Width ,, ,, ,, ,, ...	1·5		

Distinctness and affinities.—The specimen is distinguished from each of the four preceding Siwalik species, as well as from the adult of the existing *C. crassicollis*, by the presence of the three indistinct keels and the well-marked areolæ: it is further distinguished from *C. punjabiensis* (pl. XX. fig. 3.) by the form of the 1st vertebral plate; from *C. theobaldi* (pl. XX. fig. 2.) by the more elevated carapace, wide anterior marginals, much less decidedly mushroom-shaped vertebrals, and shorter gulars; and from *C. hydaspica* (pl. XX. fig. 4.) by the great difference in the contour and profile of the carapace, and by other characters which are sufficiently evident in the figures. It differs still more widely from *C. sivalensis* (pl. XX. fig. 1.) and *C. crassicollis.*

The specimen agrees very closely with the group[2] comprising *C. sinensis* from Canton and Formosa, *C. reevesi* from S. China, *C. trijuga* from India with its allied forms from the neighbouring regions, and *C. macrocephala* from Siam. Of these forms *C. reevesi*[3] is not unlike the present form, but the intergular suture is relatively longer, the three middle vertebral plates wider and less constricted posteriorly, the costal keels more widely separated from the vertebral keel, and the profile of the carapace different. Neither *C. sinensis*[4] nor *C. macrocephala*[5] approach very near to the fossil; but *C. trijuga* comes very close in general form, as is well shown in the adult specimen figured by Gray,[6] where the inward inflection of the lateral marginals

1 In figure 4 the artist has drawn the 1st and 2nd costals too large antero-posteriorly.

2 *Vide* Günther, "Reptiles of British India," p. 22. Günther includes *C. crassicollis*, which is, however, distinguished by the obliteration of the keels in the adult.

3 *Vide* Gray, "Catalogue of Shield-Reptiles," pt. I. pl. V.

4 *Vide* Gray, *loc. cit.*, pl VII.

5 Gray, 'Proc. Zool. Soc.' 1869, pl. XXI.

6 "Catalogue of Shield-Reptiles," pt. I. pl. IV.

characteristic of both the recent and fossil forms is well shown. Both agree in the continuous keels, which are perhaps rather more pronounced in the living form; and in the strongly-marked areolæ of the carapace. In Gray's specimen the 1st vertebral plate is not so much expanded anteriorly, its antero-external angles not reaching to within a considerable distance of the 1st marginal sutures; while the other vertebrals differ slightly in shape, and the vertebral keel is more strongly pronounced: other specimens in the British Museum show, however, a much closer resemblance in the form of the vertebrals, although in none of them is the 1st vertebral so much expanded anteriorly. All specimens of *C. trijuga* that the writer has seen are decidedly more depressed, and in a profile view the posterior extremity of the carapace does not rise so rapidly as in the fossil; while the latter has not the slightly reverted anterior marginals of the recent form. The 5th vertebral is much wider than either of the three preceding ones; and in some specimens is as wide as the pygals and last marginals together. An allied recent form known as *C. subtrijuga* probably from the Dutch Asiatic colonies[1] is distinguished by the absence of reversion of the anterior marginals, and a wider nuchal plate; and in the former respect would therefore appear to be nearer the fossil. *C. trijuga* is found over a great part of India, and attains a length of eight inches; but there is some doubt of the distinctness of the Ceylonese race, which is sometimes admitted as a species under the name of *C. sebæ*.[2] A larger allied form growing to a length of twelve inches has been described from Arakan, Pegu, and Tenasserim under the name of *C. edeniana*.[3]

Finally, the resemblance of the fossil under consideration to *C. trijuga* and its allies is so great that it may be pretty safely regarded as an ancestral form of this group: in view, however, of the uncertainty as to the number of existing species, and the difficulty of distinguishing them if they were found only in the fossil state, it would perhaps be unwise to make any nearer approximation to the affinity of the fossil.

C. Carapace with three interrupted keels.

Species 6. CLEMMYS PALÆINDICA, n. sp. *nobis*.

(Allied to *Clemmys hamiltoni* [Gray.])

Introductory.—This species is founded on two shells of an emydine from the Siwalik Hills in the Cautley collection of the British Museum. Casts of the larger specimen were distributed under Falconer's superintendence and labelled *Emys hamiltonoides*, Falconer and Cautley; but as this name is merely a MS. one,[4] and is a barbarous one, it has not been adopted. In 1883 the writer[5] suggested that these specimens might be specifically identical with *Clemmys hamiltoni*.

1 *Vide* Günther, "Reptiles of British India," pp. 30, 31.
2 *Ibid*; and Theobald, "Catalogue of Reptiles of British India," p. 12.
3 *Vide* Theobald, "Mason's Burma," vol. I. p. 338 (1882).
4 It occurs in a dealer's list of casts.
5 'Rec. Geol. Surv. Ind.' vol. XVI. p. 67.

Larger specimen.—The larger specimen is represented of one-third the natural size in plate XXI. figs. 3. 3a. It shows the whole of the carapace and plastron; almost the only injuries it has sustained being the loss of part of the anterior and posterior margins of the carapace. The plastron is of the elongate emydine form, with deeply notched xiphiplastrals: it was originally flat, but from the effect of crushing the median line has become depressed: only the boundaries of the gular, abdominal, and postabdominal plates are distinctly defined. The carapace is convex, oblong-ovate, with three interrupted longitudinal keels, the bone underlying each vertebral and costal plate being raised into a nodose prominence. The line dividing the two pygal plates is distinct. The nuchal plate is broad and triangular; the 1st vertebral longer than broad, and narrowest anteriorly; the 4th vertebral and the 1st costal relatively wide. The anterior margin of the carapace is entire, but the posterior is deeply serrated: the shell is broadest across the second costal; the profile anteriorly being convex.

As the sutures of the bony scutes are visible it may be well to observe that the 1st vertebral scute is oblong and impressed by the suture between the 1st and 2nd plates: the 2nd scute is broader than long; the 3rd longer than broad, narrowest posteriorly, and marked by the suture between the 2nd and 3rd plates; the 4th scute is nearly square; the 5th and 6th broader than long, the former being marked by the division between the 3rd and 4th plates; the 7th scute is subtriangular, and impressed by the suture between the 4th and 5th plates; while the 8th scute is also triangular, with its apex directed forwards.

Smaller specimen.—The smaller specimen is represented of two-thirds the natural size in plate XXI. figs. 1. 1a. 1b. The plastron has lost its xiphiplastral portion, but is otherwise perfect; although as in the larger specimen it has been crushed in along the median line: it exhibits very clearly the complete bony union with the carapace. The carapace is broken off posteriorly through the middle of the 4th vertebral plate; and as it agrees so exactly with that of the larger specimen it may be safely referred to the same species, and needs no further description.

Distinctness and affinities.—That the two specimens under consideration are emydines there is no doubt, and their general resemblance to *Clemmys hamiltoni* is so close that they may be pretty safely referred to the same genus[1]; and their differences from the living form may now be pointed out. The largest specimen of *C. hamiltoni* mentioned by Dr. Günther[2] measures 5½ inches in length, but there are larger specimens in the Indian Museum, Calcutta, and the writer is indebted to Mr. Theobald for the opportunity of comparing an unusually fine specimen with the fossils. The following table shows the dimensions of this specimen and those of the fossils:—

1 *Geoemyda tricarinata*, Blyth (*vide* Theobald, "Catalogue of Reptiles of British India," p. 6), of which there are no specimens in England, is three-keeled, but the keels are apparently continuous, the shell is broadest across the fourth costals, has a narrow nuchal plate, and seems to resemble *Clemmys trijuga* in general shape. The male has a concave plastron.

2 "Reptiles of British India," p. 32.

	Small Fossil.	*Clemmys hamiltoni.*	Large Fossil.
Extreme length of shell (margins partly broken in fossil)		8·6	11·7
Extreme width of ditto	3·45	5·9	8·1
Height of ditto	2·7	4·1	5·4
Length of plastron		7·8	11·5
Width of ditto between keels	2·3	3·85	5·2
Interval between axillary incisions	2·4	3·9	5·4
Ditto ,, inguinal ,, ...	1 95	3·4	4·85
Length of 1st vertebral plate	1·16	1·65	2·5
Width ,, ,, ,, ,, ...	0·87	1·5	1·75
Length ,, 2nd ,, ,, ...	1·07	1·65	2 24
Width ,, ,, ,, ,, ...	1·1	1·55	2·1
Length ,, 3rd ,, ,, ...	1·1	1·55	2·2
Width ,, ,, ,, ,, ...	1·12	1·52	2·12
Length ,, 4th ,, ,, ...		1·5	2·2
Width ,, ,, ,, ,, ...		1·65	2·44
Length ,, 5th ,, ,, ...		1·6	2·05
Width ,, ,, ,, ,, ...		2·22	3·0

It will be seen from these measurements that the recent and fossil forms agree very closely in general proportions: the 2nd and 3rd vertebrals are indeed of slightly greater relative width in the smaller fossil, but this difference is not nearly so great as in young and old specimens of *C. hamiltoni.* The adult of that species is distinguished from the fossil shells by the narrower nuchal plate, by the marked concavity of the profile of the anterior portion of the shell, by the keel on the 1st vertebral being lower and confined to the hinder part of the plate, by the 1st vertebral being widest anteriorly, and by the decidedly lesser degree of development of all the vertebral and costal keels. In very young specimens of the living species (plate XXI. fig. 2), which are those more commonly observed in English collections, the costal keels form a regular curve, instead of being parallel as far back as the 4th vertebral plate, and are placed more remotely from the vertebral keel: the vertebral plates are, moreover, proportionately so much wider that their width exceeds their length: the anterior profile of the carapace is less markedly concave. An apparently allied form from Siam has been described by Gray[1] as *Clemmys macrocephala*; the shell is, however, depressed, and the keels end abruptly at the 3rd vertebral plate. *Clemmys nigricans* from S. China and *C. reevesi* from Canton and Formosa are unlike the Siwalik form.

That the latter is closely related to, and probably the ancestral form of, *Clemmys hamiltoni* there seems no reasonable doubt. As, however, it appears to differ from the living species as much as several of the allied living species do from one another, it seems allowable to assign it a distinct name; and it is accordingly proposed that it should be called *Clemmys palæindica.*

According to Mr. Theobald[2] the living *C. hamiltoni* is confined to Lower Bengal.

D. Generic position uncertain.

CLEMMYS (?) sp. 7.

History.—In 1859 Falconer[3] referred to a specimen now in the Indian Museum

1 *Vide* 'Supplement to Catalogue of Shield-Reptiles," pt. I. p. 43 (*Damonia*)
2 "Catalogue of Reptiles of British India," p. 11.
3 "Catalogue of Fossil Vertebrata in Museum of Asiatic Society of Bengal," p. 209. No. P. 114.

(No. E 78), which most probably came from the Siwaliks of Perim Island as "Greater portion of the carapace and plastron of a species of *Emys* or *Testudo*. The anterior portion both of carapace and plastron removed, with loss of the most characteristic parts. This specimen requires further and careful examination." In 1880 the present writer[1] alluded to this specimen as apparently belonging to *Testudo*.

Shell.—The specimen above-mentioned is so imperfect that it has not been figured: the only plates that it shows are the 5th vertebral, the right pygal, and the hinder marginals and costals of the same side. The union of the carapace and the plastron is a bony one; and the carapace is much vaulted, and shows no trace of any keel: the condition of the sutures seems to indicate a fully adult individual, and the specimen is evidently distinct from any of the species already noticed. The width of the shell is 7·0, and the height of the carapace 3·0 inches.

Second specimen.—An imperfect shell, of somewhat smaller size, from Perim Island presented to the old India House Museum by Mr. A. Bettington, and now in the British Museum, apparently belongs to the same species as the Calcutta specimen, but exhibits no characteristic features.

Third specimen.—Among a collection of fossils from Perim Island sent to the writer by Mr. Wajeshankar Gowreeshankar[2] is the right half of the shell of a tortoise, agreeing so well in size and shape with the preceding specimens that it very probably belongs to the same species. Unfortunately no trace of the form of the plates can be detected, although the bony scutes are distinctly defined: the close union of the latter indicates that the specimen is adult. The vertebral scutes are of the narrow elongated form characteristic of most of the emydines, and quite different from the broad scutes of *Testudo*: the costals are strongly areolated as in *Clemmys hamiltoni*.

Affinities.—Assuming that the third specimen belongs to the same species as the first, it is pretty clear that the present form is an emydine; a conclusion confirmed by the resemblance in the shape of the divided pygals of the first specimen to those of *Clemmys hamiltoni*. The species is smaller than any existing species of *Batagur*, and may accordingly be provisionally referred to *Clemmys*. It appears to indicate a form not intimately allied to any existing Indian species; but more perfect specimens are needed before anything definite can be decided as to its true affinities.

Genus II. PANGSHURA, Gray.[3]

Including *Cuchoa*, *Jerdonella*, and *Emia*, Gray.

Shell entirely bony, without ligamentous joints: carapace more or less angularly elevated and compressed: 4th vertebral plate pointed anteriorly: plastron flat in both sexes.

This genus, both in the recent and fossil state, has hitherto been recorded only

1 'Journ. As Soc. Beng.' vol. XLIX. pt II p. 16.

2 *Vide supra*, p. 149.

3 "Catalogue of Shield-Reptiles," pt. I. p. 36.

from India; there is some amount of uncertainty as to the real number of existing species, but they may be provisionally ranged under five heads, *viz.*:—

A. *Third vertebral plate tapering posteriorly.*

P. TECTUM (Bell). Carapace elevated: in the type form (pl. XXII. figs. 4. 6. 7.) 1st vertebral pentagonal, narrowest posteriorly, and longer than broad: 2nd hexagonal or pentagonal, narrowed posteriorly, usually more or less rounded, and longer than broad. In var. *intermedium*, Blanford[1], (pl. XXII. fig. 8) the 1st and 2nd vertebrals are shorter; the latter being hexagonal, and not rounded posteriorly.

P. TENTORIA (Gray). Carapace less elevated: 1st vertebral subquadrangular (pl. XXII. fig. 9.), as broad posteriorly as anteriorly; 2nd rounded posteriorly, narrowed, and relatively long.

P. FLAVIVENTRIS, Günther. Carapace more elevated than in *P. tectum*: 1st vertebral bell-shaped (pl. XXII. figs. 10. 11.), broadest posteriorly: 2nd rounded posteriorly, narrowed, and relatively long.

P. SYLHETENSIS, Jerdon. Carapace elevated, 1st vertebral pentagonal, longer than broad in adult, with a tendency to a bell-shape, broadest anteriorly in young, and shorter: 2nd vertebral short and much broader than long: 3rd strongly keeled, much longer than 2nd, and slightly narrowed behind: 5th very narrow: posterior edge of carapace deeply serrated.

B. *Third vertebral plate truncated posteriorly.*

P. SMITHI (Gray). (pl. XXII. fig. 5). Carapace depressed: 1st vertebral bell-shaped, broadest posteriorly: 2nd subquadrangular, much broader than long, and shorter than the 1st.

The first four species, forming what may be called the tectiform group, are closely allied; and as the variety *intermedium* diminishes the distinction between *P. tectum* and *P. tentoria*, it has been suggested that the latter is merely a depressed race of the former.[2] *P. sylhetensis* (which Mr. Theobald[3] is inclined to class with *P. tectum*) is apparently a connecting link between the other members of the tectiform group and *P. smithi*: the specimens in the British Museum seem to leave little doubt of its claim to specific distinctness; the form of the 2nd, 3rd, and 5th vertebrals, and the deeply serrated posterior margin of the carapace being very characteristic features. Two other species are admitted in Gray's "Supplement to the Catalogue of Shield-Reptiles" (pt. I. pp. 60-61), *viz.*, *P. leithi* and *P. ventricosa*; the latter is probably only a varity of *P. tectum*[4]; and the former is founded only on a skull which Mr. Theobald thinks may belong to a distinct genus.

Species 1. PANGSHURA FLAVIVENTRIS, Günther.[5]

Syn. *Emys namadica*, Theobald.[6]
Cuchoa flaviventris, Gray.[7]

Narbada specimen.—The shell figured of half the natural size in pl. XXII. fig. 2 (the first three vertebral plates being drawn of the full size in fig. 10) was obtained

1 'Journ. As. Soc. Beng.' vol. XXXIX. pt. II. p. 339 (1870).
2 *Vide* Theobald, "Catalogue of Reptiles of British India," pp. 14-17.
3 *Ibid*, pp. 15 16 17. Jerdon was correct in describing the th vertebral as being *narrow*. 4 *Ibid*, p. 13.
5 "Reptiles of British India," p. 35 (1864). *P. flaviventer*. 6 'Mem. Geol. Surv. Ind.' vol. II. p. 395 (1860).
7 "Supplement to Catalogue of Shield-Reptiles," pt. I. p. 61 (1870).

previously to 1860 by Mr. Theobald from the pleistocene of Moar Domar in the Narbada Valley. It was mentioned by him in that year in the passage cited above, and referred to a new species under the name of *Emys namadiea.* At a later date it was described and figured by Stoliczka,[1] who referred it to *Pangshura tectum*; but his figure of the upper surface is not satisfactory, as it does not exhibit the characteristic bell-shape of the 1st vertebral plate.

The specimen is fairly perfect as far back as the 5th vertebral plate, and exhibits the form both of the horny plates and the underlying bony scutes. In general contour and proportionate size of the vertebral plates the fossil agrees with the tectiform group, and the high pitch of the carapace allies it to *P. flaviventris.* It also agrees with that species and differs from *P. tectum* and *P. tentoria* in the bell-shaped 1st vertebral. In the type specimen of *P. flaviventris* (pl. XXII. fig. 11.) the 1st vertebral is much narrower anteriorly than posteriorly, but in a specimen from near Cuttack in the British Museum (No. 70. 6. 14. 32) the 1st vertebral is relatively wider anteriorly, and although not quite so wide as in the fossil, yet the difference between the two is not greater than that between the two recent specimens. With the exception that the nuchal plate is rather narrower than in any recent specimen which the writer has seen, the fossil agrees precisely with *P. flaviventris*, and may, therefore, be pretty safely referred to that species.

Another shell of a *Pangshura* from the pleistocene of the Narbada valley has been collected by Mr. Hacket of the Survey, and is preserved in the Indian Museum (No. F 111). The carapace measures some five inches in length, and has a considerably higher pitch than in equal-sized specimens of *P. tectum*: unfortunately the boundaries of the vertebral plates are totally invisible, so that the specimen cannot be specifically determined.

Siwalik specimen.—The specimen of the shell of a *Pangshura* represented of two-fifths the natural size in plate XXII. fig. 3. was obtained from the Siwalik Hills, and is preserved in the Cautley collection of the British Museum.[2] It comprises the greater part of the shell, the plastron being fairly complete, and the carapace showing the form of the hinder part of the 1st vertebral plate, the complete 2nd and 3rd vertebrals, the greater part of the 5th, the first two costals, the pygals, and several of the marginals.

The portion of the 1st vertebral still remaining shows that this plate was bell-shaped, as in *P. flaviventris*: the strongly keeled 2nd and 3rd vertebrals differentiate the specimen from *P. smithi*, while the elongated 2nd and the wide 5th vertebral distinguish it from *P. sylhetensis.* The characteristic form of the 1st vertebral and the general agreement in the contour of the carapace and of the 2nd and 3rd

1 'Rec. Geol. Surv. Ind.' vol. II. p. 36. pl. 1. fig. 1.

2 Three views ($\frac{2}{5}$) of this specimen are given in "Falconer's Palæontological Memoirs," vol. I. pl. XXXII. figs. 1-3, where it is referred to *P. (Emys) tectum*, and erroneously regarded as being the identical Siwalik specimen described by Falconer. The view of the upper surface is incorrect, the shape of the 2nd and 3rd vertebral plates being wrongly drawn, and the space which should be occupied by the 4th vertebral plate filled with scutes which the artist has represented as plates.

vertebrals with recent specimens of *P. flaviventris* (*e.g.* Brit. Mus. No. 70. 11. 29. 50), indicates the probable specific identity of the Siwalik specimen with the existing species. The 2nd costal suture, although joining the 3rd vertebral plate at the same point as in recent specimens, makes a backward bend, but this can hardly be considered a character of specific value. The dimensions of the fossil are as follows, in inches, *viz.* :—

Greatest width of shell	6·2	Width of 2nd vertebral plate	1·25
,, height ,, ,,	3 25	Length ,, 3rd ,, ,,	1·25
Length of plastron	6·8	Width ,, ,, ,, ,,	1·2
,, ,, 2nd vertebral plate	1·5	Length ,, 4th ,, ,,	2·45

Distribution.—The type specimen of *P. flaviventris* was obtained from the Ganges at Allahabad, and there is a specimen in the British Museum from the Mahanadi basin near Cuttack. The Siwalik specimen came from within either the Jamna or Ganges basin; and the Narbada specimen indicates the former westerly distribution of the species.

PANGSHURA, sp. 2.

History.—In "Falconer's Palæontological Memoirs"[1] an essay of Falconer's on a small fossil emydine from the Siwaliks was for the first time printed. This essay is illustrated with figures of the shell of a Siwalik *Pangshura* in the British Museum considered by the editor of the 'Memoirs' as the one described by Falconer: Stoliczka,[2] however, suggested that this was not the case, and a comparison of another specimen in the British Museum has shown the correctness of this suggestion: the figured specimen is the one referred above to *P. flaviventris*. In Falconer's essay the specimen described was referred to the existing *Pangshura tectum* (Bell): it must, however, be borne in mind that the essay in question was written in 1844, at which date only two out of the five existing species mentioned in the foregoing list (page 182) had been described, *viz.*, *P. tectum* and *P. tentoria*,[3] and it is, therefore, not improbable that Falconer might have modified his original view if he had published the essay himself.

Shell.—The specimen described by Falconer is figured from the upper surface of three-fourths the natural size in plate XXII. fig. 1, the first three vertebral plates being drawn of the full size in fig. 12. "It was embedded in a hard sandstone matrix which fills the hollow of the shell, and the bony part is densely infiltrated with hydrate of iron and siliceous matter, so as to give it a dark colour and great specific gravity. It comprises nearly the whole of the carapace as far back as the commencement of the last vertebral plate. The margin is broken off in front, and the gular and anal portions of the plastron are also wanting. All the rest of the shell is distinctly shown. It has been exposed to a crush which has altered a little the form of the shell at the junction of the right sterno-costal piece with the ribs, and caused a longitudinal 'fault' on the left side of the plastron between the median line and the keel.

1 Vol. I. pp. 382-387, pl. XXXII. figs. 1-3. (1868).
2 'Rec. Geol. Surv. Ind.' vol. II. p. 38.
3 Gray, 'Proc. Zool. Soc.' 1834, p. 54, *Emys*.

"The fossil agree so closely with *Emys* [*Pangshura*] *tectum* in size and general form that the resemblance is observed to be very striking at the first glance. It has the same high-pitched, roof-shaped carapace, the same tritubercular keel occupying the first three vertebral plates and similarly formed plastron."

Thus far Falconer's description is very accurate; the extremely high pitch of the fossil carapace is, however, a character agreeing more nearly with *P. flaviventris*, although it is exhibited in some very young shells of *P. tectum*.[1] The 1st vertebral is pentagonal, and as broad behind as in front: it does not agree exactly with the corresponding plate of any specimen of *P. tectum* that the writer has seen (compare pl. XXII. figs. 4. 6. 7. 8.); although rather more like that of *P. tentoria* (fig. 9.); it has not the bell-shape characteristic of *P. flaviventris* (figs. 10. 11). The 2nd vertebral has a distinct keel, and is sub-hexagonal, elongated, and widest at a point considerably behind its centre, where it is joined by the 1st costal suture; the longest lateral border being in advance of the last-named suture: its length is nearly one-and-a-half times that of the 1st vertebral. In all varieties of *P. tectum* that have come under the writer's notice the widest point of the 2nd vertebral is either in advance of its centre (figs. 4. 6. 7.), or on the same line (fig. 8.), and the longest lateral border either behind the junction of the 1st costal suture, or the two lateral borders are of subequal length: in no specimen does the length of the 2nd vertebral appreciably exceed that of the 1st. The 2nd vertebral of the fossil is very like that of *P. tectum* turned the reverse way. Very similar features prevail in the 2nd vertebral of *P. tentoria* and *P. flaviventris* (figs. 10. 11) to those of *P. tectum*. In *P. smithi* (fig. 5) the 2nd vertebral is extremely short, but the 1st costal suture joins it behind its centre, as in the fossil. *P. sylhetensis* is distinguished from the latter by its very short 2nd vertebral. The 3rd vertebral of the fossil is shorter than the 2nd, pentagonal, and narrowed behind, with a well-marked keel: it is joined by the 2nd costal suture at a point far behind its centre, so that the lateral border in advance of this suture is longer than the one behind it. In *P. tectum* precisely the reverse of this arrangement occurs, the lateral border of the 3rd vertebral in advance of the 2nd costal suture being longer than the one behind that suture:—in some examples (figs. 4. 6.) this feature is very strongly marked, but to a less extent in others (figs. 7. 8). *P. flaviventris* (fig. 10) usually agrees very closely in this respect with *P. tectum*, but in the specimen represented in fig. 3 and provisionally referred to that species the backward flexure of the 2nd costal makes an approach to the present specimen. The 3rd vertebral of *P. tentoria* (fig. 9) makes a nearer approach to the fossil; although the line of junction between the 2nd and 3rd vertebrals is different. *P. smithi* (fig. 5), although differing by the flattened form of the 3rd vertebral, agrees in the relative position of the 2nd costal suture.

The greatest width of the fossil is 3·2, and its height 1·9 inches.

Distinctness and affinities.—In a group like the present whose existing members

[1] A very young shell in the Geological Department of the British Museum from Falconer's collection exhibits this feature. The 1st vertebral is extremely wide anteriorly, and the 2nd hexagonal, thereby agreeing with var. *intermedium*.

exhibit a large amount of variation, it is extremely difficult to come to a conclusion as to what characters in a fossil should be regarded as of specific and what merely of individual value. There seems little doubt as to the distinctness of the present Siwalik fossil from *P. smithi*, *P. sylhetensis*, and *P. flaviventris*, as well as from the Siwalik specimen provisionally referred to the latter species (fig. 3); while it appears equally distinct from *P. tectum*—or at least from the typical forms of that species. With regard to *P. tentoria* there is perhaps more room for doubt, and the writer would have liked a larger series of specimens for comparison. The high pitch of the fossil carapace is, however, a character exactly the opposite of that of the living form; while the relatively backward position of the 1st costal suture of the former and its elongated 2nd vertebral are not characters of the latter. The difference between the fossil and recent forms appears decidedly greater than that existing between *P. tectum* and *P. tentoria*, and in the writer's opinion the only possible way to identify the fossil with a recent species would be by regarding *P. tectum* and *P. tentoria* as varieties of one species, and even then such identification would be doubtful. In view, however, of this uncertainty as to the right of the present form to specific distinctness it seems advisable not to assign it any specific name.

That this Siwalik *Pangshura* is an ancestral form of the tectiform group of the genus is practically certain; and its somewhat generalized nature is perhaps indicated by the backward position of the 1st and 2nd costal sutures, which give indications of affinity with the probably still more generalized *P. smithi*. Both *P. tectum* and *P. tentoria* may well be descendants of the present form, the very forward position of the anterior costal sutures in many examples of the former species (pl. XXII. figs. 4. 6.) being an extremely specialized character; the latter conclusion being strengthened by the backward flexure of the 2nd costal suture in the Siwalik specimen provisionally referred to *P. flaviventris* (fig. 3).

Genus III. BATAGUR, Gray.[1]

Including *Tetraonyx*, Lesson; *Callagur*, *Kachuga*, *Dhongoka*, *Hardella*, and *Cantorella*, Gray.

It appears impossible to draw up any definition by which this genus (at all events in the case of fossils) can be satisfactorily distinguished from *Clemmys*. The species are, however, usually of considerably larger size than those of the latter. One species (*B. thurgi*) is included by Dr. Günther in *Clemmys (Emys)*. The genus is confined at the present day to the Oriental region; and the species noticed in the sequel are believed to be the first fossil forms that have been described.

Number of species.—The following list comprises the species recognized by Messrs. Günther[2] and Theobald[3]:—

1 "Catalogue of Shield-Reptiles in Brit. Mus." p. 35. (1855).
2 "Reptiles of British India," pp. 37-43.
3 "Catalogue of Reptiles of British India," pp. 19-25.

A. A nuchal plate.

a. 4th vertebral plate much longer than broad, and narrower than 3rd.

1. B. KACHUGA[1] (Gray [*ex* B. Hamilton, MS.]). First three vertebral plates rather broader than long; 1st hexagonal, broadest anteriorly; 3rd very short and broad; nuchal broad and triangular; vertebrals keeled in young; suture between postgulars and pectorals forms an obtuse angle. *Hab.* Bengal, Nipal, Pegu, Tenasserim, etc.
2. B. ELLIOTI, Gray. Only known by the young; and Mr. Theobald suggests it may be the same as *B. kachuga.* Nuchal plate broad and triangular; 4th vertebrals probably elongate in adult; vertebrals keeled in young; suture between postgulars and pectorals forms an obtuse angle. *Hab.* Kistna and (?) Jamna rivers.
3. B. DHOŅGOKA, Gray (*ex* B. Hamilton, MS.). 1st and 2nd vertebrals elongate, the 3rd short and broad; nuchal triangular; suture between postgulars and pectorals straight; vertebrals keeled. *Hab.* Greater part of Central and Upper India.
4. B. TRIVITTATUS (Duméril and Bibron). 1st vertebral nearly square, the 3rd short and broad; suture between postgulars and pectorals straight; vertebrals keeled in young. *Hab.* Pegu and Tenasserim.

b. 4th vertebral plate as broad as long, and of equal width with the 3rd.

5. B. THURGI (Gray). 1st vertebral elongate, narrower in front than behind; 4th hexagonal; nuchal triangular and narrow; vertebrals keeled; suture between postgulars and pectorals straight; plastron rounded in adult. *Hab.* Bengal, Indus river, etc.
6. B. BASKA, Gray. First four vertebrals nearly square; nuchal subquadrangular, broader than long; suture between postgulars and pectorals forming a very obtuse angle; vertebrals keeled in young. *Hab.* Pegu, Tenasserim, Malay Peninsula, Bengal, etc.; generally estuarine.

B. No nuchal plate.

7. B. AFFINIS (Cantor). First four vertebrals of nearly equal length, 1st and 2nd broader than long, 4th longer than broad; suture between postgulars and pectorals forming a very obtuse angle; an uninterrupted vertebral, and an interrupted costal keel in young. *Hab.* Malay Peninsula, and perhaps Tenasserim.
8. B. PICTUS (Gray). Described from a half-grown specimen. 1st vertebral four-sided rather longer than broad; 2nd, 3rd, and 4th hexagonal, 2nd and 3rd as long as broad, 4th rather longer than broad; traces of a vertebral keel in young. *Hab.* Borneo.

Species 1. BATAGUR FALCONERI, n. sp. *nobis.*
(Allied to *Batagur thurgi* [Gray.])

Type specimen.—The type specimen of this form is figured of one-fourth the natural size in plate XXIII. figs. 1. 1a, and pl. XXIV. fig. 4: it is in the Cautley collection of the British Museum, and was obtained from the Siwalik Hills. It comprises the greater portion of the shell, the carapace having been crushed in on the left side, and its posterior margin broken off, while the plastron has lost its anterior and posterior extremities. The boundaries of all the plastral plates are shown; and the carapace exhibits the form both of the vertebral horny plates and bony scutes. The general contour and structure of the specimen, which when perfect was about 20 inches in length, leaves no doubt that it belongs to the present

[1] The so-called *B. fuscus*, Gray, agrees with this species in all the characters available in the case of fossils.

genus, and the condition of the sutures between the bony scutes indicates its adult condition. The nuchal plate forms a narrow triangle: the 1st vertebral plate is bell-shaped, much narrower in front than behind, its length equaling the width of the posterior border. The 2nd vertebral is longer than the 1st, and rather shorter than the 3rd: both the 2nd and 3rd are rather longer than broad: the 4th is hexagonal, much shorter than the 3rd, which it nearly equals in breadth, and is about as long as broad. The anterior and posterior borders of the 3rd vertebral plate traverse two vertebral scutes separated by an intervening third scute situated in the centre of the plate. The hinder vertebral scutes are distinctly keeled. The plastron is rounded, without lateral keels; the abdominal plates are nearly twice the length of the pectorals; the suture between the postgulars and pectorals forms a nearly straight line; and the width between the axillary is less than that between the inguinal incisions. The shell is vaulted, and is highest near the hinder border of the 2nd vertebral plate; the ascent from the anterior margin of the carapace to this point being very rapid (*plate* XXIV. *fig.* 4). The bony scutes of the shell are marked by very bold areolæ.

Young specimen.—In the Dublin Museum there is the shell of an emydine[1] from the Siwalik Hills (being one of the specimens collected by Generals Sir W. E. Baker and Sir H. M. Durand[2]), evidently pertaining to a young individual, which not improbably belongs to the present species. It has the same general contour as the type specimen; and the vertebral plates agree in relative proportion, the 3rd vertebral plate having a scute in its centre lying between the two scutes marked by the sutures of the plate. The 1st vertebral plate is somewhat less narrowed anteriorly than in the adult; and there is an interrupted vertebral keel: the nuchal plate and the plates of the plastron are not shown. The length of this specimen when complete was about 12 inches.

Second young specimen.—In plate XXV. fig. 1. there is represented of one-half the natural size the greater part of the carapace of a young emydine tortoise collected by Mr. Theobald in the Siwaliks of Asnot, Punjab, which has such a strong general resemblance to the adult shell described above that it not improbably belongs to the same species. The sutures between the bony scutes are disunited, which is an indication of the immature condition of the specimen: the vertebral scutes are of the elongated form characteristic of the majority of the emydines. As in the adult shell, the 4th and 5th vertebral scutes bear a distinct prominence, and the relation of the 5th scute to the overlying 3rd plate is the same in both: the immature specimen also exhibits the strongly marked areolæ so characteristic of the adult. The nuchal plate is unfortunately not shown in the present specimen; but the form of the 1st, 2nd, and 3rd vertebral plates agrees precisely with that presented in the adult. The immature carapace is more depressed than in the adult, but this difference may be due merely to the different ages of the two specimens.

Distinctness and affinities.—Confining comparisons to the adult specimen, the

1 *Vide* 'Journ. R. Dublin Soc.' ser. 2. vol. III. p. 85. (1884). No. C. S.
2 *Ibid*, p. 70.

shell of the present form appears somewhat more vaulted than in any living species of the genus. The presence of a nuchal plate differentiates the present form from group *B*, while the shortness of its 4th vertebral plate distinguishes it from the first section (*a*) of group *A*; and there accordingly only remain *B. baska* and *B. thurgi* with which it can be compared. From the former it is broadly distinguished by the shape of the 1st vertebral plate, the presence of a vertebral keel, and the straight suture between the postgulars and pectorals. With the latter the fossil agrees very closely in general characters; namely, in the general shape of the shell, the sharply ascending anterior profile, the general form of the nuchal and vertebral plates, the inclusion of a portion of three vertebral scutes within the space covered by the 3rd vertebral plate, the straight line formed by the suture between the postgulars and pectorals; and the very distinct areolæ on the carapace. These points of resemblance evidently indicate that the fossil and recent forms are closely allied. The former is, however, distinguished by the higher vaulting of the carapace, the greater width of the shell, and the greater convexity of the plastron; while its point of greatest height is situated more posteriorly: the nuchal plate is, moreover, narrower, the 1st vertebral decidedly bell-shaped, and the vertebral keel much less distinctly marked on the anterior portion. It is difficult to decide whether these differences should be regarded as of specific or varietal value; but as the multiplication of varietal names seems inadvisable, and as it is desirable to mark the Siwalik form by a distinct name, it is regarded as a species, which it is proposed to term *Batagur falconeri*.

This species may be pretty safely regarded as the ancestor of *B. thurgi*; and the more vaulted shell of this and next Siwalik species perhaps indicates a closer affinity between the fossil species of *Batagur* and certain species of *Clemmys* (*e.g. C. palæindica* and *C. hamiltoni*) than exists between the living representatives of the two genera.

Cranium provisionally referred to this species.—The difficulty of specifically correlating the crania and shells of fossil tortoises when there is a considerable number of species belonging to the same genus is extremely great, but in the case of the specimen to be now noticed there is a very strong presumption for its reference to the present species.

The cranium represented of three-fourths the natural size in plate XXV. figs. 2. 2a. 2b. was obtained by Mr. Theobald from the Siwaliks of Asnot, and is in a very perfect state of preservation; its chief injuries being the loss of the extremity of the supraoccipital spine, of the alveolar border of the right maxilla, and several fractures of the fronto-parietal region. If the figures of the fossil cranium be compared with those of the skulls of four species of *Batagur* given in Gray's "Supplement to the Catalogue of Shield-Reptiles," pt. I. pp. 52, 54, 55, and 59, there will be no doubt that the former belongs to the present genus. A closer comparison will also show that it is with the cranium of *Batagur thurgi*, rather than with any of the other species, that the fossil specimen agrees. Gray describes the skull of the living species in the following words, *viz.*:—" Edge of the beaks very strongly dentated; the upper with a notch, with a 'tooth' on each side of it. . . The skull solid with the alveolar process very wide; the upper jaw with a slightly elevated, narrow, dentated [palatal] ridge, separated in front by a large deep pit, which has a sharp-edged longitudinal keel behind it." This description applies exactly to the fossil:—the strongly serrated alveolar margin of the maxilla is well exhibited on the left side, and both sides show the prominent premaxillary process described by Gray as a tooth, with the intervening median notch. The palatal ridge, although somewhat abraded, is still distinctly seen, and the median pit, nearly filled with matrix, can be easily distinguished: the longitudinal ridge behind the pit has, however, been broken away. In general contour the fossil and recent crania agree very closely, but the orbit of the former is more elliptical than that of the latter.

Bearing in mind the close resemblance presented by the shell of *Batagur falconeri* to that of *B. thurgi* there is a very strong presumption that the fossil cranium belongs to the former species; and in any case it indicates a closely allied form. The cranium is of relatively large size, and may have belonged to a somewhat larger individual than the type shell of *B. falconeri.* Its length from the occipital condyle to the extremity of the premaxilla is 4·2, and the width between the external surfaces of the quadrates 3·8 inches.

Distribution.—Assuming that at least one of the two Punjab specimens described above belongs to *B. falconeri* the range of that species extended from the typical Siwalik Hills (Ganges-Jamna basin) to the Punjab (Indus basin). The existing *B. thurgi* is likewise found in both these basins.[1]

Species 2. Batagur bakeri, n. sp. *nobis.*

(Allied to *Batagur kachuga* [Gray.])

Shell.—A second species of Siwalik *Batagur* is indicated by a fairly complete shell presented to the British Museum by the late General Sir W. E. Baker, which is represented of one-fourth the natural size in plate XXIII. figs. 2. 2a., and pl. XXIV. fig. 5. The carapace is broken off across the 4th vertebral plate: it exhibits the boundaries of the vertebral and costal plates as far back as the hinder part of the 4th vertebral, and also shows the sutures of the vertebral scutes, the condition of these sutures indicating an adult individual. The plastron is perfect as far back as the border of the preanal plates, and shows the boundaries between all the plates in advance of this point.

The specimen is nearly of the same size as the type shell of *B. falconeri* (fig. 1), and as there is a very important structural difference between the two it will be well to indicate this before proceeding to the more detailed description. It will be remembered that in the former species the space enclosed by the boundaries of the

[1] *Vide* Theobald, "Catalogue of Reptiles of British India," p. 24.

3rd vertebral plate includes a vertebral bony scute situated between two other scutes respectively impressed by the fore-and-aft boundaries of the plate: in the present specimen the two vertebral scutes so marked are contiguous, and of an extremely elongated form. This important difference clearly indicates the specific distinctness of the present specimen from *B. falconeri*; and also from the living *B. thurgi* and *B. baska*, in which the same feature exists. The writer has been unable to observe the relations of the vertebral bony scutes to the 3rd vertebral plate in all the living species, but he finds that in *B. kachuga*,[1] *B. trivittatus*, and *B. dhongoka* their relations are the same as in the fossil now under consideration, and it may, therefore, be concluded that this condition prevails in all the species having a long 4th vertebral plate (section *a* of group *A*); while the opposite condition is known to obtain in those species having a nuchal plate and a short 4th vertebral (section *b*), and not improbably also occurs in group *B*.

The specimen under consideration also differs from *B. falconeri*, in the form of the nuchal and 1st vertebral plates, as well as in the profile of the shell, the absence of a vertebral keel, and of distinct areolæ on the carapace.

The carapace is strongly vaulted, although to a somewhat smaller extent than in the last species; the highest point of the shell is situated near the middle; and in a profile view (pl. XXIV. fig. 5) the ascent from the anterior border of the carapace to this point is very gradual, The nuchal plate forms a broad triangle: the 1st vertebral plate is nearly square, and as long anteriorly as posteriorly; the 2nd is longer than either the 1st or 3rd, and is also nearly square; the 3rd is broader than long; the 4th is much narrower than the 3rd; its posterior boundary is unfortunately not shown, but judging from the shape of the anterior portion, and the relation of the 3rd plate to the underlying scutes it is evident that it was of the elongated type of *B. kachuga* and *B. dhongoka*. The plastron is rounded, the sutures separating the postgulars and pectorals forming a very obtuse angle; both the postgulars and abdominals are longer than the pectorals; and the inguinal incisions are separated by a wider interval than are the axillary. There is no trace of any vertebral keel.

Distinctness and affinities.—The specimen under consideration is distinguished from the living species of group *B* by the presence of a nuchal plate; and, as mentioned above, from section *b* of group *A* by the relations of the 3rd vertebral plate to the underlying scutes, as well as by the elongated 4th vertebral plate. In section *a* of the latter group the present form is distinguished from *B. dhongoka* and *B. trivittatus* by the obtuse angle formed by the suture between the postgular and pectoral plates; and there accordingly only remain *B. kachuga* and *B. ellioti* with which it can have any affinity. As far as concerns the latter it can only be said that the young is characterized by the extreme breadth of the 2nd and 3rd vertebrals, which are not characters found either in the specimen under consideration or in the adult of *B. kachuga*. The present form agrees with the latter species in the general form of the nuchal and vertebral plates, and of the profile of the shell; it also

[1] The specimen in the British Museum showing this belongs to the so-called *B. fuscus*.

agrees in the obtuse angle formed by the suture between the postgular and pectoral plates, in the absence of a vertebral keel in the adult, in the rounded plastron of the adult, and in the proportionate length of the inguinal and axillary incisions. The recent species differs by its decidedly more depressed shell, the highest point of which is placed somewhat more anteriorly; the nuchal plate is, moreover, somewhat narrower, the 1st and 2nd vertebrals more narrowed at their junction, the 3rd more distinctly hexagonal, the 4th somewhat more narrowed anteriorly, and the angle formed by the suture between the postgulars and pectorals more obtuse.

That the present form is closely allied to *B. kachuga*, of which it may probably be considered the ancestral form, there seems no reasonable doubt; and as in the case of *B. falconeri* the question arises whether to consider the Siwalik form as a race or a species. The view taken in the one case must be adopted in the other, and the present form is therefore regarded as a species, which, in honour of the collector of the type specimen, it is proposed to designate *Batagur bakeri*.

Distribution.—As above-mentioned, the one specimen on which this species is founded was obtained from the typical Siwalik Hills. The range of the existing *B. kachuga* covers that of the fossil.

Species 3. BATAGUR DURANDI, n. sp. *nobis.*

(Allied to *Batagur dhongoka*, Gray.).

Shell.—This third Siwalik species of *Batagur* is founded on a shell from the Siwalik Hills presented to the British Museum by Col. Sir P. T. Cautley, and figured of one-fourth the natural size in plate XXIV. fig. 2. The specimen comprises the greater part of the carapace, which shows the boundaries of the greater number of the bony scutes, as well as those of most of the overlying plates: the greater part of the plastron is also preserved, but since it does not show the form of the plates it has not been figured. The condition of the sutures indicates a subadult specimen; and the length of the shell is about 16 inches.

The shell is of an extremely depressed form, very like that of the existing *B. dhongoka*, by which character alone it is widely distinguished from the two preceding species. The suture between the postgular and pectoral plates was probably straight; the xiphiplastron is notched, although less deeply than in *B. dhongoka.* The 1st vertebral plate is of an elongated bell-shape, and very narrow anteriorly; the 2nd and 3rd vertebral plates are elongated, the hinder border of the second being produced into a long projection formed by a keel in the underlying scute, and penetrating far into the 3rd plate; the latter bears the same relation to the underlying scutes[1] as obtains in *B. dhongoka* and the other members of section *a* of group *A.* Of the 4th vertebral plate only the anterior half is shown; its junction with the 3rd vertebral is narrow, and the lateral borders of the anterior half diverge posteriorly, and indicate that this plate was of the elongate form characteristic of *B. dhongoka* and its allies. The posterior border of the 1st costal suture commences

[1] *Vide supra*, p. 191.

near the anterior border of the 2nd vertebral plate, and then bends backwards for some distance, till it finally pursues a course at right angles to the long axis of the shell. The nuchal region of the specimen is broken away, but from the analogy in general structure to *B. dhongoka* it is probable that a nuchal plate existed: the divided pygal plates are distinctly shown. There is a well-marked interrupted vertebral keel throughout the length of the carapace; the keel forming marked prominences at the hinder terminations of the 2nd and 3rd vertebral plates.

Distinctness and affinities.—The general structure of the present specimen indicates that its affinity is with section *a* of group *A* (table on p. 187). The probable straightness of the suture between the postgulars and pectorals differentiates it from *B. kachuga* and *B. ellioti*; from both of which it is also distinguished by the elongation and peculiar form of the first three vertebral plates; and from the former by the deeply notched xiphiplastron. With *B. dhongoka* and *B. trivittatus* the specimen probably agrees in the direction of the postgulo-pectoral suture. From the latter it is distinguished by the elongation of the 1st and 3rd vertebral plates; but with the former its affinity appears much closer. It is true that the 3rd vertebral plate of *B. dhongoka* is short, and not deeply interpenetrated by the 2nd, but there is the rudiment of such an arrangement in many specimens; and the shape of the 1st and 4th vertebral plates is very similar in the recent and fossil forms, which also agree in the notched xiphiplastron, and in the keeled vertebral scutes, in which knobs are formed at the posterior terminations of the 2nd and 3rd vertebral plates. There is also a close general resemblance in the contour of the shells of the recent and fossil forms; but the latter is still more depressed. The peculiar form of the 1st and 2nd vertebral plates in the fossil affords ample grounds for specifically distinguishing it from *B. dhongoka*; and it is proposed that it should be called *Batagur durandi*, in honour of Gen. Sir H. M. Durand, the associate of Sir E. M. Baker in the early collection of the fossils of the Siwalik Hills.

That *B. durandi* belongs to the ancestral group from which the living *B. dhongoka* took origin there can be no reasonable doubt; but it is not so clear whether the one form is the direct lineal parent of the other.

Species 4. Batagur (*cf.* dhongoka, Gray[1] [*ex* B. Ham. MS.])

First notice of probable occurrence in Narbadas.—The specimen noticed below, which was obtained from the pleistocene of the Narbada valley, was described and figured by Stoliczka[2] and is now in the Indian Museum.

Part of plastron.—The specimen in question consists of a part of the right hypo- and xiphiplastron, exhibiting the boundaries of the epidermal plates. Stoliczka observes that the "form, the flat surface and the outlines of the junction of the abdominal and preanal shields [plates], of the inguinal and of the adjoining marginal on the external side, entirely agree with the form of the same shields of the recent

1 "Illustrations of Indian Zoology," vol. II. pl. LX. (1830-32).

2 'Rec. Geol. Surv. Ind.' vol. II. p. 39. pl. I. fig. 3.

Batagur dhongoka. Further materials are, however, necessary to show whether this supposed identification be correct."

Species 5. BATAGUR CAUTLEYI, n. sp. *nobis.*

Type specimen.—A fourth species of Siwalik *Batagur* is indicated by a fairly perfect shell in the British Museum, obtained from the Siwalik Hills, and presented to the Museum by Dr. Falconer; this specimen is figured of one-sixth the natural size in plate XXIV. figs. 1. 1a. Superiorly it shows the boundaries between the plates, but the sutures between the underlying scutes are only partially visible; the plastron shows neither the boundaries of the plates nor the sutures between the scutes, and has not, therefore, been figured; the specimen is broken off posteriorly at the hinder part of the 5th vertebral plate. When complete the length of the shell must have been about 25 inches; and it is of very considerably larger dimensions than the adult shells of either of the three preceding Siwalik species. It is readily distinguished from *B. falconeri* and *B. bakeri* by its extremely depressed form, the gentle ascent of the profile of the anterior portion, and the concave profile of the posterior extremity; in its depressed form it agrees with *B. durandi*, but is otherwise very distinct.

The shell is highest slightly in advance of its middle point. The 1st vertebral plate makes an approach to a bell-shape, being somewhat narrower before than behind; it is longer than broad, and is considerably shorter than the 2nd. Both the 2nd and 3rd vertebrals are elongate, but the latter is much longer than the former. The 4th vertebral is much shorter than the 3rd, and is of nearly equal breadth at the line of junction; it is hexagonal in shape, and its breadth and length are nearly equal. There is a very distinct interrupted vertebral keel, the prominences of which do not coincide with the posterior terminations of the vertebral plates. The relation of the 3rd vertebral plate to the underlying scutes[1] is the same as that obtaining in *B. thurgi* and *B. baska*, and probably in *B. affinis.* There is no trace of any nuchal plate.

Second specimen.—The shell of a large *Batagur* from the Siwalik Hills in the Indian Museum (No. E 178)[2] agrees, as far as the writer can recollect, in general contour with the preceding specimen, and may not improbably, therefore, belong to the same species.

Distinctness and affinities.—The shortness of the 4th vertebral plate, and the relations of the 3rd vertebral plate to the underlying scutes distinguishes the present form from the species ranged in section *a* of group *A* in the table on page 187; and as the nuchal plate appears to have been absent its affinities are probably with group *B*, rather than with section *b* of group *A*. It may, however, be observed that of the

1 *Vide supra*, p. 191.

2 On account of the excessive weight of this specimen its transport to England was deemed inadvisable. For the same reason another specimen in the Indian Museum (No. E 176) from the Siwaliks of the Rúrki district was not sent. The latter has a highly vaulted carapace, and may perhaps belong to *B. bakeri.*

two species included in the latter section *B. baska* is distinguished by the absence of a vertebral keel in the adult, by its very broad 1st and short 2nd vertebral plates, as well as by the absence of the concavity in the profile of the hinder portion of the carapace. The contour of the shell of *B. thurgi* is totally different, and the 2nd and 3rd vertebrals are relatively shorter. Of the species without a nuchal plate *B. pictus* is distinguished by its short 2nd and 3rd vertebral plates, while *B. affinis* differs by the 4th vertebral plate being somewhat longer than broad, and the 1st and 2nd broader than long, as well as by the total absence of a vertebral keel in the adult.

These comparisons indicate the specific distinctness of the present form from all the living species, and since the shape of the vertebral plates widely distinguishes it from *B. durandi* (with which alone of the preceding three Siwalik species it agrees in the depressed shell) it appears entitled to rank as a distinct species, for which the name of *Batagur cautleyi* is proposed.

The affinities of this species are apparently nearer to *B. affinis* and *B. pictus* than to any other existing form, but the relationship does not seem so close as to indicate decisively that either of these species is the lineal descendant of the fossil.

List of species of Batagur.

The following list indicates the relations of the recent and fossil species of the genus :—

A. A nuchal plate.

a. 4th vertebral plate elongated.

1. B. KACHUGA (Gray [*ex* B. Ham.]). Recent.
2. B. ELLIOTI, Gray. Recent.
3. B. BAKERI, *nobis*. Pliocene.
4. B. DHONGOKA, Gray (*ex* B. Ham.). Recent and (?) Pleistocene.
5. B. DURANDI, *nobis*. Pliocene.
6. B. TRIVITTATUS (Dum. and Bib.). Recent.

b. 4th vertebral plate short.

7. B. THURGI (Gray). Recent.
8. B. FALCONERI, *nobis*. Pliocene.
9. B. BASKA, Gray. Recent.

B. No nuchal plate.

10. B. CAUTLEYI, *nobis*. Pliocene. (*Nuchal probably absent.*)
11. B. AFFINIS (Cantor). Recent.
12. B. PICTUS (Gray). Recent.

Genus *non. det.*

(*cf. Geoemyda*, Gray.)

Nuchal scute.—In plate XXIV. fig. 3, there is represented, of one-third the natural size, the dorsal aspect of the nuchal scute of a large emydine tortoise apparently distinct from all the forms described above, which was collected by Mr. Theobald in the Siwaliks of the Punjab. The specimen shows the boundaries of the nuchal horny plate, the inner half of the 1st marginal of either side, the anterior half of the 1st vertebral, and the antero-internal angles of the 1st costal. The carapace was evidently much depressed, and indicates an animal about the size of large individuals of *Batagur baska*.

The nuchal plate forms an isosceles triangle, and tapers to a point on the anterior margin of the carapace, expanding again very widely on the ventral surface of the latter: its posterior margin is indented by a blunt projection from the 1st vertebral plate. The latter was apparently subhexagonal, and almost certainly longer than broad: its remaining borders are curiously sinuated, and the anterior border projects considerably in advance of the costo-marginal suture. There is no trace of a keel on the remaining half of the 1st vertebral plate; and the anterior border of the specimen is deeply concave. The extreme length of the nuchal plate is 2·3, and the width of the 1st vertebral between the costo-marginal sutures 3·25 inches.

Distinctness and affinities.—The concavity of the anterior margin of the carapace distinguishes the present specimen from all the recent and fossil species of *Batagur*. The specimen indicates an animal considerably larger than any existing Indian species of *Clemmys*,[1] *Terrapene*,[2] or *Cyclemys*; while by the elongated form of the 1st vertebrals it is distinguished from *Testudo*. Compared with *Geoemyda grandis*[3] there are very considerable points of resemblance: thus in both forms the anterior border of the carapace is concave, the nuchal plate is triangular with an excavated posterior border, and the borders of the 1st vertebral plate are sinuous. The fossil presents no trace of the flat vertebral ridge of *G. grandis*, but the writer is unaware how much this would show if the horny plates were removed; and it is absent in the Siamese *G. impressa*, Günther.[4] That the fossil is specifically distinct from the former species (which attains a length a little short of 18 inches) is pretty evident, but the writer inclines to the opinion that the two are allied, and perhaps generically identical, since the same marked concavity of the anterior border of the nuchal scute obtains in *G. impressa*. More perfect specimens of the fossil form are, however, needed before anything definite can be determined; and the present is one of those numerous instances so provoking to the vertebrate palæontologist where a specimen, through its imperfections, throws only a faint glimmer of light on the affinity of the animal to which it belonged.

Family III. *TRIONYCHIDÆ.*

Shell much depressed, covered with a soft continuous skin.

Genus I. EMYDA, Gray.[5]

Shell partly ossified, with a rim of free marginal scutes, and covered with a shagreen-like sculpture; the plastron has five rugose callosities.

The genus is confined to India, Burma, etc.;[6] but is represented in Africa by

1 In the majority of species the anterior border of the carapace is not concave, although this is occasionally so (*C. nigricans*).

2 Including *Cuora*, Gray.

3 *Vide* Günther, "Reptiles of British India," pl. I.

4 'Proc. Zool. Soc.' 1882, p. 344.

5 "Catalogue of Tortoises in British Museum," p. 46 (1844).

6 The so-called *Emyda senegalensis* belongs to *Cyclanosteus*, *vide* "Supplement to Catalogue of Shield-Reptiles," pt. I. p. 111.

the allied *Cyclanosteus*, in which there are no marginal scutes to the carapace, and the ossified scutes of the plastron are widely different. The Indian forms have been referred to two species under the names of *E. granosa* (Shoepff.), and *E. vittata,*[1] Peters; the latter being distinguished from the former merely by the larger size of the azygos entoplastral callosity, which Dr. Günther is indisposed to consider as a specific character. The Pegu form[2] has been referred to a distinct species under the name of *E. scutata*, Peters, which differs from *E. granosa* only by its colouring. In his latest work[3] Mr. Theobald refers the latter species to *E. vittata.*

A. Nuchal scute convex anteriorly, and ossifying from two centres.

Species 1. EMYDA VITTATA, Peters.[4]

Syn. *E. ceylonensis*, Gray.[5]

History of Siwalik form.—The question whether the living form should be regarded as a distinct species, or merely as a race of *E. granosa*, has been alluded to in the preceding paragraph. The first record of the occurrence of the species in a fossil state in India occurs in a memoir by the present writer[6] published in 1880. Falconer[7] had, however, previously recorded the occurrence of the genus in the Siwaliks of Burma.

Shell.—The specimen on which the foregoing identification was founded was obtained from the Siwalik Hills and was presented to the British Museum by the late General Sir W. E. Baker: it comprises the entire shell, with the exception of most of the marginal scutes, and also shows some of the limb-bones. The carapace is a good deal obscured by closely adhering matrix, and as no characteristic features are shown it has not been figured: the plastral aspect of the shell is, however, very perfect, and is represented of one-half the natural size in plate XXVI. fig. 1. The six paired plastral callosities correspond exactly with those of the two living species; and the azygos median callosity is of the relatively large size characteristic of *E. vittata.*[8] The pair of anterior epiplastral callosities form a rather more open angle at their posterior junction than is usual in the living form, but this feature is not found in the next specimen, and in any case can scarcely be deemed a specific character, and as no other differences can be detected between the fossil and the living form the former may be referred to *E. vittata*, apart from the question whether the latter be more than a race of *E. granosa.* The fossil specimen indicates an individual with a shell of about 10 inches in length; the living race according to Mr. Theobald attaining a length of 13·5 inches. The sculpture of the fossil agrees

1 Syn. *E. ceylonensis*, Gray.

2 *Vide* Theobald, "Catalogue of Reptiles of British India," p. 32.

3 "Burma, its People and Productions, etc.," vol. I. p. 341 (1882).

4 'Monatsb. k. Ak. preuss. Wiss.' 1854. p. 216.

5 'Proc. Zool. Soc.' 1855, p. 201.

6 'Journ. As. Soc. Beng.' vol. XLIX. pt. 2. p. 17.

7 "Catalogue of Fossil Vertebrata in Mus. As. Soc. Bengal," pp. 32, 33 (1852). The genus is here mentioned as a sub-genus of *Trionyx* under the name of *Cryptopus*.

8 Compare the specimen figured in Gray's "Catalogue of Shield-Reptiles," pt. I. pl. XXIXA. (*E. ceylonensis*).

precisely with that of recent specimens, consisting of tubercles not arranged in distinct lines, of conical form near the periphery of the carapace, but irregular on and near the median line: there is a tendency to a concentrically linear arrangement of the tubercles on the plastral callosities. The nuchal scute apparently agrees precisely in form with that of the living forms.

Second specimen.—Another shell in the British Museum (No. 39833), also from the Siwalik Hills, exhibits the greater part of the carapace, and the plastron which has been crushed in. The azygos entoplastral callosity is unfortunately wanting, but since the shell agrees precisely in other respects with the figured specimen it may very probably be referred to the same species. The anterior paired plastral callosities form a less open angle at their posterior junction than in the figured specimen, and thereby agree with the living form. The two fossil specimens agree very closely in respect of size.

Xiphiplastral callosity provisionally referred to this species.—A specimen of a right posterior, or xiphiplastral, callosity in the Indian Museum (No. E 144), obtained by Mr. Theobald from the Siwaliks of the Punjab, agrees in size and the structure of the sculpture with the corresponding callosity of full-sized existing specimens of *Emyda*, and may, therefore, be provisionally referred to the present species. The relation of the rugose callosity to the underlying xiphiplastron indicates that the specimen belonged to a fully adult individual; its longer diameter measures 2·1 inches.

Anterior marginal scute provisionally referred to this species.—In plate XXVI. figs. 4. 4a. there is represented from the dorsal and posterior aspects a specimen of the right anterior marginal scute of an *Emyda*, also obtained by Mr. Theobald from the Siwaliks of the Punjab. The specimen agrees exactly in general form and the structure and arrangement of the sculpture with the corresponding scute of the recent forms. As its extreme length is 2·45 inches, and the length of the corresponding scute of a specimen of *E. granosa*, of which the carapace measures 6 inches in length, is 1·2 inches, the specimen would agree in relative size with a full-sized individual of *E. vittata*, and may, therefore, be provisionally referred to the present species. As particular characters of this form of scute it may be observed that there is a groove along the whole of the posterior border *(figure 4a.)* for cartilaginous union with the adjacent marginal scute; and that on the dorsal aspect *(fig. 4)* the sculpture does not extend up to the inner border, while it does so extend on the ventral aspect. On the dorsal aspect the sculpture consists of low regularly shaped tubercles, without the slightest trace of a linear arrangement. The dorsal aspect is convex longitudinally, and concave transversely.

Distribution.—In India the existing *E. vittata* is found in Ceylon, Southern, and Central India; being replaced in the North-West, the Punjab, and elsewhere by *E. granosa.* The fossil indicates that *E. vittata* originally ranged over Northern India; and it may perhaps be concluded that *E. granosa* is a race of more modern origin.

B. Nuchal scute concave anteriorly, and ossifying from a single centre.

Species 2. EMYDA LINEATA, n. sp. *nobis.*

Anterior marginal scute.—The specimen on which this species is founded is the broken anterior marginal scute of the left side represented from the dorsal aspect in plate XXVI. fig. 6; which was collected by Mr. Theobald in the Siwaliks of the Punjab. The specimen agrees very closely in size and contour with the corresponding scute of the opposite side represented in fig. 4 of the same plate. The sculpture has, however, a most distinct linear arrangement; while the individual tubercles are smaller, form sharper cones, and are placed farther apart: the sculpture also extends nearer to the inner border on the dorsal surface. The specimen indicates an individual slightly smaller than full-sized existing specimens of *E. vittata.*

Nuchal scute provisionally referred to the present species.—The specimen represented in plate XXVI. fig. 3, also collected by Mr. Theobald in the Siwaliks of the Punjab, consists of a portion of the left half of the nuchal scute of a somewhat larger *Emyda*, which from the linear arrangement of the sculpture is provisionally associated with the preceding specimen. A peculiarity in which this specimen differs from the nuchal scute of the existing forms of *Emyda* will be noticed under the head of *E. sivalensis.*

Distinctness.—The peculiar arrangement of the sculpture of the marginal is a character so marked as to indicate pretty clearly the specific distinctness of this form, which it is proposed to name *E. lineata.* If, as is pretty certainly the case, the nuchal scute belong to the same species its specific distinctness is still more strongly marked.

Distribution.—Both the specimens described above came from the Punjab, within the Indus basin.

Species 3. EMYDA SIVALENSIS, n. sp. *nobis.*

Anterior marginal scute.—The left anterior marginal scute of a very large *Emyda* represented in plate XXVI. fig. 9. from the dorsal aspect was obtained by Mr. Theobald in the Siwaliks of the Punjab. In the non-linear arrangement of the sculpture this specimen agrees with *E. vittata* and differs from *E. lineata*, so that comparisons may be confined to the former. The present specimen differs from the anterior marginal of *F. vittata* (fig. 4) by its greatly superior size, its greater proportionate breadth, the more convex dorsal surface, as well as by the circumstance that while on the dorsal aspect (fig. 9) the sculpture extends quite up to the inner border, on the ventral aspect (shown in the specimen represented in fig. 7) it does not extend to within a considerable distance of this border. Both agree in having a groove extending along the whole of the posterior surface for cartilaginous union with the adjacent marginal. The dimensions of the two specimens are as follows, *viz.*:

	Specimen.	E. vittata.
Length along inner border	3·0	2·3
Greatest width	2·0	1·1

Since the scute provisionally referred to *E. vittata* indicates a shell of about 12 inches in length the present specimen belonged to an individual whose shell was probably between 18 and 22 inches in length; and the specimen noticed below indicates a still larger individual.

Second specimen.—The posterior two-thirds of a right anterior marginal represented from the ventral aspect in fig. 7 of the same plate, although differing slightly in outline, agrees so closely in general form, size, and the arrangement of the sculpture, that it may be at least provisionally referred to the same species: it was likewise obtained by Mr. Theobald from the Siwaliks of the Punjab. The greatest width of this specimen is 2·25 inches.

A third imperfect specimen of the right side in the Indian Museum (No. 135 A), with the same history, agrees very closely with the specimen represented in fig. 9.

Nuchal scute.—The specimen represented in pl. XXVI. fig. 2, comprises rather less than the right half of the nuchal scute of an *Emyda*, which from its very large size and the general agreement in the structure of its sculpture may be pretty safely referred to the same species as the marginal scutes noticed above. The specimen was obtained by Mr. Theobald from the Siwaliks of the Punjab.

Before describing this specimen it will be necessary to notice the structure of the nuchal scute in the existing species of *Emyda*; and in order to exhibit this a specimen of this portion of the carapace of an immature individual of *E. granosa*, in which the entire carapace measures 6 inches in length, is represented in pl. XXVI. fig. 8. It will be seen from this figure that in immature specimens the nuchal scute consists of two distinct portions; namely, an anterior subelliptical moiety (*a*), and a larger posterior moiety (*b*) of very peculiar shape, which is sufficiently apparent from the figure. The anterior border of this posterior moiety is deeply concave in the middle for rather more than half its length, the anterior moiety fitting into this concavity, to which it is united by cartilage: there is of course no sculpture on the anterior surface of the concave portion of the hinder moiety. In fully adult individuals the two moieties become united by bone; the anterior border of the scute thus becoming regularly convex, and the sculpture covering the whole of the anterior surface.

The fossil specimen (fig. 2) corresponds to the hinder moiety of the nuchal scute of the immature *E. granosa*; but differs in that the sculpture extends completely over the rounded anterior surface of the concave middle portion of the anterior border, clearly showing that the anterior moiety of the recent form (*a*, fig. 8) was never developed in the fossil; and consequently that the anterior border of the nuchal scute was concave at all ages.

Taking the fossil specimen as representing half the nuchal scute (it really comprises somewhat less), the greatest width of the complete nuchal scute would be 6·2 inches; and since the corresponding width of the same scute in the figured specimen of *E. granosa* is 1·9 inches, while the length of the carapace is 6 inches, it follows that the length of the fossil carapace would be 19·6 inches. Allowing for the fossil nuchal being less than half the complete specimen, a length of 22 inches would not appear too large an estimate for the length of the complete carapace.

The tubercles on the nuchal scute are large, blunt, and somewhat irregular in shape; and present a considerable resemblance to those of adult specimens of *E. granosa*. Those on the marginal scute are also blunt and low: but of regular form and tolerably closely approximated.

Distinctness and affinities.—The foregoing comparisons indicate the existence of a Siwalik *Emyda* of nearly twice the size of either of the existing species, and broadly distinguished by the structure of the nuchal scute, as well as by equally well-marked differences in that of the anterior marginals. As the nature of the sculpture at once distinguishes it from *Emyda lineata* it may be referred to a new species, for which the name of *E. sivalensis* is proposed.

A comparison of the figures will show that the nuchal scute of *E. lineata* (pl. XXVI. fig. 3) agrees in structure with that of the present species. This structure is evidently a less specialized one than that obtaining in the existing species of the genus; but it is not at present clear what bearing it has upon the evolution of the genus.

Distribution.—All the known remains which can be referred to this species have been obtained from the Punjab.

Species 4. EMYDA PALÆINDICA, n. sp. *nobis.*

Anterior marginal scute.—The complete right anterior marginal scute of a large *Emyda* collected by Mr. Theobald in the Siwaliks of the Punjab, and represented from the dorsal aspect in plate XXVI. figs. 5. 5a., indicates a form different from any of those previously described. In general shape the specimen agrees with the corresponding scute referred to *E. vittata* (fig. 4), but differs in that the sculpturing on the dorsal surface extends completely up to the inner margin; it also differs from that form, and all the other species, in that on the posterior surface (fig. 5a) there is merely a small notch at the postero-internal angle, instead of a groove (fig. 4a) extending along the whole length of that surface. This indicates that the adjacent marginal was only very slightly attached to the present one, and that the rim of the carapace formed by the marginals, instead of being continuous as in all the other species, was interrupted by reentering vacuities. The sculpture has no trace of a linear arrangement; and the individual tubercles are more acutely pointed, and more widely separated than in either of the existing species, or in *E. sivalensis.* The length of the specimen is 3·1, and its greatest width 1·7 inches; and it probably indicates a form slightly smaller than the last-named species.

Nuchal scute.—Part of the left half of the nuchal scute of a large *Emyda* in the Indian Museum (No. E 132A), with the same history as the last specimen, is rather smaller than the homologous scute of *E. sivalensis*, with which it agrees in the concave contour of the anterior border. The sculpture, of which a portion is represented in plate XXVI. fig. 10, has not a linear arrangement, and differs from that of the existing forms, as well as from *E. sivalensis*, by the more acutely pointed and more widely separated tubercles, which are always perfectly conical, and have no tendency to the irregular shape which they present on the hinder part of the nuchal scute of the other species. As the specimen agrees in this respect with the marginal scute described above, it most probably belongs to the same species.

Distinctness and affinities.—From the evidence of the two specimens just described there seems no reasonable doubt as to the existence of a fourth well-defined species of Siwalik *Emyda*, to which it is proposed to apply the name of *E. palæindica.*

The Indian Museum possesses specimens of the later marginal scutes of various Siwalik forms of *Emyda*, but it is not easy to refer them to their respective species. It may be hoped that future researches in the Punjab will bring to light more perfect specimens of this and the two preceding species which will more fully illustrate their affinity. Fragmentary as they are, the remains on which these species are founded are very important, as serving to indicate the great development and diversity of structure which this peculiar Oriental genus attained in pliocene times.

Distribution.—All the remains referred to this species have been obtained from the Punjab, within the catchment basin of the Indus.

Genus II. TRIONYX, Geoffroy.[1]

Definition.—Shell very similar to that of *Emyda*, but with a coarser sculpture, and without marginal scutes: the callosities on the plastron may be either four or five in number, the two anterior (epiplastral) callosities of *Emyda* being invariably, and the azygos (entoplastral) one sometimes absent.

The genus and its allies presents extreme difficulty to the palæontologist (and more especially in the case of Indian forms) owing to the close similarity existing in the structure of the shell of most of the species, and the circumstance that a large series of macerated shells of the existing species is not generally attainable. The structure of the cranium of the existing *Chitra indica*[2] is so different from that of the typical *Trionyx gangeticus*[3] that it seems almost imperative to follow Gray in regarding the former as generically distinct: the shell of *Chitra* apparently, however, differs from that of the Indian species of *Trionyx* solely by its superior size and the absence of an anterior azygos (entoplastral) callosity.[4] *Pelochelys cantori* has likewise such a peculiar cranium that there seems good reason for separating it generically: its shell according to Mr. Theobald[5] has no azygos callosity, but one of the specimens in the British Museum shows a very small one. All the other existing forms may be referred to *Trionyx.*

Distribution.—At the present day *Trionyx* has a very wide distribution; and numerous fossil forms have been referred to it from various tertiary formations

1 'Ann. d. Muséum,' vol. XIV. p. 1 (1809).
2 *Vide* Gray, "Catalogue of Shield-Reptiles," pt. 1. pl. XLI.
3 *Ibid*, pl. XLII. fig. 1.
4 *Vide* Theobald, "Catalogue of the Reptiles of British India," p. 26.
5 *Op. cit.*, p. 27.

ranging down to the lower eocene of Europe,[1] and the eocene (Bridger beds) of North America.[2] The foregoing observations will, however, have shown that since these species are mainly, or entirely, founded upon the carapace, or fragments of the same, it cannot be determined whether some of them may not have belonged to *Chitra* or *Pelochelys*.

Indian and Burmese species.—Of the existing Indian and Burmese forms Mr. Theobald[3] recognizes the following three species from India proper, *viz.*:—

TRIONYX GANGETICUS, Cuvier. Facial part of cranium short; plastral callosities well developed.

TRIONYX SEWAARE, Gray (*ex* B. Hamilton, MS.). Facial part of cranium short: plastral characters of adult unknown. As far as is known this species can only be distinguished from the last by its colouration.

TRIONYX OCELLATUS, Gray. Facial portion of cranium more elongate. Sculpture on the callosities coarser than in *T. gangeticus*, and the lateral scutes more bent.

From the districts to the east of the Bay of Bengal the following five species are recognized, *viz.*:—

TRIONYX PHAYREI,[4] Theobald. Cranium resembling that of *T. gangeticus*; plastron imperfectly ossified, callosities being absent in the young: the carapace has an indistinct median keel.

TRIONYX STELLATUS, Schlegel. Facial portion of cranium elongate; plastron imperfectly ossified in the young.

TRIONYX PEGUENSIS, Gray. Described only from the skull.

TRIONYX GRAYI, Theobald. Cranium agrees with that of the latter in general characters, but differs in colouration.

TRIONYX EPHIPPIUM, Theobald. Only known by the young, in which the plastral callosities are absent.

Apparently, as far as is known, the nuchal scute is fully ossified in all these forms, and is rugose on the whole of the dorsal aspect. There is, however, another Asiatic group,[5] in which the nuchal scute (at least in the young) is not fully ossified posteriorly, and is frequently only partially rugose. Examples of this group are *T. guentheri*[6] (Gray), of which the habitat is unknown; *T. subplanus*, Schweigg, of Singapore, etc.; and *T. ornatus*,[7] Gray, of Borneo.

Siwalik forms.—The earliest record of the occurrence of *Trionyx* (or one of the allied genera) in the Siwaliks is by Clift,[8] who figured some fragments of shells obtained from Burma, among which are, however, included some specimens apparently belonging to *Emyda*. The occurrence of similar remains both in Burma and the Siwalik Hills was noted by Falconer[9] in 1831, and mention of the genus is also made in his notes.[10] In his "Catalogue of the Fossil Vertebrata in the Museum

1 *Vide* Owen and Bell, "Fossil Reptilia of the London Clay, etc.," pt. I. pp. 45-61 (1849).

2 *Vide* Leidy, "Extinct Vertebrate Fauna of the Western Territories," pp. 341-342 (1873).

3 'Proc. As. Soc. Beng.,' 1875, p. 178. "Catalogue of the Reptiles of British India," pp. 340-341.

4 Syn. *T. cariniferus*, Gray (*non Aspilus cariniferus*, Gray).

5 Comprehending the genera *Aspilus* and *Dogania* of Gray.

6 *Vide* Günther, "Reptiles of British India," pl. VI. fig. A.

7 *Ibid*, fig. B.

8 'Trans. Geol. Soc.' ser. 2. vol. II. pp. 374-375 (1828).

9 *Vide* "Falconer's Palæontological Memoirs," vol. I. p. 413.

10 *Ibid*, pp. 23, 35, 39.

of the Asiatic Society of Bengal,"[1] he again records the occurrence of the genus in the Siwaliks of Burma.

Fragments of the carapace and plastron of *Trionyx* and its allies are of exceedingly common occurrence throughout the Siwaliks of India and Burma, and strongly marked differences in the form of the sculpture of different specimens indicate the occurrence of several distinct species. The imperfect state of our knowledge of the existing species of India and Burma (and still more of those of other parts of Asia) shows, however, that it would be worse than useless to attempt the specific (or even generic) identification of many such specimens. Even with nearly complete fossil specimens of the shell it would in many cases be impossible to determine at present whether they were distinct from or identical with living species; and accordingly in the two Siwalik specimens noticed below under the head of the present genus the writer has not attempted a specific determination.

A. Nuchal scute suturally connected with the first costal.

Species 1. Trionyx gangeticus, Cuvier.[2]

(*For palæontological purposes it is obvious that this species must be taken to include* T. sewaare, *as that form is only distinguished by its colouration.*)

Earlier notice of reputed occurrence in the pleistocene.—In 1870 Stoliczka[3] described and figured two fragments of the plastron of a large *Trionyx* from the pleistocene of the Narbada valley, which he considered might very probably be referred to the present species. It is, however, by no means clear that they might not have belonged to *T. ocellatus*, as they exhibit a very coarse sculpture.

Cranium.—The cranium of a large *Trionyx* represented of three-fourths the natural size in plate XXV. figs. 3. 3a. 3b., was obtained by Mr. C. Fraser from the pleistocene of the Narbada valley, and presented by him to the British Museum sometime previously to 1843. With the exception of the loss of the occipital condyle, of the long supraoccipital projection, and of the parallel lateral projections, the specimen is almost perfect. It is precisely similar to the cranium of the existing *T. gangeticus*,[4] exhibiting very clearly the short facial portion which marks its distinction from *T. ocellatus*. It is unfortunate that the mandible is not preserved (by which the skull of *T. gangeticus* is at once distinguished from that of the Burmese *T. phayrei*[5]), but since the present specimen cannot possibly be distinguished from the cranium of the former species, and it is improbable that the latter occurred in the pleistocene of the western side of India, no reasonable doubt can be entertained that it indicates the existence of *T. gangeticus* in the Narbada pleistocene.

Distribution.—According to Mr. Theobald[6] the existing form inhabits the Ganges valley from Bengal to the North-West Provinces. The trionyches of the Narbada

1 Pages 32, 33 (1852). The genus *Trionyx* is taken to include *Trionyx* proper (=*Gymnopus*), and *Emyda* (=*Cryptopus*).

2 "Règne Animal," 2nd ed. vol. II. p. 16 (1829). For the synonomy see Theobald, 'Proc. As. Soc. Beng.' 1875, p. 171.

3 'Rec. Geol. Surv. Ind.' vol. II. p. 39. pl. I. figs. 4, 5.

4 Compare Gray, "Catalogue of Shield-Reptiles," pt, I. pl. XLII. fig. 1.

5 *Vide* Theobald, *op. cit.*, p. 178.

6 "Catalogue of the Reptiles of British India," p. 29.

river appear, however, to be totally unknown, so that there seems no reason why the species should not still inhabit that valley.

TRIONYX, sp. 2.

Shell.—In plate XXVII. fig. 3. there is represented of one-half the natural size the right half of the ventral aspect of the shell of a small *Trionyx* from the Siwalik Hills; a portion of the dorsal aspect of the carapace being represented in fig. 3a of the same plate. The specimen is now in the Indian Museum, and was obtained by exchange with the Museum of Comparative Anatomy at Cambridge, having been purchased by the latter institution among a small collection of Siwalik fossils: the matrix leaves no doubt of the correctness of the locality.

The condition of the plastron and of the costal scutes of the carapace indicates that the specimen belonged to a fully adult individual; and the length of the carapace when complete was probably about 12 inches. On the ventral aspect the whole of the plastral elements, with the exception of the epiplastra, are exhibited in a perfect condition, but the carapace is considerably damaged.

There is a well-marked azygos (entoplastral) callosity on the plastron; the paired callosities being fully ossified, and uniting in the middle line: the sculpture is somewhat finer than in *T. gangeticus*. The carapace does not show the form of the nuchal or vertebral scutes; but it exhibits three very well-marked continuous longitudinal keels, and there is no median depression.

Affinities.—The presence of an azygos plastral callosity, as well as its greatly inferior size, differentiates the present specimen from *Chitra indica*. *Pelochelys cantori* is also considerably larger, and differs in the form of the paired plastral callosities; the specimens in the British Museum not showing the distinctly tricarinate carapace of the fossil.

The fossil agrees with the Indian species of *Trionyx* in the possession of an azygos plastral callosity; but apparently differs from all in which the adult carapace is known by the presence of the three distinct keels on the carapace.[1] In addition to this character *T. gangeticus* and the two allied Indian species are distinguished by their greatly superior dimensions and coarser plastral sculpture. Nothing can be predicated as to the relations of the fossil with *T. peguensis*, *T. grayi*, and *T. ephippium*.

In *T. ægyptiacus*, Geoffr., there is a larger azygos plastral callosity than in the present specimen, and that species attains a considerably greater size, but specimens in the British Museum show a similarly tricarinate carapace.

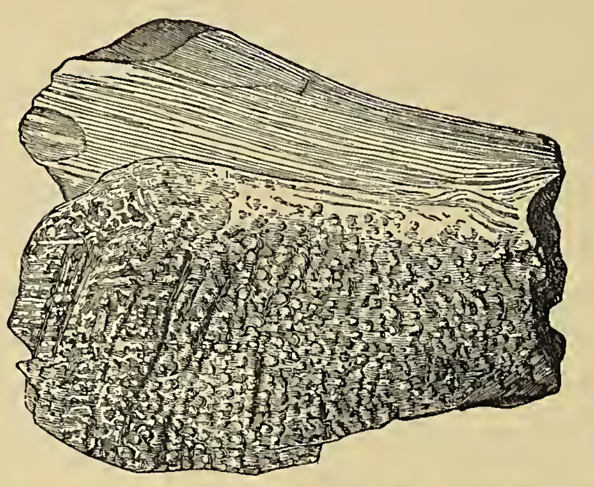
B. Nuchal scute not suturally connected with the first costal.

TRIONYX, sp. 3.

First costal scute.—This second Siwalik species is indicated by the specimen

[1] In *T. phayrei* (=*T. cariniferus*, Gray) there is a vertebral keel on the carapace, but no costal keels. The species is much larger than the present form, equalling in size *T. gangeticus*.

figured in the accompanying woodcut, which was obtained by Mr. Blanford from the lower Siwaliks of Sind.



Trionyx, sp. The greater part of the first left costal scute; from the lower Siwaliks of Sind. Indian Museum (No. E 129). ½.

The specimen comprises the greater part of the first left costal scute, perfect distally, but wanting a small portion at its vertebral extremity and on its hinder border. The anterior border is formed by the first rib, which presents an anterior and a superior surface, both of which have no trace of sculpture. The anterior surface is a free one, and shows that the nuchal scute did not unite by suture with the 1st costal. That portion of the scute situated posteriorly to the rib is covered with a well-marked sculpture, consisting of conical tubercles, and quite different in structure from that of the last species or *Chitra*.

Nuchal scute.—A fragment of the scute of a *Trionyx* from the Siwaliks of the Punjab in the Indian Museum (No. E 130) agrees in the character of the sculpture with the preceding specimen. Owing to its imperfect condition it is somewhat difficult to be quite sure of the position it originally occupied in the shell, but it appears to be a portion of the left half of the nuchal scute, and indicates an individual fully as large as the last specimen. It is entirely rugose, and both the anterior and posterior borders are free, and the under surface is bevelled away in front of the latter. It cannot be certainly determined whether this specimen belongs to the same species as the last, although this may well have been the case; but in either case it indicates a form with a nuchal scute not suturally connected with the 1st costal.

Distinctness and affinities.—The structure of the present specimens at once shows that they indicate a form allied to the group referred to on page 203, in some of which the nuchal scute is not suturally connected with the 1st costal, and is frequently imperfectly sculptured. None of the recent forms, however, appear to have the anterior half of the 1st costal unsculptured, as it is in the fossil. The nature of the sculpture of the latter agrees very closely with that of *T. guentheri*,[1] and is quite different from that of *T. ornatus*[2]; the fossil nuchal scute agrees moreover with the former in being completely sculptured, and thereby differs from the latter, in the

[1] *Vide* Günther, "Reptiles of British India," pl. VI. fig. A. [2] *Ibid*, fig. B.

adult of which the nuchal scute is entirely unsculptured, and has an unossified space between it and the 1st costal.

Although the evidence of such small fragments perhaps makes it inadvisable to assign a distinct specific name, yet it is most probable that the present specimens indicate a new species, which may be regarded as an ancestral form closely related to *Trionyx guentheri*, but with a still more generalized structure. It is a very remarkable fact that while we have evidence of this less specialized form in the Siwaliks of India, and of kindred living Asiatic species, yet that all the known species from the English eocene[1] exhibit as full a development of the nuchal scute as in the existing *T. gangeticus*; thus showing that the origin of the group is to be looked for in much earlier geological periods, and that the fossil and living Asiatic forms with imperfectly developed nuchal and 1st costal scutes should probably be regarded as survivals of a primitive type.

Distribution.—Assuming that both the specimens noticed above belong to the same species, they indicate that the range of the latter in time extended from the lower to the upper Siwaliks, and in space from Sind to the Punjab; both the latter areas being in the Indus basin.

Genus III. CHITRA, Gray.[2]

The characters of this genus have been alluded to under the head of *Trionyx*: the only known species is *C. indica*. The nuchal scute is fully ossified, and entirely rugose.

Species. Chitra indica, Gray.[3]

Syn. *Trionyx indicus*, Gray.[4]

Carapace.—The British Museum possesses two portions of the carapace of a very large species of trionychine tortoise from the Siwalik Hills, which are figured of one-fourth the natural size in plate XXVII. figs. 1 and 2. Both specimens belong to subadult individuals, as is shown by the extension of the costal scutes nearly up to the free extremities of the ribs. The first specimen (fig. 1) exhibits the nuchal, and the complete 1st and parts of the 2nd vertebral and costal scutes; while the second shows the greater part of the first six vertebral and costal scutes, and from the identity in size and form between the first two of these and the corresponding scutes of the first specimen, there can be no doubt as to the specific unity of the two specimens.

The first specimen exhibits on its ventral aspect the anterior elements of the plastron, and since the entoplastral portion shows not the slightest trace of an azygos callosity, the present form differs from the existing Indian species of *Trionyx*; and as it is of considerably larger size than *Pelochelys cantori* (in which an azygos

1 *Vide* Owen and Bell, "Fossil Reptilia of the London Clay, etc." part I. ((1849).
2 "Catalogue of Tortoises in the British Museum," p. 49 (1844).
3 "Synopsis Reptilium," p. 47 (1831). *Trionyx.* *Loc. cit.*

callosity is at least occasionally present), and differs in the form of the vertebral scutes and the nature of the sculpture, it is evidently distinct from that species.[1] Compared with *Chitra indica*[2] the fossil agrees so closely in every respect—especially in its great size, in the coarse sculpture of the carapace, the small dimensions of the 5th, and the elongation of the four preceding vertebral scutes—that there can be no reasonable doubt of its specific identity. The following are the dimensions of the fossil specimens :—

	In.
Transverse diameter of nuchal scute	11·0
Ant.-post. ,, ,, 1st vertebral scute	3·2
Transverse ,, ,, 2nd costal ,,	9·3
Ant.-post. ,, ,, ,, ,, ,,	3·65
Transverse ,, ,, 5th ,, ,,	10·5
Ant.-post. ,, ,, ,, ,, ,,	3·8

The writer has not had the opportunity of comparing a full-grown existing specimen with the fossil, but according to Mr. Theobald the shell of the former attains a length of more than three feet.

The Indian Museum possesses three fragments of costal scutes (Nos. E 112, 116, 118) from the Siwaliks of the Punjab, which agree in respect of size and the structure of the sculpture with the British Museum specimens, and may accordingly be referred to the same species. The antero-posterior diameter of the portion belonging to a 2nd costal (No. E 116) is 3·5 inches.

Hypoplastron.—An adult hypoplastral scute from the Siwalik Hills in the British Museum (No. 39829) probably belongs to the present species.

Distribution.—According to Mr. Theobald[3] the species at the present day inhabits "the Ganges, Bengal, the Irawadi, and the estuaries of the Indian and Malayan coasts"; it has also been stated to occur in the Phillipine Islands.[4] The fossil scutes in the Indian Museum indicate that its range formerly embraced the basin drained by the Indus.

1 In *P. cantori* the first four vertebrals are relatively wider—especially anteriorly—and the sculpture is much finer. In *Trionyx gangeticus* and the allied forms the 5th vertebral is relatively larger, and the sculpture less coarse.

2 The specimen compared was an immature one belonging to the Indian Museum, Calcutta (No. 1779).

3 "Catalogue of Reptiles of British India." p. 27.

4 *Vide* Günther, "Reptiles of British India," p. 50.

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INDIAN TERTIARY & POST-TERTIARY VERTEBRATA.

SIWALIK CROCODILIA, LACERTILIA, & OPHIDIA.

By R. LYDEKKER, B.A., F.G.S., etc.

(WITH PLATES XXVIII. TO XXXV.)

INTRODUCTORY.

Previous literature.—As was the case with the Chelonia till the publication of the preceding part of this volume, the Siwalik Crocodilia have been hitherto but very imperfectly known. Two memoirs were published by Cautley, which will be noticed in the sequel, and some illustrations, which are in several instances incorrectly named, are given in "Falconer's Palæontological Memoirs"; but beyond this nothing of any importance has been hitherto published. The few notes left by Falconer are manifestly crude, and were not meant to have seen the light in their present form. The single known lacertian bone has been figured in the work cited; while a brief notice of ophidian vertebræ has been previously published by the present writer.

Relation of the fossil and existing Indian Crocodilia.—The crocodilian fauna of the Siwaliks as a whole considerably exceeded that of modern India, both in the number of species and the dimensions which some of those species attained, and is thus in harmony with the relations of the pliocene to the existing mammalian fauna. This excess is, however, not equally distributed in all groups, since while in India there are at the present day three species of *Crocodilus* and one of *Gharialis*, in the Siwalik epoch there were but two species of the former, while there were no less than six species belonging to the gharialoid group, of which five are referred to the existing genus, and the sixth is made the type of a new genus. Even, however, in the genus *Crocodilus* there is in one sense an excess of the fossil over the recent forms if we eliminate from the latter the two allied species *C. porosus and C. pondicherianus*, which the fossil evidence indicates are probably immigrants into India from the eastward. One of the two Siwalik species of *Crocodilus* is evidently the ancestral form of the existing *C. palustris*, and it has been a question whether the fossil should be regarded as specifically distinct, or merely as a race of that species: in conformity, however, with the course pursued in the analogous instances among the Chelonia the former view has been adopted. In the genus *Gharialis* one form has been regarded as specifically identical with the existing *G. gangeticus*, while all the others are totally distinct, and several of them differ very widely from that species. Two members of the gharialoid group indicate crocodilians of larger size than have been hitherto described from any part of the world, and formed worthy consorts in point of size with *Colossochelys atlas*. Nothing is at present known of the crocodiles of the pleistocene Narbada beds. As the Lacertilia and Ophidia are known merely by two species, nothing can be predicated of their relations to the existing fauna, with the exception that the one species of *Varanus* largely exceeded all its living congeners in point of size.

Order. CROCODILIA.

Suborder. EUSUCHIA.

Family. *CROCODILIDÆ.*

Generic divisions.—The existing and Siwalik crocodilians, all of which it seems advisable to include in a single family, may be divided from the characters of the skull as follows, *viz.*:—

A. Alligatoroid group. Both the first and fourth mandibular teeth received into pits, or perforations, in the cranium; the maxillary teeth biting on the outer side of the smaller mandibular teeth.

a. Alligator. Nasals dividing the anterior nares.
b. Caiman. Supratemporal fossæ obliterated.
c. Jacare. Vomers appearing on the palate.
} The writer is inclined to think that all the genera might well be included in *Alligator*.

B. Suchoid group. The first mandibular tooth received into a pit or perforation, the fourth into a lateral notch in the cranium; the nasals articulate with the premaxillæ; mandibular and maxillary teeth interlocking.

a. Crocodilus.[1]

C. Gharialoid group. Skull elongated into a rostrum; splenials enter into mandibular symphysis.

1. Both the first and fourth mandibular teeth received into lateral notches in the cranium; maxillary and mandibular teeth interlocking.

a. Tomistoma.[2] Mandibular symphysis extends to the fifteenth tooth; premaxillæ hardly expanded, and articulating with nasals.

b. Gharialis. Mandibular symphysis extends to the twenty-third or twenty-fourth tooth[3]; premaxillæ and extremity of mandible much expanded[3]; nasals widely separated from premaxillæ.

2. First mandibular tooth received into a lateral notch, fourth into a pit in the cranium; maxillary teeth biting outside the mandibular.

a. No living representative.

[1] The African *C. cataphractus* is sometimes separated as *Mecistops*.
[2] Syn. *Rhynchosuchus*, Huxley.
[3] These characters are not applicable to some of the fossil forms.

Of extinct genera *Diplocynodon*, originally described from the lower miocene of France,[1] but which also occurs in the tertiaries of N. America,[2] belongs to the alligatoroid group, and is distinguished by the enlargement of the third, as well as the fourth mandibular tooth. One of the French species *(D. gracilis)* has been recorded by Dr. Filhol[3] from the upper eocene phosphorites of Quercy. *Bottosaurus*,[4] from the upper cretaceous of N. America, was described merely from a portion of the mandible, which likewise indicates an alligatoroid form. *Plerodon*[5] is also from N. America, and has a broad, short muzzle and short symphysis, but the writer is unacquainted with its full affinities. The following are gharialoid forms (*i.e.* have a long rostrum, and, as far as is known, the splenial entering into the mandibular symphysis), *viz.*, *Thoracosaurus*,[6] from the upper cretaceous, which is readily distinguished by the existence of a prelachrymal vacuity in the cranium (like *Teleosaurus*), and is said by Leidy to present a strong resemblance to the so-called *Gharialis macrorhynchus*[7] of the upper cretaceous of France, but has the cranial rostrum tapering more gradually, and the teeth stouter, in which respects it approaches *Tomistoma*: the anterior border of the orbit is not prominent. *Holops*,[8] from the same formation, has a cranium presenting a great resemblance to that of *Thoracosaurus*, but lacks the prelachrymal vacuity. The supratemporal fossæ in the type species are equal in size to the orbits, and the anterior border of the latter is not prominent; in a cranial rostrum provisionally referred by Cope[9] to *H. obscurus*, the premaxillæ have scarcely any terminal expansion, and there are interdental pits in the maxilla for the tips of the mandibular teeth. In both this genus and *Thoracosaurus* the cervical ribs are aborted. In *H. obscurus* the premaxillary fissure is of large size. The relations of the nasals to the premaxillæ are apparently unknown, but if, as is probably the case, they are the same as in *Gharialis*, the writer would be inclined to doubt the propriety of generically separating the American forms, unless it be that the structure of their teeth is a sufficient distinction. *Thecachampsa*[10] from the miocene of N. America is a gharialoid having the dental series interrupted by large caniniform teeth: its rostrum is very long and slender, and the maxillary and mandibular teeth appear to have interlocked. The so-called *Melitosaurus*, Owen, from the reputed miocene of Malta has been shown by the present writer[11] to be identical with *Tomistoma*; that genus being represented in the

1 *Vide* Vaillant, 'Ann. Sci. Géol.' vol. III. art. 1. p. 41 (1872).

2 *Vide* Cope, 'Rep. U. S. Geogr. Surv. W. 100th Meridian,' vol. IV. pt. 2. Palæontology, p. 60 (1877). 4to.

3 'Ann. Sci. Géol.' vol. VIII. art. I. p. 264 (1877).

4 *Vide* Leidy, 'Smith. Contrib. Know.' vol. XIV. art. 6. p. 12 (1865), and Cope 'Trans. Amer. Phil. Soc.' vol. XIV. art. 1. pp. 61-62 (1870).

5 *Vide* Cope 'Trans. Amer. Phil. Soc.' vol. XIV. art. 1. p. 62 (1870).

6 *Vide* Leidy, *op. cit.* and Cope, *op. cit.* pp. 61-79.

7 Cope, *op. cit.* pp. 67-71 refers this species to *Thoracosaurus*, but in the figure given by Gervais, the lachrymal region is so imperfect as apparently to render it impossible to determine whether prelachrymal vacuities were present.

8 *Vide* Cope, *op. cit.* pp. 62, 67-79.

9 *Op. cit.* p. 77, figs. 19, 20.

10 *Vide* Cope, *op. cit.* pp. 62-65. Five species are recorded in this memoir, bnt in only one is any portion of the skull known; this portion consisting of a fragment of the mandibular symphysis, which, however, is not figured.

11 In a paper read before the Geological Society on November, 18th, 1885, which will be published in the 'Quart. Journ. Geol. Soc.' vol. XLII. (1886).

tertiary of the Maltese Islands by *T. champsoides* (Owen), and *T. gaudense* (Hulke). The former differs from *T. schlegeli* by the presence of an additional premaxillary tooth, and thereby approaches *Gharialis gangeticus.* A crocodilian from the (apparently) miocene of Eggenburg in Lower Austria, described by Messrs. Toula and Kail[1] under the provisional name of *Gharialosuchus*[2] *eggenburgensis*, has likewise been shown by the present writer in the paper quoted to be inseparable from *Tomistoma*, and may be known as *T. eggenburgense.* In this species the anterior border of the orbit is prominent, as in *Gharialis gangeticus*, and there is likewise an additional tooth in the premaxillæ, between the proper first and second teeth: it is possible that it may be specifically the same as *T. champsoides*, in which case the former name has the right of priority. A new gharialoid genus from the Siwaliks is described in the sequel, and forms the second division of the gharialoid group in the table given above.

Genus I.: CROCODILUS, Linn.[3]

Definition.—It may perhaps be doubted if *Crocodilus toliapicus*, Owen,[4] from the London Clay, can really be included in this genus, as it has $\frac{22}{20}$ teeth, and the mandibular symphysis is elongated (although not to the same extent as in *Tomistoma schlegeli*); it agrees, however, with typical species of *Crocodilus* (and thereby differs from *Tomistoma*) by the extension of the nasals to the anterior narial aperture. *Crocodilus champsoides*, Owen,[5] from the same formation, has 21 upper teeth, but agrees with *C. cataphractus* (in which the teeth number $\frac{17}{15}$) in the expansion of the premaxillæ, and their perforation by the fourth mandibular tooth, as well as in the relation of the nasals to the external nares. Including the latter species, the genus may be provisionally defined from cranial characters, as follows: – Snout moderately long, or short, nasals articulating with premaxillæ,[6] anterior border of orbit not prominent, third and ninth upper and fourth lower teeth generally larger than the others, first mandibular tooth received into a pit or perforation, fourth into a lateral notch in the cranium. The muzzle is longest, and the teeth are less differentiated in the gharialoid forms like *C. cataphractus*, and *C. champsoides*, which not improbably indicate a transition towards *Thoracosaurus* and *Tomistoma.*

Distribution.—At the present day the genus occurs in America, Africa, Asia, and Australia; it is strongly developed in nearly all the tertiaries, being represented in the London Clay[7] of England by the long-snouted *C. champsoides*, and in the middle eocene by the short-shouted *C. hastingsiæ*, Owen.[8]

1 'Anzeig. k Ak. Wiss.' 1885. pp. 107-109. 2 Amended from *Gavialosuchus.*

3 'Syst. Nat.' ed. 12. vol. I. p. 359 (1766). As a subgenus of *Lacerta.*'

4 'Fossil Reptilia of London Clay, etc.' pt. 2. p. 29. pls. II. IIA. (1850). 5 *Ibid.* p. 31. pl. III.

6 In some instances (*e.g. C. hastingsiæ*) the nasals do not reach the anterior nares, although they do so in most species.

7 *C. icenicus* and *C. cantabrigiensis*, Seeley (Quart. Journ. Geol. Soc.' vol. XXX. p. 693 [1874], and XXXII. p. 437 [1876]), being founded on vertebræ, their generic determination is uncertain.

8 *Op. cit.* p. 37. pls. VI. VII.

Recent Asiatic species.—The following species are found in Asia at the present day:—

A. Palatal aspect of premaxillæ short, with posterior border nearly straight.

CROCODILUS PALUSTRIS,[1] *Lesson*, India. Ceylon, and Burma. Facial portion of cranium (pl. XXIX. figs. 1. 1a.) very broad; sculpture deep; rugose nodules in advance of orbit; interorbital space narrow and deeply concave, its width being much less than long diameter of orbit; premaxillary fissure heart-shaped; maxillo-premaxillary suture usually extends on palate but slightly behind anterior border of fifth alveolus;[2] superior surface of premaxillæ shorter than external narial aperture; facial profile concave. In old individuals the facial part of the cranium is relatively wider, and more convex than in the young.

CROCODILUS SIAMENSIS, *Schneider.* Siam, and Cambodia. General characters of last species, sculpture on face much less deep, with slight nodules in advance of orbits; interorbital space wider and flatter, its width being nearly equal to long diameter of orbit; palatal aspect of premaxillæ somewhat longer.

B. Palatal aspect of premaxillæ elongated, with centre of posterior border projecting into maxillæ.

CROCODILUS POROSUS,[3] *Schneider.* S. Asia, and N. Australia. Facial portion of cranium narrower than in *C. palustris*; sculpture slight; an elongated, longitudinal, sinuous ridge in advance of orbit; interorbital space wide and somewhat concave; premaxillary fissure a comparatively narrow slit; maxillo-premaxillary suture extends on palate as far back as hinder border of sixth alveolus.

CROCODILUS PONDICHERIANUS, *Gray.* S. India. Founded on a young specimen; general cranial characters apparently those of *C. porosus.*

African species.—Africa is inhabited by the typical *C. vulgaris*, Cuvier, in which the facial portion of the cranium is oblong and narrow, with preorbital ridges, and with elongated premaxillæ; and on the western coast by *C. cataphractus*, Cuvier, in which the face is much elongated, and the differentiation of the teeth but slight.

Species 1. CROCODILUS SIVALENSIS, n. sp. *nobis.*

(Allied to *C. palustris*, Lesson).

History.—The earliest notice of this form appears to be one by Clift,[4] in which some specimens are recorded from the Siwaliks of Burma, which were regarded as indicating an animal closely alied to *C. vulgaris*; a later memoir was published by Cautley,[5] in which three fragments of crania from the Siwalik Hills are described and figured. The cranium of a recent crocodile is figured for comparison, but was unfortunately misidentified; it being named *C. porosus* (*biporcatus*), whereas it really belongs to *C. palustris.* As the result of the comparison, the conclusion was arrived at that the fossil was a variety of the existing species,—*i.e.* of *C. palustris*, the main difference being that the premaxillæ were relatively longer in the former. Manuscript notes by Falconer, preserved in the British Museum, appear to indicate that he took the same view of the affinities of the Siwalik form.

Immature crania.—The British Museum possesses a large series of more or less

[1] Syn. *C. bombifrons*, Gray.

[2] Occasionally it extends as far as the anterior border of the sixth alveolus.

[3] Syn. *C. biporcatus*, Cuvier.

[4] 'Trans. Geol. Soc.' ser. 2. vol. II. pt. 3. p. 375 (1828).

[5] 'Asiatic Researches,, vol. XIX. pp. 25-31. pl. II. (1836). The text is reprinted in 'Falconer's Palæontological Memoirs,' vol. I. pp. 344-350, accompanied with figures of two crania.

perfect crania from the Siwalik Hills, belonging to variously aged individuals of the present form; and as those which are immature are more complete than those which are adult, the former may be first noticed. The most perfect specimen (No. 39795) is the one represented in plate XXVIII. figs. 1, 1a (of one-third the natural size),[1] which belongs to a half-grown individual. In general contour, and especially in the relative shortness of the palatal aspect of the premaxillæ, this specimen agrees more closely with *C. palustris* and *C. siamensis* than with any other recent or fossil crocodile, and comparisons may therefore be restricted to those two species. Compared with half-grown crania of *C. palustris* (plate XXIX. figs. 1, 1a) the fossil differs by the smaller degree of concavity and the relatively greater width of the interorbital bar, although this is shorter than the long diameter of the orbit[2]; by the relatively greater length of the upper surface of the premaxillæ, which is greater instead of less, than the length of the narial aperture; and by the smaller development of the preorbital rugose nodules, and the greater depth of the sculpture on the premaxillæ. The greater relative length of the upper surface of the premaxillæ causes the centre of the narial aperture to be situated considerably behind the notch for the fourth mandibular tooth, instead of some distance in advance of it. On the palatal aspect the maxillo-premaxillary suture forms a blunt inverted V and extends as far back as the sixth dental alveolus, whereas in equal-aged specimens of *C. palustris* (pl. XXIX. fig. 1a) it usually runs straight across the palate and does not extend behind the anterior border of the fifth, although there are occasional instances where it reaches the anterior border of the sixth alveolus.

The next specimen (No. 39796) comprises the anterior portion of the cranium and mandible, and has the same general characters as the preceding. The third specimen (No. 39797) comprises both the cranium and mandible; and although the maxillo-premaxillary suture is not visible on the palatal aspect, the specimen agrees in all other characters with No. 39795, the relatively great width of the interorbital bar being very well marked.[3] The fourth specimen (No. 39798), which likewise comprises the greater part of the cranium and mandible, is represented[4] from the lateral aspect of one-fourth the natural size in plate XXVIII. fig 3: it agrees with the foregoing specimens in all essential characters (especially those of the premaxilla and interorbital bar), but the anterior part of the cranium is relatively broader. The concavity of the facial profile, which is a character common to the Siwalik form and *C. palustris*, is well-shown in this specimen.

An unnumbered palatal specimen belonging to a rather older individual agrees with the preceding specimens; the maxillo-premaxillary suture extending as far back as the sixth alveolus, and the facial aspect of the premaxillæ being considerably longer than the external narial aperture.

1 The specimen is also figured in "Falconer's Palæontological Memoirs," vol. I. pl. XXVIII. figs. 2, 3.

2 In the fossil the two diameters are 1·6 and 2·0 inches; and in the figured cranium of *C. palustris* 1·4 and 2·2 inches.

3 The width of the bar is 1·9 and the length of the orbit 2·2 inches.

4 Also figured in "Falconer's Palæontological Memoirs," vol. 1. pl. XXVIII. fig. 1.

Adult crania.—Of adult crania there are two specimens comprising the anterior portion: the first (No. 39800) is represented, of one-third the natural size, in plate XXIX. figs. 2, 2a; the alveolar borders having been cut and polished in order to exhibit sections of the teeth. The second specimen (No. 39081), which has the mandibular symphysis attached, is figured in plate II. figs. 2, 4 of Cautley's memoir already cited; it agrees precisely in general characters with No. 39800. In the latter the maxillo-premaxillary suture is V-shaped and extends on the palate as far back as the hinder border of the sixth dental alveolus; the length of the facial aspect of the premaxillæ considerably exceeds that of the external narial aperture[1] (whereas it is always less in adult crania of *C. palustris*); and the centre of the narial aperture is consequently situated considerably behind the notch for the fourth mandibular tooth; the facial sculpture is much more rugose than in the latter, this feature being especially marked on the extremities of the premaxillæ which are almost smooth in the adult *C. palustris*; the lateral rugose nodosities (*a*) on the maxillæ are also more strongly marked than in the recent species. The width of the fossil cranium across the ninth tooth is 10 inches, the corresponding width in an adult *C. palustris*[2] being 9·4 inches, and the length from the quadrate to the premaxilla 22 inches: this indicates that the fossil attained a size fully equal to that of *C. palustris*. Neither of the fossil crania show the lateral sutures on the facial aspect.

Young crania.—One of the most beautiful examples of this form in the British Museum is a very young cranium with the mandible still attached (No. 40823), which measures rather less than four inches in length, and is in exquisite preservation. Although some of the characteristic features are not shown, yet this specimen agrees very closely with the older crania noticed above; it exhibits the sutures bounding the nasals, and the relative width of those bones is thus seen to be considerably greater than in *C. palustris*. The British Museum also possesses the right maxilla of an individual about one-and-a-half times the size of the preceding.

Burmese specimen.—A portion of the left premaxilla and maxilla of a crocodile in the Indian Museum (No. E. 34) collected by Mr. W. T. Blanford in the Siwaliks of Burma, apparently belongs to a subadult individual of the present species.

Punjab crocodile.—From the Siwaliks of Asnot, Punjab, Mr. Theobald has collected four fragments of the skull of a crocodile (Indian Museum Nos. E. 33, 37, 39, 40) which may very probably have belonged to the present species, although they are insufficient to afford a certain determination.

Mandible.—The mandibles attached to the immature crania noticed above do not appear to present any characters by which they can be distinguished from *C. palustris*. The symphysial extremity of an older mandible collected by Mr. Theobald from the Siwaliks of the Punjab (plate XXIX. fig. 4) which may be provisionally referred to the present species, appears likewise indistinguishable from

1 The length of the premaxilla is 5·0 and that of the narial aperture 3·4 inches; in a subadult cranium of *C. palustris* (B.M. No. 68. 4. 9. 11) the corresponding dimensions are 2·2 and 2·3 inches.

2 The specimen figured by Gray on page 10 of the "Supplement to the Catalogue of Shield-Reptiles" pt. 2 (1872).

the mandible of the existing species.

Specific distinctness and affinities.—The extreme rugosity of the facial sculpture of the species under consideration, together with the narrower interorbital bar, at once indicates its specific distinctness from *C. siamensis*, and it therefore only remains to consider whether the differences noticed above are of sufficient importance to specifically distinguish it from *C. palustris*. These differences may be summarised as follows, *viz.*—

1. The greater relative width of the interorbital bar.
2. The greater relative length of the facial aspect of the premaxilla, and the consequent more backward position of the anterior nares.
3. The inverted V-shape and greater backward extension of the maxillo-premaxillary suture on the palatal aspect.
4. The greater rugosity of the facial sculpture, more especially on the premaxillæ of the adult.
5. The smaller development of the preorbital rugose nodosities.
6. The wider nasals (only noticed in the young).

Taken together the foregoing well-marked characters appear sufficient to distinguish the Siwalik crocodile from the typical form of the allied existing species. There is, however, a variety of the latter from Ceylon,[1] which approaches the fossil in the character No. 3, and therefore tends to diminish the value of the differences; but as the few examples of this variety seen by the writer do not present the other characteristic features of the fossil there are still good grounds for regarding the latter as specifically distinct,[2] and the new name *C. sivalensis* is accordingly proposed.

That *C. sivalensis* is the ancestral form of *C. palustris* there can be no reasonable doubt, and the Ceylon variety of the latter must apparently be regarded as one retaining traces of a closer affinity with the ancestral species than is the case with the typical race. The direction and position of the maxillo-premaxillary suture on the palate of *C. sivalensis* seems to indicate a less degree of specialization than that occurring in typical examples of *C. palustris*; or, in other words, is less widely removed from the *C. porosus* and *C. vulgaris* type, which as being nearer to *Gharialis* is probably a more generalized one. It is, however, very remarkable that in the English middle eocene *C. hastingsiæ*[3] the position of the above-mentioned suture is nearly the same as in the *C. palustris* group. This fact, together with the occurence of *Gharialis* in the same beds, may perhaps indicate that the origin of the latter group is to be traced to the English middle eocene species, which attained a comparatively high degree of specialization. The occurrence of the present and the next species in the upper tertiaries of India, and the apparent total absence in

1 *Vide* Gray "Supplement to the Catalogue of Shield-Reptiles" pt. 2. p. 11 (1872).

2 The difficulty of deciding as to what should be considered specific and what merely varietal characters in the case of those Siwalik reptiles which are evidently the ancestors of existing Indian species has been already mentioned in the preceding part (p. 186). The view there adopted of regarding as specifically distinct any form which can be well distinguished from its living ally has been followed here.

3 *Vide* Owen and Bell "Reptiles of the London Clay, etc," pt. 2 pl. VII. In this species the nasals do not reach the anterior nares.

the same of any form allied to *C. porosus*, coupled with the circumstance that the latter (or a closely allied form) occurs fossil in Queensland, as is shown by examples from Darling-Downs in the British Museum, indicates that while the *C. palustris* group from the pliocene upwards is an essentially Indian one, that of *C. porosus* is of Australoid origin and a later immigrant into India. This is quite in harmony with the suggestion that the *C. palustris* group may have been derived from the crocodiles of the English eocene; and is, perhaps, confirmed by the present distribution of *C. palustris* and *C. porosus*; the former according to Mr. Theobald[1] being distributed over the whole of India and Ceylon and being comparatively rare in Burma, while the latter is very common in Burma and the east coast of the Bay of Bengal, much rarer in Bengal, and apparently absent from Ceylon. Similarly *C. pondicherianus*,—the other member of the *C. porosus* group—has been hitherto recorded only from the eastern coast of India. *C. siamensis* must probably be regarded as a member of the *C. palustris* group which has migrated from the neighbourhood of India.

Distribution.—Assuming that the Punjab specimens noticed above belong to the present species, its range will have extended from the Punjab through the typical Siwalik Hills to Burma.

Species 2. CROCODILUS PALÆINDICUS, Falconer.[2]

History.—The characters of this species were never defined and the name might therefore be treated as a manuscript one, but the writer has followed his usual rule of adopting Falconer's names in almost all cases where they occur in print and can be identified with the type specimen.

Type cranium.—The type cranium, which is represented in pl. XXVIII. figs. 2, 2a, and XXIX. fig. 3, was obtained in the winter of 1836-37 by Captain George Fulljames from the Siwaliks of Perim Island, Gulf of Cambay, on whose behalf it was exhibited at a meeting of the Asiatic Society of Bengal on February 1st, 1837; and is noticed in the 'Journ. As. Soc. Beng.' vol. VI. p. 79 (1837) as the skull of a saurian. In his "Catalogue of the Fossil Vertebrata in the Museum of the Asiatic Society of Bengal,"[3] Falconer observes that the specimen resembles in general form the cranium of *C. palustris*, and that it required minute and detailed comparison with the existing Indian species. As will be seen from the figures, the specimen, which appears to be subadult, is in a very fine state of preservation, and amply sufficient for specific determination.

As the specimen appears to indicate a species allied to the *C. palustris* group it will be convenient to compare it in the first place with the other members of that group. From the existing *C. siamensis* it is at once distinguished by the relatively narrower interorbital bar (whose length is much less than the longer diameter of the orbit), and the strongly marked facial sculpture. Compared with *C. palustris* the

1 "Reptiles of British India," p. 36 (1876).

2 "Catalogue of Fossil Vertebrata in Museum of Asiatic Society of Bengal," p. 200 (1859).

3 Page 200.

most striking difference is the convexity of the facial profile (pl. XXVIII. fig. 2a), caused by the well-marked prominence situated on the nasals half-way between the external nares and the orbits; this character equally distinguishes the specimen from *C. sivalensis* (pl. XXVIII. fig. 3). The expansion at the ninth tooth is decidedly greater than in either *C. palustris*[1] or *C. sivalensis*; and there is a total absence of the preorbital nodose rugosities of *C. palustris*, in which respect the fossil comes nearer to *C. sivalensis*. The deep concavity which occurs behind the maxillo-premaxillary suture both in *C. palustris* and *C. sivalensis* is almost entirely wanting. The nasals are relatively wider than in the former species, and thereby agree with *C. sivalensis*. The facial sculpture has the pits more elongated than in *C. palustris*; but the extremities of the premaxillæ are almost smooth, as in that species, and thereby differ widely from *C. sivalensis*. The premaxillæ likewise agree with those of the former species in the relative shortness of their facial aspect, the length of which is considerably less than that of the narial aperture. The relative position of the latter is the same as in *C. palustris*, but it is of relatively larger size, and its posterior half proportionately wider.[2] On the palatal aspect (pl. XXVIII. fig. 2) the fossil agrees with *C. palustris* and *C. sivalensis* in the relatively wide maxillæ and premaxillæ, and it is probable that it also agreed in the form and position of the premaxillary fissure (*pm. f.*), of which the boundaries are imperfect; the maxillo-premaxillary suture differs, however, from that of the typical form of the former species by extending as far back as the seventh alveolus, and also differs from the Ceylon variety of that species and from *C. sivalensis* by its direction, which, instead of forming an inverted V, is directed inwards and backwards on the two sides but transversely towards the middle of the palate.

Other specimens.—A much-damaged middle portion of a cranium from Perim Island in the Indian Museum (No. E. 185) shows the nasal protuberance characteristic of the type specimen. A second specimen[3] in the latter collection (No. E. 35) from the same locality, comprising the anterior portion both of the cranium and the mandible, but in a much-weathered condition, likewise exhibits the characteristic convex facial profile. The middle portion of a younger cranium in the Indian Museum (No. E. 32) obtained by Mr. W. T. Blanford from Perim Island appears to agree in the form of its profile with the type, but the maxillo-premaxillary suture does not extend quite so far back. The British Museum possesses two specimens from Perim Island which were transferred from the old Indian Museum; the one shows the anterior part of the cranium, and the other that of both cranium and mandible, and both exhibit the characteristic nasal prominence, and on the palatal aspect the maxillo-premaxillary suture extending backwards as far back as the seventh alveolus.

1 Compare the figures of specimens of all ages given by Gray in the "Catalogue of Shield-Reptiles," pt. 2, pp. 10-12.

2 The borders of the anterior half have been somewhat broken in the specimen.

3 This is the specimen (No. P. 197) noticed on page 214 of Falconer's "Catalogue of Fossil Vertebrata in Museum of Asiatic Society of Bengal." The matrix leaves no doubt as to its place of origin.

Distinctness and affinities.—With the exception of a slight variation in the position of the maxillo-premaxillary suture in one example, the preceding specimens show that the characters of the type cranium of the Perim Island Siwalik crocodile are constant ones, while the comparisons already instituted indicate the specific distinctness of this form both from *C. palustris* and *C. sivalensis*. From *C. siamensis* the Perim crocodile is readily distinguished by the deeper facial sculpture, and the relatively narrower interorbital bar; and as it presents no resemblance to *C. porosus*, and therefore presumably none to *C. pondicherianus*, and does not approach any other species as closely as it does the *C. palustris* group, its right to specific distinction appears evident, and Falconer's name may accordingly be retained.

That *C. palæindicus* is a member of the *C. palustris* group is perfectly evident; but the peculiar facial profile appears to indicate that it is an aberrant form which diverged at a comparatively early period from the type stock; as in the case of *C. sivalensis*, the more backward position of the maxillo-premaxillary suture on the palate indicates a species somewhat less differentiated from other existing crocodiles than is *C. palustris*.

Distribution.—Remains of this species have been hitherto recognized only from the Siwaliks of Perim Island.

Genus II. Gharialis, Geoffroy.[1]

Syn. *Leptorhynchus*, Clift.[2]

Definition.—As already mentioned,[3] it appears not improbable that the so-called *Holops* from the upper cretaceous of N. America may be included in the present genus in the sense in which that term is here employed. With the probability of that inclusion the genus may be provisionally defined as follows, *viz.*:—Skull elongated into a rostrum, teeth numerous ($\frac{[27\text{-}28]}{[25\text{-}26]}$ in the existing species), nasals separated by a long interval from the premaxillæ, 1st and 4th mandibular teeth biting into notches in the cranium (1st notch roofed over in *G. pachyrhynchus*), upper and lower teeth interlocking, splenial entering into mandibular symphysis, facial profile curved in front of orbit. The extremity of the rostrum is frequently expanded, the anterior border of the orbit may be prominent or not, and interdental pits may or may not be present in the maxilla for the reception of the tips of the mandibular teeth. An additional upper tooth between the proper first and second is usually present.

Number of species.—The genus is represented at the present day solely by the Indian *G. gangeticus*; in which the teeth number $\frac{(27\text{-}28)}{(25\text{-}26)}$, the mandibular symphysis extends to the twenty-third or twenty-fourth tooth, the anterior border of the orbit is prominent, most of the lateral teeth are directed obliquely, and those of the lower jaw are not received into pits in the maxilla.

1 'Mém. d. Muséum,' vol. XII. p. 97 (1825). Amended from *Gavialis*.

2 'Trans. Geol. Soc.' ser. 2. vol. II pt. 3. p. 375 (1828).

3 *Vide suprà* page 211.

From the middle eocene of Bracklesham *Gharialis dixoni*, Owen,[1] has been described on the evidence of portions of the mandible and vertebræ; the teeth are larger, placed farther apart, and less compressed than in *G. gangeticus*, while there are more distinctly defined interdental pits in the hinder part of the mandibular symphysis.

The upper cretaceous pisolite of Mont Aimé (Marne), France, has yielded the so-called *G. macrorhynchus* (Blainville),[2] which, as stated above,[3] has been referred on what appear to be somewhat insufficient grounds to the American fossil genus *Thoracosaurus*. The cranium has the extremity of the rostrum expanded, and is so like that of *G. gangeticus*, that, in the apparent absence of any evidence as to the presence or absence of a prelachrymal vacuity, the writer prefers to retain it provisionally in the existing genus. The anterior border of the orbit is not prominent.

Most of the N. American upper cretaceous forms described under the name of *Holops*[4] seem to be known merely by vertebræ. Numerous Indian fossil forms are described in the sequel which indicate that the genus formerly attained a great development in that country. The occurrence of these fossil forms, and the apparent absence of any species in the tertiaries of Europe of later date than the middle eocene, seems to indicate that the genus migrated eastwards from Europe during the tertiary period. The occurrence of *Tomistoma* in the reputed miocene of the Maltese Islands and lower Austria seems to indicate a similar migration of that genus.

Group A.—No pits in the cranial rostrum for any of the mandibular teeth.

Species 1. GHARIALIS GANGETICUS (Gmelin[5]).

Syn. *Lacerta gangetica*, Gmelin.[6] *Crocodilus longirostris*, Schneider.[7]
Crocodilus gangeticus, Cuvier.[8] *Crocodilus tenuirostris*, Cuvier.[9]
Leptorhynchus clifti, Meyer.[10] *Leptorhynchus gangeticus*, Auct.

History of fossil form.—The first record of the occurrence of a fossil gharial in the Siwaliks is by Clift,[11] who described some remains obtained by Crawfurd in Burma, and regarded them as allied to, or identical with, the existing species; on these specimens Meyer's *Leptorhynchus clifti* was founded. At a later date more perfect remains were described and figured by Cautley,[12] from the Siwalik Hills, who referred them to the existing species. In his "Catalogue of Fossil Vertebrata in the Museum of the Asiatic Society of Bengal" (p. 165), Falconer confidently identifies a cranium from the Siwalik Hills with the existing species.

Crania.—The British Museum possesses a considerable number of imperfect crania (some of which have the mandible attached) from the Siwalik Hills, of which

1 "Reptiles of the London Clay, etc.," pt. 2. p. 46, pl. X.
2 *Vide* Gervais "Zool. et Pal. Françaises," 2nd ed. p. 447. pl. LIX. 3 Page 211. 4 *Vide suprà* page 211.
5 "Systema Naturæ," vol. I. pt. 3. p. 1057 (1789). *Lacerta.* 6 *Loc. cit.*
7 "Historia Amphibiorum," p. 160. (1799-1801). 8 'Ann. d. Muséum,' vol. X. p. 66 (1807). 9 *Loc. cit.*
10 "Palæologica," p. 108 (1832). 11 'Trans. Geol. Soc,' ser. 2. vol. II. pt. 3. p. 375. (1828)
12 'Asiatic Researches,' vol. XIX. pp. 32-38, pl. III. (1836)

a few of the more important may be noticed. No. 36726 comprises the hinder part of the cranium and mandible of an adult; No. 39089 likewise belongs to an adult and consists of the hinder part of the cranium only, it is figured of one-third the natural size in plate XXX. fig. 2[1]; No. 36727 is the hinder part of the cranium of a half-grown individual, and has a portion of the mandible attached. The larger of these specimens somewhat exceed in size the largest recent gharial skull in the British Museum, but agree precisely in every detail:—thus the supratemporal fossæ are relatively large, and separated by a narrow bar, the bar of bone forming their posterior border being also narrow; the orbits are very widely separated, and the intervening frontal bar is deeply concave. In the Indian Museum (No. E. 25) there is the hinder part of a half-grown cranium from the Siwalik Hills, described by Falconer on pp. 165-6 of his "Catalogue of Fossil Vertebrata of Asiatic Society of Bengal." The British Museum possesses the hinder half of a large adult cranium (No. 40695), as well as a smaller specimen, from the Siwaliks of Perim Island; and there is the hinder half of a young cranium from the same locality in the Indian Museum (No. E. 188). All these specimens agree with recent examples and with those from the Siwalik Hills. Of the rostral portion of the cranium the British Museum possesses several specimens from the Siwalik Hills; the one represented in plate XXX. fig. 3 belongs to a subadult individual, while the larger one represented in fig. 1 of the same plate[2] from the frontal aspect belongs to a fully adult individual, and comprehends the rostral portion of both the cranium and mandible. The specimen of the premaxillæ of an immature individual represented in plate XXX. figs. 4, 4a was obtained by Mr. Theobald from the Siwaliks of the Kangra district; and there are other less perfect specimens in the Indian Museum from the Punjab. All the foregoing examples exhibit the straight rostrum and the terminal expansion of the premaxillæ so characteristic of the recent form. The hinder part of the rostrum of a very large specimen from the Siwaliks of Burma preserved in the Indian Museum (No. E. 21) apparently belongs to the present form.

Mandible.—The terminal portion of the right half of a mandibular symphysis from the Siwalik Hills represented in plate XXX. fig. 5 shows the characteristic lateral expansion at the second tooth. A less complete specimen in the Indian Museum (No. E. 19), belonging to the opposite side, as well as specimens from the Punjab (No. E. 20) exhibit the same feature.

Teeth.—The crown of a tooth from the Siwaliks of the Punjab, agreeing precisely with the teeth of the specimen drawn in fig. 1, is represented in plate XXX. fig. 6. It may be observed that the teeth of the gharial are slightly compressed at right angles to the two longitudinal ridges, and are set in the jaw with these ridges directed transversely; the dental alveoli having their transverse diameter rather longer than the antero-posterior.

Distribution.—According to Mr. Theobald[3] the gharial is found at the present

[1] Also figured ($\frac{1}{6}$) in "Falconer's Palæontological Memoirs," vol. I. pl. XXVIII. figs. 4, 5.

[2] Figured from the ventral aspect in "Falconer's Palæontological Memoirs," vol. I. pl. XXIX. fig. 5.

day in Bengal, the North-West Provinces, and Akyab; while the present writer possesses the skull of a specimen collected by Mr. Theobald from the Indus basin. In the pliocene the species occurs in Perim Island, the Punjab, and thence through the Siwalik Hills, and also in Burma; it is unknown in the lower Siwaliks of Sind.

Species 2. GHARIALIS HYSUDRICUS, n. sp., *nobis*.

History.—The type specimen of this species has been figured in "Falconer's Palæontological Memoirs." vol. I. pl. XXIX. fig. 3. under the name *Crocodilus (Leptorhynchus) leptodus*,[1] from which it is widely different; while another specimen was referred by Falconer in MS. to *G. gangeticus*.

Rostral portion of the skull.—In plate XXXII. figs. 1, 1a, 1b, 1c, there are given three views and a transverse section of the cranial rostrum of a gharial from the Siwalik Hills preserved in the British Museum, which differs considerably from the corresponding portion of the cranium of the existing species. The specimen has the hinder portion of the mandibular rostrum lying obliquely across its upper surface, and is so figured in "Falconer's Palæontological Memoirs," vol. I. pl. XXIX. fig. 3, under the name of *Crocodilus (Leptorhynchus) leptodus*. Superiorly the cranial rostrum is broken off immediately in advance of the orbits, but on the palatal aspect it exhibits the anterior extremity of the palatines, and part of the palatal vacuities: twenty-two teeth still remain, and it is pretty evident that the rostrum was relatively as long as in the existing species. Compared with the cranium of the latter the descent from the orbit to the rostrum (pl. XXXII. fig. 1b) is much more sudden and much greater; so that the middle portion of the rostrum is placed relatively lower in respect to the parietal plane of the cranium: it is probable that the extremity of the rostrum was bent upwards to a small extent. As in the existing species the mesial portion of both the cranial and mandibular elements of the rostrum is flattened, while the borders are bevelled away. The teeth agree in relative size with those of the existing species, and there are ten alveoli placed behind the anterior termination of the splenial element of the mandible. The specimen indicates an animal decidedly larger than the fossil race of *G. gangeticus*. The British Museum possesses another specimen (No. R. 325) from the Siwalik Hills comprising the hinder portion of a mandibular symphysis agreeing in all respects with the preceding specimen.

Hinder part of cranium.—The hinder portion of the cranium of a gharial from the Siwalik Hills preserved in the British Museum and represented from the facial aspect in plate XXXI. fig. 3, indicates an individual somewhat exceeding in size the largest fossil individuals of *G. gangeticus*. It differs from adult crania of that species by the much closer approximation of the orbits, by the inferior size of the supra-temporal fossæ, and the greater relative width of the parietal bar dividing the two latter, by the greater lateral expansion of the jugal and quadrato-jugal, and the

[1] In the plate and description the name is given simply *Crocodilus leptodus*, but *Leptorhynchus* is added on page 355.

much more sudden fall in advance of the orbits towards the rostrum. In adult crania of the existing species the width of the bar dividing the supratemporal fossæ is about one-fifth the interorbital width,[1] whereas in the present specimen the former diameter is nearly equal to one-half the latter. On the palatal aspect the specimen apparently agrees very closely with *G. gangeticus.*

That the specimen under consideration is specifically distinct from the existing gharial there can be no reasonable doubt; and since it accords well in relative size with the cranial rostrum described above, and also in the sudden descent in advance of the orbits, there is a great probability that it belongs to the same species. Unfortunately, however, the hinder part of the cranium of *G. leptodus*[2] is unknown, and it might, therefore, be inferred that the present specimen belongs to that species; the rostrum of the latter differs, however, so widely from *G. gangeticus* that it is probable that the hinder part of the cranium would likewise differ more widely from that of the latter than the present specimen does: still the specific reference of the latter must be regarded as provisional.

Undetermined mandibular symphysis.—In plate XXXI. fig. 4 there is represented from the oral aspect the extremity of the mandibular symphysis of a gharial from the Siwaliks of Perim Island which may possibly belong to a small individual of the present species. The free extremity is unfortunately imperfect, but the direction of the anterior alveolus showed that this contained the first tooth. This being determined it is evident that the specimen differs from *G. gangeticus* by the absence of any lateral expansion at the second tooth. Unfortunately neither of the preceding specimens show the extremity of the rostrum, but it is not improbable that this may have lacked the expansion characteristic of the existing species. That the present specimen does not belong to the next species is tolerably evident from the absence of a great upward curvature of the extremity which would be necessary to make it correspond with the cranial rostrum represented in plate XXXI. fig. 2.

Specific distinctness and affinity.—Taking the rostrum alone, the marked difference in the contour of the facial profile indicates pretty clearly the specific distinctness of the form to which it belonged from *G. gangeticus*: to that form it is proposed to apply the name *G. hysudricus,* as the type specimen was obtained in the neighbourhood of the Satlej valley. If the hinder part of the cranium belong to the same species, the distinction from *G. gangeticus* is more strongly emphasized. If again the extremity of the mandibular symphysis from Perim Island be likewise specifically identical, the species will differ from the existing gharial by the absence of the lateral expansion at the termination of the rostrum.

Distribution.—The type specimen and the hinder portion of the cranium were obtained from the typical Siwalik Hills; if the extremity of the mandibular symphysis belong to the same species its range must be extended to Perim Island. No traces of this form have been obtained from the lower Siwaliks of Sind.

1 The width of the parietal bar between the temporal fossæ becomes relatively wider in younger crania, till in a cranium of only eight inches in length it is equal to half the interorbital width.

2 *Vide infrà.*

Group B.—Pits in the cranial rostrum for the majority of the mandibular teeth.

Species 3. GHARIALIS CURVIROSTRIS, n. sp., *nobis.*

History.—The remains of this species are described for the first time.

Type crania.—The specimens on which the species is founded are portions of three crania in the Indian Museum collected by Mr. F. Fedden from the lower Siwaliks of the Laki Hills, Sind. Of these the most perfect are the two specimens represented in plate XXXI. figs. 1, 1a, and 2, 2a, 2b, which belong to the same individual, and indicate that the cranium was originally complete, and was probably broken up by native collectors. The fragment represented in figs. 2, 2a, 2b, consists of the terminal portion of the cranial rostrum, extending backwards as far as the third alveolus behind the termination of the maxillo-premaxillary suture. The teeth have all fallen from their alveoli, but with the exception of the loss of the outer portion of the alveolus of the third tooth of the right side the specimen is very perfect. The maxillo-premaxillary suture is visible on the facial surface, and from its position, as well as from the general structure of the specimen, and that represented in fig. 1, there can be no doubt of the close affinity of this form to *Gharialis*. As in the existing species of that genus there are distinct notches for the reception of the first and fourth mandibular teeth, and the nasals were widely separated from the premaxillæ; the alveolar borders of the rostrum are also distinctly bevelled away, but to a smaller extent. The fossil differs, however, from *G. gangeticus* in the almost complete absence of the lateral expansion of the premaxillæ, the third tooth being placed in the same line as the maxillary teeth, and the second[1] having only its external third placed outside the line, instead of the whole tooth being far beyond it. Another important difference consists in the presence of small pits on the line of the inner border of the dental alveoli for the reception of the points of the mandibular teeth. The alveoli are less obliquely placed than in the existing species, and are separated from another by an interval equal to their antero-posterior diameter. The relative width of the rostrum and the size of the alveoli are not far different from those obtaining in *G. gangeticus* – the length of the space occupied by three alveoli being considerably more than half the width of the rostrum. On the facial aspect (fig. 2) the aperture of the external nares agrees very closely in contour with that of the existing species: the high ridge on the posterior boundary, which probably indicates that the specimen belonged to a male individual, is however, unlike the same part in the latter. The anterior border of the orbit is not everted.

The fragment represented from the facial and lateral aspects in fig. 1, 1a comprises that portion of the cranium situated between the supratemporal fossæ and the ninth tooth from the posterior termination of the series. In profile (fig. 1a) this specimen differs from *G. gangeticus* by the marked upward curvation of the rostrum as it approaches the point of fracture. The nature of this curvature taken together

[1] As is so generally the case in the genus there is a small additional alveolus between the proper first and second alveoli.

with that of the anterior portion of the rostrum, indicates that the whole rostrum was very considerably shorter than in *G. gangeticus*, and its curvature very great. On the facial and palatal aspects the specimen appears to agree very closely with the cranium of the existing gharial; and apparently belongs to an adult individual, thus indicating that the species was of considerably smaller size than the fossil race of the former. The width of the interorbital bar is as great as in *G. gangeticus*; and is relatively much greater than in the cranium represented in plate XXXI. fig. 3 and provisionally referred to *G. hysudricus*.[1] The premaxillary fissure (*pm. f.*) is as narrow as in the existing species. The pitting of the facial surface of the rostrum is much more strongly marked than in the latter.

The hinder part of a smaller cranium in the Indian Museum (No. E. 187) from Sind shows that the relative proportions of the interorbital bar, of the supratemporal fossæ, and the parietal bar separating the latter, are very similar to those obtaining in *G. gangeticus*. The hinder part of the maxillary rostrum of a small individual from the same locality (Indian Museum No. E. 23) exhibits the characteristic curved profile.

Specific distinctness and affinities.—Although the present form differs from the existing gharial by the non-eversion of the orbits, by the very slight degree of the terminal expansion of the premaxillæ, and by the presence of pits in the maxillæ for the mandibular teeth, yet its general resemblance is so strong as to forbid, in the writer's opinion, its reference to a distinct genus. That this form is specifically distinct from both the preceding species is quite evident; and it is equally distinct from the so-called *G. macrorhynchus* of the French upper cretaceous, and is doubtless different from *G. dixoni*[2] of the middle eocene of England. The cranial rostrum presents a considerable resemblance to the one species of *Holops*[3] in which that part is known, but there is a marked difference in the relative size of the dental alveoli in the two forms, while the premaxillary fissure is much larger in the American species—judging, however, from *Crocodilus* the latter character might well be merely a specific one: both agree in the slight expansion of the premaxillæ, the non-eversion of the orbits, and the presence of interdental pits in the maxillæ. Reserving the question as to the propriety of generically separating the American forms, there is no reasonable doubt as to their specific distinctness from the Sind gharial, and the latter may accordingly be named *G. curvirostris*. The long, straight, terminably expanded cranial rostrum of the so-called *Gharialis macrorhynchus* apparently forbids the idea that the present form can be regarded as a direct ancestor of *G. gangeticus*, and it must accordingly be looked upon as belonging to a lateral branch now extinct, and probably related to the so-called *Holops* of the upper cretaceous of N. America.

1 In the Sind cranium this width is only half an inch less than in the Siwalik Hills cranium; the latter being nearly double the size of the former.

2 In this species at the hinder extremity of the mandibular symphysis the interdental pits are larger than in *G. gangeticus* (*vide* Owen and Bell "Reptiles of the London-Clay, etc.," pt. 2. pl. X. fig. 2); and it is therefore not improbable that interdental pits may have been present in the maxilla.

3 *Vide* Cope, 'Trans. Amer. Phil. Soc.,' vol. XIV. art. 1. p. 77 (1870).

Distribution.—All the known remains of this species have been obtained from the lower Siwaliks of Sind.

Species 4. GHARIALIS LEPTODUS (Falconer and Cautley[1]).

Syn. *Crocodilus (Leptorhynchus) leptodus*, Falconer and Cautley.[2]

History.—This species was never described by its founders, but two specimens are figured under this name in "Falconer's Palæontological Memoirs," vol. I. pl. XXIX. figs. 3 and 4. The latter may be taken as the type, as the former has been made the type of *G. hysudricus.*

Mandibular rostrum.—The type specimen is represented from the oral and lateral aspects in plate XXXII. figs. 2, 2a, and comprises the hinder portion of the mandibular rostrum; it was obtained from the typical Siwalik Hills, and is preserved in the British Museum. A very similar specimen, obtained by Mr. Theobald from the Siwaliks of the Punjab in 1875, is represented from the oral aspect and in section in figs. 3, 3a of the same plate; it exhibits the greater part of the rostral portion of the splenials, and fifteen broken teeth on either side. These specimens differ from the rostrum of each of the three preceding specimens by their much greater relative width, and the proportionately smaller size of the teeth. Whereas in all the preceding species the length of the space occupied by three teeth is equal to at least two-thirds the width of the rostrum, in the present specimens the former dimension is not more than one-third the latter; and the peculiarly flattened form of the mandibular rostrum is well exhibited in the section drawn in fig. 3a. The bevelling of the lateral borders is also much less strongly marked and the teeth (fig. 3b) have a more elliptical section, and are set with their longer transverse diameter more nearly at right angles to the long axis of the jaw. The entrance of the splenial element into the mandibular symphysis indicates the gharialoid nature of the species. In profile (fig. 2a) the mandible shows a considerable curvature,—the upper surface being concave and the lower convex. The pitting of the inferior surface is more marked than in *G. gangeticus.* Another specimen in the British Museum (No. 39807) apparently belongs to the mandibular part of the rostrum.

Cranial rostrum.—The specimen represented in plate XXXII. fig. 4 was obtained from the Siwalik Hills, and is in the Indian Museum; it comprehends a portion of the maxillary rostrum of a gharial agreeing so exactly in general proportion with the mandibles already described that there can be no doubt as to its belonging to the same species; it comprises the region immediately in advance of the orbits, and shows ten alveoli on the left side. There is a strongly marked concavity in the preorbital region; and but a slight bevelling of the lateral borders of the oral surface, the alveoli are of relatively small size, but this feature is not quite so strongly marked as in the mandible: the relative great width and flatness of the rostrum are very noticeable. This specimen is very important since it shows on the facial surface the termination of the nasals a short distance in advance of the orbits, thus

[1] "Falconer's Palæontological Memoirs," vol. I. p. 355 (1868).—*Crocodilus (Leptorhynchus).* [2] *Loc. cit.*

indicating the affinity of the species to *Gharialis.* The dental alveoli (fig. 4a.) are separated from one another by an interval somewhat less than their antero-posterior diameter; and between each alveolus there is a broad, shallow, pit for the reception of the tip of a mandibular tooth. In the presence of these interdental pits the specimen differs from *Gharialis gangeticus*; while in their position it agrees with *Tomistoma schlegeli,* although the depth of the pits themselves is very considerably less.

Distinctness and affinities.—That the present form is distinct from each of the three species already described is sufficiently apparent from the description; and it is equally distinct from the so-called *G. macrorhynchus,* and also from *G. dixoni.* The relations of the nasals indicate that it should be referred to the genus *Gharialis,* although the interdental pits of the maxillæ show an approximation to *Tomistoma.* It is much to be desired that the cranium proper and the termination of the rostrum of this interesting form may one day be forthcoming, when its true affinities may be more fully indicated.

Distribution.—All the known remains of *G. leptodus* have been obtained from the true Siwalik Hills and the eastern Punjab.

Species 5. GHARIALIS PACHYRHYNCHUS, n. sp. *nobis.*

History.—The type specimen of this species is described for the first time; a second specimen has, however, been noticed by Falconer[1] under the name of *Leptorhynchus.*

Cranial rostrum.—The specimen of which three views are given in plate XXXIII. figs. 1, 1a, 1b, was collected by Mr. F. Fedden in the lower Siwaliks of the Laki Hills, Sind, and indicates a species of gigantic size. It comprises the extremity of the cranial rostrum, extending as far back as the fourth tooth behind the notch for the fourth mandibular tooth. On the palatal aspect (fig. 1a) it will be seen that while some of the teeth, although broken, still remain in their alveoli, others have fallen out, and their alveoli are filled with matrix. As the general contour of the specimen is essentially gharialoid, comparisons may be restricted to that group. The termination of the premaxillæ much resembles that of the existing gharial, containing one large tooth on either side, the outer border of which is bounded by a deep notch; while the extremity of the premaxillæ is strongly deflected. The cavity for the reception of the first mandibular tooth does not extend on to the facial aspect of the rostrum (fig. 1.), but is roofed over with bone, and would only require the completion of the outer wall to form it into a pit; as, however, the first mandibular tooth would be entirely visible externally if the mouth were closed, the cavity in question may still be termed a notch. The second[2] and third teeth are of very large size, but the fourth appears to be absent; the widest part of the premaxillæ is at the

[1] "Catalogue of Fossil Vertebrata of Asiatic Society of Bengal," p. 258, No. 14 (1859).

[2] A depression on the posterior side of the notch for first mandibular tooth apparently indicates the alveolus of an accessory tooth between the proper first and second upper teeth.

third tooth, instead of at the second, as in *G. gangeticus* (pl. XXX. fig. 4a.) and *G. curvirostris* (pl. XXXI. fig. 2a). Some distance behind the third tooth there is a sharp constriction of the rostrum, and a well-marked notch for the fourth mandibular tooth. Posteriorly to the notch the alveoli of four maxillary teeth remain on the left side; all these teeth are much smaller than the premaxillary teeth, and increase regularly in size from before backwards. They are situated internally to the outer half of the second premaxillary tooth, and the series appears to have diverged posteriorly; each alveolus is nearly circular, and is separated from the neighbouring one by an interval of about one-third its diameter. A row of large vascular foramina runs at some distance to the inner side of the dental alveoli. On the facial aspect (fig. 1) the lateral expansion of the premaxillæ is well shown; the anterior narial aperture is not unlike that of *G. gangeticus*, but its lateral borders are raised into distinct ridges. In advance of the nares the premaxillæ are mesially hollowed; while posteriorly the profile of the rostrum appears to be straight; its width and height having nearly the same relative proportions as in *G. gangeticus*. The surface of the cranial bones appears slightly more rugose than in the latter; and the extremity of the premaxillæ is perforated by a number of large-sized vascular foramina. The extreme breadth across the expanded portion of the premaxillæ is $9\frac{1}{2}$ inches, and at the notch for the fourth mandibular tooth $7\frac{1}{4}$ inches. In a cranium of *G. gharialis* measuring 31 inches from the occipital condyle to the tip of the premaxillæ the corresponding dimensions are respectively 4 and 2·3 inches.

The specimen represented from the palatal and lateral aspects in plate XXXIII. figs. 2, 2a, was obtained from the lower Siwaliks of Sehwan in Sind, and presented to the Asiatic Society of Bengal by Dr. Young sometime previous to 1859; it is noticed by Falconer on page 258 (No. 14) of his "Catalogue of Fossil Vertebrata of the Asiatic Society of Bengal." This specimen is part of the cranial rostrum of a gharialoid crocodile, showing the alveoli of six cheek-teeth; at the anterior end there is seen the posterior termination of the premaxillæ, from which it is evident that it corresponds in relative position with the hinder portion of the specimen represented in fig. 1a. From the locality whence it was obtained and its agreement in form, there can be little doubt that it belonged to a smaller individual of the same species as the latter. The dental alveoli are sub-circular, and placed near to one another; distinct pits occur between the alveoli, placed somewhat internally to the median line of the latter, and much less deep than in *Tomistoma schlegeli*. The profile (fig. 3a) is nearly straight, and the form of the facial surface is the same as in the type specimen. Unfortunately the condition of the fragment is such as to prevent the certain determination of the relations of the nasals to the premaxillæ, although it is probable that they did not articulate with one another. The position of the interdental pits is such as to indicate that the maxillary and mandibular teeth interlocked.

Teeth.—The bases of the premaxillary teeth still remaining in the type specimen show a slight antero-posterior compression. The crown of a probably upper tooth (which has lost the greater part of its enamel) represented in plate XXXIII. fig. 4

was obtained by Mr. F. Fedden from the lower Siwaliks of Sind, and probably, therefore, belongs to the present form. This specimen agrees with the teeth of *Gharialis gangeticus* in the possession of strongly marked vertical ridges (which are placed more nearly mesially than in the fourth upper tooth of *Crocodilus*), but differs by the lesser degree of the curvature of the crown. Judging from the bases of the teeth in the type specimen of the present form, it seems that the figured tooth was placed with the plane of its vertical ridges more nearly transverse to the long axis of the jaw than is the case in the existing gharial. The dimensions of the base of this specimen are 1·11 x 1·05 inches; the corresponding dimensions of the second tooth in the type specimen being 1·35 x 1·1 inches.

Specific distinctness and affinities.—The present specimens being very much larger than any of those already described, the question might arise whether they could belong to the adult form of any of those species. Now the only one of those species to which this hypothesis could possibly apply, would be the contemporaneous *Gharialis curvirostris* (pl. XXXI. figs. 1, 2). In the first place, however, the type specimens of that species apparently indicate an adult individual; while, in the second place, the present form differs from those specimens by the great expansion of the premaxillæ, the downward flexure of the extremity of the latter, the form of the notch for the first mandibular tooth, the excess in size of the premaxillary over the maxillary teeth, the direction of the line of the latter, and the apparent straightness of the rostrum. There is, therefore, no countenance to this hypothesis; and the present form may accordingly be regarded as distinct from all the other Siwalik species of *Gharialis*; and it is equally distinct from the two European forms provisionally referred to the same genus.[1] Although the present large gharialoid differs from *Gharialis gangeticus* in the superior size of the premaxillary as compared with the maxillary teeth, in the presence of interdental pits in the maxilla, and in the form of the notch for the first mandibular tooth, yet its general characters come so close to those of *Gharialis*, in the sense in which it is here employed, that it may be at least provisionally referred to that genus; and it is proposed to designate it as *G. pachyrhynchus*.

That this species was of enormous size is quite evident, but from the imperfection of the specimens it is difficult to make a calculation of its probable dimensions. The measurements given above apparently indicate an animal between two-and-a-half and three times the size of full-grown existing specimens of *G. gangeticus*, which attain a total length of about twenty feet. If the same proportions obtained in the fossil species, its total length would have been from fifty to sixty feet.

Distribution.—Remains of *Gharialis pachyrhynchus* have at present been recognized only from the lower Siwaliks of Sind.

Genus 3. RHAMPHOSUCHUS, n. gen., *nobis*.

Definition.—Skull elongated into a rostrum, teeth numerous, nasals apparently

[1] The Sind form does not appear to approximate to the fossil N. American gharialoids known as *Thoracosaurus*, *Holops*, and *Thecachampsa* (*vide suprà*, p. 211).

separated from the premaxillæ, 1st mandibular tooth biting into a notch, and 4th into a pit in the cranium, maxillary teeth biting entirely on the outer side of the mandibular, splenial entering largely into mandibular symphysis, extremity of rostrum not expanded, facial profile straight.

Species. RHAMPHOSUCHUS CRASSIDENS (Falc. and Caut.[1])

Syn. *Crocodilus* (*Leptorhynchus*) *crassidens*, Falc. and Caut.[2]

Gharialis crassidens, *nobis*.[3]

History.—The earliest notice of this species occurs in the passage in the 'Trans. Geol. Soc.' cited below, where it is described as "an immense species far exceeding existing ones, and forming a passage from the gharials into the true crocodiles. It has the cylindrical muzzle and synostosized lower jaw of the former, with the blunt thick teeth of the latter." In 1868 the type specimen of this species was figured in "Falconer's Palæontological Memoirs," vol. I. pl. XXIX. fig. 1, under the name of *Crocodilus* (*Leptorhynchus*) *crassidens*[4]; a second specimen is figured in fig. 2 of the same plate, but is described as belonging to the cranium, whereas it is really (as will be seen below) part of the mandible. In 1880 the present writer[5] accepted Falconer's generic determination, merely substituting *Gharialis* for *Leptorhynchus*.

Rostrum.—The specimen which may be regarded as the type is in the British Museum, and was obtained from the typical Siwalik Hills; its state of preservation is more perfect than is usually the case with large fossils from that region. This magnificent specimen,[6] which is represented in plate XXXIV., comprehends the anterior portion of both the cranial and mandibular elements of the rostrum; and shows the whole of the premaxillæ and a large part of the maxillæ in the upper jaw, and in the lower the greater part of the dentary and the anterior moiety of the splenial pieces. The upper and lower jaws are in apposition, and a large number of the teeth are *in situ*; some of the latter being fully protruded, while others are only emerging from their alveoli.

The general structure of the specimen, and especially the entrance of the splenial element into the mandibular symphysis, at once indicates its gharialoid affinities. The anterior extremity of the premaxillæ (fig. 1b) is rounded, and shows no distinct contraction between the first and second teeth, although the first mandibular tooth (which is only partially protruded on the right side [fig. 1a]) bites into a small notch. There is no trace of any lateral expansion of the free extremity of the premaxillæ, which, as in *Gharialis*, terminate posteriorly in a V; and are apparently separated by a considerable interval from the nasals. The anterior narial aperture is not unlike that of *Gharialis gangeticus*, and its lateral and posterior borders

1 'Trans. Geol. Soc.' ser. 2. vol. V. p. 503, note, (1840).—As *Leptorhynchus*, a subgenus of *Crocodilus*.

2 *Loc. cit.* 3 'Journ. As. Soc. Beng.' vol. XLIX. pt. 2. p. 33 (1880).

4 In the description of the plate the name is given simply as *Crocodilus crassidens*, but on page 355 *Leptorhynchus* is inserted. 5 'Journ. As. Soc. Beng.' vol. XLIX. pt. 2. p. 33 (1880).

6 It is also figured on a smaller scale from the lateral aspect in "Falconer's Palæontological Memoirs," vol. I. pl. XXIX. fig. 1.

are not elevated; in the form of this aperture and the depressed contour of the cranial rostrum the specimen is decidedly nearer to the last-named species than to *Tomistoma schlegeli.*

When viewed from the ventral aspect (fig. 1) the specimen presents a remarkable difference both from *G. gangeticus* and *T. schelegeli*—namely, that the mandibular is very much narrower than the cranial part of the rostrum, and that consequently the whole of the lateral series of upper teeth are visible from the ventral aspect when the mouth is closed, and bite entirely on the outer side of the teeth of the mandibular series, instead of interlocking with them. The fourth mandibular tooth[1] has an elevated alveolus which, as in *Tomistoma,* is larger than the alveoli on either side; and in consequence of the narrowness of the mandible, this tooth bites entirely on the inner side of the considerably smaller fourth upper tooth,[2] its summit being evidently received into a pit on the inner side of the latter. With the exception of the first mandibular tooth being received into a notch instead of a pit, this arrangement of the dentition is essentially alligatoroid; although in the alligators the pit for the fourth mandibular tooth is situated behind, instead of on the inner side, of the fourth upper tooth; and the mandibular teeth behind the fourth are not placed so much on the inner side of those of the upper series.[3] The hinder maxillary teeth when fully protruded are nearly equal in size to the premaxillary, and their alveoli are separated by exceedingly thin partitions: as in *Tomistoma,* the third upper tooth is considerably larger than the fourth. The premaxillæ on the facial surface of the rostrum extend as far back as the ninth tooth, whereas in *Gharialis gangeticus* they usually reach the tenth tooth. On the inferior aspect of the mandible the anterior extremity of the splenials reaches as far as the ninth lower tooth, and is thus slightly in advance of the posterior extremity of the premaxillæ on the facial aspect of the cranial rostrum; while in *G. gangeticus* the splenials do not extend in advance of the twelfth or thirteenth mandibular tooth, and there is a long interval between their anterior termination on the inferior aspect of the mandible and that of the posterior termination of the premaxillæ on the facial aspect of the cranial rostrum: this probably indicates that the rostrum of the present form was relatively shorter than that of *G. gangeticus.* In *Tomistoma schlegeli* the premaxillæ on the facial aspect of the rostrum extend back to the ninth upper tooth, while the splenials extend on the inferior aspect of the mandible to the ninth lower tooth, and are therefore slightly in advance of the anterior extremity of the premaxillæ. In these respects, therefore, the fossil agrees with the living species of *Tomistoma* and differs from *Gharialis.* The dentary portion of the mandible is not expanded at its termination, but the general contour of this part is more like that of *G. gangeticus* than of *T. schlegeli*; the abrupt upward curvature of the latter being wanting. As already

1 This tooth has fallen from its alveolus on the right side, but the large elevated rim of the latter is plainly seen.

2 As is the case in *G gangeticus*, the present form has a small accessory tooth between the proper first and second; so that there are really five premaxillary teeth. The same feature occurs in the fossil species of *Tomistoma* from Malta and Austria, (*vide suprà*, pp. 211-212).

3 *Vide* Gray "Catalogue of Shield Reptiles," pt. 2. p. 24.

mentioned, the fourth lower tooth is larger than the adjacent ones; but from the imperfect protrusion of the ninth lower tooth it is not apparent whether the fossil agreed with the living *Tomistoma* in having this tooth larger than those adjacent to it. The majority of the mandibular teeth are subequal in size, and considerably smaller than those of the upper jaw.

Craniam.—The British Museum possesses the middle portion of a cranium from the Siwalik Hills evidently belonging to the present species, of which a profile view is given in the accompanying woodcut (fig. 1). This specimen consists of the portion of

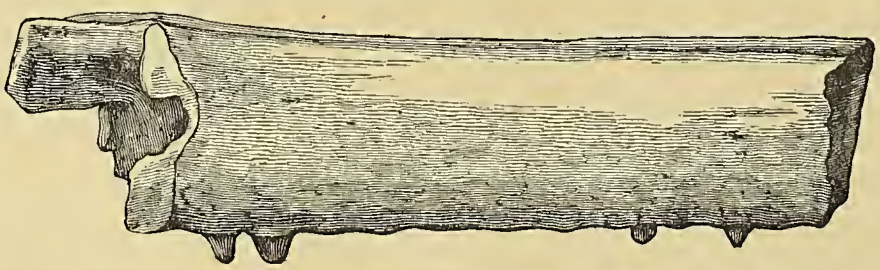

Fig. 1. *Rhamphosuchus crassidens.* Profile view of the midlde portion of the cranium; from the Siwalik Hills. $\frac{1}{6}$. British Museum (No. 39804).

the cranium from the middle of the orbits to the middle of the rostrum, and measures twenty-two inches in length, with a maximum width of eleven inches. Its most remarkable feature is the perfect straightness of the profile, there being no descent from the orbit to the rostrum, and the former lying very nearly in a horizontal plane. *Tomistoma* makes a nearer approach to the fossil in this respect than is made by *Gharialis gangeticus*; but the feature is more like that of some of the true crocodiles and alligators. The dental alveoli are subequal in size, and placed close together; pits for the reception of the tips of the mandibular teeth occur on the inner side of the maxillary alveoli. There is a more decided sculpture than in *G. gangeticus*.

The British Museum also possesses part of a crocodilian quadrate and quadrato-jugal from the Siwalik Hills which from its enormous size evidently belongs to the present form.

Mandible.—Besides the mandibular rostrum attached to the type specimen there are two other portions of mandibles from the Siwalik Hills which may be referred to the present form. The first specimen[1] is in the British Museum, and is figured from the palatal aspect in the accompanying woodcut (fig. 2); it comprises the hinder moiety of the symphysial portion, and shows the anterior termination of the splenial element *(sp.)*. The alveoli of sixteen teeth remain, and these are placed close together, and at some distance from the lateral borders of the symphysis. There is a distinct bevelling of the lateral borders, and the alveoli are subcylindrical, and of nearly equal size.

The second specimen is in the Indian Museum, and is figured from the palatal aspect in plate XXXIII. fig. 3. It is described by Falconer[2] (under the name of

1 The specimen is figured in "Falconer's Palæontological Memoirs," vol. I. pl. XXIX. fig. 2, as part of the cranium.

2 "Catalogue of Fossil Vertebrata of Asiatic Society of Bengal," pp 166-167, No. 652 (1859).

Leptorhynchus) in the following words: "Fragment of the muzzle portion of the lower jaw of an enormous-sized animal, the left side (showing the empty alveoli of

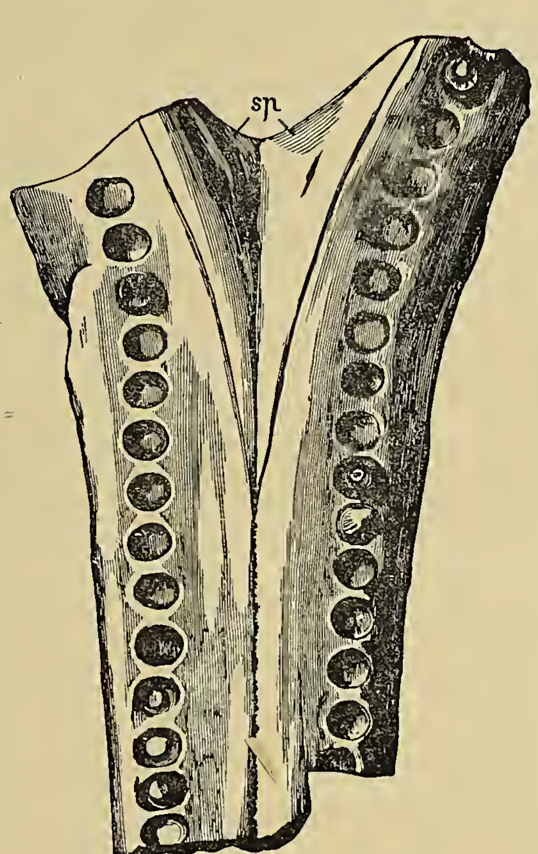

Fig. 2. *Rhamphosuchus crassidens.* Hinder portion of mandibular symphysis; from the Siwalik Hills. $\frac{1}{6}$. British Museum (No. 39803).

the five anterior teeth, [which are] of very large size,) broken off obliquely backwards; the right side broken off nearly opposite the termination of the last alveolus on the left side and continued backwards (showing the alveoli of five teeth, four of which contain more or less of the teeth), its anterior portion wanting.

	In.
"Length of fragment	11·5
"Width about middle	9·5
"Thickness	4·6

"The alveoli of the two first teeth are very large, the third and fourth still larger; the third showing a diameter of 1·8 by 1·4 inches: the sixth tooth is smaller, being 1 inch in diameter; the seventh is 1·4 by 1·2 in diameter; the eighth and ninth are smaller."

The elevated summit of the alveolus of the fourth tooth has been hammered off, but the section of the alveolus is considerably larger than that of the second or third. The first alveolus is also larger than the second, and its tooth must have curved rapidly upwards. The specimen exhibits very clearly the bevelling of the lateral borders, and the close approximation of the alveoli. A series of large vascular foramina runs on the inner side of the alveolar series. On the inferior aspect the specimen likewise exhibits a number of large vascular foramina, which give it a distinctly pitted appearance: the same feature is apparent in the mandible of the type specimen.

Dimensions.—The following dimensions taken from the specimens described above are compared with those of an adult skull of *Gharialis gangeticus* measuring thirty-one inches from the occipital condyle to the extremity of the premaxillæ.

	G. gangeticus.	Fossil.
Width of cranium in advance of palatal foramina	4·8	12·0
,, ,, at 7th tooth from do.	3·1	10·4
,, mandible at fourth tooth in advance of hinder border of symphysis.	2·9	9·6
Length of rostrum to 16th tooth	15·4	27·0
Width of articular surface of quadrate and quadrato-jugal	2·3	6·2

These dimensions indicate an animal of about three times the size of the specimen of *G. gangeticus*, but with a relatively shorter rostrum. Assuming that the cranium of the existing species belonged to an individual close on twenty feet in length, the fossil species would have attained a length of between fifty and sixty feet.

The centrum of an early dorsal vertebra from the Siwalik Hills in the British Museum may, from its gigantic size, be pretty safely referred to the present form. The vertical diameter of the anterior articular cup of this specimen is 4·4, and the transverse 3·9 inches: and it indicates an individual fully three times the size of the largest recent crocodile skeleton in the British Museum. A dorsal scute in the same collection (No. 17066) from the Siwalik Hills has a transverse diameter of 7·1, and an anterior-posterior of 4·2 inches.

Teeth.—In the subequal size of the maxillary and the majority of the hinder mandibular teeth the present form differs from the true crocodiles and alligators, and agrees with *Gharialis* and *Tomistoma*; and it appears that in proportion to the size of the rostrum the teeth are not larger than in *Tomistoma champsoides* of the miocene of Malta.[1] In the upper teeth the fore-and-aft ridges are placed more mesially than in the fourth upper tooth of *Crocodilus*, and their inner surfaces are less flattened. Instead of the ridges being directed nearly laterally as in *G. gangeticus*, they are placed obliquely as in *T. schlegeli*. The Indian Museum possesses numerous teeth from the Siwaliks of the Punjab which apparently agree with those of the present form. The specimen represented in plate XXXIII. fig. 5 closely resembles one of the teeth of the anterior third of the type mandible.

Distinctness and affinities.—The foregoing comparisons decisively indicate that the affinities of the present form are with the gharialoid group. That it is distinct from *Gharialis pachyrhynchus* (plate XXXIII. figs. 1, 2) is evident from the absence of the premaxillary expansion, by the presence of the pit for the fourth mandibular tooth, the relations of the premaxillary to the maxillary dental series, and the apparent absence in the latter of the alligatoroid relations of the upper and lower dental series. It is equally evident that it is specifically distinct from all the other Siwalik forms already described.

With regard to generic characters, the present form differs from both *Tomistoma*

[1] See a paper by the present writer in the 'Quart. Journ. Geol. Soc.' vol. XLII. (1886).

and *Gharialis* (including *Holops*) in the relations of the upper and lower dental series, and in the presence of a pit in the cranium for the reception of the fourth mandibular tooth. It agrees with *Tomistoma* in the non-expansion of the premaxillæ, in the relation of the latter to the splenials, in the enlargement of the fourth (and perhaps of the ninth) mandibular tooth, but apparently differs in the relation of the premaxillæ to the nasals; the profile of the cranium comes nearer to this genus than to *Gharialis*. It agrees with the latter genus in the depressed cranial rostrum, in the form of the extremity of the mandibular symphysis, and in the apparent non-articulation of the premaxillæ with the nasals, but differs in the straight profile, and in those characters in which it resembles *Tomistoma*: the non-expansion of the premaxillæ is a character in which it differs from *G. gangeticus* and *G. pachyrhynchus*, but this feature is almost absent in *G. curvirostris*. The American cretaceous genus *Thoracosaurus* is unlike the present form; and the writer cannot identify the latter with *Thecachampsa* from the miocene of the same country, in which the upper and lower dental series appear to have interlocked.[1]

The alligatoroid characters of the dentition of the present form appear to the writer to afford good grounds for its generic distinction, and the new generic name *Rhamphosuchus* is accordingly proposed for it. Apart from the peculiar relations of the upper and lower dental series, this genus appears to be intermediate in the characters of the skull between *Tomistoma* and *Gharialis*, and it is difficult to say with which its affinity is the nearest.

It is hard to believe that the alligatoroid features of the dentition of *Rhamphosuchus* do not indicate a real genetic affinity with the alligatoroid group; although it would at present be premature to attempt to determine the nature of this suggested relationship. It is to be regretted that we have at present no means of knowing the nature of the dermal armour on the ventral aspect of *Rhamphosuchus*.

Distribution.—*Rhamphosuchus crassidens* is known definitely from the typical Siwalik Hills, while teeth apparently indicate its western extension to the Punjab.

Order. LACERTILIA.

Family. *VARANIDÆ.*

Genus. VARANUS, Merrem.[2]

Distribution.—This genus (in which *Hydrosaurus*, *Monitor*, and *Psammosaurus* are included) is found at the present day in the tropical parts of Africa, Asia, and Australia; and includes the largest existing lizards. Six species are recorded by Mr. Theobald[3] from India; of which the largest (*V. salvator*) attains according to the same authority a length of nearly seven feet; while the Australian *V. giganteus*, according to Gray, is six-and-a-half feet in length. From the lower pliocene[4] of Pikermi M. Gaudry[5] has described some remains of a lizard which is provisionally

1 *Vide suprà.* page 211. 2 "Syst. Amphib." p. 58 (1820). 3 "Reptiles of British India," pp. 38, 39 (1876).

4 The writer now adopts this age for the Pikermi and Léberon beds.

5 "Animaux Fossiles et Géologie de l'Attique," pp. 318-319.

referred to the present group, and apparently attained a length of between four and five feet. From the upper eocene phosphorites of Quercy Gervais[1] has described a fragment of the cranium of a varanoid lizard under the name of *Varanus* (?) *margaritiferus*; while an imperfect mandibular ramus from the same deposits is described by Dr. Filhol[2] as *Palæovaranus cayluxi*, who adds, however, that it is very probably identical with Gervais' species, in which case the former specific name should stand. Whether the Quercy forms be really generically distinct or not, it is evident that the group is an old one.

Species. Varanus sivalensis, Falconer.[3]

History.—The one specimen on which this species is founded is figured in Falconer's "Palæontological Memoirs," vol. I. pl. XXXII. figs. 4-7 without description.

Humerus.—The above-mentioned specimen, which is figured of the natural size in plate XXXV. figs. 1, 1a, 1b, was obtained from the Siwalik Hills, and is preserved in the British Museum. It comprises the distal portion of the right humerus, which with the exception of the loss of the sharp ridge (restored in outline) on the radial, or outer, border, is complete, and exhibits very clearly the articular surfaces; the ectepicondylar foramen (*m*), although filled with matrix, is distinctly visible. Compared with the corresponding element in a skeleton of *Varanus salvator* in the British Museum measuring six feet in length, the present specimen agrees so precisely in every detail of form, that there can be no question as to its belonging to a member of the same genus. As the greatest transverse diameter of the distal end of the recent humerus is 1·3, while that of the fossil 2·4 inches, the length of the animal to which the latter belonged would be eleven feet—or fully four feet longer than the largest recorded individual of the existing species.

Specific distinctness.—The great excess in the size of the fossil over the living *Varanus salvator* may in all probability be regarded as a good specific character, and the name *V. sivalensis* may therefore be adopted. Since *V. salvator* is a coast-frequenting species it may, moreover, be not improbable that the Siwalik form was more closely allied to one of the smaller species now inhabiting the North-West Provinces and Punjab than to the former.

Order. OPHIDIA.

Family. *PYTHONIDÆ.*

Genus. PYTHON, Daudin.[4]

Distribution.—At the present day the genus *Python* (in which the writer includes the African so-called *Hortulia*) is confined to Africa and the Oriental region; being represented in Australia by *Morelia*. In the Indian region there are but two species (which are also the sole representatives of the family in that region), *viz.*—*P. molurus*

1 "Zool. et Pal. Générales," ser. 2. p. 60. (1876).
2 'Ann. Sci. Géol.' vol. VIII. art. 1. p. 268. (1877).
3 "Palæontological Memoirs," vol. I. pl. XXXII. (1868).
4 "Hist. Nat. Rept." vol. V. p. 226 (no date—? 1802).

ranging from peninsula India to south China, and *P. reticulatus* which is found in the Malay Peninsula, the Nikobar Islands, Burma, and Tenasserim: both species are said occasionally to attain the length of thirty feet, although specimens exceeding twenty are but of rare occurrence.

Pictet[1] has described some ophidian vertebra from the upper eocene of Switzerland which may probably be referred to the present genus; while Dr. Filhol[2] has described a species from the upper eocene phosphorites of Quercy under the name of *P. cadurcensis*. The genus *Palæophis*[3] from the upper and middle eocene of England appears to be allied to *Python*, but the vertebræ differ by their more elevated neural spine, the lower position of the costal tubucle, and by the aliform process arising from the neural arch being pointed.

Species. Python molurus (Linn[4]).

Syn. *Coluber molurus*, Linn.[5]

Previous notice of Siwalik form.—In 1882 the present writer[6] noticed some ophidian vertebræ from the Siwaliks of Sind and the Punjab, and observed that they were apparently indistinguishable from those of the existing *P. molurus*.

Vertebræ.—In figures 4, 5, 6, 7, 7a of plate XXXV. four of the above-mentioned vertebræ, which were collected by Mr. Theobald from the Siwaliks of the Punjab, are figured of the natural size, while in figs. 2, 3, 3a of the same plate two vertebræ belonging to a recent example of *Python molurus* which measured twenty feet in length, are figured for comparison. The smaller recent specimen (fig. 2) belongs to the cervical region, and exhibits the long hæmal spine (*hs*) characteristic of that part; while the larger one (figs. 3, 3a) is from the middle of the dorsal region, and is characterised by the very minute size of the same spine. The fossil specimen represented from the posterior aspect in fig. 4 is somewhat imperfect on the left side, and has lost the greater portion of the neural spine (*ns*); the small development of its hæmal spine (*hs*) shows that it belongs to the anterior portion of the dorsal region, while its dimensions indicate an individual of about twelve feet in length. It presents no characters by which it can be specifically distinguished from the vertebræ of the existing form.

The imperfect specimens represented in figs. 5, 6 likewise belong to the dorsal region, and indicate individuals of from six to eight feet in length. Slight differences in the form of the zygapophysial facettes can be detected between these specimens and the recent vertebra represented in figs. 3, 3a, but it is not certain that these may not be due merely to their different serial position. The slightly imperfect specimen represented in figs. 7, 7a apparently belongs to the anterior part of the caudal region, and indicates an individual about equal in size to the two preceding specimens. A

1 "Matériaux pour la Paléontologie Suisse," vol. I. "Ann. Vert d. l. Faune Eocéne" p. 100. pl. VIII. figs. 8-10 (1855-57).
2 'Ann. Sci. Géol.' vol. VIII. art 1. p. 270 (1877).
3 "Reptilia of London Clay, etc." part 2 pp. 56-66 (1850).
4 "Syst. Nat." ed. 12. vol. I. p. 225 (1766)—*Coluber*.
5 *Loc. cit.*
6 'Rec. Geol. Surv. Ind.' vol. XV. p. 106 (1882).

very similar dorsal vertebra has been obtained from the lower Siwaliks of Sind (Ind. Mus. No. E. 205a).

The resemblance of the specimen represented in fig. 4 to the dorsal vertebræ of *P. molurus* is so close, that, in the absence of any evidence of an opposite nature, it may be at least provisionally referred to that species. The smaller specimens, evidently indicate a closely allied form, which may or may not be specifically identical.

Distribution.—As already mentioned, *P. molurus* ranges at the present day from peninsular India to southern China, and the larger Siwalik vertebra noticed above appears to carry back its range in time into the pliocene, and to extend it in space to the northern Punjab.

LIST OF MEMOIRS.[1]

CAUTLEY, P. T. "Note on the Crocodile of the Siwalik Hills," '*Asiatic Researches*,' vol. XIX. pp. 25-31. pl. II (1836).

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INDIAN TERTIARY & POST-TERTIARY VERTEBRATA.

TERTIARY FISHES.

By R. LYDEKKER, B.A., F.G.S., etc.

(WITH PLATES XXXV [figs. 8-15] TO XXXVII.)

INTRODUCTORY.

Siwalik fishes.—Of the literature relating to Siwalik fishes (the description of which occupies the greater part of this memoir) there is but little to be said, since a paper by M'Clelland, a note by Dr. Günther, and another by the present writer (all of which are quoted in the sequel) constitute almost all that has been hitherto written on the subject.

Compared with those of mammals the remains of Siwalik fishes which admit of even ordinal determination are extremely rare, although detached vertebræ, fragments of fin-spines, etc., are of not uncommon occurrence. The majority of the determinable remains belong to the families of the *Ophiocephalidæ* and *Siluridæ*, which at the present day form such a marked feature in the ichthyic fauna of India; and it is noteworthy that nearly all the specimens of the latter family belong to those genera in which the cranial bones are of great relative stoutness, and are covered with a characteristic sculpture. Those genera, like *Bagrus*, in which the cranial bones are much thinner, have not left any characteristic remains, although it is almost certain that they must have existed in the Siwalik period. The same reason will probably account for the almost total absence of the remains of cyprinoids.

The indications of close affinity between some of the Siwalik siluroids and species at present existing in Africa is a circumstance of considerable importance in relation to the probable derivation of a great part of the present vertebrate fauna of that country from the Oriental region. Of no less interest is the occurrence of remains of sharks in the Siwaliks of the Punjab and the Burma, as affording evidence of the physical conditions of those regions in the pliocene epoch.

Infra-Siwalik fishes.—The fishes of the infra-Siwalik marine rocks of the Punjab and Kach are known merely by two specimens described in the sequel; while a glimpse of the fish-life of the tertiaries of the more southern regions is afforded by a third specimen. The brief literature referring to these specimens is quoted in the sequel.

Subclass I. PALÆICHTHYES.

Order. CHONDROPTERYGII. Suborder. PLAGIOSTOMATA.

Section I. SELACHOIDEI.

Family I. *CARCHARIIDÆ.*

Genus. CARCHARIAS, Linn.[1]

Characters.—Teeth flat and triangular, with either smooth or serrated edges.

Distribution.—The genus is represented by between thirty and forty existing species,[2] which are inhabitants of the tropical and (more rarely) temperate seas; and it is probable that some of the fossil forms described under the names of *Corax* and *Hemipristis* are not generically separable. *Carcharias gangeticus*, which is found from India to Japan, ascends tidal rivers to distances considerably above the influence of the tides,[3] and is also found in inland lakes in the Fiji Islands[4]—the latter habitat being of especial interest in relation to the specimens from the Siwaliks.

Carcharias, sp.

(From the Siwaliks.)

History.—The specimens noticed below are described for the first time.

Teeth.—The four teeth represented in plate XXXV. figs. 12-15 are selected from numerous specimens collected by Mr. Theobald in the Siwaliks of the Punjab; figs. 12, 13 being from the upper, and 14, 15 from the lower jaw. The upper teeth show strongly-marked serrations, and agree very closely with those of *Carcharias glaucus*[5] and *C. gangeticus*; the notch on the anterior border being very slight, as in the latter species. The lower teeth exhibit much less clearly-marked serrations, but the presence of such serrations indicates that they belong to the same group as that containing the two above-mentioned species. In their narrower bases both the lower teeth differ from those of *C. glaucus* and *C. gangeticus*: the specimen represented in fig. 15 is probably one of those situated close to the mandibular symphysis.

Affinities.—It is probable that the specimens are insufficient for specific determination; and all that can be safely said of them is that they indicate a form allied to the two species mentioned above. The occurrence of this form in the Siwaliks of the

1 "Syst. Nat." ed. 12. vol. I. p. 400 (1766).

2 Thirty-five species are enumerated in Günther's "Catalogue of Fishes," vol. VIII. pp. 358-375 (1870).

3 Day "Fishes of India," p. 715 (1878).

4 Günther "Study of Fishes," p. 205 (1880).

5 Compare the figure in Günther's "Study of Fishes," p. 317. fig. 112 (1880).

6 Günther "Catalogue of Fishes," vol. VIII. pp. 363-364 (1870).

Punjab is a proof of the former existence in that area either of large tidal rivers, or of lakes which at one time must have communicated with the sea.

Family II. *LAMNIDÆ.*

Genus. CARCHARODON, A. Smith.[1]

Characters.—Teeth large, flat, erect, regularly triangular, serrated. On each side of the upper jaw, at some distance from the symphysis, there are one or two teeth considerably smaller than the others.

Distribution.—At the present day the genus is represented only by *C. rondeletii*, which appears to occur in all tropical and subtropical seas; but it was extremely abundant in the tertiaries, ranging from the lower eocene upwards.

Carcharodon. sp.

(From the Siwaliks of Pegu.)

History.—The specimen forming the subject of this notice is described for the first time.

Tooth.—The tooth represented from the convex surface in plate XXXV. fig. 8 was obtained by Mr. W. T. Blanford, from the Siwaliks of Pegu, British Burma. The writer has been unable to identify this specimen with any of the teeth of *C. rondeletii* or of the larger *C. megalodus*: it agrees, however, very closely in size and contour with teeth of *C. sulcidens*, Ag., from the Red Crag, but the serrations are finer. Other specimens are required before the affinities of this form can be determined; but the specimen is interesting as indicating that during the pliocene period Pegu, as at the present day, was traversed by the numerous outlets of the Irawadi.

Genus. *non. det.*

Vertebræ.—The vertebra of a shark represented in plate XXXVII. figs. 9, 9a, is one of two similar specimens in the Indian Museum obtained from the Siwaliks of Perim Island. They agree very closely with the vertebræ of *Lamna cornubica*, and not improbably belong either to *Lamna* or *Carcharias.*

Section II. BATOIDEI.

Family. *MYLIOBATIDÆ.*

Genus. MYLIOBATIS, Cuvier[2] (*ex* Duméril).

Characters.—Teeth hexangular, large, flat, tessellated: those in the middle much broader than long; several narrower series on each side. In very young examples the median teeth are regularly hexagonal, and not larger than the others.

Distribution.—Seven existing species are known,[3] one of which is almost cosmopolitan; while of fossil forms a very large number have been described. Signor Issel[4] gives a list of forty-two species, and by adding descriptions of four new ones,

1 In Müller and Henle's "Syst. Beschreibung. d. Plagiostomen," p. 70 (1841).

2 "Règne Animal," 1st ed. vol. II. p. 137 (1817). 3 Günther "Catalogue of Fishes," vol. VIII. pp. 488-492 (1870).

4 'Ann. Mus. Nat. Genova.' vol. X. pp. 313-340 (1877).

brings up the number to forty-six; while Signor Botti[1] enumerates no less than sixty species, to which he adds the new *M. salentinus*: this list does not, moreover, include six North American species described by Prof. J. Leidy.[2] A memoir on two species (included in Botti's list) by Signor F. Bassani[3] may be also mentioned. The genus commences in the London Clay.[4]

Species. MYLIOBATIS CURVIPALATUS, n. sp. *nobis.*

(From the eocene of Kach.)

History.—The specimen on which this provisional species is founded has been previously described by the present writer[5] without a specific designation.

Dental plate.—The type specimen was obtained by Mr. A. B. Wynne from the nummulitics of Kach,[6] and is figured in plan and section in plate XXXV. figs. 9, 9a. It has been split longitudinally in the middle line, and comprises the halves of four of the middle teeth, and two entire teeth of the innermost lateral row (*a*): the median teeth are of considerable antero-posterior diameter. The characteristic feature of the specimen consists in the peculiar contour of the transverse section (fig. 9a): the middle line being considerably depressed, the contiguous portion presenting a bold upward curve, and the border showing a sharp descent to the lateral plates, which are situated much below the plane of the median line.

Affinities.—A comparison with the specimens in the British Museum apparently indicates the distinctness of the present specimen from each of the thirteen species mentioned in the foot-note (4); it comes, however, nearest to *M. striatus*, and presents some resemblance to *M. micropleurus*.[7] Figures of the dentition of five species are given by Signor Issel,[8] and the Indian specimen is almost certainly distinct from all of them, although the dental plate of *M. ligusticus* makes an approach to it in the contour of the transverse section. *M. salentinus*, Botti,[9] is a much smaller species; and *M. ombonii*, and *M. elegans*, Bassani,[10] appear equally distinct. That the Indian form is identical with any of the American fossil species is improbable; and its distinction from all the living species (in which the dental plates are simply convex) might be inferred on account of its geological age alone.

Although the writer cannot be absolutely certain that the present form is distinct from all the described species, yet it appears probable that such is the

1 'Atti. Soc. Tosc Sci. Nat.' vol. III. pp. 371-382 (1878).

2 'Proc. Ac. Nat. Sci Philad.' vol. VII. p 397 (1855), and 1876, pp 80-86.

3 "Ittiodontoliti del Veneto"—8vo Padua. (1877).

4 Dental plates of a considerable number of species are figured by Gervais in the "Zool et Pal. Françaises," 2nd ed. pls. LXVII. LXXIX. and LXXX. The following species (which unless otherwise stated are from the English eocene) are represented in the collection of the British Museum, viz: 1. *M. contractus*, Dix. 2. *M. dixoni*, Ag 3. *M edwardsi*, Ag. 4. *M. goniopleurus*, Ag. 5. *M. gyratus*, Ag 6. *M. heteropleurus*, Ag. 7. *M. irregularis*, Dix 8. *M. micropleurus*, Ag. (miocene, France and Malta.) 9. *M. nitidus*, Ag. 10. *M. punctatus*, Ag. 11. *M. stokesi*, Ag. (miocene, Malta.) 12. *M. striatus*, Ag. 13. *M. toliapicus*, Ag.

5 'Rec. Geol. Surv. Ind.' vol. X. p. 43 (1877).

6 In 'Journ. As. Soc. Beng.' vol XLIX. pt. 2. p. 10 (1880) erroneously said to be from the Punjab.

7 *Vide* Gervais *op. cit.* pl. LXXX. fig. 4. 8 *Op. cit.* 9 *Op. cit.*

10 *Vide* Günther "Study of Fishes," p. 338. fig. 125. (1880)

case, and it is therefore proposed to assign it a provisional specific name; and from the peculiar character of the dental plate the name *Myliobatis curvipalatus* will be appropriate.

The contour of the dental plate of *M. curvipalatus* shows an approach to the remarkable one in the same element of *Rhynchobatus*[1]; and if the resemblance be a true one it indicates that the type specimen of the former belongs to the upper jaw.

Subclass II. TELEOSTEI.

Order I. ACANTHOPTERYGII.

Family I. *SPARIDÆ.*

Characters.—Either cutting-teeth in the front of the jaws, or molariform teeth on the sides; palate either toothed or edentulous.

Genus. CAPITODUS, Münster.[2]

Characters.—Both palatal and premaxillary teeth present: the latter wider than in *Sargus.*

Distribution.—Five species were described by Münster[3] from the miocene of the Vienna basin; one of these (*C. truncatus*) having been subsequently recorded by Roemer[4] from contemporary strata in upper Silesia.

Capitodus indicus, *nobis.*[5]

(From the eocene of the Punjab.)

History.—The type specimen has been described by the writer in the notice cited.

Tooth.—The tooth represented in plate XXXV. figs. 11, 11a was collected by Mr. A. B. Wynne from the nummulitics of Kohát, Punjab; it is one of the incisiform series, and agrees so closely with the teeth of the European species of *Capitodus* that it may be pretty safely referred to that genus. The crown is broad and laterally expanded, its dentine having been worn into a deep hollow on the inner surface (fig. 11a). The outer surface is coated with enamel, and is convex laterally; its width is 0·7, and its height 0·4 inch.

Affinities.—In its general contour and mode of wear the Indian tooth closely resembles the teeth of *C. truncatus*,[6] but the crown is relatively much wider. In the other four European species the crowns of the incisive teeth are still narrower.

The beds from which *C. indicus* was obtained are probably of upper eocene age.

Family II. *OPHIOCEPHALIDÆ.*

Characters.—Head depressed, covered with shield-like scales superiorly; cleft of the mouth lateral, wide; teeth in the jaw and on the palate. Eye lateral; a cavity accessory to the gill-cavity for containing water.

Distribution.—The family comprises only the genera *Ophiocephalus* and *Channa* (the latter having but one species), and is mainly characteristic of the Oriental region,

1 *Vide* Günther "Study of Fishes," p. 338. fig. 125 (1880).
2 "Beiträge zur Petrefactenkunde," pt. V. p 67 (1842).
3 *Ibid.* pt VII.
4 "Geologie von Oberschlesien," pl. XLVIII. fig. 4 (*Breslau*, 1870).
5 'Rec. Geol. Surv. Ind.' vol. XIII. p. 61 (1880).
6 Münster, *op. cit.* pt. VII. pl. II. fig. 2, and Roemer, *loc. cit.*

although one or two species occur in Africa.[1] The writer is not aware that any fossil forms have been hitherto described.

Genus. OPHIOCEPHALUS, Block.[2]

Ophiocephalus, sp. *a*.

(From the Siwaliks.)

History.—The first mention of the occurrence of remains of fishes of this family in the Siwaliks was made by M'Clelland[3] in 1844, on the evidence of the specimens noticed below.

Skulls.—The specimen represented in plate XXXVII. fig. 2 was obtained from the Siwalik Hills, and is preserved in the British Museum (Cautley collection). It comprises the greater part of the cranium and mandible (the former being crushed in behind the orbit) and posteriorly exhibits the pharyngeal teeth (*f*). The strong development of the maxilla, the long series of teeth, the shield-like scales on the frontals, the presence of an accessory gill-cavity (as shown by fracture), and the general contour, agree so exactly with *Ophiocephalus*, that there can be no doubt as to the genus of the specimen. The large size of the frontal scales shows that the specimen belongs to the first group of Dr. Günther's[4] classification, but beyond this the specimen scarcely admits of closer approximation. It agrees in size with the head of an adult stuffed specimen of the Indian *O. striatus* in the British Museum, but appears decidedly less depressed.

Two other less perfect skulls in the British Museum (Nos. 15374 and 15375) from the Siwalik Hills not improbably belong to the same species as the preceding.

Ophiocephalus, sp. *b*.

(From the Siwaliks.)

Skull.—A much-rolled skull in the British Museum (No. 16402a,) from the Siwalik Hills indicates an *Ophiocephalus* of considerably larger size than the preceding specimens, which is not improbably specifically distinct. Owing to the damaged condition of the specimen a figure has not been given: the cranial shield-like scales are of very large size, and apparently relatively larger than those of the preceding species.

Order II. PHYSOSTOMI.

Family I. *SILURIDÆ.*

Characters.—Skin naked or with osseous scutes, but without scales. Barbels always present; maxillæ rudimentary, and the margin of the upper jaw formed by the premaxillæ.

Distribution.—This extensive family is found in the freshwaters of nearly all the temperate and tropical regions, and is very strongly represented in India and Africa. The writer is not acquainted with any European fossil representative of the

1 Güuther "Study of Fishes," p 513 (1880).

2 "Ausländische Fische." vol. VIII. p. 137 (1785-95).

3 'Calcutta Journ. Nat. Hist.' vol. IV. p. 83 (1844).

4 "Catalogue of Fishes,' vol. III. p. 469 (1861).

family, although remains of *Pseudotropius* and *Bagarius* have been described from the tertiaries of Sumatra[1]; while spines belonging to various genera are recorded from the tertiaries of North America.[2]

Siwalik forms.—Fragmentary remains of members of the family are of not uncommon occurrence in the Siwaliks, but it is only in comparatively few instances that they are even generically determinable. With a few exceptions only such specimens have been figured in this volume as admit of such determination being either definitely or approximately made.

Subfamily I. *HOMALOPTERÆ.*

Group. CLARIINA.

Characters.—The cranium is much depressed, and very fully ossified, all the bones being sculptured: vacuities occur in the median line of the supraoccipital and frontals.

Distribution.—The group is confined to Africa and the Oriental region.

Genus. CLARIAS, Gronovius.[3]

Characters.—Jaws with a band of villiform teeth: a band of villiform or granular teeth across the vomer; cleft of the mouth transverse, anterior, of moderate width: orbits small: upper and lateral parts of the head osseous, or covered with very thin skin: upper cranial bones covered with granular sculpture.

Distribution.—The distribution of the genus is the same as that of the group; nineteen species are enumerated in Günther's "Catalogue of Fishes,"[4] of which two occur in India. Some of the species are of large size.

Species. Clarias falconeri, n. sp. *nobis.*

(*From the Siwaliks.*)

History.—The one specimen on which this species is founded is now described for the first time; it was obtained from the Siwalik Hills, and transferred from the old India House Museum to the British Museum in 1880.

Cranium.—The type specimen is represented in plate XXXVII. fig. 1; it comprises a portion of the middle of the cranium, showing the greater part of the supraoccipital (*sup.*), and frontals (*fr.*), and the posterior extremity of the ethmoid. The characteristic supraoccipital (*a*) and frontal (*b*) vacuities are clearly exhibited, and indicate the genus of the specimen. In size the fossil indicates a species of about eighteen inches in length. The characteristic feature of the Siwalik form is the great prominence of the supraoccipital region, which the writer has not observed in the skulls of such of the existing species as have come under his notice. The sculpture is comparatively fine: the left half of the claviculo-coracoidal arch, which is strongly grooved, is attached to the ventral aspect.

1 Günther 'Geol. Mag.' dec. 2. vol. III. pp. 433-440 (1876).

2 See Leidy "Contributions to extinct Vertebrate Fauna of the Western Territories" (Rep. U. S. Geol. Surv.). p. 193 (1873).

3 "Zoophylacium Gronovianum." p. 100 (1763-81).

4 Volume V. pp. 13-21 (1865). Twenty species are mentioned in the "Study of Fishes," p. 563.

Distinctness.—Of the Indian species, *C. jagur* according to Dr. Day[1] has but one cranial vacuity; while *C. magur* and the allied *C. assamensis*[2] have not the elevated ridge on the supraoccipital, and the skull of *C. teysmanni* is considerably smaller and much flatter. The writer has been unable to identify the fossil with any African form of which there are skulls in the British Museum; and it is certainly distinct from the nearly equal-sized *C. gariepinus* (*capensis*), in which the cranial vacuities are smaller, and the supraoccipital nearly flat. Under these circumstances it is proposed to assign the provisional name of *Clarias falconeri* to the Siwalik species.

Genus II. HETEROBRANCHUS, Geoffroy.[3]

Characters.—This genus is chiefly distinguished from the preceding by the structure of the fins; but the supraoccipital process is more developed, and all the species are of small size (pl. XXXVI. fig. 3).

Distribution.—Six species are enumerated in Günther's "Catalogue of Fishes,"[4] of which five are exclusively African, while the sixth is from Banka and Borneo.

Species. Heterobranchus palæindicus, n. sp. *nobis.*

(*From the Siwaliks.*)

History.—The one specimen on which this species is founded was obtained from the Siwalik Hills, and belongs to the Cautley collection of the British Museum: it has not hitherto been described.

Skull.—The type specimen is represented of the natural size in plate XXXVI. fig. 4; a figure of the skull of the existing African *H. intermedius* being given in figure 3 of the same plate. The fossil comprises the nearly complete skull; the chief losses being the premaxillæ, the turbinals, the extremity and the lateral wings of the ethmoid (*eth.*), and the extremity of the supraoccipital (*sup.*). Compared with the skull of *H. intermedius* it will be seen that the resemblance is so close as to leave no doubt of the generic unity of the two specimens. The fossil and recent skulls are of very nearly the same dimensions, and belong to individuals of about fifteen inches in length. The fossil differs by the narrower anterior extremity of the ethmoid (*eth.*), by the shorter and wider frontal vacuity (*b*), and by the band of villiform teeth on the palate being narrower and more extended laterally. The united claviculo-coracoidal element of the humeral arch, which is preserved on the ventral aspect of the specimen, is also more deeply grooved. In the great development of the supraoccipital spine (*sup.*) the specimen agrees with *Heterobranchus*, and differs from *Clarias*.

Distinctness.—The foregoing comparisons indicate the specific distinctness of the Siwalik *Heterobranchus* from *H. intermedius*, and therefore probably also from the allied *H. dorsalis*. *H. isopterus* appears to be distinguished by its inferior size. Of the other three species, *H. laticeps* is not represented in the British Museum collection, while there are only young specimens of *H. tapeinopterus* and *H. longifilis*, and the

1 "Fishes of India," p. 484 (1878).
2 *Ibid.* p. 485.
3 "Descrip. Eg. Atl. Poissons," pl. XVI. fig 2 (1809-13).
4 Volume V pp. 21-23 (1865).

writer has not therefore been able to assure himself of the distinctness of the fossil form; but as such distinctness is probable, it is proposed to provisionally regard the latter as a new species, under the name of *H. palæindicus*.

The occurrence of a species of *Heterobranchus* in the pliocene of India is extremely interesting as affording another instance of the probable migration of existing African genera from an Oriental centre of distribution.

SUBFAMILY II. *PROTEROPTERÆ.*

GROUP A. BAGRINA.

Characters—The anterior and posterior nostrils are remote from one another.

GENUS I. CHRYSICHTHYS, Bleeker.[1]

Characters.—Teeth on the palate in two lateral portions; jaws equal in length, or the upper the longer; skull relatively broad, and the bones of the upper part of the cranium usually with a cancellous structure. *Clarotes* is distinguished by very slight characters.

Distribution.—The genus is confined at the present day to tropical Africa; seven species are recorded by Günther,[2] the largest of which attains a length of fifteen inches. *Clarotes* is also African, and is known by one species.

Species. CHRYSICHTHYS (?) THEOBALDI, n. sp. *nobis.*

(From the Siwaliks.)

History.—The specimen on which this species is founded is described for the first time.

Cranium.—The hinder portion of the cranium of a siluroid represented in plate XXXVII. fig. 4 was collected by Mr. Theobald from the Siwaliks of the Punjab. The supraoccipital and frontal region is well preserved, but the basicranial axis has been twisted to the left side, and a portion of the upper surface of the cranium displaced below the frontals. The whole of the upper cranial bones are coarsely cancellated, thus presenting an approach to a true sculpture, and showing that the overlying skin was comparatively thin. In figure 5 there is represented the skull of the existing *Chrysichthys macrops*, and a comparison of this figure with that of the fossil will show how extremely close is the resemblance between the two. Thus both exhibit the same relatively wide cranium, with the short supraoccipital process (*sup.*), the long frontal vacuity (*b*), and the cancellous upper surface of the bones.

Affinities.—The fossil indicates an individual of about two feet, or rather more, in length, and its close resemblance to *Chrysichthys* leaves but little doubt that it belongs either to that or a closely allied genus. The relatively great width of the cranium, the shorter supraoccipital process, and the cancellous structure of the cranial bones at once distinguish it from *Bagrus*: but *Clarotes* is too closely allied to *Chrysichthys* to admit of distinction in the case of specimens as imperfect as the present one.

1 "Ichthyol. Archipel. Ind. Prodromus—Siluroidei," p. 60 (1858).
2 "Catalogue of Fishes," vol. V. pp. 71-73, and 430-431 (1864).

As the fossil is larger than any of the existing species of *Chrysichthys* (and *Clarotes*), it may be regarded as distinct, and provisionally named *Chrysichthys* (?) *theobaldi.*

Genus II. Macrones, Duméril.[1]

Characters.—Teeth on the palate in a continuous band; no moveable lateral teeth; upper jaw the longer; skull long; median portion of the upper surface of the cranial bones covered with a radiate sculpture.

Distribution.—The genus is confined to Asia, nineteen species being enumerated by Dr. Günther[2]; it is divided into two groups from the characters of the fins, one of those groups being subdivided according to the presence or absence of a separate interneural shield on the nape.

A. A separate interneural shield on the nape.

Species. Macrones aor (Buch. Hamilton[3]).

Syn. *Pimelodus aor*, Buch. Hamilton.[4]

Bagrus aor, Cuvier and Vallenciennes.[5]

(*From the Siwaliks*).

History of fossil form.—The fossil specimen identified with this species is described for the first time; it was obtained from the Siwalik Hills, and on the death of Dr. Falconer was presented by his brother to the British Museum.

Skull.—The above-mentioned specimen is represented of two-thirds the natural size in plate XXXVI. fig. 5; it comprises the entire skull, and the greater portion of the bones of the humeral arch in very perfect preservation, although on the left side the gill-cover has been crushed in beneath the cranium. The villiform teeth on the premaxillæ are distinctly visible, but the palatal teeth are concealed by the mandible and matrix. The upper jaw overlaps the lower, and the position of the widely separated anterior and posterior nares (*na*, *nā*) is clearly indicated.

Compared with a full-grown stuffed specimen of *Macrones aor* in the British Museum, measuring nearly three feet in length, the fossil agrees so closely that there can be little, if any, doubt as to its specific identity. It agrees exactly with the recent skull in size, and, allowing for a small fracture on the lateral borders of the fronto-parietal region, and the loss of the extremity of the supraoccipital process, absolutely no difference can be detected in respect of form and structure. The skull of the existing Indian *Macrones lamarii*[6] (the only other member of the present sub-group) is relatively longer and narrower, and has the cranial sculpture somewhat finer.

Distribution.—The existing form appears to be distributed over Burma and the

1 "Ichthyologie Analytique," p. 484 (1856).

2 "Catalogue of Fishes," vol. V. pp. 74-84 (1864).

3 "Fishes of the Ganges," p. 205 (1822). *Pimelodus.*

4 *Loc. cit.*

5 "Hist. Nat. d. Poissons," vol. XIV. p. 405 (1839).

6 Day ("Fishes of India") identifies this species with *M. seenghala* (Sykes), and adopts the latter name. Günther ("Catalogue of Fishes," vol. V. p. 78) considered *M. seenghala* as a synonym of *M. aor.*

whole of India, and its range therefore covers the area inhabited by its fossil progenitor.

Genus III. RITA, Bleeker.[1]

Characters.—Teeth on the palate granular or molariform; the upper jaw longer than the lower; posterior border of the supraoccipital process notched to receive the basal bone of the dorsal spine (pl. XXXVII. fig. 6); upper cranial bones covered with a granular or subradiate sculpture.

Distribution.—The genus is confined to the Oriental region; five species being recorded in Günther's "Catalogue of Fishes,"[2] and a sixth having been subsequently described by Dr. Anderson[3] under the name of *R. sacerdotum.*

Species. Rita grandiscutata, n. sp. *nobis.*

(*From the Siwaliks.*)

History.—No previous description has been given of the specimen on which this species is founded.

Basal bone of dorsal spine.—The specimen represented of half the natural size in plate XXXVII. fig. 3 was collected by Mr. Wynne in the Siwaliks of the Punjab; and consists of the entire basal bone of the dorsal spine of a gigantic siluroid. Compared with existing siluroids this specimen agrees more nearly with the corresponding element in *Rita* than in any other genus, and in order to exhibit this resemblance the hinder part of the cranium and basal bone of the dorsal spine of a young individual of the existing Indian *R. crucigera*[4] (Owen) has been drawn in fig. 6 of the same plate. If the two figures be compared it will be seen that in the contour of the posterior border the fossil agrees almost precisely with the recent bone, the facettes marked *e* being exactly similar; the anterior extremity of the two is also constructed on the same plan, although the processes (*f*) for articulation with the supraoccipital process are more developed in the fossil. On the lateral borders the fossil differs by its expansion into the strongly marked processes *c* and *d*, which are totally wanting in the recent bone; but it is probably that this is not more than a specific variation. In the extreme prominence of the upper half of the middle line the fossil also differs very markedly from the recent specimen, and its sculpture also appears relatively finer.

Affinities.—That the fossil specimen indicates a siluroid specifically distinct from *Rita crucigera* (which attains a length of four feet) is perfectly evident; and its specific distinction from the four smaller species mentioned in Günther's "Catalogue" is equally clear. As *Rita sacerdotum*, which attains a length of five feet, appears to be less close to the Siwalk specimen than *R. crucigera*, the specific distinctness of the fossil form may be assumed; and since it is probable that the differences distinguishing the latter from the existing species of *Rita* are not of more than specific

1 "Ichthyol. Archipel. Ind. Prodromus—Siluroidei," p. 60 (1858).

2 Vol. V. pp. 92-94 (1864).

3 "Results of Yunnan Expedition," p. 864, pl. LXXIX. fig. 3 (1878).

4 Day ("Fishes of India") adopts the name *R. buchanani* for this species.

value, it may be provisionally referred to that genus with the name of *R. grandiscutata.*

The very large size of the type specimen indicates that *R. grandiscutata* considerably exceeded in its dimensions any of the existing species, and its length may be roughly estimated as probably not less than seven feet.

Group B. ARIINA.

Characters.—Anterior and posterior nostrils approximated.

Genus. ARIUS, Cuv. and Val.[1]

Characters.—Head osseous above; superior cranial bones covered with a granulo-radiate sculpture; teeth on the palate fixed; upper jaw longer than the lower. The genus is divided into groups from the structure of the teeth.

Distribution.—The genus is spread over the whole of the tropical regions, and comprises a very large number of species. From India and the adjacent countries twelve species are recorded by Dr. Day.[2]

I. Vomerine teeth are present, and form a continuous or slightly interrupted band, more or less confluent with the palatine teeth.

A. Teeth on the palate villiform.

Arius, sp. *a.*

(From the Siwaliks).

History.—The specimen noticed below was obtained from the Siwalik Hills, and belongs to the Cautley collection of the British Museum; it has not been hitherto described.

Cranium.—The specimen represented in plate XXXVI. fig. 2 consists of the hinder part of the cranium of a very large siluroid, showing the basicranial axis, and a considerable portion of the bones of the upper part of the face. Nearly the whole of the supraoccipital (*sup.*) and a considerable portion of the adjacent lateral bones are preserved, as well as the hinder extremities of the frontals (*fr.*); and in order to exhibit the form of this part of the cranium when complete the specimen has been restored in outline from the corresponding portion of the cranium of the existing *Arius latiscutatus* of West Africa.

Comparing the fossil with the cranium of the last-mentioned species, the resemblance between the two is so close, that not only may it be said without doubt that the former belongs to the genus *Arius*, but that it belongs to the same group as the existing species. The cranium of the latter is described as rather broad and depressed, and coarsely granulated above; the supraoccipital process is broader than long, subtriangular, with the lateral margins undulated, and with a median longitudinal ridge; the fonticulus on the upper side of the head is very narrow, tapering behind, and extending to the base of the supraoccipital process. The largest skeleton in the British Museum measures fifty-two inches in length, and the fossil

1 "Hist. Nat. d Poissons," vol. XV. p. 55 (1840).

2 "Fishes of India," pp. 458-463 (1878).

indicates a slightly larger individual. The fossil cranium agrees almost exactly with that of the existing species, but the sculpture on the median line is perhaps rather coarser, and the tubercles on the lateral portion are somewhat more regularly conical.

Affinities.—In the absence of the more characteristic anterior portion of the cranium it is almost impossible to say whether the fossil is specifically distinct from the existing African species, although on distributional grounds there is a considerable probability that such is the case. Two of the Indian species – *A. thalassinus* and *A. gagoroides*—are of considerably smaller size, but both present a median supraoccipital ridge. The largest of the twelve Oriental species of this group mentioned by Dr. Day[1] is *A. sagor*, which attains a length of at least three feet, but has not the prominent median ridge on the supraoccipital. It seems therefore very probable that the fossil is specifically distinct from any existing Indian species, but all that can be safely said of it at present is that it indicates the existence of a siluroid in the Siwaliks fully equal in size to the largest individuals of the African *Arius latiscutatus*, and doubtless closely allied to that species and the two smaller Indian species mentioned above.

II. Teeth on the palate in two generally widely separate patches; when vomerine teeth are present they are widely separated into two small groups, which may be continuous with the palatine teeth.

A. Teeth on the palate granular, or obtusely conical.[2]

ARIUS (?), sp. *b*.

(*From the Siwaliks*).

History.—The first specimen noticed below has been described by Dr. Günther,[3] who considered that it might possibly belong to *Arius*.

Palatine.—The specimen represented in plate XXXVII. fig. 7 was obtained from the Siwaliks of the Punjab by Mr. Theobald, and is described as follows by Dr. Günther. "One side (the inner) is more straight than the other (outer), which especially towards the front is curvilinear. One surface is entirely covered with small granular (molar) teeth, somewhat irregular in size and shape, the largest being about the size of a pin's head. This dental surface is strongly convex in its transverse as well as longitudinal axis, and, especially the part in which the fossil is widest, forms a conspicuous process. There is scarcely any doubt that this bone is the right palatine of a large siluroid."

An almost precisely similar, although less perfect, palatine of the same side is represented in fig. 8 of the same plate, which was collected by Mr. F. Fedden from the lower Siwaliks of the Laki Hills, Sind. There is every probability that this specimen is specifically identical with the preceding.

1 "Fishes of India," pp. 458-463 (1878).

2 There are two species belonging to section I (p. 252) in which the teeth are granular, but as they are both American it is improbable that the fossil can be related to them.

3 'Rec. Geol. Surv. Ind." vol. XIV. p. 240 (1881).

Affinities.—If, as seems very probably the case, the foregoing specimens belong to the present genus, they apparently indicate a large species belonging to the same group as the existing *A. gagora*[1] of the Ganges, but they are insufficient for indicating specific affinities.

Group. C. BAGARIINA.

Characters.—Anterior and posterior nostrils approximated.

Genus. BAGARIUS, Bleeker.[2]

Characters.—Upper jaw longer that the lower; teeth in the jaws cardiform, unequal in size; palate edentulous. Head naked above; median bones of the middle part of the cranium covered with a coarse rugose sculpture.

Distribution.—At the present day the genus is represented only by *B. yarrelli*, of India and Java; but a second species has been described by Dr. Günther[3] from the tertiaries of Padang, in Sumatra, under the name of *B. gigas*, on the evidence of part of the humeral arch and the nearly perfect pectoral fin: the points in which it differs from *B. yarrelli* are not very clearly indicated.

Species. Bagarius yarrelli (Sykes[4]).

Syn. *Pimelodus bagarius*, Buch. Hamilton.[5]
Bagrus yarrelli, Sykes.[6]
Bagarius bagarius, Günther.[7]

(*From the Siwaliks.*)

Characters.—Head depressed, with the snout produced, and the upper jaw projecting; eyes small. The band of teeth in the upper jaw narrowest in the middle.

Skull.—The specimen represented of one-half the natural size in plate XXXVI. fig. 1 was obtained by the late Col. Colvin from the Siwaliks of Nâhan, and was first described by Cantor[8] as the skull of a gigantic batrachian, but its real nature was subsequently determined by M'Clelland,[9] who showed that it belonged to a siluroid fish, and probably to *Pimelodus* (in the sense in which that generic term was then employed). It was referred at a later date to *Bagarius yarrelli* by the present writer.[10]

The specimen comprises the anterior portion of the skull as far back as the orbit, (the left orbit being restored in outline from a recent skull), and shows the ethmoid (*eth.*), the greater portion of the frontals (*fr.*) with the intervening vacuity (*b*), the turbinals (*tu.*), the anterior and posterior nares (*na*, *nâ*), and the articular surface for the barbel (*e*). The premaxilla, with its band of pointed teeth, as

1 *Vide* Günther "Catalogue of Fishes," vol. V. p. 168 (1864).
2 'Verh. Batav. Genoot.' vol. XXXV. (Beng. and Hind.) p. 121 (1853).
3 'Geol. Mag.' dec. 2. vol. III. p. 436 (1876).
4 'Trans. Zool. Soc.' vol. II. p. 370 (1841)—*Bagrus*.
5 'Fishes of the Ganges," p. 186 (1822).
6 *Op. cit.*
7 "Study of Fishes," p. 571 (1880).
8 'Journ. As. Soc. Beng.' vol. VI. p. 538. pl. XXXI (1837).
9 'Calcutta Journ. Nat. Hist.' vol. IV p. 83. pl. IX. (1844).
10 'Rec. Geol. Surv. Ind.' vol. XV. p. 105 (1882).

well as the extremity of the mandible are well exhibited on the oral surface.[1] Compared with the skull of a very fine adult specimen of the existing form caught in the Hughli at Calcutta in the winter of 1882 and preserved in the Indian Museum, the fossil agrees in every respect, and indicates an individual of only slightly inferior size. The extreme length of the recent skull is 21·4 inches, while the total length of the whole fish was but very slightly less than seven feet.

Young skulls.—The anterior portion of a skull from the Siwalik Hills preserved in the British Museum (No. 16402,e. *Cautley collection*) agrees precisely in form with the preceding specimen, and indicates a half-grown individual. A second specimen in the same collection (No. 16403,a) comprises the entire skull of a very young individual. The total length of this specimen (which is in too damaged a condition to afford a satisfactory figure) is only 3·1 inches.

Distribution.—The existing *Bagarius yarrelli* has a very wide distribution, being found in the larger rivers of both India and Java, and descending to their estuaries.[2] The occurrence of the species in the pliocene of India may perhaps help to account for this distribution, as it has been considered probable that Java and the adjacent islands have been at one time connected with the Asiatic continent.[3]

Generically Undetermined Specimens.

Fin-spine.—The fragment of a spine probably belonging to the dorsal fin of a medium-sized siluroid represented in plate XXXVII. figs. 10, 10a, was collected by Mr. Theobald in the Siwaliks of the Punjab; and may belong to one of the species described above.

Humeral arch.—A reconsideration of the specimen described and figured on page 206 of the present volume as part of the first costal scute of a species of *Trionyx* has led the writer to believe that it is probably part of the humeral arch of a large siluroid allied to the existing African genus *Auchenoglanis*; the element which the writer considered as the vertebral articulation being really part of the socket for the spine of the pectoral fin. The specimen noticed on the same page as part of a nuchal scute may perhaps also belong to a siluroid.

Family II. *CYPRINODONTIDÆ.*

Characters.—Head and body covered with scales; barbels absent; teeth in both jaws.

Distribution.—The family is represented at the present day by twenty genera, which are found in the freshwaters of south Europe, Africa, Asia, and America. The majority of the species are of very small size, but one species of the American genus *Anableps* attains a length of twelve inches. Fossil species apparently belonging to *Cyprinodon* have been described from the upper tertiaries of Europe.[4]

1 These parts are shown in M'Clelland's figure.

2 Day "Fishes of India," p. 495 (1878).

3 Wallace "Island Life," p. 359 (1880).

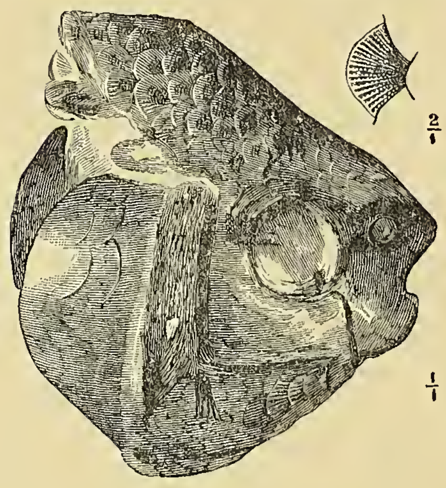
4 *Vide* Agassiz "Poissons Fossiles," vol. V. pt. 2. pp. 48-56.—*Lebias.*

Genus. *Non. det.*

(*From the Siwaliks*).

History.—The single specimen forming the subject of the present notice is preserved in the Museum of Science and Art, Dublin; and was collected in the Siwaliks by Generals Sir W. E. Baker and Sir H. M. Durand.[1]

Skull.—The above-mentioned specimen, which is figured of the natural size in the accompanying woodcut, comprises the nearly entire skull. Both nostrils and the greater part of the right orbit are clearly shown; while the opercular bones of the same side are but little injured. Teeth (though not visible in the figure) are present in both jaws, and appear to be arranged in a single series: they are all more or less broken, but those of the lower jaw appear to have been incisor-like. The nostrils are subterminal, the cleft of the mouth is small, the mandible short, the snout short and vaulted, and the scales rather large. It cannot be determined whether the mandibular rami were anchylosed. The scales show a radiate sculpture; and the specimen indicates a fish of from eight to ten inches in length.



Cyprinodont, gen. *non det.* Skull; from the Siwalik Hills. Dublin Museum (No. C. 92). The smaller figure shows one of the scales enlarged.

Affinities.—The size and form of the operculars seem to indicate that the specimen belongs to a fish allied to the carps; and the presence of scales on the head differentiates it from the *Cyprinidæ*, *Characiniidæ, and Heteropygiidæ*. In this respect, as well as in the presence of teeth in the jaws, it agrees with the *Cypriondontidæ*, to which it may be provisionally referred. The very small size of all the existing species of *Cyprinodon* renders it improbable that the fossil belongs to that genus; and the vaulting of the snout distinguishes it from the living Indian genus *Haploehilus*. Beyond this its imperfect nature renders it inexpedient to go, but the specimen is interesting as indicating a Siwalik fish apparently different from any existing Indian species.

Order III. PLECTOGNATHI.

Family. *DIODONTIDÆ*.[2]

Characters.—Bones of the upper and lower jaws confluent, forming a trenchant edentulous beak, with or without median suture.

Genus. DIODON, Linn.[3]

Characters.—Jaws without median suture; a compound palatal dental plate.

Distribution.—The genus is represented at the present day by a large number of

1 *Vide* 'Trans. R. Dublin Soc.' ser. 2. vol. III. p. 70 (1884).

2 The name *Gymnodontes* or *Gymnodontidæ* is usually applied to this family, but as it is not taken from a generic name it is inapplicable.

3 "Syst. Nat." ed. 12. vol. I. p. 412 (1766).

species, which inhabit the warmer seas. Numerous fossil species have been indicated from the lower and middle tertiaries, of which the following are the most important. *D. tenuispinus*, Ag,[1] from the eocene of Monte Bolca, is of comparatively small dimensions; *D. erinaceus*, Ag,[2] is founded on specimens now in the British Museum, and is of exceedingly small size; *D. scillæ*, Ag,[3] from the tertiaries of South Italy and Malta is of considerably larger size, and has the edges of the dental lamellæ crenulated[4]; some of the type teeth of this species are in the British Museum, and the specimens from the miocene of Malta noticed by Leith-Adams[5] are also in the same collection, and appear specifically identical. Another species has been recorded by Prof. Leidy from the tertiary of N. America as *D. vetus*,[6] but is insufficiently described.

Species. DIODON FOLEYI, *nobis*.[7]

(From the eocene of Rámri Island.)

History.—The type specimen has been already described by the present writer in the passage cited.

Dental plate.—The worn dental plate on which this species is founded is represented in plate XXXV. figs. 10, 10a; it was obtained many years ago by Captain Foley from beds which are probably of eocene age in Rámri Island, off the Arakan coast. The structure of the specimen indicates without doubt its generic position; it is of large size, and characterized by the crenulation of the external borders of the component lamellæ, and the concavity of the worn surface.

Affinities.—Compared with the dental plate in a skeleton of *D. hystrix* in the British Museum measuring about twenty inches in length, the fossil indicates a considerably larger individual, and is distinguished by the concavity of its wear. The geological age of the specimen leaves little doubt as to its distinctness from all living species. *D. erinaceus* and *D. tenuispinus* are far inferior in size to the present form, and the writer cannot identify the latter with *D. scillæ*: it cannot be compared with *D. vetus*, owing to the absence of a figure.

Although it cannot be certainly affirmed that the present specimen is specifically distinct from all other forms (if indeed the dental plate alone affords sufficient grounds for specific distinctions), yet such is probably the case, and the provisional name of *D. foleyi* may accordingly be retained.

1 "Poissons Fossiles," vol. II. p. 275. 2 *Loc. cit.* 3 *Loc. cit.*

4 *Vide* Pictet "Traité de Paléontologie," 2nd ed. vol. II. p. 123 (1854).

5 *Vide* Leith-Adams 'Quart. Journ. Geol. Soc.' vol. XXXV. p. 529 (1879).

6 'Proc. Ac. Nat Sci. Philad.' vol. VII. p. 397 (1855—vol. dated 1856).

7 'Rec. Geol. Surv. Ind.' vol. XIII. p. 60 (1880).

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——— "Notices of New and other Vertebrata from the Tertiaries and Secondaries of India," '*Rec. Geol. Surv. Ind.*' vol. X. pp. 30-43 (1877).—*Myliobatis.*

——— "Teeth of fossil Fishes from Rámri Island and the Punjab," '*Rec. Geol. Surv. Ind.*' vol. XIII. pp. 59-61 (1880).—*Diodon, Capitodus.*

M'CLELLAND, J. "Notice of a Fossil Fish, etc.," '*Calcutta Journ. Nat. Hist.*' vol. IV. pp. 83-87. pl. IX. (1844).—*Pimelodus* (= *Bagarius*).

ALPHABETICAL INDEX

OF

GENERA AND SPECIES, INCLUDING SYNONYMS.

END OF VOL. III

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PLATE I.

PERISSODACTYLA — *Rhinocerotidæ.*

Fig. 1. ACERATHERIUM BLANFORDI, var. MAJUS, Lyd. Part of left maxilla, containing the three true molars, in a well-worn condition; from the lower Siwaliks of Dera Búgti: Indian Museum (No. C. 268).

,, 2. ACERATHERIUM BLANFORDI, var. MAJUS, Lyd. Second left upper true molar, somewhat less worn than the corresponding tooth of the last specimen; from the lower Siwaliks of Gandoi, Búgti Hills: Indian Museum (No. C. 259).

,, 3. RHINOCEROS SIVALENSIS, Falc. and Caut., var. INTERMEDIUS, Lyd. Right upper true molar, slightly worn; from the lower Siwaliks of Sind: Indian Museum (No. C. 34). (*Vol.* II., *pl.* V., *fig.* 2.)

,, 4. RHINOCEROS SIVALENSIS, Falc. and Caut., var. GAJENSIS, Lyd. First or second right upper true molar, partly broken; from the Gáj group of Sind: Indian Museum (No. C. 36). (*Vol.* II., *pl.* V., *fig.* 7.)

,, 5. ACERATHERIUM PERIMENSE, Falc. and Caut. Second left upper true molar, well worn; from the Siwaliks of Burma: Indian Museum (No. C. 74). (*Vol.* I., *pl.* V., *fig.* 1. *R. iravadicus.*)

,, 6. ACERATHERIUM BLANFORDI, Lyd. First and second right upper milk-molars, from the lower Siwaliks of Gandoi: Indian Museum (No. C. 260).

,, 7. RHINOCEROS SIVALENSIS, Falc. and Caut. (type form). Second left upper true molar, from the Siwaliks of the Punjab: Indian Museum (No. C. 23). (*Vol.* I., *pl.* V., *fig.* 5.)

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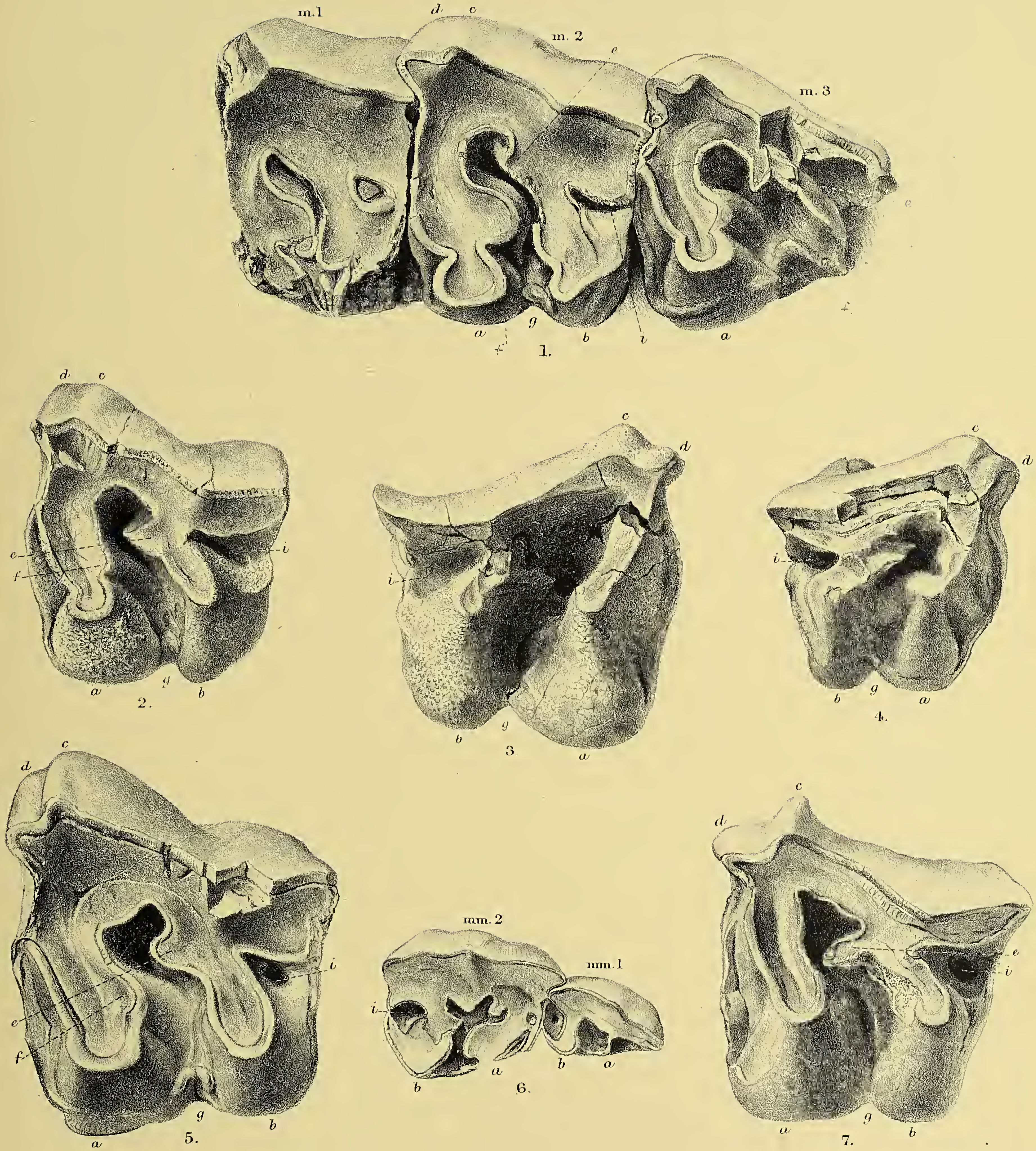
* All the figures natural size. *a*, anterior collis: *b*, posterior collis: *c*, second costa: *d*, first costa: *e*, crochet: *f*, ante-crochet: *g*, entrance of median valley: *i*, posterior valley.



J. Smit del. et lith.
Mintern Bros. imp.

PLATE II.

Perissodactyla — *Rhinocerotidæ.*

Fig. 1. ? Aceratherium blanfordi, Lyd. Last right upper milk-molar (?) in germ ; Indian Museum (No. C. 258).

" 2. Aceratherium blanfordi, Lyd. Third right upper true molar, very much worn : Indian Museum (No. C. 262).

" 3. Aceratherium blanfordi, Lyd. Part of right ramus of mandible of a calf, containing one milk-molar : Indian Museum (No. C. 267).

" 4. Aceratherium blanfordi, var. minus, Lyd. Left maxilla, with the teeth in a medium condition of wear : Indian Museum (No. C. 269).

" 5. Aceratherium blanfordi, var. minus, Lyd. Part of left ramus of mandible, belonging to the same individual as the last : Indian Museum (No. C. 270).

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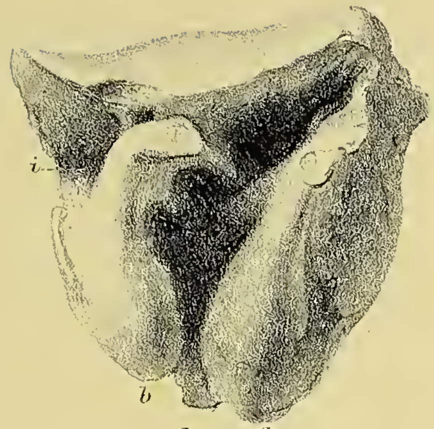
* All the specimens were obtained from the lower Siwaliks of Gandoi, Búgti Hills; and are figured of the natural size. Lettering of upper teeth the same as in plate I. In fig. 3, *a*, anterior extremity of first crescent : *b*, posterior extremity of same : *c*, posterior extremity of second crescent.



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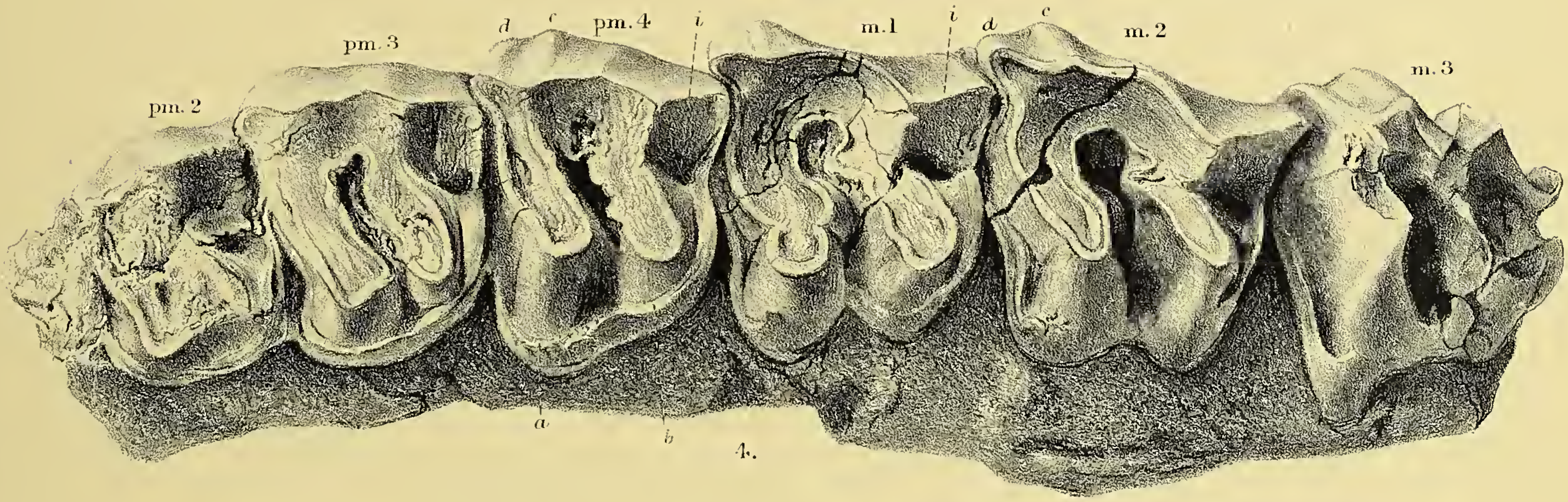

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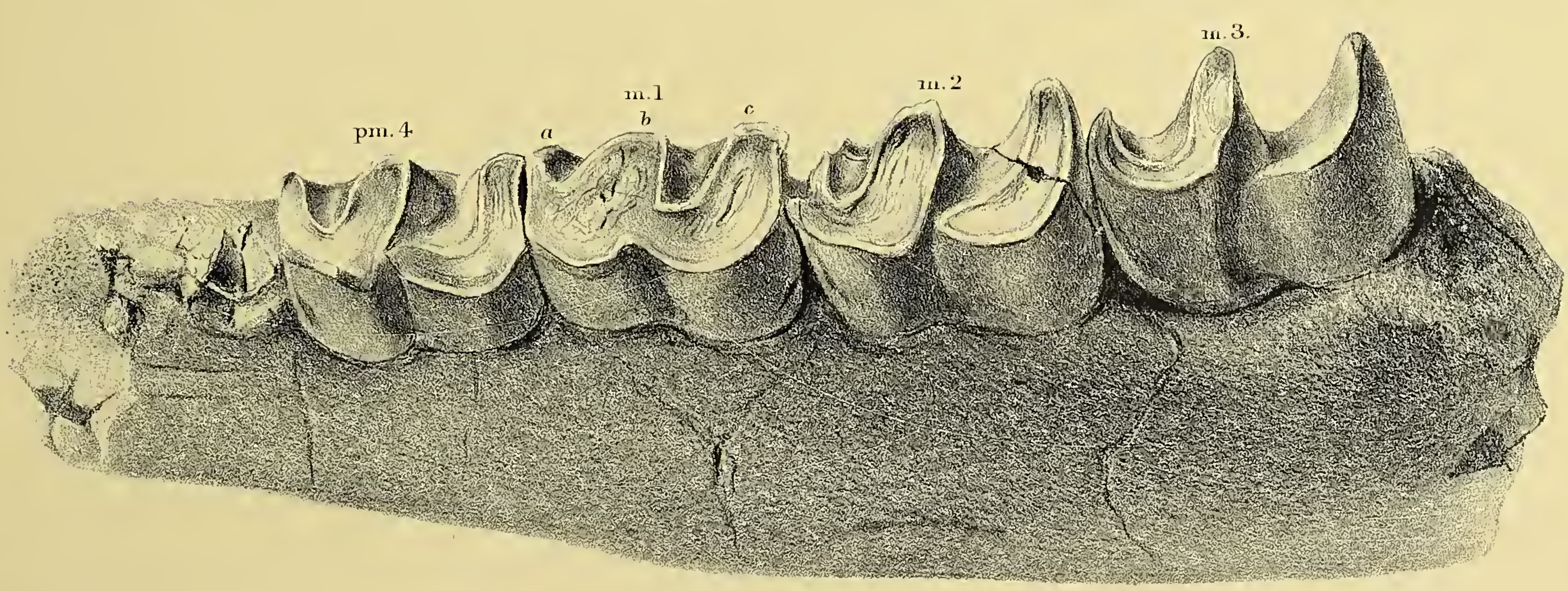

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PLATE III.

PERISSODACTYLA — *Equidæ.*

HIPPOTHERIUM ANTILOPINUM, Falc. and Caut.

Figs. 1, 2. Cranium, from Perim Island, Gulf of Cambay; in the possession of Mr. Theodore Cooke, of Poona. 1 from the left lateral, 2 from the palatal aspect.

,, 3. The cheek-teeth of the left side of the same specimen.

,, 4. Polished section of a tooth of the cheek-series of the right side; from the Punjab.

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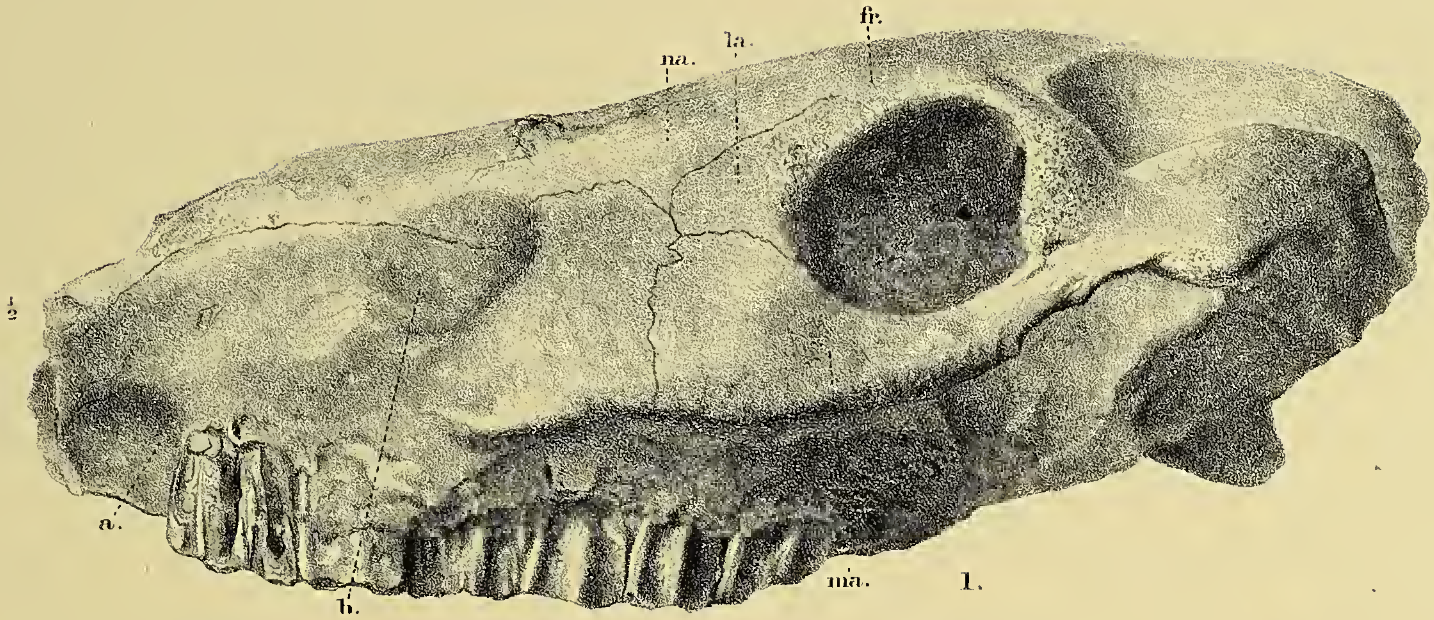
* Figs. 1, 2, one-half natural size: the others natural size: the specific determination of fig. 4 is provisional. In fig. 1, *a*, anterior maxillary cavity: *b*, posterior ditto: *na*, nasal: *la*, lachrymal: *fr*. frontal: *ma*, malar. In figs. 3, 4, *e*, anterior pillar: *f*, posterior ditto: *g*, lamina connecting first crescents: *h*, lamina connecting second ditto: *i*, *j*, cement islets.



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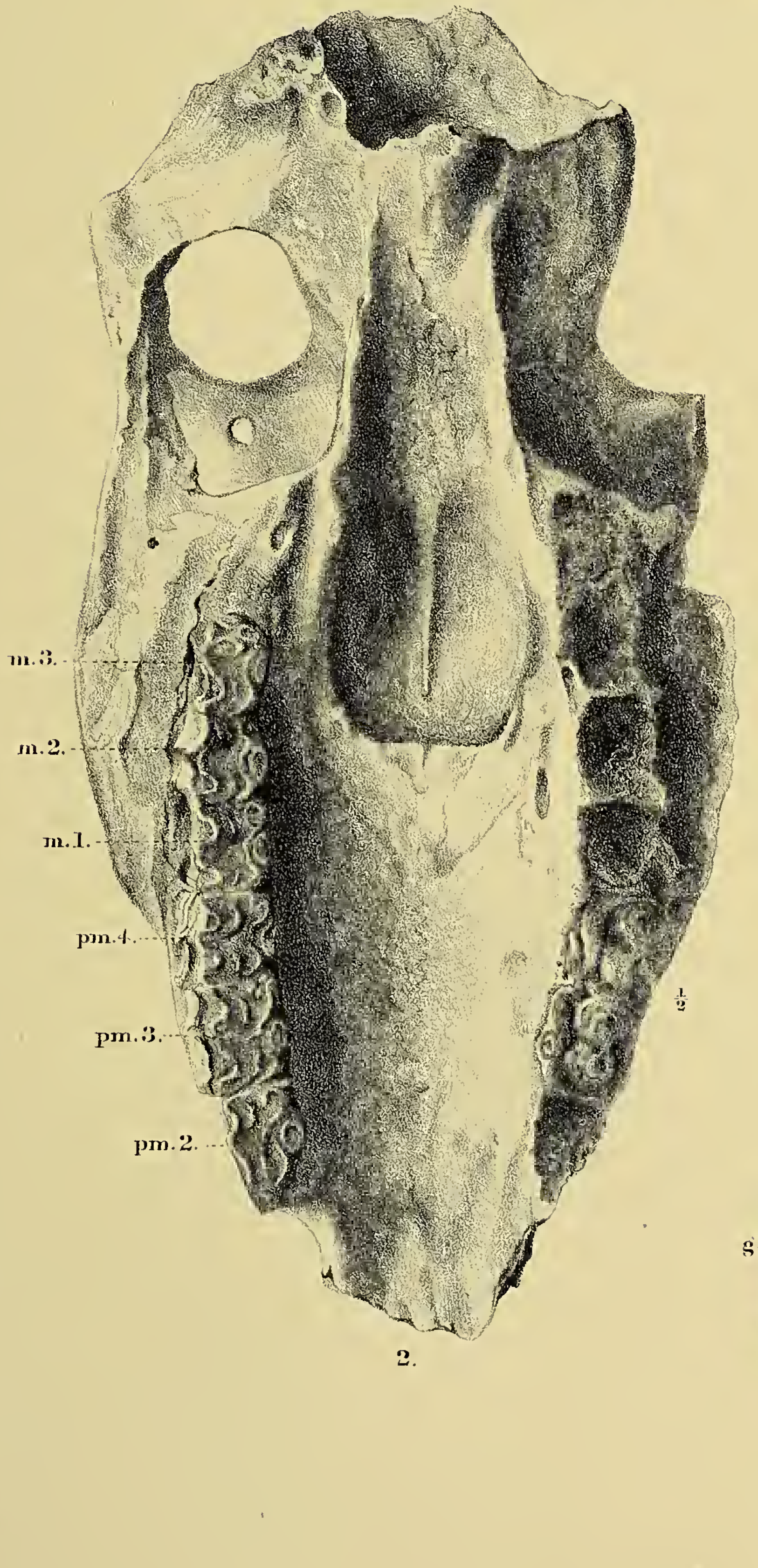

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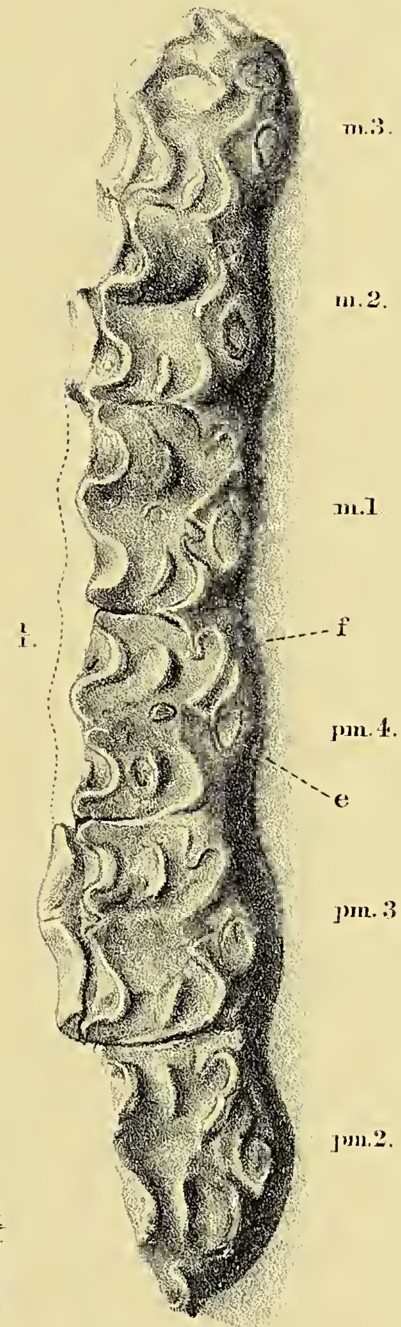

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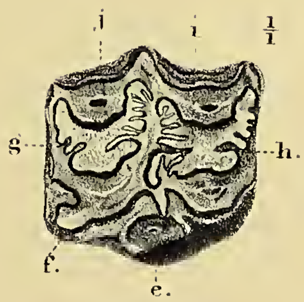

4.

J. Smit del. et lith.

Mintern Bro's. imp.

PLATE IV.

PROBOSCIDIA — *Elephantidæ*.

MASTODON ANGUSTIDENS, Cuv., var. PALÆINDICUS, Lyd.

Fig. 1. Second left upper true molar, in a much worn condition : Indian Museum (No. A. 427).

,, 2. Second left upper true molar, in a less worn condition than the last specimen: Indian Museum (No. A. 425).

,, 3. Third right lower true molar, associated with the last specimen, in a medium stage of wear: Indian Museum (No. A. 426).

,, 4. (?) Fourth left lower premolar, scarcely worn : Indian Museum (No. A. 431).

,, 5. Fourth left lower milk-molar, in a medium stage of wear : Indian Museum (No. A. 422).

,, 6. (?) Fourth left lower premolar, in a medium stage of wear : Indian Museum (No. A. 430).

,, 7. Second left lower true molar, in a very early stage of wear; Indian Mnseum (No. A. 423.)

,, 8. First left lower lower true molar, in a medium stage of wear: Indian Museum (No. A. 421).

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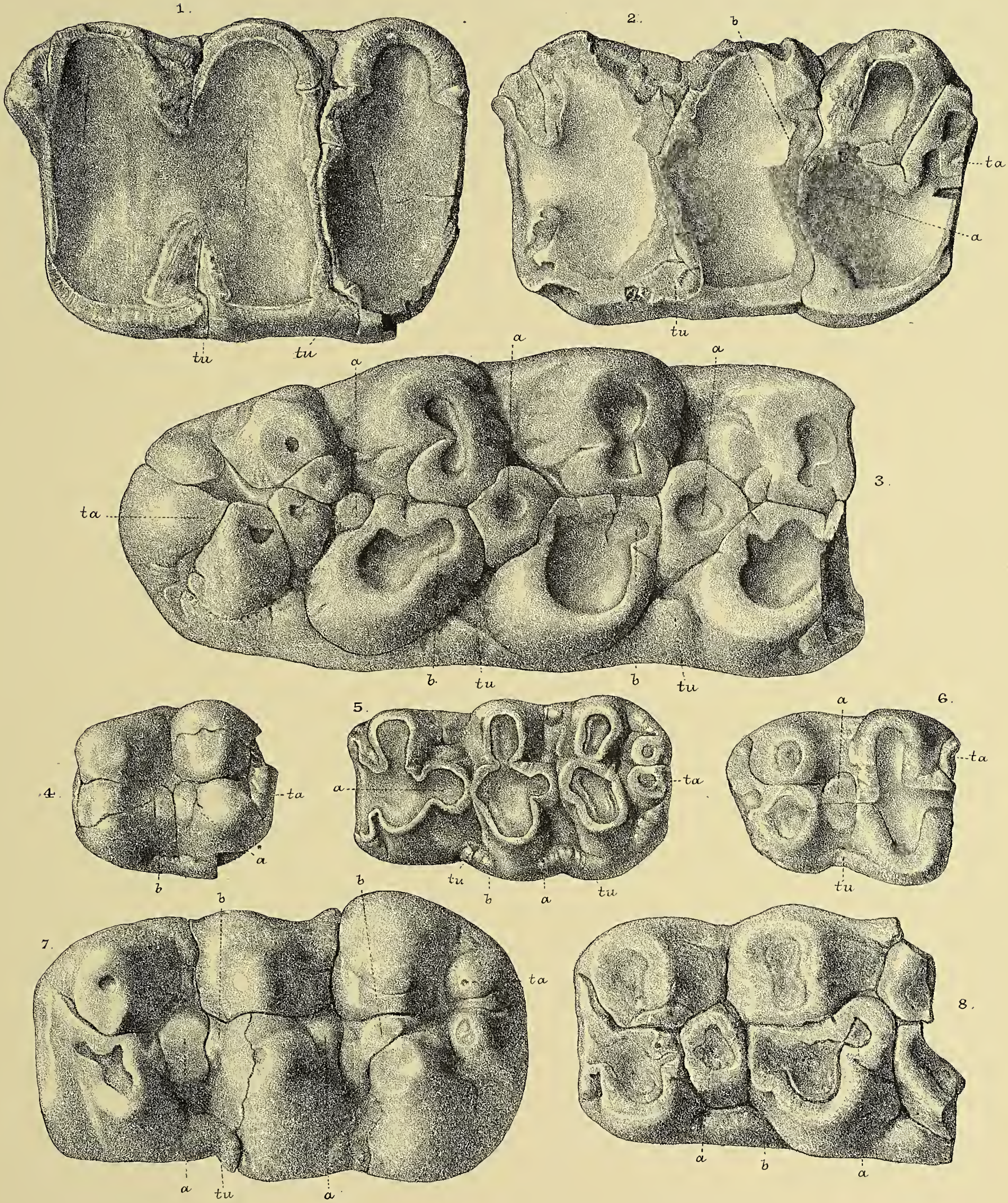
* The specific reference of figs. 4 and 6 is open to a considerable amount of doubt—Fig. 7 was obtained from the lower Siwaliks of Gandoi, Búgti Hills; all the others came from the same deposits of Dera Búgti. All the figures are of the natural size; the upper teeth being viewed from the inner, and the lower from the outer side of the grinding surface; *a*, larger accessory column (posterior in lower, and anterior in upper teeth); *b*, smaller do. (anterior in lower, and posterior in upper teeth); *ta*, hind talon; *tu*, tubercle at extremities of transverse valleys (outer in lower, and inner in upper teeth).



G. M. Woodward del. et lith.

West, Newman & C? imp.

PLATE V.

PROBOSCIDIA — *Elephantidæ.*

Figs. 1, 1a. MASTODON PANDIONIS, Falc. First left lower true molar, in an unworn condition: Indian Museum (No. A. 424); 1 from the grinding surface, 1a from the outer side.

„ 2, 2a. (?) MASTODON ANGUSTIDENS, Cuv., var. PALÆINDICUS, Lyd. Germ of fourth right upper premolar: Indian Museum (No. A. 429): 2 from the grinding surface, 2a from the outer side.

„ 3. MASTODON ANGUSTIDENS, Cuv., var. PALÆINDICUS, Lyd. Outer aspect of specimen represented in plate IV., fig, 7.

„ 4, 4a. (?) MASTODON ANGUSTIDENS, Cuv., var. PALÆINDICUS, Lyd. Third right upper premolar, in germ: Indian Museum (No. A. 428): 4 from the grinding surface, 4a from the outer side.

„ 5. MASTODON PANDIONIS, Falc. First left upper true molar, in a very early stage of wear: British Museum (No. 40,818).

„ 6, 6a. (?) MASTODON PANDIONIS, Falc. Fourth right upper premolar, in an early stage of wear: Indian Museum (No. A. 433): 6 from the grinding surface, 6a from the outer side.

„ 7. MASTODON ANGUSTIDENS, Cuv., var. PALÆINDICUS, Lyd. Part of first right lower true molar, in a well-worn condition: Indian Museum (No. A. 417).

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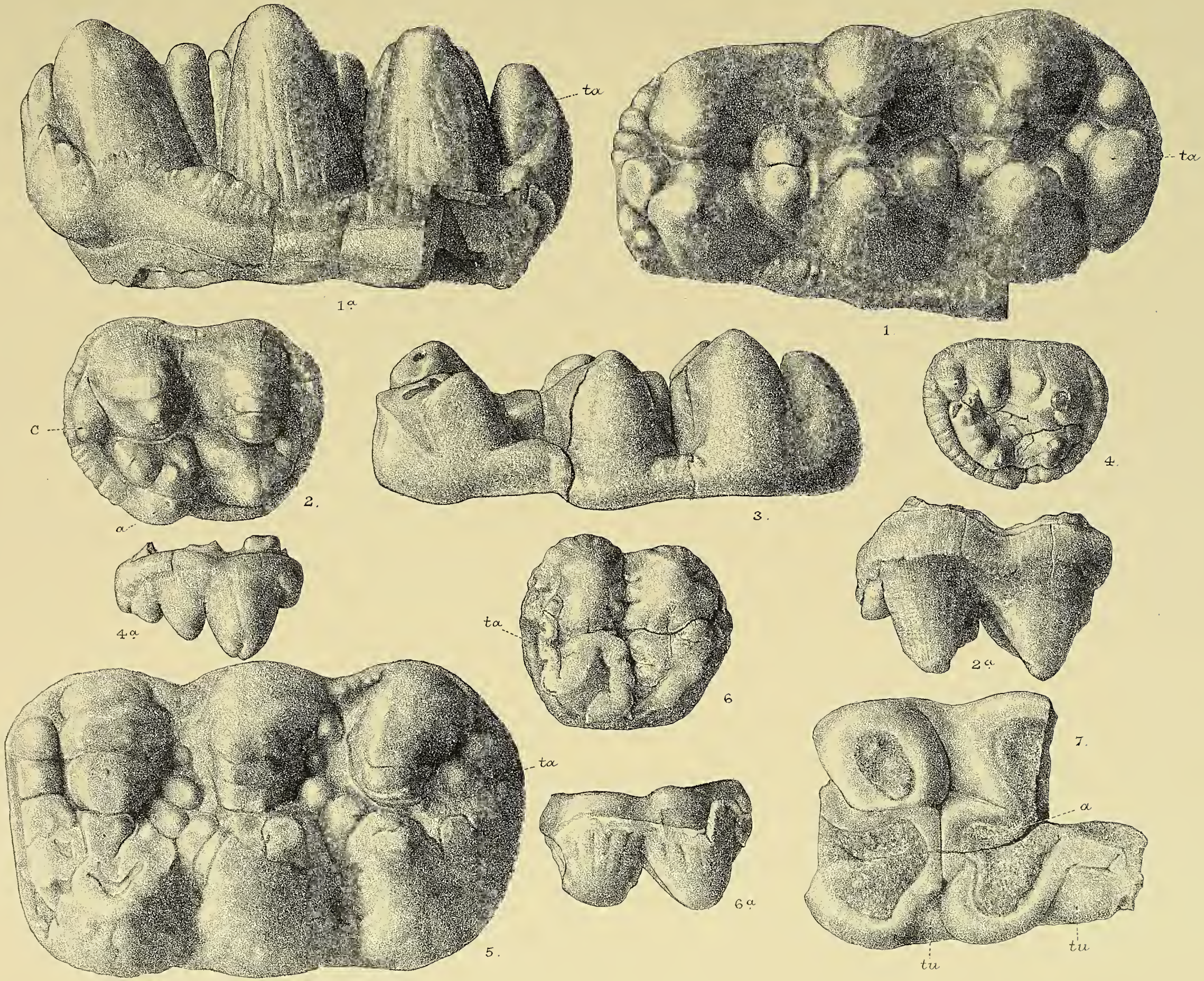
* Fig. 3 is from Gandoi, Búgti Hills: fig. 5 is stated to be from the Deccan, but is more probably from Sind: all the others are from Dera Búgti. All the figures are of the natural size: and the teeth, which are viewed from the grinding surface, are placed in the same position as in the preceding plate. The lettering of all the figures, except fig. 2, is the same as in the latter: the lettering of fig. 2 is explained in the text.



G.M. Woodward del. et lith.

West Newman & Co. imp.

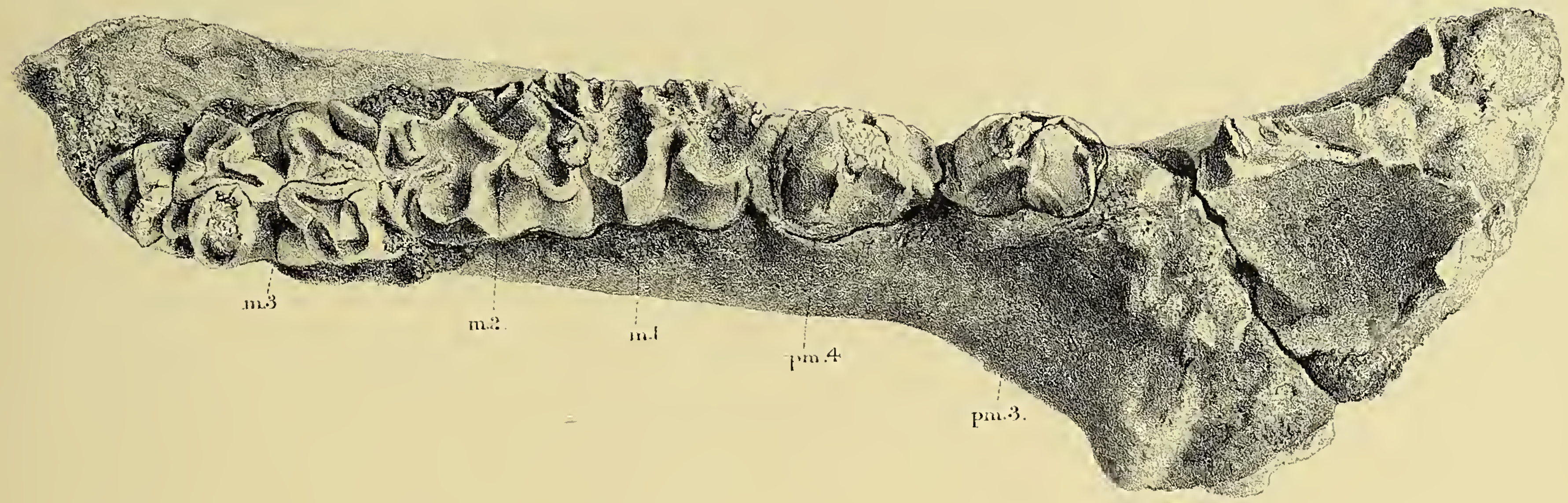
PLATE VI.

ARTIODACTYLA — *Hippopotamidæ.*

Fig. 1. HIPPOPOTAMUS SIVALENSIS, Falc. and Caut. Greater part of the left ramus of the mandible of a small variety, with the teeth in a middle condition of wear; from the Siwaliks of the Punjab: Indian Museum (No. B. 395).

,, 2. HIPPOPOTAMUS PALÆINDICUS, Falc. and Caut. Symphysial extremity of the mandible, with the crowns of the teeth broken off; from the Narbadas: Indian Museum (No. F. 149).

Both figures ⅔ nat. size.



1.

2.

J. Smit del et lith.

Mintern Bros. imp.

PLATE VIII.

Artiodactyla — *Suidæ.*

Fig. 1. Sus falconeri, Lyd. Dentition of the right ramus of the mandible of a female, from the Siwalik Hills; Dublin Museum of Science and Art (No. C. 27): the cheek-teeth are well worn.

,, 2. Sus falconeri, Lyd. Fragment of the right ramus of a mandible from the Siwaliks of Náhan, containing the two last molars: $\overline{\text{m. 2}}$ is well worn, but $\overline{\text{m. 3}}$ is almost untouched: Indian Museum (No. B. 16).

,, 3. Sus titan, Lyd. Last right lower true molar, in an early condition of wear, with the anterior columns split; from the Siwaliks of the Potwár district of the Punjab: Indian Museum (No. B. 15).

,, 4. Sus titan, Lyd. Dentition of the greater portion of the right ramus of the mandible, from the Siwaliks of the Potwár district, containing the four last cheek-teeth, the last untouched by wear: Indian Museum (No. B. 4).

,, 5. Sus falconeri, Lyd. The upper true molars of the right side (reversed from those of the left), from a palate specimen from the Siwalik Hills: the last tooth untouched by wear: British Museum.

,, 6. Sus titan, Lyd. Last right upper true molar, in an almost unworn condition, from the Siwaliks of Asnot, Punjab: Indian Museum (No. B. 19).

,, 7. Sus falconeri, Lyd. The right upper cheek-dentition of the cranium of a female represented in plate X.: all the teeth in a well-worn condition.

,, 8. Sus falconeri, Lyd. Second and third right upper true molars, the last in an early stage of wear, from the Siwalik Hills: Indian Museum (No. B. 18).

,, 9. Sus falconeri, Lyd. Inner lateral aspect of the last molar of the specimen represented in fig. 2.

,, 10. Sus titan, Lyd. Inner lateral aspect of the last molar of the specimen represented in fig. 4.

All the figures natural size. Owing to an inadvertence the letters *g. h* in figure 6 correspond to *f, g* in figs. 5, 8.

G.M. Woodward del. et lith.

West, Newman & Co. imp.

PLATE VIII.

ARTIODACTYLA — *Suidæ* and *Listriodontidæ*.

Fig. 1. SUS TITAN, Lyd. Fragment of the right ramus of the mandible of a male, with the teeth in a middle stage of wear; from the Siwaliks of Asnot, Punjab: Indian Museum (No. B. 435).

,, 2. SUS HYSUDRICUS, Falc. and Caut. Hinder portion of the right ramus of the mandible, with the teeth in a well-worn condition; from the Siwaliks of Lehri, Punjab: Indian Museum (No. B. 34).

,, 3. SUS HYSUDRICUS, Falc. and Caut. The greater part of the right ramus of the mandible, with the teeth in a well-worn condition; from the Siwaliks of the Potwár district, Punjab: Indian Museum (No. B. 30). 3a, inner view of $\overline{\mathrm{m.}\,3}$ of same.

,, 4. SUS, sp. Symphysial extremity of the left ramus of the mandible, with the teeth very slightly worn; from the Siwaliks of Asnot, Punjab: Indian Museum (No. B. 10). 4a from the outer aspect.

,, 5. SUS HYSUDRICUS, Falc. and Caut. Fragment of the right ramus of the mandible of a young individual, with the teeth in a middle stage of wear; from the Siwaliks of Asnot, Punjab: Indian Museum (No. B. 50).

,, 6. SUS HYSUDRICUS, Falc. and Caut. Fragment of the left ramus of the mandible of a young individual, with the teeth more worn than in the last specimen; from the Siwaliks of Kúshalghar, Punjab: Indian Museum (No. B. 436).

,, 7. SANITHERIUM SCHLAGINTWEITI, Meyer. Fragment of the right ramus of the mandible, containing a part of $\overline{\mathrm{m.}\,3}$ in an early stage of wear; from the Siwaliks of Kúshalghar: Indian Museum (No. B. 87).

,, 8. SUS HYSUDRICUS, Falc. and Caut. Fragment of the right ramus of the mandible of a very young individual, with the teeth in an unworn condition; from the Siwaliks of Jabi, Punjab: Indian Museum (No. B. 53).

,, 9. SUS PUNJABIENSIS, Lyd. Hinder portion of the left ramus of the mandible, with the teeth in a middle condition of wear; from the Siwaliks of Asnot: Indian Museum (No. B. 61). 9a, inner view of $\overline{\mathrm{m.}\,3}$ of same.

,, 10. SUS HYSUDRICUS, Falc. and Caut. Fragment of the right maxilla, containing the true molars in an early stage of wear; from the Siwaliks of Asnot: Indian Museum (No. B. 15).

,, 11. SUS HYSUDRICUS, Falc. and Caut. Part of the left maxilla, with the teeth more worn than in the last specimen; from the Siwaliks of Asnot: Indian Museum (No. B. 46).

,, 12. LISTRIODON THEOBALDI, Lyd. First or second right upper true molar (?), in an early stage of wear; from the Siwaliks of the Punjab: Indian Museum (No. B. 109).

,, 13. LISTRIODON PENTAPOTAMIÆ (Falc.). The first right upper true molar, in an unworn condition; from the Siwaliks of the Punjab: Indian Museum (No. B. 107, a).

,, 14. LISTRIODON PENTAPOTAMIÆ (Falc.). The first right upper incisor, in a well-worn condition; from the Siwaliks of Niki, Punjab: Indian Museum (No. B. 108, a).

,, 15. LISTRIODON PENTAPOTAMIÆ (Falc.) The second left upper true molar, in a well-worn condition; from the Siwaliks of Niki: Indian Museum (No. B. 108).

,, 15a. LISTRIODON PENTAPOTAMIÆ (Falc.). The hinder part of the third right upper true molar, from the Siwaliks of Kúshalghar: Indian Museum (No. B. 107).

,, 16. LISTRIODON PENTAPOTAMIÆ (Falc.). The third left upper true molar, in a well-worn condition; from the Siwaliks of Niki: Indian Museum (No. B. 108).

,, 17. LISTRIODON PENTAPOTAMIÆ (Falc.). The second right upper true molar, in a slightly worn condition; from the Siwaliks of Kúshalghar: Indian Museum (No. B. 107).

All the figures natural size: the molars of Listriodon are viewed from the inner aspect; all the others from the anterior aspect.


m 2
m 1
a
pm 4
1.
m 3
m 2
2.
b
c
a
m 3
m 2
m 1
a
pm 4
pm 3
3.
3 a
pm 4
pm 3
pm 2
pm 1
c
4.
4 a.
C
pm 1
pm 2
pm 3
pm 4
m 1
mm 4
5.
12.
13.
m 1
mm 4
6.
b
c
a
m 3
e
7.
9 a
mm 4
mm 3
8.
m 3
m 2
m 1
9.
14.
15.
15 a.
16.
17.
m 3
m 2
m 1
10.
m 2
m 1
pm 4
pm 3
11.

PLATE IX.

ARTIODACTYLA — *Suidæ*.

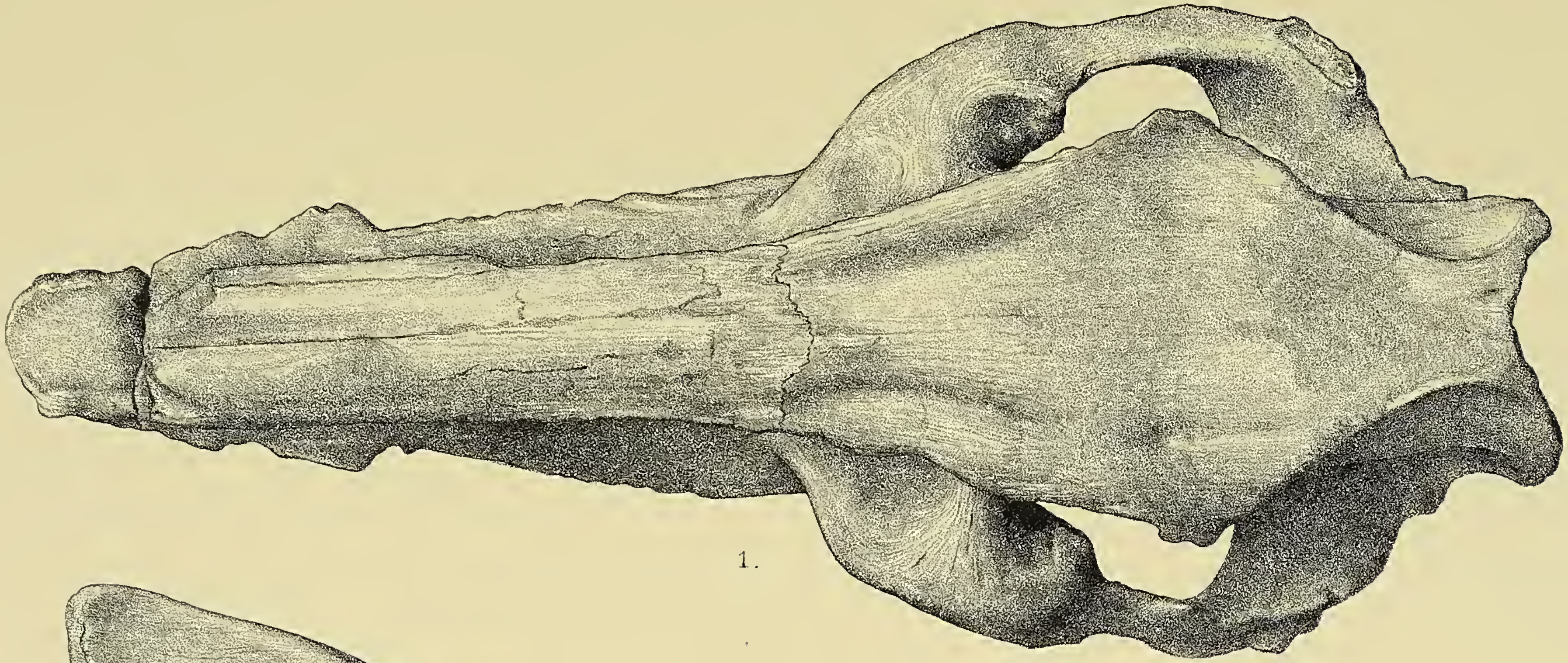
SUS TITAN, Lyd. Cranium and mandible of a male, from the Siwaliks of Niki, Punjab: Indian Museum (No. B. 26). $\frac{1}{2}$ nat. size. From the left lateral aspect.

1

PLATE X.

Artiodactyla — *Suidæ*.

Figs. 1, 2. Sus falconeri, Lyd. Cranium of a female, from the Siwalik Hills: Science and Art Museum, Dublin (No. C. 27). $\frac{1}{2}$ nat. size. Fig. 1 from the frontal; fig. 2 from the right lateral aspect.



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G. M. Woodward del et lith. West Newman & Co. imp.

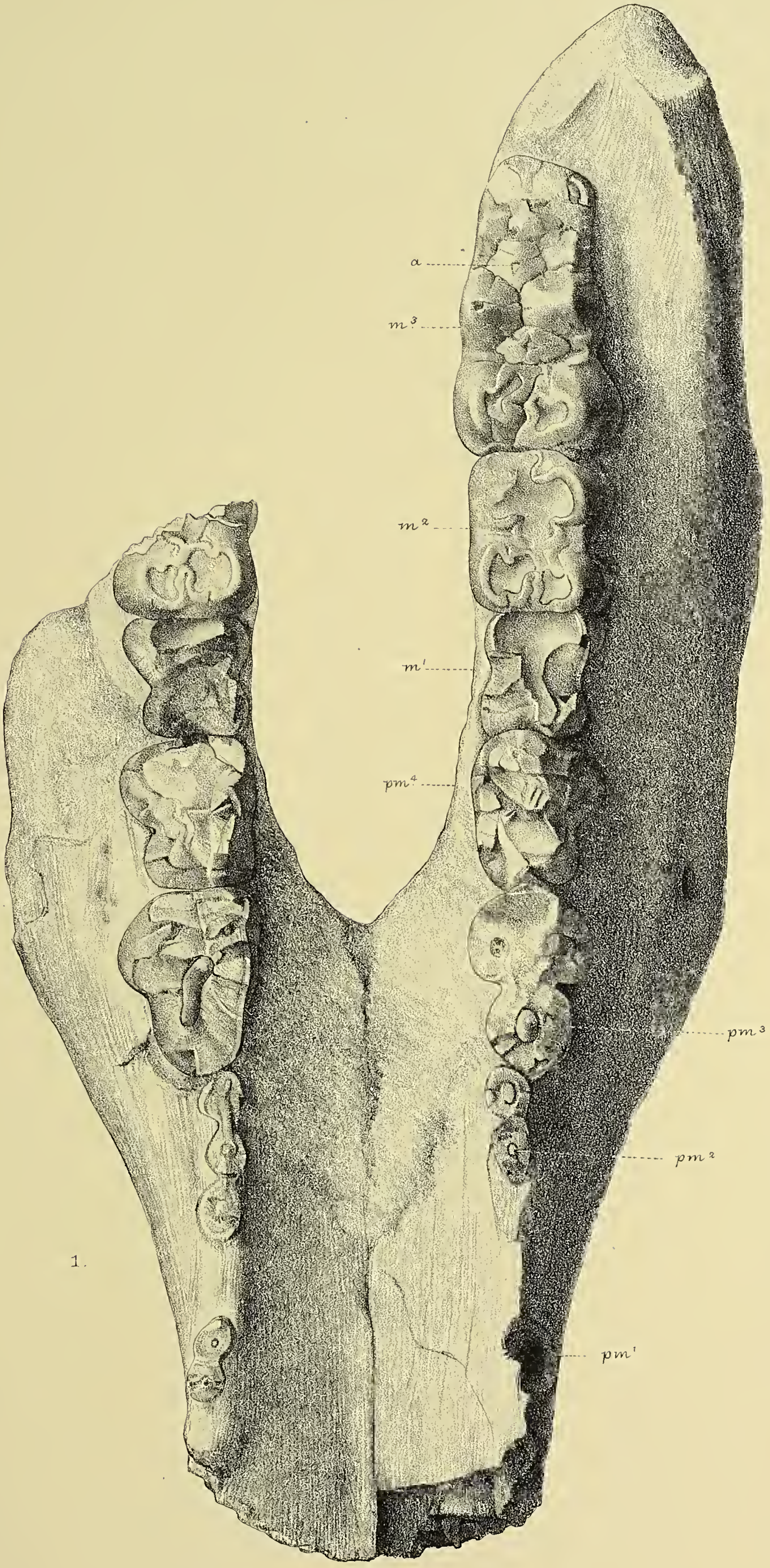
PLATE XI.

ARTIODACTYLA — *Suidæ.*

Fig. 1. (?) SUS GIGANTEUS, Falc. and Caut. Mandible, with the teeth in a well-worn condition; from the Siwaliks of Asnot, Punjab: Indian Museum (No. B. 1).

,, 2. SUS GIGANTEUS, Falc. and Caut. Right upper cheek-dentition, in a well-worn condition; from a cranium from the Siwalik Hills: British Museum (No. 16,166).

Both figures natural size.



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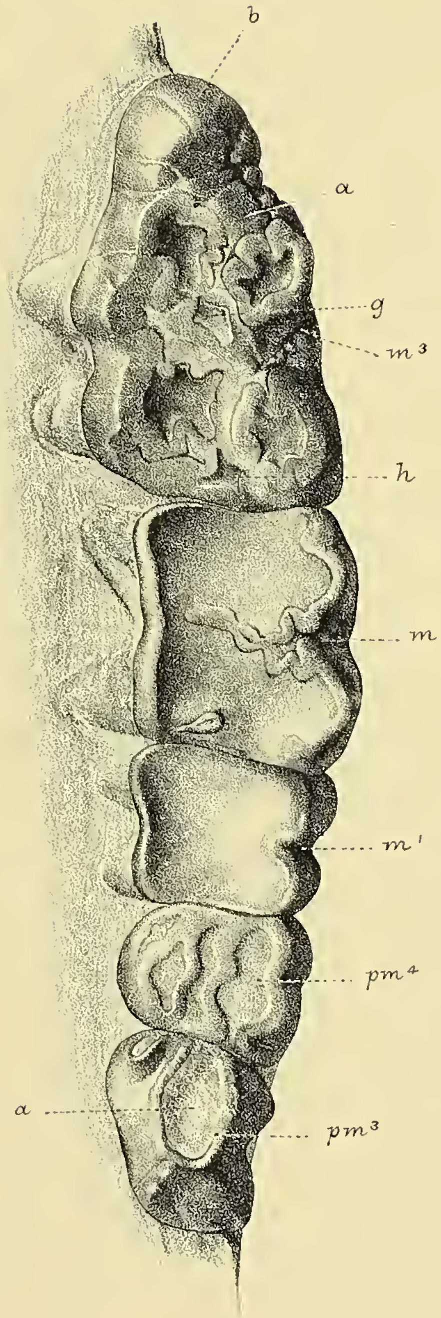


2.

G. M. Woodward del. et lith.
West Newman & Co. imp.

PLATE XII.

Artiodactyla — *Suidæ.*

Fig. 1. Sus titan, Lyd. Distal half of the left radius, associated with the cranium figured in plate IX. Indian Museum (No. B. 13): from the anterior aspect.

,, 2. Sus titan, Lyd. The third and fourth left metacarpals, associated with the last specimen: Indian Museum (No. B. 13a).

,, 3. Hippohyus sivalensis, Falc. and Caut. Part of the right ramus of the mandible, with the teeth much worn; from the Siwaliks of Kolsa, Punjab: Indian Museum (No. B. 64).

,, 4. Hippohyus, sp. Hinder part of the left ramus of the mandible, with the teeth in a medium condition of wear; from the Siwaliks of Asnot, Punjab: Indian Museum (No. B. 68).

,, 5. Hyotherium, sp. A second left lower true molar, in a slightly worn condition; said to be from the Siwaliks of Perim Island: Indian Museum (No. B. 101).

,, 6. Hyotherium sindiense, Lyd. Fragment of the left maxilla containing the second and third true molars, in a much worn and eroded condition; from the lower Siwaliks of Sind: Indian Museum (No. B. 102).

,, 7. Hyotherium, sp. The first or second right lower true molar, in a well-worn condition; from the lower Siwaliks of Sind: Indian Museum (No. B. 99).

,, 8. Hyotherium, sp. A first right lower true molar, in a well-worn condition; from the lower Siwaliks of Sind: Indian Museum (No. B. 99a).

,, 9. (?) Hyotherium, sp. A fourth left upper premolar, in an unworn condition; from the lower Siwaliks of the Laki Hills, Sind: Indian Museum (No. B. 98).

,, 10. Hyotherium, sp. A first or second upper true molar, in a very much worn condition; from the lower Siwaliks of the Laki Hills: Indian Museum (No. B. 96).

,, 11. Hyotherium, sp. A first or second right upper true molar, in a well-worn condition; from the lower Siwaliks of the Laki Hills: Indian Museum (No. B. 96a).

,, 12. Hyotherium sindiense, Lyd. A second right upper true molar, in an unworn condition; from the lower Siwaliks of the Laki Hills; Indian Museum (No. B. 96b).

,, 13. Hyotherium, sp. A first right upper true molar, in an unworn condition; from the lower Siwaliks of the Laki Hills: Indian Museum (No. B. 97a).

,, 14. Hyotherium, sp. A first right upper true molar, in a slightly worn condition; from the lower Siwaliks of the Laki Hills: Indian Museum (No. B. 97).

,, 15. (?) Hyotherium sindiense, Lyd. A fourth left (?) upper premolar, in a slightly worn condition; from the lower Siwaliks of the Laki Hills: Indian Museum (No. B. 98).

,, 16. Hyotherium, sp. A fragment of the right ramus of the mandible, showing mm. 4 and m. 1 in an unworn condition; from the lower Siwaliks of the Laki Hills: Indian Museum (No. B. 100).

,, 17. Hippohyus sivalensis, Falc. and Caut. Fragment of the right maxilla with the teeth in a partially worn condition; from the Siwaliks of Asnot: Indian Museum (No. B. 65).

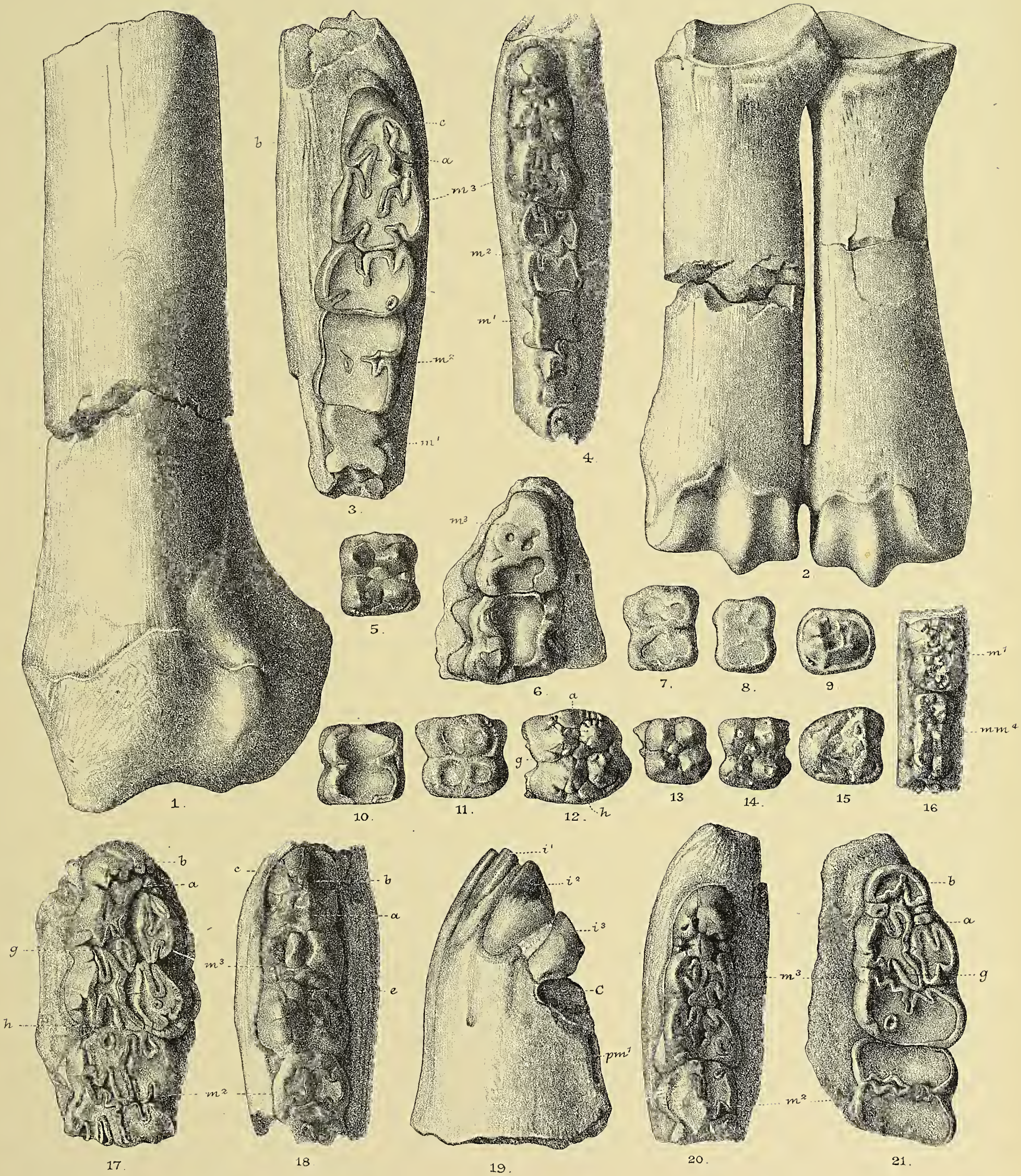
,, 18. Hippohyus sivalensis, Falc. and Caut. Fragment of the left ramus of the mandible, with m. 3 in an unworn condition; from the Siwaliks of Asnot: Indian Museum (No. B. 69).

,, 19. Hippohyus sivalensis, Falc. and Caut. The left half of the symphysis belonging to the same specimen as fig. 3.

,, 20. Hippohyus, sp. Fragment of the left ramus of the mandible, with m. 3 in an early stage of wear; from the Siwaliks of Asnot: Indian Museum (No. B. 69a).

,, 21. Hippohyus sivalensis, Falc. and Caut. The second and third true molars of the right side, in a well-worn condition, from a palate specimen; from the Siwaliks of the Punjab: Indian Museum (No. B. 66).

All the figures natural size.



G. M. Woodward del. et lith. West, Newman & Co. imp.

PLATE XIII.

Artiodactyla — *Cervidæ* and *Bovidæ.*

Fig, 1. Boselaphus, sp. The left upper cheek-dentition of a young individual, viewed from the masticating and inner aspect; from the Siwaliks of the Punjab: Indian Museum (No. B. 213).

,, 2. Boselaphus, sp. Part of the left upper dentition of a young individual, viewed from the outer aspect; from the Siwaliks of the Punjab: Indian Museum (No. B. 385).

,, 3. Boselaphus, sp. Part of the right lower cheek-dentition of a young individual; from the Siwaliks of the Punjab: Indian Museum (No. B. 211).

,, 4. Boselaphus, sp. Part of the left lower cheek-dentition of a still younger individual; from the Siwaliks of the Punjab: Indian Museum (No. B. 211).

,, 5. Boselaphus, sp. The left lower true molars of an adult; from the Siwaliks of the Punjab: Indian Museum (No. B. 210).

,, 6. Cervus simplicidens, Lyd. The left upper cheek-dentition, viewed from the masticating and inner aspect; from the Siwaliks of the Punjab; Indian Museum (No. B. 319).

,, 7. Boselaphus, sp. First (?) left upper true molar in a well-worn condition, viewed from the masticating and inner aspect; from the Siwaliks of the Punjab: Indian Museum (No. B. 206).

,, 8. Boselaphus, sp. Right upper true molar, in a slightly worn condition, viewed from the outer aspect; from the Siwaliks of the Punjab: Indian Museum (No. B. 205).

,, 9. Palæoryx (?) sp. Left upper true molar, in a well-worn condition, viewed from the inner and masticating aspect; from the Siwaliks of the Punjab: Indian Museum (No. B. 353).

,, 10. Outer aspect of fig. 9.

,, 11. Masticating and inner aspect of fig. 8.

,, 12. Oreas (?) latidens, Lyd. The left upper cheek-dentition, viewed from the outer aspect; from the Siwaliks of the Punjab: Indian Museum (No. B, 218).

,, 13. Inner and masticating aspect of the first three teeth of fig. 12.

All the figures natural size. In figs. 1, 2, *the letters a, b, c, d, e, indicate the 'costæ.'*

J. Smit, del et lith.

Mintern Bros. imp.

PLATE XIV.

Aves.

Fig. 1.	Leptoptilus falconeri (M. Edws.). Distal extremity of the left humerus, viewed from the palmar aspect; from the Siwalik Hills: British Museum (No. 48,435).
,, 2, 2a, 2b.	Dromæus (?) sivalensis, Lyd. The first phalangeal of the outer (fourth) digit of the right foot; from the Siwaliks of the Punjab: Indian Museum (No. E. 1). 2 from the anterior, 2a from the posterior, 2b from the proximal aspect.
,, 3, 3a, 3b.	Mergus (?) sp. Early cervical vertebra; from the Siwaliks of the Punjab: Indian Museum. 3 from the hæmal, 3a from the anterior, 3b from the neural aspect.
,, 4, 4a, 4b.	Dromæus (?) sivalensis, Lyd. The second phalangeal of the outer (fourth) digit of the left foot; from the Siwaliks of the Punjab; Indian Museum (No. E. 3). 4 from the anterior, 4a from the proximal, 4b from the distal aspect.
,, 5.	Dromæus (?) sivalensis, Lyd. The second phalangeal of the outer (fourth) digit of the left foot; from the Siwaliks of the Punjab: Indian Museum (No. E. 4). From the anterior aspect.
,, 6.	Dromæus (?) sivalensis, Lyd. The first phalangeal of the outer (fourth) digit of the left foot; from the Siwaliks of the Punjab: Indian Museum (No. E. 2). From the anterior aspect.
,, 7, 7a, 7b, 7c, 7d.	Ciconioid, *gen. non. det.* Fourth cervical vertebra; from the Siwaliks of the Punjab: Indian Museum (No. E. 8). 7 from the right lateral, 7a from the anterior, 7b from the posterior, 7c from the neural, 7d from the hæmal aspect.
,, 8.	Struthioid, *gen. non. det.* Second phalangeal of the middle (third) digit of the foot; from the Siwalik Hills: British Museum (No. 39,733). From the anterior aspect.
,, 9, 9a, 9b.	Leptoptilus falconeri (M. Edws.). Distal extremity of the right tibia; from the Siwaliks of the Punjab: Indian Museum (No. E. 10). 9 from the anterior, 9a from the posterior, 9b from the distal aspect.
,, 10, 10a.	Phalacrocorax (?) sp. Proximal half of the metatarsus; from the Siwalik Hills: British Museum (No. 39,742). 10 from the anterior, 10a from the posterior aspect.
,, 11, 11a.	Pelecanus cautleyi, Davies. Distal extremity of the left ulna; from the Siwalik Hills: British Museum (No. 39,740). 11 from the external, 11a from the palmar aspect.
,, 12.	Leptoptilus falconeri (M. Edws.). First phalangeal of the outer (fourth) digit of the right foot; from the Siwaliks of the Punjab: Indian Museum (No. E. 9). From the anterior aspect.
,, 13.	*Gen. non. det.* First phalangeal of the median (third) digit of the foot; from the Siwaliks of the Punjab: Indian Museum. From the anterior aspect.
,, 14.	Leptoptilus falconeri (M. Edws.). Distal extremity of the left metatarsus; Siwalik Hills: British Museum (No. 39,736). From the anterior aspect.

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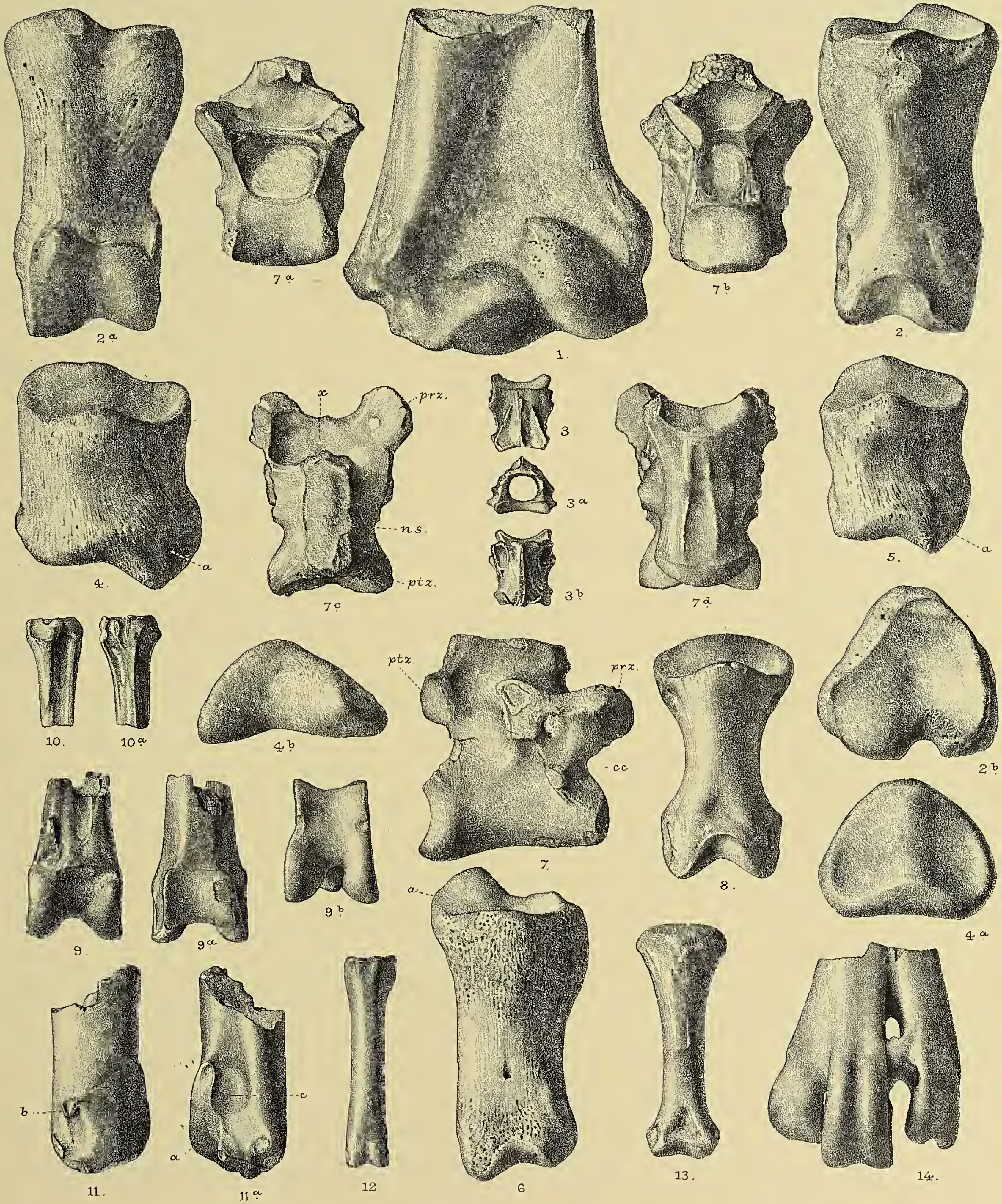
* *All the figures natural size.*



G.M.Woodward del. et lith.

West Newman & Co. imp.

PLATE XV.

Aves.

Struthio asiaticus, A. Milne-Edwards.

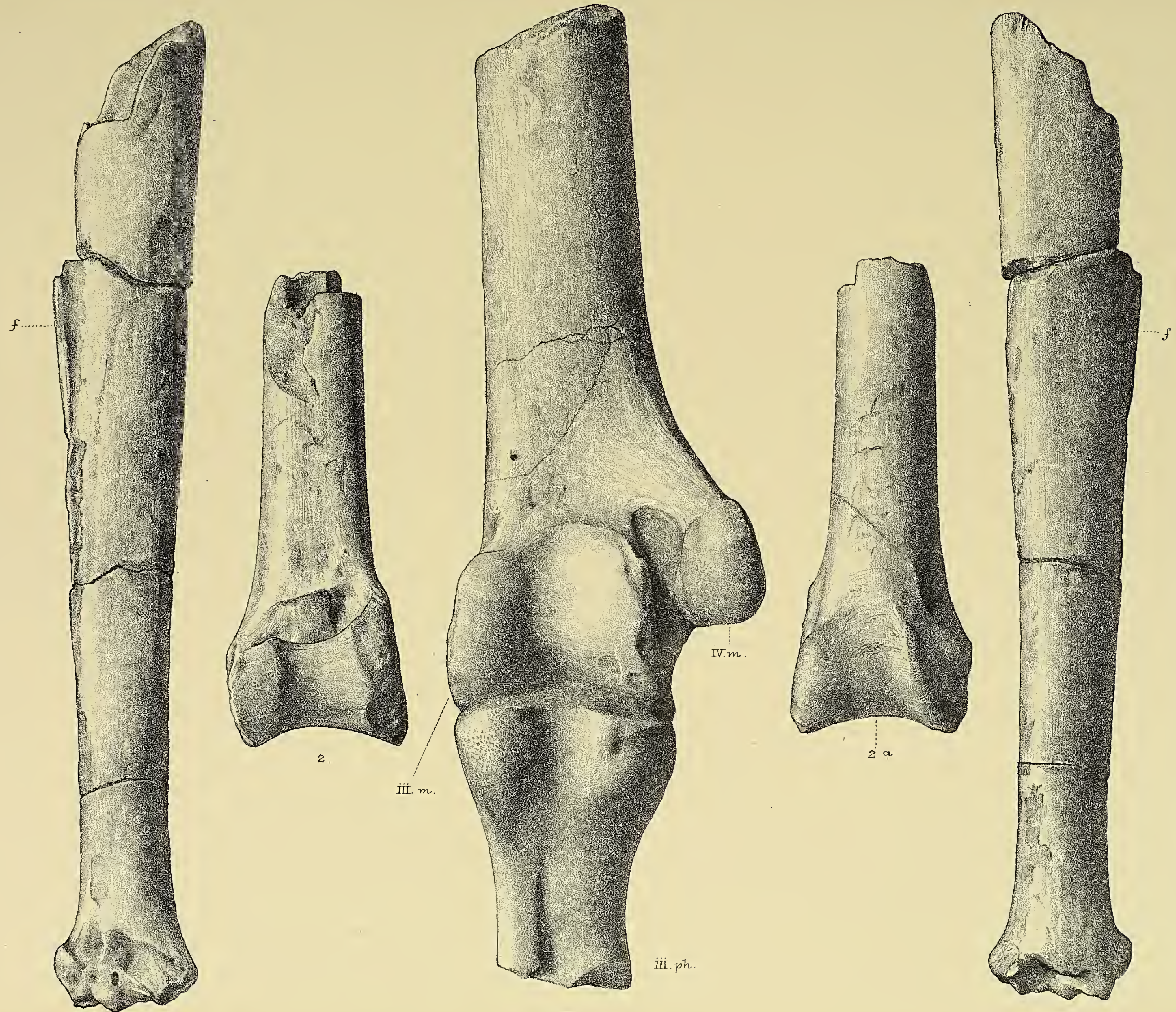
Fig. 1, 1a. The greater portion of the shaft of the right tibia and fibula; from the Siwalik Hills: Indian Museum (No. E. 7). 1 from the anterior, 1a from the posterior aspect.

,, 2, 2a. The distal portion of the right tibia; from the Siwalik Hills: British Museum (No. 39,732). 2 from the anterior, 2a from the posterior aspect.

,, 3. The distal portion of the right metatarsus, and the proximal portion of the first phalangeal of the third digit; from the Siwalik Hills: British Museum (No. 43,105). From the posterior aspect.

Figs. 1, 1*a*, 2, 2*a*, ½ *nat. size; fig.* 3, *natural size.*

TERTIARY VERTEBRATA.



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G. M. Woodward del. et lith.
West Newman & Co. imp.

PLATE XVI.

PROBOSCIDEA — *Elephantidæ.*

Fig. 1. MASTODON PANDIONIS, Falconer. The third left upper true molar, in a well-worn condition. In the possession of Mr. Wajeshankar Gowreeshankar of Bhaonagar.

„ 2. MASTODON PERIMENSIS, Falc. and Caut. The greater portion of the second right upper true molar: Indian Museum (No. A. 437). The restoration of the hind ridge and talon is incorrect.

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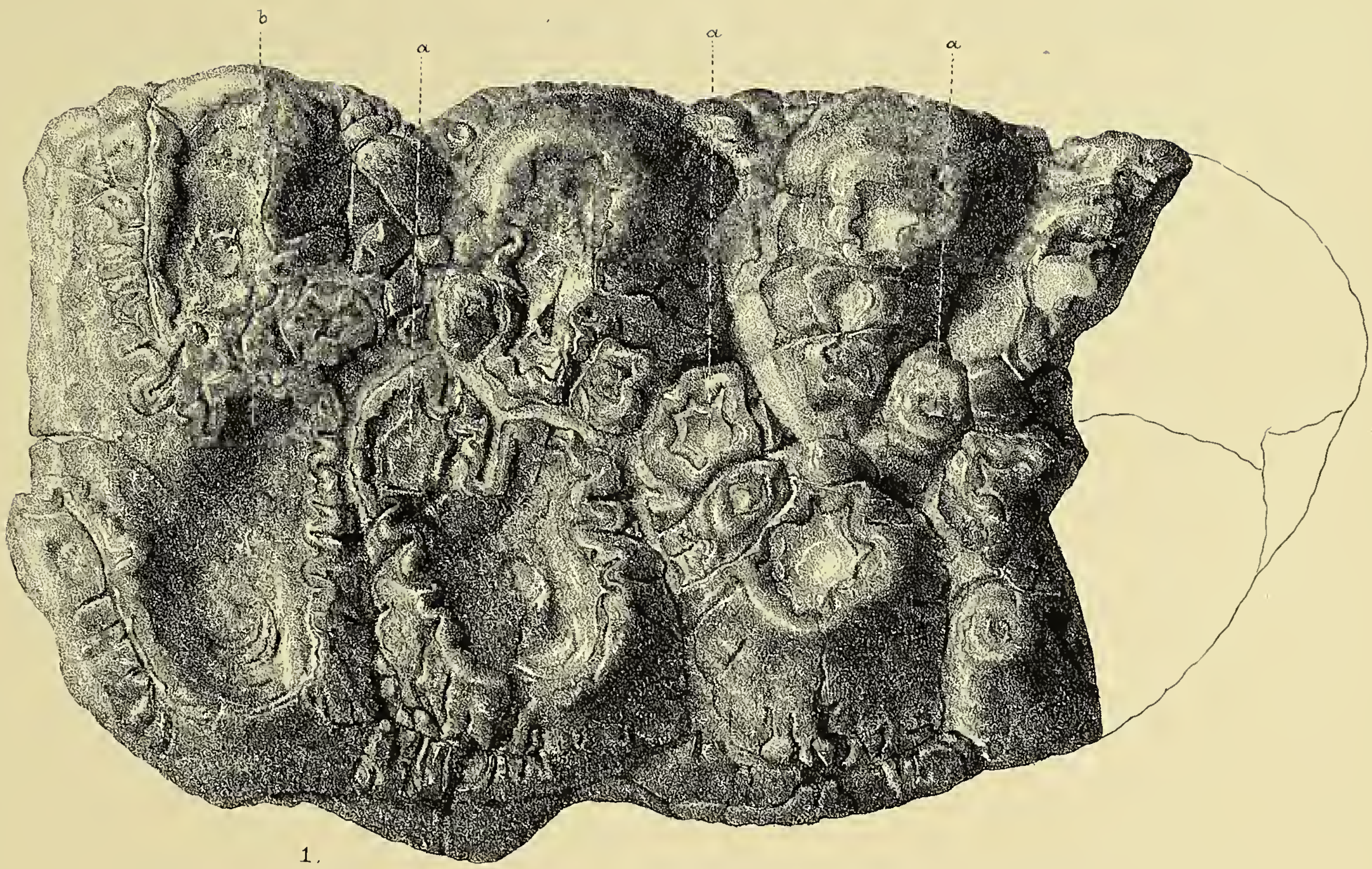
* Both specimens are from Perim Island, Gulf of Cambay; and are drawn of the natural size. *a*, anterior, and *b*, posterior accessory column.



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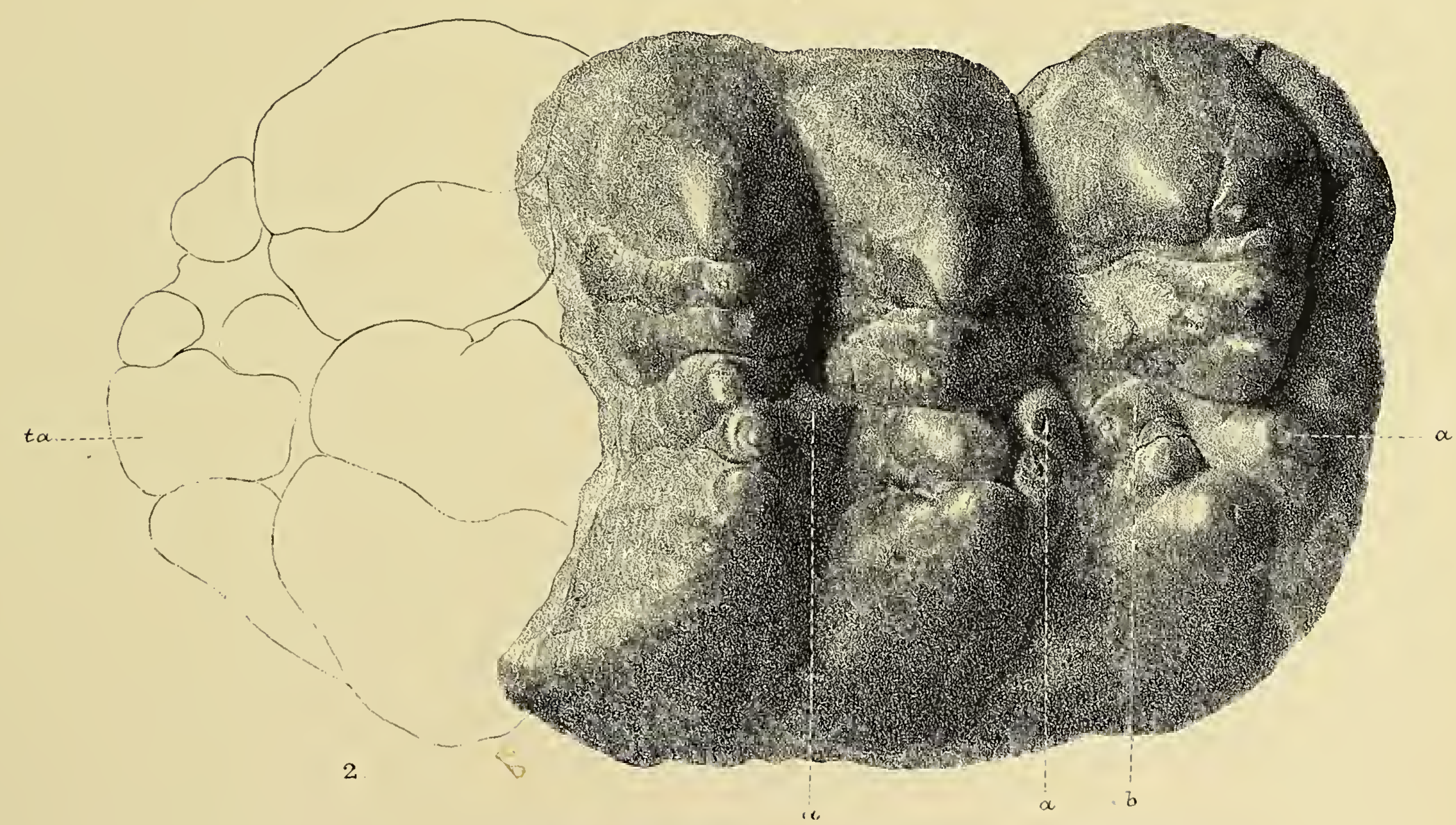

2.

G. M. Woodward del. et lith.

West, Newman & Co. imp.

PLATE XVII.

PROBOSCIDEA — *Elephantidæ.*

Fig. 1. (?) MASTODON PERIMENSIS, Falc. and Caut. Fragment of the right maxilla, with the second and third milk-molars, in a well-worn condition. In the possession of Mr. Wajeshankar Gowreeshankar of Bhaonagar.

,, 2, 2a. MASTODON PANDIONIS, Falconer. The first right upper true molar, in an unworn condition. In the possession of Mr. Wajeshankar Gowreeshankar. Fig. 2a shows the outer side.

,, 3, 3a. MASTODON PERIMENSIS, Falc. and Caut. The third left upper milk-molar, in an unworn condition: British Museum (No. 40,778). Fig. 3a shows the outer side.

,, 4. (?) MASTODON PERIMENSIS, Falc. and Caut. The third right lower premolar, in a broken condition. From a fragment of the mandible in the possession of Mr. Wajeshankar Gowreeshankar.

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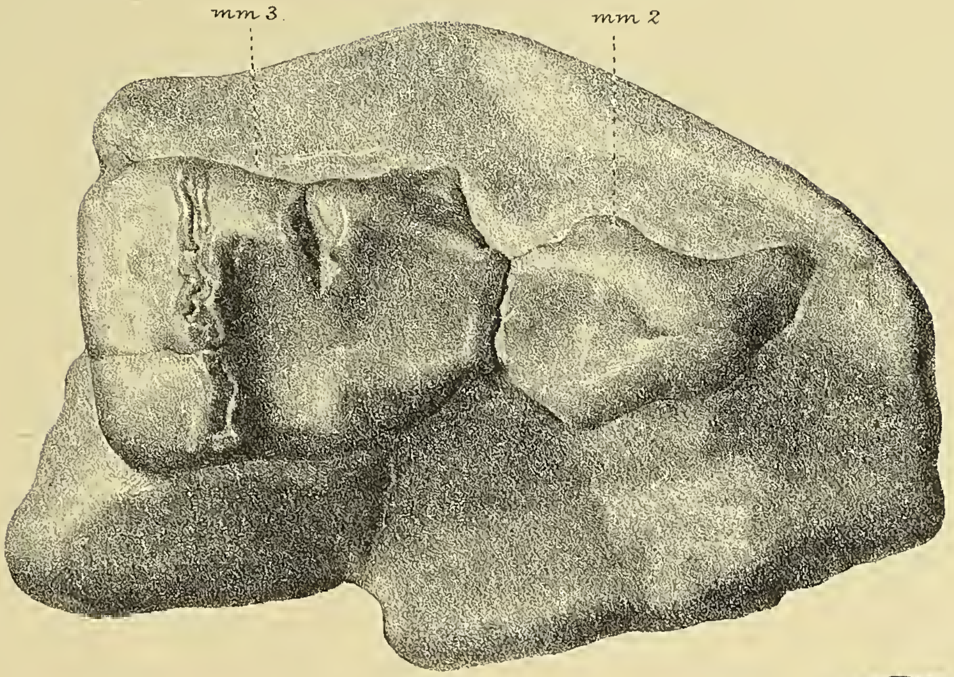
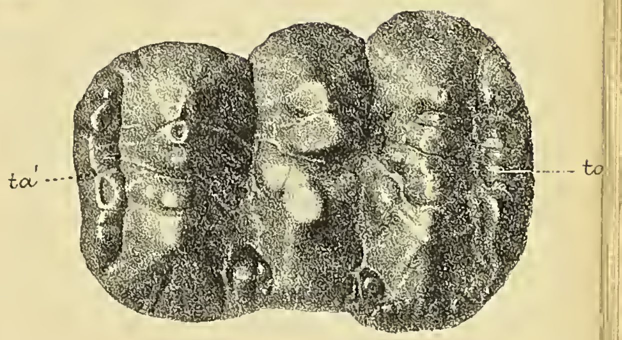
* All the specimens are from Perim Island; and are drawn of the natural size. *ta* posterior, and *ta'* anterior talon; *c*, cingulum.



1.

2 a.



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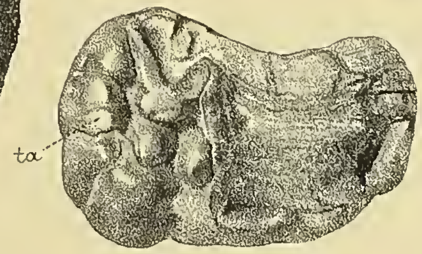

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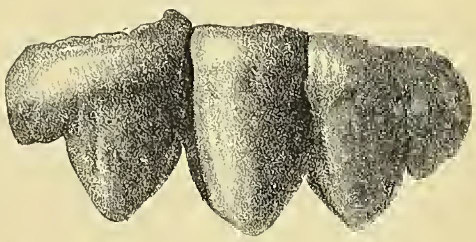

3 a.

2.

G. M. Woodward. del. et lith.

West, Newman & Co

PLATE XVIII.

Chelonia — *Testudinidæ.*

Figs. 1, 1a. Colossochelys atlas, Falc. and Caut. The anterior extremity of the plastron, viewed from the dorsal (1) and ventral (1a) aspects; from the Siwalik Hills. British Museum (No. 40603). The posterior portion is drawn from another specimen.

„ 2. Genus *non. det.* Species 3. The anterior extremity of the plastron, viewed from the dorsal aspect; from the Siwaliks of the Punjab. Indian Museum (No. E 84).

„ 3, 3a. Genus *non. det.* Species 2. The anterior extremity of the plastron, viewed from the dorsal (3) and ventral (3a) aspects; from the Siwaliks of the Punjab. Indian Museum (No. E 82).

„ 4. Genus *non. det.* Species 1. The anterior extremity of the plastron, viewed from the ventral aspect; from the Siwalik Hills. Indian Museum (No. E 82a).

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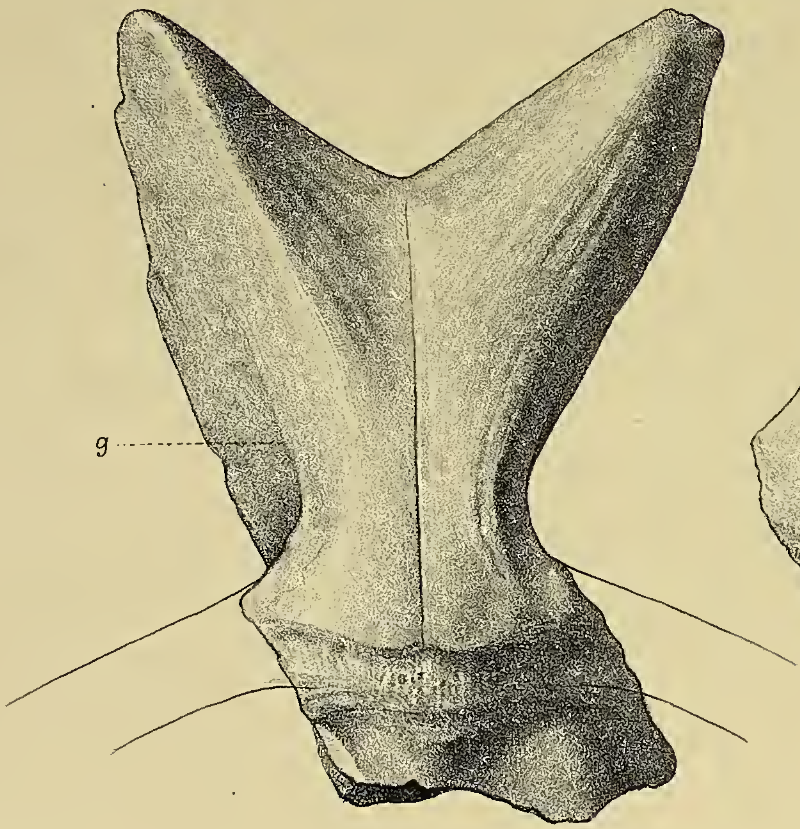
* Figs. 1, 1a $\frac{1}{6}$, the others $\frac{1}{3}$ nat. size. *g.*, gular; *pg.*, postgular plate.



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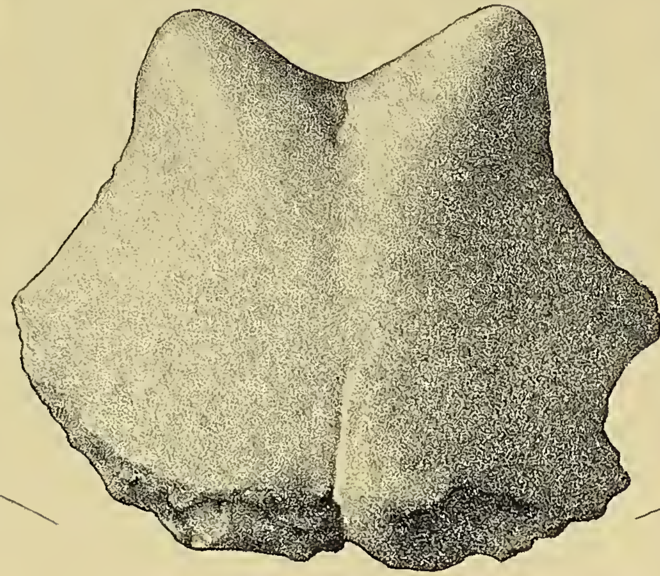

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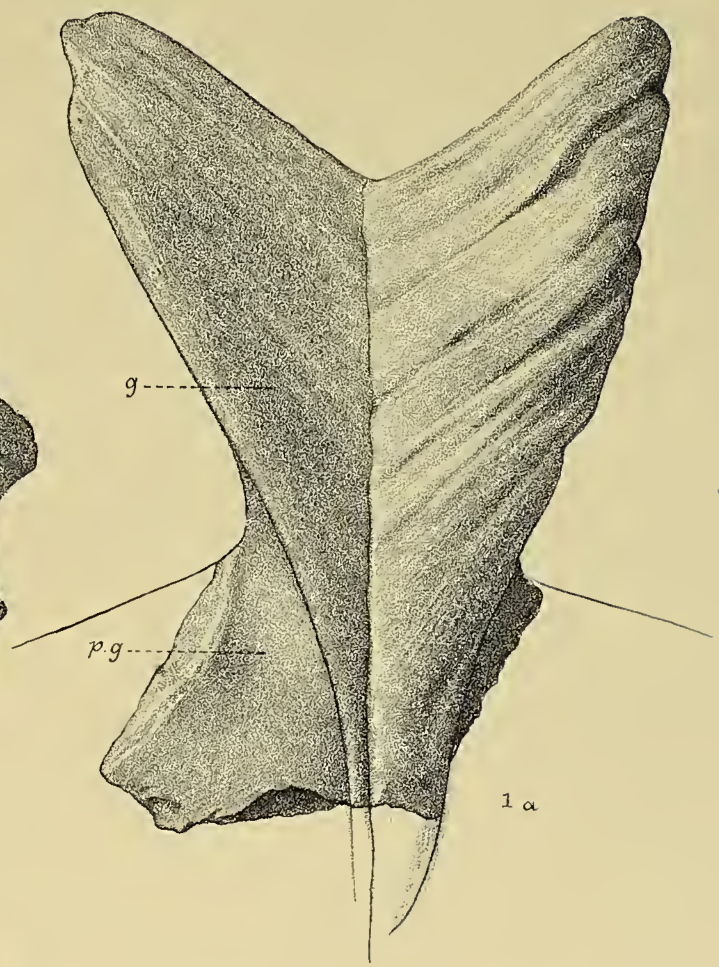

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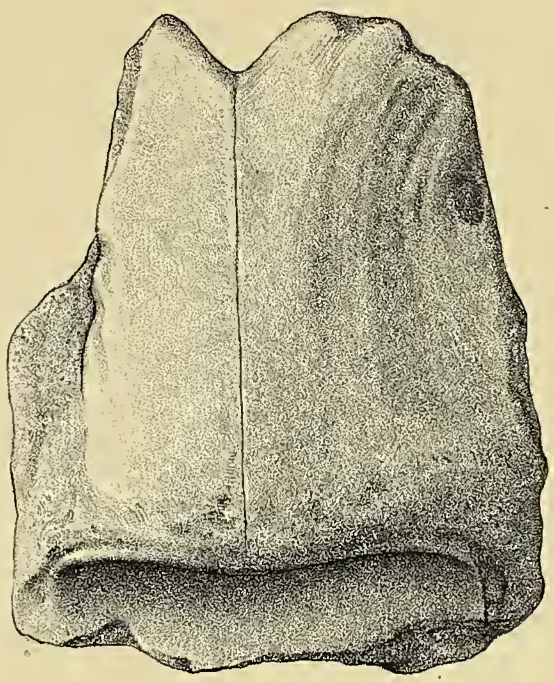

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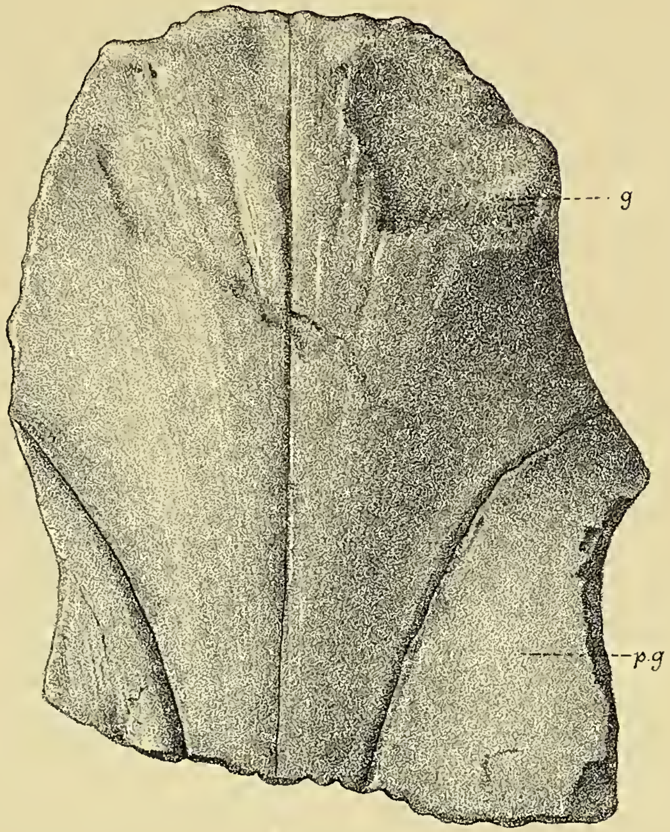

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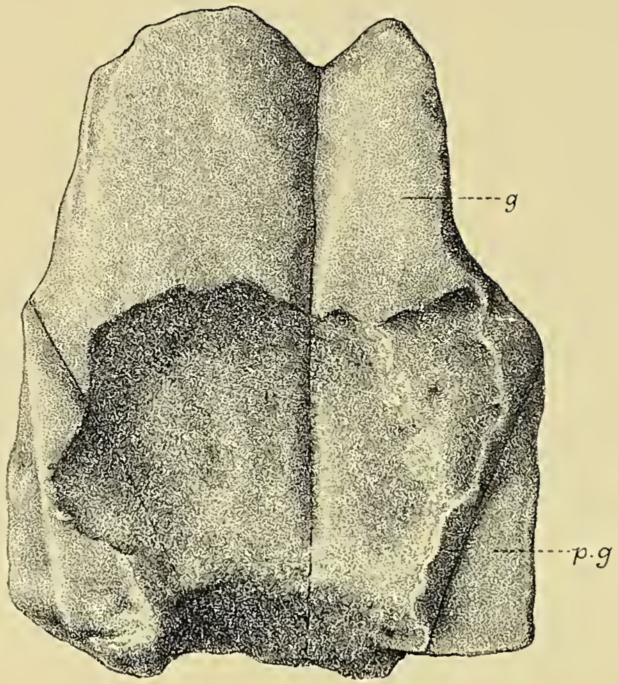

3 a.

PLATE XIX.

CHELONIA — *Testudinidæ.*

Figs. 1, 1a. GENUS *non. det.* Species 4. The anterior extremity of the plastron, viewed from the dorsal (3) and ventral (3a) aspects; from the Siwaliks of the Punjab. Indian Museum (No. E 80). $\frac{1}{3}$ nat. size.

,, 2. COLOSSOCHELYS ATLAS, Falc. and Caut. Proximal half of the right humerus, with the distal half restored, viewed from the preaxial aspect; from the Siwalik Hills. British Museum (No. 16518). $\frac{1}{5}$ nat. size.

,, 3, 3a, 3b. (?) COLOSSOCHELYS ATLAS, Falc. and Caut. The cranium (? of a female), viewed from the parietal (3), right lateral (3a), and palatal (3b) aspects; from the Siwalik Hills. British Museum (No. 39819). $\frac{1}{2}$ nat. size.

,, 4. GENUS *non. det.* Species 4. Part of the nuchal scute, viewed from the dorsal aspect; from the Siwaliks of the Punjab. Indian Museum (No. E 81). $\frac{1}{3}$ nat. size.

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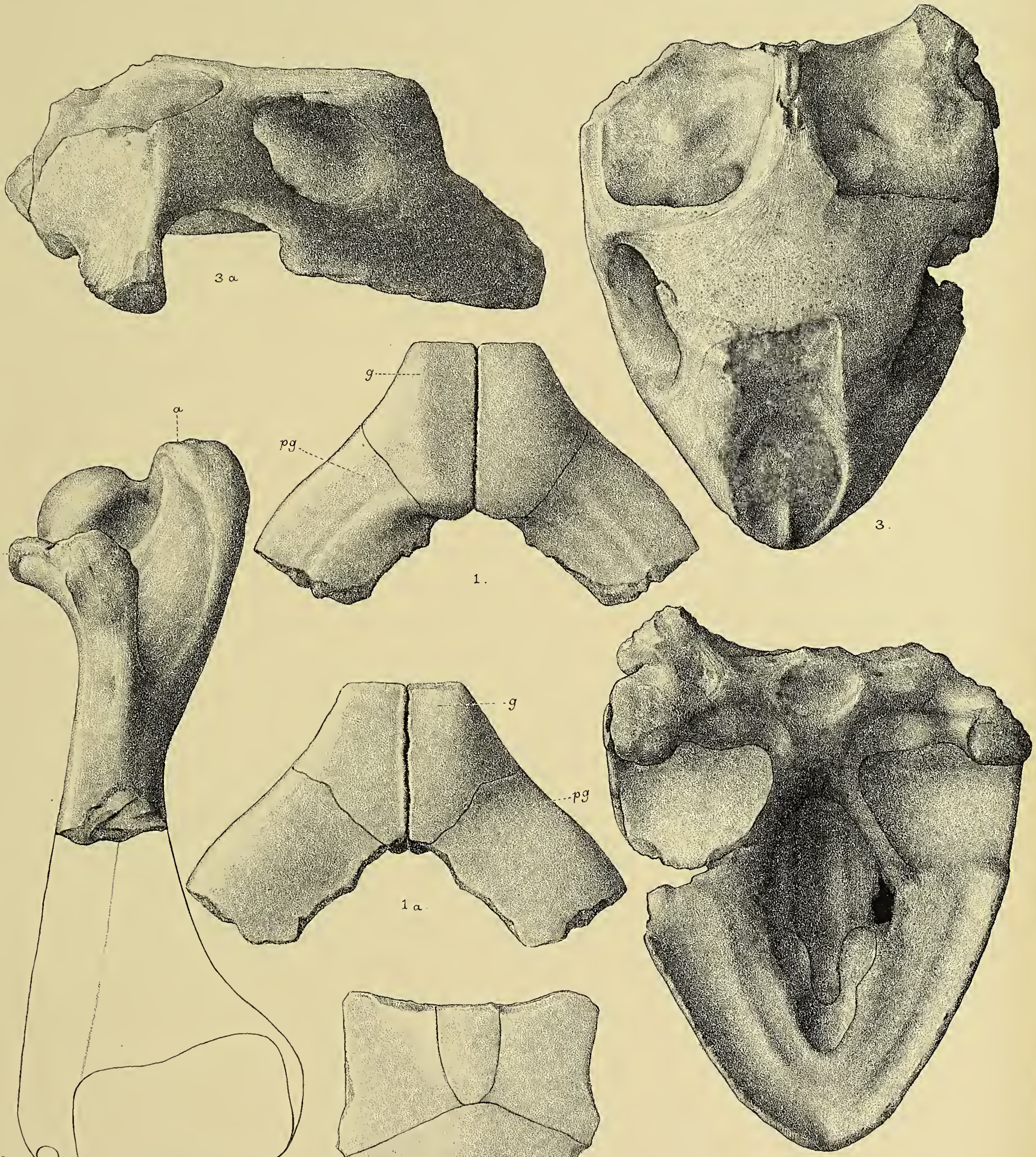
* *a*, ulnar tuberosity; *b*, radial tuberosity; *c*, position of ectepicondylar (radial) groove; *g*, gular plate; *pg*, postgular plate.



G.M.Woodward del. et lith.

West, Newman & Co imp.

PLATE XX.

CHELONIA — *Emydidæ.*

Figs. 1, 1a, 1b. CLEMMYS SIVALENSIS (Theobald). Greater part of shell; from the Siwaliks of the Punjab. Indian Museum (No. E 88). 1 from the dorsal, 1a from the right lateral aspect: 1b anterior extremity of plastron.

„ 2, 2a, 2b. CLEMMYS THEOBALDI, Lyd. Greater part of shell; from the Siwaliks of the Punjab. Indian Museum (No. E 89). 2 from the dorsal, 2a from the left lateral aspect: 2b anterior extremity of plastron.

„ 3, 3a, 3b. CLEMMYS PUNJABIENSIS, Lyd. Greater part of shell; from the Siwaliks of the Punjab. Indian Museum (No. E 92). 3 from the dorsal, 3a from the left lateral aspect: 3b anterior extremity of plastron.

„ 4, 4a. CLEMMYS HYDASPICA, Lyd. Shell; from the Siwaliks of the Punjab. Indian Museum (No. E 93). 4 from the dorsal, 4a from the right lateral aspect.

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* All the figures ½ natural size.

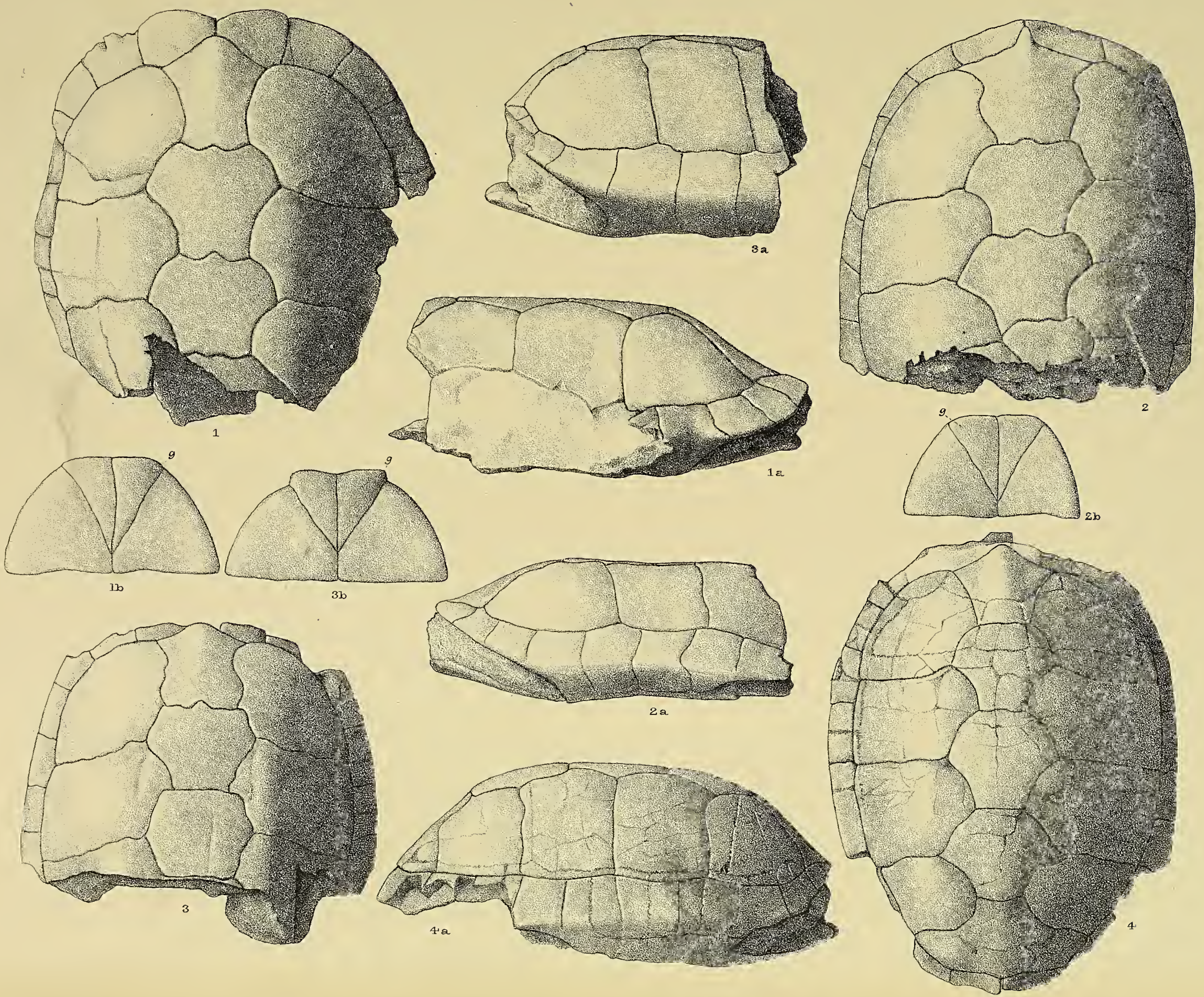
1
1a
1b
2
2a
2b
3
3a
3b
4
4a
g
g
g

PLATE XXI.

CHELONIA — *Emydidæ.*

Figs. 1, 1a, 1b. CLEMMYS PALÆINDICA, Lyd. Greater part of shell of a half-grown specimen; from the Siwalik Hills. British Museum (No. 39840). $\frac{2}{3}$ nat. size. 1 from the right lateral, 1a from the anterior, 1b from the dorsal aspect.

,, 2. CLEMMYS HAMILTONI (Gray). Shell of a young recent specimen, viewed from the dorsal aspect; from Lower Bengal. Nat. size.

,, 3, 3a. CLEMMYS PALÆINDICA, Lyd. Shell of an adult, viewed from the dorsal (3) and ventral (3a) aspects; from the Siwalik Hills. British Museum (No. 39838). $\frac{1}{3}$ nat. size.

,, 4, 4a, 4b. CLEMMYS (cf. *trijuga* [Schweigg]). Shell of an adult; from the Siwalik Hills. British Museum (No. 39839). $\frac{1}{2}$ nat. size. 4 from the dorsal, 4a from the left lateral aspect; 4b the anterior extremity of the plastron.

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* *g.*, gular plate.

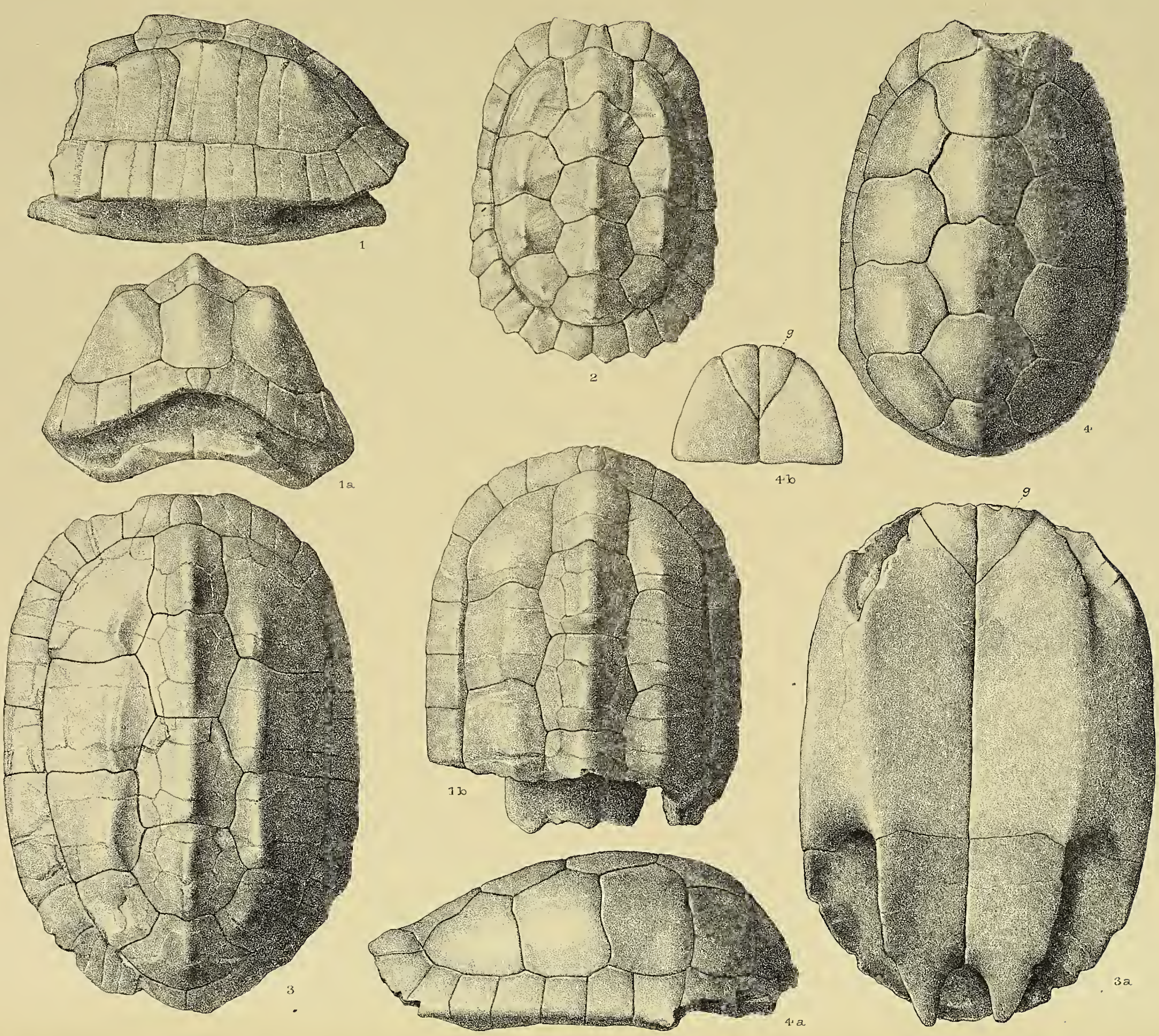

1
1a
2
g
4b
4
1b
g
3
4a
3a

PLATE XXII.

Chelonia — *Emydidæ.*

Fig. 1. Pangshura, sp. Shell; from the Siwalik Hills. British Museum (No. 17435). $\frac{3}{4}$ nat. size.

,, 2. Pangshura flaviventris, Günther. Shell; from the pleistocene of the Narbada valley. Indian Museum (No. F 110). $\frac{1}{2}$ nat. size.

,, 3. (?) Pangshura flaviventris, Günther. Shell; from the Siwalik Hills. British Museum (No. 39837). $\frac{2}{5}$ nat. size.

,, 4. Pangshura tectum (Bell). Adult recent shell of var. *ventricosum*, Gray. $\frac{2}{5}$ nat. size.

,, 5. Pangshura smithi (Gray). Adult recent shell. $\frac{2}{5}$ nat. size.

,, 6. Pangshura tectum (Bell). Shell of a young recent specimen. Nat. size.

,, 7. Pangshura tectum (Bell). First three vertebrals of a half-grown recent specimen, in the Geological Department of the British Museum. Nat. size.

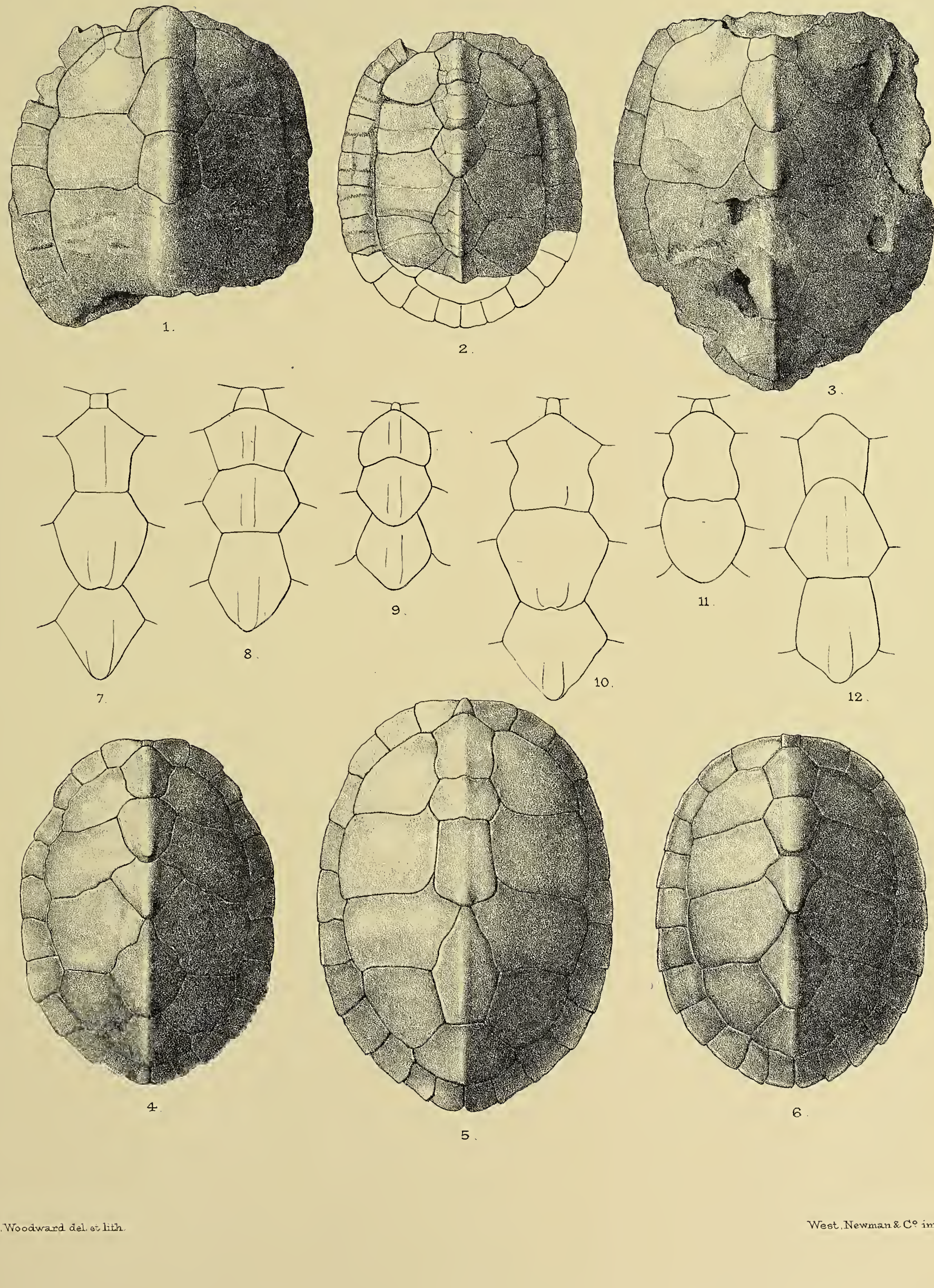
,, 8. Pangshura tectum (Bell). First three vertebrals of a recent specimen of the var. *intermedium*, Blanford. Nat. size. (*From Mr. Blanford's figure.*)

,, 9. Pangshura tentoria, Gray. First three vertebrals of a recent specimen. Nat. size. (*From Dr. Günther's figure.*)

,, 10. Pangshura flaviventris, Günther. First three vertebrals of the specimen represented in fig. 2. Nat. size.

,, 11. Pangshura flaviventris, Günther. First two vertebrals of a recent specimen. Nat. size. (*From Dr. Günther's figure.*)

,, 12. Pangshura, sp. First three vertebrals of the specimen represented in fig. 1. Nat. size.



G. M. Woodward del. et lith. West, Newman & Cº imp.

PLATE XXIII.

CHELONIA — *Emydidæ.*

Figs. 1, 1a. BATAGUR FALCONERI, Lyd. Shell, viewed from the dorsal and ventral aspects; from the Siwalik Hills. British Museum (No. 39835).

,, 2, 2a. BATAGUR BAKERI, Lyd. Shell, viewed from the dorsal and ventral aspects; from the Siwalik Hills. British Museum (No. 39835a).

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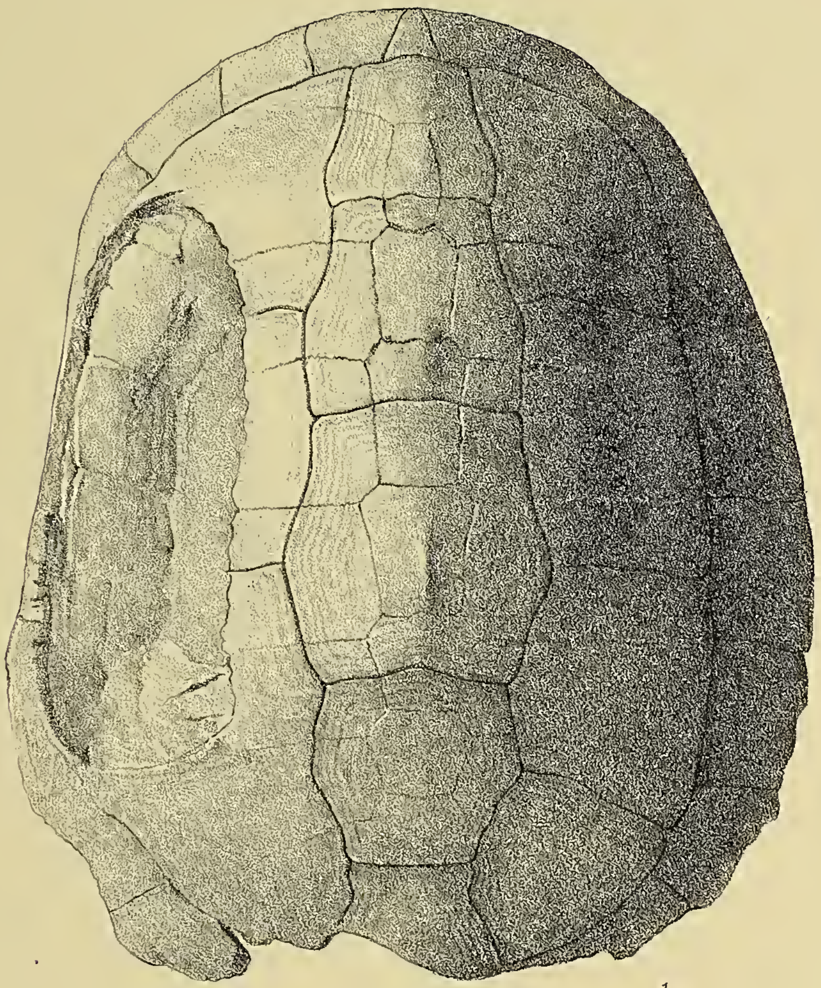
* *All the figures ¼ nat, size: a, anal, g, gular, pg, postgular plate.*



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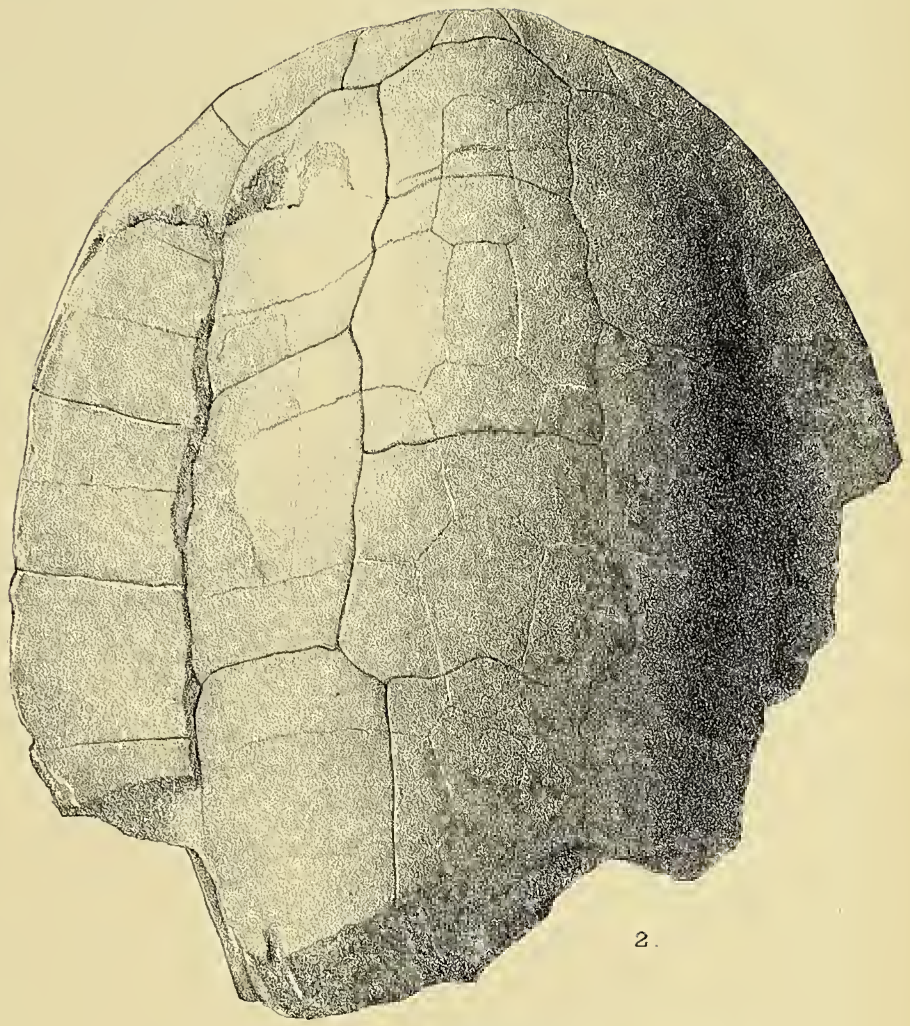
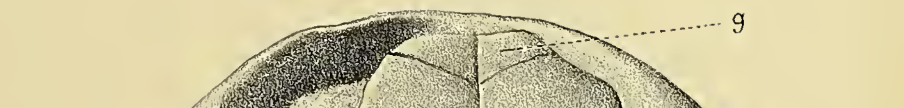


2.

1 a



2 a

PLATE XXIV.

CHELONIA — *Emydidæ.*

Figs. 1, 1a. BATAGUR CAUTLEYI, Lyd. Shell, viewed from the dorsal and left lateral aspects; from the Siwalik Hills. British Museum (No. 39834). $\frac{1}{6}$ nat. size.

,, 2. BATAGUR DURANDI, Lyd. Shell, viewed from the dorsal aspect; from the Siwalik Hills. British Museum (No. 39841). $\frac{1}{4}$ nat. size.

,, 3. GENUS *non. det.* (? GEOEMYDA, sp.). Nuchal scute; from the Siwaliks of the Punjab. Indian Museum (No. E 104).

,, 4. BATAGUR FALCONERI, Lyd. Right lateral aspect of the specimen represented in pl. XXIII. fig. 1. $\frac{1}{4}$ nat. size.

,, 5. BATAGUR BAKERI, Lyd, Left lateral aspect of the specimen represented in pl. XXIII. fig. 2. $\frac{1}{4}$ nat. size.

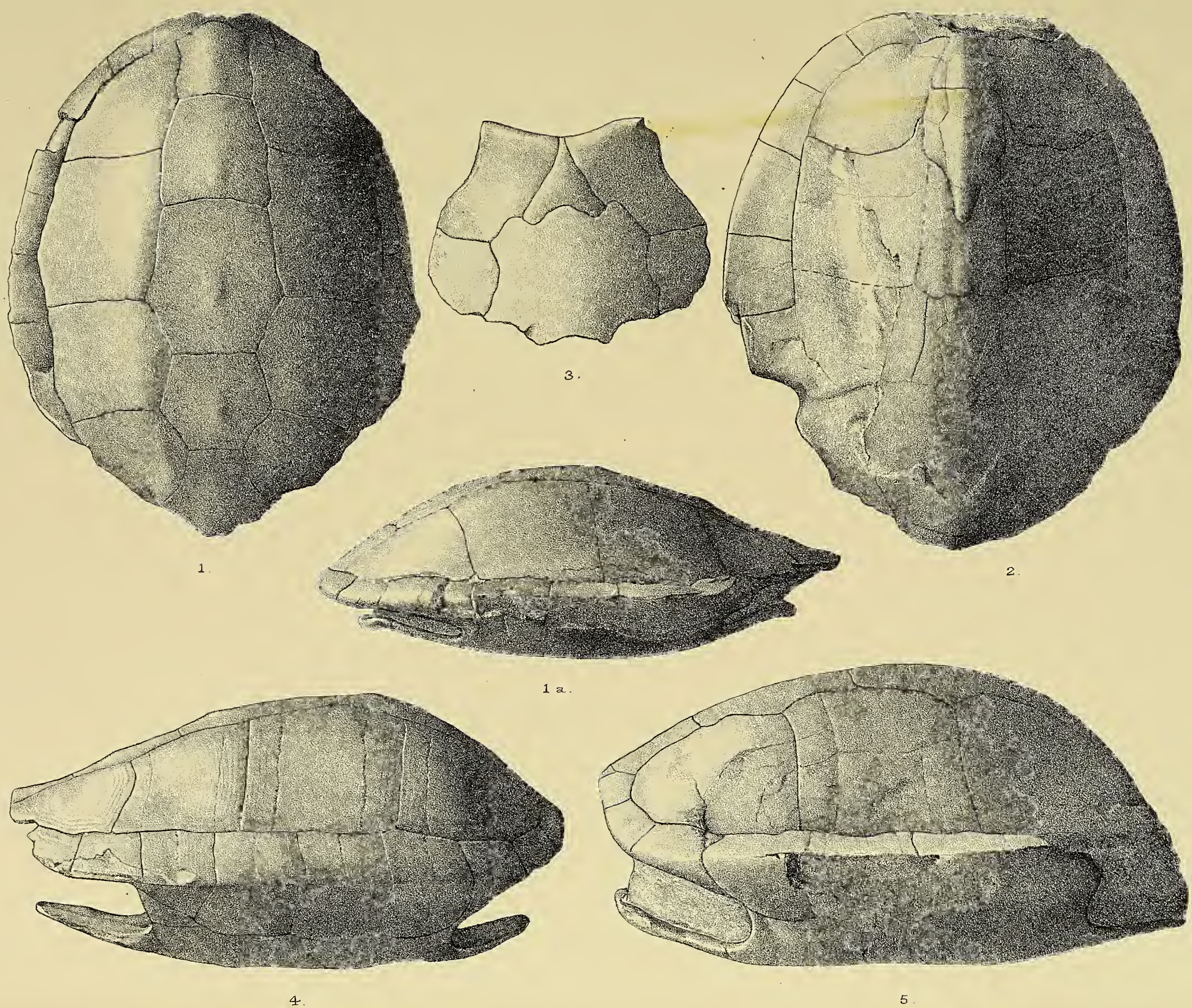

1.
1 a.
2.
3.
4.
5.

PLATE XXV.

CHELONIA — *Emydidæ* and *Trionychidæ*.

Fig. 1. (?) BATAGUR FALCONERI, Lyd. Part of the carapace of a young specimen; from the Siwaliks of the Punjab. Indian Museum (No. E 94).

,, 2, 2a, 2b. (?) BATAGUR FALCONERI, Lyd. Cranium; from the Siwaliks of the Punjab. Indian Museum (No. E 103). 2 from the parietal, 2a from the palatal, 2b from the left lateral aspect.

,, 3, 3a, 3b. TRIONYX GANGETICUS, Cuv. Cranium; from the pleistocene of the Narbada valley. British Museum (No. 39,843). 3 from the parietal, 3a from the palatal, 3b from the right lateral aspect.

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* Fig. 1 $\frac{1}{2}$ nat. size; the rest $\frac{3}{4}$ nat. size.

G. M. Woodward del. et lith.

West, Newman & Co. imp.

PLATE XXVI.

CHELONIA — *Trionychidæ.*

Fig. 1. EMYDA VITTATA, Peters. Shell, viewed from the ventral aspect; from the Siwalik Hills. British Museum (No. 39618).

" 2. EMYDA SIVALENSIS, Lyd. The right half of the nuchal scute, viewed from the dorsal aspect; from the Siwaliks of the Punjab. Indian Museum (No. E 133).

" 3. EMYDA LINEATA, Lyd. Part of the left half of the nuchal scute, viewed from the dorsal aspect; from the Siwaliks of the Punjab. Indian Museum (No. E. 132).

" 4, 4a. (?) EMYDA VITTATA, Peters. The right anterior marginal scute, viewed from the dorsal (4) and posterior (4a) aspects; from the Siwaliks of the Punjab. Indian Museum (No. E. 134b).

" 5, 5a. EMYDA PALÆINDICA, Lyd. The right anterior marginal scute, viewed from the dorsal (5) and posterior (5a) aspects; from the Siwaliks of the Punjab. Indian Museum (No. E 134a).

" 6. EMYDA LINEATA, Lyd. The left anterior marginal scute, viewed from the dorsal aspect; from the Siwaliks of the Punjab. Indian Museum (No. E 210).

" 7. EMYDA SIVALENSIS, Lyd. The posterior two-thirds of the right anterior marginal scute, viewed from the ventral aspect; from the Siwaliks of the Punjab. Indian Museum (No. E 135).

" 8. EMYDA GRANOSA (Schoepf.). Nuchal scute of a half-grown recent specimen; from Bengal. *a*, anterior, *b*, posterior moiety.

" 9. EMYDA SIVALENSIS, Lyd. The left anterior marginal scute, viewed from the dorsal aspect; from the Siwaliks of the Punjab. Indian Museum (No. E 134).

" 10. EMYDA PALÆINDICA, Lyd. The sculpture of the nuchal scute, from a specimen in the Indian Museum (No. E 132a), from the Siwaliks of the Punjab.

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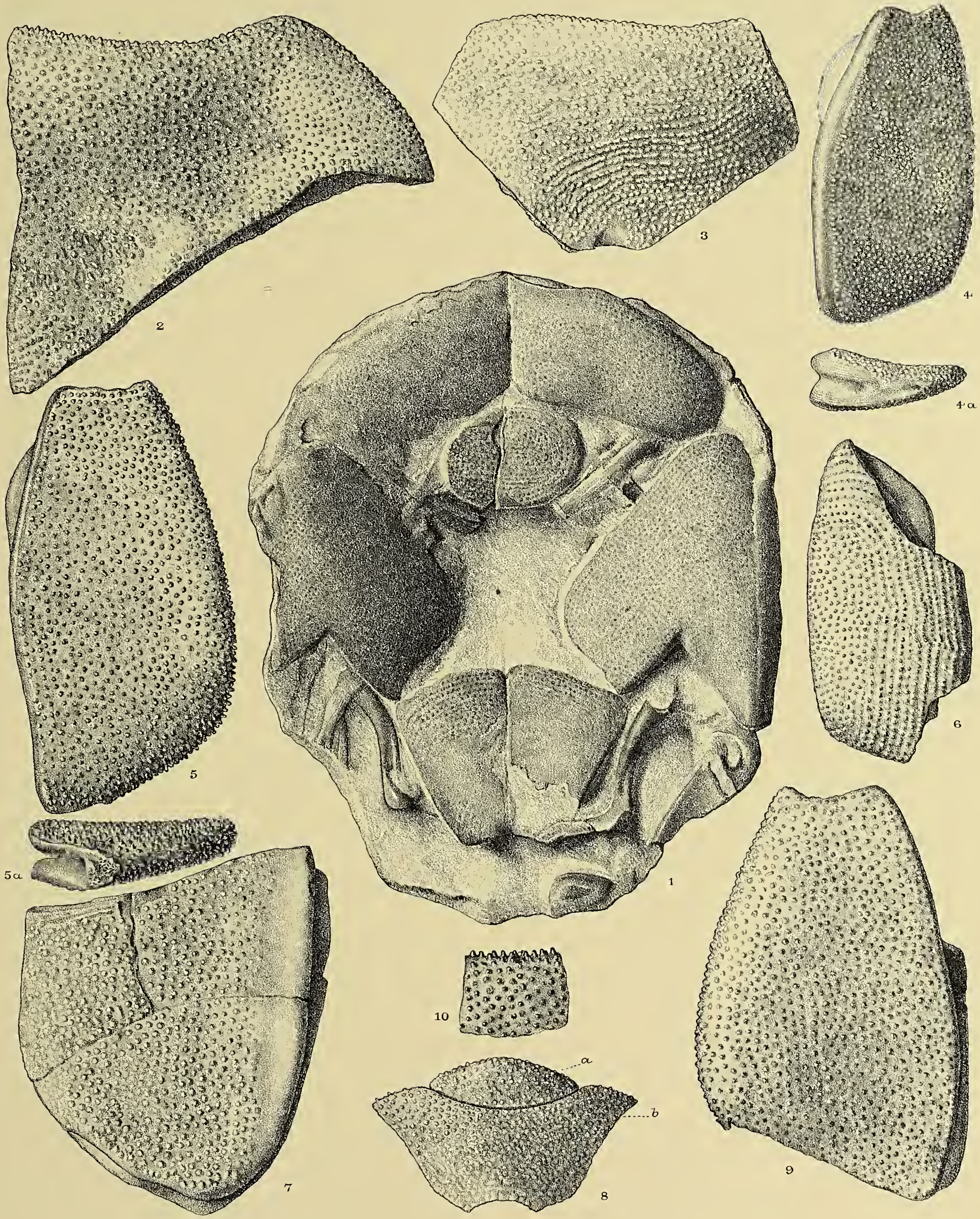
* Fig. 1 $\frac{1}{2}$ nat. size; the rest nat. size.



G. M. Woodward del. et lith.

West, Newman & Co. imp.

PLATE XXVII.

Chelonia — *Trionychidæ.*

Fig. 1. Chitra indica, Gray. Anterior portion of the carapace; from the Siwalik Hills. British Museum (No. 39830).

,, 2. Chitra indica, Gray. Greater portion of the carapace; from the Siwalik Hills. British Museum (No. 39832).

,, 3, 3a. Trionyx, sp. Right half of the plastron (3) and the vertebro-costal region of the carapace (3a); from the Siwalik Hills. Indian Museum (No. E 163).

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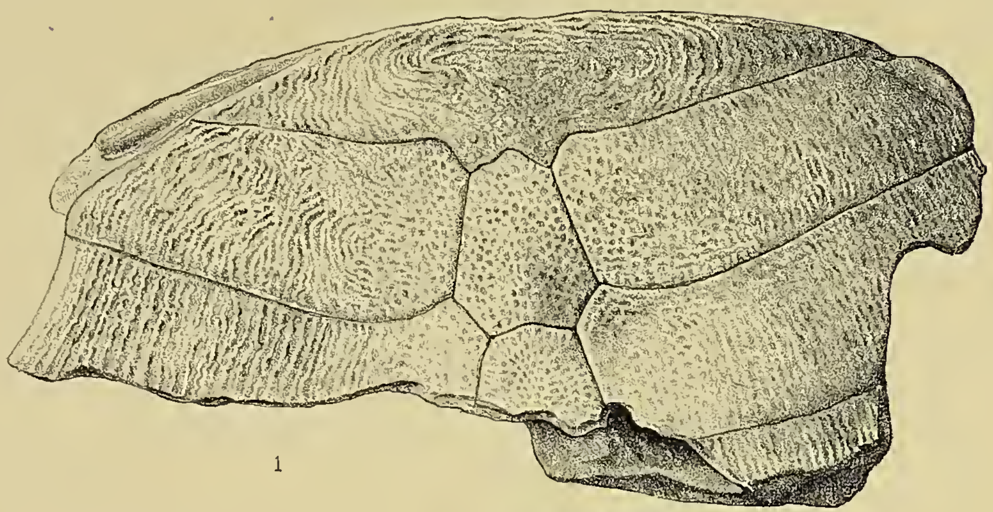
* Figs. 1, 2, ¼ nat. size; figs. 3, 3a ½ nat. size.—*ent. pl.*—azygos entoplastral callosity.



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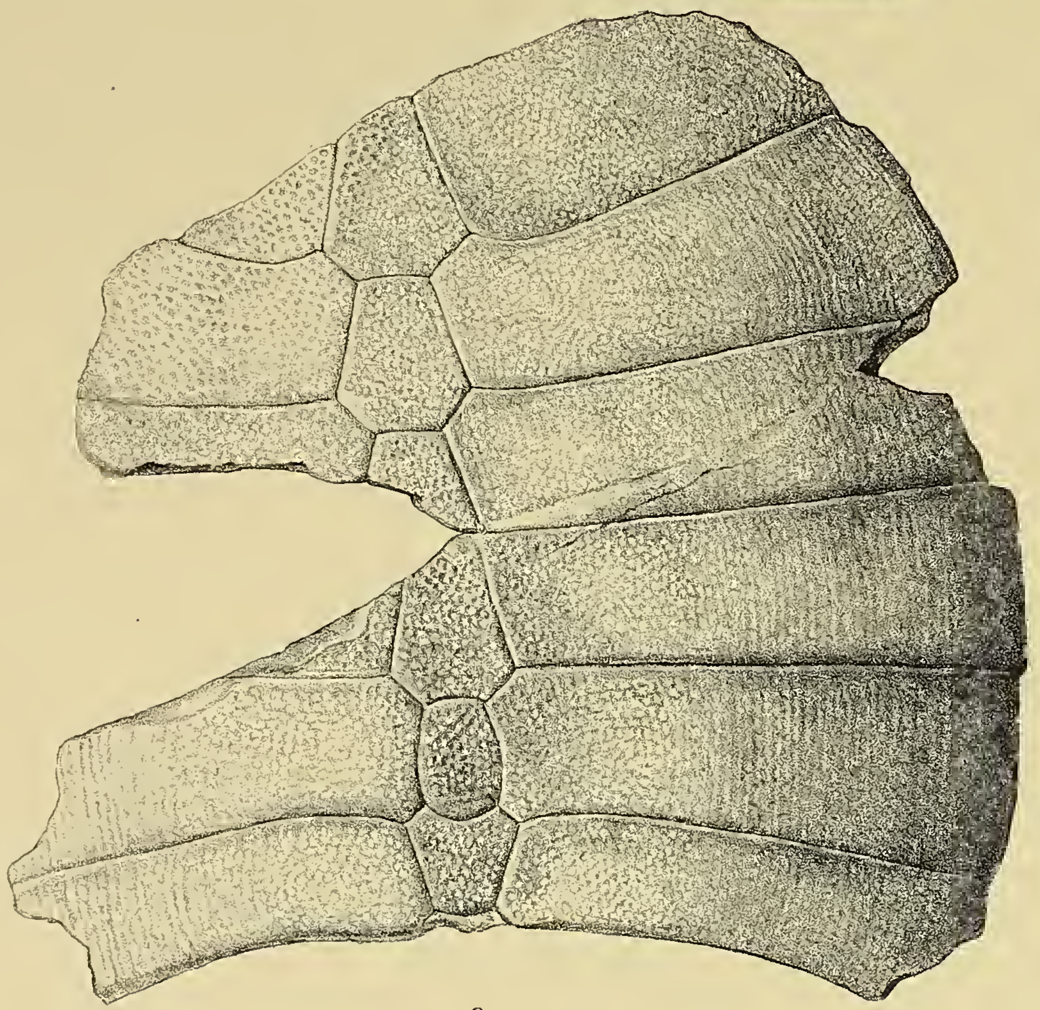

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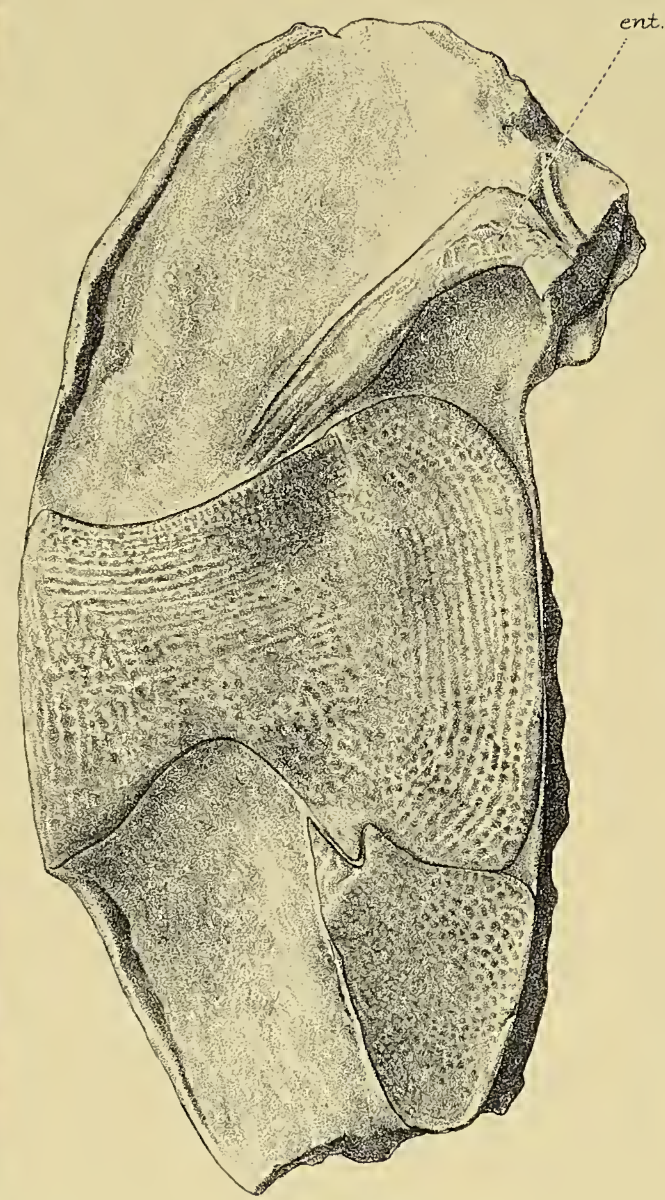

3

3 a.

PLATE XXVIII.

CROCODILIA — *Crocodilidæ.*

Figs. 1, 1a. CROCODILUS SIVALENSIS, Lyd. Cranium of a half-grown individual, viewed from the facial (1) and oral (1a) aspects; from the Siwalik Hills. British Museum (No. 39795).

,, 2, 2a. CROCODILUS PALÆINDICUS, Falc. Cranium of a sub-adult individual, viewed from the oral (2) and left lateral (2a) aspects; from the Siwaliks of Perim Island. Indian Museum (No. E. 31).

,, 3. CROCODILUS SIVALENSIS, Lyd. Skull of a half-grown individual, viewed from the left lateral aspect; from the Siwalik Hills. British Museum (No. 39798).

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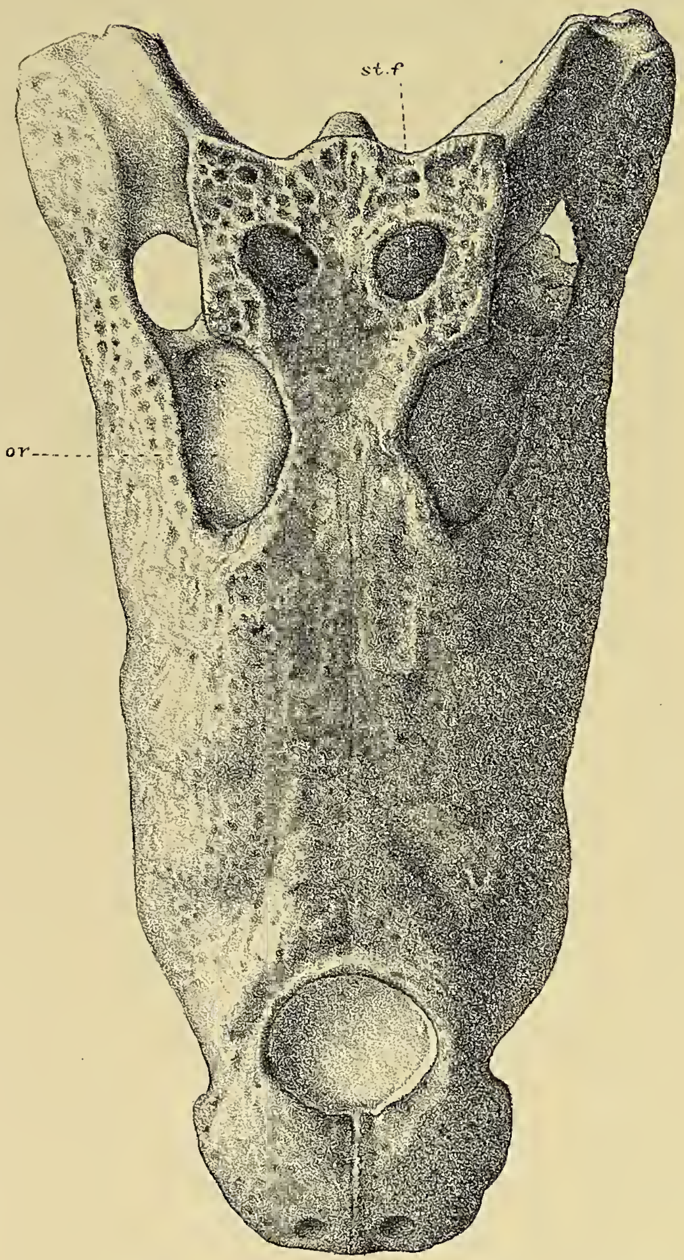
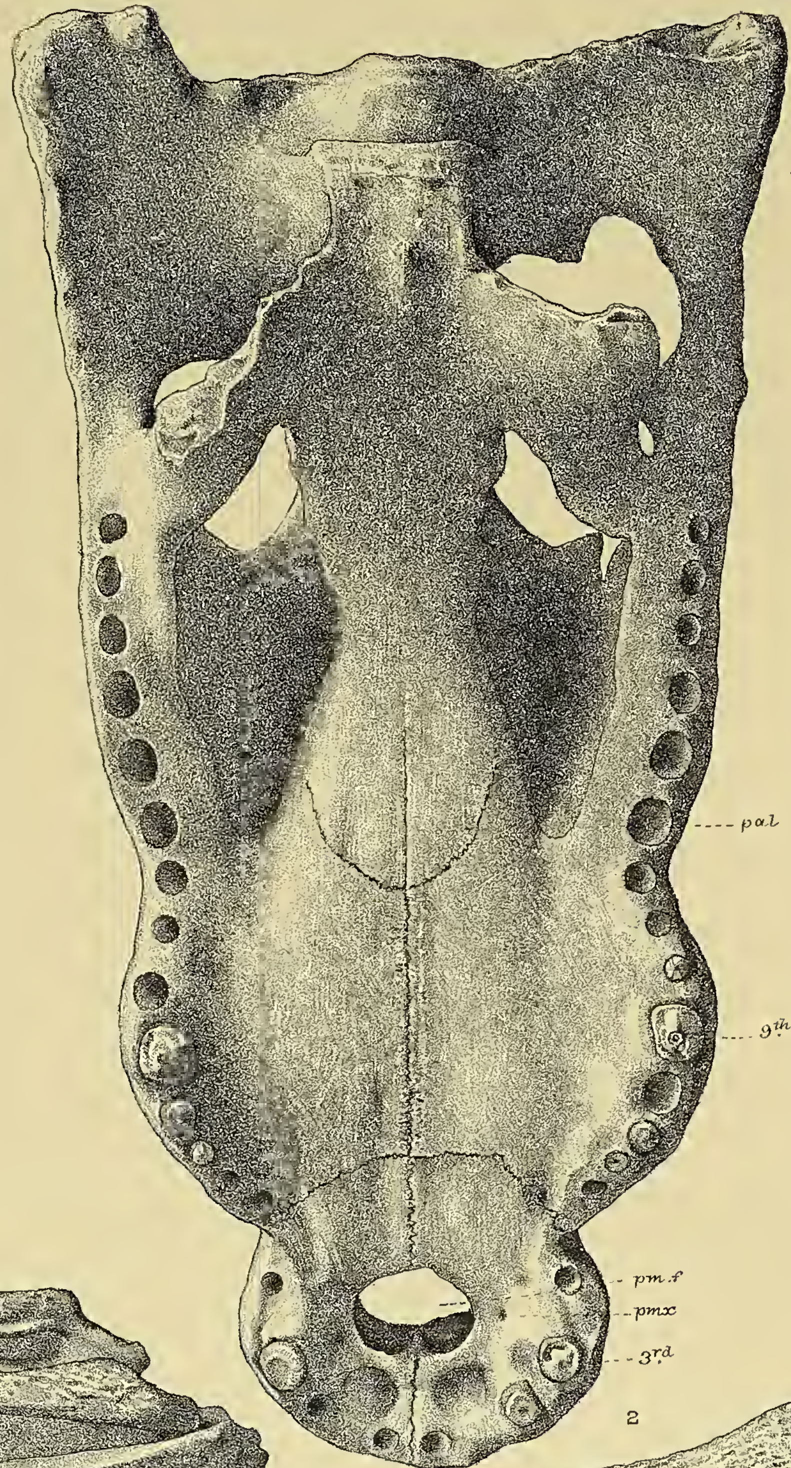
* Figs. 1, 1a, 2, $\frac{1}{3}$; figs. 2a. 3, $\frac{1}{4}$ nat. size. *or.* orbit; *pm. f.* premaxillary fissure; *pmx.* premaxilla; *st. f.* supratemporal fossa.



1



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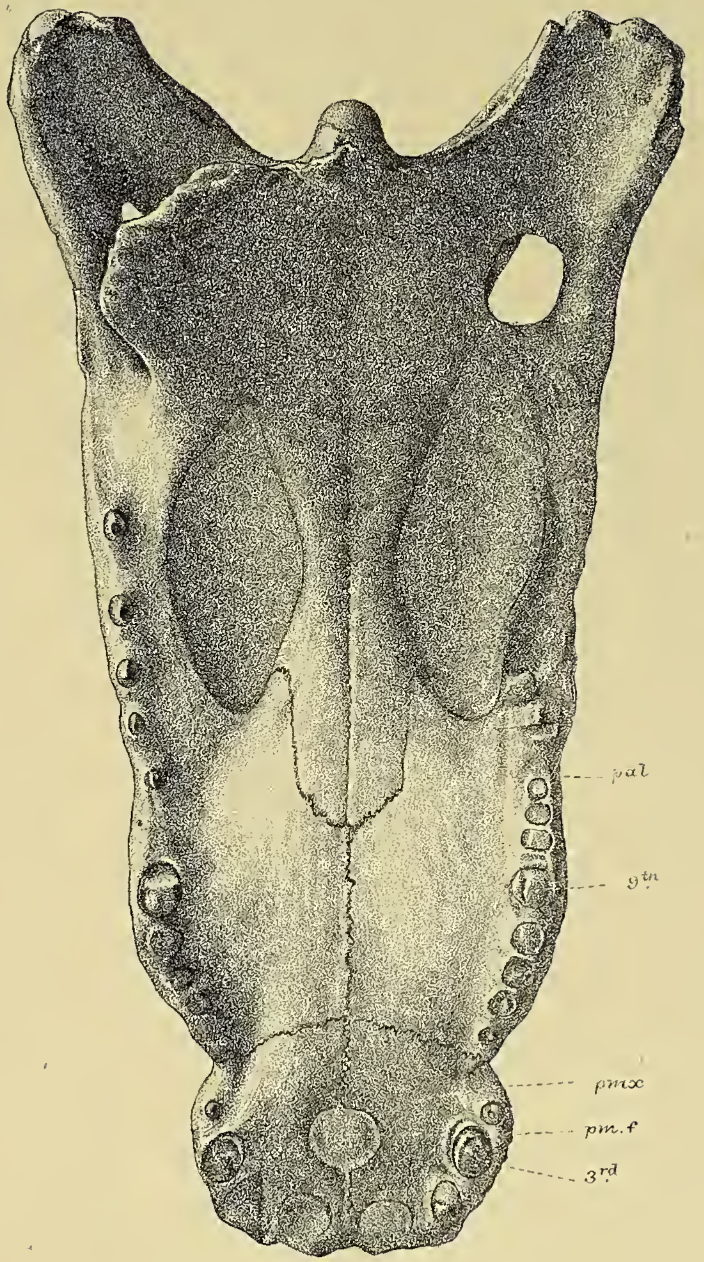
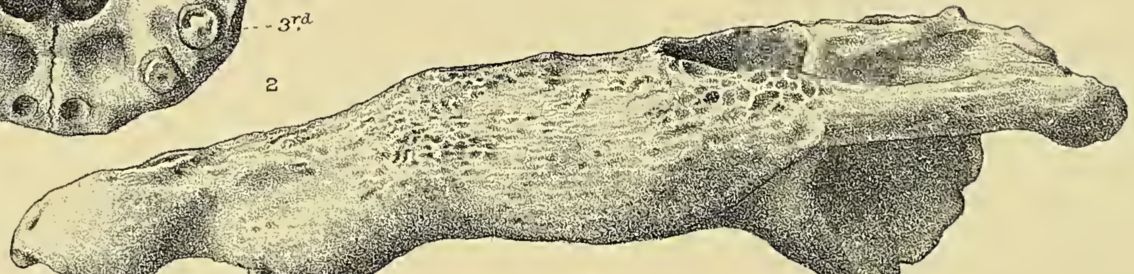


1a

3



2a

G. M. Woodward del. et lith. West, Newman & Co. imp.

PLATE XXIX.

CROCODILIA — *Crocodilidæ.*

Figs. 1, 1a. CROCODILUS PALUSTRIS, Lesson. Anterior half of the cranium of a half-grown individual, viewed from the facial (1) and oral (1a) aspects; from Bengal (recent).

,, 2, 2a. CROCODILUS SIVALENSIS, Lyd. Anterior half of the cranium of an adult individual, viewed from the facial (2) and oral (2a) aspects; from the Siwalik Hills. British Museum (No. 39800).

,, 3. CROCODILUS PALÆINDICUS, Falc. Facial aspect of the cranium represented in figs. 2, 2a of the preceding plate.

,, 4. (?) CROCODILUS SIVALENSIS, Lyd. The symphysis and part of the left ramus of the mandible, viewed from the oral aspect; from the Siwaliks of the Punjab. Indian Museum (No. E. 24).

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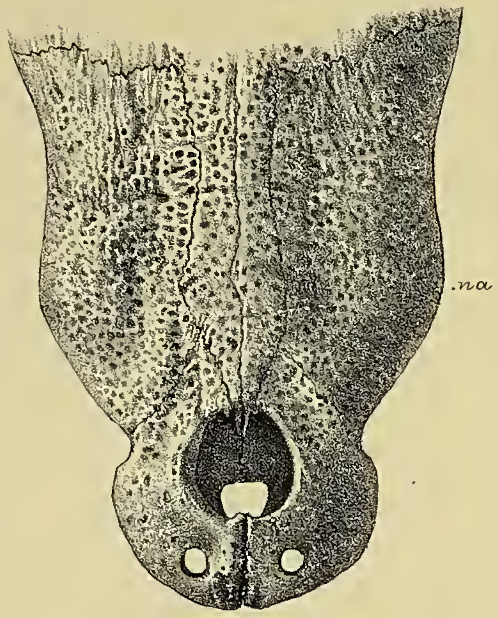
* Fig. 4, $\frac{1}{2}$, the rest $\frac{1}{3}$ nat. size. *na.* nasal; *or.* orbit; *pal.* palatine; *pm. f.* premaxillary fissure; *pmx.* premaxilla; *st. f.* supratemporal fossa.

TERTIARY VERTEBRATA



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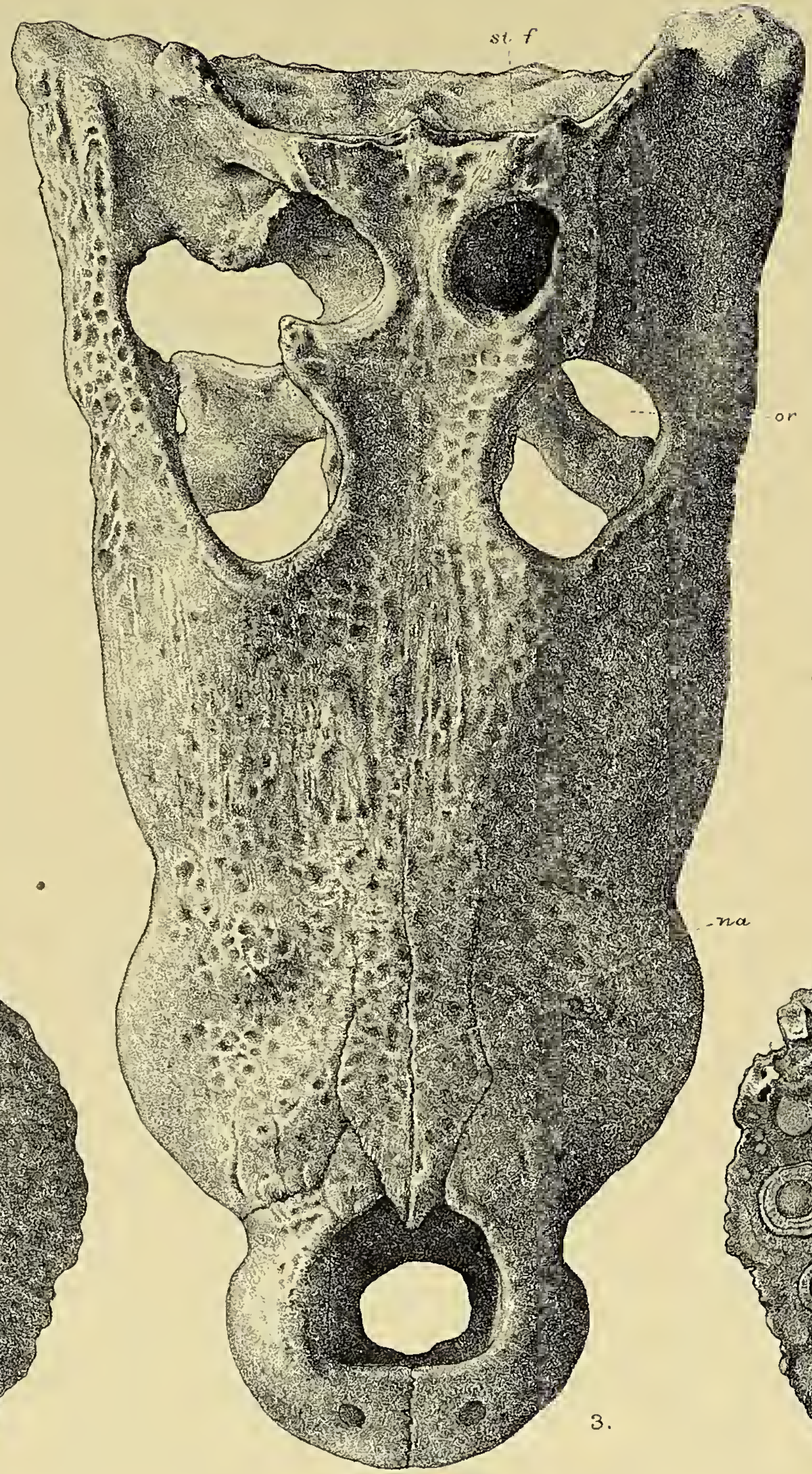

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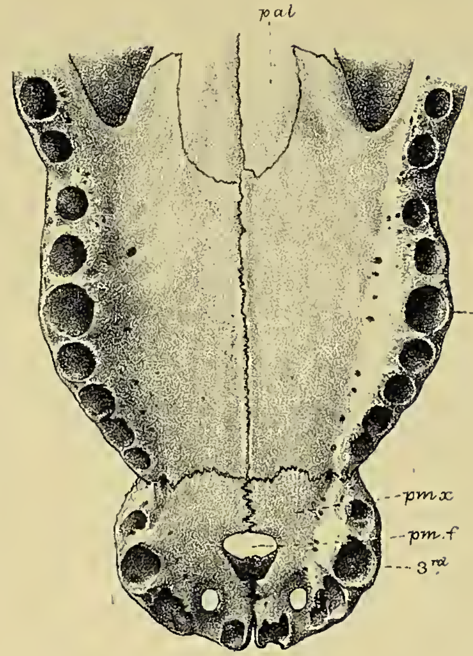
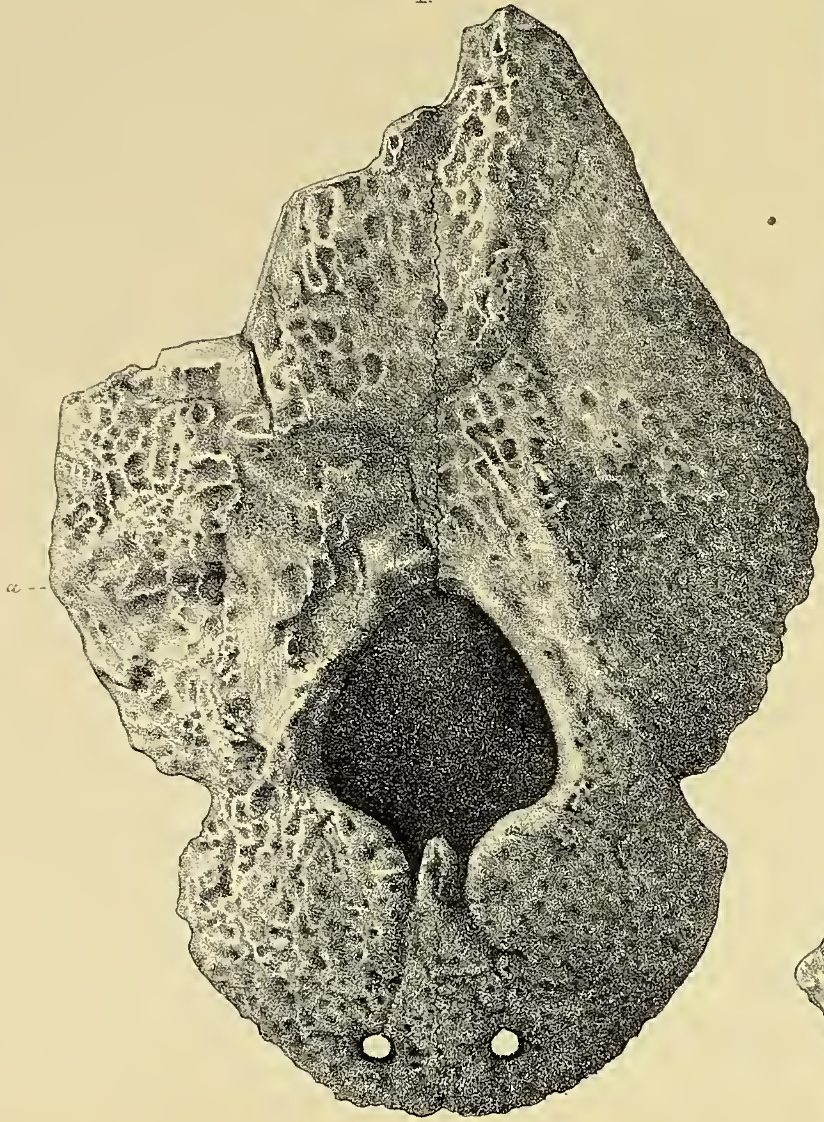


1a.



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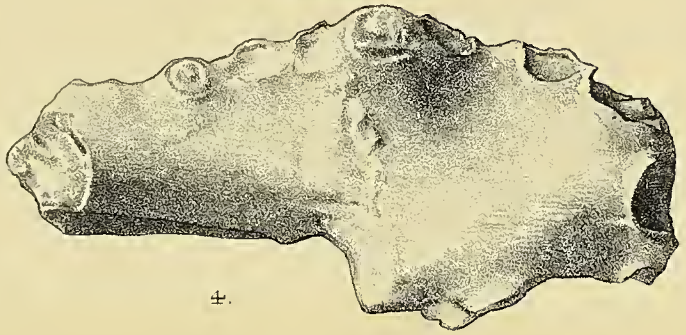
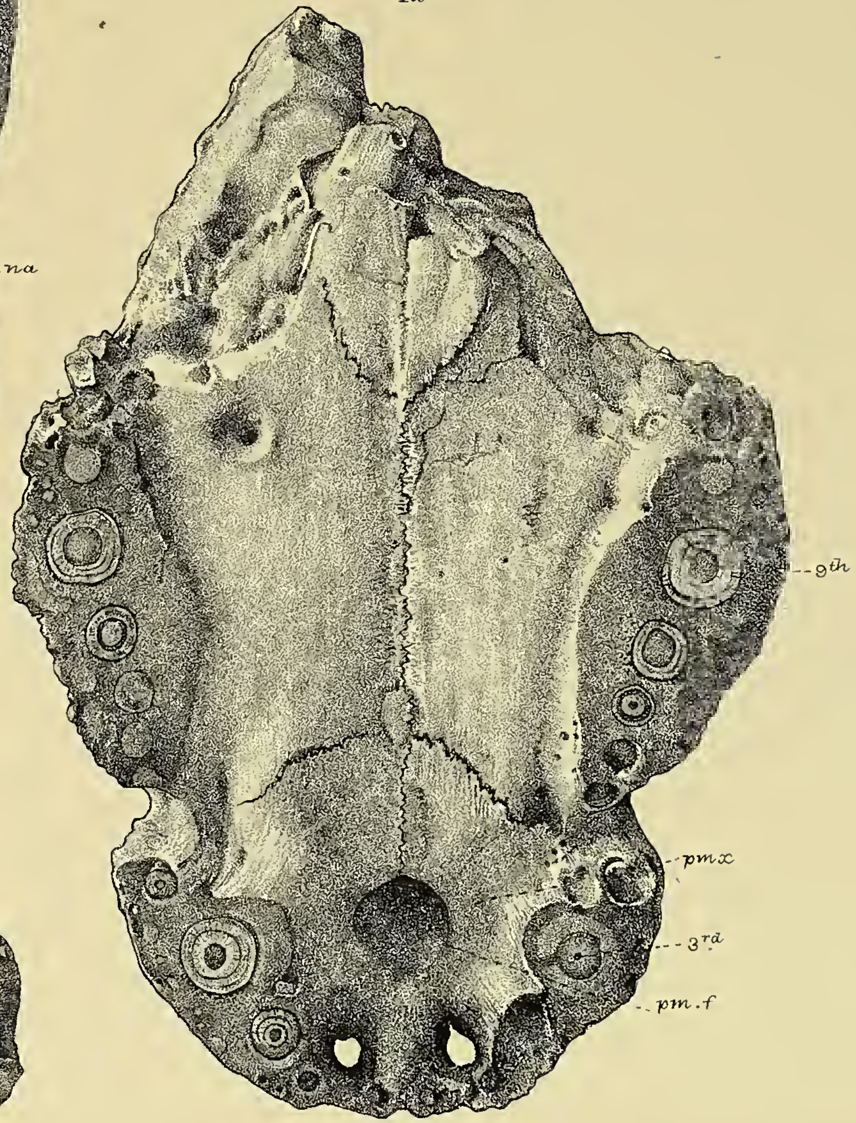


4.



2 a.

G.M. Woodward del.et.lith.

West, Newman & Co. imp.

PLATE XXX.

CROCODILIA — *Crocodilidæ.*

GHARIALIS GANGETICUS (Gmelin).

Fig. 1. Anterior portion of the skull of an adult, viewed from the facial aspect; from the Siwalik Hills. British Museum (No. 39811,a).

,, 2. Hinder part of the cranium of an adult, viewed from the facial aspect; from the Siwalik Hills. British Museum (No. 39809).

,, 3, 3a. The anterior portion of the cranium of an immature individual, viewed from the oral aspect; from the Siwalik Hills. 3a dental alveolus. British Museum (No. 39811).

,, 4, 4a. The anterior portion of the cranium of a half-grown individual, viewed from the facial (4) and oral (4a) aspects; from the Siwaliks of the Kangra district. Indian Museum (No. E. 14).

,, 5. Anterior part of the right ramus of the mandible, viewed from the oral aspect; from the Siwalik Hills. British Museum (No. 39812).

,, 6. Crown of the tooth of an adult; from the Siwaliks of the Punjab. Indian Museum (No. E. 215).

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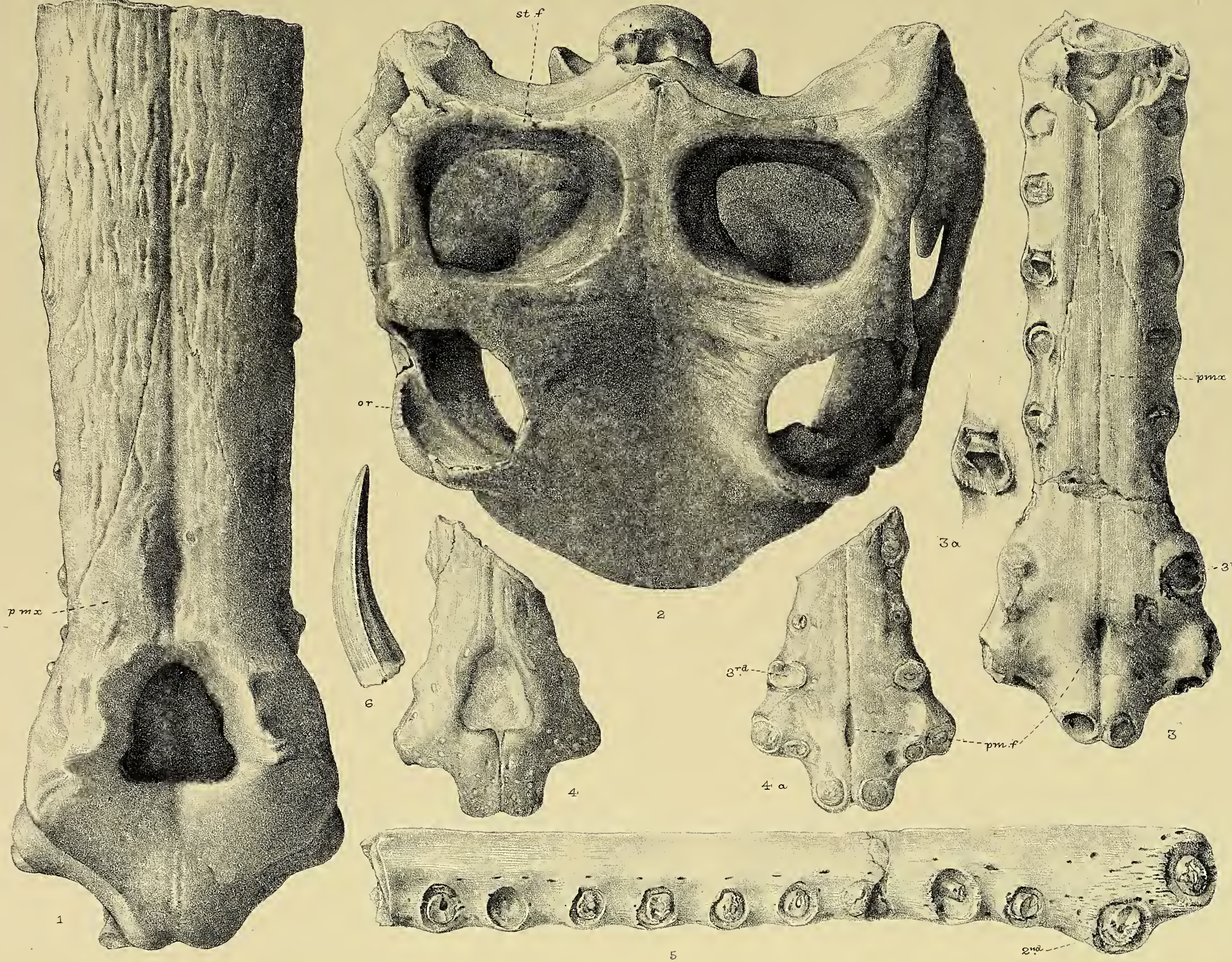
* Figs. 3a, 6 are natural size, the rest ½ nat. size. *or.* orbit; *pm. f.* premaxillary fissure; *pmx.* premaxilla; *st. f.* supratemporal fossa.



G.M. Woodward del. et lith. West, Newman & Co imp

PLATE XXXI.

CROCODILIA — *Crocodilidæ.*

Figs. 1, 1a, GHARIALIS CURVIROSTRIS, Lyd. Hinder portion of the cranium, viewed from the facial (1) and left lateral (1a) aspects ; from the lower Siwaliks of the Laki Hills, Sind. Indian Museum (No. E. 26).

,, 2, 2a, 2b, 2c. GHARIALIS CURVIROSTRIS, Lyd. Anterior portion of the cranial rostrum belonging to the same individual as the preceding specimen, viewed from the facial (2), oral (2a), and right lateral (2b) aspects ; 2c dental alveolus. Indian Museum (No. E. 26).

,, 3. (?) GHARIALIS HYSUDRICUS, Lyd. Hinder portion of the cranium of an adult, viewed from the facial aspect ; from the Siwalik Hills. British Museum (No. 39808).

,, 4. GHARIALIS, sp. (*cf. G. hysudricus*). Terminal portion of the mandibular symphysis, viewed from the oral aspect ; from Perim Island. Indian Museum (No. E. 28).

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* Fig. 2c nat. size, fig. 3 $\frac{1}{3}$, the rest $\frac{1}{2}$ nat. size. *a.* pits for mandibular teeth ; *mx.* maxilla : *or.* orbit ; *pm. f.* premaxillary fissure ; *pmx.* premaxilla ; *st. f.* supratemporal fossa.

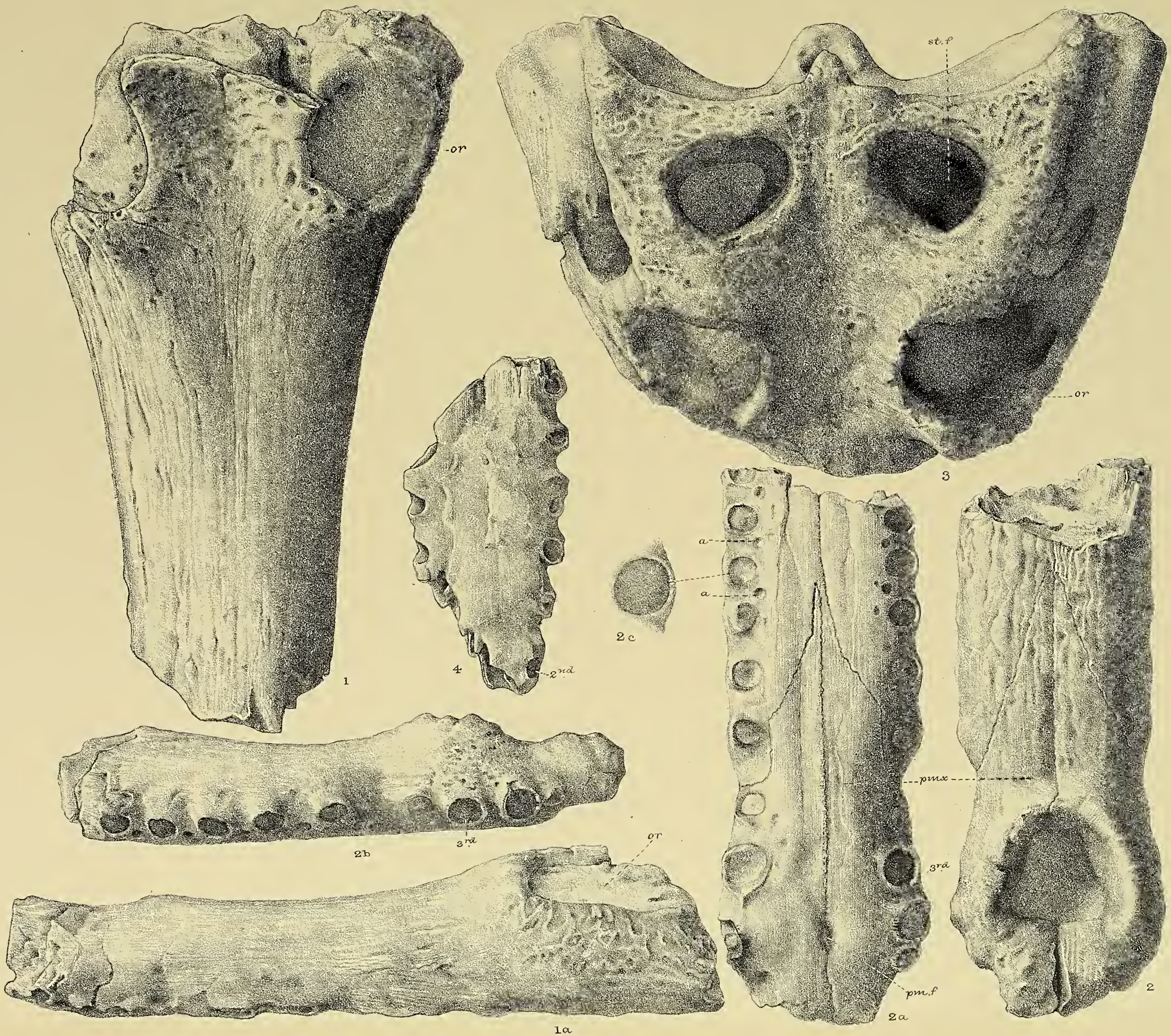
or
st.f
or
1
4
2nd
2c
a
a
3
2b
3rd
or
1a
pmx
3rd
pm.f
2a
2

PLATE XXXII.

CROCODILIA — *Crocodilidæ*.

Figs 1, 1a, 1b, 1c. GHARIALIS HYSUDRICUS, Lyd. The greater portion of the cranial rostrum, viewed from the facial (1), oral (1a), and right lateral (1b) aspects; 1c transverse section of anterior extremity; from the Siwalik Hills. British Museum (No. 39805).

,, 2, 2a. GHARIALIS LEPTODUS (Falc. and Caut.) Part of the mandibular rostrum, viewed from the oral (2) and right lateral (2a) aspects; from the Siwalik Hills. British Museum (No. 39806).

,, 3, 3a, 3b. GHARIALIS LEPTODUS (Falc. and Caut.) Hinder portion of the mandibular rostrum, viewed from the oral aspect (3), and in transverse section (3a); 3b shows the section of one tooth; from the Siwalik Hills. Indian Museum (No. E. 11).

,, 4, 4a. GHARIALIS LEPTODUS (Falc. and Caut.) Hinder part of the cranial rostrum, viewed from the oral aspect: 4a shows an alveolus and interdental pit of the full size; from the Siwaliks of the Punjab. Indian Museum (No. E. 12).

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* Figs. 1, 1a, 1b, 1c, $\frac{1}{4}$ nat. size; figs. 2, 2a, 3, 3a, 4, $\frac{1}{3}$ nat. size; and figs. 3b, 4a, natural size. *a.* pits for mandibular teeth; *pal.* palatine: *sp.* splenial.

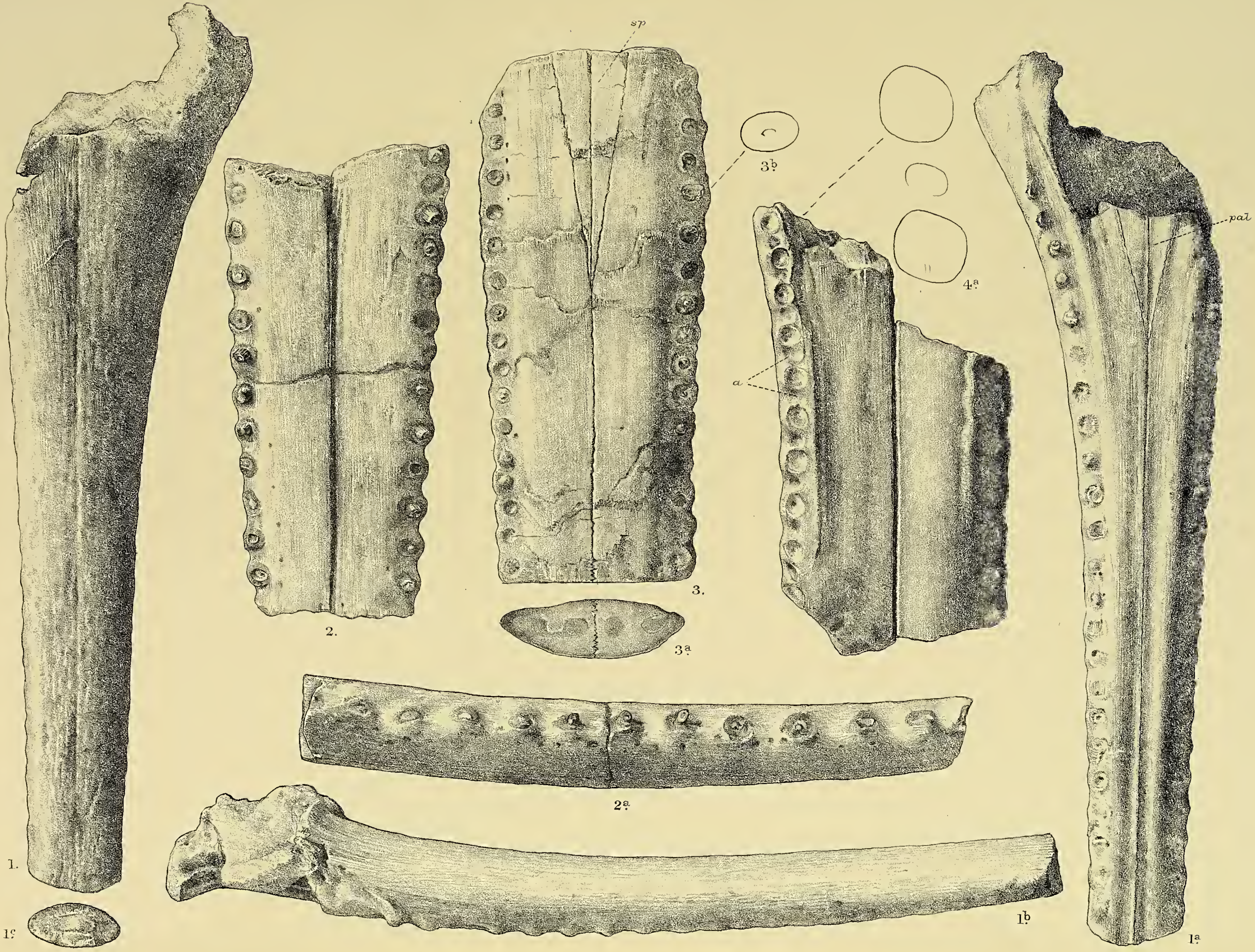

Fig. 2a. is ½ nat. size. (stated to be ⅓ in description.)

PLATE XXXIII.

CROCODILIA — *Crocodilidæ.*

Fig. 1, 1a, 1b. GHARIALIS PACHYRHYNCHUS, Lyd. Anterior extremity of the cranial rostrum, viewed from the facial (1), oral (1a), and left lateral (1b) aspects; from the lower Siwaliks of Sind. Indian Museum (No. E. 30).

,, 2, 2a. GHARIALIS PACHYRHYNCHUS, Lyd. Middle portion of the cranial rostrum, viewed from the oral (2), and left lateral (2a) aspects; from the lower Siwaliks of Sehwan, Sind. Indian Museum (No. E. 29).

,, 3. RHAMPHOSUCHUS CRASSIDENS (Falc. and Caut.) Anterior extremity of the mandibular symphysis, viewed from the palatal aspect; from the Siwalik Hills. Indian Museum (No. E. 214).

,, 4. GHARIALIS PACHYRHYNCHUS, Lyd. The crown of a tooth, with most of the enamel chipped off; from the Lower Siwaliks of Sind. Indian Museum (No. E. 216).

,, 5. RHAMPHOSUCHUS CRASSIDENS (Falc. and Caut.) A lower tooth provisionally referred to this species; from the Siwaliks of the Punjab. Indian Museum (No. E. 217).

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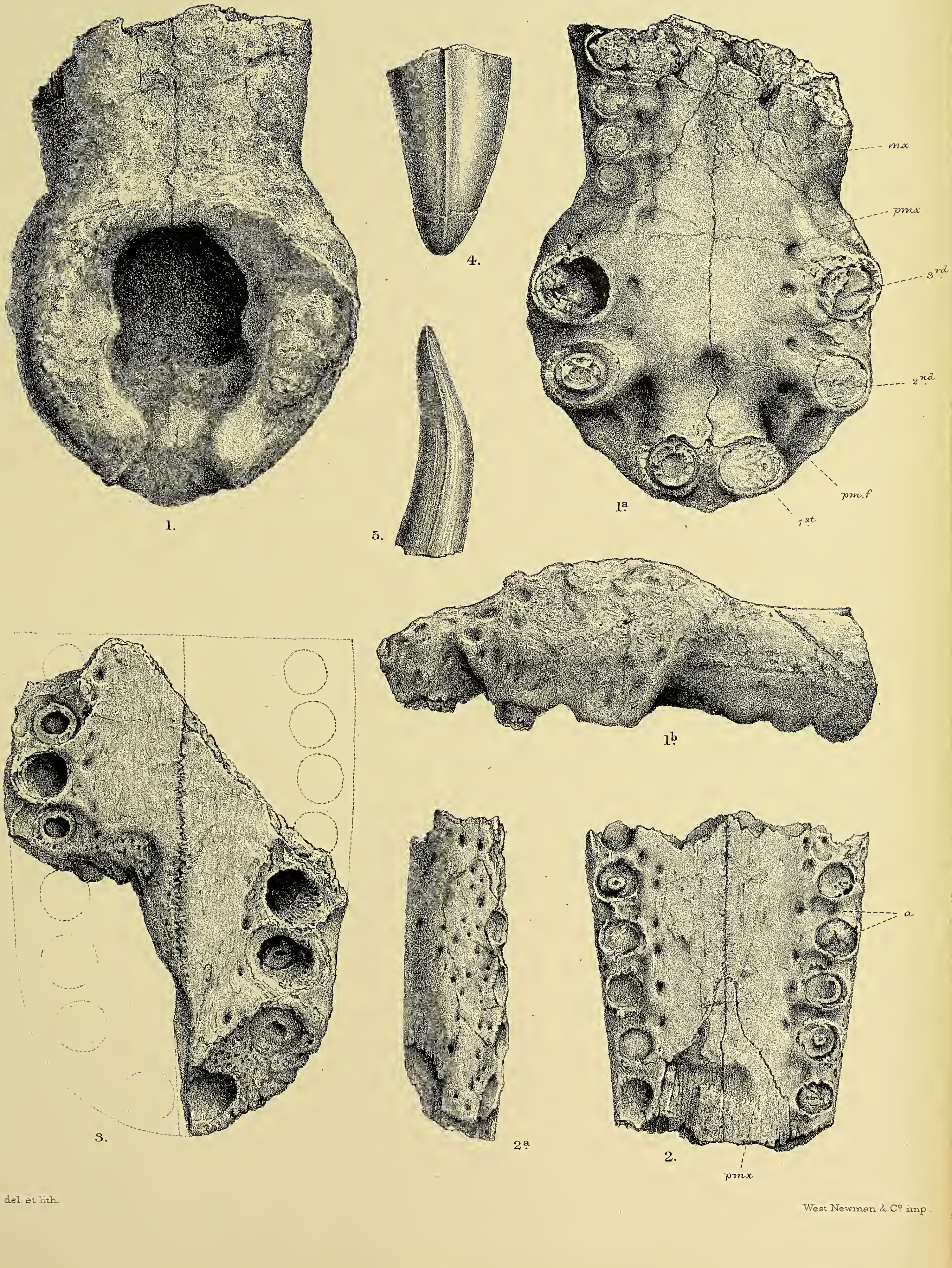
* With the exception of figs. 4 and 5, which are $\frac{1}{1}$, all the figures are drawn $\frac{1}{3}$ nat. size. *a.* inter-dental pits for mandibular teeth; *mx.* maxilla; *pm. f.* premaxillary fissure; *pmx.* premaxilla.



C. Berjeau del. et lith.

West Newman & Co. imp.

PLATE XXXIV.

CROCODILIA — *Crocodilidæ.*

RHAMPHOSUCHUS CRASSIDENS (Falc. and Caut.).

Figs. 1, 1a, 1b. The anterior half of the rostrum, viewed from the ventral (1), right lateral (1a) and facial (1b) aspects; from the Siwalik Hills. British Museum (No. 39802).

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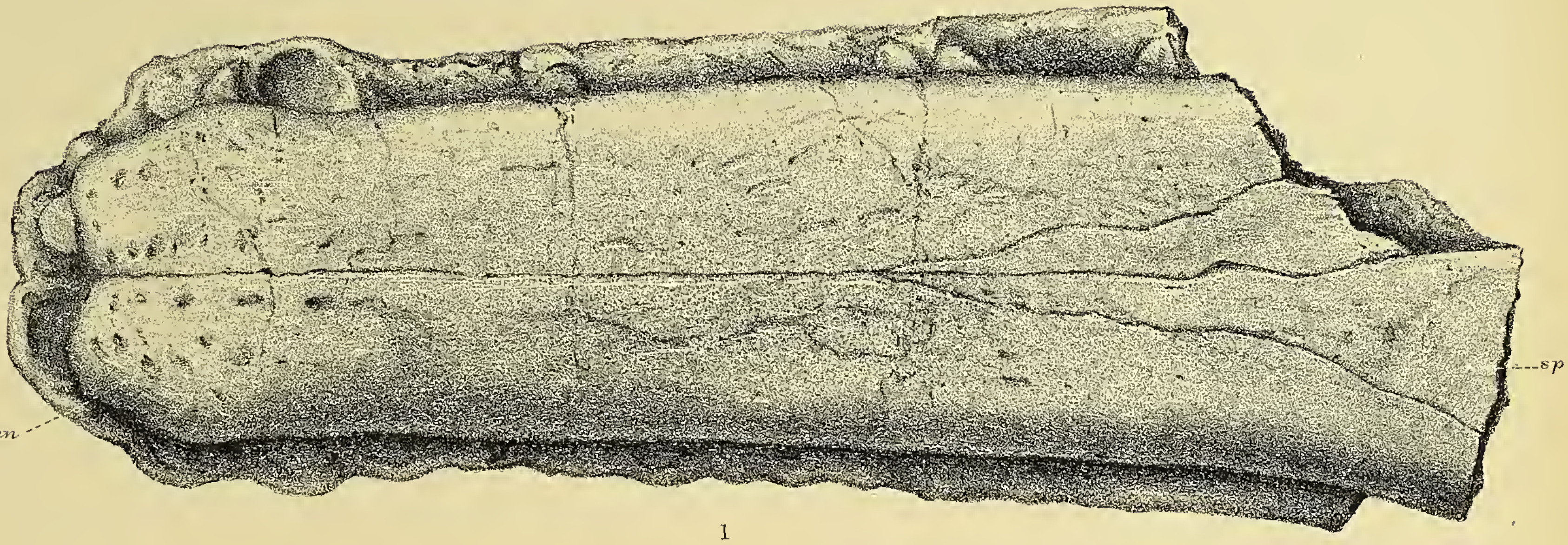
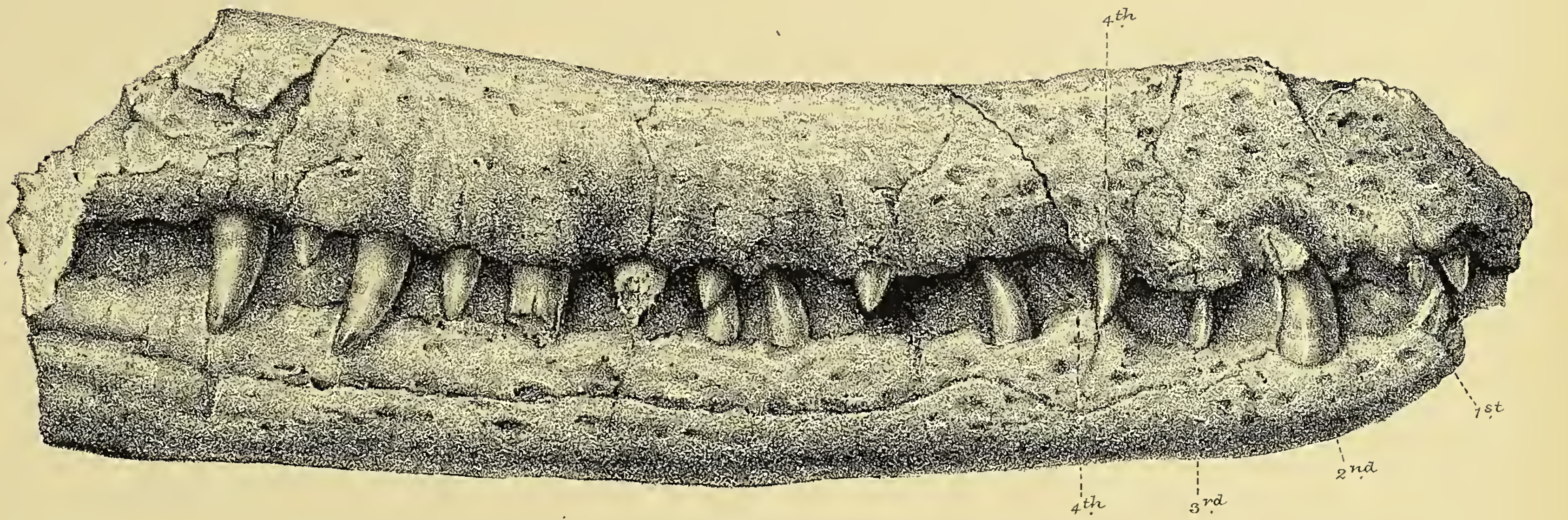
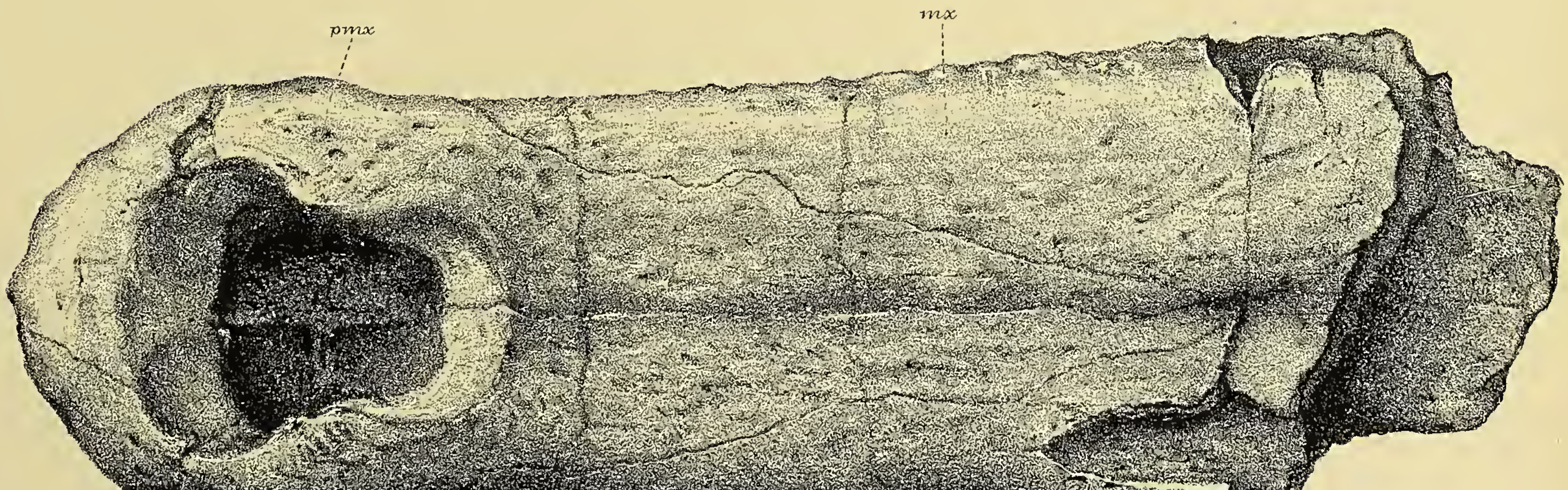
* The specimen is drawn of ⅓ nat. size. *den.* dentary; *mx.* maxilla; *pmx.* premaxilla; *sp.* splenial.



1



1a



1b

The scale is $\frac{1}{4}$ nat. size (stated to be $\frac{1}{3}$ in description.)

C. Berjeau del. et lith. West, Newman & Co. imp.

PLATE XXXV.

Reptilia and Pisces.

Figs. 1, 1a, 1b. Varanus sivalensis, Falconer. The distal portion of the right humerus, viewed from the palmar (1), dorsal (1a), and distal (1b) aspects; from the Siwalik Hills. *g.* entepicondyle; *h.* ectepicondyle; *i.* entocondyle; *k.* ectocondyle; *m.* entepicondylar foramen. British Museum (No. 40819).

,, 2. Python molurus (Linn). A cervical vertebra of a recent individual of about twenty feet in length, viewed from the left lateral aspect. *az.* prezygapophysis; *pz.* postzygapophysis; *ns.* neural spine; *t.* tubercle for rib; *c.* condyle of centrum; *hs.* hæmal spine. *zs.* zygosphene.

,, 3, 3a. Python molurus (Linn). A middle dorsal vertebra belonging to the same individual as the last, viewed from the posterior (3) and anterior (3a) aspects. *n.* neural canal; *c.* articular cup of centrum; *za.* zygantrum; other letters as in fig. 2.

,, 4. Python molurus (Linn). An early dorsal vertebra, viewed from the posterior aspect; from the Siwaliks of the Punjab. Indian Museum (No. E. 206). Letters as in figs. 2, 3.

,, 5, 6. Python (*cf.* molurus [Linn]). Two imperfect dorsal vertebræ, viewed from the anterior aspect; from the Siwaliks of the Punjab. Indian Museum (No. E. 205). Letters as in figs. 2, 3.

,, 7, 7a. Python (*cf.* molurus [Linn]). An early caudal vertebra, viewed from the posterior (7) and left lateral (7a) aspects; from the Siwaliks of the Punjab. Indian Museum (No. E. 205). Letters as in figs. 2, 3.

,, 8. Carcharodon, sp. Tooth; from the Siwaliks of Pegu. Indian Museum (No. E. 161).

,, 9, 9a. Myliobatis curvipalatus, Lyd. Part of upper (?) dental plate; from the eocene of Kach: from the grinding surface (9) and in transverse section (9a). Indian Museum (No. H. $\frac{35}{1}$). *a.* lateral teeth.

,, 10, 10a. Diodon foleyi, Lyd. Dental plate, viewed from the exposed (10), and embedded (10a) surfaces; from the eocene of Rámri Island. Indian Museum (No. H. $\frac{35}{3}$).

,, 11, 11a. Capitodus indicus, Lyd. Incisiform tooth, viewed from the outer (11), and inner (11a) aspects; from the eocene of the Punjab. Indian Museum (No. H. $\frac{35}{2}$).

,, 12, 13. Carcharias, sp. Upper teeth; from the Siwaliks of the Punjab. Indian Museum (No. E. 160).

,, 14, 15 Carcharias, sp. Lower teeth; from the Siwaliks of the Punjab. Indian Museum (No. E. 160).

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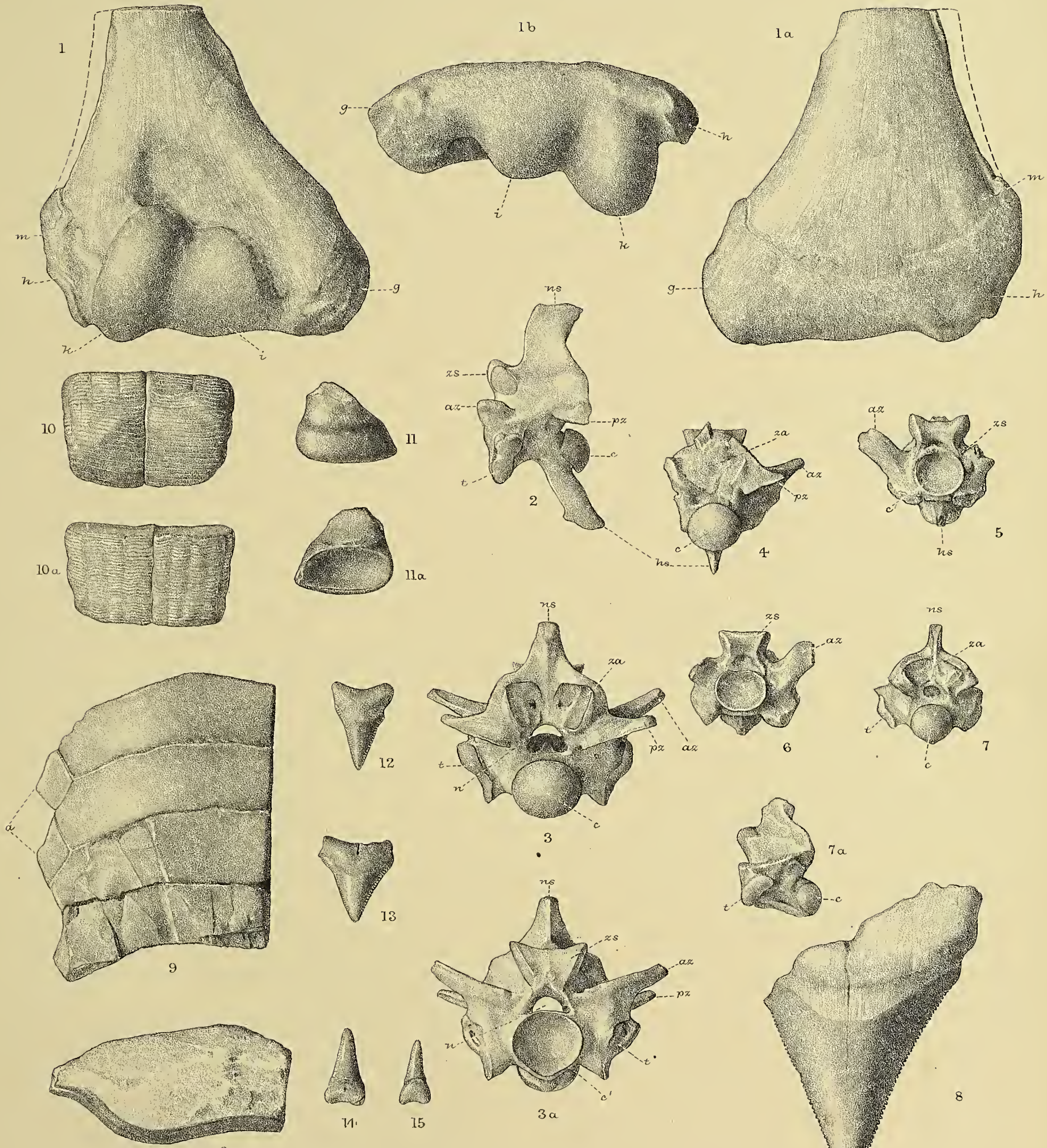
* All the figures are drawn of the natural size.


1
1b
1a
2
3
3a
4
5
6
7
7a
8
9
9a
10
10a
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11a
12
13
14
15

PLATE XXXVI.

PISCES — *Siluridæ.*

Fig. 1, BAGARIUS YARRELLI (Sykes). Anterior part of skull; from the Siwalik Hills. Indian Museum (No. E. 155).

,, 2. ARIUS, sp. Hinder part of cranium, restored in outline from *A. latiscutatus*; from the Siwalik Hills. British Museum (No. 16402, a).

,, 3. HETEROBRANCHUS INTERMEDIUS, Günther. Skull; from the Nile at Khártúm. British Museum.

,, 4. HETEROBRANCHUS PALÆINDICUS, Lydekker. Skull; from the Siwalik Hills. British Museum (No. 16402, c).

,, 5. MACRONES AOR (Buch. Hamilton). Skull; from the Siwalik Hills. British Museum (No. 40822).

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* Figs. 3, 4, nat. size; figs. 1, 2, $\frac{1}{2}$ nat. size; fig. 5, $\frac{2}{3}$ nat. size. *a.* supraoccipital, and *b.* frontal vacuity; *e.* articular surface for barbel; *eth.* ethmoid; *fr.* frontal; *na* anterior, and *ná* posterior narial aperture; *or.* orbit; *sup.* supraoccipital process; *tu.* turbinal.

G.M. Woodward del. et lith.

West, Newman & Co. imp.

PLATE XXXVII.

Pisces — *Siluridæ, Ophiocephalidæ, etc.*

Fig. 1. Clarias falconeri, Lydekker. Middle portion of skull; from the Siwalik Hills. British Museum (No. 16402, b).

,, 2. Ophiocephalus, sp. Skull; from the Siwalik Hills. British Museum (No 16402).

,, 3. Rita grandiscutata, Lydekker. Basal bone of dorsal spine; from the Siwaliks of the Punjab. Indian Museum (No. E. 157).

,, 4. Chrysichthys (?) theobaldi, Lydekker. Hinder portion of cranium; from the Siwaliks of the Punjab. Indian Museum (No. E. 158).

,, 5. Chrysichthys macrops, Günther. Skull; from the Nile at Khártúm. British Museum.

,, 6. Rita crucigera (Owen). Hinder part of cranium and basal bone of dorsal spine of a young individual; from the Ganges. British Museum.

,, 7. Arius (?), sp. The right palatine; from the Siwaliks of the Punjab. Indian Museum (No. E. 164).

,, 8. Arius (?), sp. The imperfect right palatine; from the lower Siwaliks of Sind. Indian Museum (No. E. 162).

,, 9, 9a. Selachoid, gen. *non. det.* Vertebra; from the Siwaliks of Perim Island. Indian Museum (No. E. 218).

,, 10, 10. Siluroid, gen. *non. det.* Part of spine of a fin; from the Siwaliks of the Punjab. Indian Museum (No. E. 202).

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* Fig. 3, ½ nat. size; the others nat. size. *a.* supraoccipital, and *b.* frontal vacuity; *ba.* basal bone of dorsal spine; *c.c.d.* articular processes; *eth.* ethmoid; *fr.* frontal; *mn.* mandible; *or.* orbit; *sup.* supra-occipital process.

G. M. Woodward del. et lith.

West, Newman & Co. imp.