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On the Classification of the Dinosauria, with observations on the Dinosauria of the Trias

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Notes

1. *On the Classification of the* Dinosauria, *with observations on the* Dinosauria *of the* Trias. By T. H. Huxley, LL.D., F.R.S., President of the Geological Society.

[Plate III.]

I. The Classification and Affinities of the Dinosauria.

Contents.

1. *The History and Definition of the Group.*

The recognition of what are now commonly termed the *Dinosauria*, as a peculiar group of the *Reptilia*, is due to that remarkable man whose recent death all who are interested in the progress of sound palæontology must deplore—Hermann von Meyer. In his 'Palæologica,' published so long ago as 1832*, Von Meyer classifies fossil reptiles according to the nature of their locomotive organs; and his second division, defined as "Saurians, with limbs like those of the heavy terrestrial Mammalia," is established for *Megalosaurus* and *Iguanodon*. To this group Von Meyer subsequently applied the name of *Pachypodes* or *Pachypoda*.

Nine years afterwards Professor Owen, in his "Report on British Fossil Reptilia," conferred a new name upon the group, and attempted to give it a closer definition, in the following passages:—

"*Dinosaurians*.—This group, which includes at least three well-established genera of Saurians, is characterized by a large sacrum composed of five ankylosed vertebræ of unusual construction, by the height and breadth and outward sculpturing of the neural arches of the dorsal vertebræ, by the twofold articulation of the ribs to the vertebræ, viz. at the anterior part of the spine by a head and tubercle, and along the rest of the trunk by a tubercle attached to the transverse process only; by broad and sometimes complicated coracoids and long and slender clavicles, whereby Crocodilian characters of the vertebral column are combined with a Lacertian type of the pectoral arch; the dental organs also exhibit the same transitional or annectent characters in a greater or less degree. The bones of the extremities are of a large proportional size for Saurians; they are provided with large medullary cavities and with well-developed and unusual processes, and are terminated by metacarpal, metatarsal, and phalangeal bones which, with the exception of the ungual phalanges, more or less resemble those of the heavy pachydermal mammals, and attest, with the hollow long bones, the terrestrial habits of the species.

"The combination of such characters, some, as the sacral ones, altogether peculiar among reptiles, others borrowed, as it were, from groups now distinct from each other, and also manifested by crea-

* Von Meyer refers to the 'Isis' for 1830, as containing the first sketch of his views. I have not verified the citation.

tures far surpassing in size the largest of existing reptiles, will, it is presumed, be deemed sufficient ground for establishing a distinct tribe, or suborder, of Saurian reptiles, for which I would propose the name of *Dinosauria*.

"Of this tribe the principal and best-established genera are the *Megalosaurus*, the *Hylæosaurus*, and the *Iguanodon*, the gigantic crocodile lizards of the dry land, the peculiarities of the osteological structure of which distinguish them as clearly from the modern terrestrial and amphibious *Sauria* as the opposite modifications for an aquatic life characterize the extinct *Enaliosauria*, or marine lizards"*.

Further on it is stated that "the Reptilian type of structure made the nearest approach to mammals" in the *Dinosauria* (*l. c.* p. 202).

Every character which is here added to Von Meyer's diagnosis and description of his *Pachypoda* has failed to stand the test of critical investigation; while it is to birds and not to mammals that the *Dinosauria* approach so closely. There is, in fact, not a single specially mammalian feature in their whole organization.

Even in point of etymological appropriateness, the term "*Dinosauria*" is no more fitting for reptiles of which some are small, than "*Pachypoda*" is for reptiles of which some have slender feet; but as Von Meyer's name has never obtained much currency, it may be well to allow justice to give way to expediency, and to retain the name of *Dinosauria* for those reptiles which agree in all the most important and characteristic parts of their structure with *Megalosaurus* and *Iguanodon*.

The group thus limited is susceptible of very clear diagnosis from all other reptiles, inasmuch as its members present the following combination of characters:—

1. The dorsal vertebræ have amphicœlous or opisthocœlous centra. They are provided with capitular and tubercular transverse processes, the latter being much the longer.

2. The number of the vertebræ which enter into the sacrum does not fall below two, and may be as many as six.

3. The chevron bones are attached intervertebrally, and their rami are united at their vertebral ends by a bar of bone.

4. The anterior vertebral ribs have distinct capitula and tubercula.

5. The skull is modelled upon the Lacertilian, not on the Crocodilian type. There is a bony sclerotic ring.

6. The teeth are not ankylosed to the jaws, and may be lodged in distinct sockets. They appear to be present only in the præmaxillæ, maxillæ, and dentary portions of the mandible.

7. The scapula is vertically elongated; the coracoid is short, and has a rounded and undivided margin. There is no clavicle.

8. The crest of the ilium is prolonged both in front of and behind the acetabulum; and the part which roofs over the latter cavity forms a wide arch, the inner wall of the acetabulum having been formed by membrane, as in birds.

9. The ischium and pubis are much elongated.

10. The femur has a strong inner trochanter; and there is a crest

* Prof. Owen's "Report on British Fossil Reptiles," 1841.

on the ventral face of the outer condyle, which passes between the tibia and the fibula, as in birds.

11. The tibia is shorter than the femur. Its proximal end is produced anteriorly into a strong crest, which is bent outwardly, or towards the fibular side.

12. The astragalus is like that of a bird; and the digits of the pes are terminated by strong and curved ungual phalanges.

The *Dinosauria* about which we have sufficient information appear to me to fall into three natural groups—i. the *Megalosauridæ*, ii. the *Scelidosauridæ*, and iii. the *Iguanodontidæ*.

i. The *Megalosauridæ*.

1. The maxillary teeth are sharp-pointed, and the crown has a longitudinal serrated ridge, either on the middle of its posterior face only, or on the middle of its anterior face as well. The serrations of the ridge are directed at right angles to the long axis of the tooth. The teeth do not become worn by mastication.

2. The anterior prolongation of the ilium is nearly as large as, or larger than, the posterior.

3. The rami of the mandible are deep and thick and meet by rounded ends in the symphysis.

4. The proximal end of the femur is flattened, curved, and twisted in such a manner that its plane is oblique to that of a flat surface on which the condyles rest. In other words, it is more or less crocodilian.

5. There is no dermal armour.

Teratosaurus, *Palæosaurus*, *Megalosaurus*, *Poikilopleuron*, *Lælaps*, and probably *Euskelosaurus* belong to this group.

ii. The *Scelidosauridæ*.

1. The maxillary and mandibular teeth have sharp-edged triangular crowns, with serrated margins, the serrations being oblique to, or parallel with, the long axis of the tooth. The teeth are not worn down by mastication.

2. The anterior prolongation of the ilium is more slender than the posterior.

3. The rami of the mandible are slender, and taper to their symphysis.

4. The proximal end of the femur has a subglobular articular head, borne by a neck which is set nearly at right angles to the axis of the shaft, while its direction is nearly parallel with a flat surface on which the condyles rest.

5. The integument is (usually) provided with a dermal armour in the form of bony scales or spines.

Thecodontosaurus, *Hylæosaurus*, *Polacanthus* (?), and *Acanthopholis* belong to this division.

iii. The *Iguanodontidæ*.

1. The maxillary and mandibular teeth have obtuse subtriangular crowns; the surface of the enamel being ridged on one or both sides. The crowns of the teeth are worn down flat by mastication.

2. The anterior prolongation of the ilium is more slender than the posterior.

3. The rami of the mandible unite in an excavated edentulous symphysis, which receives an edentulous prolongation of the præmaxillæ.

4. The proximal end of the femur is as in the *Scelidosauridæ*.

5. There is no dermal armour.

*Cetiosaurus**, *Iguanodon*, *Hypsilophodon*, *Hadrosaurus*, and probably *Stenopelyx*† belong to this division.

These three groups appear to me to be very well marked; but I do not propose them with the intention of suggesting that there are no others, or that the progress of discovery will leave them thus well defined.

The very remarkable reptile, *Compsognathus longipes*, has many affinities with the *Megalosauridæ*, *Scelidosauridæ*, and *Iguanodontidæ*, but it presents, at the same time, so many differences from all these, and so much of its structure is left unrevealed by the solitary specimen which exists, that perhaps the most convenient course which can be adopted, at present, is to make it the representative of a group equivalent to them. *Compsognathus* differs from all the preceding forms in the length of the cervical relatively to the thoracic vertebræ, and in the femur being considerably shorter than the tibia‡.

2. *Establishment of the Order* ORNITHOSCELIDA *to include the* Dinosauria *and the* Compsognatha.

But *Compsognathus* agrees with the *Megalosauridæ*, *Scelidosauridæ*, and *Iguanodontidæ* in the ornithic modification of the Saurian type, which is especially expressed in the hind limbs; and I therefore propose to unite it with them in one group, which I shall term ORNITHOSCELIDA. This group will contain two primary subdivisions:

* I assign this place to *Cetiosaurus* on the evidence of the splendid series of remains of this reptile which Prof. Phillips showed me in the Oxford Museum.

† Von Meyer has described a reptile from the German Wealden, in the 'Palæontographica' for 1859, under the name of *Stenopelyx Valdensis*. Only the pelvis, a few vertebræ, and the left hind limb of this very interesting genus are preserved; but they suffice to prove it to be a Dinosaurian. There are four digits in the foot, the fifth being absent, while the hallux is smaller than the others. The fibula is slender; the tibia stout and apparently as long as the femur, the head of which is at right angles with the shaft. The ischia are in place and longer than the femur; they are stouter in proportion than in *Iguanodon* or *Hypsilophodon*, and quite differently formed. What Von Meyer regards as the pubes are, if I mistake not, the anterior prolongations of the ilia.

From the absence of any dermal armour, one would be disposed to arrange *Stenopelyx* among the *Iguanodontidæ*; but many of its characters are very peculiar.

‡ Professor Cope has distinguished *Compsognathus* as the type of a division, *Ornithopoda*, from the rest of the Dinosauria, which he terms *Goniopoda*. The *Ornithopoda* have the astragalus ankylosed, while in the *Goniopoda* it is free. But there is much reason to believe that the astragalus became ankylosed in some of the "Goniopoda;" and it seems to me precisely by the structure of the foot that *Compsognathus* is united with, instead of being separated from, the *Ornithoscelida*.

—I. The *Dinosauria*, with the cervical vertebræ relatively short, and the femur as long as, or longer than the tibia. II. The *Compsognatha*, with the cervical vertebræ relatively long, and the femur shorter than the tibia.

3. *The affinities of the* Ornithoscelida *with other Reptiles.*

If we consider the relations of the *Ornithosauria* to other reptiles, it is at once obvious that they belong to that great division of the class in which the thoracic vertebræ have distinct capitular and tubercular processes, the latter being longer than the former, and springing from the arch of the vertebræ, as in the crocodiles. These reptiles may be termed *Suchospondylia*, to distinguish them from another great group, in which the thoracic vertebræ have the capitular and tubercular processes fused together into one process or facet, and which may be termed the *Erpetospondylia*,—from a third, in which the capitular and tubercular processes are both mere tubercles springing from the centrum of the thoracic vertebræ, *Perospondylia*,—and from a fourth, *Pleurospondylia*, in which the thoracic vertebræ have neither capitular nor tubercular transverse processes, but the ribs are sessile upon, and fixed to, the vertebræ.

The last-named group consists of the *Chelonia*; the *Perospondylia* contain only the *Ichthyosauria*; the *Erpetospondylia* comprise the *Ophidia*, *Lacertilia*, and *Plesiosauria*; while the *Suchospondylia* embrace the *Crocodilia*, the *Dicynodontia*, the *Pterosauria*, and the *Ornithoscelida*.

The closest relations of the *Ornithoscelida* within this group are with the *Dicynodontia* on the one hand, and the *Crocodilia* on the other. The sacrum and the iliac bones of the Dicynodonts more closely resemble the corresponding parts of the *Ornithoscelida* than they do those of any other *Reptilia*, except the *Pterosauria**; and there are a good many points of resemblance in the skull and dentition. Our knowledge of *Rhopalodon* and of *Galesaurus* is hardly sufficient to afford grounds for a safe opinion; but it seems probable that they will turn out to be annectent forms between the *Dicynodontia* and the *Ornithoscelida*.

The connexion of the *Crocodilia* with the *Ornithoscelida* is probably to be sought in some common form, more Lacertilian in its character than any of the known members of either of these groups. The oldest known Crocodilians, *Belodon* and its congeners, exhibit modifications which approximate them rather to the *Lacertilia* than to the *Ornithoscelida*.

If we seek for reptilian allies of the *Ornithoscelida* in formations of older date than the Trias, the Permian forms alone present themselves. Our knowledge of these is almost entirely due to the researches of Von Meyer, the results of whose investigations have hardly received the attention they deserve. They prove the existence of two very distinct reptilian genera, *Proterosaurus*† and *Para-*

* The complete occlusion of the obturator foramen by bone occurs in both the *Dicynodontia* and the *Pterosauria*, and in these alone among Reptiles.

† The generic distinctness of *Aphelosaurus* of Gervais appears to me to be doubtful.

saurus, in the Kupferschiefer, and two others, *Phanerosaurus* and *Sphenosaurus*, different from them and from one another, in the Rothliegende, in which formation also a peculiar Labyrinthodont, *Osteophorus*, occurs.

Proterosaurus appears to me to be a true Lacertilian. At least, neither in Von Meyer's figures and descriptions, nor in the one classical specimen which exists in this country can I find evidence of any essential departure from the old Lacertilian plan of structure, such as is exhibited by *Hyperodapedon* or *Telerpeton*—though it must be confessed that the long neck, light head, and short forelimbs, to say nothing of the opisthotonic death-spasm which has left the fossils in their present position, remind one curiously of *Compsognathus*.

Parasaurus has four ankylosed sacral vertebræ, with great sacral ribs; and perhaps the two vertebræ which succeed these must be counted as sacral. It would appear from the figures, that the anterior ribs may have been, and probably were, divided into a distinct capitulum and a tuberculum. From the position of the undisturbed femora in one specimen, it cannot be doubted that the ilia must have extended a long way in front of the acetabulum. The length of the short and stout femur does not exceed that of four conjoined vertebræ; and there is some reason to think that the bones of the leg were considerably longer than the femur.

Parasaurus therefore belongs to a totally different group of reptiles from *Proterosaurus*, and I can compare it with nothing but the *Ornithoscelida* and the *Dicynodontia*.

The structure of both *Proterosaurus* and *Parasaurus* leads to the belief that they were terrestrial reptiles; and their occurrence in the Kupferschiefer is no bar to this conclusion, as land-plants abound in that rock.

The *Phanerosaurus* of the Rothliegende is based upon a series of half-a-dozen vertebræ, the characters of which are altogether peculiar.

Sphenosaurus, on the other hand, seems to me to be a Lacertilian, though of a very different character from *Proterosaurus*.

On the whole, I am disposed to think that *Parasaurus* is related on the one hand to the *Ornithoscelida* and the *Dicynodontia*, and on the other to some much older and less specialized reptilian form. I can by no means bring myself to believe that the Reptilia commenced their existence in the Permian epoch with such specialized characters as are observable in the four known genera of that age.

4. *The affinities of the* Ornithoscelida *with Birds.*

I have treated of the relations of the *Ornithoscelida* with birds at length in a former paper, and I will merely repeat here that I know of no circumstance by which the structure of birds, as a class, differs from that of reptiles, which is not foreshadowed in the *Ornithoscelida*. Nor am I acquainted with any reptiles which can be compared in the strength and minuteness of their ornithic affinities with the *Ornithoscelida*.

It may be said that the form and mode of connexion of the sca-

pula and the coracoid, and the crested and broad sternum, of the *Pterosauria* are marks of affinity with birds, as strong as those which the hind limb and pelvis present in the *Ornithoscelida*. But I think this argumentation is invalid; for the shoulder-girdle of an ostrich or of an apteryx is more similar to that of an Ornithoscelidan than it is to that of a Pterodactyle, these special peculiarities of the shoulder-girdle, like the crest of the sternum, having relation to physiological action, and not to affinity. If the strongly crested sternum and the acute angulation of the union of the scapula and coracoid were marks of ornithic affinity, they would be found in all birds. The contrary is true: they are found only in those birds which fly; and the crest exists in bats, which cannot be said to have any affinity with birds.

On the other hand, the peculiarities of the hind limb and pelvis which the *Ornithoscelida* share with birds are found in all birds. It may be said that all birds stand upon their hinder feet, and that, as the *Ornithoscelida* did the same, the resemblance of structure arises from a resemblance of function. But I doubt if the majority of the *Dinosauria* stood more habitually upon their hind limbs than Kangaroos or Jerboas do; and unless there was some genetic connexion between the two, I see no reason why the hind limbs of *Ornithoscelida* should resemble those of birds more than they resemble those of kangaroos.

Finally, with regard to the sternum, although there is no likelihood that the *Ornithoscelida* possessed a crested sternum, yet there is some evidence that they were provided with a very broad and expanded breast-bone, more like that of a bird than it is like that of any reptile. I shall discuss this evidence below, in speaking of the Dinosaurian remains discovered by Plieninger in the Trias near Stuttgart.

II. The Dinosauria of the Trias.

Contents.

1. Dinosauria *from the Trias of Germany and Central Europe.*

The first recognition of the occurrence in the Trias of Dinosaurian remains as such, with which I am acquainted, is contained in the following extract from a letter, addressed by H. von Meyer to Bronn, and published in the 'Jahrbuch' for 1857.

"Dr. Engelhardt, of Nuremberg, brought to the meeting of Naturalists in Stuttgart some bones of a gigantic animal from a brecciated sandstone of the Upper Keuper of his neighbourhood. He had the kindness to submit to me all the bones which had been obtained. I have already examined them, and have drawn the best, which consisted of almost entire limb-bones and of vertebræ.

"The discovery is extremely interesting. The bones belong to a

gigantic Saurian, which, in virtue of the mass and hollowness of its limb-bones, is allied to *Iguanodon* and to *Megalosaurus*, and will belong to the second division of my Saurian system. None of its allies has hitherto been found so deep in the European continent, nor from rocks of so great age. These remains belong to a new genus, which I term *Plateosaurus*; the species is *Pl. Engelhardtii*. I shall hereafter publish a full account of the fossils."

The fuller account which Von Meyer promises is contained in that splendid monument of palæontological genius and industry, the 'Saurier des Muschelkalkes,' which came out between 1847 and 1855. The remains enumerated consist of a few imperfect fragments of a cranium without jaws or teeth, six more or less fragmentary separate vertebræ, an imperfect sacrum (consisting of, at fewest, three ankylosed vertebræ), fragments of ribs, and several limb-bones. The centra of the vertebræ are nearly four inches long, and the most perfect limb-bone is about sixteen inches long.

This bone is represented in tab. 69. figs. 1–3 of the work cited. Von Meyer appears to be inclined to consider it a tibia, comparing the smaller end of the bone to the distal end of the tibia of *Poikilopleuron*; and the figures support the determination. The other figures on the same plate (4, 5) represent the distal end of a femur, the posterior face of the outer condyle of which exhibits the remains of the ridge which plays between the tibia and the fibula, and is so characteristic of the *Dinosauria* among reptiles.

In the summary of results at the end of the 'Saurier des Muschelkalkes,' the following paragraph occurs (p. 162):—

"As to the family of the *Pachypoda*, with their colossal massive forms, it is certain that it is to be met with in the Upper Keuper, where it is represented by the two genera *Belodon* and *Plateosaurus*, each having one species, *B. Plieningeri* and *P. Engelhardtii*. These are different from the *Pachypoda* of the Oolite and the Chalk."

And further on, at p. 163:—

"Concerning the other Saurians, with flat, cutting teeth, which are comprehended under *Cladyodon*, *Thecodontosaurus*, *Palæosaurus*, and *Zanclodon*; it has not yet been made out to what family they belong, nor whether they are allied to the *Pachypoda* or not. They appear in rocks which occupy the horizon of the lower 'Grenzbreccia,' and therefore appear to represent a Muschelkalk which is passing into the 'Lettenkohl;' they occur besides in the actual Lettenkohl and in the Keuper. The North-American genera *Clepsysaurus* and *Bathygnathus* appear to be allied forms."

It will be observed that Von Meyer here reckons *Belodon* among the *Pachypoda*. The study of the more complete remains of *Belodon*, described in the 'Reptilien aus dem Stubensandstein des oberen Keupers' (Palæontographica, Bd. vii. 1861), however, led to a different conclusion, which is thus expressed (*l. c.* p. 346):—"Hence *Belodon* was no Pachypode; if Plieninger has declared it to be such, it is because he has mixed up the remains of two totally different animals. *Belodon* was plainly more of a crocodile than of a lizard."

The researches of Prof. Plieninger referred to by Von Meyer are

detailed in the memoir entitled "*Belodon Plieningeri* (H. v. Meyer), ein Saurier der Keuperformation," which was published in the seventh annual issue of the 'Jahreshefte des Vereins für vaterländische Naturkunde in Württemberg,' and was published in 1857. This valuable memoir contains a description, accompanied by numerous figures, of all that could be found of two skeletons of reptiles of great size, which were discovered near Stuttgart, in the "red Keuper marl" which forms the uppermost part of the Trias in that region. One of these skeletons was discovered by Herr Reiniger, the other by Prof. Plieninger himself. Both were in a much shattered condition, and were devoid of the skull. The remains of the first skeleton, which I shall call A, comprised, according to Prof. Plieninger, sixty, more or less complete, successive vertebræ, the pelvis, the hind legs down to the phalanges, the humeri, a great number of fragments of ribs, the sternum, and thirteen isolated crowns of teeth, some entire digits, and separate phalanges. Of these, Plieninger figures what he describes as the best-preserved teeth and digital bones—the right and left humeri, with attached fragments of the ulna and radius and of the shoulder-girdle, the left femur, the left tibia, with attached fragments of the fibula and the right tibia, and a massive bone, the nature of which is doubtful.

The remains of the second skeleton (B) include what Prof. Plieninger determines as:—the entire pelvis, the ilia being separated from the sacrum, which consists of three bones, two only of which are ankylosed; a femur; an ischium; a few bones of the feet; the two scapulæ; one perfect humerus, and the other pathologically deformed; together with the eight vertebræ which preceded the sacrum, with all their processes entire, and in their natural relations to one another and the sacrum.

All these remains were found together. At four feet distance on the same level, and continuing the direction of the vertebral column, was a second series of seven vertebræ, five and two of them being respectively associated together. No remains of any other animal, or any other individual, were found along with these two skeletons, which clearly appertain to the same species. The evidence which they afford as to the nature of the reptiles to which they belonged, is therefore of very great value. This evidence has already been discussed by Von Meyer (*l.c.* p. 268), who concludes that the skeletons are not referable to *Belodon*, and judges, from "a certain resemblance to the corresponding parts of *Megalosaurus Bucklandi*," that they might have belonged to a Pachypode, and possibly to *Teratosaurus*, a reptile from the same locality and bed, the jaw of which he describes.

In this view I entirely concur. In fact, Plieninger's figures, (which do not quite deserve the reproaches with which Von Meyer visits them) prove that the skeletons A & B belong to *Dinosauria*. But they also seem to me to show that one or two of Plieninger's determinations are erroneous. Thus, the two vertebræ of B, represented in tab. xii. fig. 14, are certainly cervical. The bone called "ischium" (tab. xii. fig. 5) is the united scapula and coracoid, having a characteristically Dinosaurian form. On the other hand, the

so-called "scapula" (tab. x. fig. 7) looks to me very much like the ischium; but the figure is not of such a character as to allow me to speak with confidence on this point. Putting the information yielded by these two skeletons together, it proves the existence in the Upper Trias of Stuttgart of a Dinosaurian of great size.

The sixty vertebræ which lie in uninterrupted series in the specimen A, occupy a length of seventeen Württemberg feet. Thirty-seven of these vertebræ form a tail eight feet long. Two (more probably three) vertebræ in the sacrum take up a foot, while the twenty-one præsacral vertebræ form a series 7 feet long. The centrum of the last caudal vertebra is 1·5 in. long, and rather less than 1 in. in vertical height of the articular surface; and the tail is not complete. The middle caudal vertebræ have centra 2·5 in. long, with a height of 1·25 in. Further towards the sacrum the centra are 4 inches high and 3 inches long. The hindermost of the præsacral vertebræ have the articular surface of the centra 6 inches wide, and are from 5 to 6 in. long. They diminish in size forwards; and the five most anterior, which together occupy 2 feet, have about the dimensions of the middle caudal vertebræ. The centra are all constricted in the middle of their length, and have slightly concave articular surfaces. The articular faces of the centra are almost circular in contour. The spinous process is flat, quadrangular, 3·4 in. high, 4·5 in. long. It follows from this account that the two cervical vertebræ of the specimen B, which are opisthocœlous, must have had their place in front of the twenty-one præsacral vertebræ shown to exist by A; and as neither of these is axis or atlas, there must have been, at fewest, twenty-five præsacral vertebræ, which is one more than exists in a crocodile. But as the tubercular transverse processes of the cervical vertebræ in question arise low down in their arches, and the capitular processes lie below the middle of the centrum, they may well be anterior cervicals. The characters of the dorsal vertebræ, as shown by the two consecutive series of five and eight respectively in B, are very singular, and in some respects anomalous.

The sacrum is unlike that of other *Dinosauria*, in possessing only two completely ankylosed vertebræ. On the other hand, the expansion and coalescence of the sacral ribs at their extremities is characteristically Dinosaurian. No chevron bones are described or figured.

One of the most remarkable portions of the skeleton A is an oblong plate of bone, nearly two feet long, and having apparently half that width, with edges which vary from one to three inches in thickness. The anterior external angles are prolonged into stout processes, which are directed upwards and inwards and are somewhat recurved. Professor Plieninger considers this bone to be the sternum; and I see no reason for dissenting from his interpretation. A *Rhea* of the same size as the triassic Dinosaurian would present a sternum of very similar proportions, especially as regards the antero-lateral or *pleurosteal* processes.

The scapula of B has a length of 21 inches. It is long and narrow. The coracoid is short and rounded, as in other *Dinosauria*. The humerus of A is rather more than 17 inches long; but that of B

must have been 20 in. long, if the drawing is correct. Probably therefore B was a larger animal, and the length of the shoulder-bones of A must be proportionally reduced. The femur of A is 27½ in. long; the tibia about 20 in. long. The ilium of B seems to have been not less than 16 in. long.

In the Maidstone *Iguanodon*, the scapula is 29 in., the humerus is 19 ins., the femur 33 in., the tibia 31 in., the ilium 30 in. long; so that the hind limbs were much longer in proportion to the fore limbs, the tibia in proportion to the femur, and the scapula in proportion to the humerus than in the Stuttgart Dinosaurian. The hinder dorsal vertebræ have centra rather less than 4 in. long, and fully 4 in. high, whence *Iguanodon* would seem to have possessed a shorter trunk in relation to its limbs.

The associated remains of a *Megalosaurus* which Mr. James Parker, of Oxford, was good enough to show me some time ago has ilia which are 26 inches long, femora 32 inches; and the tibiæ could not have been much shorter than the femora. *Scelidosaurus* has the ilium 16 inches long, the femur 16–17 inches, the tibia 13 inches, the scapula 13 inches, the humerus 11·25 inches. The length of a dorsal vertebra is 2⅛–2¼ inches. Thus, in the proportions of the tibia to the femur and of the humerus to the femur, the Triassic reptile comes nearer to the Liassic *Scelidosaurus* than any other Dinosaurian; but the limbs are shorter in proportion to the vertebræ than they are even in *Scelidosaurus*.

The facts now detailed show that, as I have already hinted, for the last ten years ample evidence of the existence of at least two genera of *Dinosauria* in the German Trias has been in existence.

But in 1861 Von Meyer described and founded the genus *Teratosaurus* upon a left maxilla with teeth, which he declared to be distinct from *Belodon*, and to have, in all probability, belonged to Plieninger's Pachypode. This sagacious suggestion receives the strongest support from the subsequent discovery of the maxilla of *Megalosaurus**, which is extremely similar to that of *Teratosaurus* in all its important features, though, in some minor details, the two are sufficiently different to enable them to be clearly distinguished. Hence I think that, until evidence to the contrary appear, it will be well to adopt Von Meyer's suggestion, and speak of the skeletons as well as the jaw under the name of *Teratosaurus*.

In the course of his memoir (p. 415) Prof. Plieninger refers to the discovery of the remains of a large reptile in the Upper Keuper near Basle by Prof. Gressly, and states that he has reason for identifying it with his *Belodon* (i. e. *Teratosaurus*).

2. Dinosauria *from the Trias of Britain.*

I had got thus far in accumulating evidence of the existence of *Dinosauria* in the Trias of Europe, when, looking through the memoir by Riley and Stutchbury on the Saurian remains from the Bristol conglomerate, I was struck by the resemblance which some of the bones they figure present to those of *Dinosauria*. Most

* See Quart. Journ. Geol. Soc. vol. xxv. p. 311.

especially was this resemblance apparent in the so-called "coracoid" (fig. 11), which seemed obviously to be a Dinosaurian ilium—and in the femur, the likeness of which to that of *Megalosaurus* is noticed by the able authors of the memoir themselves, and it has been subsequently referred to by Professor Owen (Palæontology, 2nd ed. p. 278) as "a Dinosaurian femur." It seemed to be highly desirable that these fossils should be examined anew; and in consequence of a communication to Mr. Saunders, they were placed at my disposal in the most obliging and liberal manner. On visiting the Bristol Museum, more than a hundred different specimens were spread before me, and I was able to select from among them illustrations of the structure of the skeleton of almost every part of the body of the "*Thecodontosauria*," and to obtain proof that these singular reptiles were in all respects *Dinosauria*.

I hope to publish an account of these remains, with full details and illustrations, in the Memoirs of the Survey. For the present I confine myself to the bones which, taken together with those already described, demonstrate the Dinosaurian affinities of the Thecodonts, and determine the relations of the latter with other *Dinosauria*.

In their well-known memoir*, Messrs. Riley and Stutchbury founded the genus *Thecodontosaurus* upon an imperfect mandible, containing twenty-one teeth (which was apparently the total original number) in a series. These teeth, they say, are acutely pointed and flattened, and the anterior edge is curved backwards and serrated; the posterior edge is also slightly curved and strongly serrated, the serratures being directed towards the apex of the tooth. The middle teeth are the largest; and all the teeth possess a conical pulp-cavity (Pl. III. figs. 1 & 2). To a single specimen of a broadly lanceolate tooth, with serrations at right angles to the axis, they attach the name of *Palæosaurus platyodon*. Another solitary tooth of more elongated conical form they term *Palæosaurus cylindrodon*. The description of the teeth of *Thecodontosaurus* is perfectly accurate; but I can see no important difference, in the direction of the serrations or otherwise, between these and the tooth called *Palæosaurus platyodon*, which, I suspect, may belong simply to a larger *Thecodontosaurus*.

In the tooth termed *Palæosaurus cylindrodon*, on the other hand, the direction of the serrations is really at right angles to the axis of the tooth; and in its form, also, the tooth more resembles that of *Megalosaurus*, being elongated, with the posterior margin straight or slightly concave, while the anterior contour is convex. The sharp posterior median ridge of the tooth extends for the whole length of the crown, and is strongly serrated throughout. The anterior serrated ridge is visible in what remains of the upper part of the crown; but I am unable to trace it in the lower half of the front face of the enamel (Pl. III. fig. 3). I think it will be proper to

* "A description of fossil remains of three distinct Saurian animals recently discovered in the Magnesian conglomerate near Bristol, by Henry Riley, M.D., and Mr. Samuel Stutchbury, A.L.S.," read March 23rd, 1836.

restrict the name *Palæosaurus* to the latter (or Megalosauroid) form of tooth, and to use *Thecodontosaurus* for the former (or Scelidosauroid) type, the varieties of which may be embraced under the common name of *platyodon*.

The bones referred to and described by Riley and Stutchbury are vertebræ, ribs of two kinds, a clavicle, two "coracoids," a humerus, a "radius," two femora, an "ischium," a tibia, a fibula, metacarpal and metatarsal bones, and ungual phalanges.

The "coracoid" figured is, as I suspected, a fragmentary ilium. The "radius" I take to be a tibia. The parts of the skeleton which diagnose the Dinosaurian nature of these reptiles, in addition to the teeth, are:—1, a caudal vertebra with the chevron bone; 2, an ilium; 3, a tibia.

The diagnostic mark in the first part of the skeleton mentioned lies in the complete union of the crura of the chevron bones at their proximal ends, in consequence of which coalescence the fork of the chevron bone is converted into a foramen (Pl. III. figs. 5 & 6). This character appears to be universal among the *Dinosauria*.

With respect to the ilium (Pl. III. fig. 7), it has every character of that bone in the *Dinosauria*. That part which enters into the acetabulum forms a semicircular arch, the piers of which are formed by the præ- and postacetabular processes (*a*, *b*), both of which are strong and trihedral. They are about equal in length; and each ends in a truncated face, which looks a little downwards and a little forwards in the anterior, downwards and a little backwards in the posterior process. The expanded supraacetabular part of the ilium (*c*) is a vertically disposed plate, equal in height to the acetabular part. Anteriorly (*d*) it is produced in front of the acetabulum for a length equal to that of the neck by which it joins the acetabular part. Posteriorly (*e*) it is prolonged into only a very short process, which does not project as far backwards as the postacetabular apophysis.

In all these respects the Thecodontosaurian ilium exaggerates the peculiarities of that of *Megalosaurus*. And the like is true of the form of the outer and inner surfaces, and of the superior contour, of the supraacetabular part. In the Triassic Dinosaurian the outer surface of this part of the bone is strongly concave from before backwards above the acetabulum, the posterior iliac process being sharply bent outwards; while it becomes flat above the anterior iliac process. Hence the superior contour has a sort of ∫-like curve. The supraacetabular part of the ilium of *Megalosaurus* has the same curvature, though less strongly pronounced. The inferior surface of the anterior process of the supraacetabular part of the ilium of *Megalosaurus* presents a narrow groove, bounded on each side by ridges of bone. In the Thecodont, the place of the groove is taken by a broad surface which is only slightly concave from side to side. In *Megalosaurus* the posterior iliac process is a little longer than the postacetabular, and possesses a considerable height. In the Thecodont it is shorter, and much lower and more tapering posteriorly.

The proximal end of the tibia (Pl. III. fig. 8) possesses the great outwardly bent cnemial crest which is characteristic of that bone in the *Dinosauria*.

The ilia, femora, and tibiæ in the Bristol collection are all of one kind; and the question therefore arises, do they belong to *Thecodontosaurus* or to *Palæosaurus*? Considering that three sets of Thecodontosaurian teeth have been found for only a solitary Palæosaurian tooth, the probabilities would seem to be in favour of the bones belonging to *Thecodontosaurus*. But, on the other hand, the teeth of *Thecodontosaurus* are Scelidosaurian in character; and it seems to be hardly likely that these teeth should have accompanied hind limbs which are the reverse of Scelidosaurian, and exaggerate the peculiarities of those of *Megalosaurus*, when we have, in *Palæosaurus*, a tooth so like that of *Megalosaurus* that it is only distinguishable by critical examination. With the present materials I do not think any decision can be safely arrived at on this question, and I shall speak of the bones as those of Thecodontosaurians, without prejudice as to the particular genus to which they may belong.

I may observe, in conclusion, that the ilium is shorter in proportion to the femur in these Dinosauria than in any others with which I am acquainted, and that the cavities in the bones are so extraordinarily large and well defined that, if found alone, it would be hard to distinguish some of them from those of *Pterosauria*.

The Thecodontosaurians, then, are *Dinosauria*; but the question may be raised whether the conglomerate in which they are found is really Triassic, some geologists appearing to be inclined to think them of Rhætic age, while Von Meyer, as has been seen, looks upon them as transitional between Muschelkalk and Keuper*. It does not lie within my province to discuss this problem, the decision of which, either way, will not affect the occurrence of Dinosauria in the Trias; and I therefore pass on to examine into what evidence there may be of the existence of Dinosaurian reptiles in the Warwickshire sandstones, the Triassic age of which appears to be beyond question.

Many years ago certain teeth were discovered in these sandstones by Dr. Lloyd, and were placed by him in the hands of Professor Owen, who has thus described them in his 'Odontography,' which was published between the years 1841 and 1845:—

"In their compressed form, anterior and posterior serrated edges, sharp points, and microscopic structure, these teeth agree with those of the Saurian reptiles of the Bristol conglomerate. In their breadth, as compared with their length and thickness, they are intermediate between the *Thecodontosaurus* and the *Palæosaurus platyodon*. They are also larger and more recurved, and thus more nearly approach the form characteristic of the teeth of the *Megalosaurus*. From these teeth, however, they differ in their greater degree of compression and in a slight contraction of the base of the crown."

* On this question I refer the reader to a forthcoming paper by my colleague Mr. Etheridge.

Figures of these teeth, of the natural size, are given in plate 62 A, figs. 4 a & b, of the work cited.

I am at a loss to discover the smallest resemblance between these teeth and either those of *Thecodontosaurus* of Riley and Stutchbury or the so-called "*Palæosaurus*" *platyodon* tooth, which is represented in the same plate, fig. 7; nor can I divine in what sense the *Cladyodon* teeth can be said to be intermediate between the two. If they were affirmed to be intermediate between *Thecodontosaurus* and *Palæosaurus cylindrodon*, the statement would be intelligible, though I do not think it would be altogether accurate.

I have been favoured by Mr. T. G. B. Lloyd, F.G.S., with the opportunity of examining three Saurian teeth from the quarries which yielded *Cladyodon*. Two of these teeth (Pl. III. fig. 4) are so similar to those of *Palæosaurus cylindrodon* in form, and even in colour, that I conceive them to belong to the same genus, and perhaps to the same species, although they are twice as large as the teeth from Bristol. They show most distinctly the abrupt cessation of the anterior serrated ridge about halfway down the crown, which beneath this point is rounded and curved as in *Megalosaurus*. I see no reason to doubt that these are Dinosaurian teeth. Of the other tooth, only the crown, which is 1·8 inch long, is preserved (Pl. III. fig. 11). This tooth must have had, as nearly as may be, the same dimensions as the hindmost tooth in the upper jaw of the *Megalosaurus* figured in the 'Quarterly Journal' of this Society (vol. xxv. pl. 12); and if placed over that tooth it corresponds with it in contour with remarkable closeness. On the whole, however, the crown of the Megalosaurian tooth is thicker near the fang than the present tooth. But what distinguishes the latter at once from all the Megalosaurian teeth of which I have been able to obtain a sufficiently clear view, is the fact that the serrated anterior ridge extends along the whole length of the crown, instead of stopping short halfway from the apex, as it does in *Megalosaurus*. In this respect the tooth from the Trias resembles those of *Teratosaurus*; and it may possibly belong to that genus.

Thus it appears that there are two kinds of Dinosaurian teeth in the Warwickshire Trias—one kind allied to *Megalosaurus*, the other to *Thecodontosaurus*.

Thanks to Mr. Kirshaw, who has so skilfully worked out many of the fossils of the Warwickshire Trias, I am able to add new evidence which tends in the same direction. This consists of three consecutive vertebræ (Pl. III. fig. 9), which have been ankylosed together, though they are now separated by the breaking away of the greater part of the hinder portion of the second vertebra. The centra of these vertebræ are much constricted in the middle, while their articular surfaces are flat or slightly excavated (Pl. III. fig. 10). The bones have been so much distorted and crushed that it is hard to say what the contour of these surfaces may have been; but they were either circular or oval, the long axis of the ellipse being vertical. The spinous processes are broken away. The faces of the præzygapophyses look inwards as well as upwards, so as to embrace the postzygapo-

physes of the antecedent vertebra laterally. The postzygapophyses of the first vertebra are completely ankylosed with those of the second; and those of the second seem to have been similarly united with those of the third. The centrum of the first vertebra, on the other hand, is not absolutely fused with that of the second, the separation being everywhere traceable; and the union between the centra of the second and third vertebræ seems to have been still more lax. Each neural arch is connected only with its own centrum, and the intervertebral foramen lies over the posterior moiety of each centrum.

A strong, prismatic sacral rib with a triangular section, only the proximal end of which remains, springs from the junction of the centrum with the neural arch on each side, in the first vertebra, and appears to have been directed perpendicularly outwards. The second vertebra seems to have possessed a similar rib, which, however, springs rather further back from the anterior edge of the arch. The third vertebra also possesses a strong rib, the root of which occupies the middle of the arch. The contour of the broken end of the rib is more nearly four-sided. The anterior and posterior faces are concave from above downwards, and are directed obliquely, the anterior upwards, and the posterior downwards. The centrum of the anterior vertebra is 1·6 inch long, that of the third 1·75 inch; but the difference may be the result of the crushing of the vertebræ, which are a good deal distorted. The height of the centrum seems to have been about 1·3 inch, the width about 1·1 inch.

Mr. Kirshaw has sent me two centra of vertebræ, which may very well have belonged to the same animal as the sacrum. One of these is almost undistorted, and belongs to the dorsal region. It is 1·6 inch long; and the better-preserved articular surface is 1·55 inch high, while its greatest width is rather less than 1 inch. The surface is very slightly concave, and is perpendicular to the axis of the centrum. The centrum is much constricted, so as to be not more than 0·6 inch wide in the middle; and, as in the other vertebræ, the floor of the neural canal sinks rapidly from each end towards the middle of the centrum. Some of the vertebræ from the Bristol conglomerate bear an extraordinarily close resemblance to these.

The fragmentary vertebra described and figured by Professor Owen as belonging to *Labyrinthodon pachygnathus* has the same general characters as those now described. The vertebra ascribed to *Labyrinthodon leptognathus*, on the other hand, appears to have belonged to some other reptile.

The remarkable ilium ascribed to *Labyrinthodon pachygnathus* (*l. c.* pl. 45. figs. 16, 17) is also a reptilian bone, intermediate in its characters between the ilium of a Teleosaurian and that of a Lizard. It is very similar to an ilium from the Keuper described and figured by Von Meyer ('Palæontographica,' Bd. vii. pl. 41), and ascribed by him to *Belodon*. I propose to discuss the nature and signification of this remarkable bone in another communication.

I have no direct evidence of the presence of *Dinosauria* in the Elgin sandstones; but ample proof is in my possession that the

cast of a mandible, which I have described ('Quarterly Journal of the Geological Society,' 1858, vol. xv. p. 454) as probably appertaining to *Stagonolepis*, did not belong to that reptile, the teeth of which possess short and comparatively obtuse crowns. I think it more than probable that this mandible, with its great recurved and pointed teeth, which had large pulp-cavities and were implanted in distinct alveoli, may have belonged to a Dinosaurian reptile.

I know of no further evidence of the existence of *Dinosauria* in rocks of Triassic age in Western Europe than that which I have now brought forward; but it is sufficient to demonstrate the existence of, at fewest, two genera in the German Trias, and of three in that of Britain.

3. Dinosauria *from the Trias of the Ural Mountains and India.*

In the extreme east of Europe, namely in the Ural Mountains, there is a series of rocks which have been supposed to be Permian, but which there now appears to be every reason to consider to be of Triassic age. Remains of reptiles associated with those of Labyrinthodonts from these rocks have been described and figured by D'Eichwald ('Lethæa Rossica') and by Von Meyer (Palæontographica, Bd. xv.). Now the teeth and jaws of the *Deuterosaurus* of D'Eichwald, no less than the vertebræ which are referred to the same genus by this author, have a strongly Dinosaurian aspect; and though the evidence is incomplete, I am greatly inclined to think that *Deuterosaurus* is a Dinosaurian. But the specially interesting feature of the Ural Triassic fauna is the association with the Labyrinthodonts and possible *Dinosauria*, of the *Rhopalodon*, so singular for its great canine tusks, in front of and behind which were comparatively small "incisors" and "molars;" for no one who compares *Rhopalodon* with the *Galesaurus* of Prof. Owen, from the Dicynodont-yielding sandstones of South Africa, can fail to see that the two forms are closely allied.

On the other hand, Von Meyer describes humeri and portions of crania from the same deposits, the nearest resemblance to which he finds in the corresponding parts of the skeleton of *Dicynodon* itself. Thus there is a clear affinity between the Triassic fauna of the Ural and that of South Africa. But in the Ural we have reached a point halfway between the West of England and Central India. I have already ("Palæontologica Indica," in 'Memoirs of the Geological Survey of India,' 1865) shown reason for the belief that the Central-Indian and the African faunæ of the "Poikilitic" period were closely allied; and I have described a small Thecodont Saurian (*Ankistrodon*) from the Indian beds. Thanks to Professor Oldham (the Director of the Indian Survey), I am now enabled to go a step further; for among the remains which last reached me from him there are portions of a Crocodilian closely allied to *Belodon*; and thus the Indian fauna, together with that of the Ural, binds the Triassic fauna of Western Europe with that of Africa*.

* A fragment of a jaw from Malédi reminds me forcibly of *Rhopalodon*.

4. Dinosauria *from the Trias of North America.*

The Trias of North America has yielded the remains of two forms of reptiles, *Clepsysaurus* and *Bathygnathus**. The teeth, jaw-fragments, and vertebræ of these reptiles have characters which are quite in accordance with those of the *Dinosauria*, to which group they have lately been referred by Cope and Leidy, and I entertain no doubt that they are *Dinosauria*; but, unfortunately, none of the remains which have been discovered belong to what may be called *diagnostic* bones, such as the ilium, the femur, or the tibia.

5. *The Arctogæal province constituted in Triassic times.*

Assuming, provisionally, that these reptiles are *Dinosauria*, the distribution of that group and of the other *Reptilia* and *Amphibia* of the Trias may be tabulated in the annexed form.

	North America.	Britain.	Germany.	Ural Mountains.	Central India.	South Africa.
Reptilia—						
Crocodilia	.....	Stagonolepis.	Belodon.	.....	Parasuchus.	Pristerodon ?
Dinosauria	Clepsysaurus, Bathygnathus.	Thecodontosaurus, Teratosaurus, Palæosaurus, Cladyodon.	Palæosaurus, Teratosaurus, Zanclodon ?	Deuterosaurus, Rhopalodon ?	Ankistrodon. Dicynodon.	Galesaurus ? Dicynodon, Oudenodon.
Dicynodontia	.....	.....	.....	.....	.....	
Placodontia	.....	.....	Placodus.	.....	Hyperodapedon.	Saurosternon.
Lacertilia	.....	Hyperodapedon, Telerpeton, Rhynchosaurus.	.....	.....		
Plesiosauria	.....	.....	Nothosaurus, Pistosaurus, Simosaurus, &c. Ichthyosaurus ?	.....	.....	Microphotis.
Ichthyosauria	.....	.....	.....	.....	Goniopholis, Pachygonia.	
Amphibia—						
Labyrinthodontia	.....	Labyrinthodon.	Labyrinthodon, Mastodonsaurus, Metopias, Trematosaurus, Capitosaurus.	Melosaurus, Zygosaurus, Chalcosaurus.		

Putting together all the facts now ascertained respecting the distribution of the "Poikilitic" *Reptilia*, I think that the horizon of all these beds tends to become definitely Triassic rather than Permian.

And, in conclusion, I may draw attention once

* See the memoirs by Lea and Leidy in the second volume of the second series of the 'Journal of the Academy of Natural Sciences.'

more to the very remarkable fact, that, so far as the present evidence goes, the dry land of those Triassic epochs was as extensive in the old and northern New World as it is at the present day, and that, just as the mammalian and ornithic faunæ of these regions lead us to group North America, Europe, Asia, and South Africa in one vast Arctogæal province, so the affinities of the land reptiles of the Trias lead to the conclusion that at that epoch the same regions constituted a similar great distributional area.

EXPLANATION OF PLATES I.–III.

Plate I.

Fig. 1. The skull of *Hypsilophodon Foxii*, of the natural size.
Pa, parietal; *Fr*, frontal; *Na*, nasal; *Pmx*, præmaxilla; *La*, lacrymal; *Mn*, mandible; *a*, prælacrymal vacuity; *b*, suture between the præmaxillary and maxillary bones; *N*, nasal aperture; *c*, centrum of a vertebra.
2. A molar tooth, and
3. An incisor tooth, magnified.
4. The left ramus of the mandible: *Qu*, the quadrate bone; *a*, the coronoid process.
5. The left præmaxilla. In this figure and in fig. 1. the line from *Pmx* leads to the edentulous prolongation.
6. Side view of a caudal vertebra, of the size of nature.
7. End view of another caudal vertebra.
8. A chevron bone, of the natural size.

Plate II.

The pelvis of *Hypsilophodon Foxii*, two-thirds the natural size.
a, the anterior, *b*. the posterior extremity of the right ilium; *Is. Is.* the right and left ischia; *Pb*. the pubis.

Plate III.

Fig. 1. The dentary portion of the left ramus of the mandible of *Thecodontosaurus*.
2. One of the teeth of *Thecodontosaurus*, magnified three times.
3. The typical specimen of the tooth of *Palæosaurus cylindrodon*, magnified three times.
4. One of the teeth of the Warwickshire *Palæosaurus*.
5. A caudal vertebra of *Thecodontosaurus* (?) with its chevron bone, which is imperfect below.
6. The anterior aspect of the same chevron bone.
7. The inner face of the right ilium of *Thecodontosaurus* (?).
8. The proximal end of the right tibia of *Thecodontosaurus*.
9. The three sacral vertebræ from the Warwickshire Trias.
10. End view of the anterior vertebra of the sacral series (fig. 9).
11. *A*. anterior view, *B*. lateral view, of the tooth from the Warwickshire Trias which probably belongs to *Teratosaurus*.

Discussion.

Sir Roderick Murchison, who had taken the Chair, inquired as to the lowest formation in which the bird-like character of Dinosaurians was apparent, and was informed that it was to be recognized as low as the Trias, if not lower.

Mr. Seeley insisted on the necessity of defining the common plan both of the Reptilia and of the ordinal groups before they could be treated of in classification. He had come to conclusions as to the grouping and classification of Saurians somewhat different from

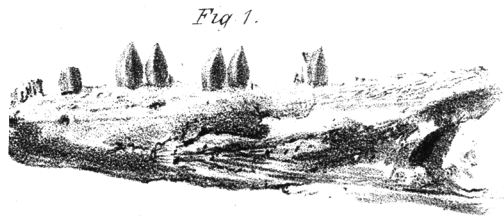
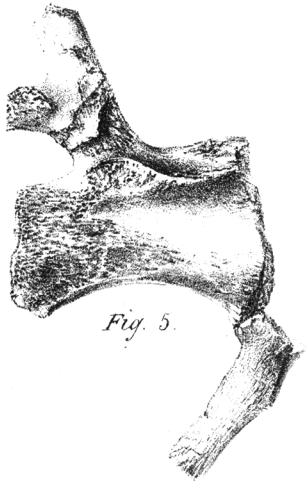


Fig. 1.


Fig. 2.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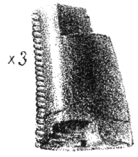
Fig. 3.

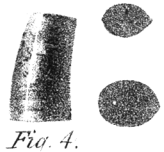
Fig. 4.


Fig. 6.

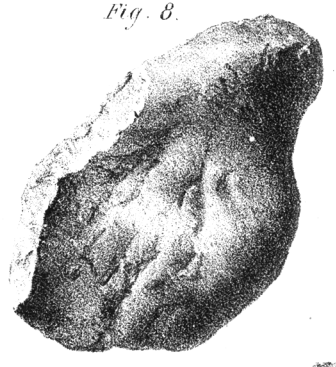
Fig. 8.

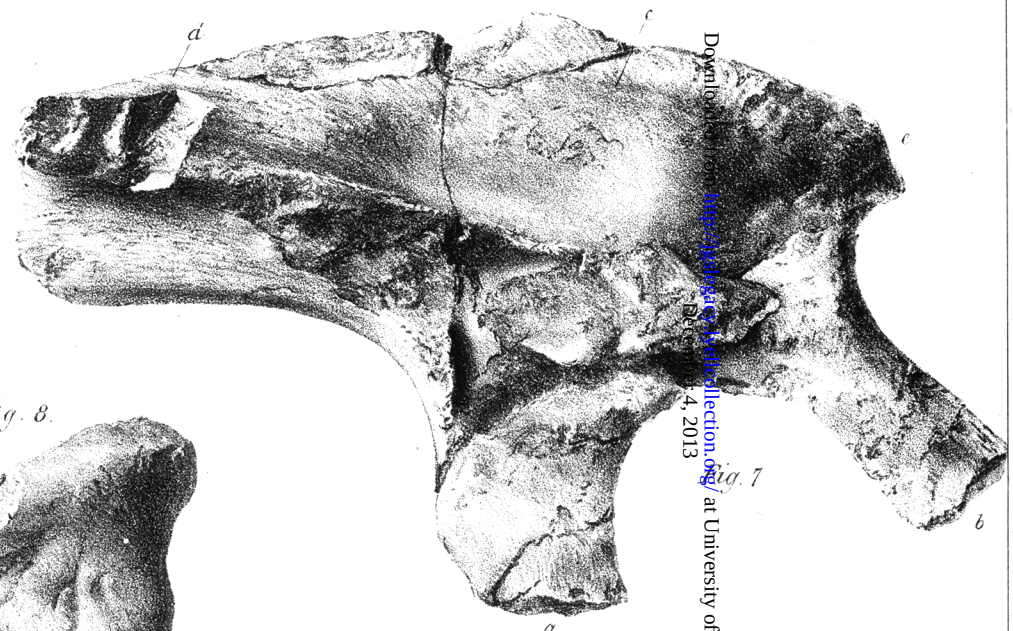
Fig. 7.


Fig. 10.

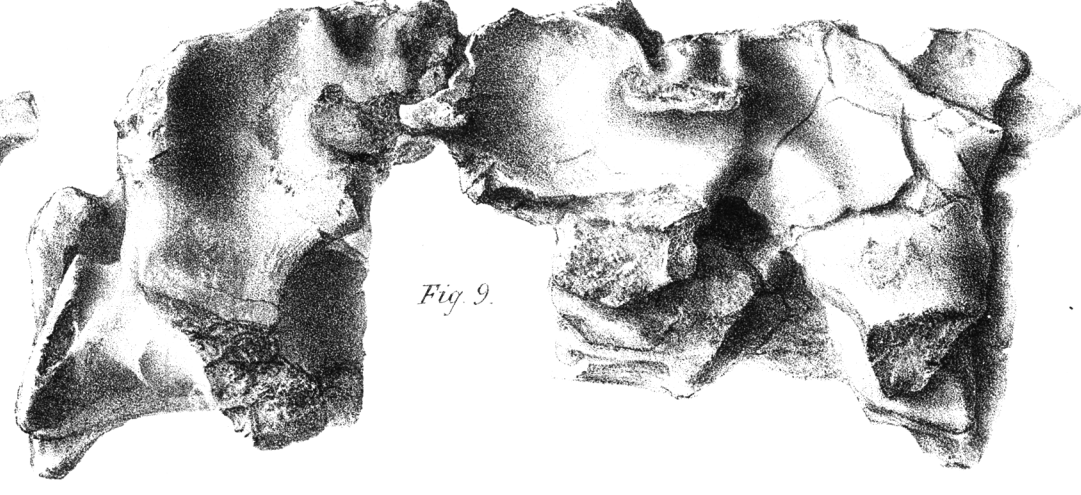
Fig. 9.

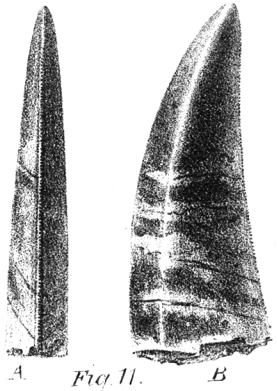
Fig. 11.

those adopted by the President. This would be evident, so far as concerned Pterodactyles, from a work on Ornithosauria which he had just completed, and which would be published in a few days.

Mr. ETHERIDGE stated that the dolomitic conglomerate in which the Thecodont remains occurred near Bristol was distinctly at the base of the Keuper of the Bristol area, being beneath the sandstones and marls which underlie the Rhætic series. There were no Permian beds in the area. He regarded the conglomerates as probably equivalent to the Muschelkalk. It was only at one point, near Clifton, that the Thecodont remains had been found.

Prof. HUXLEY was pleased to find that there was such a diversity of opinion between Mr. Seeley and himself, as it was by discussion of opposite views that the truth was to be attained. He accepted Mr. Etheridge's statement as to the age of the Bristol beds.

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2. *The* PHYSICAL GEOGRAPHY *of* WESTERN EUROPE *during the* MESOZOIC *and* CAINOZOIC *periods elucidated by their* CORAL FAUNAS.

By P. MARTIN DUNCAN, M.B.Lond., F.R.S., Sec.G.S.

CONTENTS.

I. INTRODUCTION.

THE physical conditions which determine and accompany the existence of coral reefs, and the natural history of those vast aggregations of species of Madreporaria, have been sedulously and successfully studied ever since Darwin and Dana published the facts and theories which aroused the scientific world to a sense of their importance to geological reasoning. The physical geography of the Indo-Pacific and West-Indian seas has been investigated with as much care as the zoology of those marine banks which, fashioned by coral polypes, form a nidus for the existence of vast numbers of Invertebrata, fish, and birds. Nothing has been more satisfactorily determined than the scheme of the production of reefs, and the system of species-grouping that obtains in them.

The dependence of the coral polypes upon certain definite external conditions is as well understood as is that of the myriads of mollusca upon the flourishing state of the reef-builders. The dredge * has done much to show the characters of the corals in the shallows and moderately deep seas of reef areas; and the species and genera frequenting them have been distinguished from those peculiar to the

* The late Mr. Christy gave me the results of his dredgings of Corals between Cuba and Jamaica Pourtales, Bull. Mus. Harvard Coll. nos. 6, & 7.