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Notes

III.—*Observations on the Fossils representing the Thylacotherium Prevostii, VALENCIENNES, with reference to the Doubts of its Mammalian and Marsupial Nature recently promulgated ; and on the Phascolotherium Bucklandi.*

By RICHARD OWEN, Esq., F.G.S., F.R.S.

PART I.—*On the Thylacotherium.*

[Read November 21, 1838.]

PLATE V.

THE ample experience which Comparative Anatomists possess of the truth and tact with which the illustrious Cuvier formed his judgement of the nature and affinities of an extinct animal from an inspection of part, or even a single fragment of its skeleton, would justify our not attaching much weight to a conflicting opinion, maintained on mere theoretical grounds, and without actual inspection of the fossil itself ; but when the accuracy of one of Cuvier's interpretations is called in question by an anatomist so eminent as his successor in the chair of Comparative Anatomy, the confidence of geologists in their great guide in Palæontology becomes liable to be shaken, and an examination into the validity of such objections is requisite.

The doubts which M. de Blainville has published*, as to the mammalian nature of the animals represented by the well-known fossil jaws discovered in the Stonesfield oolite, rest,—first, on their being probably too imperfect to yield any conclusive evidence as to the class of animals to which they may have belonged ; and, secondly, on an interpretation of appearances presented by casts of these fossils leading to conclusions opposite to those which Cuvier, and afterwards M. Valenciennes, derived from an inspection of the actual fossils.

It is in compliance chiefly with Dr. Buckland's request that I have undertaken to test the validity of these doubts, for which purpose he has transmitted to me from Oxford the two original fossils, each consisting of the ramus, or lateral half of a lower jaw ; I have also re-examined the similar, but larger and more perfect

* "Doutes sur le prétendu Didelphe de Stonesfield." *Comptes Rendus de l'Acad. de Sciences*, Oct. 22nd, 1838.

fossil, described by Mr. Broderip*, and, since, liberally presented by that gentleman to the British Museum.

And first, with reference to the condition of these specimens, I am justified in stating, unequivocally, that each and all of them are sufficiently complete to furnish grounds to any anatomist, conversant with the established generalizations in Comparative Osteology, for determining therefrom the class, if not also the more restricted group of animals to which they have belonged.

Cuvier, after an examination of one of the jaws from Dr. Buckland's collection, pronounced "the animal to have been mammiferous, resembling an Opossum, although of an extinct genus, and differing from all known Carnivorous Mammalia in having ten molar teeth in a series in the lower jaw†." It is to be regretted, that, with the exception of the number of molar teeth, Cuvier did not specify the particulars on which he founded his belief that the jaw in question represented a new but extinct genus of mammalian, and probably marsupial quadrupeds.

This specimen (Pl. V. fig. 3), however, plainly exhibits,—first, a convex articular condyle (*a*) ;—secondly, an indubitable and well-defined impression of what was once a broad, thin, high, and slightly recurved triangular coronoid process (*b*), rising immediately anterior to the condyle, having its basis extended over the whole of the interspace between the condyle and the commencement of the molar series, and having a vertical diameter equal to that of the horizontal ramus of the jaw itself ;—thirdly, the angle of the jaw (*c*) continued to nearly the same extent below the condyle as the coronoid process reaches above it, and its apex is continued backwards in the form of a process ;—fourthly, the parts above-described forming one continuous portion with the horizontal ramus of the jaw, which is not compounded of three or four distinct pieces. It is true, with respect to the last proposition, that an inferior marginal groove (*d*) has been considered as evidence of the composite structure of the jaw under consideration ; but there is no other mark that could be interpreted as an indication of this reptilian structure, whilst a similar groove characterizes the lower jaw of the marsupial *Myrmecobius* and *Wombat*, and of some large species of *Sorex*.

Now these points, which may be presumed to have influenced Cuvier in forming his opinion of the nature of the fossil in question, are precisely those which arrested the attention of M. Valenciennes, when he examined the fossil itself, and which he has ably advanced in his endeavour to dissipate the doubts expressed by M. de Blainville.

Whence then, it may be asked, is the necessity of again describing these appearances, and of again urging their importance as evidence of the mammiferous nature of the Stonesfield jaw ? It arises from the circumstance that the Professor of

* Zoological Journal, vol. iii. p. 409, Pl. XI. 1828.

† *Loc. cit.* p. 409.

Comparative Anatomy at the Jardin des Plantes has declared, after an inspection of casts of the fossil examined by Cuvier and Valenciennes, that these anatomists have been deceived in all those points. M. de Blainville (*loc. cit.*) asserts that there is no trace of a convex condyle, but that, in its place, there exists an articular fissure, somewhat as in the jaws of Fishes; that the teeth, instead of being imbedded in sockets, have their fangs confluent with, or anchylosed to, the substance of the jaws; and that the jaw itself presents evident traces of the composite structure.

The point, therefore, which first demands our closest attention, is the actual condition in the Stonesfield fossils of the articular or condyloid process. Now it is scarcely necessary to observe, that the condyle of a lower jaw, independently of any other part, is sufficient to indicate whether it belongs to a mammiferous or oviparous animal. In the Mammalia it is convex or flat, in all Ovipara it is concave; in the fossil Stonesfield jaw examined by Cuvier (Pl. V. fig. 3), in the second specimen of the same species (Pl. V. fig. 1) examined by M. Valenciennes, and in the lower jaw of another genus (Pl. VI. fig. 2), described and figured by Mr. Broderip*, a prominent, convex, articular condyle is more or less distinctly revealed. It is most entire and unequivocal in Mr. Broderip's specimen, which I shall subsequently describe. What M. de Blainville has mistaken for an articular fissure—"une sorte d'échancrure articulaire un peu comme dans les poissons,"—must be the entering angle or notch either above or below the true articular condyle.

In Plate II. fig. 1 of the Bridgewater Treatise of Dr. Buckland, this important part of the structure of the jaw is very accurately represented. The figure also of the jaw of the *Thylacotherium*, given by M. Prevost in the *Annales des Sciences*†, is by no means "tout-à-fait inexacte," as asserted by M. de Blainville; but the form of the condyle is less completely displayed in this fossil than in the second specimen of *Thylacotherium Prevostii*, Val. (Pl. V. fig. 1). Although mutilated in both, what remains is situated in a line parallel with the crowns of the teeth, and projects beyond the vertical line dropped from the extremity of the coronoid process.

In the example examined by Cuvier, the form and extent of the coronoid process is indicated in a very clear and well-defined manner by the impression which it has left upon the matrix.

Now the coronoid process of the Opossum's jaw is plane on its inner surface, but slightly convex on the outer surface, the anterior margin of the process being produced externally in the form of a smooth convex ridge; and both this ridge and the shallow depression behind it, are accurately represented in the impression which this portion of the jaw has left on the matrix in which it was imbedded.

* Zoological Journal, vol. iii. p. 408, Pl. XL.

† Avril 1825, Pl. XVIII. fig. 1, p. 389.

A similar impression would be made by the outer side of the coronoid process of the Mole's jaw, but not by that of any known reptile or fish.

In the Opossum's jaw it will be likewise perceived that a depression is continued forwards and slightly downwards from the condyle of the jaw to the foramen of the dental artery and nerve : in the fossil a corresponding depression of the jaw has left a convex elevation of the matrix, leading likewise from the condyle to the dental foramen ; but this foramen, in the *Thylacotherium*, is situated relatively more forwards than in the *Didelphys*.

What therefore might at first sight seem to be an imperfection in the present fossil, affords in reality an additional clue for tracing out its true affinities. The fossil resembles the *Didelphys* in the breadth, the height, and the direction of the coronoid process ; but, among the placental Insectivores, the *Gymnurus Rafflesii* sufficiently resembles in these particulars the present Stonesfield fossils, to prevent undue stress being laid upon the modifications of the coronoid process as indicative of their marsupial affinities.

The simple structure of the jaw of the Thylacothere, its convex prominent condyle, and the process continued backwards from the angle of the jaw, have been adduced by M. Valenciennes as establishing the truth of Cuvier's opinion of the nature of that extinct animal ; and we have seen that all the fossils hitherto discovered justify such support. But these anatomical facts only go to prove the mammiferous and carnivorous, and not the marsupial character of the *Thylacotherium* : there is however a constant modification of the angle of the jaw, recognised by Cuvier* as peculiar to the family of Opossums (*Pedimanes*), and which I have found to characterize, not only that family, but all the marsupials hitherto discovered, and to distinguish them from their nearest congeners in the placental series : this character has not been taken into consideration in the inquiry into the nature of the present fossils by any of the able anatomists who have written respecting them, although, if co-existing with a convex condyle, it would be strong evidence of the marsupial nature of a fossil jaw, even if all the teeth were wanting.

In the carnivorous Marsupials, as the Thylacine, for instance, the lower maxillary bone resembles, in many respects, that of the corresponding species in the placental series, as the Dog : a similar transverse condyle is placed low down near the angle of the jaw ; a broad and strong coronoid process rises high above the condyle, and is slightly curved backwards ; there is the same well-marked depression on the exterior of the ascending ramus for the firm implantation of the temporal muscle ; and the lower boundary of this depression is formed by a strong ridge extended downward and forward from the outside of the condyle. But in the Dog and other placental Carnivores (the Seals excepted), a process, representing

* Ossem. Fossiles, Ed. 8^o, 1835, vol. v. p. 524.

the angle of the jaw, extends directly backwards from the middle of the above ridge, which process gives precision and force to the articulation of the jaw, and increases the power by which the masseter acts upon the jaw. Now, although the same curved ridge of bone bounds the lower part of the external muscular depression of the ascending ramus in all the Marsupialia, it does not in any of them send backwards, or in any other direction, a process corresponding to that just described in the Dog and other placental Carnivora. The angle of the jaw itself, in the Marsupials, is bent inwards in the form of a process, encroaching in various shapes and degrees of development, in the different marsupial genera, upon the interspace of the rami of the lower jaw. In looking directly upon the lower edge of the jaw, we see, therefore, in place of the margin of a vertical plate of bone, a more or less flattened triangular surface or plate of bone extended between the external ridge and the internal process or inflected angle. In the Opossums this internal angular process is triangular and trihedral, directed inwards, with the point slightly curved upwards, and more produced in the small than in the large species. In the Dasyures it has a similar form, but the apex is extended into an obtuse process. In the Perameles it forms a still longer process of a flattened form, extended obliquely inwards and backwards, and slightly curved upwards. It presents a triangular, slightly incurved and pointed form in the Petaurists, in which it is longest and weakest in the Pigmy species (*Acrobates*, Desm.). In the Potoroos and Phalangers the process is broad, with the apex slightly developed. It is bent inwards, and bounds the lower part of a wide and deep depression in the inside of the ascending ramus. In the great Kangaroo the internal margin of this process is curved upwards, so as to augment the depth of the internal depression above-mentioned. The internal angular process arrives at its maximum of development in the Wombat, so that the breadth of the base of the ascending ramus very nearly equals the height of the same part.

Now if the process from the angle of the jaw in the Stonesfield fossil be actually continued backwards, as M. Valenciennes describes, in the axis, or nearly so, of the ramus of the jaw, then such fossil would resemble the jaw of an ordinary placental carnivorous or insectivorous mammal, and the term *Thylacotherium* would be inappropriately applied to it; but in both the specimens of the fossil jaws to which that name has been restricted, and which present their inner or mesial surfaces to the observer, the angular process (Pl. V. figs. 1 and 3, c) presents a fractured surface; and we are led to conclude, therefore, that when the jaw was entire its angle was produced inwards or mesially; but whether to the same extent as in the Opossum and other Marsupials, or with a slight inclination, as in the Mole and Hedgehog, cannot be certainly determined in the present fossils. In these specimens, however, the apex of the angle only is fractured; while in the fossil

described by Mr. Broderip, the entire process, and consequently the angle of the jaw, which in the Marsupials constitutes this process, is broken away: in this jaw, likewise, the gentle convex line, continued from the condyle into the lower margin of the horizontal ramus of the jaw, is uninterrupted, precisely as in the jaw of the Marsupial (*Dasyurus viverrinus*) now on the table*, in which I have broken away, in a similar manner, the inwardly produced angle. In the fossils, something which projected inwards has evidently been broken off. The very circumstance of the angular process projecting inwards beyond the plane of the ramus of the jaw, would render it most liable to be broken off when the matrix came to be detached from the inner surface of the jaw; whereas, if it had been simply continued backwards, it might have been preserved entire; but this has not been the case in any of the fossils hitherto obtained from Stonesfield.

These appearances, in conjunction with the condyloid and coronoid processes forming parts of one simple, continuous, undivided plate of bone, would be sufficient to determine, not only the mammiferous, but the carnivorous, and to strongly indicate, in the *Phascolotherium* at least (Pl. VI. fig. 2), the marsupial nature of the Stonesfield fossils, if even every tooth and alveolar process had been destroyed.

Nevertheless, in a question of so much interest in the problem of the order of appearance of animated beings on our planet, it is well that these parts also are present, and in sufficiently good preservation in the fossils in question to yield important auxiliary proofs of their mammiferous, if not marsupial nature.

M. de Blainville alludes to a careful drawing of one of these jaws which represented the posterior molars as having “la forme en palmette, quinquelobée,” a form which he observes is sufficient to expel them not only from the marsupial but the mammiferous series. To this it may be replied, that certain species of Seal, both recent and fossil, might, for the same reason, be argued to be non-mammalian.

The following is the exact condition of the teeth in the specimen of the *Thylacotherium* examined by Cuvier (Pl. V. fig. 3):—there are ten molars *in situ*, each with two fangs imbedded, as the seven anterior molars show, in deep and distinct sockets; there is an evident trace of the sockets of another molar anterior to those in place.

The molars very gradually increase in size from the first or anterior one to the sixth in the present specimen; the rest are equal, except the last, which is somewhat smaller. The crowns of all the grinders, except the second, third and fourth †,

* This specimen is now placed by the side of the jaw of the *Phascolotherium* in the British Museum.

† The teeth are here enumerated as they exist in the fossil, not with reference to the true dental formula.

are vertically split, and more or less of their internal grinding surface is broken away.

The *tenth molar* presents only the inner side of the middle external cusp, with part of the anterior cusp ; a similar appearance would be produced in the true molar of a *Didelphys*, if the internal middle cusp and the posterior cusps were obliquely sliced away.

In the *ninth molar* the large middle external cusp is nearly entire to its sharp apex ; part of the anterior cusp and the base of the internal posterior cusp are preserved : the same appearances would be produced in the true molar of a *Didelphys*, if the middle internal cusp and part of the anterior and posterior internal cusps had been obliquely truncated.

In the *eighth* tooth the fractured surface of the crown gives a view of the anterior and large middle external cusp, with part of the posterior external cusp.

In the *seventh* tooth the crown is more mutilated than in the preceding teeth ; only a part of the anterior cusp and the base of the external cusp are visible ; but the fracture displays the breadth of the crown, and corroborates the evidence afforded by the preceding teeth, and confirmed beyond question by the posterior molar of the second jaw (Pl. V. fig. 1), that these posterior molars were not provided, as M. de Blainville asserts, with mere compressed, five-lobed crowns.

In the *sixth* tooth the evidence of the complicated structure of the crown becomes indistinct : part of a large anterior and small posterior cusp are alone visible.

In the *fifth* tooth two similar cusps are present, but the points are broken.

The crowns of the *fourth*, *third* and *second* grinders are perfect, and clearly show that they are each divided into two, and not three, sub-compressed conical cusps, the posterior one being very much less than the other : these teeth precisely resemble the second and third false molars of the lower jaw in the Mole, as well as in some species of *Didelphys*. I cannot perceive the tricuspid structure given to these teeth in the figure in the Bridgewater Treatise of the jaw now described ; that of M. Prevost in the *Annales des Sciences* is more exact in this particular, at least as regards the *third* tooth in place.

The minute cylindrical medullary canal (*cavitas pulpi*) is plainly visible in the anterior fang of both the second, third, fourth and fifth molars.

The crowns of the first and second premolars in the present specimen are broken vertically like the posterior teeth ; but sufficient of the crown is preserved in both to show that it was unequally bicuspid, as in the two succeeding false molars.

The anterior false molars are altogether displaced ; but traces of the alveoli, for the two short fangs of one of these, may be perceived at the broken anterior extremity of the present fossil.

The double fangs of the seven anterior molars in place are exposed by the breaking away of the internal plate of the ramus of the jaw: in the three following molars the beginning of the fangs are visible, slightly protruded from their sockets. The fangs extend half way through the vertical diameter of the ramus; their dense ivory is clearly contrasted both by its texture and deeper colour from the surrounding bone: so far from being anchylosed to this bone, as M. De Blainville asserts, they are clearly separated from it by a thin layer of a distinct colour from either; and which appears to be due to the matrix which has insinuated itself into the sockets of the teeth, as it has into the vascular canals of the jaw.

Lastly, it must be obvious to all who inspect this fossil and compare it with the jaw of a small *Didelphys*, that, contrary to the assertion of M. de Blainville, the teeth and their fangs are arranged with as much regularity in the one as in the other; and that instead of an argument in favour of the saurian nature of the fossil being afforded by this part of its structure, the distinct sockets and their double cavities, corresponding with the long and slender double fangs of the teeth, are conclusive against the saurian theory.

I proceed next to the description of the second specimen of the half-jaw of *Thylacotherium Prevostii* in Dr. Buckland's collection (Pl. V. fig. 1): this agrees in size and form with the preceding. Such teeth as are preserved in it, agree with the corresponding ones in the previous specimen: there can be no doubt that they both belonged to mature individuals of the same species and the same size. M. Valenciennes, after an inspection of this second example, declared it to be the left ramus of the lower jaw, having its internal side exposed to view: he founded his opinion on the presence of the orifice of the dental canal near one end, and of the articular surface of the symphysis at the other.

M. de Blainville, after an inspection of the casts of this example, came to a contrary opinion; he denies the existence of the orifice of the dental canal and of the symphysial articulation, and describes the specimen in question as being the external side of a compound jaw with an articular notch, like that of a fish or reptile. It has become necessary, therefore, again to subject this specimen to a severe scrutiny; and M. Valenciennes will pardon me for reiterating facts which he has so ably and accurately described, when he reflects that the progress of geological truth and the establishment of a sound theory of the succession of animal development in this planet would be impeded, if the doubts, cast upon his statements by so able an anatomist as his learned colleague, should remain untested by a second appeal to the specimen itself.

In this specimen the whole of the exposed surface of the lower jaw, with the exception of the coronoid, articular and angular processes, is entire; the smooth surface near the anterior extremity of the jaw is in bold relief, and slopes away at

nearly a right angle from the rougher articular surface of the elongated symphysis. It may be supposed that this symphysial articular surface (Pl. V. fig. 1, *e*), which at once determines the side of the jaw, might be obscured in a plaster-cast, but there is no possibility of mistaking it in the fossil itself; it is long and narrow, and is continued forwards in the same line with the gently convex inferior margin of the jaw, which thus tapers gradually to a pointed anterior extremity, precisely as in the jaws of the *Didelphys*, as well as in other Insectivora, both of the marsupial and placental series. Its lower margin presents a small but pretty deep notch, which possesses every appearance of a natural structure; and a corresponding but shallower notch is present in the same part of the jaw of the *Myrmecobius* (Pl. V. fig. 2, *f*). In the relative length of the symphysis, its form and position, the jaw of the *Thylacotherium* corresponds with that of the *Didelphys*, *Myrmecobius*, and *Gymnurus*. A greater proportion of the convex articular condyle is preserved in this than in the foregoing specimen, and it projects backward to a greater extent. The precise contour of the coronoid process is not so neatly defined in this as in the first specimen of *Thylacotherium*, but sufficient remains to show that it had the same height and width.

The exposed surface of the coronoid process is slightly convex: had it been the outer side, as M. de Blainville asserts, it would have been concave. The surface of the ascending ramus of the jaw is entire above the angle, whence we may conclude, that if the process from the latter part had been continued directly backwards, it would also have been entire; but the extremity of the angular process is broken off, proving it to have originally inclined inwards, or towards the observer: as, however, the greater part of the angle (*c*) is entire, it could not have been inflected to the same extent as in the *Didelphys*, *Dasyurus*, or the *Phascolotherium*, next to be described. A groove is extended from the lower end of the articular condyle forward to the orifice of the canal for the dental artery, where it divides; the upper branch terminates in the dental orifice; the lower and larger division (*d*) is continued forward near the lower margin of the jaw, and is gradually filled up half way towards the symphysis:—no one could mistake this smooth vascular groove for an articular fissure. There is a broader and shorter groove in the corresponding part of the jaw of the *Myrmecobius* (Pl. V. fig. 2, *d*), and a narrower groove in that of the Wombat. The alveolar wall of the posterior grinders makes a convex projection, characteristic of the inner surface of the ramus of the lower jaw. The posterior grinder in the present jaw (Pl. V. fig. 1) is fortunately more complete than in the first example, and shows a small, middle, internal cusp, with part of a large external cusp, both projecting from the crown of the tooth in nearly the same transverse line. The enamel covering the internal cusp, which is vertically fractured, is beautifully distinct from the ivory, and considerably thicker in proportion to the size

of the tooth than is the enamel or its analogue in the teeth of any species of Reptile, recent or fossil. The six molars, anterior to the one in place, are broken off close to the sockets; both the fifth and fourth false molars are entire: the anterior cusp has the same superior size, as in the first specimen. The thick enamel coating, and the silky iridescent lustre of the compact ivory, are beautifully shown in these teeth.

The third and second grinders are more fractured than in the first specimen, but sufficient remains to show that they possess the same form and relative size; but the most interesting evidence, as regards the teeth, which the present jaw affords, is the existence of the sockets of not less than seven teeth, anterior to those above described. Of these sockets the four anterior ones are small and simple, like those of the Mole, being more equal in their size and interspaces than in the *Didelphys*. The fifth socket contained a small premolar with double fangs, and so likewise the sixth and seventh. Thus the two false molars, with perfect crowns in the present specimen, are the eighth and ninth teeth, counting backwards, or the fourth and fifth of their class, viz. *premolars*, or false molars.

Thus, as regards the genus *Thylacotherium*, we have now evidence that its dental formula must include thirty-two molars in the lower jaw,—sixteen on each side: that these, instead of presenting an uniform compressed tricuspid structure, and being all of one kind, must be divided into three series, as regards their form: five, if not six, of the posterior teeth are quinque-cuspidate, and must be regarded as *molares veri*. Some of the *molares spurii* are tricuspid and some bicuspid, as in the Opossums; but they are six, if not seven, in number: anterior to these are four simple teeth, of which the fourth may be regarded as the representative of the canine, and the anterior three as incisors. Thus the *Thylacotherium* differs considerably from the genus *Didelphys* in the number of its teeth: indeed, at the time when Cuvier wrote, no mammiferous ferine quadruped was known to possess more molar teeth than the *Chrysochlore*, which has nine molars on each side of the upper jaw, and eight molars on each side of the lower jaw.

The *Chrysochlore*, however, is not the only Mammal in which the molars exceed the number usually found in the unguiculate Mammalia.

In the Transactions of the Zoological Society for the year 1836 (vol. ii. p. 149), Mr. Waterhouse published a description of an Australian Marsupial, forming the type of a new genus (*Myrmecobius*), and having nine molars on each side of the lower jaw, besides one small canine and three simple conical incisors*.

* The six posterior grinders of *Myrmecobius* are compound and multicuspidate; the three anterior ones are *molares spurii* and tricuspid; with the exception of the last, they gradually diminish in size as they advance forwards (Pl. V. fig. 2).

The teeth of *Thylacotherium* moreover differ from those of *Didelphys* not only in number but also in size, being relatively smaller. The teeth of *Myrmecobius*, besides their approximation in number to those of *Thylacotherium*, resemble them in their small relative size more than do those of *Didelphys*; but they are still smaller than in *Thylacotherium*, which, in this respect as well as in the structure of the teeth, holds an intermediate position between *Didelphys* and *Myrmecobius*. And it is interesting to find that the recent Mammal, which thus approaches most nearly the extinct *Thylacotherium*, should exhibit in the structure of its lower jaw, and of the articular cavity for the same, unequivocal evidence of its belonging to the marsupial family.

The *Didelphys Prevostii* being evidently, as Cuvier stated, a genus distinct from *Didelphys*, properly so called, and as great inconvenience arises in applying to it that name in the Linnæan sense, or as an equivalent to the term *Marsupialis*,—in which sense alone it has ever been so applied by the naturalists of this country,—M. Valenciennes has added to the value of his examination of the present fossil by proposing for it a distinct generic appellation. It would have been more prudent, perhaps, to have chosen one less descriptive than '*Thylacotherium*,' since the affinities of the fossil Insectivore to the marsupial order may be regarded as indicated only with a certain degree of probability, and as requiring further evidence before the desired demonstration can be attained. The determination of the particular order of Mammals to which the animal represented by these ancient remains is referrible, is a matter, however, of little moment, compared to the discovery of the class of vertebrate animals to which it belonged. In reference to this point, the evidence afforded by the two jaws, above described, decisively proves, in my opinion, that they belonged to a true, warm-blooded, mammiferous species, referrible also to the higher or unguiculate division of the class Mammalia, and to an insectivorous genus; with a probability, according to the present known fossils, of the marsupial character of such genus.

At a subsequent Meeting I propose to bring forward my observations on the more perfect fossil half-jaw, described by Mr. Broderip under the name of *Didelphys Bucklandi*, and of which the marsupial character is more strongly manifested.

As this, however, like the *Thylacotherium*, is generically distinct from the modern genus *Didelphys*, I shall describe it under the name of *Phascolotherium Bucklandi*.

The dental formula of the genus *Thylacotherium* is, as regards the lower jaw, as follows :

$$\text{Incisors } \frac{?}{3-3} ; \text{ canine } \frac{?}{1-1} ; \text{ premolars } \frac{?}{6-6} ; \text{ molars } \frac{?}{6-6} = \frac{?}{32}.$$

PART II.—*Of the Phascolotherium.*

[Read December 19th, 1838.]

PLATE VI.

IF the question of the existence of the remains of animals so highly organized as Mammalia, in the Stonesfield oolite, depended only on the evidence afforded by the half-jaws of the *Thylacotherium* described at a previous Meeting of the Geological Society, that evidence, I have contended, is amply sufficient to enable the anatomist to answer that question in the affirmative.

The remains of the split condyles in these fossils demonstrate their original convex form,—a form which is diametrically opposite to that which characterizes the same part in all Reptiles, and, indeed, in all Ovipara. The size, the figure, and the position of the coronoid process are such as have never yet been witnessed in any other than a zoophagous mammal, with a temporal muscle sufficiently developed to demand so extensive an attachment for the purpose of working a destructive carnivorous jaw.

The teeth are composed of dense ivory, with crowns covered with a thick coat of enamel; they are everywhere distinct from the substance of the jaw, and those of the molar series have two fangs, deeply imbedded in distinct sockets. These teeth are, moreover, of three kinds: the hinder ones are bristled with five cusps, of which four seem to have been placed in pairs transversely across the crown of the tooth. The anterior ones present a very different form, and have but two or three cusps in the same plane; the four anterior teeth were simple, and each with a single fang. Now these particulars have never yet been found united in the teeth of any other than a zoophagous mammiferous quadruped. The general form of the jaw corresponds with the more essential indications of its mammiferous nature just described.

The *Thylacotherium* being thus established in its true position as regards the primary divisions of the Vertebrate sub-kingdom, there next remained to be detected such secondary characters as might reveal the affinities of the fossil to some of the minor groups of the zoophagous and insectivorous Mammalia; and such seemed to be indicated by the fractured angle of the jaw. But the evidence that may be drawn from this appearance is not so clear and convincing as that which relates to the first and main argument.

Many naturalists and anatomists may concede the mammiferous character of the *Thylacotherium*, but may require further evidence in proof of its marsupial nature.

Still I must repeat, that the jaws of the *Thylacothere*, as at present known, resemble those of the small Opossums more closely than any other group of the mammiferous class ; and in the number of the teeth, the Australian genus *Myrmecobius* offers the nearest approach to them.

It is, however, comparatively of little consequence to what particular order of Mammals the Stonesfield jaws belong, provided it can be certainly proved from them that they do belong to the class *Mammalia*.

The announcement of the fact of mammiferous remains in the oolitic formations, as it invalidated a received and general proposition relative to the first appearance of these remains in the component strata of the earth's crust, gave rise, in the minds of those philosophers who were unwilling to modify the general law so as to include the new fact, in the first place to doubts as to the antiquity of the matrix ; and afterwards, when these doubts could no longer be maintained, to a denial of the high organization of the fossils.

With respect to the fossils themselves it is asserted,—

1st. That they are too imperfect to support any safe conclusion as to the class of Vertebrates to which they belonged ; and that therefore, since all previous experience is contrary to the existence of mammiferous remains below the chalk or anterior to the Eocene period, the cold-blooded Ovipara ought to have the benefit of the doubt, and the fossils in question should be transferred to their low organized community.

The answer to this objection, which is founded on a view of casts only, is simply an appeal to the fossils themselves ; the result of which has already been given as regards the *Thylacotherium*.

2nd. These natural hieroglyphics, though considerably time-worn, being allowed to be sufficiently entire to give, if rightly interpreted, the date of the strata on which they are inscribed, we have to consider the differences of opinion as to their real form and meaning. In other words, the objections to the mammiferous nature of the Stonesfield jaws rest not only on a difference of opinion as to their actual structure, but also on a different interpretation of admitted appearances.

It is asserted that the jaws in question must belong to the cold-blooded Vertebrates, because the articular surface is in the form of an entering angle. My answer to this has been, that the articular surface is supported on a prominence, and that that prominence is convex ; and that a convex condyle is met with in no other class of Vertebrata, save in the *Mammalia*.

It is asserted, again, that the teeth are all of an uniform structure, as in certain reptiles. But this argument, in like manner, falls to the ground on reference to the fossils themselves ; the contrary being the fact, and the actual structure of the teeth strongly supporting the mammiferous theory of the fossils.

We have next to consider those arguments which have been founded on admitted structures.

The advocate of the mammiferous nature of the Stonesfield *Thylacothere* allows that it has an unusual number of molar teeth, it may be twelve, true and false, on each half of the lower jaw ; but he denies the inference, that, therefore, this half-jaw has not belonged to a Mammal. There is not sufficient constancy in the number of the teeth in the Mammalia, or even in the carnivorous or insectivorous subdivisions of that class, to render the excess of teeth in the *Thylacothere* of any value as an indication of its classial relations. Among the placental Carnivora the *Canis Megalotis* has constantly one more grinder on each side of the lower jaw than the usual number. Among the Insectivora the *Chrysochlore* has also eight instead of seven molars in each ramus of the lower jaw. Among the Marsupialia the genus *Myrmecobius* has nine molars on each side of the lower jaw. Some of the insectivorous Armadillos and of the zoophagous Cetacea offer examples of a combination of still more numerous and reptile-like teeth, with all the true and essential characters of the mammiferous class. The anatomist, contending for the saurian nature of the Stonesfield jaws, must have felt the weakness of his cause when he appealed to the number of the teeth in that fossil for its support.

All the spurious molars of the *Thylacotherium* have two well-developed fangs : but this fact has also been adduced as an objection to the Cuvierian determination of that extinct animal. The greater number of the spurious molars, however, in every genus of the placental *Feræ*, have two fangs, and in the marsupial Mammalia, as well as in the Mole, and some other Insectivora, the whole of the false molars invariably possess two fangs, and this structure as little co-exists with a complicated crown of the tooth as in the extinct *Thylacothere*.

If the ascending ramus of the Stonesfield jaws had been absent, and with it the evidence of their mammiferous nature afforded by the condyloid, coronoid and angular processes,—the structure of the teeth, and especially the implantation of the molars in distinct sockets by means of long double fangs, would, nevertheless, have yielded proof that the fossils in question were the remains of a species referrible to the highest class of animals. Since a Shark's tooth is never implanted in a socket, its form, whether it have a bifurcate base or not, cannot afford any argument for the non-mammalian nature of the *Thylacotherium* : the saurian nature of the so-called *Basilosaurus* is too problematical for the attachment of any value to an objection founded on the two-fanged structure of its teeth*.

When also it is recollected that Cuvier described and figured (after Garriga) the teeth of the *Megatherium* as having two fangs, and when the origin of that

* See Brú's Descripción del Esqueleto de un Quadrupedo muy corpulento y raro, &c. Folio, Madrid, 1796.

mistake is kept in view, the anatomist, anxious after truth, would pause before he accepted the reputed structure of the molars of the *Basilosaurus* as valid proof of so anomalous an exception to the condition of the teeth characteristic of the class *Reptilia*, if even the *Basilosaurus* should prove to be a true Saurian. In the teeth of the *Megatherium* the appearance of the double fang was produced by an accidental fracture in the axis of the tooth, displaying the two converging sides of the simple conical cavity, which, as in the teeth of the larger Saurians, occupies the base of the really simple and fangless tooth of the *Megatherium*.

Until, therefore, the teeth of the *Basilosaurus* shall have been examined with a view to the possibility of this mistake, and their size, form and relations to the jaws have been described, the simple statement that such an extinct animal had teeth with double fangs, can have little force against the argument for the mammiferous nature of the *Thylacothere*, founded on the structure of its teeth*.

The objection to the mammiferous character of the *Thylacothere* founded on the colour of the fossil, as indicative of a proportion of animal matter originally therein present, and presumed to be such as is found only in the cold-blood *Vertebrata*, will have but little weight with the geologist practically acquainted with fossil remains. The dentine of the *Mastodon*'s grinders commonly exhibits a colour much more nearly approaching to jet black than is presented by any tooth of the *Thylacothere*. On the other hand, there are numerous fossils of both reptiles and fishes, which, from the accident of their matrix, offer evidence of a much less original proportion of the animal matter than is conjecturally assigned to those of the *Thylacothere*.

There remain then for discussion the arguments for the saurian nature of the *Stonesfield* fossils, founded on the appearance of a compound structure observable in them.

As these appearances are more numerous and imposing in the jaw of the *Phascolotherium* about to be described, I have reserved their consideration to the present opportunity, repeating only, with respect to the *Thylacothere*, that the only trace of this structure in the jaw of that fossil is due to a mere vascular groove running along its lower margin; and that a similar structure is present in the lower jaw of some species of the *Opossum*, in the *Wombat*, *Myrmecobius*, and in that of the *Sorex Indicus* and of other *Mammalia*.

Description of the Half-jaw of Phascolotherium Bucklandi. Pl. VI. fig. 2.

The fossil on which this genus is founded is the right ramus of the lower jaw, having its external

* Since this paper was read, I have had the unexpected gratification of being able to determine the mammiferous, and probably cetaceous nature of the so-called *Basilosaurus*. See *postea*, p. 69 of the present volume.

surface imbedded in the oolitic matrix, and its inner or mesial surface exposed to the observer. It is the fossil described and figured by Mr. Broderip in the Third Volume of the Zoological Journal (Pl. XI.), in which its generic distinction from the Stonesfield fossils of *Thylacotherium* is distinctly pointed out, and the name of *Didelphys Bucklandi* given to it only 'for the sake of convenience and perspicuity;' the word *Didelphys* being here used in its widest sense, and the author expressly stating that it would perhaps be presumptuous in him to pronounce on its generic identity with the group of Marsupials, to which the term *Didelphys* is restricted by Cuvier.

In presenting another description of this interesting fossil to the scientific world, I have to offer the same apology to Mr. Broderip as to M. Valenciennes, in reference to the *Thylacotherium*. And the imposition of a distinct generic name on the *Didelphys Prevostii* by MM. Agassiz*, de Blainville and Valenciennes, has, in some measure, compelled me to take the same step in reference to the *Didelphys Bucklandi*, since I shall be able to prove in the sequel, that this fossil offers characters which distinguish it generically, not only from the *Didelphys Prevostii* or *Thylacotherium*, as Mr. Broderip has already pointed out, but also from the true genus *Didelphys* of modern Mammalogists, to which, nevertheless, it has a much nearer affinity.

The condyle of the jaw of the *Phascolotherium* here described (Pl. VI. fig. 2. a.), instead of being vertically split, as in the specimens of *Thylacotherium*, is fortunately entire, and stands out in bold relief from the oolitic matrix; it presents exactly the same form and degree of convexity as in the genera *Didelphys* and *Dasyurus*. In its relative position to the series of molar teeth, with which it is on a level, it corresponds with *Dasyurus* more nearly than with *Didelphys*: in the *Dasyurus ursinus*, in fact, as well as in the allied marsupial genus, *Thylacinus*, the condyle has precisely the same relative position to the molar series; so that this particular structure in the jaw of the *Phascolotherium* affords no argument against its admission into the marsupial series.

The general form and proportions of the coronoid process (b.) resemble those in the zoophagous Marsupials; but in the depth and form of the entering notch, between this process and the condyle, it corresponds most closely with the *Thylacinus*.

It is, indeed, a most interesting fact, that this rare and solitary genus, represented by a single species (the Hyæna of the Tasmanian colonists), whose term of existence seems fast waning to its close, should afford the only example of a form and backward extension of the coronoid process, and a corresponding deep emargination above the condyle, which would else exclusively characterize the ancient *Phascolotherium*†.

* Von Leonard and Bronn's Neues Jahrbuch, 1835, s. 186.

† Mr. Broderip, in his description above alluded to, observes, "that it may not be uninteresting to note, that a recent species of *Trigonia* has very lately been discovered on the coast of Australia, that

The base of the inwardly-bent angle of the lower jaw progressively increases in *Didelphys*, *Dasyurus* and *Thylacinus*; and, judging from the fractured surface of the corresponding part in the fossil, it also resembles most nearly, in this respect, the *Thylacinus*.

The condyle of the jaw is nearer the plane of the inferior margin of the ramus in the Thylacine than in the Dasyures or Opossums; and consequently, when the inflected angle is broken off, the curve of the line continued from the condyle along the lower margin of the jaw in the Thylacine is least: in this particular again the Phascolothere resembles the Thylacine. In the position of the dental foramen, the Phascolothere, like the Thylacothere, differs from all the zoophagous Marsupials already cited, and also from the placental *Feræ*; but in the *Potoroo* (*Hypsiprymnus*), a marsupial Herbivore, the orifice of the dental canal is situated, as in the Stonesfield Marsupials, very near the vertical line, dropped from the last molar tooth. (See letter *e*, Pl. V. figs. 1, 2 and 3, and Pl. VI. figs. 1 and 2.)

A portion of the inner wall of the jaw, near its anterior margin, in the Phascolothere, has been violently broken off, so that the form of the symphysis cannot be precisely determined; but in the gentle curve by which the lower margin of the jaw is continued along the line of the symphysis to the anterior extremity of the jaw, the *Phascolotherium* resembles *Didelphys* more than *Dasyurus* or *Thylacinus*.

It is interesting to find that this analogy is associated with a correspondence in the condition of the teeth at the anterior part of the jaw. In examining the fossil we can scarcely refuse our assent to Mr. Broderip's opinion, that there were originally four incisors in each ramus of the jaw of *Phascolotherium*, as in *Didelphys*. Of the three incisors which are actually present in the fossil, only the internal and posterior surfaces are displayed, and not the whole breadth of the tooth; so that in the enlarged figure of the jaw detached from its matrix, the incisors appear both narrower and further apart than they really are. The incisors in the *Thylacinus* are of a prismatic form; and the surface, corresponding to that which is exposed on the fossil, forms one of the angles, from which the tooth increases in breadth to its anterior part, which forms one of the three facets.

Allowing for this circumstance, which must be borne in mind in an endeavour to arrive at the true affinities of the Phascolothere, the incisors in that fossil are

land of Marsupial animals. Our specimen," continues Mr. Broderip, "lies imbedded with a number of fossil shells of that genus. The individuals are of the same species so frequently found at Stonesfield."—*Loc. cit.* p. 4. May we be permitted to conjecture that Australia, in its marsupial inhabitants, its *Araucariæ* and Cycadeous plants, with the living *Clavagellæ*, *Terebratulæ* and *Trigoniæ* of its coasts, presents us with the picture, as it were, of the last remains of an old and worn-out world,—of one that has long been superseded in this hemisphere by other strata and a higher type of mammiferous organization?

evidently separated by wider intervals than in *Thylacinus*, *Dasyurus* or *Didelphys*; and the *Phascolothere* resembles, in this respect, as in the smaller proportions of its canine, the genus *Myrmecobius*.

In the proportions of the grinders to each other, especially the small size of the hindmost molar, the *Phascolothere* resembles the *Myrmecobius* more than it does the Opossum, the *Dasyure* or the *Thylacine*; but in the form of the crown it resembles the *Thylacine* more closely than any other genus of Marsupials. In the number of molar teeth the *Phascolothere* differs both from the *Thylacothere* and the *Myrmecobius*, and resembles the Opossum and *Thylacine*, having three false and four true molars, or seven grinders altogether, in each maxillary ramus. The distinction between the false and true molars is however much less strongly marked, both in the *Phascolothere* and *Thylacine*, than in the Opossum. The difference between the false and true molars in the Opossum is chiefly indicated by the addition, in the true molars, of a pointed tubercle on the inner side of the middle large tubercle, and in the same transverse line with it; but in the *Phascolothere*, as in the *Thylacine*, there is no corresponding tubercle on the inner side of the large, middle, pointed cusp; its place is occupied in the *Phascolotherium* by a ridge, which extends along the inner side of the base of the crown of the true molars, and projecting a little beyond both the anterior and posterior smaller cusps, gives the quinecuspid appearance to the crown of the tooth, as represented by Dr. Buckland in his magnified view of the antepenultimate grinder of the *Phascolotherium*, given in the 2nd Plate of the illustrations of the Bridgewater Treatise. In the *Thylacine* the internal ridge is not continued across the base of the large middle cusp, but it extends along and beyond each of the lateral cusps, so as to give the tooth a similar quinecuspid form to that which characterizes the true molars of the *Phascolothere*. Connecting the close resemblance which the molar teeth of the *Phascolothere* bear to those of the *Thylacine* with the similarities which have been already shown to exist in the several characteristic features of the ascending ramus of the jaw, I am of opinion that the marsupial extinct genus, indicated by the Stonesfield fossil here described, was nearly allied to *Thylacinus*, and that its position in the marsupial series is between *Thylacinus* and *Didelphys*.

There are two linear impressions on the inner side of the horizontal ramus of the jaw of the *Phascolothere* which have been mistaken for indications of *harmonia*, or toothless sutures, analogous to those which join together the component pieces of the compound jaws of reptiles and fishes. One of these is a faint, shallow, linear impression, continued from between the antepenultimate and penultimate molars, obliquely downwards and backwards, to the foramen for the dental artery. I conceive it to be due to an accidental crack; and if the portions of the bone

which it separates were to be compared to the contiguous margins of the opercular and dentary pieces of a reptile's jaw, it would be seen that the only suture, which in Reptiles is continued from any part of the level of the dental series between these pieces, passes in a totally different direction ; it is the suture which bounds the anterior part of the opercular piece, and which, in all reptiles, runs obliquely downwards and forwards, instead of downwards and backwards. The second impression (*d. fig. 2. Pl. VI.*) in the jaw of the *Phascolotherium* is much more strongly marked than the preceding ; it is a linear groove continued from the anterior extremity of the fractured base of the inflected angle obliquely downwards to the broken surface of the anterior part of the jaw. Whether this line be due to a vascular impression, or an accidental fracture, I do not offer an opinion ; but this may be confidently affirmed, that there is not any suture in the compound jaw of a reptile which occupies a corresponding situation. And lastly, with reference to the philosophy of pronouncing judgement on the saurian nature of the Stonesfield fossils from the appearances of sutures in the jaws themselves, I would offer one remark, the justness of which will be obvious alike to those who are and those who are not conversant with the details of Comparative Anatomy.

The cumulative evidence of the true nature of the Stonesfield fossils, afforded by the shape of the condyle, coronoid process, angle of the jaw, different kinds of teeth, with the shape of their crowns, double fangs, and implantation in sockets, reposes on structures which cannot be due to accident, while those which favour the evidence of the compound structure of the jaw *may arise* from accidental circumstances.

The dental formula of the genus *Phascolotherium* is as follows :—

Incisors $\overset{?}{3}\text{--}\overset{?}{3}$; canines $\overset{?}{1}\text{--}\overset{?}{1}$; premolars $\overset{?}{3}\text{--}\overset{?}{3}$; molars $\overset{?}{4}\text{--}\overset{?}{4}$.

Downloaded from <http://trn.lyellcollection.org/> at Duke University on November 21, 2012

Fig. 1 & 3 Thylacotherium Prevostii. Fig. 2 Myrmecobius

J. C. Curtis, del.

The outline figures are of the natural size.

J. C. Buxton, sc.

Fig. 1 Thylacotherium Broderipii. Fig. 2 Phascototherium Bucklandi.