20. *On the SKULL of MEGALOSAURUS.* By Prof. OWEN, C.B., F.R.S.,
F.G.S., &c. (Read April 25, 1883.)

[PLATE XI.]

SINCE the description of the fossils on which the genus and species (*Megalosaurus Bucklandi*) was founded *, the additional specimens have been, mainly, parts of the trunk and limbs. To the mandibular and dental fossils have been added two portions of the upper jaw, now in the Oxford Museum, on which Professor Phillips has founded the restoration of the skull given in Diagram lvii. of his 'Geology of Oxford' †.

Acceptable, therefore, were the additional cranial and dental evidences obtained by Edward Cleminshaw, Esq., M.A., F.G.S., of Greenhill, Sherborne, Dorset, from the freestone of the 'Inferior Oolite,' near Sherborne ‡. Blocks of this stone were in course of preparation for a building, when, indications of imbedded fossils being detected by Mr. Cleminshaw on fractured surfaces of the quarry-stones, he withdrew all such from the building-yard and transmitted them to the British Museum for identification.

Further requisite development of these remains having been there carried out, the following descriptions and drawings are now submitted to the Geological Society.

In the section devoted to the genus *Megalosaurus* in vol. i. pp. 329-354 of the undercited work §, the materials for a reconstruction of the skull were limited to portions of the mandible and divers teeth therein implanted or detached. The most instructive of these was a portion of the lower jaw, in the collection of His Grace the Duke of Marlborough, from the same formation (Oolitic Slate, Oxford) as that which had afforded Buckland the materials for the species which bears his name. The other localities, yielding the detached teeth figured in my '*Dinosauria*,' plate 33, were the 'Corn-brash' of Oxfordshire, the 'Bath Oolite' of Somersetshire, and the 'Wealden' of Sussex ||.

The differences shown by the mandibular specimens were limited to size—the vertical diameter of the deepest part of the type mandible being $3\frac{1}{2}$ inches, while that of the Blenheim specimen gave $4\frac{1}{2}$ inches. But as the teeth retained in these mandibular pieces

* Buckland (Rev. Wm., F.R.S., G.S.), "Notice on the *Megalosaurus*," &c., in 'Transactions of the Geological Society of London,' 2nd series, vol. i. 1824, pp. 390-396, plates xl.-xliv.

† 8vo, 1871, p. 199; see also Prof. Huxley, Quart. Journ. Geol. Soc. vol. xxv. 1869, p. 311, pl. xii.; and Prof. H. A. Nicholson, 'Ancient Life-history of the Earth,' 8vo, 1877, p. 249.

‡ 'Dorset County Chronicle,' June 15th, 1882, "Report of a Meeting of the Dorset Natural-History and Antiquarian Field Club."

§ Owen, British Fossil Reptiles, 4to, 1855.

|| *Ibid.* p. 351.

were of the same size, as well as form and structure, there was no ground for predicated distinction of species.

In the Blenheim specimen I was permitted to expose the germs and portions of the successional teeth concealed in the substance of the mandible*.

Before entering on the description of the first of the present series of fossils which demonstrates cranial characters not hitherto determined, I may premise that existing Saurians show differences in the degree of ossification of the outer wall of the facial part of the skull.

In Crocodilia it is entire from the relatively small orbit behind to the smaller single nostril in front; and there is no break in that wall in modern and tertiary species, answering to the antorbital vacuity in Liassic genera; but this opening, recalling the antorbital nostril of *Ichthyosaurus*, is very small and is margined by the maxillary, lacrymal, and nasal bones.

In existing Lacertians much difference is seen in this character; but in none is the face so completely ossified as in the Crocodiles. The Monitors (*Thorictes*, *Tupinambis*) come nearest thereto, the nostril being divided from the orbit by a broad triangular facial plate of the maxillary, supplemented behind by a narrow malolacrymal one. In *Lacerta* the lacrymal enters in larger proportion into the formation of this part of the bony face, and the external nostrils are relatively wider. In *Iguana* the facial wall dividing the nostril from the orbit is relatively narrower, and the apex of the maxillary process is further removed by a large interposed lacrymal from the nasal bone. But in the Lacertians with a carnivorous dentition (*Hydrosaurus*, *Varanus*) the outer bony nostrils are remarkable for their great relative size, especially length; and the maxillary sends upward and backward a long but narrow pointed plate, which, in *Varanus bivittatus*, crosses in front of a small lacrymal bone to articulate with the prefrontal.

Here we attain the cranial modification which forms the best guide to the interpretation of the appearances presented by the fossil, the subject of Plate XI. fig. 1, and restored on a Varanian type in the Cut, p. 340.

But, before entering on this comparative survey, I may note the corresponding degree of resemblance which the skull of *Iguanodon* presents to those of the herbivorous and mixed-feeding Lacertians, *Iguana* and *Thorictes*, with correspondingly adaptive shapes of the teeth. In the relative size of the external nostril *Iguanodon Foxii* resembles *Tupinambis* more than it does *Iguana* with the larger nostril; and the side wall between nostril and orbit is relatively broader and more extensive in *Iguana* than in either of the blunt- or thick-toothed Lacertians. I may remark also that, as usual in the larger forms, the orbits are relatively smaller than in the dwarfed kinds.

In all the Lacertians here compared, teeth are developed from the whole (*Iguana*, *Tupinambis*), or nearly the whole (*Hydrosaurus*, *Varanus*), of the alveolar border of the maxillary; consequently this

* See 'Remarks' thereon in the volume above cited.

dental series extends beneath both nasal and orbital vacuities, but for a less extent in the carnivorous than in the herbivorous Laceratians. *Scelidosaurus*, in the degree and kind of its facial ossification, repeats the mammalian character exemplified in *Iguanodon* *.

Of the subjects of the present paper the first block of lower oolitic freestone includes a great proportion of the right side of the facial part of the skull (Plate XI. fig. 1). The missing parts are the fore end of the premaxillary, 22', and the hind or suborbital end of the maxillary, 21'; the upper and hinder pointed termination of the facial process, *f*, of the maxillary, is likewise wanting.

The length of this facial fossil is 1 foot 3½ inches; its height from the upper angle, *a*, of the maxillary process to the tip of the subjacent tooth *t*, *in situ*, is 9 inches.

Of the premaxillary are preserved part of the nasal process, 22'', and so much of the alveolar part, 22, as lodges two fully developed and protruded teeth and the socket of a third: an intervening part of the bone has been chiselled away to admit a wedge for the quarrying-operations; the length of the preserved premaxillary nasal process, 22'', is 4 inches, the breadth of its base is 1 inch; it narrows to its apex, being limited to the fore and under part of the large bony nasal vacuity, *n*, in the present specimen.

So much of 22'' as is preserved forms rather more than one third of the lower border of the external nostril, *n*, the rest of that border with the hinder boundary, *a*, being contributed by the maxillary, 21''. The limitary suture between these bones is distinct.

The preserved length of the alveolar part of the maxillary, 21, 21', is 1 foot: the upper border of this part contributes an equal share to the large nasal (*n*) and orbital (*o*) vacuities; but these portions of such tooth-bearing part of the upper jaw combine to form the base of the facial process, *a f*, which is between four and five inches in extent: its breadth, at one inch above the border line, 22'', is three inches; this breadth is nearly preserved to the angle, *a*, about six inches above the alveolar border, at which angle the maxillary is continued backward, above the fore part of the orbit, gradually narrowing to the point, *f'*, which is here broken off.

Much of the outer wall of the alveolar part of the maxillary adheres to the block of freestone in which the counterpart of the above-described cranial fossil is preserved: but this counterpart shows only the impressions of the teeth, which are well preserved in the block containing the chief part of the fossil. Of these teeth four are premaxillary, the rest maxillary.

The teeth closely repeat the characters of previously described dental evidences of *Megalosaurus Bucklandi*.

Of the foremost preserved premaxillary tooth, 2 inches of the crown remain, with half an inch of a mutilated base; the next tooth is represented by a smaller protruded apical part of the crown. The socket of the larger intervening tooth is broken away with the implanted tooth-root, exposing the pulp-cavity. The impression of the broken

* Monograph in the volume of the Palæontographical Society for the year 1861, tab. v. fig. 1.

and missing part of the smaller premaxillary tooth gives two inches of length to this tooth; the implanted remainder of both teeth has gone with the supporting bone. In advance of the larger premaxillary tooth is an elliptical cross-fractured basal part of a third (the anterior) tooth, showing a long diameter of nearly half an inch.

Ten teeth are preserved in the maxillary bone. Between the foremost, third, and fifth are crowns of successional or undeveloped teeth. Of the foremost of these (second in the series) the apex only of the crown has appeared above its socket; the rest of the tooth is exposed by removal of the socket's outer wall: a length of enamelled crown of 2 inches 5 lines is thus shown. The length of the protruded crown of the first maxillary tooth is 1 inch 9 lines; that of the third tooth is 2 inches 3 lines; its total length is 5 inches. Of the fourth tooth the apical half-inch of the crown is protruded: the total length exposed in the quarrying is $3\frac{1}{2}$ inches. The similarly shown length of the fifth tooth is 4 inches 9 lines, that of the enamelled crown being 3 inches. The sixth tooth shows 2 inches of free enamelled crown, and $2\frac{1}{2}$ inches of the rooted cement-clad part, the latter exposed by loss of the bone. The seventh maxillary tooth is represented by a smaller proportion of the protruded crown. The eighth tooth is a functional fully developed one, but of smaller size than the third and fifth. The apical half of a somewhat smaller crown of a ninth tooth has emerged; and behind this is the indication of a fully developed tenth tooth, not larger than the eighth. I cannot predicate with confidence the existence of an eleventh maxillary tooth. The crown of such exposed tooth on the transversely fractured surface of the block may have come from the lower jaw.

Of the maxillary teeth the four or five hinder ones are suborbital, the three front ones are subnarial; the three intermediate teeth, including those with longest and largest crowns, received the support, in biting action, of the base of the facial process, *a*.

At the fore part of the orbital cavity are two thin osseous plates, *e, e*, convex outwardly, of subtriangular form, with the apex naturally cut off so as to contribute half the circumference of a protruding circular space, half an inch across, exposing the matrix: the margin of this circular aperture is slightly raised. These plates show, or have been resolved into, three lamellæ, each less than a millimetre in thickness: part of one lamella, and an impression of another, are shown on the slab containing the teeth and bones; parts of three lamellæ of one of the plates adhere to the counterpart block. The matrix near what seems to be the pupillary border is stained of a darker colour than the rest. I deem it probable that we have here an indication of the eye-ball of the Megalosaur, and that the pupillary corneal part of the ball was strengthened by a few large sclerotic plates. The indicated diameter of such eye-ball is two inches. The attention devoted to this part of the fossil was requisite to determine whether it might be part of a lacrymal bone or of the sclerotic.

The orbit in its great relative size and departure from the usual

circular form finds, amongst existing Saurians, its nearest approach in the large carnivorous Varanians. The comparatively small size of the eye-ball accords with the hugeness and carnivory of the extinct terrestrial Dinosaur.

An indication that the lower jaw had been enclosed, with the portion of the upper one above described, in the same mass of matrix, is given by the impression of the crown of the mandibular tooth projecting into the interval between the third and fourth maxillary teeth, in the block exposing the upper jaw, the tooth leaving that impression being preserved in the counterpart block. The extent of the mandibular tooth so preserved measures 1 inch 8 lines, and includes the upper two thirds of the crown: the breadth of the fracture is 8 lines; and this exposes the termination of the pulp-cavity.

I infer therefore that the portions of mandible with teeth next to be described are not only Megalosaurian, but formed parts of the same individual as the preceding fossil. They were worked out of separate blocks of freestone which were in contiguity prior to the masonic operations.

The first portion shows the outer side of the anterior ten inches of the right mandibular ramus, a portion of which, two thirds the natural size, is shown in fig. 3. The vertical diameter of the bone is $2\frac{1}{2}$ inches at two inches distance from the fore end, and $2\frac{3}{4}$ inches at the opposite fractured end. The symphyseal profile is obtusely rounded or moderately convex, as shown in the restoration of the skull (Cut, p. 340). The foremost tooth rises at half an inch therefrom. This tooth gives an exerted length of crown of $2\frac{1}{4}$ inches, with a basal breadth of 9 lines. An interval of nearly one inch divides it from the second tooth, also fully developed, but with the apical half of the crown broken away. The third, fourth, and fifth mandibular teeth rise at similar intervals; and only the fifth falls short of full protrusion, the upper two thirds of the crown appearing above the alveolar border. The base of a sixth tooth, with a large formative cavity, is discernible, with the usual interval between it and the fifth. So much of the outer surface of the bone as remains indicates a shallow longitudinal groove, nearly midway between the upper and lower margins, and disappearing beneath the second tooth in place: anterior to this the bone shows a few irregular shallow pits, some of which, occupied by matrix, indicate nervous or vascular foramina. In the same block are two fragments of probably the left ramus of the same jaw, each in connexion with, or lodging, a portion of a fully developed tooth.

A larger portion (fig. 2), which has been freed from another block, consists of the anterior part of the left mandibular ramus of the same skull, 8 inches in length, but wanting the symphyseal end. On its outer side it repeats the longitudinal groove, here extending backward three inches beyond the part interrupted in the right ramus. In advance of this groove there are similar depressions and indications of the small nervo-vascular foramina. As the lower border of the present fragment begins to bend upward at the anterior

fracture in a degree similar to the fore end of the right ramus, I conclude that not more than an extent of two or three inches is wanted to complete that end. The oblique fracture of the bone here exposes the hollow base of the crown of a functional tooth; and on its inner side is the partially calcified germ of the successor.

The inner surface of the ramus (fig. 2) is flatter and smoother than the outer. It is traversed by a deeper, narrower, and better-defined longitudinal groove—partially divided at its hinder half by a low linear ridge, indicative of the groove having been traversed by two impressing soft parts, probably a nerve as well as a vessel. The main groove becomes shallower and wider as it advances, inclining from the middle to near the lower border of the inner surface. Part of the suture between the splenial (31) and dentary (32) elements is here seen.

The teeth indicated in the portion of the left ramus have been more or less broken away, but answer in number and relative position to the entire ones in the right ramus. The tooth rising to fill the space between the first and second is more advanced; and on the inner side of the present fragment are seen the crown-tips of other successional teeth, appearing at the inner side of the base of preserved portions of the fully developed teeth. At the intervals of these rising teeth are seen the “series of triangular plates of bone (*b*, *b*, fig. 2), forming a zigzag buttress along the interior of the alveoli, and from the centre of each triangular plate the bony septum which crosses to the outer parapet and thus completes the alveolus,” well described in the type example*.

As respects the dental characters exhibited in the present series of fossils, I find nothing to add to the discoverer's original and graphic descriptions and to the supplementary details afforded by the more complete mandible and teeth in the private collection of the Duke of Marlborough at Blenheim†. In the restoration of the skull I have been guided by that of the largest existing carnivorous land-lizard (*Varanus giganteus*); and it may prove that the post-orbital part of the skull is somewhat too short in the Cut, p. 340. Moreover the present fossils impress me with the notion that they have come from a rather smaller individual than those yielding the subjects of the under-cited plates‡. But on these data and subsequent materials I estimate the total length of the skull of *Megalosaurus Bucklandi* not to have exceeded 2 feet 6 inches; they certainly do not support that of “four or five feet” ascribed to it by Professors Phillips and Alleyne Nicholson.

The opportunities of supplementing the original indication of the great extinct carnivorous Saurian having been few and far between, may condone the details above recorded of the additional elements toward its restoration here submitted.

I conclude with some general remarks to which their study, in

* Buckland, *loc. cit.* p. 395, pl. xl. fig. 1.

† ‘History of the British Fossil Reptiles,’ 4to, vol. i. pp. 348–352.

‡ *Ibid.* Dinosauria, pls. 24–32.

connexion with previous communications on the same subject, has given rise.

Restoration of the Skull of Megalosaurus. $\frac{1}{10}$ nat. size.

The restored portions are indicated by broken lines.

Hermann v. Meyer, in his folio 'Zur Fauna der Vorwelt, Reptilien aus dem lithographischen Schiefer' (1859), affirms "the beak (upper jaw and mandible) of the Pterodactyles to be formed, as in birds, by a single bone, the intermaxillary;" which bone he held to be "prolonged backward to the region of the orbits" (*ibid.* p. 15); and the sole modification which he admits, in the avian comparison, is that of a greater density of the bone, in relation to its sustaining and wielding teeth instead of being sheathed with horn (*ibid.*).

Prof. Huxley sees, or surmises, the same structure in the portion of the skull of the *Megalosaurus* described in the 'Quarterly Journal of the Geological Society,' vol. xxv. p. 311; and, similarly, he founds thereon an argument for the affinity of the great terrestrial Saurians to the class of birds*; but, as will be presently shown, there are other and truer grounds for that affinity.

From the evidence of the premaxillo-maxillary suture (Pl. XI. fig. 1, s, s) in the present mature skull, it is improbable that such suture should have been obliterated in the Oxford cranial specimen, the mutilated condition of which might condone a conclusion supposed to support a favourite hypothesis. The primitive separation of the maxillary and premaxillary bones is retained throughout life in the existing reptiles nearest akin to *Megalosaurus*. The conjecture, therefore, that the jaw figured in plate xii. *tom. cit.* is simply the premaxillary, "a possibility which must not be lost sight of, in view of the resemblances between *Dinosauria* and Birds" (*ib.* p. 312), has no support from fact, nor needs it.

In his remarks, Prof. Huxley, with Hermann v. Meyer, holds that the upper jaw in birds is formed by a premaxillary which is "prolonged backward to the region of the orbit." A portion of the

* Quart. Journ. Geol. Soc. vol. xxvi.

slender continuation of the jaw, answering to part of that in the subject of the present paper (Plate XI. fig. 1, 21'), which is so prolonged, appears at *c* in plate xii. *tom. cit.*

Concomitantly with the superior development of the circulating and respiratory organs and their vigorous action in the Avian class, the obliteration of the boundaries of bones takes place earlier, and, among Vertebrates, is most complete in birds. But one result of my researches in the osteogeny of the class was, that in no species was the premaxillary produced backward to beneath the orbit, but that such portion of the upper jaw is contributed by the maxillary bone*. In *Dinornis ingens* the maxillo-premaxillary suture is retained †; so likewise in *Aptornis*: in these great wingless birds, with somewhat lower locomotive, circulating, and respiratory activities, the ossific process is retarded.

So the experienced ornithotomist Dr. Schufeldt writes:—"The malar is the mid style of the infraorbital bar, the maxillary completing the connexion anteriorly with the intermaxillary." "It simply requires ordinary maceration in the adult of any of the Grouse or Quails to have the three styles separate from each other" ‡.

Pterodactyles show a larger proportional size of the premaxillary than do either *Iguanodon* or *Megalosaurus*; but neither in *Dimorphodon* nor any other of its order, in which the maxillo-premaxillary suture can be unequivocally traced, does the premaxillary extend backwards beneath the orbit.

In this respect birds agree with Pterodactyles; but as regards the affinity which is held to amalgamate the two groups, the question has always presented itself to my mind in the following condition:—It is true that Pterodactyles flew, and birds fly; but their organs of flight are not only different, but the differences throw light on those of other organs of much greater, indeed of real, importance in forming a judgment as to their class-affinities.

In birds the main mechanical part of the wing is due to cuticular developments, in reptiles to cutaneous ones; in the one 'Appendages of the Integument,' in the other 'Extensions of the Integument' itself, are pressed into the formation of the organs of flight. In birds the 'remiges,' or feathers of flight, are supported and wielded by short and thick bones; in Pterodactyles the dermal webs are sustained by long and slender bones.

The main condition of these modifications of wings is the temperature of the body which the two kinds of flyers are, or were, capable of maintaining: in one kind it is fixed; in the other it varied to a certain extent with that of the atmosphere. In no class of Verte-

* See 'Archetype and Homologies of the Vertebrate Skeleton,' 8vo, 1848, p. 128, fig. 23, 21, 22; 'Anatomy of Vertebrates,' vol. ii. p. 51, figs. 26, 28 (young Ostrich), fig. 31 (young Emu), fig. 30 (Parrot).

† 'Extinct Wingless Birds of New Zealand,' 4to, 1878, vol. ii. pl. lxxxii. fig. 1, 21, 22.

‡ See his plate v. fig. 51, showing the remoteness of the premaxillary from the suborbital region, in his 'Contributions to the Anatomy of Birds,' 8vo, 1882.

brates is the heat of the body maintained at so high a degree as in that of Birds: in Mammals it rarely exceeds, and not always reaches 100° Fahr.; in Birds it ranges, according to species, from 106° (*Apteryx*) to 112° (Eagle).

This thermogenous character involves a tegumentary one. The body-warmth of a Mammal is protected, as a rule, to which bats are no exception, by a covering of wool or hair, or both, the body-warmth of a bird by a clothing of down and feathers; and it is the latter that are pressed into the mechanism of the organs of flight; and their presence is demonstrated by impressions in a suitable matrix of the secondary extinct species of the class *.

If he had never had a recent bird to dissect, the physiologist would have inferred, and rightly, that the heart had partaken, in its structure, of all the perfections which characterize that of the warm-blooded mammalian class; and he knows, *ex visu*, that it superadded structures, in the muscularity of certain of the heart-valves, which relate to the higher activities of the bird. Concomitantly do the organs of respiration manifest their highest grade of development. Not only are the lungs, as in Mammals, "spongy," *i. e.* subdivided into multitudinous minute cells, multiplying the surface on which the pulmonary capillaries are exposed to the oxygenating atmosphere, but other cells are continued from the lungs proper, and submit, in different degrees, the systemic capillaries to the action of the air inhaled. So birds are said to enjoy a double respiration as well as circulation.

In no reptile is the arterial blood, as it is returned from their large-celled lungs, distributed pure and unmixed with venous blood to the general system †; in none is the function of respiration so complete, so extensive, as in the warm-blooded classes. Impressions of the sheets of skin have been preserved, which the long and slender finger-bones of the Pterodactyle were destined to support; but not a trace of non-conducting hair or protecting feather has been detected therewith in any, the most conservative, beds.

I consequently infer a correlated inferiority of structure in the circulating and respiratory systems, and that the Pterodactyles were as cold-blooded as are the flying fishes and the flying insects: therefore I prefer the term *Pterosauria* to *Ornithosauria*.

Never, however, have I excluded considerations from other organs and functions in treating of the affinities of the Vertebrate animals recent and extinct. They weighed with me, mainly, in my endeavours to interpret the nature and structure of the sacrum in *Megalosaurus*, and the affinities so indicated.

In Buckland's time (1824) no exception to the number two in the reptilian sacrum had been recognized; he consequently described the "five anchylosed joints of the vertebral column of the *Megalosaurus*, as

* "*Archæopteryx*," Phil. Trans. 1863, pp. 33-47.

† For the partial degree in which the respired or arterial blood may be so transmitted from the left ventricle of the Crocodile's heart, see '*Anatomy of Vertebrates*,' vol. i. (1866) p. 512.

including the two sacrales and two others, which are probably referable to the lumbar and caudal vertebræ”*.

Baron Cuvier, incorporating Buckland’s discovery in the concluding volume of his ‘*Ossemens Fossiles*,’ refers to the figure cited below as “*Suite de cinq vertèbres de Megalosaurus*”†, without further definition.

In determining the nature and class of these five coalesced vertebræ as truly “sacral”—and that determination has been accepted—I did not indicate, as has been alleged, any affinity therefore to the class *Mammalia*, but proceeded to unravel the structure of the sacrum, and demonstrated that it was such as occurred in no Mammal, but was repeated in the class of Birds.

Now, the condition to which I have referred, which has deceived such able palæontological osteologists as Von Meyer and Huxley in regard to the construction of the upper jaw in Birds and Pterodactyles, and by inference in Megalosaurus, the speedy confluence, viz., of essentially distinct bones and bony elements in Birds, constituted the main difficulty to be overcome in the correlation of the peculiar and, at that time, unique structure of the sacrum of the Megalosaurus with that of the many-vertebrated sacrum in other classes.

In the extinct reptile the neurapophyses, in each vertebra, were shifted in position from their proper centrum so as to cross the interspace of two centrams; and I had to determine to which of these centrams the neural arch did properly belong. The mammalian class was exhausted without result; the avian class presented the difficulty of the complete blending of the several sacral vertebræ with other pelvic elements into a single mass of bone.

The resource (fossils of great wingless birds not having then come under my ken) was investigation of the development of the sacrum of a bird; and that line of research was not abandoned until I could testify with certainty to that class of vertebrates repeating the singular modification in the great terrestrial extinct *Reptilia*‡, thence and thereupon associated together as *Dinosauria*.

No other affinity is deduced from the discovery save of the Dinosaur to the Bird. The result of the embryonal researches is limited in the ‘Report’§ to that inference. The labours leading thereto are detailed in the work ‘On the Archetype of the Vertebrate Skeleton’||.

In my Hunterian Lectures at the Royal College of Surgeons¶, after defining the class-characters based on the circulating and respiratory systems, I took occasion to remark:—“But many im-

* Geol. Trans. 2nd Series, vol. i. (1824) p. 395, pl. xliii. fig. 1.

† Tome v. 2^de partie (1822), p. 348.

‡ “Report on British Fossil Reptiles,” Part ii. ‘Reports of the British Association for the advancement of Science,’ vol. for 1841, pp. 105–108.

§ Ib. ib.

|| 8vo, 1848, “Composition of the Sacrum in Birds,” in which the congeries of vertebræ in that of an immature Ostrich is the subject of figure 27, p. 159.

¶ *Anatomy of Vertebrates*, vol. i. 1866, pp. 6 & 7.

portant relations and affinities are thereby masked. Although the last two classes (Mammalia and Aves) agree as 'hot-blooded Vertebrates' in their higher cerebral development, and in the more complex heart and lungs, Birds, by their genetic and developmental characters, as well as by the general plan of the organization, are more intimately and naturally allied to the oviparous Saurians than to the viviparous Mammals."

So, likewise, I proceeded to state that "in their generation and development, modern Batrachians differ from other cold-blooded air-breathers and agree with fishes: both classes are 'anallantoic' and branchiate, whilst Birds and Reptiles are 'allantoic and abran- chiate' " *.

The occipital condyle offered no available character in this division and association of vertebrate animals. The condyle is single in most fishes as in the abran- chiate Ovipara; and it is convex in some kinds, *e. g.* the Pipe-fishes (*Fistularia*) †, as in Birds. On the other hand the occipital condyle is double in the batrachian air-breathing Anallantoids or Branchiates, as it is in Mammals.

In short, in the preliminary chapter of my 'Anatomy of Vertebrates,' I found no other than the developmental characters above cited to add to those which John Hunter, in the previous century, had defined in his 'Schemes of the Classification of Animals.'

They are given in the 'Essays and Observations on Natural History,' published with notes in 1861 (two vols. 8vo, Van Voorst, vol. i. p. 28); and the subjoined quotation may be acceptable.

"Of the similarity of many Parts of the Fowl and Three-cavity-breathed Animals" (which Hunter termed *Tricoilia* = Reptiles).

"The lungs of the fowl open into thin cells or bags that are in the cavity of the belly. The cells of the lungs are large. The lungs in the *Tricoilia* are continued into the belly, are cellular at the upper part, but in most, *e. g.* the snake, become smooth bags at the lower end as it were, answering the same purpose as the abdominal bag in fowls: the cells of the lung-part are large.

"No proper diaphragm in either class, but fowls have something similar to one." (The degree in which it most nearly attains the mammalian character is shown in my "Anatomy of the Apteryx," Zool. Trans. vol. i.)

"The gall is green in both. The kidneys are placed in what may be called the pelvis in both; they are conglomerated in a particular manner, have the ureter ramifying through their whole substance, and it enters into the rectum. The urine is a chalky substance in many of both classes, and is a kind of slime in others.

"The testes are situated in the abdomen in the males of both. The vasa deferentia enter the rectum in both. The penis is grooved in both. Both are oviparous.

"The structure of the ear is similar" (p. 28).

To these characters I added the subsequently determined develop-

* 'Anatomy of Vertebrates,' tom. cit. p. 7.

† Tom. cit. p. 7.

mental ones, viz. the presence of an allantois and the non-development of branchiæ.

By what Hunter defined as "lungs in the neck, called 'Gills,'" he characterized his 'Fourth Class;' and, in reference to the two poles of the 'Amphibious' division of the 'Fourth,' he observes, in his quaint style, that they are "more fishified than what the fish of the first class (*Cetacea*) are," *op. cit.* p. 27. De Blainville, entertaining similar views, proposed, in 1816, the name *Ornithoidea* for the abbranchiate, *Ichthyoidea* for the branchiate group*.

The terms which Professor Huxley has invented for the two groups previously defined and characterized by Hunter and myself are as convenient as De Blainville's; but it seems odd to speak of a Lizard as a "Sauropsid," when it is not only like, but is, a Saurian, or to call a perch an "Ichthyopsid," which is not merely like, but is, a fish. The terms "Abranchiates" and "Branchiates" appear to me to express an essential character of the two groups without suggesting any absurdity.

Returning to my proper subject, I would, finally, remark that, in the summary of what I had learnt on fossil Reptiles in 1841, the respective outward resemblance in the different orders to existing vertebrate classes was briefly indicated—Pterodactyles to birds, Ichthyosaurs to fishes, Dinosaurs to mammalian quadrupeds, &c. But this was in no wise intended, or could be fairly construed, to prejudice conclusions as to affinity founded on structure; and those which demonstrated the truer and deeper relations of Dinosaurs to birds were given in detail in 1841†. As to the dental and limb-resemblances of extinct Saurians, I have since been enabled to show that a group of triassic *Reptilia*, the *Theriodontia* of the Karoo formation, make a nearer approach to *Mammalia*, especially the marsupial forms, than the later mesozoic Dinosaurs do, in outward character‡.

Professor Huxley, however, asserts, in the Quarterly Journal of the Geological Society, vol. xxvi. part 1, p. 13, *note*, that "Prof. Owen evidently attached no weight to the fact as indicating any affinity of the Dinosauria with birds, as in his 'Report on British Fossil Reptiles,' 1861, p. 102, he says that 'the Reptilian type of structure makes the nearest approach to Mammals in the Dinosauria.'"

Other Fellows of the Society, besides myself, have been puzzled to verify this statement; and I have therefore added a summary of what I did record ten years previously, and I have never changed my opinion, of the near approach to Birds which the reptilian type of structure makes in the Dinosauria, and more especially in the genus and species which is the subject of the present paper.

* Nouveau Bulletin des Sciences de la Société Philomathique, 1816.

† 'Reports of the British Association' for that year.

‡ In summing up the characters of Theriodonts I did not omit to notice that their "sacrum was not limited, as in existing Reptiles, to two vertebræ, but was composed of five or six anchylosed vertebræ" (Quart. Journ. Geol. Soc. 1876, p. 99). But this in no way affected the structural resemblance of the sacrum of Dinosauria to that of birds, pointed out a quarter of a century before.

DESCRIPTION OF PLATE XI.

MEGALOSAURUS BUCKLANDI.

- Fig. 1. Side view of the premaxillo-maxillary, or facial part of the skull, rather less than one half natural size.
2. Inner side view of portion of the left mandibular ramus, two thirds nat. size.
3. Outer side view of portions of upper and lower jaws, with teeth, two thirds nat. size.

DISCUSSION.

The PRESIDENT expressed the pleasure of the Fellows in seeing Prof. Owen among them at this meeting. He had himself listened with the deepest interest to this extremely suggestive paper, but would limit his remarks to the subject indicated by the title of the paper, viz. the skull of *Megalosaurus*. He thought that if it was impossible by the regulations of the British Museum to place the actual remains before the meeting, it was much to be regretted that one of the excellent casts taken by Mr. G. M. Barlow, the sculptor of the Palæontological Department, had not been placed upon the table. *Megalosaurus* was, in a certain sense, the property of the Society, as it was in a communication made to it by the late Dean Buckland that this Dinosaur was first brought under the notice of palæontologists. Besides this paper, and that by Prof. Huxley, both mentioned by the author, and the latter's valuable description of Megalosaurian remains in the 'Fossil Reptilia,' he would call attention to Eudes Deslongchamps's exhaustive and accurate account of *Poikilopleuron Bucklandi*, in the 'Memoirs of the Linnean Society of Normandy,' because there can be no doubt that this Saurian was a member of the genus *Megalosaurus*. It should be borne in mind that the genus *Megalosaurus* is not represented by the single species *Bucklandi*, but there exists evidence of several species, notably the very large series of Megalosaurian remains in the collection of Mr. James Parker, of Oxford, which certainly illustrates two distinct species. With respect to the skull, a premaxillary in Mr. Parker's collection (poorly figured by Phillips in the 'Geology of Oxford') distinctly shows the extent to which this entered into the composition of the snout. In the author's restoration a lower temporal bar was omitted; but as this is present in the skull of every Dinosaur in which this part of the skeleton is known, viz. in *Iguanodon* (as illustrated by *I. Mantelli*), in *Hypsilophodon*, and in *Scelidosaurus*, he thought its presence highly probable in *Megalosaurus*; he would suggest also the probability of a greater extension backwards of the roof of the cranium, and a more vertical direction and greater stoutness of the quadrate bone.

Prof. SEELEY spoke of the difficulty of discussing a paper of such wide grasp; for, in this memoir, Prof. Owen had gathered up the threads of many lines of research. Prof. Owen had now cleared up uncertainties as to the form of the premaxillary bone; but the idea of the blending of that bone with the maxillary had for

some years been given up by palæontologists. Several bones in these specimens had been noticed by Prof. Owen which had certainly escaped the observation of others. He believed that the complete skull would show a curious combination of Lacertilian and Avian characters, such as might result from growth of the cerebral region in an embryonic Crocodilian type. He thought the figure represented, in the back part of the head, too wide a divergence from known Dinosaurians. Up to the present time he had had a very imperfect conception of the relation between the premaxillary bone and the maxillary in the Ornithosauria. He held that the Ornithosauria need not be cold-blooded because no trace of an exterior covering to the integument could be detected. He thought some trace of a filamentous covering could be detected. Their structures appeared to him to agree in so many respects with those of birds that he thought Ornithosaurs must have been warm-blooded.

Prof. OWEN expressed his sense of the kind way in which his communication had been received. It was to some extent polemical; but his excuse was that the last attempt to add to our knowledge of *Megalosaurus* was in vol. xxvi. part 1, of the 'Quarterly Journal;' and there the author had made statements concerning his (Prof. Owen's) views as to the relations of Dinosauria which were not exactly correct.