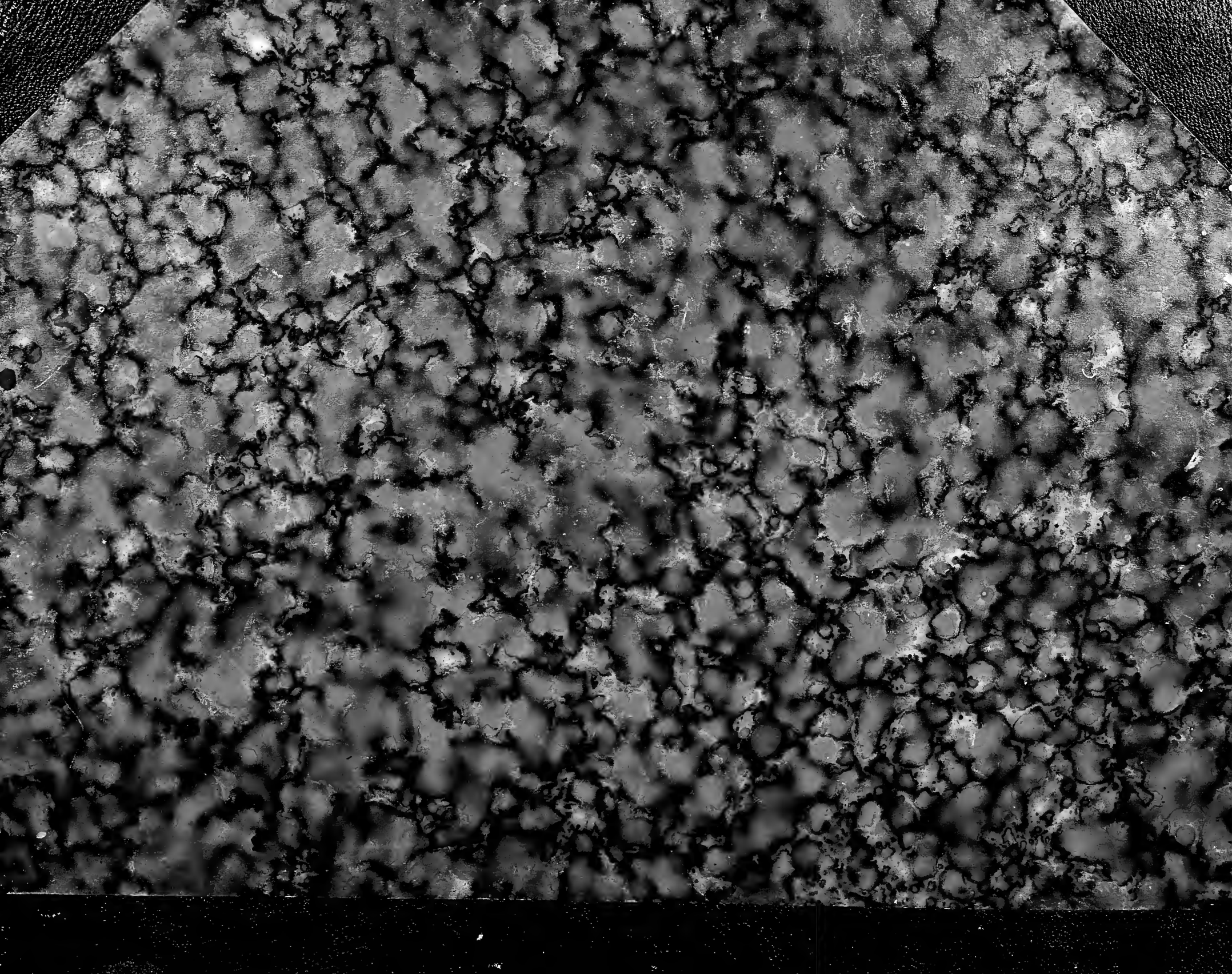

To M. Rodwell Field from the Author

ON A

FOSSIL SAURIAN

OF THE

NEW RED SANDSTONE FORMATION

OF PENNSYLVANIA,

WITH SOME

ACCOUNT OF THAT FORMATION.

ALSO: ON SOME

NEW FOSSIL MOLLUSCS,

IN THE

CARBONIFEROUS SLATES

OF THE

ANTHRACITE SEAMS OF THE WILKESBARRE COAL FORMATION.

BY

ISAAC LEA,

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PHILADELPHIA:

MERRIHEW & THOMPSON, PRINTERS, No. 7 CARTER'S ALLEY.

1852.

Description of a Fossil Saurian of the New Red Sandstone Formation of Pennsylvania; with some account of that Formation.

By Isaac Lea,
Mem. Am. Phil. Soc., The Acad. of Nat. Sci., &c.

The existence of "fossil footmarks" was received with great doubt by geologists, when first announced, and it required numerous observations before such geological evidence was generally accredited.

It appears that Dr. Duncan first noted these interesting and peculiar relics of ancient life, in 1828, having observed the impressions made by tortoises in the "New Red Sandstone" of Dumfriesshire in Scotland. A few years after this, among other discoveries, was that of the tracks of the *Cheirotherium* (*Labyrinthodon* of Owen) in Saxony, where it was found also in the "New Red Sandstone."

In this country, Dr. Deane and Professor Hitchcock observed fossil footmarks in the "New Red Sandstone" of the Valley of the Connecticut River, the age of which has been recently doubted by Elie de Beaumont and Dr. Jackson, who think it belongs to a lower member of the series. I do not myself incline to that opinion, having no doubt of its being a member of that group of red sandstones which form the masses between the carboniferous strata and the Lias. In 1836 Professor Hitchcock published his account of bird tracks, (Ornithichnites,) in the American Journal of Science, and his statements were received with a good deal of doubt, until, by repeated observations and publications by himself and others, geologists generally became satisfied with the established fact, that while there had not been found a single bone in these rocks, yet the undoubted foot-prints of numerous species of birds and reptiles, gave the fullest and most satisfactory evidence that, at that geological epoch, immensely remote, the plastic shores of these waters received the impression of numerous air breathing animals. Prof. Forbes has recently observed that "the *symmetry* with which the prints succeeded each other on the surface of the sandstone, &c., furnished an agreement, geometrical, no doubt."

Two years subsequently various foot-marks were found in the New Red Sandstone near Liverpool, and, subsequently again, they were found in various parts of England, and on the continent, in the same formation, as well as in more recent strata.

In the Valley of the Connecticut, Professor Hitchcock informs us, that sixteen quarries are known to produce foot-marks, and Mr. Redfield has observed them at Pompton, in New Jersey; and, more recently, they have been found near Princeton, New Jersey, by Mr. Jones, an industrious young naturalist of the College there. In

(From Journ. Acad. Nat. Sci., Part 3, Vol. II., N. S.—Read May 11th, 1852.)

some cases, in the Connecticut Valley, the impressions are so numerous as to create a confused surface, and the distinct foot-marks in the vicinity only prove their identity. The evidence of "ripple marks" which usually accompany these foot-marks, prove them to be littoral, and the marks of "rain drops" are often observed with them. Some of the birds which left their foot-impressions in these rocks were of gigantic size, far larger than any living species, but not of greater dimensions than some of those described by Prof. Owen, the bones of which were taken to London from New Zealand, and which he named *Dinornis*..

Accompanying the numerous species of *Ornithichnites* in the Connecticut Red Sandstone, Prof. Hitchcock found foot-marks of *Sauroid* animals, of which he has given descriptions and figures in the Memoirs of the American Academy of Arts and Sciences, vol. 3d, new series, as Dr. Deane has also done in vol. 4th, all of which had attracted great attention, when first published in the American Journal of Science. A new interest has, however, arisen in the discovery of fossil foot-marks of reptiles, air-breathing animals, in rocks of an earlier epoch; and geologists were startled with the announcement, a few years since, of Mr. Logan's discoveries in the coal rocks of Nova Scotia, and of Dr. King's, subsequently, near Greensburg, Pennsylvania, they having dicovered unquestionable foot-marks of reptiles in the sandstone of the coal measures; those of Dr. King accompanied by the tracks of birds. (?) Dr. King made his discovery known by a communication to the Academy of Natural Sciences of this city, in Dec., 1844. He described and figured, in the Proceedings, several "Saurian reptiles," and in the American Journal of Arts and Sciences, April, 1845, gave additional figures.

Mr. Lyell communicated to the American Journal of Science and Arts, October, 1843, the fact that Mr. Logan had discovered, in the "ripple marked sandstones" of Horton Bluff—coal formation of Nova Scotia—"footsteps, which appeared to Mr. Owen to belong to some unknown species of reptile, constituting the first indications of the reptilian class known in the carboniferous rocks."

No Saurian foot-prints had, before these announcements, been found lower in the series than the *New Red Sandstone.* Dr. King states that the tracks found by him were on the exposed surface of a stone "fifteen by twenty feet, rising, like the other rocks in the neighborhood, to the west, and dipping, at a small angle, to the east. It is a coarse grained sandstone, about 150 feet below the largest of our coal seams, and near 800 feet beneath the topmost stratum of our coal formation. From the fact of the existence of numerous holes or pots, some of which will hold fifteen or twenty gallons, excavated, as we know they are at the present day, by the whirling of pebbles, set in motion by a running stream, I infer that the stone must have lain in the bed of a river which was subject to partial periodical desiccation."* "In another locality, about twelve miles distant, but in the same synclinal axis, on a slab

* Proceedings of the Acad. Nat. Sci., v. 2, p. 178.

of fine grained micaceous sandstone, which was taken from a quarry about fifty feet beneath the rock already described, I found beautiful imprints of hind and fore feet of an animal, which I have ventured to refer to the *class Mammalia* and *order Marsupialia.* The hind and the fore feet are obviously different. On the hind foot the toes are five, on the fore foot there are but four," &c.* These discoveries were followed up by others, of "foot-prints" in the red sandstones of Schuylkill county, Pa., Formation No. 11 of Prof. Roger's State Reports. In April, 1849, I observed in these red and grey rocks which underlie the conglomerate, (considered by Mr. Taylor, Mr. Hall, and other geologists, as the equivalent of the "Old Red Sandstone" of Europe,) a fine series of six pairs of foot-marks, which I referred to impressions made by a saurian, and which I named *Sauropus primævus.* (See Proceedings Am. Phil. Soc., 1849, and Trans., Vol. x., 1852.)

Subsequently foot marks were found near Montreal by Mr. Logan, in the Potsdam sandstone, which he, Mr. Lyell and Prof. Owen, attribute to *Chelonians*, "probably an estuary Emydian Tortoise."†

The very able memoir of Prof. Hitchcock, on the foot-prints of the New Red Sandstone of the Valley of the Connecticut, read before the American Academy of Arts and Sciences, April, 1848, Volume Third, gives us a systematic account of forty-nine species of fossil foot-marks of the United States, with numerous exceedingly well executed illustrations. Of these, twelve were quadrupeds, two were annelids or molluscs, three of doubtful character, and the remaining thirty-two were bipeds, chiefly birds, some of which were of gigantic size.

Heretofore there had been no well established fact of the bones of *Saurians* or

* Proceedings of the Acad. Nat. Sci., vol. 2, p. 179, and Am. Journ. of Arts and Sciences, vol. 48, p. 348. The reference of this animal to the order *Marsupialia* is no doubt an error, as it seems to be more of a *Batrachian*, and Dr. King, in his subsequent communication to the American Journal of Arts and Sciences, says the difference in the number of toes on the hind and fore feet, seem to indicate an alliance with the Batrachians. Professor Hitchcock has, in fact, in his description of it, in the Memoirs of the American Academy of Arts and Sciences, vol. 3, p. 218, placed this species under Dr. King's name as *Thenaropus heterodactylus*; and he says "that it is possible that it might have been a Chelonian. More probably, however, it was a Batrachian," in which latter opinion I should certainly concur.

† It is only due to American science to say, that great doubt has existed in the minds of geologists here, as to these tracks being made by vertebrate animals. Several members of the Academy of Natural Sciences of this city, about four months since, tried some experiments with a living tortoise; and we all came to the conclusion that the foot-marks, as represented, of the so-called Chelonians, could not have been made by the locomotion of a tortoise.

Within a few days I observe, by a report of the meeting of the Geological Society of London, March 24th, that Mr. Owen himself had come to the conclusion, that the impressions in the Potsdam sandstone rocks of Beauharnois, near Montreal, could not have been made by Chelonians. The "foot marks," therefore, of the red sandstones near Pottsville, above mentioned, present the oldest known air-breathing animal in the Palæozoic rocks of this continent, and the oldest on record, except the Chelonian foot-prints in the Old Red Sandstone of Morayshire, and the skeleton of a reptile supposed, by Dr. Mantell, to be Lacertian, and called by him *Telerpeton*, if they be really lower in the series.

Batrachians having been found in the New Red Sandstone of this country; but recently some of the vertebræ, ribs, and teeth of a Sauroid animal, of considerable size have been found, near Hassac's creek, in Upper Milford, Lehigh county, Pa., by Dr. J. Y. Shelley, of Berk's county, who presented them to the Academy of Natural Sciences, in November, 1847. These interesting fossil remains were supposed to be coeval with the fossil foot-prints which Dr. King discovered in the sandstones of the coal measures. In the examination of them I came to a different conclusion, and I am of opinion that they belong to the well known New Red Sandstone formation of Pennsylvania.* (See Proceedings Acad. Nat. Sci., vol. 5, pp. 171 and 205, *Clepsysaurus Pennsylvanicus*, Lea.) The lithological character of the rock, (impure conglomerate limestone,) and its geographical position, would indicate this; and there need be no disappointment in this reference to a later period, for this specimen has the great interest of being, so far as I know, the only well authenticated portion of a skeleton of a *Saurian* found in the new red sandstone of this country. In Europe, some of the bones and teeth of the *Cheirotherium* have been found in the Triassic portion of the new red sandstone, of which the tracks had long been noticed. These prove it to be a gigantic Batrachian. Also the tracks, and subsequently the bones of the *Rhyncosaurus articeps*, Owen, were discovered in the *Upper New Red Sandstone* near Shrewsbury. In the Magnesian Limestone the *Thenaropus* had been observed, and in the Muschelkalk the *Nothosaurus*.

The "New Red Sandstone" formation, so called, of the United States, seems to belong, or rather to consist of a single member of the system. The "New Red Sandstone" of British and Continental geologists, has been divided into "Lower New Red Sandstone," (Permian,) and "Upper New Red Sandstone," (Trias,) these divisions being sub-divided usually into three parts each; the lower portion of the Permian is known in Germany as "Rothliegendes," the second as "Zechstein," the third as "Magnesian Limestone." The "Trias," is divi ded by Lyell into Lower, Middle and Upper Trias; but these divisions are better known as "Bunter Sandstone," "Muschelkalk," and "Keuper."

In the Virginia and Pennsylvania State Reports, the Messrs. Rogers call this great belt of red sandstone and conglomerates, the "Middle Secondary Red Sandstone." It passes from South Carolina, along the eastern border of the first range of

* Some doubt has arisen in the minds of some of our geologists, as stated before, as to the identity of the New Red Sandstone of Europe with the red sandstone formation which stretches, like a great river, through our Middle States. Dr. Jackson says he "agrees with Elie de Beaumont, that what is here called the New Red Sandstone, is not the same as the New Red Sandstone (properly so-called) of Europe." Geologists generally, in this country, have dissented from Mr. Maclure's idea of its being the Old Red Sandstone, and they have placed it correctly as the analogue of the European New Red Sandstone. This is the opinion of Prof. Hitchcock and Prof. Agassiz, and other eminent geologists, and is certainly my own. Its position in that group will be treated of hereafter.

mountains, in a slightly interrupted, rather curved line, to the Hudson river at Stony Point, its greatest breadth being about thirty miles, and always resting unconformably to the primary rocks beneath. To the eastward of this it appears in the Valley of the Connecticut, and extends through Massachusetts, north, near to the Vermont State line.

The first notice of the existence of this red sandstone, seems to be in the Transactions of the American Phil. Soc., in 1799, by Th. P. Smith. In examining the "basaltes" of the Conewago Hills, he found "they were interspersed with large masses of *brechia*, composed of *silicious* pebbles, evidently rounded by friction, imbedded in the red freestone of our mountains." These pebbles were probably *calcarious*, not silicious, and the same now known as *Potomac Marble*. Chief Justice Gibson, in a paper, on the Trap Rocks of the Conewago Hills, in the same Transactions, 1820, followed Mr. Maclure's views in considering this the Old Red Sandstone.

This red sandstone formation was considered by Mr. Maclure, in his Geology of the United States,* to be analogous to the Old Red Sandstone of Europe; but that error was, a long time since, obvious to the Geologists of this country. The great difficulty which presented itself was in the absence of organic remains, these not having then been observed. The lithological characters are so nearly the same with the *Old Red Sandstone*, that, relying on them only, the mistake was very natural.

Subsequently, organic forms were observed in the imprinted foot-marks of Birds and Batrachians, by Dr. Deane and Prof. Hitchcock,—heterocercal fish by Mr. Redfield, and some obscure fucoids by Prof. Mather, as well, also, thin seams of ligniform coal. These were followed by Prof. H. D. Rogers having observed "distinct impressions of Encrini," in the fragments which composed the calcareous conglomerates, used, under the name of *Potomac Marble*, in the columns of the Senate Chamber at Washington. The origin of these fragments, Prof. W. B. Rogers refers, at their nearest source, to the great Valley west of the Blue Ridge in Virginia, which ridge in Pennsylvania is known under the name of the South West Mountains, or Conewago Hills. This valley is formed of the earlier palæozoic rocks, and embraces formations No. 1, 2 and 3, of the Pennsylvania State Reports. They are equivalents of the Potsdam Sandstone, Calciferous Group, and Black River Limestones of the New York Geologists. These, lying contiguous on the western border of the Red Sandstone formation, would naturally present the materials for such a deposit, and, therefore, we have that which appears to be the result of the forces in action at the time, breaking into fragments, and rolling into forms more or less irregular, the component rocks of the older strata of the district which now forms the valley, the present intervening range of mountains having been subsequently

* Transactions of the American Philosophical Society, vol. 1, new series.

elevated in their present irregular condition. But one or two Molluscs, it would seem, had been observed, heretofore, indicating their existence during the period of this formation. In a future portion of this paper I shall show that another did exist in the "Potomac Marble."

It has been well known for a long time, that the calcareous conglomerates of this Red Sandstone formation, formed the North-Western border of it, with some interruptions and some changes in its composition, resulting from its derivative rocks. Thus we find it in Rockland County, in the State of New York, near to the New Jersey line; and Prof. Mather describes it under the name of "Red Conglomerate Limestone," and states that "it occurs at or near the junction of the red sandstone formation with the primitive rocks," that it is composed mostly of pebbles and angular fragments of grey and black limestone, (like the adjacent limestone,) mixed with pebbles of quartz, granite, gniess, hornblende, sienite, &c., and all cemented together by a reddish argillo-calcareous paste, mixed with gravel and sand of the various materials mentioned." "In its general aspect it is similar to the Potomac Marble." He considers them "to be among the last formed rocks of the Red Sandstone division," and formed of the beds of a limestone, of more ancient date in the vicinity, and "near the ancient shore on which the attrition may have been effected."

Proceeding from the State of New York into New Jersey, we find these limestone conglomerates at Pompton, at Germantown, and at Spring Mills on the Delaware fifteen miles below Easton. In the New Jersey Reports, Prof. Rogers names it "Variegated Calcareous Conglomerates," and calls it a heterogeneous, though well characterized rock, which "may be regarded as a distinct formation from the group of red shales and sandstones beneath it, being the result of a wholly different train of physical causes." He considers it to constitute the uppermost member of the middle secondary series, overlying the red shale along its north-western margin, in insulated patches near the foot of the primary hills. (p. 135.) In its line south-westwardly, I recognized this *Calcareous Conglomerate* on Hassac's Creek, in Upper Milford, Lehigh County, Pa., where Dr. Shelly found the interesting Saurian bones which he presented to this Academy, and which, in April of last year, I stated to be the fossil bones of a "*reptilian quadruped*," which I proposed to call *Clepsysaurus Pennsylvanicus*.* (χλεψύδρα, hourglass.) From this point to the Schuylkill three miles below Reading, this rock may be observed in various places, and, where the Reading Railroad crosses it by a deep cut, it is exposed for nearly a mile, as a beautifully variegated limestone conglomerate, properly a breccia, so coarse sometimes in its materials as to present pieces quite eighteen inches in diameter. Continuing on the same line of direction, it crosses the Susquehanna at Bainbridge, and the Potomac south of Frederick, and there affords the "Potomac Marble."

* See Proceedings of the Academy of Natural Sciences, 1851, pp. 171 and 205.

In the Report Prof. Rogers gives us his theory of the formation of this extensive sedimentary deposit. He divides it, under the name of "Middle Secondary Rocks," into two portions:

"1. Variegated calcareous conglomerate. Generally a very heterogenous rock, in which a large portion of the pebbles are limestone, the cement consisting chiefly of red argillaceous earth.

"2. Red argillaceous sandstones and red shales. Towards the lower part of the formation, contains numerous beds of coarse gray arenaceous sandstone." (p. 10.)

He considers that "all these rocks of the middle secondary dates, of which the argillaceous red and brown sandstone is the prominent and characteristic variety, appear from numerous geological indications, to have been produced at a period subsequent to the elevation of the lower secondary strata, including the coal deposits. They seem to have originated in a long narrow trough, which had its source as far south at least as the eastern base of the Blue Ridge in Virginia and North Carolina, and which probably opened into the ocean somewhere near the present position of the Raritan and New York Bays. Their materials give evidence of having been swept into this estuary, or great ancient river, from the south and south-east, by a current producing an almost universal dip of the beds towards the north-west,* a feature clearly not caused by any uplifting agency, but assumed originally at the time of their deposition, in consequence of the current from the opposite or south-eastern shore." After some observations on the igneous intruding rocks, Prof. Rogers observes that "the organic remains hitherto discovered are extremely few, and the evidence they afford is not sufficient to establish within near limits the area to which the strata should be referred." "Later, therefore, than the carboniferous rocks and earlier than the green-sand, the most appropriate title claimed by this group of strata would seem to be that of the *middle secondary series*. Though they present an obvious analogy in general aspect and composition to the new red sandstone rocks of Europe, and may in fact have originated somewhere about the same epoch, yet I must prefer the above designation in the present state of geological research, because the other name involves the notion of an identity of age, which, from the singular paucity of organic remains in the American group, may probably never be susceptible of demonstration." (p. 117.)

Prof. Rogers' opinion is, that the red coloring matter of this "Calcareous Conglomerate" is derived from the red rocks below it, and such no doubt is the case, as the pasty cement is frequently composed of argilaceous matter. Near the village of Pompton in New Jersey, it was detected in contact with the inferior sandstone formation and the conformability of the rocks clearly ascertained.

To sustain his theory of this being the deposit of an extensive ancient river, having its source in the Southern States, and its estuary in the region of the Raritan and the

* At angles varying from 15° to 25.°

Hudson rivers, he mentions the fact that it forms a gently inclined plane, descending from its source in Carolina several hundred feet above the sea to its estuary on a level with the ocean. A full account of Prof. Rogers' views will be found in his New Jersey report, and the facts and observations adduced by him strongly recommend the acceptance of his theory. Certainly the position of the deposit and its mineral contents would go to sustain his ideas, but the fact that we have not the evidence of its being a fresh water deposit would induce us to have some hesitation on the subject. It would seem that from its inclined position and its forming a broad estuary in an arm of the sea, that it must necessarily have been of fresh water origin; but in its organic remains, the paucity of which is remarkable, we have no evidence to that effect. The numerous bird, Batrachian and Saurian tracks, represent the littoral character of its condition, as the ligneous coal also does. The Saurian bones mentioned by Mr. Wells, of which there has been some doubt expressed, and those of the *Clepsysaurus* described by me, may have belonged to species living either in fresh or salt water.

There seems to be no reason to doubt of the red sandstone formation of the Connecticut Valley being of the same period with that which sweeps through the Middle States to New York. It consists of a narrow belt, commencing in the Valley within four miles of the Vermont State line, and passing south through Massachusetts it terminates in Connecticut, where it is supposed by Prof. Adams, that "the Connecticut River emptied into a long narrow bay, which reached up from Long Island Sound, nearly to, or quite over the southern line of Vermont and in which the sandstone deposits accumulated."* He considers that most of this deposit had its origin in the rocks of the State of Vermont, as Prof. Hitchcock had found some of the coarse conglomerates near to that State to contain pebbles derived from Vermont rocks, and which some geologists regarded as indicating violent freshets. Prof. Hitchcock had considered it perhaps in the same light, as he viewed it as a tidal estuary. But, if this long narrow bay extended from Long Island Sound to the northern terminus of the deposit, it would prove the marine origin of the formation. I should doubt this, and would rather refer it to the same cause as that of the more South-Western deposit of which I have been treating. It would seem to me that both deposits had their origin in a district several hundred feet above tide water, and the waters flowing down an inclined plane deposited the debris according to dynamic laws. This view of the facts would tend to prove the fresh water origin of the formation, and I would be inclined to look rather for such organic remains as would sustain such an origin.

Prof. Mather in the New York Reports, does not agree in the view of the fluviatile origin of these red rocks, but considers them to have been deposited by the action of two oceanic currents, the polar and equatorial, flowing in opposite directions on the ancient coast of the Middle States, the meeting of which currents, regulated by known

* Second Geological Survey of Vermont, p. 160.

dynamic laws and the mountain chains occupying positions the same as they now do, and as they did at the period of the deposition of the red sand-stone strata, he considers sufficient to account for the position and form of the deposit, the wider portion being where the axis of rotation took place. (p. 292.)

The fossil fishes of this formation, to which the Messrs. Redfield and Prof. Hitchcock have given so much attention, are all heterocercal so far as observation has yet gone, and must be at least as old as the New Red Sandstone. But I am not aware that this character implies a necessity of their having lived only in salt water. On the contrary as they are *Ganoides*, and belong to one family, *Lepidoides*, which includes the *Esox osseus* of our western waters, the evidence is in favor of their having been inhabitants of fresh water. Mr. W. C. Redfield has found many species of two genera, *Palæoniscus* and *Catopterus*,* at Boonton and Pompton in New Jersey, and in several places in Massachusetts and Connecticut. He remarks that at Boonton the fish beds are under the "variegated calcareous conglomerate," and that at Pompton a second fish bed of bituminous shale lies two hundred feet below the other.

Mr. Redfield informs me that some of the fossil fishes from the Oolitic coal field of Virginia, were considered by Sir Philip Egerton to be homocercal, and that they belonged to the genus *Dictyopege*. But Mr. Redfield differed in opinion as to the character of their tails, which he considered to be *oblique*, and that in this oblique character these Virginia fishes are scarcely distinguishable from the *Catopterus* of the New Jersey and Connecticut red sandstones. Indeed, that "all the fishes of this red sandstone formation from New Jersey, Connecticut and Massachusetts, have the same character of tail with those from the coal of Virginia." Mr. Redfield mentioned at the same time, that the genus *Dictyopege* would be dropt, in the new work of Redfield and Agassiz on these fossil fishes, but that the name of *Ischypterus* would be retained, for some, or most of the *Palæonisci* of Connecticut Valley. At the meeting of the American Association at Cincinnati, he stated that this formation was characterized by a flora and fauna as recent as the Trias.

Prof Hitchcock, who has labored so much in this hitherto sterile field to the palæontologist, in addition to his numerous discoveries in *Ornithichnites*, &c., has observed and figured several plants in this formation, which he refers to *Voltzia*, and which, with *Tæniopteris*, also found by him, are considered as characteristic plants, peculiar to the New Red Sandstone. Mr. Redfield also found impressions of plants which he refers to *Voltzia*. They are from the Little Falls of Passaic in New Jersey. In Virginia near Prince Edward's Court House, Prof. Rogers observed a deposit of coal which was nearly two feet thick, and in a brownish sandstone were inclosed thin seams of bituminous coal, the shales of which were impressed with rhombic fish scales, the rocks being slightly calcareous. He found, also, "black

* See American Journal of Science, Vol. 41, p. 24, and catalogue in De Kay's New York Reports, p. 385.

polished rhombic fish scales in the bituminous shales near Farmville, and at Leakesville, in North Carolina."

In regard to the character of the Molluscs which may have inhabited this formation, it is difficult to adduce them as much evidence, where so little is known. The almost total absence of fossil shells, or impressions, is most remarkable in the New Red Sandstone here, as it is, also, in Europe. In the Palæontological tables of M. D'Orbigny, there are a few genera given, as existing in his *Saliferien*, (the upper portion of the Trias,) and among the *Lamellibranchia* is the genus *Posidonia*, a species of which Prof. W. B. Rogers states he has found in Virginia, and which he refers to a well-known species in the *Keuper*, or uppermost division of the *Trias*, known as *P. Keuperi*.* He also mentions that, in Cumberland County, Virginia, in the Yellow Brown Sandstones, he found a spiral univalve and a rhombic fish scale.

To this I may add a minute species of *Gasteropoda*, which I suspect belongs to the genus *Loxonema*† and which I have observed in a polished specimen of the Potomac Marble,‡ and for which I propose the name of *Loxo. Poveliana*. These are the only *Molluscs* which have been, to my knowledge, found in the *New Red Sandstone* of this country. The question might now be asked, are these of marine or fresh water origin? I think it would be difficult to answer, with any degree of certainty. The shell of *Posidonia* has evidently been, in all the species, exceedingly fragile, and, as far as my knowledge extends, the casts only have been observed, and those rarely perfect. I doubt very much whether those found in the Carboniferous Formation can be properly placed in that genus, particularly if they be found in the slates of the coal seams, which are probably of fresh water origin.§ In the slates taken from the *anthracite beds* of Pennsylvania, I have found bivalves, which I should consider so much allied to the form of *Posidonia*, as not to think of separating them, had they not been in a coal slate. At the same time, I must say that the same slate contained impressions of a *lamellibranc*, which has all the external characters of the genus *Modiola*; which, however, would not exclude it from fresh water origin, as we have a living genus,

* But a few years ago it was considered in vain, Mr. W. King, author of "Permian Fossils," says, to look for fossils in this Formation in Europe. That there are now found fishes, shells, and impressions of footsteps, probably a Batrachian. That in Germany the *Posidonia minuta* is stated to pervade the new red system, from the *Keuper* to the *Bunter sandstone*, inclusive, but in England it is peculiar to the upper Formation, and very abundant in some of the beds. p. 338.

† The genus *Loxonema* was established by Phillips, for a shell near to *Chemnitzia*, and belongs to the Family *Melaniana*. It has been found in the Silurian and Permian Formations.

‡ This specimen, which my friend Samuel Powel, Esq., submitted to my examination, is the only one, of this conglomerate limestone, in which I have been enabled to detect the smallest remains of a mollusc. There are in it several fragments of whorls, and only one which has as much as three entire whorls. These present very closely the form and size of *L. Geinitziana*, King, from the Permian of England. The specimen is presented to the Academy by Mr. William Struthers.

§ The fossil plants, chiefly of the order *Felices*, which prevail in these slates to such an extent, must have been nourished in marshy fens of fresh water.

the *Dreissena* of Vanbeneden, (*D. polymorpha,*) which inhabits the Volga and other rivers of the north of Europe, and which has been transferred to, and diffused throughout Great Britain.

Professor Ansted states that "the whole of the upper new red sandstone of England bears evident marks of its marine origin, even if the occurrence of so large a quantity of salt associated with it, did not place the matter beyond a doubt. The almost total absence of fossils is, however, a very remarkable phenomenon, and one which is not satisfactorily accounted for, either by the prevailing sandy character of the deposit, or by the quantity of oxide of iron distributed through it."

The diffusion of salt mentioned here, and which is also well known to prevail throughout the formation in England, and on the Continent, is totally absent in the *New Red Sandstone* of this country, and in this character they altogether differ from each other. The salines of the United States are in the older palæozoic rocks, having their origin below the carboniferous series, but sometimes passing through the coal rocks to the surface, from the Silurian strata below.*

In May, of last year, I visited the locality of Upper Milford, in the hope of finding some other portions of the *Clepsysaurus*, or the remains of other animals in this locality. A diligent search was made, with the assistance of Dr. Shelley and another person, but we were not able to detect the smallest indication of further specimens. One of the principal objects of my visit was to ascertain clearly the position of the rocks from which the bones, in possession of the Academy, were exhumed. The spot, pointed out to me by Dr. Shelley, was at the point of a hill, in the excavation of which, for a road, the rocks were blasted, leaving a perpendicular wall of the confused calcarious conglomerate rock, which was here composed of small portions, cemented by a reddish or greyish, somewhat argillacious, paste, presenting the appearance of masseration, while in other localities the same rock has quite a brecciated and beautiful structure. This locality is near to the north-western boundary of this New Red Sandstone formation; and, in an early part of this paper, I have traced it to the South-west, across the Schuylkill, Susquehanna, and Potomac rivers.

In the present state of our knowledge of this calcarious portion of the red sandstone deposit of the United States, it is exceedingly difficult to come to a satisfactory conclusion as to its exact equivalent in Europe. On the whole, I am inclined to place it among the superior strata of the Permian system. I do not see any portion of the Magnesian Limestones, which present characters more analogous to ours than the "*Brecciated and Pseudo-brecciated Limestones*" of Mr. King's "Monograph of

* The Onondago Salt group gives origin to all the productive salines of New York. It constitutes No. 12 of the New York Survey: is part of No. 5 of the Pennsylvania survey, and forms the middle portion of the Upper Silurian of English geologists.

Permian Fossils." This is the second (b) of his six divisions of the Permian rocks, beginning at the top, and is included in the Zechstein of German geologists. He considers that the Permian rocks were deposited during the latest division of the Protozoic or primary organic period. Those of the Triassic in the earliest division of the Deuterozoic period. "The separation is based on the idea that organic nature underwent a marked change at the time the Permian rocks were being deposited. This idea invests the fossil remains of this rock with the utmost importance in philosophical geology."

He gives a very full account of the organic remains of the Permian system, and in his views in regard to its relations with the formations above and below it, he does not seem to be so decisive as to a well determined separation from the Trias, as most geologists of England at the present time. At the same time, he finds a stronger relation to the carboniferous series than to the Trias. In regard to the plants, he says, "doubtless a few large groups, and several genera appeared for the first time during the early part of this period; but there is nothing to indicate any great phytological break between the two widely separated systems—the Carboniferous and Triassic," &c. "Generically these periods are related to each other; they are, also, to a certain extent, specifically connected; it may, therefore, be fairly concluded that the Permian Flora did not differ, to any material extent, from either the Carboniferous or the Triassic." In regard to the molluscs, he says, "they bind together the Carboniferous, Permian and Triassic systems. Several species of the Carboniferous period continued to live, or were closely represented, in the Permian; and a few appear to have had their existence prolonged into the Triassic. There is a strong generic, and a faint specific relation running through the three systems; but taking all the classes into consideration, especially the Palliobranchiate, the relation has obviously more of a Protozoic than a Deuterozoic character." (p. xxv.)

In regard to the Permian fishes, Professor King considers them to be specifically distinct from those of the Carboniferous rocks. In its reptilian fauna, he says, as yet we cannot form any satisfactory conclusion, as to whether the Permian system is more related to the Carboniferous than to the Triassic. "The occurrence of Labyrinthodons and Rhynchosaurs in the Triassic rocks, and, according to the determination of Von Meyer, of Labyrinthodont forms (*Archigosaurus* and *Sclerophalus*) in the coal measures of Germany, shows that there is a strong reptilian connexion between the Carboniferous and Triassic systems." He considers "on hypothetical grounds, we are warranted in anticipating, that future researches will establish a more intimate reptilian connexion than at present prevails between these systems and the one intermediate to them—the Permian." His conclusions are that the Permian deposits are "co-ordinate with, and intermediate to, the Carboniferous and Triassic systems—including them in the Protozoic, rather than in the Deuterozoic period." (p. xxvi.)

Mr. Lyell finds great difficulty in pointing out the derivative rocks of this formation. He says:

"The brecciated limestone (No. 2,) contains no fragments of foreign rocks, but seems composed of the breaking-up of the Permian limestone itself, about the time of its consolidation. Some of the angular masses in Tynemouth Cliff are two feet in diameter. This breccia is considered by Professor Sedgwick as one of the forms of the preceding limestone, (No. 1,) rather than as regularly underlying it. The fragments are angular, and never water-worn, and appear to have been re-cemented on the spot where they were found. It is therefore suggested, that they have been due to those internal movements of the mass which produced the concretionary structure; but the subject is very obscure, and after studying the phenomenon in the Marston Rocks, on the coast of Durham, I found it impossible to form any positive opinion on the subject. The well-known brecciated limestones of the Pyrenees appeared to me to present the nearest analogy, but on a much smaller scale."*—*Lyell's Elementary Geology, 3d ed., p.* 302.

Prof. Sedgwick† views these deposits (all of the Trias and Permian) as being of violent mechanical origin, but having several characters in common, which enable us to connect them together, and, for general purposes of comparison, to regard them as one group. "The greatest difficulty in classing distant portions of the New Red Sandstones have not, however, so much arisen out of its mechanical origin and complexity of structure, as from its general want of conformity to all the inferior formations."

The inducements which lead me to lean towards the opinion that this calcarious conglomerate may be on the same horizon with the Magnesian Limestone of England, are in the lithological characters, in addition to the organic remains of the Magnesian Limestone. In the cabinet of our Academy we have a collection from Bristol, England, some of the specimens of which are so similar, in their brecciated form and in their colors, to some specimens I procured near Reading, as to defy a separation of the specimens if placed together. But the much more important characters consist in the similarity of the structure of the bones, together with the single small *Gasteropod*, found in the brecciated Limestone rocks of both continents. The *Thecodonts* from Bristol are described, by Mr. King and by Professor Owen, as having bi-concave vertebræ, with the middle of the body more constricted, and the terminal articular cavities rather deeper than in *Teleosaurus*; and Mr. King says that they are "chiefly remarkable for the depth of the spinal canal at the middle of each vertebræ, where it sinks into the substance of the centrum. Thus, the canal is wider vertically at the middle than at the two ends of the vertebræ; an analogous structure, but less marked, exists in the dorsal vertebræ of the *Rhynchosaurus* from the New Red

* Murchison & Strickland detected in Shropshire a band of Limestone in the red sandstone, but no organic remains. Proceedings Geological Society, v. 2, p. 563.

† Transactions Geological Society, v. 3, N. S., p. 38.

Sandstone of Shropshire."* This description would almost answer for the vertebræ of our *Clepsysaurus*, and it would seem that this was the prevailing structure of this important portion of the frame of the reptiles of that period.

Having given the facts connected with the condition of the "New Red Sandstone" of this country, so far as ascertained, and stated the views of various geologists on the subject, I shall proceed to the consideration and description of the saurian bones found by Dr. Shelley in Lehigh county, now in the cabinet of the Academy, and I acknowledge with thanks the kind assistance of my friend Dr. Leidy.

In the examination of these interesting remains, we are naturally led first to consider their analogies. The epoch in which they were animated, and moved on oozy shores, has been remarked for the small amount of animal life which must have then prevailed within the area of the sedimentary matter forming this deposit. Organic forms of Palæozoic life had changed, in a measure,—a new phase was making its appearance; in fact, a new order of things was in preparation. In the carboniferous period the immense growth of vegetable matter which must have covered the areas now forming our coal fields, ceased longer to produce these vast store houses of carbon. They were finished. The animal life that peopled the waters, and the fauna which lived on the soil at that time, no longer existed—all was becoming changed. An advance in organization was to be made—mesozoic, or secondary life was to assume its sway. We, therefore, naturally find very little in previous organisms to establish homologies. In plants the forms had changed; in the fishes the heterocercal tail was becoming less oblique; in the reptilia we have only the foot-marks, and a few imperfect bones of saurians, to compare with. For analogies, therefore, we must rather look to the superior deposits, where reptilian life became so prevalent, viz: the Lias, Oolite, etc., there the *Teleosaurus, Ælodon*, etc., among the *Crocodilidæ*, and various genera of the *Megalosaurinidæ*, presented species of great size and extraordinary abundance, becoming the monarchs of these periods. All these present an advance in their organic structure, passing from the bi-concave system of the vertebræ to the more perfect concavo-convex system.†

GENUS CLEPSYSAURUS, Lea.

The characters of this genus are derived from the form of the vertebræ and the teeth. The name is given from the remarkable form of the centrum of the vertebræ, which are very much compressed laterally towards the centre. The teeth are minutely serrated on the posterior edge, but the serratures are not continued to the apex, the superior portion becoming cylindrical. The anterior portion towards the base is flattened, presenting at this part a gibbous form.

* Mono. Permian Fossils, p. 237. † Since the above was in type, I have received from Mr. W. Struthers a large block of this Limestone conglomerate, from Plymouth, 13 miles N. West of Philadelphia. I believe it has not been before observed on the south side of the New Red Sandstone.

CLEPSYSAURUS PENNSYLVANICUS, Lea.

Vertebræ. Natural size. Pl. 17, fig. 1 and 2. Pl. 18, fig. 2, 3, 4 and 5. Pl. 19, fig. 2.

The vertebræ belong to the bi-concave system. All the specimens are more or less mutilated, eroded, crushed, or bruised, so that it is quite impossible to assign their particular position in the vertebral column. It is evident that they are more compressed laterally than vertically (see pl. 17, fig. 2,) and in one of the specimens where three of the vertebræ are in juxta position, they are but slightly compressed. (pl. 18, fig. 5.) The superior portion of all the three is broken off, and none of the processes remain attached, to designate what portion of the column they belonged to. The spinal canal is not perfect in a single vertebra. In two broken specimens of the centrum, there is a slight appearance of this canal, having the character described by Dr. Riley and Mr. Stutchbury* in the *Thecodontosaurus* of the Magnesian Limestone of Bristol † They say, "The body of the vertebræ is hollowed out by a deep and narrow depression on its upper surface, so that the inferior boundary of the vertebral canal would not be on one level plane, as in other animals, but would present a succession of narrow and deep depressions, corresponding to the body of each vertebra." (p. 353.) Such, no doubt, has been the case in the spinal canal of our animal, and it presents a characteristic so peculiar, and so important, as to deserve particular attention. The form of the spinal canal is, I believe, without any analogy in the vertebrata of more recent formations, and therefore this peculiar structure is of the highest importance in the consideration of the position of this rock, as it is also in comparative osteology. The enlargement of the spinal canal in the middle of the centrum, is characteristic in these reptiles. It is evident that at the junction of each vertebra,the canal must present a node of more or less magnitude.

Great consideration is also due to the fact of the centrum being concave, both posteriorly and anteriorly. Dr. Riley and Mr. Stutchbury describe the vertebræ of their reptile as being "concave at each end." M. D'Orbigny states that among the extinct reptiles there are six genera which had bi-concave vertebræ.‡ The former gentlemen very properly remark, that the leading characters of these vertebræ are the double cancave system; the hour glass form of the annular portion, and the peculiar form of the vertebral canal.

* Geological Society's Transactions, v. 5, 2d ser., p. 352.

† Dr. Riley and Mr. Stutchbury founded the genera *Palæosaurus* and *Thecodontosaurus* on the character of the teeth. The bones not being found in connexion with the teeth, they hesitated to assign them to either of the genera which they established. They describe the vertebræ "as possessing the peculiar characters of having the centre of the body diminished one-half in its transverse and vertical diameters, so as to resemble an hour-glass,; of a suture connecting the annular part or body with the processes; and in the extremities of the vertebræ being deeply concave. These characters, the authors conceive, distinguish the fossil vertebræ from those of all recent Saurians." Proceedings Geological Society, v. 11, p. 399.

‡ Cours Elementaire, p. 205.

One of the specimens (pl. 19, fig. 2,) presents the posterior face of a vertebra with the centrum broken off. The spinous process, the superior oblique process, and the left transverse process, are all nearly perfect, but somewhat bruised. The right transverse process is probably still in the mass of the stone, from whence I have not attempted to remove it. The canal is much broken round the edges, and it is filled up with the very hard mass of the surrounding rock.

The length of this spinous process is 2.1 inches.

The distance across the oblique processes is 2.9 inches.

The length of the transverse process is 2 inches; its width is half an inch.

The distance from the centrum to the apex of the spinous process is 2.2 inches.

In the specimen pl. 17, fig. 1, there are parts of two vertebræ, with the spinous process attached, and, although these processes are much broken, they are still in place. The two vertebræ are nearly in their natural positions. The length of these spinous processes is about $2\frac{3}{4}$ inches; antero-posterior diameter 1.2 inches; transverse diameter seven-twentieths of an inch; the surface of the terminal extremities 1.5 by 1 inch, in their greatest diameters.

A vertical view of a centrum is given on pl. 17, fig. 2. It is somewhat fractured, and partly concealed in the mass of the rock. It presents a most remarkable compressed central portion, being exceedingly contracted laterally, while the terminal articular portions are nearly rounded. Its length is 2.1 inches; its vertical diameter in the centre one inch, and its transverse diameter .3 of an inch. On pl. 18, fig. 2, another centrum is represented, which is rather shorter, and not quite so much laterally compressed; but it presents the same remarkable hour-glass form of the vertebra of this animal. Fig. 3 presents a view of the terminal articular cavity of a centrum, somewhat elliptical, a portion of the border being fractured. The depression is gentle towards the centre. Its greater diameter is 1.6 inches. Fig. 4 represents a fractured portion of a centrum, which has a slight groove on its superior surface, which may be the impression of the undulating canal. Fig. 5 consists of three somewhat mutilated centri, less compressed than those of the other portions of the column.

Ribs. Plate 19, fig. 1 and 1 a; natural size.

The mutilated state of the specimens permits but a slender description and representation of these bones. They consist of a few fractured pieces, and one proximal extremity, the head being broken off, as well as a small portion of the neck; but the tubercle is entire. The anterior and posterior faces of this portion are represented at fig. 1 and 1 a, of the natural size.

Bones of the Limbs. Plate 18, fig. 1.

There are several fragments in the collection, but they are so imperfect as to render it very difficult to designate as to what particular bones they belong. There is an impression in the rock, of what appears to be the cast of a portion of a femur or humerus, too imperfect to be represented ; the diameter is about two inches Fig 1 represents a bone, which may be one of the fore arm or the leg. It is curved, flattened on one side and slightly impressed on the other. The head is broken off, and the fractured portion presents a subtriangular outline. The length of this piece is 3.8 inches; the width .9, and thickness 18 twentieths of an inch in the middle. At the superior fractured portion it is 1.3 inches.

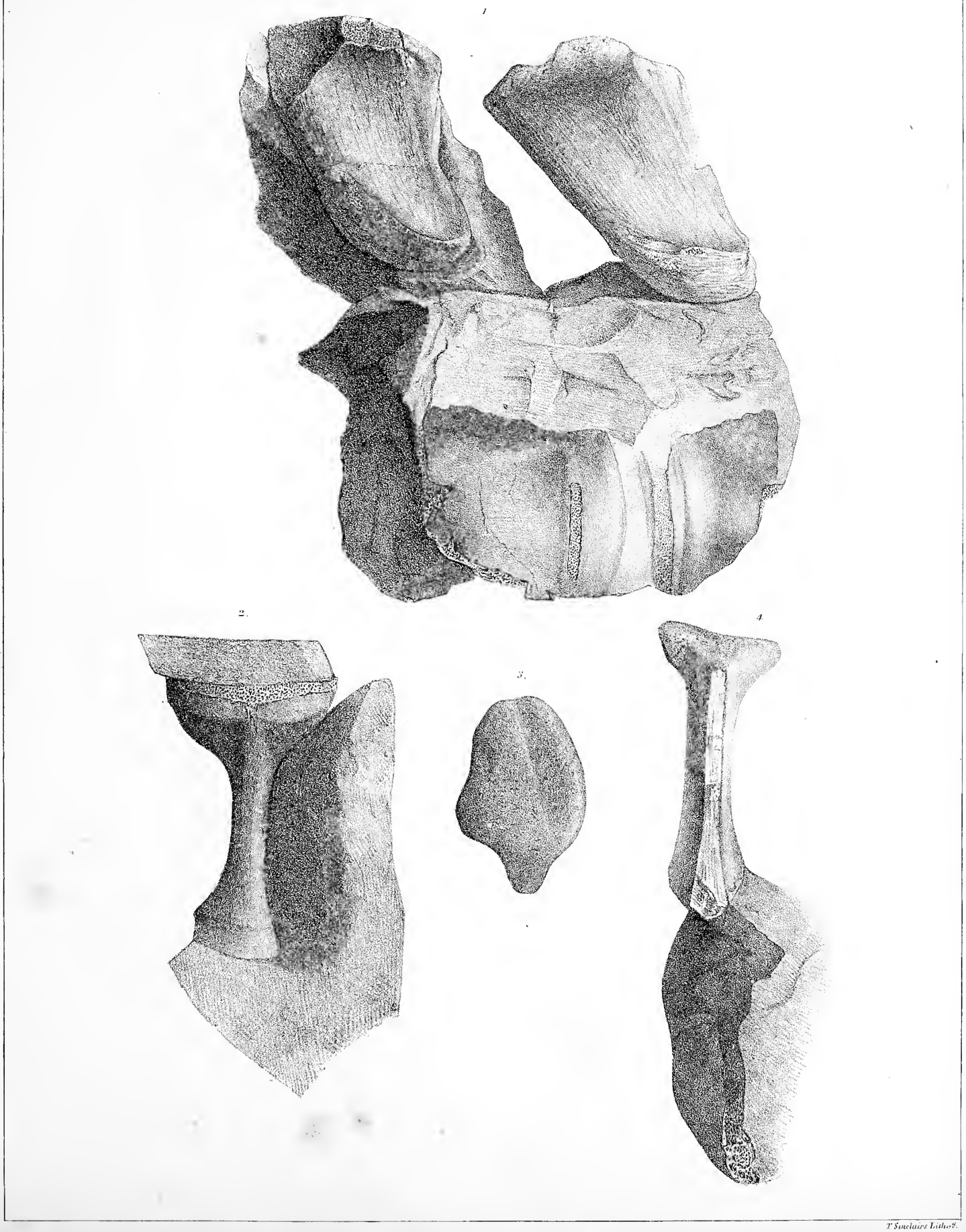
The Teeth. Pl. 19, fig. 3, 3 a, 3 b, 3 c, 3 d.

There was neither a whole tooth nor any portion of the jaw found with the bones of this animal. Three fractured portions of a tooth, and some still smaller pieces only were obtained. I have, at fig. 3 b, endeavored to reconstruct it with these. In length it must have been about 1.8 inches long, its widest part, near the base, being nine-twentieths, and transversely seven-twentieths of an inch. It is here flattened on one side, and gibbous on the other. The posterior portion is compressed into an accute angle, the edge being armed with very minute closely approximate serratures. There are four-tenths of an inch of this cutting edge unbroken, (fig. 3,) on which there are forty-two serratures=105 to an inch. At 3 d these serratures are represented, enlarged. The anterior portion near the base is flattened, so that the transverse section presents a very irregular figure. This form is gradually changed, through the upper portions to an elliptical and circular form. Five of these sections are represented at fig. 3 c. The body of the tooth is smooth, but towards the apex it is slightly striate. The upper fragment (fig. 3 a) only shows the striæ In comparing this tooth with those nearest allied to the *Clepsysaurus*, it seems to me that the most approximate is that of the *Cladeiodon*, Owen, Odontography page 268, pl. 62 A, fig. 4, from the "New Red Sandstone (Keuper?) of Warrick and Leamington," which are found in the same quarries as those containing the remains of the *Labyrinthodon*. He says the teeth are intermediate between the *Thecodontosaurus* and the *Palæosaurus*. None of the bones had been found. The figure of Professor Owen represents a much shorter tooth than ours, and the transverse diameters differ very much. The serratures in his figure extend nearly the whole length of the tooth while in the *Clepsysaurus* they do not seem, from the fractured portions we have seen, to extend more than half the length.

EXPLANATION OF PLATE XVII.

CLEPSYSAURUS PENNSYLVANICUS, Lea.

1. Parts of two Vertebræ, with Spinous Processes attached.
2. A Centrum; vertical view, showing its hour-glass form.
3. Terminal extremity of Spinous Process.
4. Antero-posterior view of a Spinous Process.



T. Sinclairs Lithog.

Clepsysaurus Pennsylvanicus, Lea.

EXPLANATION OF PLATE XVIII.

CLEPSYSAURUS PENNSYLVANICUS, Lea.

1. A part of a Bone, probably of the Fore Arm or Leg.

1 a. Transverse Section near the superior Part.

1 b. Transverse Section of the inferior broken portion.

1 c. Transverse section of the same at the middle.

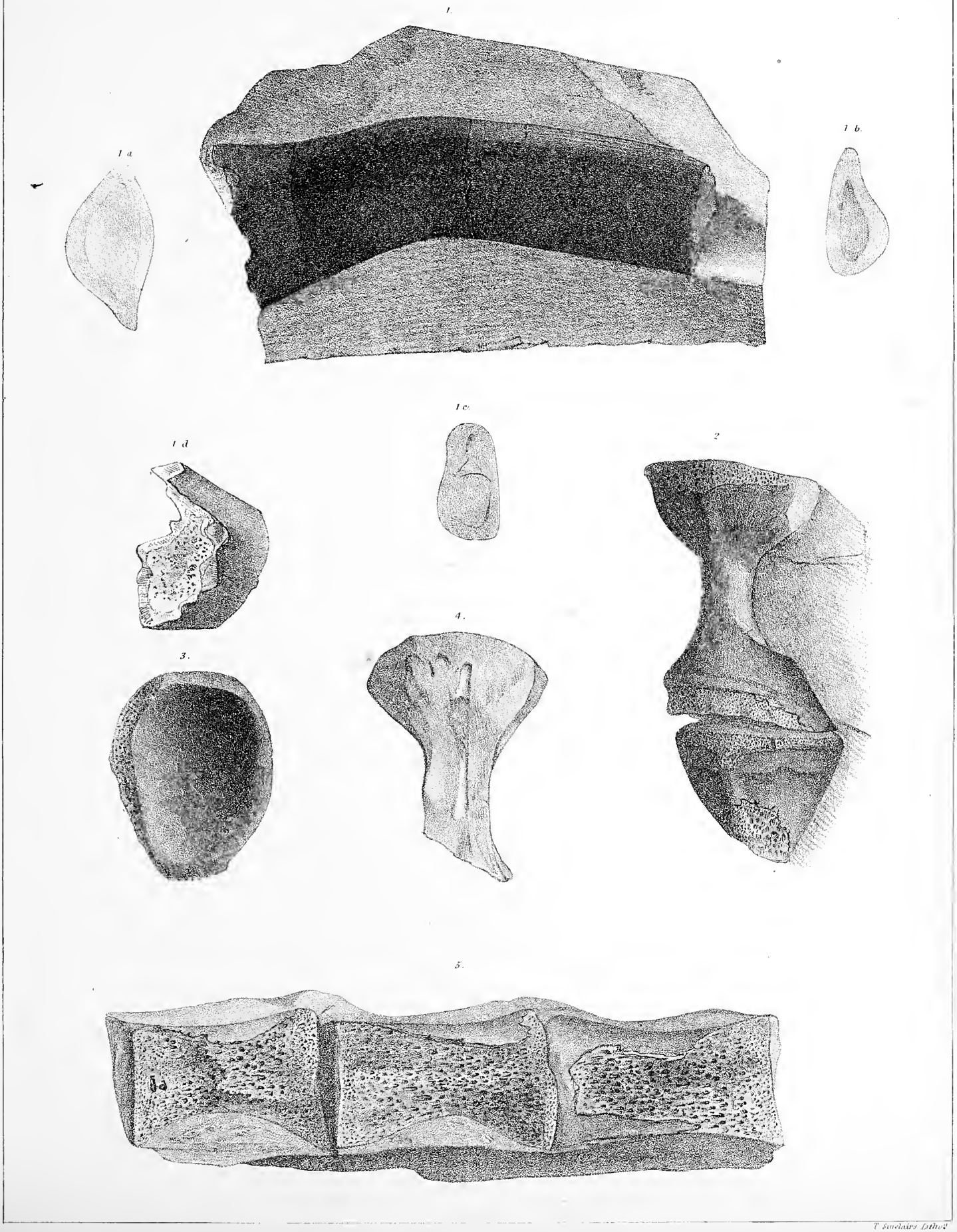
1 d. An oblique view of the superior fractured portion.

2. An oblique view of a Centrum, with a portion of a second one.

3. View of the Terminal Articular Cavity of a Centrum, broken on the left side.

4. Vertical view of a broken Centrum, with a slight groove on its superior surface.

5. Vertical view of three Centri, somewhat mutilated, in juxtaposition.



T. Sinclair Lith.

Clepsysaurus Pennsylvanicus, Lea.

EXPLANATION OF PLATE XIX.

CLEPSYSAURUS PENNSYLVANICUS, Lea.

1. The proximal extremity of a Rib, the head being broken off, as well as a small portion of the neck. The tuberele is entire. The anterior and posterior faces are represented at 1 and 1 a.

2. A Vertebra imbeded in the roek. The posterior face is presented. The centrum has been carried off, leaving only a fragment. The spinous and oblique processes are nearly perfeet, but somewhat bruised. The left transverse proecss is exposed. The canal is mutilated, and filled up with the matrix of hard Limestone.

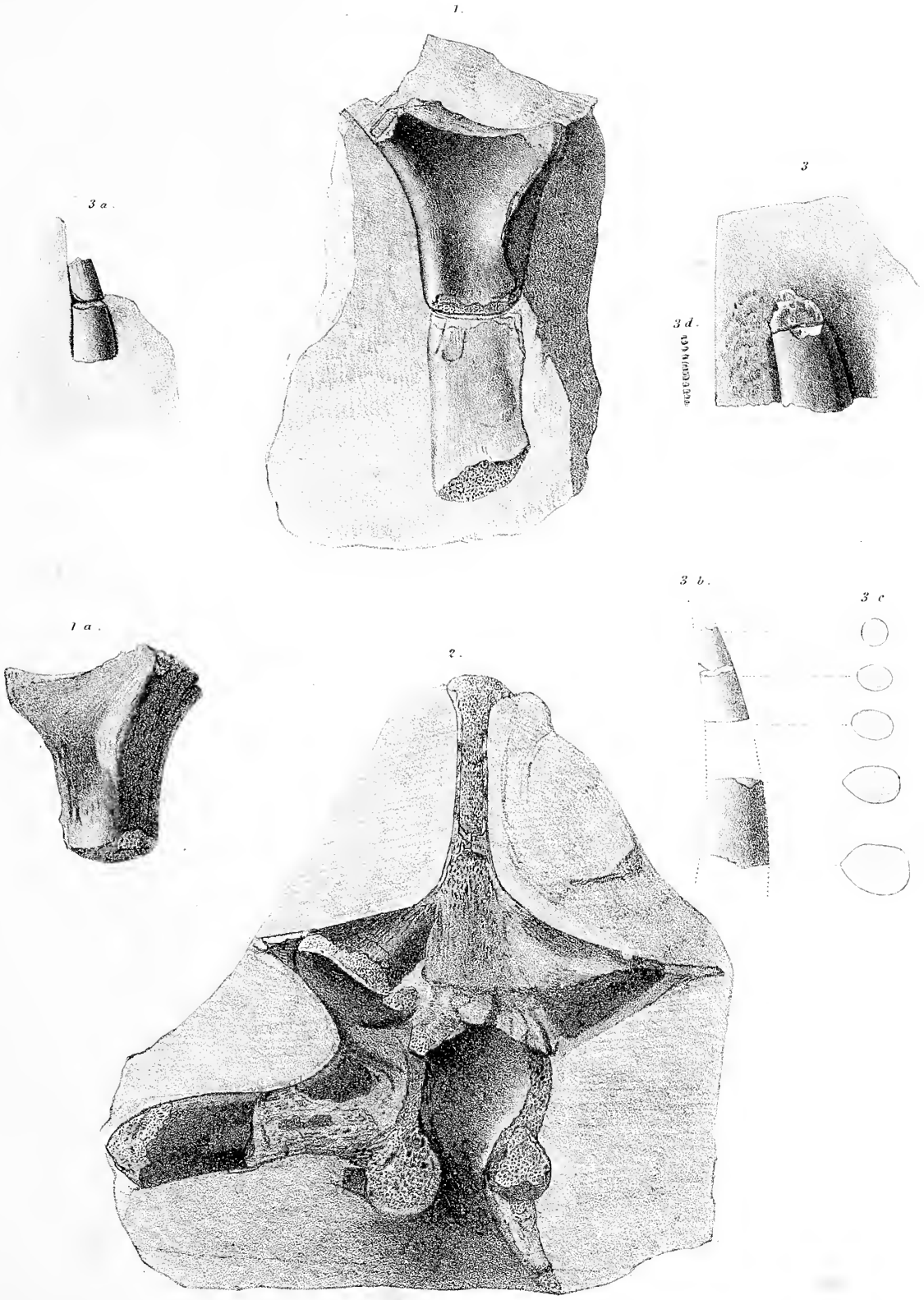
3. Fragment of the inferior portions of a Tooth, with its minute serratures imbedded in the rock.

3 a. Two fragments of the superior portion of a Tooth, imbedded in the rock.

3 b. The Tooth, reconstructed from the three fragments.

3 e. Five transverse seetions of the Tooth are eorreetly represented, and indieate the form of the faces of the fractured parts, passing from a gibbous to a eireular transverse form.

3 d. The Serratures of the Teeth, magnified about four diameters.



T. Sinclairs Lithog.

Clepsysaurus Pennsylvanicus Lea.

On some New Fossil Molluscs in the Carboniferous Slates of the Anthracite Seams of the Wilkesbarre Coal Formation.

By Isaac Lea.

Mem. Am. Phil. Soc., The Acad. of Nat. Sci., &c.

It is rare to find any of the Molluscs in the slates of the coal bearing deposits, either in this country or in the foreign Carboniferous coal strata. Mr. Lyell observes the fact, but mentions an exception, in the Richmond strata, where a species of "*Posodonomya* is in such profusion as to divide the shaly beds, like the plates of Mica in Micaceous shales." At Frostburg, in Maryland, in the black shale, resting on a seam of coal three feet thick, he found seventeen species.*

It is so rare, in Pennsylvania, to find impressions of Molluscs in the shales immediately connected with the seams of coal, that I have not, in more than thirty years observation, met with more than one instance of the kind. This specimen taken, by myself, from a mass which had been brought out of a working coal mine, above Wilkesbarre, Luzerne county, on the Susquehanna, has several different species, belonging to at least two genera, which are accompanied with several scales of fishes, evidently belonging to the *Ctenoidians*.

In the calcareous strata and sandstones of the Carboniferous System, fossils of the Molluscs are very abundant; but in the red and grey sandstones of the inferior strata, Devonian, they are rare. Mr. Richard Griffith† states that he found many shells in the lower portion of the Carboniferous Limestone series of Ireland. He observed *Cytherea*, *Modiola*, *Nucula*, &c., and mentions that fossils of the genus *Modiola* have been considered to belong to the Old Red Sandstone or Devonian System, but as he had discovered these fossils in great abundance, as high up as the carboniferous slates, and far above the arenaceous limestones, he should include them among the fossils belonging to the Carboniferous System; and hence, as these fossils have been met with in the red shales, which alternate with red and grey sandstones and limestones, near the bottom of the series, and among those strata which he had hitherto considered to belong to the upper portion of the Old Red Sandstone, he thought he was warranted in including it in the Carboniferous Series. (p. 46.)

Professor Sedgwick and Mr. Murchison‡ found the genus *Posidonia* abundant, both in the upper and lower limestone shales of the true Carboniferous series of England and Ireland; and D'Orbigny, in his Palæontological Tables, assigns to it

* Second Travels, p. 16. † Proceedings British Association, 1843, p. 42.

‡ Geological Transactions, vol. 5, 2d series, p. 633.

[From Journ. Acad. Nat. Sci., part 3, vol. ii., N. S —Read May 18th, 1852.]

(*Posidonomya*) a range from the lower Silurian to the upper portion of the Oolite, its maximum existence being in the Devonian.

The importance of the existence of marine shells in the shales enclosing a seam of coal, will be admitted at once, when we reflect on the necessity of the fact that it designates a return of the ocean to a point from which it had receded; and were it supposed to be a fact that all shales were deposited by marine action, the return of the ocean in some carboniferous deposits, would require an oscillation so frequent, as to forbid such a theory. In Belgium, where it is said there are one hundred and twenty-six seams of coal, in successive superposition, if each deposit of Carbon had an inferior and a superior slate of this marine origin, the salt water would be required to advance and recede two hundred and fifty-two different times. This frequent oscillation of the surface, from a position sufficiently elevated above the level of the sea to produce air plants, to a submergence sufficiently depressed to sustain marine life, would require a frequency and regularity of oscillation that we could not reasonably admit. That depressions and elevations occurred we cannot doubt, and that some elevations were of long continuance is certain, for we have the existence of large fossil trees still erect, in a vertical position, and of great magnitude. Such have been observed in France, in England, and in Nova Scotia. These are not marine plants, but great trees, and chiefly Palms and gigantic Ferns, requiring a warm and humid atmosphere to sustain their rapid and great growth.

It is evident, from the horizontality and parallelism of the beds of Carboniferous strata, that they were deposited at a tranquil period. Independently of the general even condition of the seams of coal, the perfection of the delicate fossil flora, existing in the shales, would bear ample testimony as to the fact. It must I think, therefore, be admitted, that the enclosing slates, in which we find these numerous coal plants, were terrestrial, and not submarine. The exception is when marine molluscs are found, which must be at points where there is no floral exhibition. In these cases we naturally look for Ichythic existence also, and this view is sustained by the fossil remains of impressions of scales, and, in some cases, whole fishes, with their characteristic heterocercal tails.

The genus *Modiola* came into existence during the epoch of the Upper Silurian, and has continued through the various strata to the present time, where it has obtained its maximum. It is now a very extensive form. The vastly long period that this genus has survived the great changes on the surface of the globe, clothes it with more than usual interest. Mr. Morris, in his "Catalogue of British Fossils," mentions forty-four species in the strata of England and Ireland, one only of which existed during the deposit of the Coal Measures. Ten are found below, six of them being in the Carboniferous Limestone, immediately below, and four in the Silurian. The *Modiola carinata*, Sow.,* is found in the Coal Measures of Coalbrookdale. Bronn, in

* Geological Transactions, 2d ser., vol. 5, pl. 39, fig. 15.

1 a *Modiola Wyomingensis, Lea.*
2 *M minor, Lea.*
3 b *Posidonia? clathrata, Lea*
3 a *P perstriata, Lea.*
3 b *P distans, Lea.*
4 5 *Palæoneaera Leaiviana, Lea.*

Sarlain lith

his Index Palæontologicus, gives a long list of this genus, nearly 200, two species of which were observed by Verneuil, in the Coal Formation, *M. Teplopi* and *M. Pallesi*.

In the specimen from the vicinity of Wilkesbarre, formerly known as Wyoming, there are at least two distinct species, one broad and rather large, and the other small and much more transverse in proportion. Pl. 20, fig. 1 a, represents the larger, and fig. 2 the smaller. I propose to call the first *Modiola Wyomingensis*, and the second *M. minor*. There are also several species which seem to me to be more analogous to *Posidonia*, than to any genus I am acquainted with. I propose to put these provisionally in *Posidonia*, and to name them *P. clathrata*, *P. perstriata* and *P. distans*. Several small fish scales are distributed over the surface, on both sides of the laminated specimen. These probably belong to the genus *Palæoniscus*, and to it I shall refer them, under the name of *P. Leidyiana*, (pl. 20, fig. 4 and 5,) in the hope that perfect specimens may be obtained hereafter.

MODIOLA WYOMINGENSIS. Plate 20, fig. 1 a.

Testâ lævi triangulari, infernè compresso-alatâ; umbonibus elevatis, acutè angulatis.

Remarks.—This is a broad flat species, very different from the *minor*, which is on the same specimen. There are parts of four distinct specimens on this small piece of slate, which is represented of the natural size.

MODIOLA MINOR. Plate 20, fig. 2.

Testâ infernè striatâ, ellipticâ, subplanulatâ; antico latere rotundato.

Remarks.—A single specimen only was found of this species, and the umbones are obliterated. The lower part, as represented, is perfect, and very distinctly marked.

POSIDONIA? CLATHRATA. Plate 20, fig. 1 b.

Testâ complanatâ, clathratâ, rotundato-obliquâ, striatâ; striis decussatis.

Remarks.—There are two specimens of this species lying together on the stone, both of which are imperfect. One is more oblique than the other, and they may eventually prove to be distinct species.

POSIDONIA? PERSTRIATA. Plate 20, fig. 3 a.

There is too small a portion of this species remaining on the surface of the specimen, to characterize it by a proper diagnosis. Perhaps a third of the valve only remains, but this is perfect, and beautifully and transversely striate—the striæ being parallel.

POSIDONIA? DISTANS. Plate 20, fig. 3 b.

Like the above, there was but a small portion of a valve found. It has longitudinal striæ, somewhat like *perstriata*, but the striæ are more distinct and distant, amounting almost to ribs.

PALÆONISCUS? LEIDYIANA. Plate 20, figs. 4 and 5.

I am induced to represent the most perfect, out of some half dozen fish scales on the specimen. One of them is magnified to about four diameters. They all seem to belong to the same species. The scales are diminutive, rhomboidal, serrated on one edge, and marked with nearly equidistant striæ, which are arrested by transverse striæ. I name this after my friend Joseph Leidy, M. D.

In giving the above descriptions, I am aware of the disadvantage arising from the want of perfect descriptions: but as these forms are the only ones yet found, that I am acquainted with, I have deemed it better to give an exact representation of the specimen itself, and to give provisional names, that geologists may be able to recognize them when met with again.