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PLATES I AND II.

THE PERISSODACTYLA OF THE EOCENE OF BURMA

By

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Superintendent, Geological Survey of India.

During the field season 1920-21, Sub-Assistant H. M. Lahiri and, for a portion of the time, Sub-Assistant B. B. Gupta were engaged in collecting fossil mammals from the Pondaung Sandstones of the Pakokku district in Burma, from which Cotter obtained the original specimens of Eocene age, which formed the subject of a joint paper [1] by Cotter and myself.

Amongst the most important of the new material now available is that belonging to the Perissodactyla, representing the families of the *Titanotheriidæ*, the *Amynodontidæ* and the *Tapiridæ*. A description of this [2] is undertaken in the present paper. A greater interest attaches to these specimens than to the *Anthracotheriidæ*, because of the affinities which they present both to European and American species of Eocene age. Numerically, however, they bear no comparison with the *Anthracotheriidæ* which occur in this deposit. Some valuable specimens of the latter family have also been collected; these will form the subject of a later communication.

The affinities of the species now described provide additional evidence of the Bartonian or Ludian age of the deposits, while the indications favour a correlation with the earlier rather than with the later portion of this period. At the same time, I would suggest that the older affinities of many of the species are explainable on the hypothesis that they represent an independent local, but parallel, evolution from Middle or even Lower Eocene migrants from the Holarctic region.

With these brief introductory remarks I shall pass on to the detailed description of the material. I cannot, however, omit to acknowledge the kindness of Sir Arthur Smith Woodward of the British Museum of Natural History and of Dr. H. G. Stehlin of the Naturhisorisches Museum at Basel in putting at my disposal much material which was most valuable for purposes of comparison.

Family : *TITANOTHERIIDÆ.*

A few fragmentary teeth contained in Cotter's collections of 1914, were assigned without hesitation to this family,[3] although the imperfect nature of

[1] Pilgrim and Cotter, Eocene Mammals from Burma, *Rec. Geol. Surv. Ind.*, Vol. XLVII, p. 72 (1916).

[2] The specimens referred to in the text are in the Geological Museum, Calcutta, unless otherwise stated. The numbers quoted are those under which they have been registered in the Geological Survey of India collections.

[3] Pilgrim and Cotter *op. cit.* p. 72, Pl. V, figs. 2-11.

the material forbade more than a provisional generic reference. In naming them *Telmatherium* (?) *birmanicum* the authors of the paper quoted were guided, more by a reluctance to leave the described specimens unclassified, and an even greater reluctance to make them the types of a new genus, than by any sure belief that they really represented the American genus *Telmatherium*. In certain quarters some doubt has been expressed as to whether the specimens were really Titanotheroid. This was natural, perhaps, especially as some palæontologists regarded it as by no means certainly proved that the family of the *Titanotheriidæ* ever existed outside of America. On the other hand those who have accepted the reference to that family of *Brachydiastematherium transilvanicum* Böckh and Maty,[1] *Titanotherium rumelicum* Toula[2] and *Titanotherium bohemicum* Kiernik [3] will not find it surprising that representatives of it should be found in a locality still nearer the land of their origin.

Within the last year further confirmation of the migration of the Titanotheres out of America has been afforded by a notice regarding the discovery of a Titanothere in China by the American Expedition of 1922. A lower jaw has been taken by Osborn [4] as the type of a new species of *Protitanotherium*.

During the field season of 1920-21 B. B. Gupta brought back from the Pakokku district a fragmentary Titanothere skull, not found *in situ*, but which, from information received at the time, he thinks was originally embedded in the Yaw series, immediately overlying the Pondaungs. No mammalian remains have so far been found in the Yaws, and it would be satisfactory to have further proof of the horizon of the skull. It may be referred to the same species as some of the remains already described by Pilgrim and Cotter.

H. M. Lahiri collected from the Pondaung Sandstones of the Pakokku district several additional teeth of Titanotheres, some of which, though not actually found in position in the maxilla or mandible, were so associated as to suggest the possibility that they belonged to the same individual. In one case the number of these associated specimens is sufficient to enable me to decide definitely that this Burma Titanothere cannot be classed under any of the American genera hitherto described. These have been taken as the types of a new genus *Sivatitanops*. At least three other species are represented in the collection. Of these, the skull mentioned above, along with the previously figured upper premolar collected by Cotter, may be known as *Sivatitanops birmanicum* Pilg. and Cott.

The second may provisionally be referred also to *Sivatitanops*, and the third to the American genus *Eotitanotherium* Peterson, with which a single specimen of p^2 and some fragmentary molars show sufficient affinity to justify the provisional reference as a preferable alternative to establishing a new genus on meagre material. Certain lower premolars associated with a canine invite a reference

[1] Böckh, *Mitt. Jahr. k. Ungarn. Anstalt* IV (1876), p. 125 and Vacek, *Verhandl. d.k.k. Geol. Reichs.* (1877), p. 54.

[2] Toula *Sitzungsber. d.k. Akad. Wiss. Wien. Math-Naturw.* Kl. Bd. 101, Abt. 1 (1892).

[3] Kiernik, *Bull. Internat. Acad. Sci. Cracovie* (1912) Ser. B, pp. 1211-1225.

[4] Osborn, Titanotheres and Lophiodonts in Mongolia. *American Museum Novitates* No. 91, October 1923.

to *Brachydiastematherium transilvanicum* Böckh and Maty, but as the upper dentition of that species is unknown and in view of the fact that it comes from an older horizon than the Pondaung sandstones, it seems more convenient to regard our jaw as belonging to *Sivatitanops*. Should the upper dentition of *Brachydiastematherium*, when discovered, prove to be nearly related to that of *Sivatitanops*, it will be necessary to abolish the latter name in favour of that given by Böckh and Maty to the Transylvanian jaw.

Before describing these specimens in detail and comparing them with other Titanotheres, it will be as well to state briefly what particular points in their structure render it impossible to regard them as Chalicotheroid, the only other family to which they could be assigned if they do not belong to the *Titanotheriidæ*.

1. In all known Chalicotheroids the metacone and the hypocone in the upper molars are united by a transverse crest. In the Burma molars these two cusps are separated by an open valley.

2. In the premolars of all known Chalicotheroids the inner lobe is united to the external lobe either by one or by two transverse crests. In the Burma premolars the transverse valley is open, except for slight ribs internal to the exterior lobes in p^4 and p^2, and quite open in p^3.

3. In all Chalicotheroids the protocone and the tritocone in the premolars have united to form an almost undifferentiated ectoloph. In the Burma premolars the two cusps can be plainly separated.

4. P^1 is absent in all known Chalicotheroids. It is presumed to be present in the Burma species.

5. An upper canine is wanting in the Chalicotheres, while the lower canine, if present, is of a simple subconical shape, without lateral ridges or basal cingulum, as is the case in the Burma specimens.

6. Upper incisors have not been observed in any Chalicothere. In certain genera they are known to be absent, and most probably are wanting in all genera. In the Burma species they are present to the full mammalian complement.

7. It may further be mentioned that the p^2, which is referred to *Eotitanotherium*, has two separate internal cusps, a condition which is never found in any Chalicothere.

Genus: SIVATITANOPS gen. nov.

The two species of Titanothere now described under the names of *Sivatitanops cotteri* n. sp. and *Sivatitanops birmanicum* Pilg. and Cott., the former of which is represented by certain more or less associated single teeth, and the latter by an imperfect skull, share in common some peculiar characters which seem not to occur in any other hitherto described species. These mainly consist in the conformation of the antero-internal angle of the molars and in the shortening of the anterior facial region. It does not, therefore, seem feasible to separate these two species generically. The skull is of the greatest value not only because it affords confirmatory evidence of the correct association of the various single teeth which are referred to the species *Sivatitanops cotteri*, but also because it supplies us with additional information regarding the cranium and the dentition, which would otherwise be lacking. At the same time the skull is far too unsatisfactorily preserved to enable us adequately to define the new genus from it alone. Under these circumstances the diagnosis of the new genus *Sivatitanops* will be made from the characters of the various specimens which may be referred with more or less of certainty to either of the two species.

Sivatitanops is a Titanothere possessing a short, broad facial region, with widely expanded zygomata and a stoutly built jugal process. The presence or absence of horns is unknown, but if present, they must have been merely in an incipient condition. The infra-orbital foramen is large and situated directly over p^4. The posterior nasal foramina open opposite m^3. The molar series greatly exceeds in length the premolar series. The latter is much reduced: in the species *S. birmanicum* p^1 is absent, and there is no diastema between the canine and p^2. M^3 is as large as m^2 and possesses a well-marked hypocone. All the molars are rectangular in outline; in front of the protocone is a broad cingular shelf, elevated into a cusp which is much more prominent than in the genus *Titanotherium*. Running backward from the cusp, along the median valley, is a rugose ridge, which may represent a rudimentary protoconule. Internal cingulum absent. Premolars in a merely incipient stage of molarization; tetartocone scarcely differentiated from the cingulum, and without marked ridges connecting the deuterocone to the ectoloph; p^2 with a broad posterior cingular shelf; p^1, if present, a small elongate tooth, without an internal lobe.

Canine large, with antero-posterior ridges passing down into a strong basal cingulum.

Incisor series complete. Incisors large; i^2 the smallest of the three; elongate transversely, with a convex external surface and an internal ridge, without a distinct cingulum.

Sivatitanops is sharply distinguished from all members of the subfamily of the *Titanotheriinæ* which may be taken as exclusively Oligocene, by the strong development of the incisors, which are high crowned and show no sign of the degeneracy which is characteristic of the Oligocene Titanotheres. In the latter the incisors are low-crowned button-like teeth, and are merely rudimentary. Side by side with this degeneracy of the incisors goes the molarization of the premolars, which has hardly begun in the Indian genus. A tetartocone is entirely absent in p^2 and in p^3 and p^4 is quite immature and scarcely noticeable; p^1 [if the specimen C. 336 is correctly identified] has no internal lobe at all. *Megacerops*, it is true, shows very much less molarization than the other genera of the sub-family, but even here the tetartocone is much stronger than in *Sivatitanops*. In p^2 and to a smaller extent in p^3 and p^4 a ridge unites the protocone to the external lobes, of which there is no trace in the Burma species, while a pronounced internal lobe is present in p^1.

In *Protitanotherium*, *Diplacodon* and *Eotitanotherium*, which may be regarded as representing a type of development intermediate between the *Palaeosyopinae* and the *Titanotheriinae*, while the incisors retain their functional character in a greater degree, the molarization of the premolars has proceeded almost as far as in the Oligocene genera. The character of the canine of *Sivatitanops*, with its almost antero-posterior ridges, passing down gradually into a strong basal cingulum, is altogether different from what we observe in any of the *Titanotheriinæ* or in *Protitanotherium*, *Eotitanotherium* and *Diplacodon*.

Comparing *Sivatitanops* with the earlier genera of the lower Eocene, it is obvious that the Burma genus is in a much more advanced stage of development. This is shown amongst other features by the height of the external lobes, the acuteness and constriction of the external buttresses, the weakness of the intermediate conules, the commencement of molarization of the premolars and the specialization of the canine and incisors, which in *Palaeosyops* are simpler and more regularly conical, with an entire absence of cingulum and lateral ridges.

From *Manteoceras*, *Telmatherium* and *Dolichorhinus*, *Sivatitanops* is distinguished :—

(1) by the presence of a hypocone in m^3 ; (2) by the fact that the incisors have not a cup-shaped cingulum; (3) the canine has much more pronounced lateral ridges and basal cingulum.

It seems possible to conclude that *Sivatitanops* is a representative of a special line of which the ancestral form may have been a brachycephalic lower Eocene species of *Palæosyops*, which migrated to Asia. Its development then proceeded in a direction parallel to *Manteoceras* and *Protitanotherium* with specially adapted canines and incisors. Apart from these special features the Burma species would seem to have reached a stage of development nearly identical with *Dolichorhinus* and *Telmatherium*, which would agree well with the upper Eocene age assigned to the Pondaung sandstones by Cotter.

Sivatitanops cotteri sp. nov.

Pl. I, figs. 3-6, 9 ; Pl. II, figs. 4, 5.

The types of this species are the following upper teeth, which were collected by H. M. Lahiri in the Myaing township of the Pakokku district, 6½ furlongs distant from Hill 1258 and in a direction 9° W. of S. from it :— a second upper molar, a second and third premolars, and an upper canine. These are registered under the numbers C. 330—333. From ¼ mile W. of Pangan village in the same township, Lahiri obtained a last upper premolar, which resembles the type third premolar sufficiently nearly as to leave hardly any doubt that it belongs to the same species. With this were associated an incisor and a small two rooted tooth, which is presumed to be first premolar. These are registered C. 334—336. Associated with some fragmentary molars which seem to be almost identical in character with the types, B. B. Gupta found another incisor, smaller than the one just mentioned and probably occupying a different position in the jaw. This came from 1½ miles W. of Mogaung in the Lower Chindwin district and is registered C. 337. As the general conformation of most of the teeth is typically Titanotheroid, I need only describe them in so far as peculiarities of structure serve to ally them to or differentiate them from known genera.

Upper Molars.—M^2, which is the only one of the series known, is a very long tooth. Its antero-posterior exceeds its transverse diameter to a much greater degree than I have found in any hitherto described species of Titanothere. The only two genera which approach it in this particular are *Dolichorhinus* and *Titanotherium*. This character is not inconsistent with brachycephaly. The crown is moderately high; the external Vs are well developed and angular, while the prominent median buttress is strongly constricted off and of equal width from the apex to the base. This character sharply distinguishes *Sivatitanops* from *Lambdotherium*, *Palaeosyops* and other genera of the Lower Eocene, in which the buttress is rounded; it is precisely the condition which exists in *Manteoceras*, *Telmatherium* and *Dolichorhinus*, as well as in the Oligocene sub-family of the *Titanotheriinæ*. The basal portion of the crown slopes inward very slightly; but half way down the obliquity increases considerably, so that both the buttresses and the surface of the lobes between them are convex in a vertical direction. There is a slight trace of a median rib in both lobes. The internal lobes, protocone and hypocone are approximately equal in size and sub-conical. The line joining the protocone to the paracone is exceedingly oblique. This obliquity does not affect the rectangular outline of the tooth, because in front of the protocone is a great extent of surface occupied partly by a high and broad cingular ridge and partly by a broad valley between this ridge and the protocone. Behind this cingular ridge and not separated from it by any valley, is a small irregularly shaped rugose tubercle. This may be taken to represent a rudimentary protoconule. The general appearance of this part of the tooth is suggested in *Titanotherium* and to a less extent in *Diplacodon* and *Protitanotherium*. Neither *Telmatherium* nor *Dolichorhinus* have as a rule any trace of a protoconule. Also the protocone closely adjoins the narrow anterior cingulum in both these genera as well as in *Palaesyops* and the lower Eocene genera. The latter are distinguished from *Sivatitanops* by the much more clearly marked protoconule, and from *Lambdotherium* and *Limnohyops* in addition by a metaconule, of which there is here no trace, unless a minute tubercle in the valley between the metacone and the hypocone may be regarded as such. There is a slight external cingulum at the base of the lobes, but no internal cingulum.

Upper Premolars.—P⁴ is very little molarized, in which respect it differs considerably from p⁴ in *Titanotherium*, *Diplacodon*, *Eotitanotherium* and all members of the sub-family of the Titanotheriinæ. Even *Megacerops*, in which the molarization of the premolars has proceeded less far than in the other Oligocene genera, has a more pronounced tetartocone than is the case in *Sivatitanops*. The tooth under consideration is, evidently, much inferior in size to m², the difference in size being even more marked than in the Titanotheriinæ. The external lobes are well differentiated. The protocone has a prominent external concavity, more pronounced than I have observed in any other genus: the tritocone is on the contrary almost flat externally. The deuterocone is sub-conical. The only representative of a tetartocone is a low ridge-like tubercle, which passes into the posterior cingulum without any intervening valley. One or two short buttresses jut out internally from each of the external lobes. These, however, do not extend across the valley which separates the internal lobe from the external ones. There is a strong anterior cingulum, to which is attached a minute tubercle which may be a rudimentary protoconule like that which exists in the molars. Neither the anterior nor the posterior cingula quite meet on the internal side of the tooth.

P³ is similar in its general structure to p⁴. Both external lobes are, however, more convex. The rudimentary tetartocone is better differentiated from the deuterocone, but it is equally fused with the cingulum. There is on the anterior margin of the tooth, a small cusp, which projects above the cingulum and is in the same position as the supposed protoconule in p⁴. The cingulum on the internal side of the tooth is rather more distinct than it is in p⁴.

P² as regards the external part of the tooth is very similar to p³. It is very much more elongated, however. The deuterocone is more ridge-like than conical and the ridge seems to pass into the anterior cingulum. There is a broad posterior cingular shelf, corresponding to the region where the rudimentary tetartocone is seen in the two hinder premolars, but in the case of p² this cusp is even more rudimentary. Two buttresses run inward from the external lobes to the deuterocone, but they do not meet it, nor in any way block the transverse valley. This shows the internal cingulum best of the three premolars.

P¹ lacks a large portion of the front of the tooth and is very much worn. It is however interesting as exhibiting a primitive type quite unlike that of any of the Oligocene Titanotheres. It is a narrow elongated tooth with apparently a single main oblong conical main cusp which seems to lead by a ridge, which, however, is worn entirely smooth, into an abbreviated heel. It gives me the impression of resembling the p¹ of *Manteoceras uintaensis* as figured by Douglass.[1]

[1] Douglass, Preliminary description of some new Titanotheres from the Uinta Eocene, *Ann. Carnegie Museum*, VI (1910), p. 307.

Although the precise ratio of the length of the premolar to that of the molar series cannot be stated, yet it will be seen from the measurements of the various specimens that this ratio is markedly less than is the case in any other species, with the exception of the skull described below. This indicates a great reduction of the facial region of the skull, which may be regarded as a generic character.

Upper Canine.—This tooth is associated with the upper molar and the 2nd and 3rd upper premolars described above, so that one may presume that it is the upper canine of the same individual. Although complete as regards the upper portion of the crown, which is unworn, it is badly defective at the base. Certain remarkable characters can, however, be observed, which separate it distinctly from any American species, of which the upper canine has been figured.

It is almost circular in cross section except at the very base, where at the hinder end the beginning of a basal cingulum can be plainly seen. Two very strong ribs run from the apex to the base of the tooth. The plane on which these lie does not coincide with the antero-posterior plane of the tooth, one of the edges being antero-internal and the other postero-external. The cutting edges are directed towards the inner side, but all the same the inner surface is not concave as is apparently the case in *Telmatherium* and *Dolichorhinus* but convex, only very much less so than the external surface. The postero-external cutting edge passes gradually into the basal cingulum, in which respect the present tooth would seem to differ from the canines of those American genera which approximate to it in character; in these the passage is abrupt. The same condition is very well seen in the lower canine (C. 338) which is described below, and appears to be almost identical with the lower canine of *Brachydiastematherium* figured by Böckh.[1]

Upper Incisors.—Associated with the last upper premolar (C. 334) is an upper incisor, which seems to be either the 1st or 2nd. It is very slightly asymmetric. The transverse greatly exceeds the antero-posterior diameter. There are two sharp cutting edges, which run to the base of the tooth, but do not join to form a cingulum, which is such a marked feature of *Manteoceras*, *Telmatherium* and *Dolichorhinus*. In the median plane one main rib runs from the apex to the base of the tooth, and on either side of it near the base are a few subsidiary ribs. Between the median rib and the lateral edges are two flat surfaces. Another incisor, which is associated with several fragments of the upper and lower dentition of Titanotheres (C. 337) is very much worn. It is more asymmetric than the last described tooth, and, therefore, probably occupied a hinder position in the mouth. There is a faint trace left of one of the cutting edges, which passes down into a more pronounced basal cingulum than is the case in the incisor (C. 335) described above.

[1] Böckh *op. cit.* p. 132, Plates 17 and 18.

Lower Dentition.—A mandible of a young animal in an extremely fragmentary condition (C. 338) was found by H. M. Lahiri 1 mile west of Bahin. The most interesting part of it is a fragment of the symphysis with the two canines, both incompletely erupted from the jaw but broken off above the base. The canine agrees with the upper canine already described in having two cutting edges, one antero-internal, which is extremely strong, and the other postero-external, which is much weaker. The anterior one is slightly incurved and passes gradually downward into a strong postero-internal basal cingulum. The posterior edge passes more abruptly into this cingulum. The cross section is convex between the two cutting edges, both on the internal as well as on the external side. There is also another cingulum developed anteriorly and postero-externally, but these do not quite join on the external side of the tooth. The canines are very procumbent. They are smaller than the corresponding upper canine figured above, and the anterior cutting edge is stronger. The difference in size may, however, be individual or sexual, and the same may be true of the cutting edges, even supposing the character of the upper and lower canines to be identical. In any case it is impracticable to separate this mandible from the upper teeth described above, and it may accordingly be referred to the same species.

As I have said above, there is a great similarity between the canine of the Burma mandible and that of *Brachydiastematherium transilvanicum* Böckh and Maty. The tooth is, however, smaller, and the cingulum seems to be more hollowed in the Burma species. Moreover the premolars in the Burma species entirely lack the strong external cingulum which is characteristic of *Brachydiastematherium*. A more important difference may lie in the shape of the upper incisor of *Sivatitanops* (C. 335) as compared with the lower incisors of *Brachydiastematherium*. The latter have a similar basal cingulum to that of the canine, which is not the case in the Burma incisor, and they lack the median ribs present in my specimen. Since the upper dentition of *Brachydiastematherium* is unknown, we have only the parts just mentioned for comparison, and their likeness does not seem sufficient to predicate generic identity, especially as both the geological horizon and the locality are so different.

SIVATITANOPS BIRMANICUM Pilg. and Cott.

(Plate I, figs. 1*a*-*c*.)

1916.—*Telmatherium* (?) *birmanicum* Pilgrim and Cotter. Some newly discovered Eocene Mammals from Burma, Rec. Geol. Surv. Ind., Vol. XLVII, p. 72.

The original Titanothere specimens described by Pilgrim and Cotter are so fragmentary that they do not afford sufficient evidence for a precise specific or even generic determination. It cannot even be definitely asserted that the fragments figured represent a single species. Under these circumstances I have chosen, perhaps somewhat arbitrarily, to take the skull (C. 329) collected by

B. B. Gupta as a co-type of Pilgrim's and Cotter's species. The identification is mainly based on the apparently greater breadth index of the fragmentary premolar, figured in Pl. V, fig. 11 of the paper quoted above, than the premolar (C. 334) referred to *Sivatitanops cotteri* and figured in Pl. I, fig. 6 of the present paper. In that case it is p^3 and not p^4. I am inclined to think that both the molar fragments figured in figs. 9 and 10 of the original paper belong to a different species from both the skull and the premolar. They resemble rather the species *Sivatitanops cotteri*, both in regard to the weaker development of the anterior cingulum and of the beaded ridge which runs from it along the median valley; further, the rib on the external face of the paracone and metacone resembles that in *S. cotteri* and seems stronger than in the skull now described.

The skull is fractured behind the palate; it shows the posterior nasal foramina and the hamular processes on the lower aspect, and laterally the front part of the jugal processes. The nasals are broken off. The entire dental series is in place, but the incisors and canines are represented merely by their roots; the crowns of all the premolars are so badly splintered that hardly any of the detailed structure is visible; the external cusps of all the molars have for the most part been broken away, but the internal portions of the molars are fairly perfectly preserved.

From the characters which can be distinguished in the specimen, it is evident that we have before us a skull of a brachycephalic type, with an extremely short facial region, due mainly to the great reduction of the premolar series; p^1 is not present and there is no diastema between p^2 and the canine. The incisor series forms an arc of about a quarter of a circle. The upper surface in the frontal region is flat both transversely and antero-posteriorly, from which it would appear that horns, if present, could have been merely incipient. The absence of the nasals prevents us from seeing the actual condition. The front part of the jugal process is stout and jutted out considerably. The infra-orbital foramen is big and situated directly above p^4. The posterior nasal foramina are opposite the last molar.

The structure of the molars agrees closely with that of the type molar of *Sivatitanops cotteri*, except that the breadth index is greater, and the anterior internal cingular cusp is more prominent than in *S. cotteri*, as well as the beaded ridge which runs backward from it along the median valley. The distinctness of this cingular cusp from the protocone becomes more marked in each successive molar from behind forward. In m^1 there is a deep valley, separating it from the protocone, and it has taken on the appearance of an actual cusp, almost comparable with the main cusps of the tooth. This character of the antero-internal region of the molars does not occur in any previously described Titanothere which I have seen, though in a minor degree it is suggested in the genus *Titanotherium*. The external surface of the outer cusps, paracone and metacone, appears to be flat or at any rate less strongly ribbed than in the species *S. cotteri*. M^3 is not inferior in size to m^2; there is a hypocone at the postero-internal angle of the tooth, which is perfectly distinct, though rather smaller than is the case in the two anterior molars.

The breadth index of the premolars is also greater than in *S. cotteri.* So far as one can see, the internal part of p^3 and p^4 consists merely of a single large cusp, the deuterocone, with anterior and posterior cingula which do not extend to the inner margin of the tooth. There is no indication of a tetartocone. The detailed structure of p^2 cannot be made out.

The roots of the canine and the three incisors are large and indicate that the teeth in question were large and fully functional. The third is the largest of the three and the second is smaller than the first.

I can find no sound reason for separating the skull generically from *S. cotteri,* while it shares in common with the latter certain characters which I cannot find in any other previously described species of Titanothere.

Horizon.—B. B. Gupta was informed in the village from which he obtained the skull that it was originally brought from a nala ½ mile N. E. of Kyawyaw. This locality lies on the Yaw series, immediately overlying the Pondaungs. If correct its age will be slightly newer than that of the other mammalian remains in the collection.

SIVATITANOPS (?) RUGOSIDENS sp. nov.

Pl. II figs. 6, 7.

Four associated fragments of upper teeth of a Titanothere (C. 339), found by H. M. Lahiri 1 mile E.S.E. of the village of Sinzwe, may provisionally be referred to the genus *Sivatitanops,* to which they are allied by the backward position of the protocone of the molars. The crowns of the teeth are, however, lower; the protocone of the molars is smaller and more truly conical, and a greater space intervenes between it and the anterior margin of the tooth. There is a more pronounced protoconule, which is isolated from the cingulum. The cingulum extends to the internal side of the tooth and both it and the surface of the base of the protocone are strongly rugose. This rugosity is even more pronounced in the case of p^4. The deuterocone is smaller than in the corresponding tooth of *Sivatitanops cotteri;* there is a small tetartocone, isolated from the cingulum. The cingulum itself is narrower than in *S. cotteri,* and extends to the inside of the tooth, and the remainder of the broad area on either side of the deuterocone is covered with small pimples or wrinkles. It is not unlikely that it will prove entitled to generic rank, but as so little of the dentition is known, it seems unwise to found another genus on such slender evidence.

Genus: EOTITANOTHERIUM Peterson.

EOTITANOTHERIUM (?) LAHIRII sp. nov.

Pl. I figs. 2, 7, 8.

The specimens described under this name (C. 340-343) were collected in association by H. M. Lahiri 1 mile E.S.E. of Sinzwe village and include (1) a portion of the right maxilla, showing the beginning of the zygomatic process and two teeth in a very poor state of preservation, which are probably m^1 and p^4. (2) A few fragments showing the external walls of the hinder molars and the antero-internal corner of m^2 or m^3. (3) A left p^2 in a perfect state of preservation.

This material is insufficient to determine the genus with certainty. The portions of the skull so far discovered seem to be too closely related to Peterson's genus to make it practicable to separate them, although considering the entirely different part of the world in which they occur, it is highly probable that the rest of the skull when discovered will entitle it to generic rank.

The maxilla is stout, the jugal process especially so, if one may judge by the anterior beginning of it which forms the lower border of the orbit. In this character our species resembles *Diplacodon* and *Titanotherium* rather than any of the earlier genera. A remarkable feature of the orbital portion of the maxilla is its regularly rounded form from the base of the 1st molar up to the border of the orbit. Its contour is entirely free from any of that angularity which is seen in *Titanotherium* and still more in the earlier genera such as *Dolichorhinus* and *Telmatherium*. So far as I can gather without having seen the actual specimens or casts of them, the appearance of this part is not unlike that of *Eotitanotherium osborni* as figured by Peterson.[1] The infraorbital foramen is large and is situated immediately over p^4 as in *Eotitanotherium osborni* and *Protitanotherium emarginatum*.

M^1 is in shape altogether unlike the molars of *Sivatitanops*, being relatively a very broad tooth; the protocone is farther forward; the anterior cingular ridge is much less pronounced, and there is no trace of a protoconule, even in a rudimentary form. Regarding the external wall of the molars, the styles are pronounced as in *Sivatitanops*, but are less constricted. The surface of the lobes is without the convexity from apex to base, which is the case in that genus. A median rib can only just be distinguished on the anterior lobe, and is entirely wanting on the posterior one. As in *Sivatitanops*, there is no internal cingulum. The appearance of the tooth is very much that of *Diplacodon* and *Eotitanotherium*.

P^4 is too much broken to be certain about its characters. It is probable that there was an internal cingulum and that its transverse diameter approached that of m^1.

P^2, which is the only perfect tooth known, more nearly resembles the corresponding tooth of *Eotitanotherium osborni*. In outline it is not square as in *Titanotherium*, the anterior border being oblique, though less so than in *Sivatitanops*, *Dolichorhinus* and the earlier genera. In this it agrees perfectly with *Eotitanotherium osborni* and *Diplacodon*. The external lobes are very much less convex than in *Sivatitanops*, and rather less so than in *Eotitanotherium osborni*, the deep median groove of the latter being much less pronounced here. There is a distinct external cingulum. Both deuterocone and tetartocone

[1] Peterson, *Ann. Carnegie Mus.*, Vol. IX (1914), Plates 6, 7, 8.

are distinctly developed, and the slight ridge connecting them in *Eotitanotherium osborni* and in *Diplacodon elatum* is here absent. On the other hand there is a distinct ridge connecting the deuterocone with the protocone, though it is much less prominent than in *Diplacodon elatum* and is probably much about the same intensity as in *Eotitanotherium osborni.* The tetartocone is quite isolated from the external tritocone, in which we may note a difference from the genus *Titanotherium.* Internal as well as anterior and posterior cingula are present. A low tubercle, situated midway between the deuterocone and tetartocone, partially blocks the valley between the internal and external lobes, although it is quite unconnected with the internal lobes and only slightly so with the external ones.

Without entering into any further detailed comparisons, it is obvious that we have to do with a species that is far advanced to *Titanotherium,* and is therefore in much the same state of development as *Protitanotherium, Eotitanotherium* and *Diplacodon.* Since the parts available for comparison seem to be distinctly nearer to the second of these three genera and may possibly indicate generic identity, there seem some grounds for a provisional reference to the genus *Eotitanotherium.*

The following are the dimensions in millimetres of the various Titanotheroid remains in the present collection, in all cases where this can be measured either with certainty or approximately.

Upper dentition.

—		*Sivatitanops birmanicum.*	*Sivatitanops cotteri.*			*Eotitanotherium (?) lahirii.*
		C. 329	C. 330-32	C. 334-36	C. 337	C. 340, 342
		approximate.				
M^3	Anteroposterior diameter	72·1		..	..	..
	Transverse diameter	69·5		..	..	..
M^2	Anteroposterior diameter	71·9	56·3	..	..	..
	Transverse diameter	69·4	49·8	..	..	..
M^1	Anteroposterior diameter	52·9	..	..	..	**39**
	Transverse diameter	59·4	..	..	..	**54**
P^4	Anteroposterior diameter	39·1	..	30·7	..	..
	Transverse diameter	48·5	..	32·1	..	..
P^3	Anteroposterior diameter	30·6	25·3	..	..	..
	Transverse diameter	40·5	29·2	..	..	..

Upper dentition—contd.

——	*Sivatitanops birmanicum.*	*Sivatitanops cotteri.*			*Eotitanotherium (?) lahirii.*
	C. 329	C. 330-32	C. 334-36	C. 337	C. 340, 342
	approximate.				
P2 Anteroposterior diameter .	30·5	22·1		..	20·7
P2 Transverse diameter . .	26·7	20·6	..	..	19·6
P1 Anteroposterior diameter .			14+	..	
P1 Transverse diameter . .		..	10·0	..	..
C Anteroposterior diameter at the base.	31	..			..
C Transverse diameter at the base	26·5	..	..	..	..
I1 ? Anteroposterior diameter at the base.		..	12·4	..	..
I1 ? Transverse diameter at the base			14·5	..	..
I2 ? Anteroposterior diameter at the base.	..	..	..	9·5	..
I2 ? Transverse diameter at the base		..		11·3	..
Length of molar and premolar series.	269			..	
Width of palate between last molars.	95·7			..	..
Distance between base of m3 and upper surface of frontal.	155·0				

Lower dentition.

——	*Sivatitanops (?) cf. cotteri* C. 338			
P2 Anteroposterior diameter . .	27·8	..	..	..
P2 Transverse diameter .	18·7	..	..	..
C Anteroposterior diameter at the base .	23·2	..	..	
C Transverse diameter at the base .	23·2	..	..	..

Family : *AMYNODONTIDÆ.*

Genus : Metamynodon Scott and Osborn.

In a previous communication on the Mammalia of the Pondaung sandstone, Pilgrim and Cotter figured a mandible and some fragmentary upper teeth, the Amynodont character of which was certain. The authors produced evidence which appeared to justify them in referring these remains provisionally to the genus *Metamynodon.*

The recent collections made by H. M. Lahiri contain a complete mandible associated with the front portion of a skull, which corresponds in essential details with Cotter's material. A comparison of this with the figures and descriptions of *Metamynodon planifrons* [1] seems to confirm the generic reference. The new specimen belongs to a somewhat larger animal than the former one, and, what is more important, the canine is elliptical in cross section, whereas the previous canine possesses an anterior cutting edge. C. Forster Cooper [2] has described a species of *Metamynodon, M. bugtiensis,* from the upper Aquitanian or Lower Burdigalian beds of the Bugti Hills, in Baluchistan. This seems comparable with the American species, but exceeds it in size. The dentition anterior to the premolar series is unknown.

Since, however, of two of the known species of *Amynodon, Amynodon antiquus* [3] has a canine with a trihedral crown, while *Amynodon intermedius* [4] has one with an oval crown, this difference cannot be regarded as generic. H. M. Lahiri has found several upper molars associated with a canine of trihedral cross section, which may be referred to the species *Metamynodon birmanicus* Pilg. and Cotter, while the associated skull and mandible may be made the type of a new species, *Metamynodon cotteri.*

Though their characters do not warrant a generic separation from *Metamynodon,* yet they undoubtedly represent a less specialized form, somewhat nearer to *Amynodon* than the species *Metamynodon planifrons* and, therefore, probably earlier in age.

Metamynodon cotteri sp. nov.

Pl. II figs. 1 *a-e.*

The types of this species are an almost complete mandible and the front portion of a skull (C. 344), which when found were closely cemented together in their natural position. My thanks are due to Mr. F. O. Barlow, the

[1] Scott and Osborn, Preliminary account of the Fossil Mammals from the White River formation, *Bull. Mus. Comp. Zool.,* Vol. XIII (1887), p. 165; Osborn and Wortman, Perissodactyls of the Lower Miocene White River beds, *Bull. Amer. Mus. Nat. Hist.,* Vol. VII (1895), p. 373, Pl. 10, 11; Osborn, The Extinct Rhinoceroses, *Mem. Amer. Mus. Nat. Hist.,* Vol. I (1898), p. 91, fig. 10, p. 93, fig. 12.

[2] C. F. Cooper, *Metamynodon bugtiensis,* sp. n. from the Dera Bugti deposits of Baluchistan, *Ann. Mag. Nat. Hist.* (9), Vol. IX (1922), p. 617.

[3] Scott and Osborn, *Contr. Princet. Coll. Mus.,* Vol. III (1883), p. 3.

[4] Osborn, The Perissodactyla of the Uinta formation, *Trans. Amer. Phil. Soc., Philad.,* New series, Vol. XVI (1890), p. 508, Pl. 10; Osborn, Fossil Mammals of the Uinta basin, *Bull. Amer. Mus. Nat. Hist.,* Vol. VII (1895), p. 95.

preparator at the British Museum of Natural History, for the care and skill which he has been kind enough to devote to their development. They were collected by H. M. Lahiri, $1\frac{1}{4}$ miles west of Mindezu village. The dimensions of the various parts are given on pp. 20 and 21 in parallel columns with those of the corresponding parts of *Metamynodon planifrons* and *Amynodon.*

Skull and upper dentition.—The animal to which the skull belonged was an aged one, and the advanced state of wear renders it quite impossible to discern the details of the enamel folds in either molars or premolars. It is quite clear, however, that m^3 has a metaloph which essentially corresponds in character with that of *Metamynodon* and *Amynodon,* and differs from *Cadurcotherium* by its greater length; m^3 in the latter genus is much more compressed transversely and its transverse valley is more closed in and sinuous. There is a deep facial cavity in front of the orbit, which agrees with *Amynodon intermedius* and probably also with *Metamynodon.* The distance between the orbit and the premaxillary border is relatively much greater than in *Metamynodon planifrons,* but less than in either of the species of *Amynodon.* The breadth of the premaxillary portion of the skull, as taken opposite the canines, agrees fairly well with *Amynodon intermedius.* The general shape of this part of the skull seems to be intermediate between *Metamynodon planifrons* and *Amynodon intermedius.*

Upper premolars.—P^2 is lost, probably through age, since it undoubtedly exists in another maxilla (C. 345) belonging to the species *Metamynodon birmanicus.* Its former presence in the present maxilla is probably indicated by some surface irregularity and discolouration, but no trace of a cavity can be seen, so that one must assume that the alveolus has been entirely absorbed. If this is so, it seems very probable that a small p^1 once existed, since the irregular and discoloured area is larger than would be accounted for by a single tooth. It may be remembered that the presence of a p^1 was inferred by Pilgrim and Cotter from the sizes of the premolars originally collected by Cotter. Moreover p^3 occludes partly with m^1 and partly with p_4, so that presumably p^2 will occlude at least equally with p_4 and p_3, and the front part of p_3 will remain to occlude with the supposed p^1. The presumptive evidence in favour of four upper premolars is, therefore, of some value, but the actual presence of p^1 cannot be demonstrated. In any case it was probably only partially functional, and was shed early in the life of the animal.

The approximate length of the diastema between p^2 and the canine was 46 mm., as compared with about 23 mm. in *Metamynodon planifrons,* and 22 mm. in *Amynodon intermedius. Metamynodon planifrons* is obviously a much larger animal than either of the other two, so that the relative excess of length is very considerable in the case of the Burma species. It does not seem that there was much difference in size between *Amynodon intermedius* and the Burma species, so that the length of the diastema in the latter also exceeds that dimension in *Amynodon intermedius.*

Upper canine.—The canine is very large and projects strongly forward. Its cross section is an oval, flattened transversely. There is a considerable zone of wear on the anterior side. It is relatively larger than in *Metamynodon planifrons*, but agrees fairly well in size with that of *Amynodon intermedius*. It may be observed that the canines are less procumbent than is the case in *Amynodon intermedius*, but are much less erect than in *A. antiquus*.

Upper incisors.—The incisors are placed rather asymmetrically but there seems no doubt that their serial order can be correctly identified. It seems likely that i^1 on the right side and i^2 on the left side have their crowns preserved. The root of i^2 on the right is plainly visible, and also the root of i^3 on both right and left sides. The jaw is fractured in the position which the assumed i^1 on the left side would occupy. I^3 is situated very much to the outside, almost directly in front of the canine, so that the incisor series forms an approximate semi-circle, without any diastema in front of the canine. It is thus intermediate in shape between *Metamynodon planifrons* and *Amynodon intermedius*. I^3 is the smallest of the series; the specimen figured in Plate II, fig. 1*e*, is believed to belong to the skull. I^2 is the largest of the series and i^1 is slightly smaller than i^2. They are rather procumbent, and are more convex externally than internally. On the inner side of i^1 is a cingulum, from which four weak ridges run a short way towards the crown of the tooth, so as to form three faces, the remainder of the cross section being occupied by the external convex side of the tooth. The small incisor i^3 shows the same character except that the ridges and faces are less pronounced. It is extremely probable that the tooth figured by Pilgrim and Cotter in Plate VI, fig. 6, as an upper premolar is one of the incisors. The incisors appear to be larger than in *Amynodon intermedius* and still more so than in *Metamynodon planifrons*. In *Amynodon antiquus*, the ridges on the inner side of the incisors are much stronger and the faces which they enclose are strongly concave.

Mandible and lower dentition.—The mandible is almost complete on the right side, but the left ramus is broken off behind m_1. The crowns of the molars and premolars are so much worn, where not covered by a hard matrix, that their pattern is almost indistinguishable. It is, however, possible to make out that the ectoloph of m_1 is continuous, as in *Metamynodon planifrons*, and that the notch which is characteristic of *Amynodon* is practically non-existent. There is no trace of any premolar in front of p_3, and there seems little doubt that there were only two in all. The relative length of the premolar series as compared with the molar series is greater in this mandible than in that of *Metamynodon planifrons*, but is less than in that of *Amynodon antiquus*, even if we do not reckon p_1 and p_2 which are present in the last named species. The dimensions put in the table for the two American species are compiled in part from the figures, the scale of which is apparently only approximate, so that the estimate can only be a rough one. The Burma species seems to be intermediate, in regard to the relative size of the premolars, between *Metamynodon planifrons* and *Amynodon antiquus*. The length of the diastema behind the canine is relatively about twice what it is in *Metamynodon planifrons*. It is also relatively greater than in *Amynodon antiquus*, but the disproportion is here much less. Corresponding to this is the exceptionally long symphysis in the Burma mandible, which is relatively much greater than in either of the American species with which we are now comparing it.

The canine appears to be relatively larger than in *Metamynodon planifrons*, and also than in *Amynodon antiquus*. Its cross section is elliptical, slightly flattened transversely, with a zone of wear on the hinder side, produced by the abrasion of the upper canine. It is probably more erect than the canine of *Metamynodon planifrons*, but less so than that of *Amynodon antiquus*.

There is only one incisor preserved, probably i_2 on each side. Between these two teeth, however, the alveoli of two very small teeth can be faintly discerned, which will represent i_1. It is also possible that the alveoli of i_3 are present in the space between i_2 and the canine. These are no larger than i_1. The crown of i_2 is very similar in character to that of the upper i^1, but there are signs of no less than seven faint ribs running up from the cingulum.

Comparisons.—The most important character available by which this species can be distinguished from *Amynodon* is the laterally compressed crowns of the lower molars and the continuous ectoloph, which is very different from the notched ectoloph of *Amynodon*. While both *Cadurcotherium* and *Metamynodon* possess this character, the former of these genera shows a very much greater lateral compression of m^3; the transverse valley of m^3 is also narrower and more sinuous.

The absence of p_1 and p_2 further distinguishes the Burma species from *Amynodon* and allies it to *Metamynodon*.

It is perfectly obvious, however, that it is a much more primitive species than *Metamynodon planifrons*, the differences being in the direction of *Amynodon*. These primitive characters are :—

(1) The greater relative length of the facial portion of the skull, correlated with the larger premolars and the longer diastemata and symphysis.

(2) The probable presence of a rudimentary p^1.

(3) The more erect position of the canines.

(4) The larger incisors.

In all these characters there is a transition from *Amynodon antiquus* to *Amynodon intermedius* and in regard to some of them the present species is more primitive than *Amynodon intermedius*, as for example in (3) since the upper canines of *A. intermedius* are more procumbent than in the Burma species and in (4). Under these circumstances it does not seem practicable to separate the

Burma species from *Metamynodon*. One would expect an upper Eocene representative of the genus to be more primitive in such features than the Oligocene *M. planifrons*.

METAMYNODON BIRMANICUS, Pilg. and Cott.

1916: *Metamynodon birmanicus* Pilgrim and Cotter, Some newly discovered Eocene Mammals from Burma. Rec. Geol. Surv. Ind., Vol. XLVII, p. 65.

Pl. II, figs. 2, 3.

The additional material of this species which has been obtained by H. M. Lahiri from the Pondaung Sandstones, not only serves to confirm the generic position in which Pilgrim and Cotter placed it, but also renders its specific distinction from the species *Metamynodon cotteri* certain.

The most valuable specimens are a right and left maxilla (C. 345), collected 6½ furlongs 9° W. of S. of Peak 1258 Myaing, Pakokku district. (The right maxilla is in the British Museum.) These show the complete molar and premolar series, though the crowns of many of the teeth are badly fractured. The metaloph of m^3 is, however, clear and also the pattern of p^2 and p^4.

Another set of associated specimens (C. 346) collected from 6 furlongs 8° E. of S. of Peak 1258, Myaing township includes the right p^4. m^1 and m^2 and fragmentary m^3; the left fragmentary p^4 and the well preserved m^2 and m^3; also a canine and some fragments of the front premolars.

These specimens indicate an animal which is slightly larger than the one to which the type mandible described by Pilgrim and Cotter belonged. On the other hand, it is smaller than the skull and mandible which have been described above under the name of *Metamynodon cotteri*. More important than the actual difference in size is the entirely distinct character of the canine. This, instead of being elliptical in cross section, is trihedral, with a strong anterior cutting edge and two strong posterior cutting edges. These enclose three faces, of which the two lateral ones are slightly convex, while the posterior face is flatter but with a median rib. The enamel on the upper part of the posterior face is worn away by the abrasion of the opposing upper canine. This tooth appears to resemble the canine of *Amynodon antiquus*. In both *Amynodon intermedius* and *Metamynodon planifrons* the cross section of the canine is elliptical. I am unaware of the precise value to be attached to this character, but it has not apparently been regarded so far as implying more than a specific difference. Of these teeth m^3 and p^2 are figured in Plate II, figs. 2, 3. The molars are identical in pattern with the one figured by Pilgrim and Cotter. M^3 appears to differ little from the corresponding tooth in *Metamynodon* and *Amynodon*. The absence of an internal cingulum on all the molars, except at the entrance of the transverse valley, distinguishes the Burmese from the American species.

Measurements in millimetres of skull and upper teeth.

—		*Amynodon antiquus.*	*Amynodon intermedius.*	*Metamynodon planifrons.*	*Metamynodon birmanicus.*	*Metamynodon cotteri.*
Transverse measurement of skull outside zygomatic arches.		160	..	365	..	215
Length of face from front of orbit to anterior border of premaxillary.		206	240	170	..	180
Breadth of skull opposite canines.		..	110	..	..	105
M^3	Antero-posterior diameter	28	46	60	45	50
	Transverse diameter .	30	46	64	46	49
M^2	Antero-posterior diameter	45	53	..	44	46
	Transverse diameter .	37	42	..	51	56
M^1	Antero-posterior diameter	37	44	47	32	38
	Transverse diameter .	37	43	68	43	50
P^4	Antero-posterior diameter	22	..	25	19	21
	Transverse diameter .	33	..	45	33	39
P^3	Antero-posterior diameter	19	..	..	15	16
	Transverse diameter .	..	..	..	25	..
C	Antero-posterior diameter	..	31	35	..	..
	Transverse diameter .	..	..	35	..	..
Antero-posterior measurement of molar series.		104	..	160	110	128
Antero-posterior measurement of premolar series.		..	..	65	51	70

Measurements in millimetres of mandible and lower teeth.

—	*Amynodon antiquus.*	*Metamynodon planifrons.*	*Metamynodon birmanicus.*	*Metamynodon cotteri.*
Length of mandibular ramus	360	450	..	215
Depth of mandibular ramus below m_1	65	96	69	88
Length of symphysis	90	130	..	145
Diastema behind canine	40	50		78
Breadth of jaw opposite lower canine	44	130	..	92
Antero-posterior diameter of molar series	126	174	110	133
Antero-posterior diameter of premolar series (p_3, p_4 only).	52	36	33	36
C { Antero-posterior diameter	15	37	17·5	36
C { Transverse diameter	20	30	12·5	29
C { Vertical height of crown	35	..	..	60
I_1 { Antero-posterior diameter	..	..	..	..
I_1 { Transverse diameter	..	..	..	..
I_2 { Antero-posterior diameter	15	..	..	9
I_2 { Transverse diameter	18	..	..	11

Family: *TAPIRIDÆ.*

The only material from the Pondaung sandstone referable to this family comprises the following :—(1) two rami belonging to the same mandible, containing the molars and the last premolar, and (2) the left maxilla of a young animal, in which the first two molars have erupted, while the last three milk molars were yet unshed. Of these m^2 and mm^2 have lost their crowns. The last three embryo premolars have been extracted from the bone which formerly enveloped them.

The mandible is too large to have belonged to the same individual as the maxilla, but as the difference in size is probably within the limits of individual variation, we cannot entirely exclude the possibility that the two specimens represent the same species.

While, however, the mandible possesses characters which allow it to be referred, at all events provisionally, to the European genus *Chasmotherium*, the maxilla shows dental characters which cannot be paralleled in any hitherto described genus. At any rate they differ considerably from those of *Chasmotherium*, and perhaps find their nearest homology with the American genera *Systemodon* of the Lower, and *Isectolophus* of the Upper Eocene. In any case it seems necessary to differentiate it generically from both of these. Should the lower dentition at any time be definitely shown to be the same as the mandible described below, the name *Indolophus* will obviously be valid for both specimens. If, as is more likely, it prove to be different, more evidence will be available to enable us to determine its affinities with certainty.

Genus : INDOLOPHUS gen. nov.

INDOLOPHUS GUPTAI sp. nov.

Pl. II, figs. 8 a—d.

The present species is founded on a left maxilla of a young individual (C. 347), in which two of the molars have erupted, though the crown of m^2 has been entirely destroyed. Three milk molars were originally in position, but of these mm^2, which no doubt was on the point of being shed, has the crown missing. The last three premolars have been developed out of their embryonic position in the bone. The specimen was collected by B. B. Gupta from $1\frac{1}{4}$ miles N. of Konywa.

Molars.—M^1 is in an initial stage of wear. The external portion of this tooth comprises two approximately equal sized cusps, the paracone and the metacone. Both of these cusps have strongly convex external faces, though the metacone is slightly the flatter and longer of the two. In front of these two is a smaller cusp, the parastyle. Internally are two cusps, the protocone and the hypocone, slightly inferior in height to the outer cusps. These are connected by cross crests to the outer cusps, the crests running obliquely to join respectively the anterior edge of the paracone and the metacone. The anterior crest is, in fact, just as closely united to the parastyle as to the paracone. A strong anterior cingulum runs from the parastyle along the entire front edge of the tooth, but is not continued on the internal side. A posterior cingulum connects the hypocone with the metacone. A faint external cingulum can be seen on the antero-external and the postero-external margins of the tooth. Internally there is a small ledge between the protocone and the hypocone.

Mm^3 is too much worn to show the character of the cusps, but mm^4 seems to be identical with m^1, except in being very slightly smaller.

Premolars.—P^4 has two strongly differentiated convex cusps externally, besides an anterior cusp corresponding to the parastyle of the molars. Internally there is a strong cusp, convex internally, and flattened externally, which shows the faintest trace of a cleft on its external face. Running outward from this cusp, is an anterior crest which joins the outer lobe between the protocone and the protostyle. The summit of this crest passes imperceptibly into the peak of the inner cusp, forming with it a quarter crescent. No crest connects the posterior part of the inner cusp to the outer lobes, but there is a faint tendency at the posterior end of the cusp to bend round towards the outer surface. There are strong anterior and posterior cingula, which do not unite on the inner margin of the tooth. There is a faint external cingulum.

P^3 is very similar to p^4 and differs only by the absence of any trace of a division in the internal cusp, and by the fact that this cusp shows no tendency at its hinder end to bend round towards the outer surface of the tooth.

P^2 differs from both of the last two premolars by the prolongation of the antero-external angle of the tooth, so that the triangle formed by the outline of the tooth is not equilateral but has the anterior side longer than the posterior side. Moreover the internal cusp is absolutely conical in shape, without any flattening or concavity on its outer surface. Unlike the other two premolars, the anterior cross crest is not a continuation of the inner cusp but forms a distinct element separated by a notch from the latter. There is rather more trace of the cingulum internally.

Comparisons.—The specimen is clearly distinguished from *Hyrachyus* by the equality in size of the paracone and the metacone of the molars, as also by the absence of a metaloph in the premolars.

By Osborn and Wortmann[1] the genera *Heptodon*, *Lophiodon* and *Helaletes* were united into one family, the *Lophiodontidæ*, which are distinguished from the *Hyracodontidæ* by the equality in size between the paracone and metacone of the upper molars, and from the *Tapiridæ* by the flattening and internal position of the metacone. In the present specimen the metacone is not flattened, nor does it occupy a position internal to the paracone, in which respect it resembles the primitive members of the *Tapiridæ*. In general appearance the molars of the Burma species remind one very much of *Systemodon*, especially in somewhat worn specimens in which the presence of a protoconule cannot be distinguished. It may be inferred, however, from the smooth nature of the enamel, as compared with its unevenness in *Systemodon*, that the present species has not a protoconule, even in a rudimentary condition. The external surface of both the protocone and the hypocone is also more flattened than is the case in *Systemodon*. In the latter genus the internal cingulum is much more strongly developed, while the posterior cingulum does not run into the hypocone, as in the Burma species, but keeps near the base of the tooth.

The premolars seem to be more like those of *Systemodon tapirinus* figured by Cope,[2] than of *S. primaevus*. I have, however, only had actual material of the latter species available for comparison. In both p^4 and p^3 of *S. primaevus* the inner cusp is sharp and conical, a distinction from its elongate shape in the Burma species. In p^4 an intermediate tubercle marks the commencement of the posterior crest connecting the inner cusp to the external lobe; of this there is no trace in mine. In both species the anterior transverse crest is fully formed.

[1] Osborn and Wortmann, Fossil Mammals of the Wahsatch and Wind River beds, *Bull. Amer. Mus. Nat. Hist.*, Vol. IV (1892), p. 127, and Perissodactyls of the Lower Miocene White River beds, *Bull. Amer. Mus. Nat. Hist.*, Vol. VII (1895), p. 358.

[2] Cope, Tertiary Vertebrata, p. 619, Plate LVI, fig. 1.

P^3 of *S. primaevus* has only a single transverse crest, which runs directly outward from the conical inner cusp. The different situation of the crest gives the corresponding tooth in the Burma species quite a different appearance.

The triangular outline of p^2 is identical in both *Systemodon* and the Burma species, but in *S. primaevus* there is no inner cusp.

I may next compare the Burma species with the genus *Isectolophus*, represented, according to Osborn,[1] by two species, *I. annectens* and *I. latidens*, and according to Hatcher[2] by *I. annectens* only, *I. latidens* being, if not generically the same as *Helaletes*, the type of a new genus distinct from both *Isectolophus* and *Helaletes*. The molars of *Isectolophus* are nearer to the present species than those of *Systemodon*, because of the absence of a protoconule in *Isectolophus*. As in *Systemodon*, however, the posterior cingulum does not join the hypocone, thereby constituting a difference from the Burma species. The latter is very inferior in size to *Isectolophus annectens* but agrees in this respect with *I. latidens*. The upper premolars have not, so far as I am aware, been figured. Osborn[3] certainly says that p^3 and p^4 have double internal lobes, while on the contrary Hatcher[4] fails to find the faintest sign of division in the upper premolars of either of the two species of *Isectolophus* mentioned. As Hatcher's observation has remained without comment from Osborn, so far as I am aware, it appears that it must be accepted as correct.

I have seen a cast of *Isectolophus latidens*, which shows that the inner cusp of p^4 is pointed as in *Systemodon primævus*, and not elongated as in the Burma species. Though the inner cusp of this tooth may be single, yet it differs from the Burma species by the presence of a distinct trace of a posterior crest, which does not, however, appear to actually join the external lobe to the inner cusp, but the state of preservation of the postero-internal quarter of the tooth is insufficient to enable me to determine this with absolute certainty. The inner cusp in p^3 of *I. latidens* seems to suggest a tendency towards a double lobe, if one may judge by a cleft at the base.

Desmatotherium guyoti may be taken as typical of the genus *Desmatotherium*. In this species both p^4 and p^3 have a double inner cusp and two transverse crests; p^2 is not triangular in shape, while the connection of the inner cusp to the external lobe is complete and not interrupted as in the Burma species. It is evident then that the molarisation of the premolars is considerably more advanced than in *Indolophus*.

In *Chasmotherium* the premolars are entirely molariform, although the relative size, convexity, and position of the paracone and metacone of the molars are as in *Indolophus*.

The greatest resemblance to *Indolophus*, in regard to the upper premolars, is found in the European Eocene genus *Lophiodon*. In this genus there is

[1] Osborn, Perissodactyls of the Unita Formation, *Trans. Amer. Phil. Soc.* N.S., Vol. XVI (1889), p. 518.
[2] Hatcher, Recent and Fossil Tapirs, *Amer. Journ. Sci.*, Series 4, Vol. I (1896), p. 178.
[3] Osborn, *op. cit.*, p. 519.
[4] Hatcher, *op. cit.*, p. 177.

no trace of a posterior crest, but the elongation of the inner cusp in *Indolophus* gives rise to a more crescentic appearance of the inner lobe than is the case in the European genus. Moreover the flattening of the metacone of the molars and its internal position relative to the paracone clearly differentiates *Lophiodon* from *Indolophus.* It may also be remarked that *Lophiodon* greatly exceeds in size the species under consideration, the smallest form being double the size of the Burma species. The molarization of the upper premolars in *Mesotapirus* (*Colodon*), *Protapirus* and all later Tapiroid genera is clearly a very important character and indicates a later stage of development, generically distinct from that which we find in the Burma species.

In conclusion *Indolophus* seems to be in some ways intermediate between *Systemodon* and *Isectolophus,* but certainly shows features which are distinct from both of them. The primitive condition of the upper premolars undoubtedly shows that it represents an early stage of development, which cannot belong, we should say, to a later period than the upper Eocene, and may even be earlier. I am inclined to regard it as a descendant of an early emigrant of the Lower Eocene, even more primitive than *Systemodon,* in which the posterior crest of the premolars had not as yet made its appearance.

Measurements in millimetres of Indolophus guptai.

M^1	Antero-posterior diameter	10·8	Transverse diameter	11·8.
P^4	Antero-posterior diameter	10·3	Transverse diameter	11·9.
P^3	Antero-posterior diameter	9·1	Transverse diameter	10·6.
P^2	Antero-posterior diameter	8·7	Transverse diameter	8·1.

Genus: CHASMOTHERIUM Rütimeyer.

CHASMOTHERIUM (?) BIRMANICUM sp. nov.

Pl. II, fig. 9.

In the collection made from the Pondaung sandstone by H. M. Lahiri are two mandibular rami (C. 348), belonging to the same individual, and each containing the three molars and the last premolar. (The right ramus is in the British Museum.) They were collected from about 1½ mile S. W. of Thadut Village, Myaing township.

Molars.—Each of the molars consists of two transverse crests, slightly convex behind and slightly concave in front. The valley which lies between these two crests is entirely open throughout, in a way which can be paralleled in no other Perissodactyl genus of the Eocene except *Chasmotherium*[1] or the much more recent genera *Tapirus* and *Protapirus.* In the case of the latter both ends of the crests bend round towards the front more than they do in the present mandible. An indication of this curl on the external side of the crest is more

[1] Stehlin, Die Saügetiere des Schweizerischen Eocaens, *Abh. schw. pal. Gesells.*, XXX (1903), p. 17.

noticeable in the anterior than in the posterior lobe of the Burma species. On the other hand in *Hyrachyus*, no less than in the Lophiodonts such as *Heptodon*, *Helaletes* and *Lophiodon*, as well as in *Systemodon* and *Isectolophus*, the external end of the posterior crest bends round until it unites with the anterior crest, and so blocks the transverse valley entirely. The absence of the third lobe in m_3 distinguishes the Burma species from all the Eocene genera except *Hyrachyus* and *Chasmotherium*. From the former of these the other molar and premolar characters sufficiently distinguish it. The Oligocene *Mesotapirus* agrees with the Burma species in this respect. All the molars have a strong anterior and posterior cingulum, which is faintly continued externally, with a tubercle at the entrance of the transverse valley.

Premolar.—P_4 has two transverse crests, differing from those of the molars only by the fact that a process from the external end of the posterior crest runs towards the front to meet a backwardly directed process from the external end of the anterior crest, thus blocking the transverse valley. A small backwardly directed process can be noticed in the posterior crest; this runs into the posterior cingulum. The external cingulum is much stronger than in the molars. Owing to fracture the anterior cingulum cannot be made out. It will be remarked at once that the complete posterior crest of p_4 distinguishes the Burma species from *Hyrachyus*, and the Lophiodonts *Heptodon*, *Helaletes* and *Lophiodon*, as well as from *Systemodon*, *Isectolophus*, *Mesotapirus* and *Protapirus*. On the other hand this complete molarization of p_4 occurs in the Eocene genus *Chasmotherium* and in the recent genus *Tapirus*.

Comparisons.—I may observe that in such of the characters, as are available for comparison, this mandible agrees with *Tapirus* in a general way, but equally with the Eocene genus *Chasmotherium*.

I am much indebted to Dr. H. G. Stehlin of Basel for giving me the opportunity of comparing this mandible with *Chasmotherium cartieri* Rüt. The points in which it agrees with the Swiss genus alone amongst the Eocene tapiroids have been mentioned above, and a detailed comparison shows the structure of the lower teeth to be so similar in the two species that I can find no grounds for separating them generically. In that case the resemblance to *Tapirus* must be regarded as due to convergence, or to a precocious development of certain characters, which in the direct Tapir line did not make their appearance until much later. At the same time, since the upper dentition of the Burma species is unknown, I propose as a precaution to make the reference only a provisional one at present. I shall now proceed to compare the two species more minutely.

1. The Burma species is much smaller than *C. cartieri*.
2. The 3rd lobe of m_3 is represented in a posterior cingulum which is perfectly similar in both species.
3. In the molars the valley between the crests is less open in *C. cartieri* than in the Burma species, which is rather closer in this respect

to *Tapirus*. The crests in the Burma molars curve round less to the front at each end, and especially so at the internal end. The same is true of the external end of the anterior of the two crests.

4. So far as one can judge in the very advanced stage of wear in the Burma specimen, the crests were higher and sloped down to the anterior cingulum and to the median transverse valley respectively more abruptly than in *C. cartieri*.
5. Although the posterior crest of p_4 is completely formed in *C. cartieri* and in *C. birmanicum*, yet a distinct difference can be noticed in the two cases. Unworn teeth of the Swiss species show that it is not only weaker than the anterior crest, but that it diminishes in height towards the internal end, where a notch exists which separates off a small tubercle at the extreme internal end of the crest. The advanced wear of the Burma tooth does not permit me to assert definitely that a tubercle was entirely absent, but such was probably the case. At any rate, the posterior crest seems to have been almost as strong as the anterior one, and not to have weakened appreciably, as we follow it inward, while the notch, if present, must have been less pronounced than in the Swiss species.
6. In both species the external wing of the posterior crest in p_4 is far stronger than in the molars, but a backwardly directed process from the anterior crest, which joins the forwardly directed wing of the posterior crest, is present in the Burma species but is lacking in *C. cartieri*, so that the transverse valley of p_4 is actually blocked at the external end to a greater extent in the former than in the latter species.
7. Both species possess an identical fold in the enamel of the anterior lobe of p_4, which is situated still further to the outside than the process mentioned in 6, and runs down to the cingulum.
8. Both species possess a backwardly directed process on the external side of the posterior crest of p_4 which meets the cingulum.
9. The external cingulum seems to be similar in both species in the case of p_4, m_1 and m_2 but in m_3 it is less strong in the Burma species than in *C. cartieri*.
10. There is no internal cingulum in the molars of either species, but p_4 of *C. cartieri* has a strong internal cingulum, which is wanting in the Burma species.

Although *Chasmotherium cartieri* is a middle Eocene species, abundant at Egerkingen, yet this must not be necessarily considered to afford any evidence of an earlier date than Bartonian or Ludian for the Burma species, since it seems highly probable that the latter represents a more advanced stage of evolution than its European congener. The reasons for holding this view will be stated.

1. The gradual obliteration of the forwardly directed wing of the transverse crests would appear to be a progressive character, not only because it can be observed to have taken place in the more orthodox Tapiroid line as we follow it from *Systemodon* and *Isectolophus* through *Mesotapirus* and *Protapirus* to *Tapirus*, but also because in an older species of *Chasmotherium*, *C. stehlini*, described by Depéret[1] from the Schweiz Bohnerz, the transverse valley of the molars is blocked to a still greater extent by this forwardly directed wing than in *C. cartieri*.

2. It is well recognized that in the Tapiroid line the gradual formation of the posterior crest in p_4 is a feature of the evolution of the tooth and truly progressive. If we assume that the Burma species is in a more advanced stage of evolution than the other two species of *Chasmotherium* referred to, the gradual development of this crest is plainly observable. Thus in *C. stehlini* it is practically absent, there being only an antero-posterior ridge behind the main lobe of p_4. In *C. cartieri* the crest is fully formed, but its incomplete development is shown by its diminished height, when followed internally, and by the presence of a small cusp at the internal end. In *C. birmanicum* the posterior crest is stronger and no small cusp can be observed.

3. The increased height of the crest is possibly also a progressive character.

Measurements in millimetres of Chasmotherium (?) birmanicum.

M_3 Antero-posterior diameter 15·2 Transverse diameter 11·8.

M_2 Antero-posterior diameter 13·8 Transverse diameter 10·6.

M_1 Antero-posterior diameter 12·3 Transverse diameter 9·7.

P_4 Antero-posterior diameter 11·7 app. Transverse diameter 9·7.

[1] Depéret C., Sur les caractères et les affinités du genre *Chasmotherium* Rutimeyer, *Bull. soc. geol. France* (4), IV, (1904), p. 583.

EXPLANATION OF PLATE I.

FIG. 1.—SIVATITANOPS BIRMANICUM Pilg. and Cott. Front portion of skull, from Yaw series (?), ½ mile N. E. of Kyawyaw (C. 329). 1*a*, view from palatal surface; 1*b*, view from upper surface; 1*c*, side view.—Page 9.

FIG. 2.—EOTITANOTHERIUM (?) LAHIRII sp. nov. 2nd left upper premolar, from 1 mile E. S. E. of Sinzwe (C. 340).—Page 11.

FIG. 3.—SIVATITANOPS COTTERI sp. nov. 2nd right upper premolar, from 6½ furlongs 9° W. of S. from Hill 1258 Myaing township (C. 331).—Page 7.

FIG. 4.— „ „ „ Upper incisor, from ¼ mile W. of Pangan, Myaing township (C. 335).—Page 8.

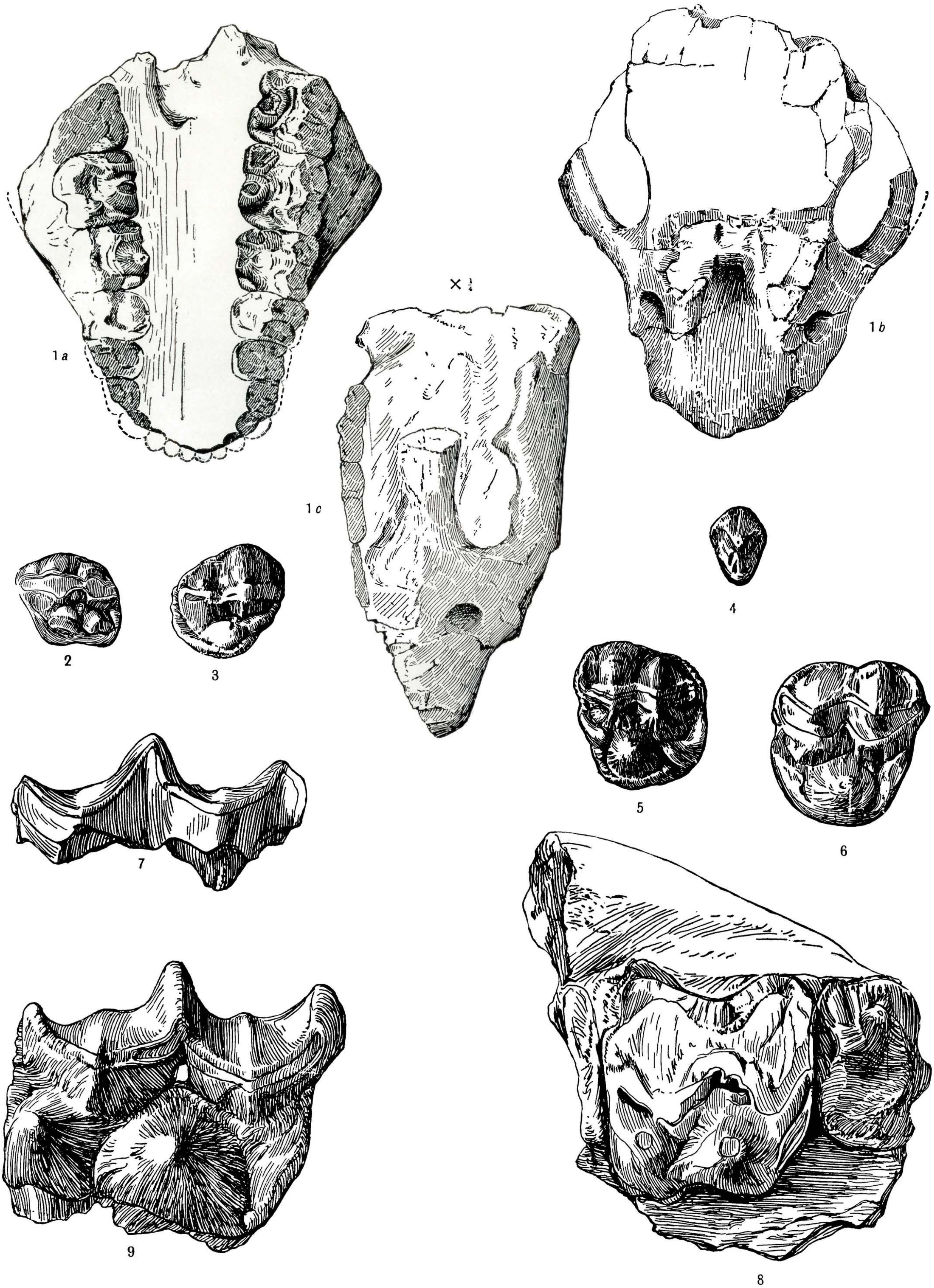
FIG. 5.— „ „ „ 3rd left upper premolar, from the same locality as the specimen in fig. 3 (C. 332).—Page 7.

FIG. 6.— „ „ „ Last right upper premolar, from the same locality as the specimen in fig. 4 (C. 334).—Page 7.

FIG. 7.—EOTITANOTHERIUM (?) LAHIRII sp. nov. External wall of 2nd or 3rd upper molar, from the same locality as the specimen in fig. 2 (C. 341).—Page 11.

FIG. 8.— „ „ „ Right maxilla with fragmentary 1st molar and last premolar, from the same locality as the specimen in fig. 2 (C. 342).—Page 11.

FIG. 9.—SIVATITANOPS COTTERI sp. nov. 2nd right upper molar from the same locality as the specimen in fig. 3 (C. 330).—Page 6.



Figs. 1a—1c by S. N. Guine.
,, 2—9 by G. M. Woodward.

All figures except 1a, b and c natural size.

G. S. I. Calcutta

EXPLANATION OF PLATE II.

FIG. 1.—METAMYNODON COTTERI sp. nov. Front portion of skull and mandible, originally cemented together, from 1½ mi s W. of Mindezu (C. 344) 1*a*, palatal view of skull; 1*b*, side view of skull; 1*c*, upper view of mandible; 1*d*, side view of mandible (¼ natural size).; 1*e*, crown of incisor believed to belong to the same skull (natural size).—Page 15.

= Paramynodon

FIG. 2.—METAMYNODON BIRMANICUS Pilg. and Cott. 2nd upper premolar belonging to a left maxilla containing the complete dental series, from 6½ furlongs 9° W. of S. of Hill 1258, Myaing township (C. 345).—Page 19.

= Paramynodon

FIG. 3.— „ „ „ Last left upper molar, being one of a set of upper teeth belonging to the same individual, from 6 furlongs 8° E. of S. of Peak 1258, Myaing township (C. 346).—Page 19.

FIG. 4.—SIVATITANOPS COTTERI sp. nov.(?) Right lower premolar of a fragmentary mandible, from 1 mile W. of Bahin (C. 338).—Page 9.

FIG. 5.— „ „ „ A broken lower canine, upper view, belonging to the same mandible as the premolar in fig. 4 (C. 338).—Page 9.

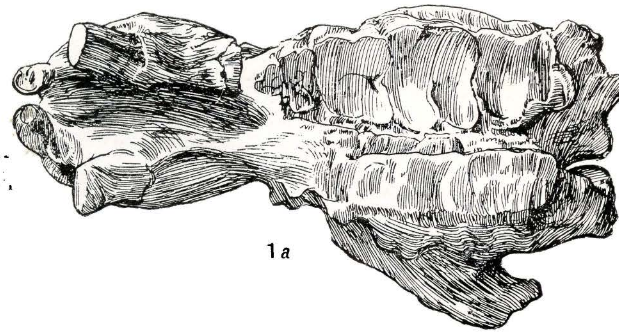
FIG. 6.—SIVATITANOPS RUGOSIDENS sp. nov. Inner half of the last right upper premolar from 1 mile E. S. E. of Sinzwe (C. 339).—Page 11.

FIG. 7.— „ „ „ Fragmentary right upper molar, belonging to the same individual as e premolar in fig. 6 (C. 339).—Page 1 .

FIG. 8.—INDOLOPHUS GUPTAI gen. nov. sp. nov. Last three upper premolars in embryo) and 1st upper molar belonging to an immature left maxilla from 1¼ miles N. of Konywa (C. 347). 8*a*, 2nd premolar; 8*b*, 3rd p olar; 8*c*, 4th premolar; 8*d*, ' —Page 22.

FIG. 9.—CHASMOTHERIUM (?) BIRMANICUM sp. nov. Left mandibular containing the three molars and the last premolar from 1½ miles S. W. of Thadut village, Myaing township (C. 348).—Page 25.

GIPC—M-V-2-14—21-3-25—425

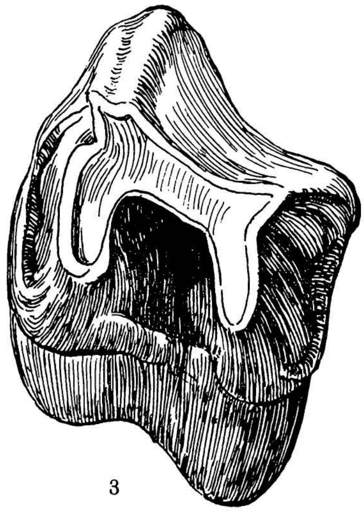


× $\frac{1}{4}$

1*a*

2

1*e*



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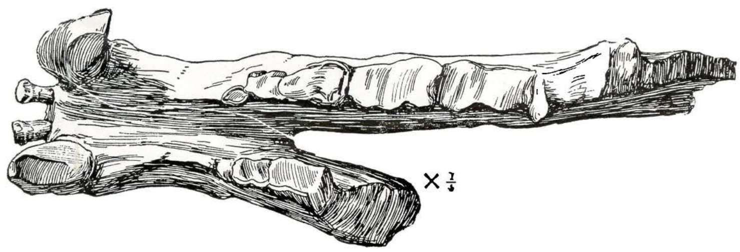


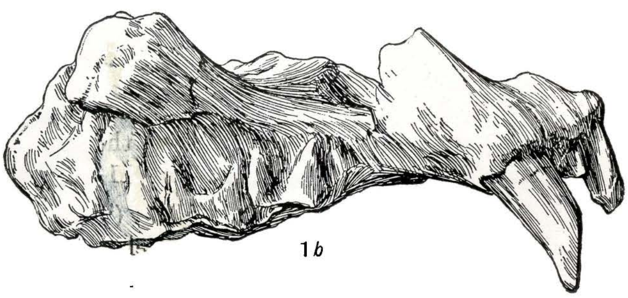
× $\frac{1}{3}$

1*c*

4

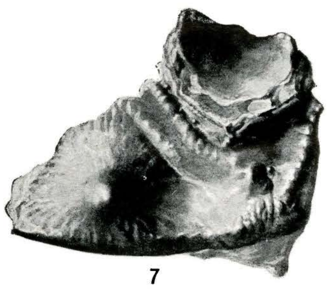
5

× $\frac{1}{4}$



1*b*

6



7

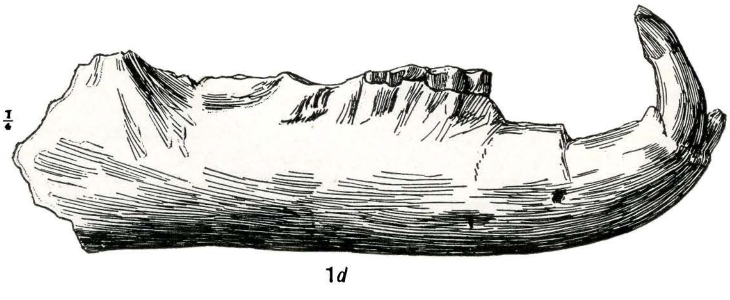
8*a*

8*b*

8*c*

8*d*

× $\frac{1}{4}$



1*d*

9

G. M. WOODWARD, *del.* *G. S. I. Calcutta.*

All figures except 1a—d natural size.

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