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THE

ZOOLOGY

OF

THE VOYAGE OF H.M.S. BEAGLE,

UNDER THE COMMAND OF CAPTAIN FITZROY,

DURING THE YEARS

1832 TO 1836.

PUBLISHED WITH THE APPROVAL OF
THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

Edited and Superintended by

CHARLES DARWIN, ESQ. M.A. F.G.S.

CORRESPONDING MEMBER OF THE ZOOLOGICAL SOCIETY,

AND NATURALIST TO THE EXPEDITION.

FOSSIL MAMMALIA,

BY RICHARD OWEN, ESQ.

PROFESSOR OF ANATOMY AND PHYSIOLOGY IN THE ROYAL COLLEGE OF SURGEONS, LONDON.

LONDON:
SMITH, ELDER AND CO., 65, CORNHILL.
MDCCCXXXVIII.

STEWART AND MURRAY, OLD BAILEY.

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[*Temporary Title.*

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PREFACE.

His Majesty's ship, Beagle, under the command of Captain FitzRoy, was commissioned in July, 1831, for the purpose of surveying the southern parts of America, and afterwards of circumnavigating the world. In consequence of Captain FitzRoy having expressed a desire that some scientific person should be on board, and having offered to give up part of his own accommodations, I volunteered my services; and through the kindness of the hydrographer, Captain Beaufort, my appointment received the sanction of the Admiralty. I must here, as on all other occasions, take the opportunity of publicly acknowledging with gratitude, the obligation under which I lie to Captain FitzRoy, and to all the Officers on board the Beagle, for their constant assistance in my scientific pursuits, and for their uniform kindness to me throughout the voyage. On my return (October, 1836) to England, I found myself in possession

of a large collection of specimens in various branches of natural history; but from the great expense necessary to secure their publication, I was without the means of rendering them generally serviceable.

The Presidents of the Linnean, Zoological, and Geological Societies, having given me their opinion respecting the utility to be derived from publishing these materials, I addressed a letter to the Right Honourable the Chancellor of the Exchequer (T. Spring Rice, Esq.) informing him of the circumstances under which I hoped that I might venture to solicit the aid of Government. In reply, I received a communication (as below) announcing to me that the Lords of the Treasury, from their readiness to promote Science, were willing, under certain conditions, to give me the most liberal assistance.

"*Treasury Chambers, August* 31, 1837.

"Sir,

"It having been represented to the Lords Commissioners of Her Majesty's Treasury, from various quarters, that great advantage would be derived to the Science of Natural History, if arrangements could be made for enabling you to publish, in a convenient form, and at a cheap rate, the result of your labours in that branch of science, my Lords will feel themselves justified in giving their sanction to the application of a sum, not exceeding in the whole one thousand pounds, in aid of such a publication; upon the clear and distinct understanding that the Work should be published, and the plates engraved, in such a manner as to be most advantageous to the Public at large, upon a plan of arrangement to be previously submitted to, and sanctioned by the Board, after consultation with those persons, who, from their attainments

in this branch of science, are the most capable of advising their Lordships thereupon; and that the payments on account of the said sum of one thousand pounds are to be made to you from time to time, on a certificate that such progress has been made in the engravings, in accordance with the plan previously approved of, as to justify the issue then applied for. My Lords have therefore directed me to communicate to you the views they entertain upon this subject; and to apprize you that they will be prepared to act in conformity with their arrangement, upon learning from you that you are ready to proceed with the Work upon the principles above laid down, and upon receiving from you a statement of the manner in which you think the Work should be published, and the plates engraved, so as most effectually to accomplish the object my Lords have in view, in sanctioning the payment from the Public Funds, in aid of the expenses of the Work in question.

"I remain,

"Sir, Your Obedient Servant,

"A. Y. SPEARMAN."

The object of the present Work is to give descriptions and figures of undescribed and imperfectly known animals, both fossil and recent, together with some account, in the one case, of their geological position, and in the other of their habits and ranges. As I do not possess the knowledge requisite for such an undertaking, and as I am, moreover, particularly engaged in preparing an account of the geological observations, made during the voyage, several gentlemen have most kindly undertaken different portions of the Work. Besides the very great advantage insured in thus enlisting the attainments of these Naturalists in the several departments of science, to which they have paid most

attention, a great delay is avoided by adopting this method of publication, which must otherwise have been incurred before the materials could have been made known.

An Account of the Voyage, drawn up by Captain FitzRoy, (and to which I have added a volume) being on the point of publication, I shall not in this Work enter on any minute details respecting the countries which were visited, but shall merely give a sketch of the geology in the introduction to the part containing Fossil Mammalia, and a brief geographical notice in that attached to the account of existing animals. At the conclusion of this Work, I shall endeavour to place together the leading results in the natural history of the different countries, from which the collections were procured. I may here state that Mr. Owen has undertaken the description of the Fossil Mammalia; Mr. Waterhouse, the Recent Mammalia; Mr. Gould, the Birds; Mr. Bell, the Reptiles; and the Rev. L. Jenyns, the Fish. Whatever assistance I may obtain in the invertebrate classes, will be noticed in their respective places. The specimens have been presented to the various public museums, in which it was thought they would be of most general service: mention will be made in each part where the objects described have been deposited.

FOSSIL MAMMALIA,

Described by

RICHARD OWEN, ESQ. F.R.S. F.G.S. F.L.S.

PROFESSOR OF ANATOMY AND PHYSIOLOGY TO THE ROYAL COLLEGE OF SURGEONS IN LONDON; CORRESPONDING MEMBER OF THE ROYAL ACADEMY OF SCIENCES OF BERLIN; OF THE ROYAL ACADEMY OF MEDICINE, AND PHILOMATHIC SOCIETY OF PARIS; OF THE ACADEMY OF SCIENCES OF PHILADELPHIA, MOSCOW, ERLANGEN.

WITH

A GEOLOGICAL INTRODUCTION,

BY CHARLES DARWIN, ESQ. M.A. F.G.S. &c. &c.

CORRESPONDING MEMBER OF THE ZOOLOGICAL SOCIETY.

GEOLOGICAL INTRODUCTION.

BY MR. DARWIN.

Mr. Owen having undertaken the description of the fossil remains of the Mammalia, which were collected during the voyage of the Beagle, and which are now deposited in the Museum of the College of Surgeons in London, it remains for me briefly to state the circumstances under which they were discovered. As it would require a lengthened discussion to enter fully on the geological history of the deposits in which these remains have been preserved, and as this will be the subject of a separate work, I shall here only give sufficient details, for the reader to form some general idea of the epoch, at which these animals lived,—of their relative antiquity one to the other,—and of the circumstances under which their skeletons were embedded. All the remains were found between latitudes 31° and 50° on the eastern side of South America. The localities may conveniently be classed under three divisions, namely—the Provinces bordering the Plata; Bahia Blanca situated near the confines of Northern Patagonia; and Southern Patagonia.

The first division includes an enormous area, abounding with the remains of large animals. To the eastward and southward of the great streams, which unite to form the estuary of the Plata, those almost boundless plains extend, which are known by the name of the Pampas. Their physical constitution does not vary over a wide extent;—the traveller may pass for many hundred miles on a level surface, without meeting with a single pebble, or discovering any change in

the nature of the soil. The formation consists of a reddish argillaceous earth, generally containing irregular concretions of a pale brown, indurated marl. This stone, where most compact, is traversed by small linear cavities, and in several respects resembles the less pure fresh-water limestones of Europe. The concretions not unfrequently become so numerous, that they unite and form a continuous stratum, or even the entire mass.

At Bajada de St^{a}. Fé, in the Province of Entre Rios, beds of sand, limestone, and clay of different qualities, containing sharks' teeth and sea-shells, underlie the Pampas deposit. The shells, although numerous, are few in kind. Mr. George B. Sowerby informs me that they appear to belong to one of the less ancient tertiary epochs; they consist of *Venus nov. spec.* near to *V. cancellata*; *Arca nov. spec.* near to *A. antiquata*; a very large oyster, probably an extinct species; an imperfect specimen of a second species of oyster near to *O. edulis*; and a *Pecten* near to *P. opercularis*. These beds pass upwards into an indurated marl, and this again into the red argillaceous earth of the Pampas, containing the remains of those extinct quadrupeds, which every where characterize that deposit. To the southward of the Plata level plains of an uniform composition, interrupted only at wide intervals by hills of crystalline rock, extend to a distance of about three hundred miles; and to the northward for at least an equal space, and probably much further. As might have been expected from the perfectly level surface, wherever a continuous section is presented on the banks of the great rivers, very slight changes of colour show, that the deposit has been accumulated in strata as horizontal as the land, or as the water-line at the base of the cliffs.

In the province of Banda Oriental (to the N. and N. E. of the Plata), and in part of that of Entre Rios, the land, though very low and level, has a foundation of granitic and other primary rocks. These older formations are partially covered, in most parts, by a reddish earthy mass containing a few small calcareous concretions; while in other parts, they are concealed by more regular strata, of indurated marl passing into limestone, of conglomerates, and ferruginous sandstone. The entire formation probably belongs to the same epoch with that of the Pampas deposit. In the earthy mass, even where it is of little thickness, and where it might readily be mistaken for detritus produced from the underlying granites, remains of large quadrupeds have several times been discovered.

On the shores of the Plata and in the neighbouring districts, proofs of a change of level having taken place between the land and the water within a recent period, may be observed. Both near Monte Video and Colonia del Sacramiento, beds of shells are lying on the beach at the height of several feet above the present tidal action. Near Maldonado I saw estuary shells of recent species embedded in clay, and raised above the level of a neighbouring fresh-water lake.

On the banks of the Parana, a shell identical with, or most closely resembling an estuary species (*Potamomya labiata*, now living in that part of the Plata, where the water is brackish) is accumulated in great masses, which are found some miles inland, and are elevated several yards above the level of the river. Sir Woodbine Parish, also, has in his possession, shells procured from an extensive formation near Ensenada de Barragan (south of Buenos Ayres), which is quarried for lime. Mr. George Sowerby has examined these fossils, and says the following are identical with living kinds; *Voluta colocynthis*, Dillwyn: *V. angulata*, Swainson: *Buccinum globulosum*, Kiener: a variety of *Oliva patula:* a *Cytherœa* closely resembling or identical with *C. flexuosa*, and a fragment of a second species, probably *C. purpurascens; Potamomya labiata;* and fragments of oysters. There is, however, a species of *Mactra* in very great numbers, with which Mr. Sowerby is wholly unacquainted. I may observe that I found recent shells of the first five species inhabiting the coast, a short distance to the southward. Some shelly limestone from the same place, which Sir Woodbine Parish had the kindness to show me, resembles that which I saw at Bajada, and in Banda Oriental. These beds, therefore, probably form parts of the Pampas deposit, and are not merely indicative of the period of its elevation. Nevertheless, on the opposite shores of the Plata, near the mouth of the Uruguay, I found lines of sand dunes, where the *Mactra* and *Cytherœa flexuosa* were lying in such quantities on the bare surface, that the inhabitants, by merely sifting the sand, collect them for burning into lime.

After these facts we may feel certain, that at a period not very remote, a great bay occupied the area both of the Pampas and of the lower parts of Banda Oriental. Into this bay the rivers which are now united in the one great stream of the Plata, must formerly have carried down (as happens at the present day) the carcasses of the animals, inhabiting the surrounding countries; and their

skeletons would thus become entombed in the estuary mud which was then tranquilly accumulating. Nothing less than a long succession of such accidents can account for the vast number of remains now found buried. As their exposure has invariably been due to the intersection of the plain by the banks of some stream, it is not making an extravagant assertion, to say, that any line whatever drawn across the Pampas would probably cross the skeleton of some extinct animal.

At Bajada, a passage, as I have stated, may be traced upwards from the beds containing marine shells, to the estuary mud with the bones of land animals. In another locality a bed of the same mineralogical nature with the Pampas deposit, underlies clay containing large oysters and other shells, apparently the same with those at Bajada. We may, therefore, conclude that at the period when the Arca, Venus, and Oyster were living, the physical condition of the surrounding country was nearly the same, as at the time when the remains of the mammalia were embedded; and therefore that these shells and the extinct quadrupeds probably either co-existed, or that the interval between their respective existences was, in a geological point of view, extremely short. In this part of South America there is reason to believe that the movements of the land have been so regular, that the period of its elevation may be taken as an element in considering the age of any deposit. The circumstance, therefore, that the beds immediately bordering the Plata, contain very nearly the same species of molluscs, with those now existing in the neighbouring sea, harmonizes perfectly with the more ancient (though really modern) tertiary character of the fossils underlying the Pampas deposit at Bajada, situated at a greater height, and at a considerable distance in the interior. I feel little doubt that the final extinction of the several large quadrupeds of La Plata did not take place, until the time when the sea was peopled with all, or nearly all, its present inhabitants.

Bahia Blanca, situated in latitude 39°, and about 250 miles south of the Plata, constitutes the second district, in which I found the remains of quadrupeds. This large bay is nearly surrounded by very low land, on which successive lines of sand dunes mark in many parts the retreat of the water. At some distance inland a formation of highly indurated marl, passing into limestone, forms an escarpment. Beyond this, rocks of the same character extend over a wide and

desolate plain, which rises towards the flanks of the distant mountain of the Sierra de la Ventana, composed of quartz. On the low shores of this bay, only two places occur, where any section of the strata can be seen; and at both of these I found fossil remains.

At Monte Hermoso, a line of cliff of about 120 feet in height, consists in the upper part of a stratum of soft sandstone with quartz pebbles; and in the lower of a red argillaceous earth, containing concretions of pale indurated marl. This lower bed has the same mineralogical character with the Pampas deposit; and possibly may be connected with it. The embedded bones were blackened, and had undergone more chemical change than in any other locality, which I examined. With the exception of a few large scattered bones, the remains seemed to belong chiefly to very small quadrupeds.

In another part of the bay, called Punta Alta, about eighteen miles from Monte Hermoso, a very small extent of cliff, about twenty feet high, is exposed. The lower bed seen at ebb tide, extends over a considerable area; it consists of a mass of quartz shingle, irregularly stratified, and divided by curved layers of indurated clay. The pebbles are cemented together by calcareous matter, which results, perhaps, from the partial decomposition of numerous embedded shells. In this gravel the remains of several gigantic animals were extraordinarily numerous. The cliff, in the part above high-water mark, is chiefly composed of a reddish indurated argillaceous earth; which either passes into, or is replaced by, the same kind of gravel, as that on which the whole rests. The earthy substance is coarser than that at Monte Hermoso, and does not contain calcareous concretions. I found in it a very few fragments of shells, and part of the remains of one quadruped.

From the bones in one of the skeletons, and likewise from those in part of another, being embedded in their proper relative positions, the carcasses of the animals, when they perished, were probably drifted to this spot in an entire state. The gravel, from its stratification and general appearance, exactly resembles that which is every day accumulating in banks, where either tides or currents meet; and the embedded shells are of littoral species. But from the skeleton, in one instance, being in a position nearly undisturbed, and from the abundance of serpulæ and encrusting corallines adhering to some of the bones, the water, at

the time of their burial, must have been deeper than at present. This conclusion might also have been inferred from the fact, that in the neighbouring cliff the same bed, with its shells, has been uplifted some yards above high-water mark. On the coast to the southward abundant proofs occur, of a recent elevation of the continent. In the gravel, nearly all the pebbles are of quartz, and have originally proceeded from the lofty range of the Ventana, distant between forty and fifty miles. Besides the pebbles of quartz, there are a few irregular masses of the same indurated marl, of which the escarpment of the neighbouring great plain is composed. Hence the gravel beds must have been deposited, when the plain existed as dry land; and on it probably those great animals once lived, of which we now find only the remains. The indurated marl forming the plain, is the same kind of rock with that occurring over a wide extent of the Pampas; and there is no reason to doubt, they are parts of one great formation. Nevertheless, the gravel bed of Bahia Blanca, although subsequent to the calcareous formation, may be of the same age with those parts of the Pampas, which stand at a low level near the Plata. For on this whole line of coast, I believe, as the land has continued rising, fresh littoral deposits have been formed; and each of these would often owe part of its materials to the degradation of the one last elevated.

With respect to the relative age of the Monte Hermoso and Punta Alta beds, it is not possible to speak decidedly. A certain degree of similarity in the nature of the strata containing quartz pebbles, and those of the reddish indurated earth; and the short distance between the two localities, would indicate that no long interval had intervened. The beds at Monte Hermoso, certainly were deposited more tranquilly, and probably in a deeper sea; so that even skeletons of animals, no larger than rats, have been perfectly preserved there. In some parts of the surrounding country, obscure traces of a succession of step-formed terraces may be observed; and each of these indicates a period of repose during the elevation of the land, at which time the strata previously existing were worn away, and fresh matter deposited. The Monte Hermoso beds were, perhaps, formed during one such interval, anterior to the accumulation of the shingle bank at Punta Alta.

Mr. G. Sowerby, who has been good enough to examine the shells which were found with the remains of the quadrupeds, has given me the following list.

1.	*Voluta angulata.*	
2.	—— *colocynthis.*	
3.	*Oliva Brasiliensis.*	
4.	——	Nearly related to *O. patula*, but specimen imperfect.
5.	——	Nearly related to *O. oryxa*; less nearly to small species now living at Bahia Blanca.
6.	——	*Nov. spec.*
7.	*Buccinum cochlidium.*	
8.	———— *globulosum.*	
9.	————	One or two minute species, perhaps young specimens, — unknown.
10.	*Trochus*	*Nov. spec.* (?) same as one now living in the bay.
11.	————	*Nov. spec.* (?) nearly related to last; differs in not being granular on the surface.
12.	*Assiminia* (?)	Minute species, identical with one living in the bay.
13.	*Bulinus nucleus.*	
14.	*Fissurella*	Probably same as a kind (*nov. spec.* ?) living in the bay.
15.	*Crepidula muricata.*	
16.	————	*Nov. spec.*
17.	*Cytherea*	Closely related to, or identical with *C. purpuracaens.*
18.	*Modiola*	Same as recent kind (*nov. spec.*) living in the bay.
19.	*Nucula*	Near to *N. margaritacea.*
20.	*Corbula*	Minute species, unknown.
21.	*Cardita*	Ditto ditto
22.	*Pecten*	*Nov. spec.* (?) very imperfect specimen.
23.	*Ostrea*	Oysters of the same size now live in the bay.

I may add that a fossil encrusting coralline is the same with one now living in the bay.

Of these shells it is almost certain that twelve species (and the coralline) are absolutely identical with existing species; and that four more are perhaps so; the doubt partly arising from the imperfect condition of the specimens. Of the seven remaining ones, four are minute, and one extremely imperfect. If I had not made a collection (far from perfect) of the shells now inhabiting Bahia Blanca, Mr. Sowerby would not have known as living kinds, five out of the twelve fossils: therefore, it is probable, if more attention had been paid to collecting the small living species, some of the seven unknown ones would also have been found in that state. The twelve first shells, as well as the four doubtful ones, are not only existing species, but nearly all of them inhabit this same bay, on the shores of which they are likewise found fossil. Moreover, at the time, I particularly noticed that the proportional numbers appeared closely similar between the different kinds,—in those now cast up on the beach, and in those embedded with the fossil bones. Under these circumstances, I think, we are justified (although some of the shells are at present unknown to conchologists) in considering the shingle strata at Punta Alta, as belonging to an extremely modern epoch.

From the principle already adduced, namely, the regular and gradual elevation of this part of the continent, I should have judged from the small altitude of the beds at Punta Alta, that the formation had not been very ancient. The conclusion here arrived at, concerning the age of these fossil mammalia, is nearly the same, with that, inferred respecting those entombed in the Pampas; and it will hereafter be shown, that some of the species are common to the two districts. We may suppose, that whilst the ancient rivers of the Plata occasionally carried down the carcasses of animals existing in that country, and deposited them in the mud of the estuary; other animals inhabited the plains round the Sierra de la Ventana, and that lesser streams, acting together with the currents of a large bay, drifted their remains towards a point, where sand and shingle were accumulating into a shoal. The whole area has since been elevated: the estuary mud of the former rivers has been converted into wide and level plains; and the shoals of the ancient Bahia Blanca now form low headlands on the present coast.

The third locality, which I have to specify, is Port St. Julian, in latitude 49° 15′ on the coast of Southern Patagonia. The tertiary plains of that country are modelled into a succession of broad and level terraces, which abut one above the other; and where they approach the coast, are generally cut off by a line of precipitous cliff. The whole surface is thickly covered by a bed of gravel, composed of various kinds of porphyries, and probably originating from rocks situated within the Cordillera. The lower part of the formation consists of several varieties of sandstone, and contains many fossil shells, the greater number of which are not found in a living state.

The south side of Port St. Julian is formed by a spit of flat land, of nearly a hundred feet in height; and on its surface existing species of littoral shells are abundantly scattered. The gravel is there covered (a circumstance which I did not observe in scarcely any other locality) by a thin but irregular bed of a sandy or loamy soil, which likewise fills up hollows or channels worn through it. In the largest of these channels the remains of the single fossil quadruped, which was here discovered, were embedded. The skeleton probably was at first perfect; but the sea having washed away part of the cliff, has removed many of the bones,—the remaining ones, however, still occupying their proper relative position to each other. I am inclined to attribute the origin of this earthy matter, to the

mud which might have accumulated in channels, and on the surface of the gravel, if this part of the plain had formerly existed as a harbour, such as Port St. Julian is at the present day. The Guanaco, the only large animal now inhabiting the wild plains of Patagonia, often wanders over the extensive flats, which are left dry at the head of the harbour during ebb tide: we may imagine that the fossil animal, whilst in a like manner crossing the ancient bay, fell into one of the muddy creeks, and was there buried.

I have stated that existing species of shells are scattered over the surface of this plain; namely, *Mytilus Magellanicus;* a second and undescribed species, now living on the beach; *M. edulis; Patella deaurata;* and on another part of the coast, but having similar geological relations, *Fusus Magellanicus; Voluta ancilla;* and a *Balanus*:—all these shells are among the commonest now living on this coast. Although they must have been lying exposed to the atmospheric changes for a very long period, they still partially retain their different colours. From these facts we know, with certainty, that the superficial deposit, containing the remains of the quadruped, has been *elevated* above the sea, within the recent period. From the structure of the step-like plains, which front the coast, it is certain that each step must have been modelled, subsequently to the elevation of the one standing above it; and, as the same recent shells occur on two higher plains, we may, with safety, conclude, that the earthy matter, forming the surface of this lower one, together with its embedded skeleton, was *deposited* long after the existence of the present species, still inhabitants of the sea. According, therefore, to the chronology, taken from the duration of species among the molluscs, the fossil quadruped of Port St. Julian must have been coeval, or nearly so, with those from Bahia Blanca.

Having now briefly described the principal circumstances in the geology of the three districts, to which I at first alluded, I will conclude, by observing, that the fossil mammalia of La Plata, Bahia Blanca, and Port St. Julian, must all have lived during a very modern period in the geological history of the world. It is not the proper place in this work to enter on any speculations, concerning the cause of the extinction of so many gigantic animals. I will only here add, that there is the strongest evidence against admitting the theory of a period of overwhelming violence, by which the inhabitants of the land could have been swept away, and

destroyed. On the contrary every thing indicates a former state of tranquillity, during which various deposits were accumulating near the then existing coasts, in the same manner, as we may suppose others are at this day in progress. The only physical change, which we know has taken place, since the existence of these ancient mammalia, has been a small and gradual rising of the continent; but it is difficult to believe, that this alone could have so greatly modified the climate, as to have been the cause of the utter extermination of so many animals. Mr. Owen will mention the exact locality where the remains of each quadruped were discovered; and, at the conclusion, it will be easy to specify by name those, which, from being embedded in the same deposit, are known formerly to have co-existed on the continent of South America.

FOSSIL MAMMALIA.

BY MR. OWEN.

It may be expected that the description of the osseous remains of extinct Mammalia, which rank amongst the most interesting results of Mr. Darwin's researches in South America, should be preceded by some account of the fossil mammiferous animals which have been previously discovered in that Continent. The results of such a retrospect are, however, necessarily comprised in a very brief statement; for the South American relics of extinct Mammalia, hitherto described, are limited, so far as I know, to three species of Mastodon, and the gigantic Megatherium.

One of the above species of Mastodon (*Mast. Cordillerarum*) was established by Cuvier* on remains discovered by Humboldt, in Quito, near the volcanic mountain, called *Imbaburra*, at an elevation of 1200 toises above the level of the sea; and likewise at the Cordilleras of Chiquitos, near Santa Cruz de la Sierra, a locality which is near the centre of South America. A second species (*Mastodon Humboldtii*, Cuv.†) is indicated by molar teeth, stated to have been discovered by the same philosophic traveller, in Chile, near the city of Concepcion. The third species of Mastodon appears to have once ranged in vast troops over the wide empire of Peru: numerous teeth were brought thence to Paris by Dombey,‡ and similar teeth, together with a humerus and tibia from Santa Fé de Bogota were placed by Humboldt at the disposal of Cuvier,§ who considered them to belong to the

* See Ossemens Fossiles, Ed. iv. tom. ii. p. 368. Pl. 27. fig 1. 12.
† *Ibid.* p. 370. Pl. 27. fig. 5. ‡ *Ibid.* p. 347, 367. § *Ibid.* p. 337. Pl. 26. fig. 7.

Mastodon angustidens, a species of which the fossil remains are by no means uncommon in several localities of Europe. Cuvier is also disposed to refer to the same species the teeth of the Mastodon from Brazil and Lima, mentioned by Dr. W. Hunter in his observations on the *animal incognitum* from the Ohio.* The Megatherium has been scientifically described and illustrated in the works of Bru, Cuvier, and D'Alton, whose accounts are founded on a nearly complete skeleton of this stupendous quadruped which has existed in the Royal Museum at Madrid for more than half a century. The few deficiencies in its osteography have recently been supplied by the descriptions and figures given by Dr. Buckland† and Mr. Clift,‡ taken from remains of the Megatherium, brought by Sir Woodbine Parish from Buenos Ayres, and which were discovered in the bed of the Rio Salado, a tributary of the Rio Plata. Sir Woodbine Parish's collection from the same locality, includes also remains of other species of extinct Edentata, which have not yet been described. M. D'Orbigny, in his travels in South America (vol. i. p. 96.), states that, in the banks of the Parana, he found the fossil remains of a large quadruped, of the size of an Ox, — another quadruped of the size of a Cat, apparently of the carnivorous order ;—and a third, a Rodent as large as a Rat.

This meagre condition of the historical part of the subject of South American fossils by no means arises from their actual scarcity. The writings of some of the old Spanish authors, for instance, Torrubia, Garcillasso, and others,§ contain frequent allusions to the bones of giants, who in times of old dwelt in Peru. Legentil, also, in 1728, speaks as an eye-witness of these Peruvian remains ; and his guides pointed out to him the traces of the thunder-bolts, by which the Anaks of the New World had been exterminated. Bones and teeth of the Mastodon are, according to Humboldt, so abundant in a locality near Santa Fé de Bogota in Columbia, that to this day it bears the name of the "Field of Giants."

But independently of these indications, the abundance and variety of the osseous remains of extinct Mammalia in South America are amply attested by the materials for the following descriptions, collected by one individual, whose

* Philosophical Transactions, vol. lviii. p. 34. (1768.)
† Bridgewater Treatise, p. 139. ‡ Geological Transactions, vol. iii. p. 437. pl. 44, 45, 46.
§ Quoted by Cuvier, Ossem. Foss. Ed. iv. tom. ii. p. 351.

sphere of observation was limited to a comparatively small part of South America; and the future traveller may fairly hope for similar success, if he bring to the search the same zeal and tact which distinguish the gentleman to whom Oryctological Science is indebted for such novel and valuable accessions.

It is remarkable that all the fossils, collected by Mr. Darwin, belong to herbivorous species of mammalia, generally of large size. The greater part are referrible to the order which Cuvier has called Edentata, and belong to that subdivision of the order (*Dasypodidæ*) which is characterized by having perfect and sometimes complex molar teeth, and an external osseous and tesselated coat of mail. The Megatherium is the giant of this tribe; which, at the present day, is exclusively represented by South American species, the largest (*Dasypus Gigas*, Cuv.) not exceeding the size of a Hog. The hiatus between this living species and the Megatherium, is filled up by a series of Armadillo-like animals, indicated more or less satisfactorily by Mr. Darwin's fossils, some of which species were as large as an Ox, others about the size of the American Tapir. The rest of the collection belongs, with the exception of some small Rodents, to the extensive and heterogeneous order Pachydermata; it includes the remains of a Mastodon, of a Horse, and of two large and singular aberrant forms, one of which connects the Pachydermatous with the Ruminant Order; the other, with which the descriptions in the following pages commence, manifests a close affinity to the Rodent Order.

A DESCRIPTION OF THE CRANIUM OF

TOXODON PLATENSIS;

A gigantic extinct mammiferous animal, referrible to the Order Pachydermata, but with affinities to the Rodentia, Edentata, and Herbivorous Cetacea.

THE cranium, which is the subject of the present description, was found in the Sarandis, a small stream entering the Rio Negro, and about 120 miles to the N. W. of Monte Video: it had been originally embedded in a whitish argillaceous earth, and was discovered lying in the bed of the rivulet, after a sudden flood had washed down part of the bank.

The zoological characters deducible from this cranium, forbid its association, generically, with any known Mammiferous animal, and it must therefore be referred to an extinct genus, which I propose to call ***Toxodon***,* from the curved or arched form of the teeth, as will afterwards be described. The specific name, in the absence of other means of knowing the peculiarities of the animal than those afforded by the skull, may be most conveniently taken from the district (La Plata), in which its remains were first discovered.

The dimensions of the cranium of the ***Toxodon Platensis*** amply attest that the animal to which it belonged was of a magnitude attained by few terrestrial quadrupeds, and only to be compared, in this respect, with the larger Pachyderms, or the extinct Megatherium. The length of the skull (of which a base view of the natural size is given in Plate I.) is two feet four inches: the extreme breadth one foot four inches. The other requisite admeasurements are given in the table at the conclusion of this description.

The general form of the skull, as seen from above, is pyriform; but viewed sideways, and without the lower jaw, it is semi-ovate; it is depressed, elongate, of considerable breadth, including the span of the zygomatic arches, but becoming rather suddenly contracted anterior to them, the facial part thence growing narrower to near the muzzle, which again slightly expands.

Among the first peculiarities which strike the observer, is the aspect of the plane of the occipital foramen, and of the occipital or posterior region of the cranium, the latter of which inclines from below upwards and forwards at an angle of 50° with the basal line of the skull. This slope of the back part of the skull is one of the characteristics of the Dinotherium; it is common to all the Cetacea, and is met with in a slighter degree in many Rodentia, and in the great Ant-eater and some others of the Edentate order. The corresponding aspect of the *foramen magnum* presents nearly the opposite extreme to man in the occipital

* Τοξον, arcus; ὀδους, dens.

scale, proposed by Daubenton to determine the diversities of the form of the cranium, as a gage of the intelligence of different animals*; and the indication of the limited capacity of the Toxodon, thus afforded, is strengthened by the very small proportion, which the bony walls of the cerebral cavity bear to the zygomatic and maxillary parts of the skull, and to the size of the vertebral column, as indicated by the condyloid processes, and foramen magnum.

The zygomatic arches are of remarkable size and strength; they commence immediately anterior to the sides of the occipital plane, increase in vertical extent as they pass outwards, forwards and downwards, and are suddenly contracted as they bend inwards to abut against the sides of the sockets of the two posterior molar teeth.

The cranial cavity is remarkably narrow at the space included by the zygomatic arches; being, as it were, excavated on each side to augment the space for the lodgment of the temporal muscles, so that its diameter at this part is less than that of the anterior extremity of the upper jaw. The upper surface of the cranium expands to form the post-orbital processes, and again contracts anterior to these.

The muscular ridges, or other characters, at the top of the skull, cannot be precisely determined, as a great proportion of the outer table of the bone is broken away, exposing a coarse and thick diploë. There seems, however, to have been a strong ridge separating the occipital from the coronal or upper surface of the cranium. The form of the remaining parts, which are modified in relation to the attachment of the muscles of the jaws, indicates that these were powerfully developed both for the offices of mastication and prehension. The general form of the skull, while it presents certain points of resemblance to that of the aquatic Pachydermata, and even of the Carnivora, has much that is peculiar to itself; but, in the facial part, it approaches the nearest to that of the Rodentia; and the dentition of the Toxodon, as exhibited in the upper jaw, corresponds with that which characterizes the Rodent Order.

The teeth of the Toxodon consist of molars and incisors, separated by a long diastema, or toothless space. In the upper jaw the molars are *fourteen* in number, there being seven on each side; the incisors *four*, one very large, and one small, in each intermaxillary bone.

The general form and nature of the teeth are indicated by the sockets; and the structure of the grinders is exhibited in a broken molar, the last in the series on the left side of the jaw of the present cranium (See a figure of the grinding surface restored of this tooth, fig. 2, Pl. I.), and by another perfect molar, the last but one on the right side of the upper jaw, which, though not belonging to the same individual as the skull here described, undoubtedly appertains to the same species.

* Mem. de l'Acad. des Sciences de Paris, 1764, p. 568.

This latter tooth (Fig. 3, Pl. I.; figs. 2 and 3, Pl. IV.) was found by itself, embedded in the banks of the Rio Tercero, or Carcarana, near the Parana, at the distance of a hundred and eighty miles from the locality where the head was discovered. Fragments of a molar tooth of a Toxodon, apparently the seventh of the left side, upper jaw, were also found at Bajada de Stª Fé, in the province of Entre Rios, distant forty miles from the mouth of the Rio Tercero.

All the molar teeth are long and curved, and without fangs,* as in most of the herbivorous species of the Rodent Order: in those, however, with curved grinders, as the *Aperea* or Guinea-pig, and *Cavia Patachonica*, the concavity of the upper grinders is directed outward, the fangs of the teeth of the opposite sides diverging as they ascend in the sockets; but, in the Toxodon, the convexity of the grinders is outward, and the fangs converge and almost meet at the middle line of the palate, forming a series of arches, capable of overcoming immense resistance from pressure. (See the upper view of the skull, Plate III., in which the fractures expose to view a part of the series of these arched sockets.)

Of the incisors, the two small ones (the sockets of which are indicated at *s s*, Pl. III.) are situated in the middle of the front of the upper jaw, close to the suture between the intermaxillaries, and the two large ones in immediate contiguity with the small incisors, which they greatly exceed in size. The sockets of the two large incisors (*t t*, Pl. III.) extend backwards, in an arched form, preserving a uniform diameter, as far as the commencement of the alveoli of the molar teeth: the curve which they describe is the segment of a circle; the position, form, and extent of the sockets of these incisors are the same as in those of the corresponding teeth of the Rodentia.

The matrix, or secreting pulp of the large incisors, was lodged, as in the Rodentia, in close proximity with the sockets of the anterior molars; and we are enabled to infer, from the form of the incisive sockets, notwithstanding the absence of the teeth themselves, that the pulp was persistent, and that the growth of these incisors, like those of the Rodentia, continued throughout life.

This condition, joined with the form and curvature of the socket, implies a continual wearing away of the crown of the tooth by attrition against opposing incisors of a corresponding structure in the lower jaw: and as a corollary, it may be inferred that the teeth in question had a partial coating of enamel, to produce a cutting edge, and were, in fact, true *dentes scalprarii*. The number of incisors in the upper jaw of Toxodon, is not without its parallel in the Rodent Order, the genus *Lepus* being characterized by four, instead of two superior incisors, which also present a similar relative size but have a different relative position, the

* True fangs exist only in teeth of temporary growth, they may be one or more in number, but always diminish in size as they recede from the crown of the tooth, and are either solid, or with a very small canal.

small incisors, in the hare and rabbit, being so placed immediately behind the large pair, as to receive the appulse of the single pair of incisors in the lower jaw.

In the Toxodon the position of the incisors, in the same transverse line, might lead to the inference, that they were opposed by a corresponding number in the lower jaw; but the numerous examples of inequality, in the number of incisors, in the upper and lower jaws of existing mammalia, forbid any conclusion on this point.* The sockets of the small mesial incisors of the Toxodon (*s s*, Pl. III.) gradually diminish in size, as they penetrate the intermaxillary bones, and we may, therefore, infer that the pulp was gradually absorbed in the progress of their development; and that, like ordinary incisors, their growth was of limited duration, and their lodgment in the jaw effected by a single conical fang.

I may observe, that the formation of a fang is the necessary consequence of the gradual absorption of the matrix or pulp of a tooth; for the pulp continues, as it diminishes in size, to deposit ivory upon the inner surface of the cavity of the tooth from which it is receding, and the tooth or fang thus likewise progressively diminishes in size. The formation of the socket proceeds uninterruptedly, and the bone encroaching upon the space left by the tooth, closely surrounds the wasting fang, and affords it a firm support; and thus an inference may be drawn from the form of the socket alone, as to whether the tooth it contained had or had not one or more conical fangs, and consequently whether its growth was temporary or uninterrupted.

Applying this reasoning to the molar teeth of the Toxodon, we infer that their growth, like those of most of the Phytiphagous Rodents, of the Megatherium and Armadillo, was perpetual, because their sockets are continued of uniform size from the open to the closed extremity; and the molar tooth which is preserved proves the accuracy of the deduction, inasmuch as its base is excavated by a large conical cavity for the lodgment of the pulp, the continued activity of which was the compensation here designed to meet the effects of attrition on the opposite or grinding surface of the tooth.

The molar tooth discovered by Mr. Darwin in the banks of the Tercero, not only belonged to the same species as the skull under consideration, but to an individual of the same size; it fits exactly into the socket next to the posterior one of the right side. The figures subjoined of this molar tooth (Fig. 3, Pl. I.; figs. 2 and 3, Pl. IV.) almost preclude the necessity of a description. The transverse section of the tooth gives an irregular, unequal sided, prism; the two broadest sides of which converge to the anterior angle, which is obtusely rounded. The

* This was written before an examination of the fragment of a lower jaw, forming part of Mr. Darwin's collection of Fossil Remains, had led me to suspect that it was referrible to the genus Toxodon; should this suspicion prove correct, the four unequal incisors of the upper jaw are opposed to six equal sized ones in the lower.

outer surface of the tooth (fig. 2, Pl. IV.) is slightly concave in the transverse direction, but undulating, from the presence of two slight convex risings which traverse the tooth lengthwise. The inner surface presents at its anterior part a slightly concave surface, and posteriorly two prominent longitudinal convex ridges, separated by a groove which is flat at the bottom, and from the anterior angle of which the reflected fold of enamel penetrates the substance of the tooth, advancing obliquely forwards, rather more than half way across the body of the tooth. A longitudinal ridge of bone projects from the internal side of the socket, and fits into the groove above mentioned, and as a corresponding ridge exists in all the sockets of the grinders, save the two anterior small ones, we may infer that the five posterior grinders on each side, had a similar structure to the tooth above described. The external layer of enamel is uniformly about half a line in thickness; it is interrupted for the extent of nearly three lines at the anterior angle, and for more than double that extent at the posterior part of the tooth, which is consequently worn down much below the level of the rest of the grinding surface. Where the ivory is thus unprotected by the enamel, it has a coat of cæmentum, which also fills up the small interval at the origin of the reflected fold of enamel. On the grinding surface of the entire tooth, and on the fractured ends of the mutilated molars, the component fibres, or tubules, of the ivory, are readily perceptible by the naked eye, diverging from the line which indicates the last remains of the cavity of the pulp of the tooth, as it was progressively obliterated during growth.

Although the complication of the grinding surface by the inflection of simple or straight folds of enamel is peculiarly characteristic of the Rodent type, we must regard the number of molar teeth, and their diminution of size as they advance towards the anterior part of the jaw, in the Toxodon, as indicative of a deviation from that order, and an approach to the Pachyderms. The common number of grinders in the upper jaw of Rodent animals is eight, four on each side. In some genera, as Lemmus, Mus, Cricetus, there are only three on each side, and in Hydromys and Aulacodus, only two on each side. In Lepus, however, we find six on each side of the upper, and five on each side of the lower jaw. The Toxodon, like the Tapir and Hippopotamus, has seven on each side of the upper jaw: the first in each of these species being the smallest. It is worthy of notice, however, that the Capybara which adheres to the Rodent type in the number of its molars, presents in the vastly increased size, and additional number of component laminæ of the posterior grinders, an approximation to the pachydermatous character just adduced, and the bony palate at the same time presents an expansion between these molars, offering a resemblance to the Toxodon which I have not found in any other Rodent besides the Capybara.

The most important deviation from the Rodent structure presented by the teeth, occurs in the direction of the reflected fold of enamel, and such a deviation

might have been inferred, even in the absence of the teeth, from the structure of the articular surface, or glenoid cavity for the reception of the condyle of the lower jaw. As the ridge of enamel runs, as above described, in a direction approaching that of the longitudinal axis of the skull, it is obvious that the grinding motions of the lower jaw should be in a proportionate degree in the transverse direction. The glenoid cavity, therefore, instead of being a longitudinal groove, and open behind, as in the true Rodents, is extended transversely, and is defended behind by a broad descending bony process preventing the retraction of the jaw, and showing marks of the forcible pressure to which it was subject.

It is worthy of observation that, in the Wombat,—which exhibits the Rodent type of dentition, and, like the Toxodon, has remarkably curved molars, but in an opposite direction,—the condyle of the lower jaw is also extended transversely, and adapted to an articular surface, which admits of lateral motion in the trituration of the food. In the outward span of the zygomatic arches, in which Toxodon deviates from the Rodentia, we may trace a relation of subordinacy to the above structure of the grinding teeth and joint of the lower jaw: the widening of the arches giving to the masseter muscles greater power of drawing the jaw from side to side. The depth of the zygoma bespeaks the magnitude of these masticatory muscles, and the included space shews that the temporal muscles were also developed to a degree, which indicates the force with which the great incisors at the extremity of the jaws, were used; probably, like the canines of the Hippopotamus, to divide or tear up by the roots the aquatic plants, growing on the banks of the streams, which the Toxodon may have frequented.

In the Rodentia, the zygoma, though sometimes as deep as in the Toxodon, is generally almost straight, and the space included between it and the cranium is consequently narrow. The zygoma also is placed more forwards in all true Rodents, than in the Toxodon; and, instead of abutting against the posterior alveoli, it terminates opposite the anterior ones. It thus affords such an attachment to the masseter, that this muscle extends obliquely backwards to its insertion in the lower jaw, at an angle which enables it to act with more advantage in drawing forwards the lower jaw,—a motion for which the joint is expressly adapted. In many Rodents, also, there is a distinct muscle, or portion of the masseter, which passes through the ant-orbital foramen, which is on that account of large size. In examining the cranium of Toxodon, with reference to this structure, it was found that the ant-orbital foramen was not larger than might have been expected to give transmission to nerves requisite for supplying with sensibility the large lips, and whiskers with which the expanded muzzle of this remarkable quadruped was probably furnished.

Having thus examined the cranium of the Toxodon in its relation, as a

mechanical instrument, subservient to the function of digestion; we next proceed to consider the structure and composition of those cavities of the skull which gave lodgment and protection to the organs of *special* sense, and endeavour to deduce from their structure conclusions as to the degree in which the organs were developed, and the circumstances under which the senses were exercised.

The orbit of Toxodon forms the anterior boundary of the zygomatic area; it is about as distinctly defined as in the Tapir or Dugong, having its osseous rim less complete than in the Hippopotamus, yet more developed than in the Capybara, Coypus, and many other Rodentia, in which the orbit is scarcely distinguishable in the cranium from the small space occupied by the origin of the temporal muscle.

The lower boundary of the orbit in Toxodon is formed by an excavation in the upper and anterior part of the zygoma; the upper boundary by a strong and rugged overarching process of the frontal bone, the posterior angle of which (*a*, Pl. III.) descends a little way, but leaves a space of three inches and a half between it and the opposite angle of the malar bone below (*b*, Pl. II. and III.), the circumference of the orbit being completed probably by ligament in the recent subject. The cavity thus circumscribed is remarkable for the preponderance of the vertical over the transverse or longitudinal diameter, and indicates great extent of motion of the eyeball in the vertical direction, such as may be supposed to be well adapted to the exigencies of an amphibious quadruped. The orbit of the Capybara, or Water-hog, makes a near approach to the form just described. In the elevation of the supra-orbital boundary, and its outward projection in the Toxodon, we perceive an approximation to the form of the orbit in the Hippopotamus, but the size of the orbit is relatively larger in the Toxodon, which in this respect manifests its affinity to the Rodentia.

In that part of the bony structure of the auditory apparatus, which is visible on the exterior of the cranium, the skull of the Toxodon presents a character in which it recedes from the Rodentia. In these, the tympanic portion of the temporal bone is remarkably developed, forming a large bulla ossea between the glenoid cavity and the occiput; and it always remains disunited to the other elements of the temporal bone. In the Toxodon the tympanic bone (*c*, Pl. II.) consists of a rough compressed vertical osseous plate, wedged in transversely between the occiput and the posterior part of the glenoid cavity. The internal extremity of this plate points inwards and forwards, representing the styloid process; behind this is seen the petrous bone, which forms a small angular protuberance at the basis cranii, and is less developed than in the Hippopotamus. Anterior to the petrous bone are the orifices of the Eustachian tube, and carotid canal; external to it is the great foramen lacerum, for the jugular vein and nervus vagus; and behind it is the anterior condyloid foramen. The foramen auditorium externum is only half an

inch in diameter, and gives passage to a long and somewhat tortuous meatus, which passes inwards and slightly forwards and downwards; its direction being precisely the same as in the Hippopotamus; it was accompanied, probably, by as small an external auricle.

But the indications of the aquatic habits of the Toxodon, which are presented by the osseous parts relating to the senses of sight and hearing, are of minor import compared with those afforded by the bony boundary of the nostrils. This boundary circumscribes a large ovate aperture, the aspect of whose plane is upwards, and a little forwards, as in the Herbivorous Cetaceans, and especially the Manatee (*Trichecus Manatus*, Cuv.) In one part of the bony structure of the nasal cavity the Toxodon deviates, however, in a marked degree from the Cetaceous structure; I allude to the frontal sinuses, which are exposed by the fracture of the upper part of the skull. (They are shewn in Plate III., and an asterisk is placed on one of the narrow canals of intercommunication between the sinuses and the nasal passages.) The posterior orifice of the nasal cavity is relatively larger and wider than in the Herbivorous Cetaceans, and differs both in form and aspect in consequence of the greater extent of the bony palate. The Toxodon further differs from the Manatee and Dugong, in the firm nature of the connexion of the bones of the head; and it differs from the Hippopotamus in the strong attachment of the intermaxillary bones to the maxillaries.

There next remain to be described, as far as the shattered condition of the skull will permit, the relative position, extent, and connexions of the principal bones composing it.

The *occipital bone* exhibits a complete confluence of its basilar, condyloid, and supra-occipital elements. The basilar portion, in connexion with the corresponding element of the sphenoid bone, describes a curve whose convexity is downwards. The condyles are large, extended in the transverse direction, completely terminal, and a little inclined downwards below the level of the basilar process. The curve of the articulating surface describes, in the vertical direction, two-thirds of a circle, indicating that the head must have possessed considerable extent of motion upwards and downwards upon the atlas; thus, while the body of the Toxodon was submerged, the head probably could be raised so as to form an angle with the neck, and bring the snout to the surface of the water without the necessity of any corresponding inflection of the spine. Indeed, in the form and position of the condyles, the Toxodon more nearly resembles the true Cetacea than any other existing mammalia; and it is only with these that it can be compared in regard to the aspect of the plane of the occipital foramen, and of the occipital region of the skull. This is inclined forwards from the occipital foramen at such an angle, that on viewing the skull from above, not only the

condyles, but the entire circumference of the occipital foramen are visible. (See Pl. III.) The upper part of the supra-occipital plate presents a broad rugous depression, indicative of the insertion of strong cervical muscles, and probably of a *ligamentum Nuchæ*.*

The ex-occipital processes advance forwards for about an inch beyond the condyles, and then suddenly extend outwards at right angles to the former line, and terminate in the form of vertically compressed bony plates; the lower rugged margins of which represent or perform the office of the mastoid processes (*d*, *d*, Pls. II. and III.). The breadth of the entire occipital region of the skull (fig. 1, Pl. IV.) appears to have been, allowing for the fractures, about one-third more than the height of the same part.

The great development of the *tympanic* bones in the Rodentia, occasions the intervention of a considerable space between the occipital bone and the zygomatic process of the temporal; but in the great Toxodon, in which the sense of hearing was doubtless inferior to that enjoyed by the small and timorous Rodents, the tympanic bone is reduced to a thin plate, which is wedged in between the occiput and glenoid cavity. In this structure, and the consequent posterior position of the glenoid cavity, there is a close resemblance between the Toxodon and the Hippopotamus, Tapir, and Rhinoceros.

The *squamous* element of the temporal bone (s, Pl. II.) forms a small proportion of the lateral walls of the cranium, and also enters into the composition of the lateral and superior parts of the posterior region of the cranium, where two deep fossæ perforated by large vascular foramina, indicate the junction of the squamous bones with the supra-occipital bone. The posterior surface of the skull is thus divided into three broad and shallow depressions, the two lateral facets being slightly over-lapped by the middle one, at their junction with it. In this structure the Toxodon rsembles the Hippopotamus, and differs considerably from the Cetacea, in which the occipital region is rendered convex by the extraordinary development of the brain within.

The *zygomatic* process of the temporal bone projects boldly outwards at its commencement, where it is of great strength, and three-sided; the glenoid cavity extends transversely across the base or inferior surface of this part; the lateral surfaces converge to form the ridge or upper boundary of the zygoma. The depth of the glenoid cavity is increased by a transverse production of bone both before and behind it: the posterior process (*g*, Pl. II.) descends the lowest, and affords the requisite defence against backward dislocation of the lower jaw; the pressure of the condyle against this process is denoted by a well defined, transversely-ovate, flattened and smooth surface, as if the bone had been planed down at that

* I have ascertained that this elastic ligament exists in the neck of the Dugong.

part: the anterior transverse boundary is convex and smooth, and probably formed part of the articulation for the lower jaw. The lower facet of the zygoma anterior to the glenoid cavity gradually contracts in breadth, as it advances forward, and at the distance of three inches from the articular cavity the zygoma changes from a prismatic to a laminar form. It is at this point that the zygomatic suture commences, at the lower margin of the arch; whence it extends directly forwards for more than half its length, and then bends upwards at a right angle. The zygomatic suture has a similar course in the Capybara, and Hippopotamus.

The remainder of the zygoma is formed externally by the *malar* bone (G Pl. II.), which in its position is intermediate to the Rodent and Pachydermatous structures. It is not suspended in the middle of the zygomatic arch, as in the former order; neither does it extend into the region of the face so far anterior to the orbit as in the Tapir or Hippopotamus. The exterior line of the malo-maxillary suture defines the orbit anteriorly; but from this line the maxillary bone extends backwards, along the inner side of the malar portion of the zygoma, until it almost reaches the temporo-malar suture; thus abutting by an oblique surface against nearly the whole internal facet of the malar bone, and materially contributing to the general strength of the zygomatic arch. The malar bone is of considerable vertical extent, and presents a rugged and thickened inferior margin for the attachment of the masseter. The upper margin of the malar bone is smoothly rounded, and presents a regular semi-circular excavation, forming the lower boundary of the orbit. The relative magnitude of the zygomata to the entire cranium far exceeds in the Toxodon that which exists in the Hippopotamus or any other known Pachyderm. This arises from the great vertical development of the malar bone behind the orbit, and the vertical expansion of the temporal portion of the arch. The oblique position of the zygoma, descending as it advances forwards, is deserving of attention, as the Toxodon, in deviating from the Pachyderms in these respects, makes an evident approach to the herbivorous Cetaceans, as the Dugong and Manatee: in the latter Cetacean we observe a similar development of the lower part of the zygomatic process of the malar bone. It is here, also, that we may perceive an indication of a resemblance between the Megatherium and Toxodon.

There is no discernible trace of the *lachrymal* bone (E, Pl. II.) having extended, as in the Hippopotamus beyond the anterior boundary of the orbit: the lachrymal foramen is situated rather deep in the orbit, and the bone itself appears to have been of very small size.

The surface of the supra-orbital process of the *frontal* bone (C, Pl. II.) is deserving of attention, as it presents a peculiar ruggedness which is not found in any other part of the skull; the irregularity seems, as it were, to have been produced by the impression of numerous small tortuous and anastomosing vessels. In the

skull of a Sumatran two-horned Rhinoceros, in the Museum of the College of Surgeons (No. 816), the circumference of that part of the surface of the skull which supported the posterior horn, and which includes precisely the same part of the os frontis, presents the same character, the surface being broken by numerous vascular impressions. On the supposition that this character of the supra-orbitary arch in the Toxodon might indicate the superincumbency of a bony case, I examined the skulls of two Armadillos, *Dasypus Peba* and *Das. 6-cinctus*, and found that in the Dasypus 6-cinctus, the supra-orbital ridges, which are slightly elevated, to support the cephalic plate, presented, in a minor degree, a corresponding rugosity. May we venture then to conjecture that the Toxodon was defended by an ossified integument like the Armadillo, or that it was armed with an epidermic production, analogous to the horn of the Rhinoceros; or had the rugous surface in question as little relation with the parts that covered it as the sculptured surface of the malar bones in the Cavy?

After forming the rugged and prominent supra-orbital processes already described, the frontal bone continues to send backwards a slightly elevated ridge or *crista*, circumscribing the origin of the temporal muscles, but the extent of this ridge, and the disposition of the inter-orbital portion of the frontal bones cannot be determined in the present mutilated specimen. The fractures it has sustained are not, however, wholly unattended with advantage; they expose the structure of the diploë, which from its coarseness of texture and thickness, resembles that of the Cetaceous crania; and what is of still more importance, they also demonstrate the existence and form of the frontal sinuses.

The cavity of the nose is extensive, and the remains of the ossa spongiosa superiora testify that the Toxodon enjoyed the sense of smell to a degree equal at least to that of the Hippopotamus.

The *sphenoid bone* resembles that of the Hippopotamus, but it contributes a larger share to the formation of the internal pterygoid processes (*p*, Pl. II.); these are of a simple form, and more developed than in the Hippopotamus; they project outwards to a greater extent, and terminate in a point. The sphenoid also sends off a short and thick pointed process from the posterior part of the base of the internal pterygoid processes. The ala of the sphenoid does not rise so far into the orbit, nor does it articulate with the parietal bone, as in the *Hippopotamus;* but in this part of its structure, is the same as in the Rhinoceros. The spheno-palatine foramen is relatively larger than in the above-named Pachyderms, and is bounded above by the descending orbital plate of the frontal bone.

The palatal processes of the *palatine* bones terminate anteriorly between the last molars, and extend backwards for some distance beyond the alveolar processes, increasing the extent of the bony roof of the mouth posteriorly: this is a structure in which the Toxodon deviates both from the Rodents, and Pachyderms,

position of the supernumerary incisors, and in the number, and direction of the curvature, of the molars. If, moreover, the lower jaw, next to be described, belong, as I believe, to the Toxodon, the dental character of the genus will be *incisors* $\frac{2}{2}$; *pro laniariis diastema; molares* $\frac{7}{7}$.

The Toxodon again deviates from the true Rodentia, and resembles the Wombat, and the Pachyderms, in the transverse direction of the articular cavity of the lower jaw.

It deviates from the Rodentia, and resembles the Pachydermata in the relative position of the glenoid cavities and zygomatic arches, and in many minor details already alluded to.

In the aspect of the plane of the occipital foramen, and occipital region of the skull; in the form and position of the occipital condyles; in the aspect of the plane of the anterior bony aperture of the nostrils; and in the thickness and texture of the osseous parietes of the skull, the Toxodon deviates both from the Rodentia and existing Pachydermata, and manifests an affinity to the Dinotherium and Cetaceous Order, especially the Herbivorous section.

At present we possess no evidence to determine whether the extremities of the Toxodon were organized on the ungulate or unguiculate type, nor can we be positive, from the characters which the skull affords, that the genus may not be referrible to the *Mutica* of Linnæus;* although the development of the nasal cavity and the presence of large frontal sinuses render it extremely improbable that the habits of this species were so strictly aquatic, as the total absence of hinder extremities would occasion.

Where the dentition of a mammiferous animal is strictly carnivorous, this structure is obviously incompatible with a foot incased in a hoof: — but where the teeth are adapted for triturating vegetable substances the case is different. If animals so characterized are of small size and seek their food in trees, or if they burrow for roots or for shelter, the vegetable type of dentition must co-exist with unguiculate extremities, as in the Edentata and Rodentia generally: but the largest genus (Hydrochærus) of the Rodent Order, whose affinity to the Pachydermata is manifested in its heavy shapeless trunk, thinly scattered bristly hair, and many other particulars, has each of its toes inclosed in a miniature hoof.

The affinity above alluded to, is too obvious to have escaped popular notice, and the Capybara, from its aquatic habits, has obtained the name of Water-hog. It is highly interesting to find that the continent to which this existing aberrant

* The German Translator (See *Froriep's Notizen*., 1837, p. 119) of the abstract of my description of the Toxodon, published in the Proceedings of the Geological Society, asks, what is the *Mutica* (misprinted *Muticata*), of Linnæus? The term is quoted from the Systema Naturæ, Ed. xii. p. 24. Linnæus first divides Mammalia into three groups, according to modifications of the locomotive organs, viz. *Unguiculata*, *Ungulata*, *Mutica*, and subdivides these, according to modifications of the dentary organs, into the orders, *Bruta*, *Glires*, *Primates*, &c.

and resembles the Armadillos among the Edentata; excepting that the post-dental part of the bony palate in the Toxodon is suddenly contracted in breadth. The palato-maxillary suture is in the form of a chevron, with the angle directed forwards, as in the Hippopotamus and Capybara, but truncated.

The *superior maxillary* bones (F, Pl. II.) are united posteriorly to the malar, as above described: they ascend and join the frontal and nasal bones: their outer surface is almost vertical, smooth, and slightly undulating; perforated at its posterior part by the ant-orbital foramen, and joined anteriorly to the intermaxillaries by a suture running in the sigmoid direction (as shewn in Pl. II.) from the middle of the nasal cavity, to within four inches of the anterior boundary of the upper jaw. We have, in the position and extent of this suture, and the absence of tusks and their large prominent sockets, a most important difference between the Toxodon and Hippopotamus. The chief peculiarity in the maxillary bones, obtains in the arched form of the alveolar processes, corresponding to the shape and position of the grinders above described, and which are peculiar among known mammalia to the present genus. The palatal surface of the maxillary bones is obliquely perforated by two large foramina, from which two deep longitudinal grooves extend forwards, and are gradually lost; we find the posterior palatine foramina represented by similar grooves and foramina in the Capybara.

The *intermaxillary* bones (D, Pls. II. and III.), though large, are relatively of less extent than in the Rodents generally. The nasal processes do not reach the frontal bone, but are limited to the anterior half of the nasal boundary; approaching in this respect to the Herbivorous Cetacea. In the outward expansion of their anterior extremities, the intermaxillaries resemble those of the Hippopotamus, in which, however, this character is more strongly marked. The intermaxillaries in the Hippopotamus are also much less firmly united to the maxillary bones than in the Toxodon, and are consequently commonly lost in the fossil crania. On the palatal surface of the intermaxillary bones there are two grooves which diverge forwards from the line of the suture; and anteriorly to these grooves there are the two large anterior palatine foramina. The maxillo-intermaxillary sutures on the palate converge as they extend backwards to a point; there appears to have been a fissure left between this suture and the mesial suture of the intermaxillaries; in which structure the Toxodon resembles the Hippopotamus.

After summing up the different affinities, or indications of affinity, which are deducible from the cranium of this most curious and interesting fossil mammal, we are led to the conclusion, assuming it to have had extremities cased in hoofs, that it is referrible to the Order Pachydermata. But the structure, form, and kind of teeth in the upper jaw, prove, indisputably, that the gigantic Toxodon was intimately related to the Rodent Order. From the characters of this order, as afforded by the existing species, the Toxodon, however, differs in the relative

form of Rodent is peculiar, should be found to contain the remains of an extinct genus, characterized by a dentition which closely resembles the Rodent type, but manifesting it on a gigantic scale, and tending to complete the chain of affinities which links the Pachydermatous with the Rodent and Cetaceous Orders.

ADMEASUREMENTS OF THE CRANIUM OF TOXODON.	feet	inches	lines
Extreme length	2	4	...
Extreme breadth	1	4	..
Extreme height, (exclusive of the lower jaw)	...	10	...
Length of zygomatic process	1	1	6
Depth or vertical extent of do.	...	6	...
Transverse extent of zygomatic fossa	...	6	...
Transverse diameter of cranium between the zygomatic arches	...	5	...
Transverse diameter of occipital plane of the cranium	1	...	...
From the outside of one condyle to that of the opposite condyle	...	8	6
Length of the bony palate	1	6	...
Extreme breadth of ditto	...	6	...
Breadth of palate at the intermaxillary suture	...	2	6
Do. do. behind the molar alveoli	...	3	...
Longitudinal extent of the molar alveoli	...	9	6
Do. do. diastema	...	5	6
Transverse diameter of posterior nasal aperture	...	3	9
Do. do. of occipital foramen	...	3	...
Do. do. of glenoid cavity	...	4	6
Antero-posterior do of ditto	...	1	...

DESCRIPTION OF FRAGMENTS OF A LOWER JAW AND TEETH OF A TOXODON.

Found at Bahia Blanca, in latitude 39° on the East coast of South America.

In looking over some fragments of jaws and teeth, forming part of Mr. Darwin's collection of South American mammiferous remains, and which had been set aside with mutilated specimens referrible to species belonging to the family of Edentata, my attention was caught by the appearance of roots of teeth projecting, in a different direction from the grinders, from the fractured anterior extremity of a lower jaw, and I was induced to examine minutely the structure of the teeth in this specimen, and to search the collection for corresponding fragments. The result was the discovery of portions of the two rami, and the commencement of the symphysis of a lower jaw, containing anteriorly the roots of

six incisors, and at least six molars on each side; but as the rami had been fractured through the middle of the sixth alveolus, the number of grinders may have corresponded with those in the upper jaw of the Toxodon.

The most perfect of these fragments is figured in Pl. V. figures 1 and 4; figure 2 shows the form of the teeth in transverse section, and the disposition of the enamel upon the grinding surface of the molars on the right side, as restored from a comparison of the fractured teeth in the two rami. From the remains of the symphysis shown at fig. 4, it will be seen that the jaw was remarkably compressed, or narrow from side to side; while the rami (fig. 1.) were of considerable depth, in order to give lodgment to the matrices and bases of grinders enjoying uninterrupted growth.

The pulps of the six incisors in this lower jaw are arranged in a pretty regular semi-circle, whose convexity is downwards; the teeth themselves are directed forwards, and curved upwards, like the inferior incisors of the Rodentia. The form and degree of the curvature are shown in the almost perfect incisor (Pl. V. fig. 5) which corresponds with the left inferior incisor of the lower jaw, and was found in the same stratum, but belonged to another individual.

These incisors are nearly equal in size: they are all hollow at their base, and the indurated mineral substance impacted in their basal cavities well exhibits the form of the vascular pulps which formerly occupied them. Sufficient of the tooth itself remains in four of the sockets to show that these incisors, like the nearly perfect one (fig. 5), had only a partial investment of enamel; but though in this respect, as well as in their curvature and perpetual growth, they resemble the dentes scalprarii of the Rodentia, they differ in having a prismatic figure, like the inferior incisors of the Sumatran Rhinoceros, or the tusks of the Boar. Two of the sides, viz., those forming the anterior convex and mesial surfaces of the incisor have a coating of enamel, about half a line in thickness, which terminates at the angles between these and the posterior or concave surface. In plate V. fig. 4, the enamel of the broken incisors is represented by short lines, showing the direction of its crystalline fibres; the white space immediately within the enamel shows the thickness of the ivory at the base of the tooth, the included gray substance represents a section of the formative matrix or pulp of the tooth, which was of the usual conical form: the inferior broken end of the incisor (fig. 5,) appears to have been distant about one-third from the apex of the pulp.

From the relative position of the bases or roots of these incisors, we may infer that they diverged from each other as they advanced forwards, in order to bring their broadest cutting surfaces into line. That they were opposed to teeth of a corresponding structure in the upper jaw is proved by the oblique chisel-like cutting surface of the more perfect incisor: and it is not without

interest to find that the presence of *dentes scalprarii* at the anterior part of the mouth has not been necessarily limited to Mammalia of small size.

The position of the pulps of these incisors, in close proximity with the anterior grinders, corresponds with the position of the pulps of the incisors in the upper jaw of the *Toxodon*, and indicates, in conjunction with the size of the pulps, that a considerable extent of the inferior incisors was lodged in the substance of the anterior part of the jaw. It is most likely that no vertically directed tooth would be developed in the part of the jaw so occupied by the curved bases of the incisors, and hence a diastema or toothless space would intervene between the molars and incisors of this lower jaw, as in the upper jaw of the Toxodon.

It is interesting, also, to observe, that as the deviations from the Rodent type, which occur in the cranium of the Toxodon, are the same, in some instances, as those which obtain in the Wombat; so we find a corresponding deviation in the size and relative position of the inferior incisors, which, as in the Wombat, terminate anterior to the molar teeth, instead of extending backwards beyond the last grinder, as in most of the true Rodents. The Capybara presents the nearest approach to this structure, the pulps of the inferior incisors being situated opposite the interspace of the first and second grinders.

The molar teeth, in this mutilated lower jaw, like those in the upper jaw of Toxodon, had persistent pulps, as is proved by the conical cavity at their base, as represented in fig. 3; they consequently required a deep socket, and a corresponding depth of jaw to form the socket and protect the pulps. In order to economise space, and to increase the power of resistance in the tooth, and perhaps, also, to diminish the effects of direct pressure on the highly vascular and sensible matrix, we find the molars and their sockets are curved, but in a less degree than those of the upper jaw of the Toxodon. They correspond, however, with the superior molars of the Toxodon in the antero-posterior diameter, in being small and simple at the anterior part of the jaw, and by increasing in magnitude and complexity as they are situated more posteriorly. They are, however, narrower from side to side; but supposing them to belong to the Toxodon, it would agree in this respect with most other large herbivorous mammalia;—the fixed surface for attrition in the upper jaw being from obvious principles more extensive than the opposed moveable surface in the lower jaw.

The *first* grinder, in the lower jaw here described (Pl. V. fig. 2), is of small size and simple structure, being surrounded with a coating of enamel of uniform thickness, and without any fold penetrating the substance of the tooth. It is more curved than any of the other molars, and appears to have differed from the external incisor only in its entire coating of enamel and direction of growth; it is interesting, indeed, to find so gradual a transition, in structure, from molar to incisive teeth,

as this jaw presents; for the robust incisors may here be regarded as representing molars simplified by the partial loss of enamel, and with a change in their direction.

In the *second* molar, we find an increase in the antero-posterior diameter, and in the length of the tooth, and the enamel at the middle of the outer side makes a fold which penetrates a little way into the tooth; the line of enamel, on the inner side, is slightly concave and unbroken.

The *third* molar presents an increase of dimensions in the same directions as the second; the enamel on the outer side of the tooth presents a similar fold, but it is directed a little more backwards.

In the *fourth* molar, besides a further increase of size, and a corresponding but deeper fold of enamel in the external side of the tooth, we have the grinding surface rendered more complicated by two folds of enamel entering the substance of the tooth from the inner side: these folds divide the antero-posterior extent of the tooth into three nearly equal parts; they are both directed obliquely forwards, half-way across the substance of the ivory.

The *fifth* molar presents the same structure as the fourth, which it exceeds only slightly in size.

In the *sixth* molar we have a proportionally greater increase of size in the antero-posterior diameter, which measures two inches; but the lateral diameter is but slightly augmented; its structure resembles that of the fifth.

As these grinding teeth by no means increase in the lateral diameter in the same proportion as in their antero-posterior diameter, the posterior ones present, but in a greater degree, the compressed form which characterizes the grinders of the upper jaw of the Toxodon.

It will be seen, however, that there is a difference in the structure of the grinders in this fragment of the lower jaw and those of the upper jaw of the Toxodon. In the lower grinders there are two folds of enamel proceeding from the inner side of the tooth into its substance, whilst in the upper grinders there is only one fold continued from the inner side; in the lower grinders there is also a fold of enamel reflected into the substance of the tooth from the outer surface, while in the upper grinders of Toxodon we find the enamel coating on the outer side of the tooth merely bent inwards, so as to describe, in the transverse section, a gently undulating line; fig. 7, Pl. V. is the grinding surface of the sixth molar, right side, upper jaw.

But this difference of structure is by no means incompatible with the coexistence of the two series of teeth in the same animal, since we find the grinders of the upper and lower jaws presenting differences of structure of equal degree in existing herbivorous species. If we examine the jaws of the Horse, for example, we shall find not only an equal amount of difference in the structure of the upper

and lower grinders, but that they deviate from one another in a very similar manner to that above described in the Toxodon. In this comparison attention should be confined to the course of the external enveloping layer of enamel, leaving out of consideration the central crescentic islands of enamel which constitute the additional complexity of the Horse's grinder. Viewing then the course of the external coat of enamel on the worn surface of the tooth, we find it describing on the outer side of the tooth in the upper jaw an undulating line,—a middle convexity being situated between two concavities; on the inner side of the tooth one fold of enamel penetrates to the middle of the tooth, and on each side of this there is a smaller fold. But in the lower jaw the line of enamel on the outer side of the tooth, instead of merely bending outwards midway in its course, is reflected a little way inwards; while on the opposite, or inner side of the tooth, the enamel sends two extensive folds into the substance of the tooth, opposite to the interspace of which the shorter fold projects from the outer side. Now, on the supposition that the fragment of the lower jaw here described belongs to the Toxodon, the kind and degree of difference in the complexity of the grinding surface of the teeth in the upper and lower jaw, are remarkably analogous to those which exist in the Horse. I have only further to remark that in the Horse the inflected folds of enamel, instead of being simple and straight with the two constitutive layers in apposition, as in the Toxodon, are irregular in their course, with cœmentum intervening between the constitutive layers, which also diverge from each other at their angle of reflection, so as to augment the amount of dense material which enters into the composition of the tooth.

Many analogous examples will readily occur to the experienced comparative anatomist. The Horse has been adduced as one to which reference can very readily be made; but I would also cite the Sumatran Rhinoceros, the skull of which, in the Hunterian collection, has already been alluded to. In this species the anterior grinders, in both jaws, are small and simple, and increase in complexity as they recede backwards. The third superior grinder (fig. 8, Pl. V.) presents a single fold of enamel, reflected obliquely forwards from the inner side half-way across the tooth; the outer line of enamel describes a simply undulating line. The opposite grinder of the lower jaw (fig. 9, Pl. V.) has only one-half the breadth of the upper one, but has its grinding surface further complicated by having two inflected folds of enamel from the inner side, and one shorter and broader fold from the outer side. This tooth, therefore, presents a close resemblance to one of the posterior grinders of the lower jaw of the Toxodon, but differs essentially in being of limited growth, and consequently in having fangs.*

* Besides the relation to *food requiring much comminution*, which teeth with persistent pulps bear, they are also connected with the *longevity of the individual*. The term of life in a herbivorous animal, with grinders

In speculating upon the nature of the organized substances which the teeth of the Toxodon were destined to grind down, we must not only take the structure of the tooth into consideration, but also the power of perpetual renovation, which will compensate for the defective quantity of enamel in the grinders of the Toxodon, as compared with those of the existing Ruminants and Pachyderms, whose grinders, when once completed, receive no further addition of dental substance at their base. The Toxodon, in this character of its dentition, participated in the same advantages with the Capybara and the Megatherium.

Although we have been enabled to observe the structure of the grinding teeth of the upper jaw of the Toxodon in two examples only; one, an insulated perfect grinder corresponding to the sixth alveolus on the right side, and the other, a portion of the last grinder of the left side remaining in the socket of the head previously described, yet from the relations subsisting between socket and tooth, a very satisfactory opinion may be formed of the structure of those teeth which are wanting, as well as of their size. It thus appears, that the grinders of the upper jaw of the Toxodon, are small and simple at the anterior part of the jaw, and that they increase (chiefly in antero-posterior extent) in size, as well as in complexity, as they recede backwards in the jaw. In this respect, as well as in size, the teeth, in the fragments of the lower jaw just described, exactly correspond. There is, however, a slight difference in the lateral diameter of the two sets of grinders, those of the lower jaw being narrower, as is usually the case, but not in the same degree as in the Horse or Ruminant. A greater difference obtains in the degree of curvature of the two sets of molars, those of the lower jaw, especially the posterior grinders, being much less bent than the corresponding teeth of the upper jaw. It is necessary to observe, also, that the convexity of the curve of the inferior grinders is directed outwards, as in the superior grinders; while in the Guinea Pig and Wombat, which have also curved grinders, the convexity is outwards in the lower jaw, and inwards in the upper jaw.

Nevertheless, if we take into consideration the close similarity which exists between the teeth of the upper jaw of the Toxodon, and those of this lower jaw in more essential points, as in their persistent pulps, their characteristic structure and form, the depth of their sockets, and their relative sizes and complexity; and when we consider how the depth of this lower jaw, and its narrowness in the transverse direction, corresponds with the characteristic form of the upper jaw of the Toxodon, and that to these resemblances is added an apparatus of incisors adequate to oppose the great dentes scalprarii of the upper jaw, the conclusion seems irresisti-

of temporary growth, is, of necessity, dependent on the duration of these essential aids to nutrition; thus, a sheep generally wears down its grinders in twelve years, and its natural term of life is consequently limited to about that period.

ble, that the lower jaw, here described, must be referred, if not to the same, at least to a nearly allied species of Toxodon, as that to which the large cranium belonged.

Further researches in South America, it is hoped, will lead, ere long, to the completion of our knowledge of the osteology of this very remarkable and interesting genus of extinct mammiferous animals.

DESCRIPTION OF PARTS OF THE SKELETON OF

MACRAUCHENIA PATACHONICA;

A large extinct Mammiferous Animal, referrible to the Order Pachydermata; but with affinities to the Ruminantia, and especially to the Camelidæ.

In the preceding pages the nature and affinities of a large extinct Mammal were attempted to be determined from the cranium and teeth exclusively: we come now to consider the remains of a quadruped consisting of bones of the trunk and extremities, without a fragment of a tooth or of the cranium to serve as a guide to its position in the zoological scale.

It may appear, even to anatomists and naturalists familiar with the kind of evidence afforded by a fossil fragment, that an opinion as to the relation of the present species to a particular family of Ruminants, formed without a knowledge of the important organs of manducation, must be vague and doubtful, but the evidence about to be adduced, will be regarded, it is hoped, as more conclusive than could have been *à priori* expected.

The portions of the skeleton of the animal—which, in relation to the affinity above alluded to, as well as from the length of its neck, I propose to call *Macrauchenia**—were discovered by Mr. Darwin in an irregular bed of sandy soil, overlying a horizontal accumulation of gravel on the south side of Port St. Julian: and independently of the circumstances under which they were found, their correspondence with each other in size, colour, texture and general character prove them to have belonged to one and the same individual.

These remains include two cervical vertebræ, seven lumbar vertebræ, all more or less fractured; a portion of the sacrum and ossa innominata; fragments of the left scapula; of the left radius and ulna, and left fore-foot; the left femur

* Μακρος *longus*, αυχην *cervix:* from the latter word Illiger derived *Auchenia*, his generic name of the Llama, Vicugna, &c.

nearly entire, the proximal and distal extremities of the left tibia and fibula; and a metatarsal bone of the left hind foot.

Before entering upon the description of these remains, a few observations may be advantageously premised on some of the distinguishing characters of the Camelidæ. It is well known that the Camels and Llamas deviate in their dentition, viz., in the presence of two incisors in the upper jaw, from the true Ruminants; and we cannot avoid perceiving that in this particular the direction in which they deviate tends towards the conterminous Ungulate Order, in which incisor teeth are rarely absent in the upper jaw. They also further deviate from the Ruminants and approach the Pachyderms in the absence of cotyledons in the uterus and fetal membranes; having, instead thereof, a diffused vascular villosity of the chorion, as in the sow and mare.

But besides these characters, by which, in receding from one type of hoofed mammalia, the Camelidæ claim affinity with another, there are many parts of their organization peculiar to themselves; of some of these peculiarities, the relation to the circumstances under which the animal exists, can be satisfactorily traced; in others, the connection of the structure with the exigencies of the species, is by no means obvious, and in this predicament stands the osteological peculiarity, which is immediately connected with our present subject—a peculiarity in which the Camelidæ differ not only from the other Ruminants, but from all other existing Mammalia, and which consists in the absence of perforations for the vertebral arteries in the transverse processes of the cervical vertebræ, the altas excepted.

I may observe that what is described as a perforation of a single transverse process in a cervical vertebra is essentially a space intervening between two transverse processes, a rudimental rib, and the body of the vertebra. In the cold-blooded Saurians,—in which the confluence of the separate elements of a vertebra takes place tardily and imperfectly, if at all,—the nature of the so called perforation of the transverse process is very clearly manifested, as in the cervical vertebræ of the Crocodile, in which the interspace of the inferior and superior transverse processes is closed externally by a separate short moveable cervical rib. In the Ornithorhynchus paradoxus the vertebra dentata also preserves throughout life this condition of its lateral appendages: in other Mammalia it is only in the fœtal state that the two transverse processes are manifested on each side with their extremities united by a distinct cartilage, which afterwards becomes ossified and anchylosed to them.

In the Hippopotamus the inferior transverse process sends downwards a broad flat plate extended nearly in the axis of the neck, but so obliquely, that the posterior margins of these processes, in one vertebra, overlap the anterior ones of the succeeding vertebra below, like the cervical ribs in the Crocodile; the same structure obtains in many other mammalia, especially in the Marsupials. In the

Giraffe, the inferior transverse processes are represented by relatively smaller compressed laminæ, projecting obliquely downwards and outwards from the anterior and inferior extremity of the body of the vertebra. The superior transverse processes in this animal are very slightly developed in any of the cervical vertebræ, and the perforation for the vertebral artery is above and generally in front of the rudiment of this process, being continued as it were through the side of the substance of the body of the vertebræ.

In the long cervical vertebræ of the Camel and Llama, the upper and lower transverse processes are not developed in the same perpendicular plane on the sides of the vertebræ, but at some distance from each other; the lower transverse processes (*a*, fig. 1, Pl. VI.; *a*, fig. 1, 3, 4, Pl. VII.) being given off from the lower part of the anterior extremity of the body of the vertebra; the upper ones (*b*, fig. 1, Pl. VI.; *a*, fig. 1, 3, 4, Pl. VII.) from the base of the superior arch near the posterior part of the vertebra, or from the sides of the posterior part of the body of the vertebræ. The extremities of these transverse processes do not become united together, but they either pass into each other at their base, or continue throughout life separated by an oblique groove (as in fig. 1, Pl. VI.) This groove would not, however, afford sufficient defence for the important arteries supplying those parts of the brain which are most essential to life; and, accordingly the vertebral arteries here deviate from their usual course, in order that adequate protection may be afforded to them in their course along the neck. From the sixth to the second cervical vertebræ inclusive in the *Auchenia*, and from the fifth to the second inclusive in the *Cameli*,* the vertebral arteries enter the vertebral canal itself, along with the spinal chord, at the posterior aperture in each vertebra, run forwards on the outside of the dura mater of the chord between it and the vertebral arch, and when they have thus traversed about two-thirds of the spinal canal, they perforate respectively the superior vertebral laminæ, and emerge directly beneath the anterior oblique or articulating processes, whence they are continued along with the spinal chord into the vertebral canal of the succeeding vertebra, and perforate the sides of the anterior part of the superior arch in like manner; and so on through all the cervical vertebræ until they reach the atlas, in which their disposition, and consequently the structure of the arterial canals, resemble those in other Ruminants.

The two cervical vertebræ of the Macrauchenia present precisely the struc-

* In the seventh cervical vertebra of the Camel, as in many other Mammalia, there is no perforation in any part for the vertebral arteries. In a Vicugna, I find the same structure; but in a Llama, the side of the body of the seventh cervical vertebra is perforated longitudinally on the right side. In the Camel, the vertebral arteries pierce the sixth cervical vertebra, immediately below the superior transverse processes, and pass obliquely to the anterior aperture of the cervical canal, where they emerge beneath the anterior oblique processes, and then enter the spinal canal of the fifth cervical vertebra, as described in the text.

ture and disposition of the bony canals for the vertebral arteries which are peculiarly characteristic of the Camelidæ among existing Mammalia. In Plate VI. fig. 2, the groove and orifices of the canal for the vertebral artery are shown in a section exposing the spinal canal: in Plate VII. figures 1 and 3 exhibit the orifices at the commencement of the arterial canals, as seen in a posterior view of the vertebræ; in figs. 2 and 4, the terminations of the same canals are shown, in the anterior view of the same vertebræ; the smaller figures (3 and 4) are taken from the fourth cervical vertebra of a Llama. The vertebræ of the Macrauchenia also closely resemble the middle cervical vertebræ of the Vicugna and Llama in their elongated form; approaching the Auchenial division of the Camelidæ, and deviating from the true Camels in the relations of the length of the body of the vertebra to its breadth and depth, and in the much smaller size of the inferior processes. Excepting the Giraffe, there is no existing mammal which possesses cervical vertebræ so long as the Macrauchenia; but the cervical vertebræ of the Giraffe, differ in the situation of the perforations for the vertebral arteries, and in the form of the terminal articular surfaces, as will be presently noticed.

Both of the cervical vertebræ of the *Macrauchenia* here described, are of the same size, each measures six inches and a half in extreme length, two inches, ten lines in breadth, and two inches, four lines in depth. In the Giraffe and the Camelidæ, the spinous processes are thin laminæ of considerable extent in the axis of the vertebra, but rising to a very short distance above the level of the vertebral arch: the spinous processes have the same form in the corresponding vertebræ of the Macrauchenia, but present a still greater longitudinal extent; they commence at the interspace of the anterior oblique processes, and extend to opposite the base of the posterior oblique processes; the upper margin describing a gentle curve, as shown in fig. 1, Pl. VI. The transverse processes also present the form of slightly produced, but longitudinally extended, laminæ: their disposition is essentially the same as in the Camelidæ, but more nearly corresponds with the modifications presented by the Aucheniæ. The inferior transverse processes,—those which are alone developed in fish, but which are not present in any other vertebræ save the cervical, in mammalia,—these processes in the Macrauchenia are continued from the sides of the under surface of the anterior part of the body of the vertebra; their extremities being broken off, it cannot be determined how far they extended from the body of the vertebræ, but they gradually subside as they pass backwards: the superior transverse processes are continued outwards from the sides of the posterior part of the body of the vertebra, and gradually subside as they advance forwards along three-fourths of the body of the vertebra: they are not continued into the anterior and inferior transverse processes, as in the Vicugna, but are separated therefrom by a narrow and shallow groove. The articular, or oblique processes, closely resemble those of the Auchenia

in form, and in the direction of the articular surfaces; those of the anterior processes looking inwards and a little upwards; those of the posterior, outwards and a little downwards.

In the Macrauchenia a small longitudinal process (*e*, fig. 2, Pl. VII.) is given off immediately below the base of the anterior oblique process; this structure is not observable in any of the cervical vertebræ of the Giraffe or Camelidæ.

In the form of the articulating surfaces of the bodies of the vertebræ the Macrauchenia deviates from the Giraffe and Camel, but resembles the Aucheniæ. In the Giraffe and Camel the anterior articulating surface is convex and almost hemispheric, the posterior surface is proportionally concave, so that the cervical vertebræ are articulated by ball and socket joints; yet not, as in most Reptiles, with intervening synovial cavities, but by the concentric ligamentous intervertebral substance characteristic of the Mammiferous class. In the Llama and Vicugna, the degree of convexity and concavity in the articular surface of the bodies of the cervical vertebræ is much less than in the Camels; and in consequence they carry their necks more stiffly and more in a straight line. In Macrauchenia the anterior articulating surface (fig. 2, Pl. VII.) presents a still slighter convexity than in the Llama (fig. 4, Pl. VII.), and the posterior surface (fig. 1, Pl. VII.) presents a correspondingly shallower concavity. The form of the extremities of the body of the vertebræ, especially of the posterior, is sub-hexagonal, the breadth being to the depth as eight to five. The sides and under part of the vertebræ are slightly concave; on the inferior surface there are two ridges, continued forwards from the posterior margin of the vertebra, each situated about an inch distant from the middle line; they converge as they pass forwards, and are gradually lost in the level of the vertebra; their greatest elevation does not exceed half an inch. In the Aucheniæ there is a longitudinal protuberance in the mesial line, instead of the two ridges. The two long cervical vertebræ of the Macrauchenia are also characterized by the maintenance of an almost uniform diameter of the body, both in its vertical and transverse extent; the cervical vertebræ of the Vicugna come nearest to them in this respect; those of the Camel deviate further in the large excavation at the under part of the body.

The long vertebral or spinal canal offers a slight enlargement at the two extremities; this structure which is generally in the ratio of the extent of motion of the vertebræ on each other is more marked in the Camel, where the form and mode of articulation of the bodies of the vertebræ are designed to admit of a free and extensive inflection of the cervical vertebræ; and the result of this structure is very obvious in the sigmoid flexure of the neck in the living animal. In the Aucheniæ, on the contrary, the neck is carried less gracefully erect and in an almost straight line, and the form of the vertebræ and the nature of their joints correspond, as we have seen, to this condition. From the length of the bodies of the

cervical vertebræ of the Macrauchenia, and the almost flattened form of their anterior and posterior articular surfaces, I infer that the long neck in this singular quadruped must have been carried in the same stiff and upright position as in the Vicugna and Guanaco.

The following individual differences are observable in the two cervical vertebræ of the Macrauchenia; — in the posterior one the superior arch is wider and with thicker parietes, the body is more concave below, and the inferior transverse processes have a more lengthened origin.

Not a fragment of dorsal vertebræ, ribs or sternum, is included in the collection of the bones of the Macrauchenia; but fortunately seven lumbar vertebræ, forming a consecutive series of the same individual as that to which the cervical vertebræ belonged, were obtained, all more or less fractured, but all sufficiently perfect to demonstrate their true nature. These vertebræ, although not possessing such distinctive characters as the cervical, contribute by no means an unimportant element towards the illustration of the osteology of the Macrauchenia, and support the view which I have taken of its affinities; for, although, as will be seen from the structure of its extremities, this animal must be referred to the Order Pachydermata, yet no existing species of that order has more than six lumbar vertebræ; whilst among the Ruminants it is only in the Camel, Dromedary, Llama and Vicugna, that the lumbar vertebræ reach the number seven,— the same number which characterizes the extinct annectant species in question. The dimensions of the vertebræ in the Macrauchenia present the same relations to the two cervical vertebræ above described, which the lumbar vertebræ of the Vicugna bear to the third, fourth, or fifth of its cervical vertebræ. But here we begin to discover modifications of form, in which the Macrauchenia deviates from the Camelidæ, and approaches the Pachyderms, as the Horse and Hippopotamus; and these indications become stronger as the vertebræ approach the sacrum.

In the Camel, as well as in the Horse and Hippopotamus, the bodies of the lumbar vertebræ diminish in vertical extent, or become flatter, as they approach the sacrum; but this character is more strongly marked in the Macrauchenia than in either of the above species. But in the Camelidæ the transverse processes of the lumbar vertebræ, are elongated, flattened, and narrow, resembling ribs, except that they are nearly straight; and this is more particularly the case with the transverse processes of the last lumbar vertebræ, which are the narrowest of all in proportion to their length, and stand freely out without touching the sacrum. The transverse processes of the lumbar vertebræ of the Giraffe resemble those of the Camel, but are relatively smaller and shorter. In the Hippopotamus the transverse processes of the lumbar vertebræ are much broader in proportion to their length than in any of the Ruminants, and they increase in breadth to the

Base of the Skull of Toxodon Platensis.

G.Scharf del et lithog

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Side View of the Skull of Toxodon
one third the Natural Size.

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Top View of the Skull of the Toxodon.
One third the Nat. Size.

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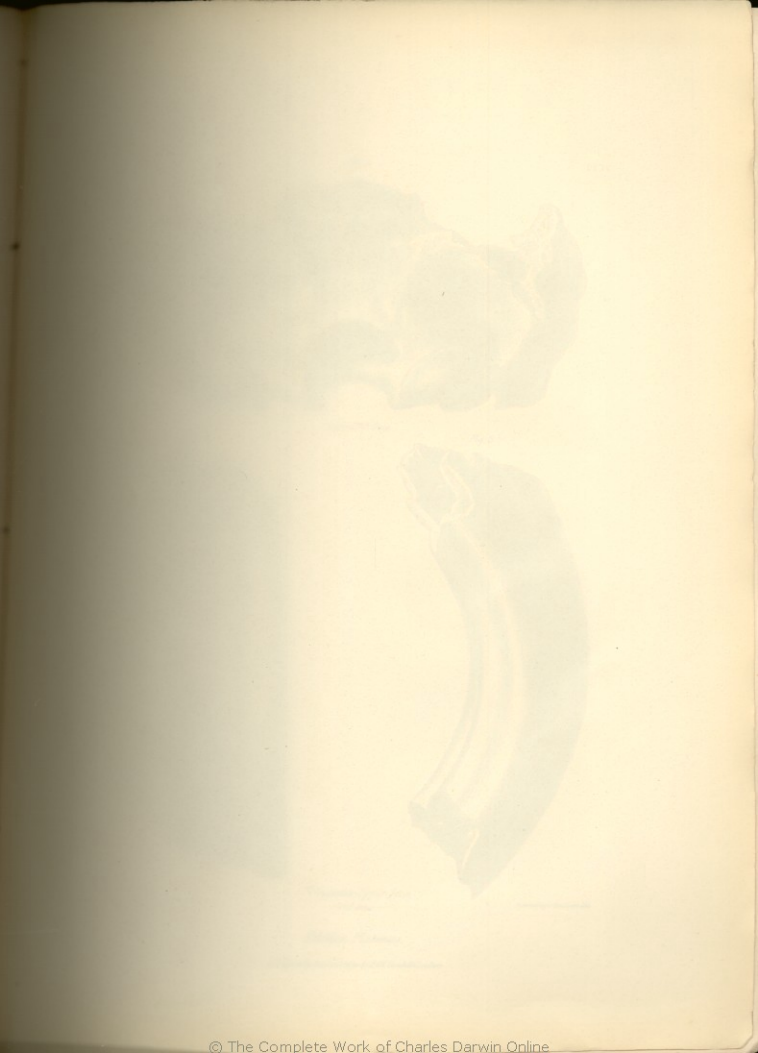

Fig 1.

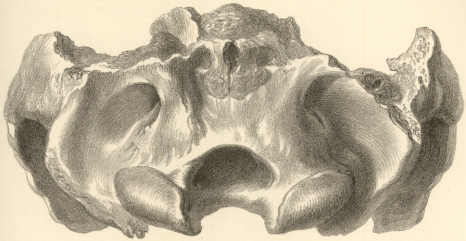

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Fig 2.

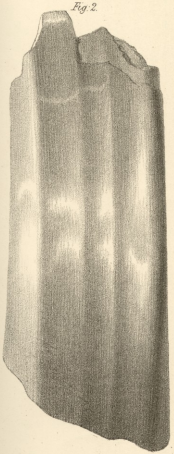

Fig 3.

E. Ibbart del. et lithog.

6th Grinder. Upper Jaw.
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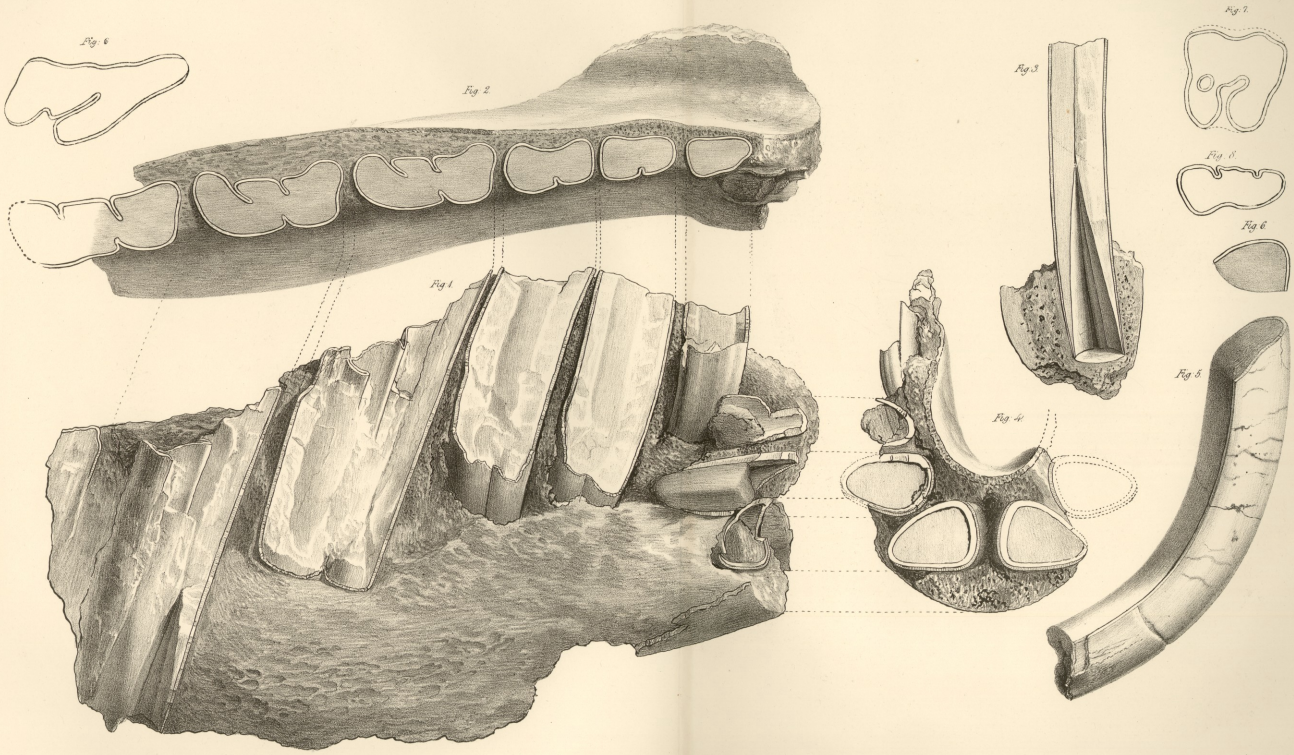

Fragments of the lower Jaw and Teeth of a Toxodon.

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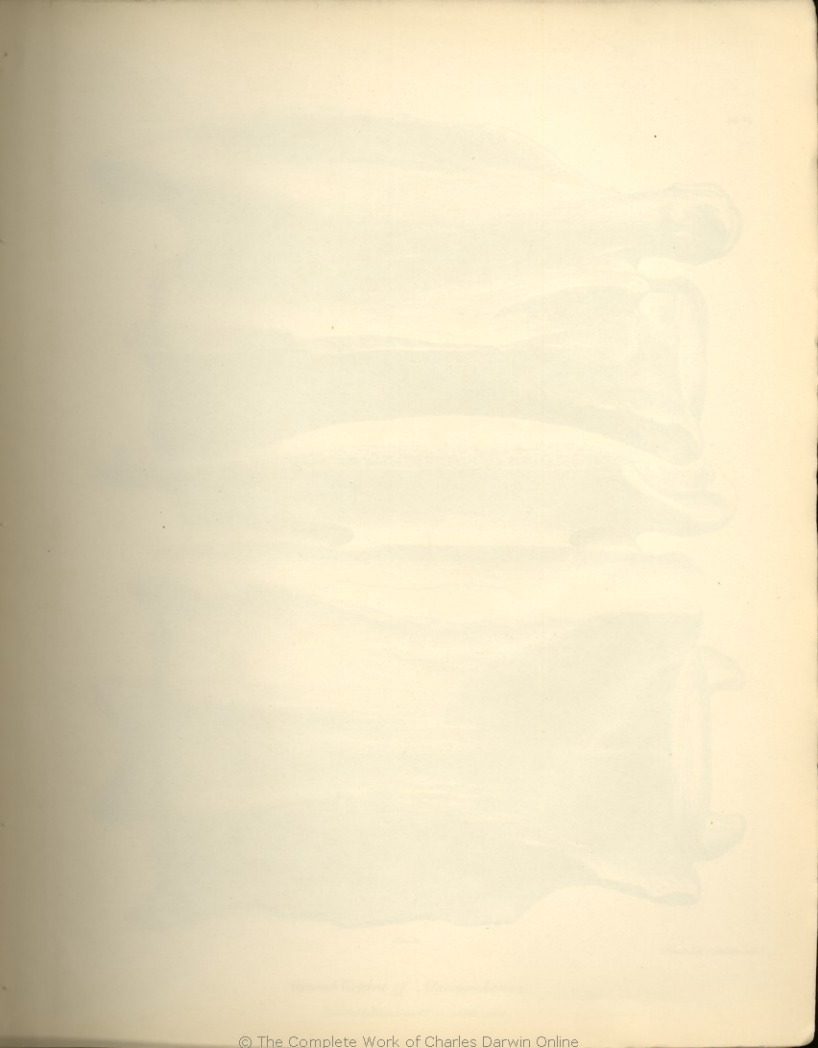

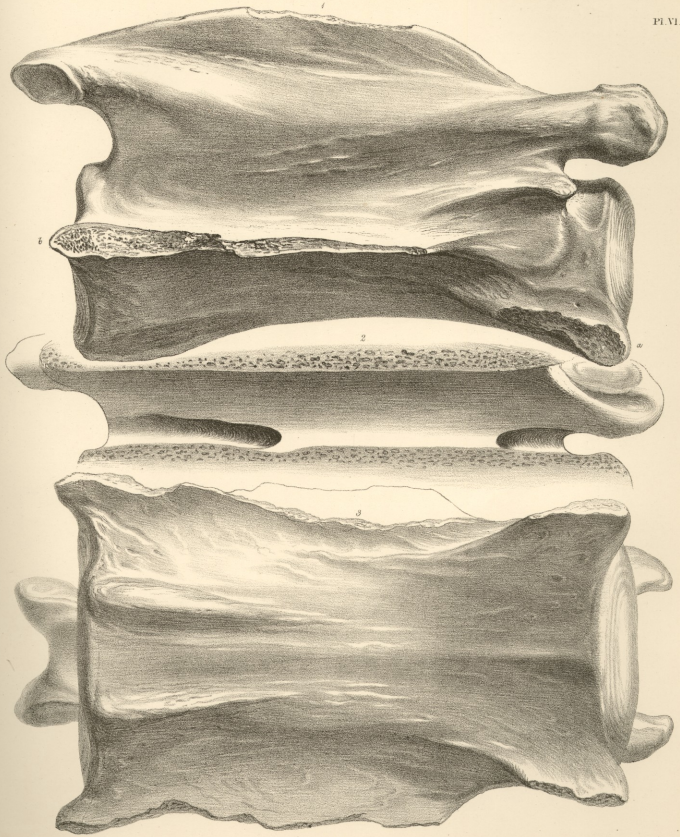

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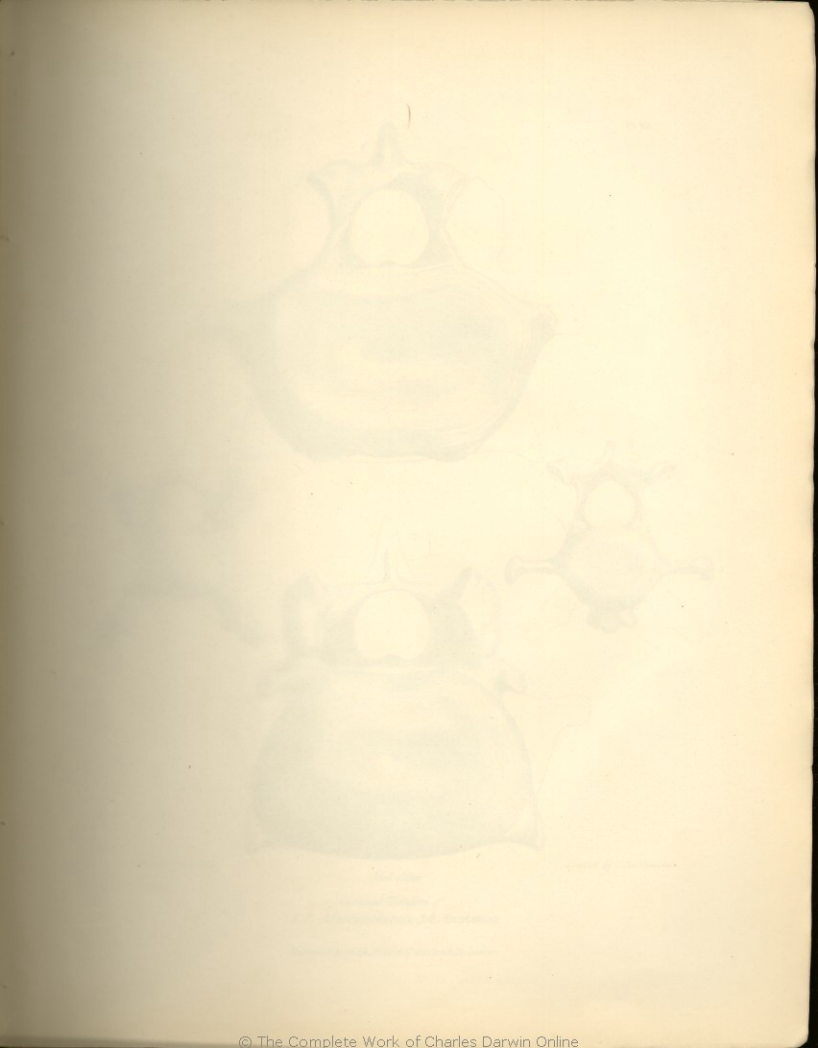

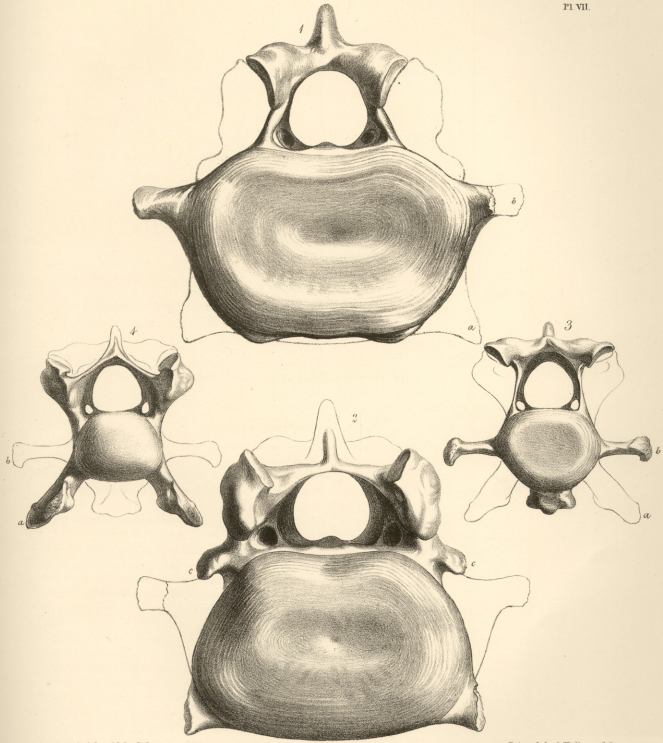

C. Scharf del et lithog.

Nat. Size

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Cervical Vertebræ of
1. 2. Macrauchenia. 3 4 Auchenia.

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Preparing for Publication, in Royal Quarto.

ILLUSTRATIONS

OF THE

ZOOLOGY OF SOUTH AFRICA.

BY

ANDREW SMITH, M.D.

DIRECTOR OF THE RECENT EXPEDITION FROM THE CAPE OF GOOD HOPE INTO CENTRAL AFRICA.

PUBLISHED UNDER THE AUTHORITY OF THE LORDS COMMISSIONERS OF HER MAJESTY'S TREASURY.

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THE Cape of Good Hope is now acknowledged to be one of the greatest avenues as yet opened for the researches of the Naturalist. Our Colony in that part of Southern Africa is the key to a large portion of an extensive continent which is still but very partially explored; and the field to which it admits the scientific traveller is rich to exuberance in the variety and novelty, both of animal and vegetable life. —

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Secondly, animals known, but not yet figured; and

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