1. Three foot-prints about 8 inches long; stride from toe to toe of 1 and 2 about 19 inches; from toe to toe of 2 and 3, about 31 inches. The tracks resemble the form named *Anomœpus major* by Edw. Hitchcock, the print embracing the impression of the foot together with that of the lower part of the tarso-metatarsus, which latter would make the prolonged, indefinitely-ending, heel-like projection wherever the animal crouched upon the beach.* If this explanation be applicable in this case, the foot proper has a length of about 5 inches.

2. Three-toed prints from 2·5 to 3 inches long, digital impressions jointed; one line of these prints contained five distinct tracks, with a stride of about one foot. The second line of tracks was similar, with six prints.

A heart-shaped impression about four inches on a side and sharply defined was seen on another slab. A similar impression, in the Amherst collection, is in a relation to foot-prints to indicate that it was made by an animal crouching on the beach. Other vague impressions, due to the moulding of the bottom as if by the rolling contact of a flexible, wrinkled body, are probably to be explained as made by dinosaurs in a recumbent position. Long straight and curved furrows also exist both at Avondale and on the track layers in the Newark quarries.

So far as one can judge from tracks, these impressions afford nothing not already known in the Connecticut area. Their existence in the section which has been taken for the type of the Jura-Trias basins along the Atlantic coast, is of importance as serving to remove the criticism which has been made against the revival of Redfield's term,—the Newark group,—that the characteristic fossil tracks of the better known Connecticut area do not occur in it.

I am indebted to my friend, Prof. Geo. C. Sonn, of Newark, N. J., for essaying to have the large slab with fourteen tracks preserved in the High School of that city.

Harvard University, September 18th, 1895.

* I am indebted to Professor Emerson for this explanation of the similar tracks in the collection at Amherst.

ART. LV.—*On the Affinities and Classification of the Dinosaurian Reptiles*;* by O. C. MARSH. (With Plate X.)

INTRODUCTION.

FOR several years I have been engaged in the study of the Dinosaurs of North America, and the main results of the investigation have been published both in that country and in Europe. The material for this study consisted of the extensive collections made during my explorations in western North America, especially in the Rocky Mountain region, and the type specimens are nearly all preserved in the museum of Yale University. I first attempted in 1881 to make a classification of the series of specimens thus secured, and in the following year I extended this classification to include the European forms, and again in 1884 I expanded it still further to include all the *Dinosauria* then known.†

Since that time, many new discoveries have been made, and some very strange forms have been brought to light in America, which render a revision of this classification necessary. Besides the American forms, I have studied with care nearly every important specimen of Dinosaurs preserved in the museums of Europe, and as a result of all this investigation, I shall present to you an abstract, bringing the subject down to date. This will include a short statement as to the affinities of the Dinosaurs, so far as I have been able to make them out, and a synopsis of the classification, based mainly upon the characters of the Dinosaurs I have myself examined.

To bring the subject directly before you, I have prepared the chart here shown (Plate X), which gives restorations of the skeletons of the twelve best known Dinosaurs, so far as I have been able to reconstruct them. Of these twelve forms, eight are from America; *Anchisaurus*, a small carnivorous type from the Trias; *Brontosaurus*, *Camptosaurus*, *Laosaurus*, and *Stegosaurus*, all herbivorous, and the carnivorous *Ceratosaurus*, from the Jurassic; with *Claosaurus* and *Triceratops*, herbivores from the Cretaceous. These American forms, with four from Europe, types of the well-known genera *Compsognathus*, *Scelidosaurus*, *Hypsilophodon*, and *Iguanodon*, complete the series represented on this chart. They form together an instructive group of the remarkable Reptiles we are now considering.

* Abstract of paper read before the International Congress of Zoologists, at Leyden, September 17, 1895.

† This Journal, vol. xxi, p. 423, May, 1881; vol. xxiii, p. 81, January, 1882; Report British Association for the Advancement of Science, for 1884, p. 763.

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Affinities of Dinosaurs.

The extinct reptiles known as Dinosaurs were for a long time regarded as a peculiar order, having, indeed, certain relations to Birds, but without being closely allied to any of the other groups of known Reptiles. *Megalosaurus* and *Iguanodon*, the first Dinosaurian genera described, were justly considered as representing two distinct families, one including the carnivores, and the other the herbivorous forms.

With the discovery and investigation of *Cetiosaurus* and its allies in Europe, and especially of the gigantic forms with similar characters in America, it became evident that these reptiles could not be placed in the same families with *Megalosaurus*, or *Iguanodon*, but constituted a well-marked group by themselves. It was this new order, the *Sauropoda*, as I have called them, that first showed definite characters allying them with other known groups of Reptiles. In 1878, I pointed out that the *Sauropoda* were the least specialized of the Dinosaurs, and I gave a list of characters in which they showed such an approach to the Mesozoic Crocodiles as to suggest a common ancestry at no very remote period.*

1.

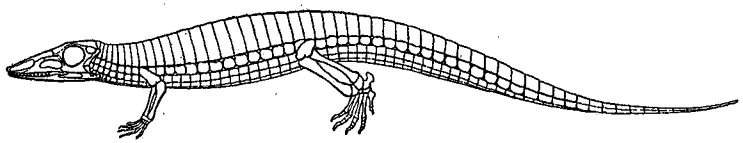

Figure 1.—Restoration of *Aëtosaurus ferratus*, Fraas; with dermal armor of the limbs removed. One-eighth natural size.

Again in 1884, I called attention to the same point, and also to the relationship of Dinosaurs with the *Aëtosauria*, as I had named them, a group of small reptiles from the Triassic of Germany, showing strong affinities with Crocodilians.† A restoration of one of these small animals is shown in the diagram before you (figure 1). In the same communication I compared with Dinosaurs another allied group, the *Hallopoda*, which I had described from the lower Jurassic of America, but had not then fully investigated. Subsequent researches proved the latter group to be of the first importance in estimating the affinities of Dinosaurs, and in another diagram (figures 4–5), I have placed before you restorations of the fore and hind limbs of the type species (*Hallopus victor*).

* This Journal, vol. xvi, p. 412, November, 1878.
† Report British Association, Montreal Meeting, 1884, p. 765.

Another group of extinct Reptiles, which may be termed the *Belodontia*, were considered in the same paper, as allies of the *Dinosauria*. They are known from the Trias of Europe and America, and the type genus *Belodon* has been investigated by many anatomists, who all appear to have regarded it as Crocodilian; an opinion that in the light of our present knowledge may fairly be questioned.

2. 3.

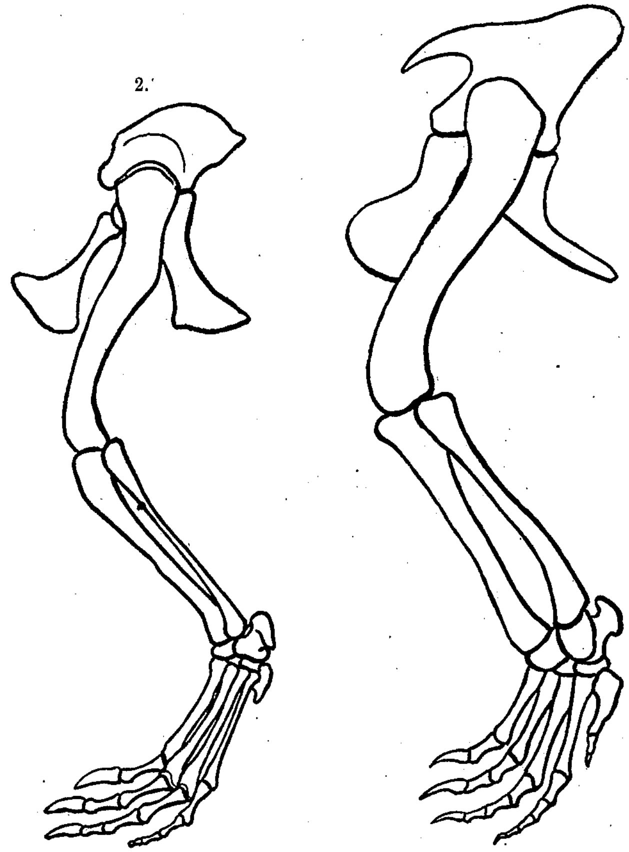

Figure 2.—Diagram of left hind limb of *Alligator Mississippiensis*, Gray; seen from the left; in position for comparison with Dinosaurs. One-fourth natural size.
Figure 3.—Diagram of left hind limb of *Aëtosaurus ferratus*; in same position. One-half natural size.

The relations of these various groups to the true Crocodiles on the one hand and to Dinosaurs on the other is much too broad a subject to be introduced here, but I may at least call your attention to some points of resemblance between the Dinosaurs and these supposed Crocodilian forms, that seem to indicate genetic affinities.

If we compare some of the characteristic parts of the skeletons of these groups; e. g., of the true *Crocodilia* as existing to-day, the *Belodontia*, the *Aëtosauria*, and the *Hallopoda*, and all with the corresponding portions of the more typical Dinosaurs, the result may indicate in some measure the relationship between them. Taking first the

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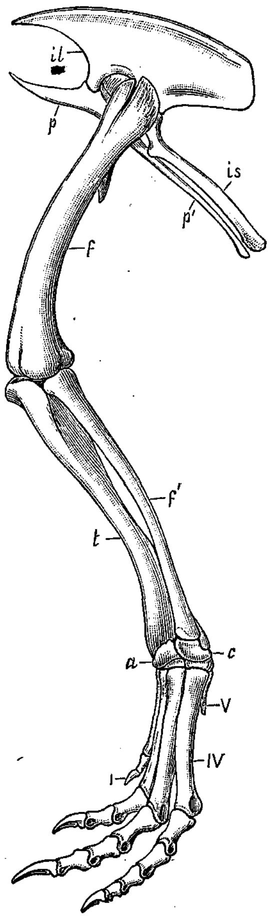

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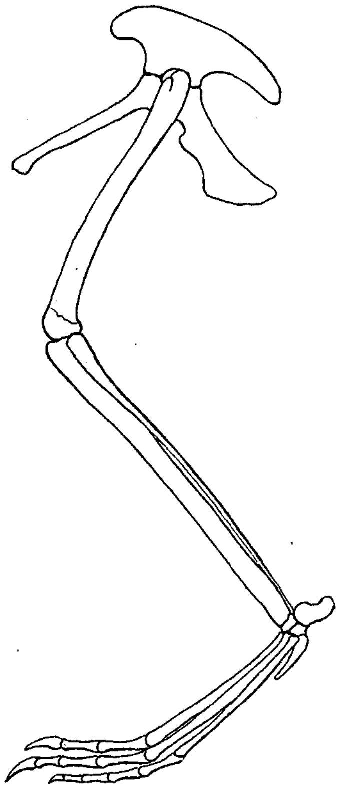

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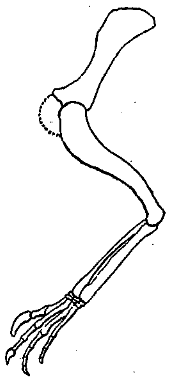

FIGURE 4.—Diagram of left fore limb of *Hallopus victor*, Marsh; seen from the left.
FIGURE 5.—Diagram of left hind limb of same individual. Both figures are one-half natural size.
FIGURE 6.—Left hind leg of *Laosaurus consors*, Marsh; outside view. One-sixth natural size. *a*, astragalus; *c*, calcaneum; *f*, femur; *f'*, fibula; *il*, ilium; *is*, ischium; *p*, pubis; *p'*, postpubis; *t*, tibia; *I*, *IV*, *V*, first, fourth, and fifth digits.

pelvis and hind limb, as being especially characteristic, we find in the existing *Alligator*, as represented in the diagram (figure 2), that the pubic bone is excluded from the acetabulum, articulating alone with the ischium, and not at all with the ilium. The calcaneum, moreover, has a posterior extension. In *Aëtosaurus*, as shown in the corresponding diagram (figure 3), the pubic bone forms part of the acetabulum, as in Dinosaurs and Birds, and this is a noteworthy difference from all the existing Crocodiles. The hind foot, however, is of the Crocodilian type, with the calcaneum showing a posterior projection.

7.

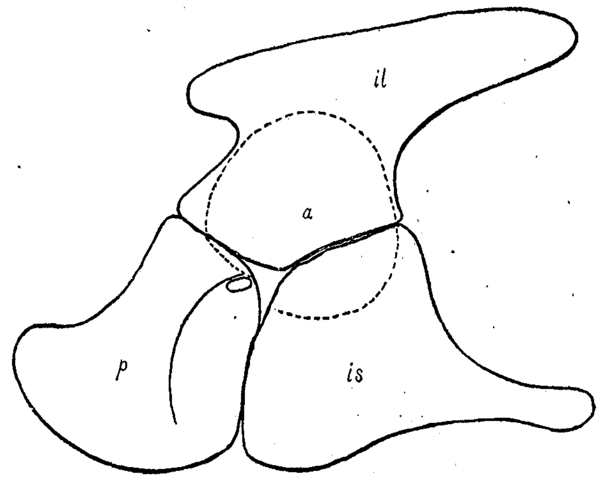

FIGURE 7.—Diagram of pelvis of *Belodon Kapffi*, von Meyer; seen from the left. One-fourth natural size.
a, acetabular surface, within dotted line; *il*, ilium; *is*, ischium; *p*, pubis.

In *Belodon*, the pelvis of which alone is here represented (figure 7), the pubis contributes a very important part to the formation of the acetabulum, and to the entire pelvic arch. The latter differs from the pelvis of a typical Dinosaur mainly in the absence of an open acetabulum, but a moderate enlargement of the fontanelle at the junction of the three pelvic elements would essentially remove this difference. A more erect position of the limb, leading to a more distinct head on the femur, might possibly bring about such a result. The feet and limbs of *Belodon* are Crocodilian in type.

Bearing these facts in mind, the diagram representing the restored fore and hind limbs of the diminutive *Hallopus* (figures 4–5) shows first of all the true Dinosaurian pelvis, with the pubic bone taking part in the open acetabulum, and forming an important and distinctive element of the pelvic arch. The delicate posterior limb and foot, evidently adapted

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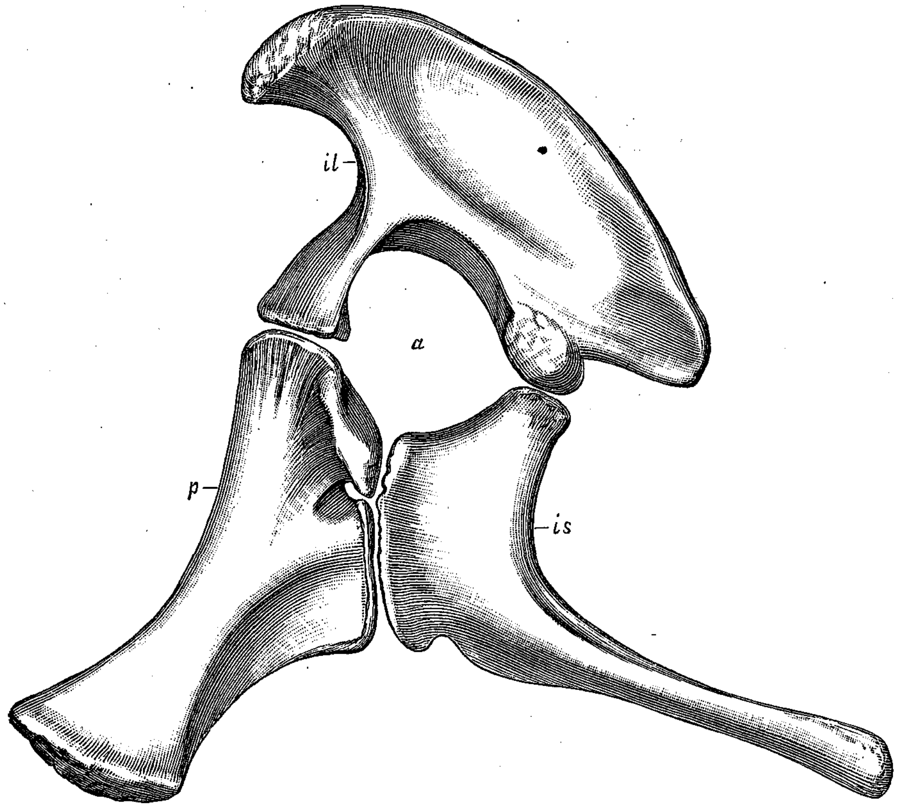
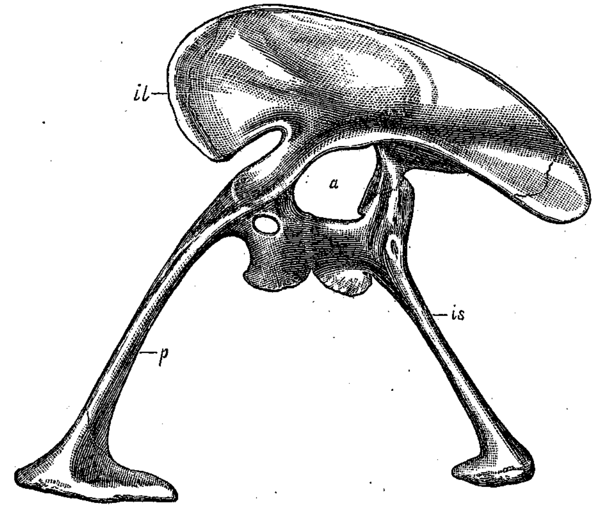


FIGURE 8.—Pelvis of *Morosaurus lentus*, Marsh; seen from the left. One-eighth natural size.
a, acetabular opening; other letters as in figure 7.

mainly for leaping, as the generic name suggests, are quite unique among the *Reptilia*, but the tarsus, especially the calcaneum, recalls strongly the same region in the orders already passed in review.

9.



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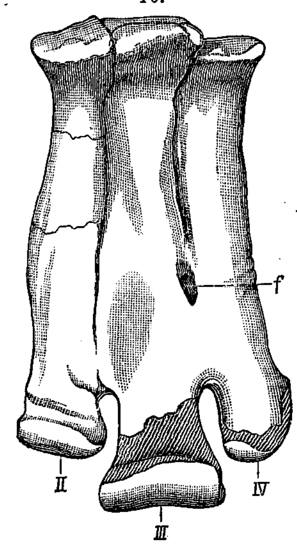

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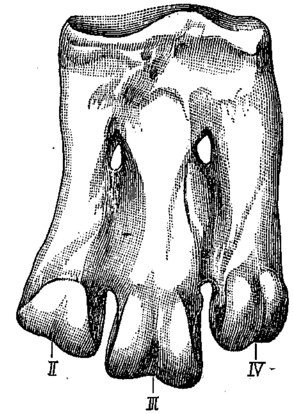

FIGURE 9.—Pelvis of *Ceratosaurus nasicornis*, Marsh; seen from the left. One-twelfth natural size. Letters as in figure 8.
FIGURE 10.—United metatarsal bones of *Ceratosaurus nasicornis*; left foot; front view. One-fourth natural size.
FIGURE 11.—United metatarsal bones of great Penguin (*Aptenodytes Pennantii*, G. R. Gr.); left foot; front view. Natural size.

Just what this posterior extension of the calcaneum signifies in this case, it is difficult to decide on the evidence now known. It may be merely an adaptive character, as *Hallopus* appears in nearly every other respect to be a true carnivorous Dinosaur. It may, however, be an inheritance from a Crocodilian ancestry, and preserved by a peculiar mode of life. Whatever its origin may have been, it was certainly, during the life of the animal, an essential part of the remarkable leaping foot to which it belonged, and in which it has since kept its position undisturbed. The presence of such an element in the foot of this diminutive Dinosaur certainly suggests that the group *Hallopoda*, which I have considered an order, stands somewhat apart from the typical *Theropoda*, but not far enough away to be excluded from the subclass *Dinosauria*, as I have defined it in the present communication.

In the genus *Zanclodon*, which is from essentially the same geological horizon in Germany as *Aëtosaurus* and *Belodon*, we have one of the oldest true Dinosaurs known, and a typical member of the order *Theropoda*. In the pelvic arch of this reptile, the ilium and ischium are in type quite characteristic of the group to which it belongs, but the pubic elements are unique. They consist of a pair of broad, thin plates united together so as to form an apron-like shield in front, quite unlike anything known in other Dinosaurs. The wide pubic bones of *Belodon*, and the corresponding plates in some of the *Sauropoda* (*Morosaurus*, figure 8), indicate that this feature of the reptilian pelvis may have been derived from some common ancestor of a generalized primitive type. The known transformations of this same pelvic element in one other order of Dinosaurs (the *Predentata*) make the modifications here suggested well within the limits of probability. The hind limb of one genus of this order is shown in figure 6.

The skulls of *Aëtosaurus* and *Belodon* both show features characteristic of some of the Dinosaurs, especially of the *Sauropoda*, but these features need not be discussed here.

The relation of Dinosaurs to Birds, a subject of importance, must also be postponed for another occasion. One point, however, may be mentioned in this connection. The pelvic bones of all known Birds, living and extinct, except the genus *Archæopteryx*, are coössified, while in all the known Dinosaurs they are separate, excepting *Ceratosaurus* (figure 9) and *Ornithomimus*. Again, all known adult Birds, living and extinct, with possibly the single exception of *Archæopteryx*, have the tarsal bones firmly united (figure 11), while all the *Dinosauria*, except *Ceratosaurus* (figure 10), have these bones separate. The exception in each case brings the two classes near together at this point, and their close affinity is thus rendered more probable.

These few facts will, I trust, throw some light on the affinities of the Reptiles known as the *Dinosauria*. The problem is certainly one of much difficulty, and I hope soon to discuss it more fully elsewhere.

Classification of Dinosaurs.

In the present review of the Dinosaurs, I have confined myself mainly to the type specimens which I have described, but have included with them other important remains where these were available for investigation. The extensive collections in the museum of Yale University contain so many of the important type specimens now known from America, that they alone furnish an admirable basis for classification, and it was upon these mainly that I first established the present system, which has since been found to hold equally good for the Dinosaurs discovered elsewhere. In the further study of these reptiles, it was also necessary to examine both the European forms and those from other parts of the world, and I have now studied nearly every known specimen of importance. These investigations have enabled me to make this classification more complete, and to bring it down to the present time.

Many attempts have been made to classify the Dinosaurs, the first being that of Hermann von Meyer, in 1830. The name *Dinosauria*, proposed for the group by Owen, in 1839, has been generally accepted, although not without opposition. Hæckel, Cope, and Huxley followed, the last in 1869 proposing the name *Ornithoscelida* for the order, and giving an admirable synopsis of what was then known of these strange Reptiles and their affinities. Since then, Hulke, Seeley, and Lydekker, Gaudry, Dollo, Baur, and many others, have added much to our knowledge of these interesting animals. The remarkable discoveries in North America, however, have changed the whole subject, and in place of fragmentary specimens, many entire skeletons of Dinosaurian reptiles have been brought to light, and thus definite information has replaced uncertainty, and rendered a comprehensive classification for the first time possible.

The system of classification I first proposed in 1881 has been very generally approved, but a few modifications have been suggested by others that will doubtless be adopted. This will hardly be the case with several radical changes recently advocated, based mainly upon certain theories of the origin of Dinosaurs. At present these theories are not supported by a sufficient number of facts to entitle them to the serious consideration of those who have made a careful study of these reptiles, especially the wonderful variety of forms recently made known from America.

Further discoveries may in time solve the problem of the origin of all the Reptiles now called Dinosaurs, but the arguments hitherto advanced against their being a natural group are far from conclusive. The idea that the *Dinosauria* belong to two or more distinct groups, each of independent origin, can at present claim equal probability only with a similar suggestion recently made in regard to mammals. This subject of the origin of the Dinosaurs and the relation of their divisions to each other will be more fully treated by me elsewhere.

A classification of any series of extinct animals is of necessity, as I have previously said, merely a temporary convenience, like the book shelves in a library, for the arrangement of present knowledge. In view of this fact and of the very limited information we now have in regard to so many Dinosaurs known only from fragmentary remains, it will suffice for the present, or until further evidence is forthcoming, to still consider the *Dinosauria* as a subclass of the great group of *Reptilia*.

Regarding, then, the Dinosaurs as a subclass of the *Reptilia*, the forms best known at present may be classified as follows:

Subclass DINOSAURIA, Owen.

Premaxillary bones separate; upper and lower temporal arches; no teeth on palate; rami of lower jaw united in front by cartilage only. Neural arches of vertebræ joined to centra by suture; sacral vertebræ united. Chevrons articulated intervertebrally. Cervical and thoracic ribs double-headed. Clavicles wanting. Ilium prolonged in front of the acetabulum; acetabulum formed in part by pubis; ischia meet distally on median line. Fore and hind limbs present, the latter ambulatory, and larger than those in front. Head of femur at right angles to condyles; tibia with procnemial crest; fibula complete; first row of tarsals composed of astragalus and calcaneum only, which together form the upper portion of ankle joint; reduction in number of digits begins with the fifth.

Order THEROPODA (Beast foot). Carnivorous.

Skull with external narial openings lateral; large antorbital vacuity; brain case incompletely ossified; no pineal foramen. Premaxillaries with teeth; no predentary bone; dentary without coronoid process; teeth with smooth compressed crowns, and crenulated edges. Vertebræ more or less cavernous; posterior trunk vertebræ united by diplosphenal articulation. Each sacral rib supported by two vertebræ; diapophyses distinct from sacral ribs. Sternum unossified. Pubes projecting downward, and united distally. Fore limbs small; limb bones hollow; feet digitigrade; digits with prehensile claws; locomotion mainly bipedal.

(1) Family *Megalosauridæ*. Lower jaws with teeth in front. Anterior vertebræ convexo-concave; remaining vertebræ biconcave; five sacral vertebræ. Ilium expanded in front of acetabulum; pubes slender. Femur longer than tibia. Astragalus with ascending process. Five digits in manus and four in pes.

Genus *Megalosaurus* (*Poikilopleuron*). Jurassic and Cretaceous. Known forms European.

(2) Family *Dryptosauridæ*. Lower jaws with teeth in front. Cervical vertebræ opisthocœlian; remaining vertebræ biconcave; sacral vertebræ less than five; ilium expanded in front of acetabulum; distal ends of pubes coössified and much expanded; an interpubic bone. Femur longer than tibia; astragalus with ascending process. Fore limbs very small, with compressed prehensile claws.

Genera *Dryptosaurus* (*Lælaps*), *Allosaurus*, *Cœlosaurus*, *Creosaurus*. Jurassic and Cretaceous. All from North America.

(3) Family *Labrosauridæ*. Lower jaws edentulous in front. Cervical and dorsal vertebræ convexo-concave; centra cavernous or hollow. Pubes slender, with anterior margins united; an interpubic bone. Femur longer than tibia; astragalus with ascending process.

Genus *Labrosaurus*. Jurassic, North America.

(4) Family *Plateosauridæ* (*Zanclodontidæ*). Vertebræ biconcave; two sacral vertebræ. Ilium expanded behind acetabulum; pubes broad, elongate plates, with anterior margins united; no interpubic bone. Femur longer than tibia; astragalus without ascending process. Five digits in manus and pes.

Genera *Plateosaurus* (*Zanclodon*), ? *Teratosaurus*, *Dimodosaurus*. Triassic. Known forms European.

(5) Family *Anchisauridæ*. Skull light in structure, with recurved, cutting teeth. Vertebræ biconcave. Bones hollow. Ilium expanded behind acetabulum; pubes rod-like and not coössified distally; no interpubic bone. Fore limbs well developed. Femur longer than tibia. Five digits in manus and four in pes. (See Plate X, figure 1.)

Genera *Anchisaurus* (*Megadactylus*), *Ammosaurus*, ? *Arctosaurus*, *Bathygnathus*, and *Clepsysaurus*, in North America; and in Europe, *Palæosaurus*, *Thecodontosaurus*. All known forms Triassic.

Suborder Cœluria (Hollow tail).

(6) Family *Cœluridæ*. Teeth much compressed. Vertebræ and bones of skeleton very hollow or pneumatic; anterior cervical vertebræ convexo-concave; remaining vertebræ biconcave; cervical ribs coössified with vertebræ; an interpubic bone. Femur shorter than tibia. Metatarsals very long and slender.

Genera *Cœlurus*, in North America; and *Aristosuchus*, in Europe. Jurassic.

Suborder Compsognatha.

(7) Family *Compsognathidæ*. Skull elongate, with slender jaws and pointed teeth. Cervical vertebræ convexo-concave; remaining vertebræ biconcave. Bones very hollow. Femur shorter than tibia. Ischia with long symphysis on median line. Three functional digits in manus and pes.

Genus *Compsognathus*. Jurassic. Only known specimen European. (Plate X, figure 3.)

Suborder Ceratosauria (Horned saurians).

(8) Family *Ceratosauridæ*. Horn on skull. Cervical vertebræ plano-concave; remaining vertebræ biconcave. Pelvic bones coössified; ilium expanded in front of acetabulum; pubes slender; an interpubic bone. Limb bones hollow. Manus with four digits. Femur longer than tibia; astragalus with ascending process; metatarsals coössified; three digits only in pes. Osseous dermal plates. (Plate X, figure 5.)

Genus *Ceratosaurus*. Jurassic, North America.

(9) Family *Ornithomimidæ*. Pelvic bones coössified with each other and with sacrum; ilium expanded in front of acetabulum. Limb bones very hollow. Fore limbs very small; digits with very long, pointed claws. Hind limbs of true avian type; feet digitigrade and unguiculate.

Genus *Ornithomimus*. Cretaceous, North America.

Suborder Hallopoda (Leaping foot).

(10) Family *Hallopidæ*. Vertebræ and limb bones hollow; vertebræ biconcave; two vertebræ in sacrum; acetabulum formed by ilium, pubis, and ischium; pubes rod-like, projecting downward, but not coössified distally; no postpubis; ischia with distal ends expanded, meeting below on median line. Fore limbs very small, with four digits in manus. Femur shorter than tibia; hind limbs very long, with three digits only in pes, and metatarsals greatly elongated; astragalus without ascending process; calcaneum much produced backward; feet digitigrade, unguiculate.

Genus *Hallopus*. Jurassic, North America.

Order Sauropoda (Lizard foot). Herbivorous.

External nares at apex of skull; premaxillary bones with teeth; teeth with rugose crowns more or less spoon-shaped; large antorbital openings; no pineal foramen; alisphenoid bones; brain case ossified; no columellæ; postoccipital bones; no predentary bone; dentary without coronoid process. Cervical ribs coössified with vertebræ; anterior vertebræ opisthocœlian, with neural spines bifid; posterior trunk vertebræ united by diplosphenal articulation; presacral vertebræ hollow; each sacral vertebra supports its own transverse process, or sacral rib; no diapophyses on sacral vertebræ; neural cavity much expanded in sacrum. Sternal bones parial. Ilium expanded in front of acetabulum; pubes projecting in front, and united distally by cartilage; no postpubis. Limb bones solid; fore and hind limbs nearly equal; metacarpals longer than metatarsals; femur longer than tibia; feet plantigrade, ungulate; five digits in manus and pes; second row of carpal and tarsal bones unossified. Locomotion quadrupedal.

(1) Family *Atlantosauridæ*. A pituitary canal; large fossa for nasal gland. Distal end of scapula not expanded. Sacrum hollow; ischia directed downward, with expanded extremities meeting on median line. Anterior caudal vertebræ with lateral cavities; remaining caudals solid.

Genera *Atlantosaurus*, *Apatosaurus*, *Barosaurus*, *Brontosaurus*. Include the largest known land animals. Jurassic, North America. (Plate X, figure 2.)

(2) Family *Diplodocidæ*. External nares superior; no depression for nasal gland; two antorbital openings; large pituitary fossa; dentition weak, and in front of jaws only; brain inclined backward; dentary bone narrow in front. Ischia with shaft not expanded distally, directed downward and backward, with sides meeting on median line. Sacrum hollow. Caudal vertebræ deeply excavated below; chevrons with both anterior and posterior branches.

Genus *Diplodocus*. Jurassic, North America.

(3) Family *Morosauridæ*. External nares lateral; large fossa for nasal gland; small pituitary fossa; dentary bone massive in front. Shaft of scapula expanded at distal end. Sacral vertebræ nearly solid; ischia slender, with twisted shaft directed backward, and sides meeting on median line. Anterior caudals solid.

Genera *Morosaurus*, ?*Camarasaurus* (*Amphicœlias*). Jurassic, North America.

(4) Family *Pleurocœlidæ.* Dentition weak; teeth resembling those of *Diplodocus.* Cervical vertebræ elongated; centrum hollow, with large lateral openings; sacral vertebræ solid, with lateral depressions in centra; caudal vertebræ solid; anterior caudals with flat articular faces, and transversely compressed neural spines; middle caudal vertebræ with neural arch on front half of centrum. Ischia with compressed distal ends, meeting on median line.

Genus *Pleurocœlus.* ? Jurassic, North America.

(5) Family *Titanosauridæ.* Fore limbs elongate; coracoid quadrilateral. Presacral vertebræ opisthocœlian; first caudal vertebra biconvex; remaining caudals procœlian; chevrons open above.

Genera *Titanosaurus* and *Argyrosaurus.* ? Cretaceous, India and Patagonia.

European forms of the order *Sauropoda* are *Bothriospondylus*, *Cardiodon* (*Cetiosaurus*), *Chondrosteosaurus*, *Eucamerotus*, *Ornithopsis*, and *Pelorosaurus.* All probably Jurassic.*

Order PREDENTATA. Herbivorous.

Narial opening lateral; no antorbital foramen; brain case ossified; supra-orbital bones; teeth with sculptured crowns; maxillary teeth with crowns grooved on outside; lower teeth with grooves on inside of crown; a predentary bone; dentary with coronoid process. Cervical ribs articulating with vertebræ; each sacral rib supported by two vertebræ. Ilium elongated in front of acetabulum; prepubic bones free in front; postpubic bones present; ischia slender, directed backward, with distal ends meeting side to side. Astragalus without ascending process.

Suborder STEGOSAURIA (Plated lizard).

No teeth in premaxillaries; teeth with distinct compressed crowns, and serrated edges. Fore limbs small; locomotion mainly quadrupedal. Vertebræ and limb bones solid. Pubes projecting free in front; postpubis present. Femur longer than tibia. Feet plantigrade, ungulate; five digits in manus and four in pes; second row of carpals unossified. Osseous dermal armor.

(1) Family *Stegosauridæ.* Vertebræ biconcave. Neural canal in sacrum expanded into large chamber; ischia directed backward, with sides meeting on median line. Dorsal ribs T-shaped in cross section. Astragalus coössified with tibia; metapodials very short. Five digits in manus; three functional digits in pes. (Plate X, figure 8.)

* The Wealden is here regarded as upper Jurassic, and not Cretaceous. See this Journal, vol. 1, p. 412, November, 1895.

Genera *Stegosaurus* (*Hypsirhophus*), *Diracodon*, ?*Dystrophæus*, *Palæoscincus*, *Priconodon*, all from North America; and in Europe *Omosaurus*, Owen. Jurassic and Cretaceous.

(2) Family *Scelidosauridæ.* Astragalus not coössified with tibia; metatarsals elongated; three functional digits in pes.

Genera *Scelidosaurus*, *Acanthopholis*, *Hylæosaurus*, *Polacanthus.* Jurassic and Cretaceous. Known forms all European. (Plate X, figure 6.)

(3) Family *Nodosauridæ.* Heavy dermal armor. Bones solid. Fore limbs large; feet ungulate.

Genus *Nodosaurus.* Cretaceous, North America.

Suborder CERATOPSIA (Horned face).

(4) Family *Ceratopsidæ.* Premaxillaries edentulous; teeth with two distinct roots; skull surmounted by massive horn-cores; a rostral bone, forming a sharp, cutting beak; expanded parietal crest, with marginal armature; ? a pineal foramen. Vertebræ solid; anterior cervical vertebræ coössified with each other; posterior dorsal vertebræ supporting on the diapophysis both the head and tubercle of the rib; lumbar vertebræ wanting; sacral vertebræ with both diapophyses and ribs. Pubes projecting in front, with distal end expanded; postpubic bone rudimentary or wanting. Limb bones solid; fore limbs large; femur longer than tibia; feet ungulate; locomotion quadrupedal.

Genera *Ceratops*, *Agathaumas*, *Monoclonius*, *Polyonax*, *Sterrholophus*, *Torosaurus*, *Triceratops*, in North America; and in Europe *Struthiosaurus* (*Cratæomus*). All are Cretaceous. (Plate X, figure 10.)

Suborder ORNITHOPODA (Bird foot).

Premaxillaries edentulous in front. Vertebræ solid. Fore limbs small. Pubes projecting free in front; postpubis present. Feet digitigrade; three to five functional digits in manus and three to four in pes; locomotion mainly bipedal.

(5) Family *Camptosauridæ* (*Camptonotidæ*). Premaxillaries edentulous; teeth in single row; a supra-orbital fossa. Anterior vertebræ opisthocœlian; sacral vertebræ with peg and notch articulation. Limb bones hollow; fore limbs small. Postpubis reaching to the distal end of ischium. Femur longer than tibia, and with pendent fourth trochanter; hind feet with four digits. (Plate X, figure 7.)

Genus *Camptosaurus* (*Camptonotus*). Jurassic, North America.

(6) Family *Laosauridæ.* Premaxillaries edentulous; teeth in single row. Anterior vertebræ with plane articular faces; sacral vertebræ coössified. Sternum unossified. Limb and

foot bones hollow; fore limbs very small; five digits in manus; femur shorter than tibia; metatarsals elongate; four digits in pes.

Genera *Laosaurus* and *Dryosaurus*. Jurassic, North America. (Plate X, figure 4.)

(7) Family *Hypsilophodontidæ*. Premaxillaries with teeth; teeth in single row. Anterior vertebræ opisthocœlian; sacral vertebræ coössified. Sternum ossified. Limb bones hollow; five digits in manus; femur shorter than tibia; hind feet with four digits.

Genus *Hypsilophodon*. Wealden, England. (Plate X, figure 9.)

(8) Family *Iguanodontidæ*. Premaxillaries edentulous; teeth in single row. Anterior vertebræ opisthocœlian. Sternal bones ossified. Postpubis incomplete. (Plate X, figure 11.)

Genera *Iguanodon*, *Vectisaurus*. Jurassic and Cretaceous. Known forms all European.

(9) Family *Trachodontidæ* (*Hadrosauridæ*). Premaxillaries edentulous; teeth in several rows, forming with use a tesselated grinding surface. Cervical vertebræ opisthocœlian. Limb bones hollow; fore limbs small. Femur longer than tibia.

Genera *Trachodon* (*Hadrosaurus*, *Diclonius*), *Cionodon*. Cretaceous, North America.

(10) Family *Claosauridæ*. Premaxillaries edentulous; teeth in several rows, but a single row only in use. Cervical vertebræ opisthocœlian. Limb bones solid; fore limbs small. Sternal bones parial. Postpubis incomplete. Feet ungulate; three functional digits in manus and pes. (Plate X, figure 12.)

Genus *Claosaurus*. Cretaceous, North America.

(11) Family *Nanosauridæ*. Teeth compressed and pointed, and in a single, uniform row. Cervical and dorsal vertebræ short and biconcave. Limb bones and others very hollow; fore limbs of moderate size. Sacral vertebræ three; ilium with very short pointed front, and narrow posterior end. Femur curved, and shorter than tibia; fibula pointed below; metatarsals very long and slender. Anterior caudals short.

Genus *Nanosaurus*. Jurassic, North America. Includes the smallest known Dinosaurs.

EXPLANATION OF PLATE X.

Restorations of Dinosaurian Reptiles.

In this plate, the scientific name, the size, geological formation, and country where found, are given under each of the twelve figures. The skeletons here restored are represented in the same general position, to aid in comparing them with each other.

This plate is a reduced copy of the chart shown at Leyden, when the present paper was read. The same chart was also shown at the meeting of the British Association, Ipswich, September 14, 1895.

Plate missing!

SCIENTIFIC INTELLIGENCE.

I. Chemistry and Physics.

1. *A Method for completely dehydrating Alcohol* is recommended by H. Wislicenus and L. Kaufmann, which seems very convenient and practical, and which will probably fill a long-felt want in the laboratory. The reagent used is amalgamated aluminium, which can be prepared in a few moments by treating aluminium filings, free from oil, with caustic soda solution until a brisk evolution of hydrogen is produced, then washing once superficially with water and allowing a $\frac{1}{2}$ per cent solution of corrosive sublimate to act for one or two minutes upon the metal, which is still moist with weak alkali solution. The whole operation is rapidly repeated to remove a black scum which forms, and the product is quickly and thoroughly washed with water, alcohol and ether in succession, and is preserved, if necessary, under low-boiling petroleum-ether. Aluminium filings are on the market, at least in Germany, at a reasonable price. The amalgamation of this metal changes its chemical properties in a remarkable manner, so that it decomposes water violently, and it even becomes hot spontaneously from the action of the moisture of the air, with formation of white flakes of aluminium hydroxide. The reagent has no action upon alcohol and ether, but it reacts promptly with any water contained in them. The authors especially recommend the substance for use in organic chemistry as an entirely neutral reducing-agent.—*Berichte deutsch. chem. Ges.*, xxviii, 1323, June, 1895. H. L. W.

2. *Carbon in Meteoric Irons.*—The well-known finding of diamonds in the Cañon Diablo meteorite has led Moissan to examine several other holosiderites. Five irons, from Texas, Scotland, Chili, Mexico and Russia were studied, but in no case were diamonds found. The author concludes from this investigation that in some metallic meteorites there is no carbon, in others carbon exists either in an amorphous condition or mixed with graphite, and finally, that up to the present time the Cañon Diablo meteorite is the only one known which contains three forms of carbon, viz., black and transparent diamond, graphite and amorphous carbon.—*Compt. Rend.*, cxxxi, 483. H. L. W.

3. *A Study of Amorphous Boron.*—Moissan has investigated the nature of this substance, as prepared by reduction with an alkali-metal according to previously described methods, and finds that such products are very impure. He has succeeded, however, in preparing almost absolutely pure amorphous boron by igniting an excess of anhydrous boracic acid with magnesium powder in a crucible by means of a gas-furnace, then treating the product with acids and igniting it with more boracic anhydride, to remove some remaining magnesium boride, and washing the final product with acids. Special precautions were taken to exclude atmospheric