MEMOIR

ON

POEKILOPLEURON BUCKLANDII,

A LARGE FOSSIL REPTILE, INTERMEDIATE BETWEEN CROCODILES AND LIZARDS;

Discovered in the La Maladrerie Quarries, near Caen, in the month of July 1835.

By Mr. Eudes-Deslongchamps,*

PROFESSOR OF NATURAL HISTORY IN THE FACULTY OF SCIENCES OF CAEN, SECRETARY OF THE LINNEAN SOCIETY OF NORMANDY.

(*Extract from the 6th Volume of the Mémoires de la Société Linnéene*.)

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Caen,

A. HARDEL, **SUCCESSOR TO MR. CHALOPIN, PRINTER OF THE ACADEMY AND LEARNED SOCIETIES.**

1837.

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{5} §. Ist. *Preliminary remarks.*

For twenty years, the naturalists of Caen have fixed their attention on the fossil bones that have been found so frequently in the quarries of the vicinity of this village, and precious documents for the geologist and paleontologist resulted from their zeal to recover these bones and make them known; and although they have yet published or communicated only a part of the documents that they possess, the natural sciences drew great profit from them. Those of these bones on which the attention of the world's scientists had been particularly attracted are referred nearly exclusively to reptiles close to crocodiles, which the works of Lamoroux, Cuvier, M. Geoffroy-St.-Hilaire, and the author of this memoir have made known in varying detail.

The bones of crocodilians, which are the most common, are not the only ones contained in the limestone banks in the environs of Caen, although it is easy to believe this; and if, up to now, these others have hardly been spoken of, this silence was principally caused by their imperfect {6} state and the hope that new elements would come to be added to those which are already possessed, and render their identification and history more complete.

A recent discovery has procured for me a fairly large number of bony elements, sufficient to characterize the species of this animal, although teeth or remains of jaws were not among them. I thought that it was suitable not to defer the publication of this which I possessed, except to rectify or confirm by the identification, if new materials, or relatives of this species, came to be added to those which I collected.

These bony elements consist of twenty caudal vertebrae, a humerus, a radius, an ulna, two manual phalanges, a femur, fragments of the tibia and fibula, some tarsal bones, fragments of the metatarsals, and a great number of pedal phalanges; many ribs, of which several have extraordinary shapes leading to the belief that they were located amidst the abdominal muscles, some unpaired and regular were situated on the abdominal midline. I have yet several other elements, more or less damaged, whose position in the skeleton is not easy to determine.

These bones belonged to a large, strong animal whose length must be between 25 and 30 feet. Initially, a rapid examination made me think that they came from a gigantic crocodilian; in effect, several of the bony elements were analogous to those of crocodiles, either as a whole or in their details. The reasons that led me to regard them as belonging to an intermediate type between crocodiles and lizards will be seen thereafter in this memoir; I could say in advance that I stopped with this identification only after deeper examination of these various bones compared to those of crocodiles and lizards, living as well as fossil.

I believed for a long time that the bones of my large reptile could be referred to *Megalosaurus bucklandii*. Initially, their great size, their similarities with the bones of lizards, and above all the presence of the megalosaur in the Caen limestones, noted {7} unquestionably by a tooth found at Quilly by Mr. de Caumont, described and figured in vol. IV of the Memoirs of our Society (p. 207, pl. VIII) and with which he agreed to enrich my collection, provided enough probability to this opinion. It is true that the comparison that I was able to establish, by means of the description and figures given by Cuvier (*Oss. foss*., vol. V, 2nd part, p. 345 and following, pl. XXI), did not confirm it, and that I had to take then the decision to consider my elements as coming from an animal still unknown to naturalists. However, it is not completely proven that the vertebrae, femora, and other bones described by Mr. Buckland belong necessarily to the portions of jaws and teeth, which alone involve the characteristics of the genus *Megalosaurus*: “Because,” wrote Cuvier (*loc. cit*.), “it is only by their zoological connection and their existence in the same quarries that one can conclude that they come from a single species: yet these zoological connections are of a fairly equivocal and mixed nature.” According to that it would not be impossible that new discoveries would make known that the bones found at Stonesfield in the Tilgate Forest belonged to a different species from that to which the teeth and portions of jaws belonged; as it is also possible that out animal from La Maladrerie had possessed the teeth of the megalosaur, but these results are hardly probable.

§. IInd. *History of the discovery*.

The history of the discovery of these bones is unique enough; it is only by a combination of happy and bizarre circumstances all at the same time that I came to reassemble those that I have. I hope that one will excuse me the details of this discovery; they are for me a sort of compensation for all the tribulations they have caused me, and one sees that if I came to save them from destruction and to restore, as far as it could be, a precious enough monument for science, it is neither without pain, nor without perseverance.

I owe the first knowledge of the discovery of part of these {8} bones to Mr. Bourienne, a medical doctor and our colleague. He came to my home one morning to inform me that he had seen in passing, in a construction quarry on the Rue de Bayeux, at Bourg-l'Abbé (one of the country lanes of Caen), a sizeable block of stone in which large bones were found; but that he had to hasten me, because around the stone there had been the child-amateurs, armed with hammers, who amuse themselves by butchering these bones, whose presence in the stone excited their curiosity.

I ran there. The vandals were no longer there, but I saw the despairing traces of their presence. The stone was chipped everywhere where the bones had appeared, and these were broken in part; I carefully collected all the bone fragments that had fallen around. The workmen were not there, it was Sunday, I went to the house of the contractor to which the building site belonged; another disappointment, he had gone to the country and would not return until the evening. My poor stone was thus going to be exposed, during a long dangerous day, to the assaults of the neighbors, the curious, the passing, and that in an oft-frequented place!

This delay was still fatal to my bones; because the next morning, when I acquired the block of stone, I saw unequivocal marks of new degradations; still I carefully collected the pieces. Thanks to the good offices of an inhabitant of that quarter who came with me, from door to door, everywhere that he thought someone had taken the fragments, in large part I managed to recover them.

I learned from the masons of the building site that my block came from one of the quarries of La Maladrerie, a village situated a quarter of a mile from there, and that other blocks containing bones and from the same quarry had been brought into the village, without being able to tell me to which building sites.

I traversed the village during two days; I got information in the building sites, from the masons, from the contractors; I discovered nothing.

I visited the quarry from which my block had been taken; I descended there[1]{9}; I was shown the place from which it had been extracted, but I could not make suitable research there; it was recovered from several cart-loads of fill. The workmen gave me some small, insignificant pieces that they had kept; they confirmed for me that another block containing bones had been transported into the village, but without being able to indicate the place to me.

The attentive examination of the bones contained in my block, and the readjustment of the fragments that I was able to reassemble, gave me for a result: the upper end of a femur; a fairly large number of phalanges of very strong size, among which are five unguals; some short spongy bones in very poor condition, and some portions of long bones which appeared to me to belong to the metatarsals.

Four or five days after the discovery of this first block, Mr. Blin, chemistry preparator in the faculty of Caen, came to bring me some unidentified bone fragments stuck to pieces of limestone; he told me that he got them from a contractor of his acquaintance who gave them to him, and that they had been found in a sizeable stone found in La Maladrerie, which had been at his building site for several days. Accompanied by Mr. Blin, I went at once to this building site, situated near the port on the Basse-rue; it was time: the bone-bearing stone, installed, cut and scraped, had been broken in place to form the lintel of a window. I acquired it and carefully collected the small bony fragments that this trimming had removed. The sizeable stone was prism-shaped, with a square base of three and a half feet and one foot on a side; at the two ends, I noticed the well-characterized cross-section of a vertebra, which gave me hope that an uninterrupted series of vertebrae would be found along the axis of the cut piece. My conjecture would be found true; I recovered from this piece seven nearly complete vertebrae, and two others damaged, which were showing at the two ends; chevrons [= “forked bones”] were found in place with them as well; these vertebrae were from the middle region of the tail. It will be seen, in the chapter where the vertebrae are described, the inductions by which I was again led to suppose that these were crocodilian bones.

{10} About eight hours after, one of the workmen from the quarry that produced the

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[1] At La Maladrerie, the quarries are worked by subterranean galleries where one descends by shafts. See the memoir of Mr. Le Neuf of Neuville, 1st vol. of the *Memoirs* of our Society.

aforementioned bones arrived at my house; he had a great number of bones in a handkerchief, reduced to fragments and mixed; they were entirely removed from the stone. One could guess the displeasure that I felt that I had not been informed in time; I at least put the fragments in order so that I could easily understand to reconnect them. The workmen told me that in removing this stone in which bones were not suspected, although it was close to the point from which the other bone-bearing blocks had been extracted, it was split down the middle and then revealed all these bones, of which the majority were detached by breaking, and that he had removed the rest, *very carefully*, with the stroke of a granite hammer(1). I had already given well to the devil my misfortune and his granite hammer, because it necessarily lost a part of the fragments, as I saw afterwards when I sorted out and reconnected all those that had been brought to me. I restored thus a dozen vertebrae much better than I had dared to hope when I first saw all these mixed fragments. These vertebrae followed those that I already had, but a considerable intermediate series is lacking.

I was not yet at the end of the adventure. Around three weeks after these discoveries, at the same moment when I had left for the country, I saw a quarry workman arrive at my door, all in sweat, on the most ill-tempered hack of a horse I had seen in my life, who passed by his arms a packet full of bone fragments. It was a pity to see the state of this debris, which had been so mistreated, the majority being thus made into powder. He told me that they were from the same quarry as those that I already had; that in hauling the stone, it was not noticed that it contained bones(2); that {11} it had been transported to Mouen, a village three miles from Caen; that the masons had wanted to sell it and having found it full of bones, had it refused; that it had gone to the contractor, that he had broken it, partly in anger to see so beautiful a block weighing more than 60 pounds refused; that he had remembered when I bought the bones that his comrades had brought me; that he had collected the debris and brought it to me. – One may guess the state in which such very fragile bones must have been, broken down by hits from a granite hammer by a man in anger who believed he had lost the fruit of his labor, then brought the distance of three miles, in a handkerchief packet, and shaken by the trot of an ill-tempered hack! I examined the

(1) The granite hammer is a sort of wide hammer, short-hafted, with which the masons cut the rubble.
(2) I believe it easily enough: the workmen worked in their galleries, illuminated only by a small candle; the pulverized debris of the stone, which is named *chaussin* in our country, could have masked the edge of bones visible on some points of the surface of the stone. When the tools break the bones and pulverize them, the resulting powder is white, although their rusty yellow color slices well enough on the bottom of the stone when they are broken

contents of the handkerchief, all the while murmuring: there I surveyed a great number of fragments that seemed to me to belong to the large femur whose superior end I already had, a great quantity of pieces that must belong to a large flat bone, portions of a long bone smaller than the femur, more fragments of ribs, etc. The workman told me that more bones still remained in the stone, and that it was on the great road in a stone-yard belonging to Miss Thomine. Happily I knew this person; and as I could not go that instant to Mouen, I wrote immediately and sent the letter by express, with a plea that the refused stone be reserved, without touching it, and that I would take it on my account.

There was undoubtedly what plagues such significant objects for science, in large part, had fallen under the blows of my quarryman. Everything considered, I owe him for the discovery; because without the advice that he gave me, all the remains would have been infallibly lost; it was seen afterwards that the remains contained precisely the most interesting pieces. There is much place to fear that a similar chance will not always be presented, showing a collection of pieces so singular, so fragile, so well preserved, situated with regard to one another in such a manner that it was possible for me to recover, at least I think, their natural relationships.

Because I could, I went to Mouen: I give many thanks to the Thomine family for the promptness that they sent to reserve the block for me, and furnished all the means to benefit from it. I had the stone cut down and {12} worked it with precaution under my eyes; I derived 12 to 15 small blocks, all penetrated with bones; I numbered them and enveloped them in old linens; I carefully collected the bony debris that was detached during the working, just as a fairly great number left by my quarryman on the place of disaster; the entirety forms a cart-load that I had transported to my house, where I worked my blocks with available precautions.

§. IIIrd. *Restoration of the bony elements*.

Thus there I am finally as possessor of my treasure; but in what state, great God! The least inconvenient is still, to my eyes, that the elements which compose it are in a thousand fragments; the worst of the affair is that all the fragments are for the most part mixed, estranged,

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cleanly. For the people who do not look there very near, as the quarries, it is very possible that they did not survey the presence of bones.

mingled; how to recover amidst this chaos? Some bones of which the forms are not known to me, a thousand fragments that it is necessary to try to reunite in order to reform these bones; which will tell me if this or that fragment belongs to this or that bone, to this one rather than that one! But the most hopeless is that most of the fragments are lost, that the others have their breaks chipped, rounded; how to bring together then the fractured parts!… Cuvier, in his discourse that would be a preamble to his immortal researches on fossil bones, speaking of the great difficulties as he tried to connect to each of their species the numerous bones, more or less isolated, that he found in the plasteries of Paris, regretted not having in his possession the almighty trumpet of the Last Judgement, to command each bone to go to its place; his genius and vast anatomical knowledge have replaced this trumpet that he implored. It has been very necessary for me also, who had neither his genius nor his knowledge, to extricate a more difficult step, under certain relationships, than these which he had so gloriously overcome.

The desire to save for paleontological science such precious remains of an ancient inhabitant of our globe stirred my zeal up to enthusiasm and revived my courage. I was not a novice to similar work: several times already I had successfully restored and remade, piece by piece, interesting fossils {13} whose extreme fragility, along with the few precautions taken in extracting and transporting them, had put them into a deplorable state. My first care was to create a certain order for myself and to arrange all my fragments according to it: the products of resemblance, tissue, nuances in coloration, the direction of bony fibers, the presence of small dendrites, and a thousand outlines or fugitive characters that I could not relate but that the study and comparison of the moment suggested to me, were my principle guides. I established some *centers* that furnished me the largest fragments, some other smaller fragments were joined to these; soon the forms were marked, the chaos managed little by little, and I finished to see approximately what I had been dealing with. The greatest obstacle always came from those pieces either completely lost or so mistreated that I could not attach their neighbors; the absence of the first prevented me from reconciling other, present ones with the pieces to which they evidently belonged. It must not be neglected to reconcile the smaller fragments, when I could find their place; how many times did they serve to bring together many larger pieces that, without them, would have remained isolated! But also that having obtained a result from fruitless trials; how many times had I put together fractures that did not match, and whose placement had to be sought elsewhere at another moment. Sometimes the chance served me; in less than no time several pieces were recovered that soon indicated to me the place of certain others left in reserve; more frequently I passed entire hours without being able to reconcile a single piece.

To be exposed to fewer fruitless trials, all my fragments, classed in small cardboard boxes, were ranged on an immense table. In order that my centers would speak out more, the boxes containing the fragments supposed to belong to each of them were placed around it; I took each of these centers and their dependents in turn; when one bored me, I passed to another. Finally through fumblings, time and patience (I was employed there for close to two months), I had obtained some satisfying results. In truth, a great number of fragments remained that I was not able to place, but their {14} absence provides hardly any inconvenience other than returning the restored bones a little less complete, a little more or a little less chipped. I was certain that no important bony piece, included in what I had had at my disposal, had escaped me, and that it would be easy to restore by thought what the others need in order to be completed.

I served myself to stick my pieces with Arabic gum dissolved in water to the consistency of pulp. I was careful to only interpose the thinnest possible layer between the fractures, in order to avoid deformations; without this precaution, while one bone was remade by means of a great number of fragments, the last to place, which acted as key (so to speak), only having been able to be reconciled. To measure that a fragment found was restuck, I let it dry having applied it to another; it was necessary for me to employ all sorts of expedients so that in drying these fragments remained in a good position, which was not always easy, particularly when the crack was very thin. I would not finish if I mentioned the multiple maneuvers, some fruitful, some without success, that I needed to try in order to end this ungrateful and fastidious work.

§. IVth. *Remarks on the restoration of the bony elements*.

One will make probably two principal remarks on my bone-setting and, while accepting my zeal and patience, one could doubt the value of the results obtained. Could it not happen, and has it not in effect happened that, allured by a certain resemblance, I was mistaken in my reattachments, that I had not put to one bone that which belonged to another, from one end to the other, and, as is expressed very well in vulgar diction, *that I did not take a heel and place it at the leg*?

I respond that this fear was ceaselessly pressed on my spirit, and that I put all my attention on avoiding this hybrid mixing which would only have produced a ridiculous bundle of sticks. I even think that this inconvenience cannot happen, if one puts a certain rigor into the suitability of connections: the cracks are nearly always {15} of a reciprocal configuration, such that it is impossible that a fractured surface can be applied exactly to any other that that with which it corresponded at the moment to the solution of continuity. This was my guide and my safeguard. I judged the nuances of each region of bone, the direction of fibers, the thickness of the compact tissue, and a thousand other marks that proclaim with difficulty to an attentive eye, and that one has soon made by reassessing all the small pieces so many times; because at the end I know them nearly individually. Also the number of fruitless chances diminished rapidly when this forced study was made; it was easy for me to establish a class of piece that I hardly hoped to put back in place, because its intermediates were lost.

As to the remains, I conserved the refitted bones; one could always note by intuition whether I was mistaken. I also conserved the pieces that I could not replace in small bottles of glass; they are classed according to whether they should belong to this or that bony element, or else as indeterminable. I do not doubt that it would be possible to replace more, with a new access to zeal; work that, I think, would not learn anything new, regarding the number and form of the elements that I reproduced in a more or less complete state.

Another remark could be made regarding the solidity and durability of the bones thus remade. Without doubt, it would be unfortunate if so much sorrow and care did not come to anything but an ephemeral duration: but it is already much to have been able, by these means, to describe these bones, to draw them, and to make known their existence to some scientists whose testimony would be enough to give them the importance and authenticity demanded by science. I am persuaded that the inconvenience is to fear for them not more than for most of the objects that ornament our museums, and that their durability, to take a point of comparison, will far outlast those which have so laboriously reconstructed them, however long that it is[(1)]{16}.

The gum, employed alone, has the inconvenience of attracting humidity during cold and humid times, and a part of the fragments could then be unglued; in every case, these alternatives

[(1)] I have ten good vertebrae from a large crocodilian that I extracted by fragments from a block from the quarries of the village of Allemagne, near Caen; they have been reconnected with putty like the bones of my great Saurian from the quarries of La Maladrerie. In the six years since they were thus prepared, they did not undergo the slightest of softening and hardening were eliminated by altering the composition of the gum and removing its agglutinating properties. To obviate this inconvenience, I employed concurrently with it, while it is hard, a putty made with chalk and linseed oil to harden it faster. I used it at two degrees of consistency: 1st in a paste state, to fill the intervals which can be found between the fragments, either because of the loss of their salient angles, or to replace those which are lost and whose absence would occasion voids; 2nd while the first preparation is very hard and firm, I use the same putty near liquid; I coat the reglued lines and the same the entire surface of the bone, and I make it penetrate the composition by applying it with my finger where porosities are found. When this coat is well hardened, I scrape it with an appropriate instrument and remove all that which could not fit in the troughs or fissures. The gum is thus protected from the humidity; the entirety finishes by acquiring a considerably durability. In other circumstances, I have tried various proceedings to reglue, either by heat or cold; those that I indicate here seemed the surest, the simplest, and above all the most convenient.

The blocks of stone, from which I disengaged the bones myself, have given me infinitely less evil and have had results much more fruitful for me; I can say that I tried all the possible choices. If they had tested the fate of others, it is certain that they would have furnished me nearly nothing, because chance required that they confined the most fragile pieces and at the same time the most important for the identification of the animal.

I had two views to follow to discover the contained bones: either to partly disengage them, leaving them to adhere to the stone, or to isolate them entirely, as had been done forcibly to those that were brought to me by the workmen. This last choice offered the double advantage of permitting studying the bones on all their faces, and not exposing them to leave others in the stone, which could not have missed happening; {17} because, in several points, one was nearly confused with the others; but it was more or less necessary to break them in order to extract them, and perhaps mutilate them without resources. Thus the first choice seemed preferable regarding the integrity and solidity of the pieces and perhaps their natural relationships to each other.

But, when I wanted to, I was not able to proceed in this manner: the blocks, of an excessively unequal hardness in very closely brought together points, were in others fissured in

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alteration, they are strongly solid, much more so than they came out of the stone, because then their fragments broke at the least contact.

several directions; they had been broken by the first blows of the hammer and chisel. The bones were in general in the following state: firm enough in their middle parts and where existed a fairly thick bed of compact tissue, but nearly everywhere filled with fissures; the ends, entirely spongy, were of an extreme fragility to the point of being crushed under the pressure of a finger. Where compact tissue was found, the bones ordinarily only adhered very little to the stone; and, when they were sufficiently uncovered, the least force detached them, not whole, because they were separated in splinters at the places of the fissures. The spongy ends, in contrast, adhered strongly; if I had wanted to disengage them by sculpting the stone with little blows, the commotions that they produced would have reduced them to powder at the first attempts.

There was only one course to take, less dangerous than it seemed at first, which was to break, by sparing blows of the hammer, the stone and bone at the same time, and to carefully recover those fragments that had been detached. The number of blows thus became much less, because the blows that break the stone shake it much less than those that are without result. The essential thing was, in recovering each fragment of bone, to not mix together those which were from different bony elements, but to put all those that belonged to each of these elements into the small labeled and numbered cardboard boxes.

In acting thus, I was certain of success; but I am persuaded that if one had seen me breaking so curious an object, I could have in turn been accused of vandalism. And everywhere the pieces thus broken {18} very clearly preserve the reciprocal configuration of their fractures, which are easy to find again and reconnect: only insignificant bits are lost; there are few fumblings to fear in the rebuilding, because the fragments of each bone are reassembled in the particular cases; I believe to have proved that the restored pieces, with the cares indicated above, are much more solid and durable than they would have been without this; in obtaining the bones thus isolated, they can be studied under all their aspects. I add finally, as a convincing example, the results that I have obtained on the objects I disengaged: I used very little time, hardly a week; while the fragments that were furnished to me by the workmen, mixed, confused, and partly lost, cost me nearly two months of unyielding work, and still I have been able to reunite several pieces only imperfectly.

This method should be put to use in disengaging fossils from the Caen limestone, or others presenting a similar state of preservation, in the following cases: first, when they are easily detached and are at the same time very fragile; second, when the stone is of a strongly unequal durability or is fissured; 3rd, when the bones do not remain in their natural relationships and are confused pell-mell; for other rocks and in other circumstances, doubtless it would be necessary to act otherwise. In every case, I would not advise making an apprenticeship on an important element of this genus; one needs to have practiced on elements of little value, it is necessary to gauge the effect of each hammer blow before applying it, to choose the convenient place to break, and to know finally when to use the hands, without which one would make irreparable damages.

§. Vth. *Conjectures on what the habits of* Poekilopleuron *must have been*.

I do not need to prove that I needed a good provision of zeal and patience in order to accomplish all this fastidious work; I swear that several times the courage nearly abandoned me, above all when I saw my time consumed in useless attempts. I remounted my {19} perseverance for all the ways that I could invent: and as this occupation required the use of my eyes and hands rather than my head, I gave rein to my imagination during these long hours; I carried myself forward in thought to the time where these bones were penetrated by life, I asked these mute witnesses on the epoch where they had lived, I was told what was now the aspect of that nature, I made myself contemporaneous with the great lizard, I asked it what were the conditions of its existence.

Its size was gigantic, its strengths proportional; it had few enemies to fear, but it must have been fearsome to all those that surrounded it. It could hardly move a mass so heavy freely with velocity except in liquid; thus it must have passed a great part of its life in the waters and probably the marine waters, because its bones remained in a limestone that evidently owed its formation to some marine debris. Doubtless it was there that it pursued its prey, because it was necessarily predatory: crocodilians, fishes, and perhaps also large molluscs, ammonites, nautiloids, and belemnites must have been its victims. It must have also have moved well on the ground, because the form of its feet suggests that it could have progressed on firm soil; it would have gone on the shores to rest and sleep in the sun, in the same sun that today illuminates its bones buried for so long a time!

What must have been the appearance of our country during these epochs where similar monsters, lizards of thirty feet and weight to match, were living? Because it was not alone; there were others of its species; at the same time there existed many other different ones. The whole of nature and its products of that time were coordinated so that they lived and propagated there. Our peaceful inhabitants of Caen hardly suspect, in the night of the times, that their countryside, now so calm, so flowering, so well cultivated, was the bed of a sea where swarmed monstrous reptiles and such that now no longer exist. Which would tell them what would have risked finding more than the incredible; however nothing is true any longer, and whatever one could say or allege, the paleontological proofs are unchallengeable.

And these monsters were not always there; when *Poekilopleuron* {20} appeared, they had been preceded by living beings of another nature and aspect. From whence came the first of this race? Is that whose bones we have found the first of its species left by the hands of the Creator? Or did it owe its life to similar parents? An impenetrable mystery. I know that it lived, I have proved it, and that is all. Simultaneous or successive creation, the changing or perfection of species by the influence of time, habits or climates, have always been irresolvable problems for human reason. No analogy passes under our eyes; we see the individuals succeed themselves by reproduction; we conceive the possibility of the annihilation of species; but their arrival on the earth…this is there where it is necessary to cease!

§. VIth. *Locality of the bones and geological characters of the terrain that enclosed them.*

We quit these receding epochs and come again to the present time; first we examine the locality of the great saurian.

The bones were situated at a depth of 25 to 30 feet and contained in those strata that the workmen name *the wide bank*(1).

I think that here I must recall that the Caen limestone, reported by the Normandy geologists as the inferior stage of the Jurassic limestone, and which according to the opinion of Mr. Hérault seemed must be placed between the Inferior Oolite and the Polyps Limestone

(1) This is in the same bank where some bones of *Teleosaurus* were found fifteen years ago, consisting of a certain number of scales forming the anterior part of the plastron, several dorsal scales, a scapula, a coracoid, a humerus, a cervical vertebra, and several ribs. These pieces were acquired by Lamoroux, and they are now in the village museum. Up until now, these remains of *Teleosaurus* and those of the great saurian subject of this memoir, are the only objects of this nature from the quarries of La Maladrerie; the numerous remains of *Teleosaurus* and other saurians that ornament the collections of Caen were recovered in the quarries of the village of Allemagne, removed three-quarters of a mile from La Maladrerie and separated by the Orne valley; several others were furnished by the

(Forest Marble?), differs much by its aspect, its tissue, and all its mineralogical characters from other {21} limestones belonging to the same Jurassic stage. It greatly resembles the coarse limestone of the environs of Paris in its grain, color, and consistency, to the point that it would be nearly impossible to distinguish two specimens from these two limestones deprived of fossils; one can take an idea of one from the other; it is however very certain that these two rocks have no geological and paleontological connection between them.

The Caen limestone occupies a fairly large extent; nearly everywhere it is situated immediately under the vegetated earth. In several points it is covered by the upper banks of the Polyps Limestone, without knowing positively how it behaved relative to the inferior layers of this latter limestone, that is to say, whether it is distinct or confused with them. As for the rocks on which it rests, Mr. Hérault indicates a locality at the summit of the Notre-Dame-d'Esquai butte where it is situated immediately on the Inferior Oolite(1). Of the numerous quarries where it is exploited, none reaches its inferior limit and shows bare the rock on which it rests. The quarries examined for this subject assure that a bank of fairly durable grayish marl exists below the Caen limestone, succeeded by a bank of sandstone of the same color, and below the layer of water. Several times I saw in effect some debris from these banks brought back by the borer used to reached the layer, when the pits are excavated to traverse the series of banks composing the Caen limestone; unfortunately these debris brought back by the borer presented no fossils to me. (See *Le tableau des terrains du département du Calvados*, by Mr. Hérault, p. 121-126, and *La topographie géognostique du même dépt*., by Mr. Caumont, p. 205 and following.)

It is without doubt true that most of the members of the inferior layer of the Jurassic formation, considered together, belonged to the same epoch; but it would be well to desire that the delimiting of all these limestones, either different in aspect or singularly divided as {22} to the most abundant number and species of their fossils, would be made with care and detail, as a monograph of the locality. Undoubtedly one will either establish a constant distinction of these limestones by their mineralogical aspect according to their relative superpositions, or report their passage and fusion of one into the others.

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quarries of Quilly, Aubigny, and Vaucelles, near Caen; all are established in a limestone of the same aspect and quality.

§. VIIth. *Physical state of the bones*.

The state of preservation of the bones of my great reptile, similar to the rest of all the bony elements found in the Caen limestone, is remarkable and at the same time extraordinary, if one considers that they come from a rock that is very permeable to dissolving agents, to the point that most of the fossil shells, which very certainly were contained in the limestone, have disappeared, and that the small number found there still is strongly altered and changed into rock.

I have already made known that the bones adhering a little to the entombing stone, except in the points where the roughness and the regions occupied by the spongy tissue are found. A very thin, nearly powdery, bed covering the surface of the bone, but of a paler color, could be the cause of this lack of adherence; it often presents small roses of black dendrites, and it is removed easily by scratching with a knife: one remarks that the dendrites penetrate its thickness and are still marked on the surface of the scratched bone; all the internal cavities—the medullary cavity, the spongiosities, the vascular canals—are empty as in a dried bone, only these internal surfaces have a more pronounced rusty taint than everywhere else. The bony tissue seems to have not altered in its intimate structure; on several long bones, such as the ribs, femur, etc., the compact substance is removed easily by layers of which the most exterior are the thinnest.

Their color is in general a fairly clear rusty yellow when they are dry, much darker when they are humid, as when one recovers them from the stone that has not yet lost its water from the quarry {23} and contains much of it. These fossil bones have nearly the consistency and aspect of recent bone (except the color and weight) that for a long time had been submitted to the action of fire; but it was not necessary to conclude that they had been heated in place by the action of several subterranean fires; nothing in the localities where the Caen limestone is found indicates the mediate or immediate action of a similar agent.

§. VIIIth. *Chemical composition of the bones*.

The remarkable state of preservation of the tissue of these bones, at least as to its

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(1) At the village of Mai, this limestone might rest immediately on this bank belonging to the Upper Lias called *rock*. To the truth I have not been able to see the point of contact, but within ten steps of the small quarries of the Caen limestone, exploited on the buttes, the *rock* is visible at their foot.

appearance, excites in me the desire to know up to which point the chemical composition responded to the apparent organic state.

I found phosphate and carbonate of limestone there, small quantities of animal material in a particular state, and iron oxide and fluorate of limestone[(1)]{24}.

§. IXth. *Remarks on the physical and chemical state of the bones.*

If anything must be surprising, it is to meet, in a similar rock, a similar state of preservation for a material that was organic. This state of preservation seemed rather to belong to the fossils contained in the alluvial, or tertiary, terrains or also in several of these ancient terrains so impermeable to all agents that the fossils there remained in nearly the same state as when they were buried; as one sees for several coal-bearing terrains where the leaves of ferns were preserved including their flexibility. But, on the contrary, the rock that forms the Caen limestone is one of the most easily penetrable, one which must experience the most changes in its appearance and mineralogical tissue, and in which the majority of fossil shells were destroyed or strongly altered.

The bones of my fossil and all those that I know from the same rock constantly presented

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[(1)] I was not content with a qualitative analysis; although I had only fairly imperfect balances at my disposition, with the endorsement of other instruments, and though I was only an unskillful chemist, I tried a quantitative analysis. Preserving, with reason, doubts on the exactness of my results, I communicated to Mr. Girardin of Rouen, whose obligingness was known to me, and whose skill in the delicate researches of chemistry is universally appreciated; I communicated my results to Mr. Girardin, the exposure of the procedures that I had used, and several remains of bones on which I had worked, with my request that he speak frankly what he thought. His response confirmed my doubts: the procedure that I had used was not susceptible to much precision, and the great quantity of limestone carbonate that I noted (44 percent) seemed to him to depend on an evident error, “Because,” he said in his response, “it is not believable that a great amount of salt had formed during the fossilization; and the greatest quantity that had yet been noted in the fossil bones does not exceed 16 percent.” Without wanting to defend my analysis in any manner, I was able to find to oppose the opinion of Mr. Girardin that my fossil bones, which had lost the greatest part of their animal matter, nevertheless had a specific weight of 2.01; while the dried bones of the crocodile (non-fossil) only weighed 1.80; that in the limestone beds, the bodies of fossil organisms underwent notable changes (I give proofs in the following parts of my memoir); that a certain quantity of limestone carbonate was able to infiltrate and be deposited in the intimate tissue of the bones, because they were placed in the middle of a rock where water of the quarry filters and transports not only this salt, but many other mineral materials, whose dissolution, deposition, and also subsequent disappearance, are much more difficult to admit and above all to explain, although they are very real. But that which stops all objection is that Mr. Girardin, in an essay he wrote on the bones that I sent him, found there only 9.92% limestone carbonate. Thus I suppress my quantitative analysis, and give very cordial thanks to Mr. Girardin for the frankness that he agreed to place with me.

their internal cavities and the cellulosities of the entirely empty spongy substance[1]. I am convinced that it was not always so; that during the epoch of their sojourn in the rock, the internal cavities and the spongiosities were filled with spathic limestone or some other mineral substances[2]; that by the progress of time and the action of the water that continually penetrates and traverses the rock and the enclosed bodies, this spathic limestone or other mineral materials had disappeared.

Doubtless one will find this opinion very hazardous. I will not develop here all the reasons that lead me to adopt it, which would involve me much too far; I will only observe that it is nearly impossible to believe that the internal cavities of the bone were not covered and filled by crystalline materials, as seen in the interior {25} of well-closed shells and in the small voids existing at the heart of the majority of rocks: fossil bones that are found in less permeable ancient rocks are always filled with spathic material. I would be content to relate a fact of petrifaction that is offered often enough in the Caen limestone, a fact curious in itself that proves in an unchallengeable manner the transformations, substitutions, changes, etc., that the mineral substances experienced in this rock. It has already been indicated, although very incompletely, by Mr. Le Neuf of Neuville, in a memoir that makes part of the first volume published by the Société Linnéenne de Normandie, p. 62 and 63[1], and reproduced, according to him, by Mr. Hérault (*Tableau des terr. du Cal*., p. 23) and by Mr. de Caumont (*Topog. géogn. du Calvados*, p. 206).

§. Xth. *Remarks on the changes experienced during fossilization by the organic debris furnished by the Caen limestone, notably some great ammonites*.

This fact is furnished by the state of petrifaction of some ammonites.

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[1] I exclude from them a small crocodilian coming from the quarries of Aubigny, near Falaise, whose spongiosities are filled with spathic limestone. At the same time it is wise to note that the stone from Aubigny is much more durable than the other varieties of Caen limestone.

[2] In the following pages I will speak of a portion of bone from my great reptile whose interior is filled with spathic barite sulfate.

[1] This fact is not particular to the quarries of La Maladrerie, as the author indicated: I saw it in the pieces from the villages of Allemagne and Venoix; it is very probable that it is noted in all the localities where the Caen limestone is exploited. Mr. Le Neuf of Neuville said that the ammonites, at whose center quartz is found, are situated in the fissure of stratification that separates the *wide bank* from the *bottom bank*; that is too exclusive; similar ammonites, with their quartz alveoli, are also found in the thickness of the banks; in truth I cannot say whether, in this case, those that I have seen belong to the *wide bank* or to another; the essential thing is to remark here that there is no necessary relationship between them and the fissures of stratification.

Those of great dimensions (1 to 2 feet in diameter) are fairly frequent in the Caen limestone; the workmen name them *plards*. There are probably several species; the most common could be related, I believe, to *Am. giganteus* Sow. They are in general very poorly preserved, the test is nearly always destroyed, and the interior mold covered by a great number of small irregular plates of a beautiful white, nearly friable, formed of quartz or chalcedony in a very advanced state of alteration; ordinarily there remains only the last turn {26} and a part of the next-to-last of the ammonite, those of the center have disappeared and have left only slight traces of their presence on the stone. But one often finds there, adherent to the stone, the remains of the siphon of the vanished turns, now end-to-end and forming a curve, (pl. I, fig. 1. *a. a*.) now in disorder (*b. b., etc*.); they are formed by a very thin, corn-colored bed having an interior filled of calcareous spath; these nearly gigantic ammonites had a very straight siphon.

In other rarer cases, and to which I wish to pay particular attention, the central turns have equally disappeared; but one finds a mass of flattened quartz occupying part of their place, pierced by a prismatic figure in all directions of the cavities, in which it is evident that the crystals were contained; the quartz must have been molded on those and preserved their imprint after they disappeared (fig. 2).

This quartz is of a slightly milky tint, its fresh break is vitreous, and consequently it belonged to the variety named hyaline quartz; but when the breaks are old, they have a dull and waxy appearance that made this quartz be taken for chalcedony. The name of chalcedonious quartz, given to it by Mr. Le Neuf of Neuville, is very well founded; in effect this material seems to be a connection between these two varieties of aspects that show the silica; it often sticks in the debris of the siphon.

The prismatic cavities are very drawn together; although directed in several directions, their summits in general look toward the center of the mass; one sees that these cavities contained some crystal groups whose bases or points of origin were outside, that is to say, on the stone in the interval where it was molded on the central turns of the ammonite. In the spots where the prismatic cavities left a certain space between them, the quartz that filled it ordinarily offers, in the thickest point, a small geode adorned with summits of crystals belonging to the bisaltern variety. I possess some specimens showing the primitive form of quartz, that is to say the rhomboid that is particular to it; the summits of these crystals have {27} up to line [= mm] on a side; they are sometimes covered by a very white, very fine powder that is removed easily with a steel point and leaves the surface very clear and brilliant.

It is believed that the prismatic cavities contained some crystals of strontium sulfate; in effect they seem to be molded on some forms entirely similar to those of the crystal figured in the mineralogical atlas of Haüy, pl. 44, fig. 86, under the name *pointed strontium sulfate*. To assure me, I filled several of these cavities with Darcet's mixture; I was careful that the quartz mold, full of mixture, rested for a certain time in boiling water and that the entirety cooled very slowly. The goniometer applied on the faces M M and *o o* (*pl. I*, *fig. 3*) indicated the angles of barite sulfate and not of strontium: in effect I obtained 101° for the inclination of faces M M, and 105° for that of faces *o o*; I molded four crystals, and all gave me the same value of angles within some few minutes. Supposing that the cavities had been occupied by strontium, I was not able to be misled even roughly on the opening of the angles; a similar degree but for a few minutes; but 3 degrees at least on faces M M, and three more for faces *o o*, the thing is not presumable. One can only say that the mixture, by its dilation, was able to make varied angles at this point; I left it to cool slowly in the quartz cavities, and I was only able to remove it by breaking them; the prismatic cavities could not be made ready by a similar variation of forms. Thus no doubt remains that the mineral substance on which the quartz was molded was barite sulfate.

The variety of form that the barite has taken in this case was what should be designated by the name *pointed* following the method of Haüy: the figure of this variety represented in this author's mineralogical atlas (pl. 34, fig. 14) does not seem, at first aspect, to resemble our vanished crystals; in effect the crystal figured by Haüy is in table, because of the great development of faces P P, whereas the same faces are very straight in our prisms (*pl. I*, *fig. 3*); the supposition that our crystals belonged to strontium is perhaps due to this dissimilarity {28}; but as the laws of diminution are the same for these two forms contained one in the other, the sole value of the angles determines here the difference of the substances.

We now examine the diverse states through which the ammonites and accompanying mineral materials must have passed, during the long series of centuries of their sojourn in the stone.

1st. Deposition of the shell with its primitive or marine test, and formation of the banks by silty or sandy deposition.

2nd. Destruction of the marine test and its replacement by a spathic test, at the same time that the cavities are covered or filled with calcareous spath.

3rd. Destruction of the spathic test and calcareous crystals covering or filling the cavities.

4th. Formation of the crystals of barite sulfate.

5th. Deposition of quartz material on the surface of these crystals.

6th. Disappearance of the barite sulfate, without alteration of the quartz.

I can add a seventh modification of which I possess several examples: this is the new deposition of calcareous crystals in the prismatic cavities of quartz, a pseudomorphosis of the carbonate limestone into pointed barite sulfate; and, so as to leave no doubt on the origin of this assumed form, several of the prismatic cavities are only partially filled; one sees, in the voids, the real form of the carbonate limestone that is found, in this case, to be the dodecahedron of scalene triangles called *metastatic*.

Without pretending that all these modifications were succeeded with the precision indicated here, they were nevertheless successive. Necessarily these changes, in the nature and appearance of the fossils, should be principally caused by a dissolving and depositional agent, which had penetrated the stone and was found charged now with one material, now with another: this agent could only be water. I have already remarked on how permeable is Caen limestone, and the great quantity of quarry water it contains habitually.

According to these remarks on the nature of this limestone and the changes experienced by some ammonites captured here for example, changes {29} that appear to have been made on more or less all the materials that it enclosed, organic or not, it is clear that the bones could not have been substrates, and that it is impossible that their internal cavities remained void. They were at first filled with water, and crystalline deposits were made there, limestones or others, as instead in the majority of other rocks enclosing the bones; but we remark that the crystalline deposits were redissolved without altering bony walls. This last circumstance is truly very unique: of bodies so little homogeneous and so permeable that the bones remained intact and retained the most beautiful preservation up to their smaller details, while some crystalline substances, with much more compact tissue, completely disappeared. It is not thus of shells; they are in general strongly altered and hardly recognizable. Those with leafy or fibrous marine test, such as oysters, terebratulates, clams, belemnites, mussels, *gervillies*, etc., that ordinarily persist with their marine test in the majority of rocks, persist also with this structure in the Caen limestone. With regard to the others, a more or less thick bed of calcareous spath indicates their presence; they are very rare in the majority of banks; it is only in some localities[1] and in certain points of the banks[2] that they are found in fairly great abundance; then the rock presents more durability and less homogeneity that where shells are not seen. It is unquestionable, for me, that during the epoch where the Caen limestone was deposited, this rock enclosed infinitely more shells than now; they were dissolved, replaced at first by calcareous spath, and this carried away in the end, totally or in part, under the influence of the previously-indicated causes. I will further remark that I always found more traces of shells in the vicinity of the bones than anywhere else. They were rarely there in the spathic state, but rather in the mold and imprint, the interval being void; I except the shells with leafy or fibrous structure, which preserve their marine test.

I do not pretend to explain the good preservation of the bones in a {30} rock that *seems to consume* its other fossils: but it seems important to note there the persistence of some shells with laminated or fibrous marine tests; because the test of these molluscs contains, all things considered, more animal material than those of the molluscs with *porcelain* tests, which disappear entirely, and which a spathic material replaces in most cases. It is further noted that the bones are generally very well preserved in all the rocks, and that the quantity of animal material that they enclosed is greater than that contained in the tests of molluscs with fibrous or laminated shells. Does this animal material, united through life processes in certain proportions with calcareous salts, play an important role here? Did it have an advantage against certain tendencies toward active chemical reactions in the heart of the rocks during the periods of fossilization and petrifaction? I think it did; but I could only apply this opinion in lieu of the observation of the fact itself.

Although the preceding remarks were, for me, the expression of verified facts, I greatly fear that they are not found more unbelievable. Perhaps the continual changes that operated in the interior of the rocks had not been observed and studied enough; they were for me the subject of subsequent studies, and I had collected many facts on this subject that I will probably not publish; I feared that they would either be regarded as deserving of little interest or as erroneous. For my great saurian, I hazarded some of these remarks made on the Caen limestone; I dare to hope that if they did not obtain the assent of paleontologists, they would, having condemned them, have cause to examine anew the phenomena of fossilization in homogeneous permeable

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[1] At Aubigny.
[2] At Quilly, on the surface of certain banks and elsewhere.

limestones.

§. XIth. *Portion of the bone of* Poekilopleuron *enclosed in barite sulfate*.

I announced in a note (page 56) that, among the bony elements of my great lizard, one was found whose spongy tissue was filled with spathic material. This portion of bone is too incomplete for its place in the skeleton to be assigned with certainty; it is perhaps the head or the bulging portion of some flat bone of the shoulder {31} or pelvis. I give the figure, pl. V, fig. 18-19. It is entirely spongy, hardly if any compact tissue it is found at its surface; it is not filled everywhere with spathic material, and in some points the cellules are empty. This piece of bone comes from the block transported to Mouen, and was found amidst the debris felled by my mason; except on the side of the fracture, it was surrounded by a fairly great mass of stone whose grayish color and dried tissue, for 3 to 4 inches around the bone, contrasted with the color of the rest of the mass, which—as well as the stone in general—is of a fairly good white color, slightly yellowish washed; this grayish color formed a sort of halo around the bone, whose nuance weakened and ended by melting into that of the stone. The fragment of spathic-filled bone was of a remarkable weight; the gray portion of the matrix was also heavier than the rest of the stone; I suspected the presence of barite, and analysis verified this suspicion. I found, except error, 30% sulfate of barite in the portion of the bone; a little less, 25%, was in the grayish part of the stone that enclosed it. I could not discern any trace of barite either in the other pieces of limestone surrounding the bone of my great saurian, or in those which envelop the bones of *Teleosaurus*, or finally in the other randomly-selected pieces of the same limestone without fossils. I found the specific weight of the Caen limestone to be 2.63, and that of the grayish baritiferous limestone to be 3.07.

This was the first time that I had found barite sulfate in nature in the Caen limestone. It must not have been rare in geological epochs before the present, because traces of its sojourn are found in the prismatic cavities of quartz described in the preceding paragraph. It must have been for the Caen limestone, relative to barite sulfate, as it is now for the Valognes limestone(1), whose fossils sometimes contain barite crystals: I removed of an asteroid fossil from this limestone, of beautiful enough crystals of the variety named by Haüy *anisotic*.

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(1) See the geognostic topography by Mr. de Caumont, p. 253.

{32} §. XIIth. *Pathological cases observed in several bones of* Poekilopleuron.

The bones of my fossil presented two pathological cases to me. The most remarkable exists on one of the chevrons: it is fused to the centrum of the vertebra by its left branch, which offers at the same time an exostosis of very notable volume (pl. II, fig. 1 and 3, *b b*). The other case, less apparent but not less real, is instead on one of the pedal phalanges (pl. VIII, fig. 21, *a. b. c.*). This was a decay with osteo-sarcomatic growths; in the place of the phalangeal compact tissue is found a very fine and very fragile cellulosity, with unequal surface, corroded at some points, exuberant in others, briefly having the greatest resemblance with the alteration that constitutes decay in the bones of man and animals. The great fragility of this element did not permit me to remove it from the stone without breaking several of the growths that it showed, but the alteration is very easy to report when this phalanx is compared to others whose tissue was healthy; the posterior articular surface is nearly entire, the anterior is missing; perhaps it was already destroyed before the death of the animal. And so that one did not believe that this was due to the effects of fossilization, there was nothing to mistake; in seeing the element in nature, it is not possible to deny that it had not been altered during the life of the animal.

Thus now, if one could doubt, since the times of the existence of these ancient inhabitants of the earth, the laws of organization and all their consequences, that is to say up to the alterations to which they were susceptible, were those which are of our own days: the inflammations, organic lesions, and pain was also the procession of life. In the series of ages, the forms of the productions of nature, their varied generic and specific types, this fact is incontestable; that these differences were the result of creations taking the place of other creations, or that they depend on successive modifications occurring in primitive types, is little important here; but the profound, intimate laws that preside over the fixtures of the organized material and the ruling of this state, were not varied.

{33} §. XIIIth. *Small rounded pebbles, tooth of* Cestracion *and altered bony fragments, found among the ribs of* Poekilopleuron.

In exploiting the Mouen block (see p. 43, 44), the stone was split according to the direction where the fragments of four to five large ribs were found imbedded that were thus laid bare in an extent of around one square foot; they were not at all parallel, but were crossed in several directions; they were much more fragile in this extent than in the rest of their length; the tone did not have its ordinary consistency there, and at some points it could be nearly crushed under the fingers; it was strewn with small irregular cavities, covered by a sort of brownish-violet powder; some contained small, white, irregularly-outlined plates formed of siliceous material in a nearly friable state of opal. This particular state of the stone, limited to the interval expressed above, is extended to a depth of around two inches on each of the portions of the stone splintered: I found in the middle of this space eight to ten small rounded pebbles, some of milky oily quartz, others of flint; the largest having hardly the volume of a large nut; they were made sticky by the stone, but without being *melted* with it; the flint pebbles were enclosed by a layer of nearly friable opal, a half line in thickness, seeming to come from the alteration of the more exterior layer of the flint; those of quartz did not have any trace of alteration on their surface. Evidently these flints and quartzes are not formed in the stone by the set of affinities, but are of foreign origin and were deposited at the same time as the bones of the animal. Among these pebbles one was found of the volume of a great weight, formed of compact iron hydroxide; like the others it is rounded or, if one wishes, rolled.

In disengaging the nearly complete skeletons of crocodilians enclosed in the same limestone, several times I found similar pebbles; only the stone in which they were stuck was not friable. Among these pebbles are found several of a lamellar tissue substance that seems to be feldspath.

{34} I never saw similar rounded pebbles in the Caen limestone other than with the bones, and I had the occasion to observe this limestone ceaselessly since the town was built. The chalcedony quartz with prismatic cavities of which I spoke previously had no relation to the origin of the rounded quartz pebbles that are questioned here. Some banks of Caen limestone enclosed flint that was formed in this stone, and comparable under this relationship to those of the Chalk, but they are *melted* insensibly into the tissue of the stone and do not at all resemble those accompanying the fossil bones.

These rounded pebbles necessarily have a direct relationship with the bones among which they are found, and were deposited at the same time as them; it is easy to explain this circumstance: *they were enclosed in the stomachs of the animals*.

On one hand, the circumstance of a great number of bones reassembled in a small space and situated mostly in their articular relations, proves evidently that at the epoch of their deposition they retained their ligaments; a part of the flesh must have adhered there still; most of the viscera, including the stomach, must have been found enclosed in the interior of the carcass, and with them the materials that they contained. On the other hand, it is certain that several, and perhaps all, reptiles swallow pebbles at the same time as their food, such as granivorous birds; and that these pebbles remain in the stomach where they help the digestion in favoring the crushing of alimentary materials. This fact is affirmed for the crocodiles of Egypt by Mr. Geoffroy-St.-Hilaire in his work entitled: *Of the Crocodiles of Egypt*, p. 99[(1)]; lately I had the occasion to report the same fact for a marine turtle *(T. imbricata*) that I had preserved living, for two and a half months, by keeping it in a bucket of mild water that was renewed frequently; it constantly refused all types of food; after six weeks of captivity, it rendered by the anus a fairly great quantity of small rounded pebbles with polished surfaces, some {35} calcareous, others siliceous. I only know these observations relative to living reptiles; it is not in the recent work of Mssrs. Duméril and Bibron on herpetology, which seemed to include all that science possesses on reptiles. That the same observation was offered, by a happy chance, on several fossil reptiles would tend to generalize this fact.

With and among the rounded pebbles of the Mouen block was found a tooth of good preservation; I give a drawing of it, pl. I, fig. 6, *a b*. It is very evident that this tooth cannot belong to my saurian or to some reptile, but that it comes from a fish of the shark family, belonging to the subgenus *Cestracion* of Cuvier. In the living state only a single species of this subgenus is known, *Cestracion philippi*, found in the seas of New Holland. This animal is above all remarkable by the singular form of its pavement teeth, of different shapes and sizes, placed obliquely and in a spiral on the two sides of the jaws.

Some similar teeth are not very rare in our diverse limestones. It is easy to recognize, according to those that we have at Caen, that the ancient seas where our limestones were deposited nourished several species of *Cestracion*: because, despite the difficulty in establishing species by means of these teeth, given that their forms are very variable for each species, the differences in size and form are such that it is impossible to admit that they belonged to one

[(1)] "The interior (of the stomach) was however full of small pebbles whose polish announced that they had served to break down alimentary materials. (*loc. cit.*)"

animal. I have in my collection two magnificent specimens coming from the quarries of the village of Allemagne that show a fairly great number of these teeth situated in their natural relationships. I intend to publish unceasingly a work where all that I have recovered on this subject will be described and figured.

We return to our *Cestracion* tooth found among the rounded pebbles. To my view, it confirms the opinion issued above that the pebbles were contained in the stomach of the great reptile; it comes very probably from one of the last prey that it had swallowed. It is nevertheless surprising that this tooth was alone, since the *Cestracion* had them in great number; but many causes could have disseminated them: perhaps {36} they are found some steps from there in the bank and remained in the quarry, or they were been removed with other blocks. It is also possible that they had already been yielded by the animal, or that they were found in some portion of the intestine carried farther away; one can make a thousand conjectures on this subject that do not destroy my supposition.

The tooth is around an inch long and three lines wide in its middle; it is slightly arched laterally and armed with seven conical bosses ranged along its length; the largest is in the center, its point is a little worn by trituration; the others diminish in size towards each end. All the bosses are ornamented with small salient striations, radiating from the point towards the circumference. The two edges of the tooth are supplied with a range of irregular folds more salient on the convex side than on the other; the striations of the bosses came bifurcating to be reunited at these folds.

With the rounded pebbles were found still several rusty yellow fragments, having nearly the appearance of the fossil bones; but they are very fragile and have another tissue resembling, if the preservation does not deceive me, the solid network that forms the base of certain bones of cartilaginous fish, and that becomes very evident in those bones remaining exposed to the intemperances of the atmosphere for a long time. I am persuaded that these fragments came from the bone of some fish of this genus swallowed by the great saurian, of *Cestracion* without doubt, and that was not entirely digested at the instant when death surprised it.

It is also very supposable that these small cavities, filled with violet powder and containing the small altered siliceous plates, had enclosed some portions of the materials contained in the vanished stomach, leaving in their place a small fragment of silica, as if they had favored the deposition of siliceous material, as well as what seemed so probable according to what is seen in a great number of terrains where the presence of organized bodies seems to have retained or attracted silica.

Although nothing was as simple as supposing that an animal, passed into the fossil state, had been surprised by death at the moment of its digestion, is it not very remarkable to see therefore this digestion {37} *fossilized* and presented to the attentive observer with circumstances that hardly permit recognizing it? One cites the fossil fish seized by the matrix at the moment they swallowed another fish; this fact could be contested up to a certain point, but it is very presumable that, in examining the region of the stomach of whole fossil fish or reptiles, one will find debris of animals that fed them.

It was not necessary to recover the traces of swallowed prey by our reptile to judge that it must have been predatory; this habit is proved by direct observation. In seeing its dimensions, one could still guess that it should frequent the waters, because a similar mass could only be easily moved in a liquid; but this habit is made evident by the nature of the prey contained in it stomach: this prey being a fish whose analogs inhabit the seas, it must be inferred directly that our great lizard frequented marine waters.

§. XIVth. *Shells found in the blocks of stone containing the bones*.

In disengaging the bones of my animal, I found some shells. I have already remarked that they were rare in the Caen limestone, and so badly preserved that they are difficult to identify; it is only by force of time and happy chance that the malacological character of this rock came to be understood. I have already reported about thirty species there, in various recoveries, of which the majority were found, much better preserved, in the calcareous strata that precede and immediately follow it, according to the order of the formations; only five or six species had not yet been found, which does not wish to say that they were particular to it.

I have remarked for a long time that it was in disengaging the fossil bones that I found the most shells in the Caen limestone, above all the species with thin shell. I saw previously how permeable this limestone was to dissolving agents, and what singular changes {38} had affected several of the enclosed bodies. Was the stone preserved intact for a long time in the portions surrounding the bones? Had their neighborhood been some influence on the other organized debris? That is probable, because the fact of preservation exists is pronounced there than everywhere else.

BELEMNITES HASTATUS? Bl. Pl. I, fig. 4, 5.

Shell elongated, subcylindrical, slightly depressed and a little widened toward its posterior third, narrow toward its middle third, barely widened from the side of the opening. Summit pointed, median; furrow ventral, beginning from the opening, a little splayed in the widened portion.

I possess four individuals of this species, all coming from the Caen limestone; this is the only belemnite that I have observed there, and it is very rare. Two of my specimens have at least double the volume of that which I figure here; the forms and proportions are entirely similar. It is very distinct from *B. acutus*, Bl., of which I possess a large number of individuals that are all compressed and have their siphon on the side straight from the shell. It is equally fairly well distinguished from *B. apiciconus*, Bl., which is common enough in the ferruginous oolite banks of the Moutiers and Bayeaux; it differs principally by its more pointed summit, more depressed form, and the narrowness of its middle region. It is not without some resemblance to *B. altdorfensis*, Bl.; but I do not know how to distinguish it, in practice, from *B. hastatus*, Bl. and *semi-hastatus,* Bl., although the description of the two given by Mr. de Blainville does not suit them completely. Of the rest, I was astonished that all these belemnites, *acutus* excepted, were not varieties of the same species.

The principal merit of this specimen, which I was only able to obtain by carefully recovered fragments, is due to the considerable extension existing from the side of the opening, which I had never seen so long in nature or figure. The thinning test ceases to be apparent a little beyond the point where a break leaves some perceptible traces of partitions (*a*). It is presumable that something was extended {39} beyond; a body must have existed following the shell, extended with it, whose destruction left a cavity that ended by being filled with calcareous crystals, although the stony mould was penetrated toward the base of the test in the interior of the shell. This extension (I do not know what other name to give it) is not entirely in the axis of the shell, but is a little arched from the side of the ridge; the two sides are not at all symmetrical, the one (*b, b*) is a little nearer in the extended direction of the shell, the other presents two embosses and a depression (*b', b'*), as if it had an accidental deformation there. There are however far from there the remarks by Mr. Agassiz, of a well characterized belemnite being extended with a body very analogous to the shell of the cuttlefish. (See the letter of Mr. Férussac, addressed to the Academy of Sciences. Institute of November 1835.)

My belemnite offered me an interesting fact of petrifaction: it is changed, on the exterior, into fine orbs of chalcedony figuring species of arabesques; this change has only taken place in the thickness of a third of a line, one finds that it is ordinary again below the radiating calcareous tissue. These orbs have mostly passed to the state of a sparkling white opal, but their center is still in a state of chalcedony.

NUCULA NUCLEUS. Nobis. Pl. I, fig. 8.

I found two isolated valves of this small shell, or rather their exterior imprint and the interior mould, the place of the test being void. It does not differ from a small *Nucula* that I had found fairly rarely in the ferruginous oolite of the environs of Bayeaux; to better assure me of the identity, I poured wax into the imprint; not the least doubt could remain. Fig. *d* is that of the interior mould from the Caen limestone; figures *a, b, c* were drawn from a specimen lacking its test and coming from the environs of Bayeaux.

It seems to have some resemblance with *N. antiquata*, Sow. (*Min. conch*., pl. 475, fig. 4), but its edge is not at all denticulate, nor is its surface longitudinally striated; it seems to me to differ equally from *N. impressa*, Sow. (*ibid. id*., fig. 3) because this is depressed. I believe mine to be new.

{40} Shell subglobular, very salient hook, rounded, nearer the anterior end than the posterior; well circumscribed lunate, broken at its circumference, salient at its center; corselet not distinct; surface gleaming, covered in the well-preserved subjects with fine concentric striations, little apparent, with some striations growing well pronounced and irregularly spaced. Edges complete; thick valves relative to the small volume of the shell. Teeth of the hinge slightly numerous, very large, and very salient.

AVINCULA DIGITATA. Nobis. Pl. I, fig. 9.

This species seems to me strongly distinct from *A. costata* Sow; it has more relations with *A. inaequivalvis* of the same author, however this has its left valve more splayed. I possess a fairly great number of individuals of these three species and I think their differences are constant. I have only found *A. inaequivalvis* in the Upper Lias; *A. costata* is very common in the upper bank of Polyps Limestone (white stone), and less in the successive descending beds (Caillase); I found those described here in the bank with ferruginous oolites of the environs of Bayeaux and the Moutiers, in the Caen limestone, the Caillase of the Polyps Limestone, and in the clay of Dives: it is rare in these diverse strata.

The number of sides of its left valve is twelve; they are terminated by some very elegant and thin extensions or digitations that are very rarely found whole. The right valve is much smaller and flatter than the left; its free edge is complete and its surface ornamented with some slightly salient longitudinal striations; it presents a deep angular sinus under its anterior auricle. Of the rest, as I only found the left valve in the Caen limestone, I did not describe this shell more amply; that which I came to say, joined with the figure that I give, will suffice to make it known. On this section of pearl-oysters with heightened sides, I propose to give myself more developments in the work that I am preparing on the fossil shells of Calvados.

MYA? *SCRIPTA*? Sow. Pl. I, fig. 7, *a*, *b*.

It is with reluctance that I inscribe under the name *Mya* this singular shell that is evidently related to those that Sowerby figured in his plate 224, and which he describes under the names *Mya litterata*, *scripta*, {41} and *angulifera* (*Min. conch*.). In effect, this is not at all a *Mya*; the left valve (the only one that I have found), although it was only an imprint, perfectly allows seeing the trace that has imprinted its hinge; or this hinge was simply linear, without teeth, spoon-bowl, or ossicle; briefly, this shell whose form could suggest relationship to *Mya*, *Anatine*, or *Thracie*, did not belong to any of these genera, but must constitute a distinct one. I possess four species (that comprise) that present this form, a considerable gape in back, and a simple linear hinge. If I do not establish this genus here, this is because it was necessary for me to enter into some developments that did not permit the nature of these researches, and that it would be difficult to judge its value on a single species. I propose to establish this generic section in the work that I prepare on the fossil shells.

The figures and descriptions given by Sowerby are too vague (without doubt because of the bad state of his specimens) to decide positively to which of these three species it would be necessary to relate this, if however they are not a single one and that their bad state had not permitted characterizing them well.

This is the first time that I encountered this shell, and I am right to consider it very rare; its test must be excessively thin; it was couched in the centrum of a vertebra; the place of the test was void; a part of the inferior edge is lost. I will characterize it thus:

Shell very gaping in back, attenuated in front, moderately swollen; salient hooks, situated toward the anterior third; simple linear hinge; one longitudinal fold leaving the hooks and directed forwards and another back, parallel to the superior edge; thin test, paper-thin, undulated by the ribs and grooves coming from the superior edge to form angles with the rounded sinus from the side of the hooks, of which the series is directed on a line leaving them and going to end at the inferior border toward its middle part.

I have found still, in disengaging the bones of my fossil, the valve of a small shell resembling a *donace*, but in too bad a state to be described and figured. This small shell seems to me to have analogy with some of those that one finds sometimes in the upper part of our Forest Marble.

{42} VERTEBRAE.

§. XVth. *Remarks on the bony elements. – Description.*

The number of vertebrae that I have been able to procure is 21, all from the tail, forming two series, one of none, the other of 12. The first series comes from a block that I worked myself (see page 41); the second was found as numerous more or less broken fragments that were brought to me by a quarryman (see page 42). Although in this last series all the vertebrae appear to be in their natural order, it would not be impossible that some are missing, and that, observing the great resemblance of their forms and dimensions, I did not realize any: this error, if it exists, is of little consequence. In the first series, all the vertebrae are in legitimate succession as they were in the animal, and as they also were arranged in the block that I worked; one can see, in plate II, fig. 1, the indication of saw-marks that removed some portions of the end of the stone.

Between the two series another necessarily was found; I will soon try to calculate the number of vertebrae that must form this absent intermediate series.

A superficial examination led me first to suppose that these vertebrae belonged to a crocodilian, although different from all those that I know from the fossil state, and more so from living species. This supposition appeared well-founded when I discovered ribs on another block, particularly those that supported the abdominal muscles. In the following chapter, it is seen that if these last have some analogy with the same bones existing in the middle of the abdominal muscles in living crocodiles, they also have some analogy with bony or cartilaginous extensions that surround the abdomen in certain lizards, such as chameleons, marbled lizards, and anoles. A profound study of these same vertebrae revealed that although they differ notably from those of living or fossil {43} crocodilians, they approach those of lizards, although they have unique characteristics.

The anterior and posterior faces of the centrum are a bit concave, and this concavity is much deeper in the vertebrae closer to the end of the tail. This morphology is found in all our fossil reptiles, and appears general for all those formations prior to the Chalk. The only exception to this rule that I know of is the group of vertebrates described by Cuvier *(Oss. foss*., vol. V, p. 155, pl. VIII, fig. 12, 13, and pl. IX, fig. 10) from the clay of Honfleur, which he compared to a crocodile; still the convexity is anterior instead of posterior, as is the condition in most living reptiles; moreover, the convexity is only very apparent in the neck vertebrae, the following have the two ends of the centrum entirely planar.

The constancy of this configuration in ancient reptiles, and that of the concave-in-front and convex-in-back form in living reptiles (geckos[1] and batrachians excepted), is a very remarkable fact that doubtless has a profound diversity in the general organization of these beings, the nature of which has not yet been appreciated.

I believed, during an instant, to be on the way.

In separating the ribs of my animal, I first found a {44} V-shaped bend (pl. IV, fig. 1, 2, 7) that did not resemble at all anything I knew. I believed that it was part of a branchial apparatus; other small, equally extraordinary rib pieces confirmed my opinion that the large lizard whose remains I discovered could have been like certain batrachians in possessing a double respiratory apparatus, branchial and pulmonary. Pursuing this idea without counting, for the moment, the considerable differences between the bones of batrachians and those that I compared to them, especially the absence of ribs or their rudimentary state in these reptiles and their well-pronounced development in my fossil, I envisioned only the general state, knowing that all animals with permanent or transitory branchials, have the anterior and posterior faces of the centra of their vertebrae more or less concave, except in the first age.

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[1] Meckel (*An. comp., trad. franç.,* vol. 11, p. 598), after having described the articulation of the vertebral centra of Saurians united together by arthroses, adds: "Others, on the contrary, but only in small numbers, geckos, for example, present the arrangement of mammals or better yet those of fish; the vertebral centra are excavated, in front and in back, by a considerable infundibuliform cavity filled with a fibro-cartilaginous substance, which makes them appear to be composed of two cones."

Mssrs. Duméril and Bibron (*Erpet. gén.,* vol. III, p. 258) mention the arrangement of the vertebrae in geckos: however it appears that they did not note it in nature, but after Meckel; they express it thus: "Meckel says that the vertebral centra are excavated by two conical cavities, about like in fish."

Here is that which I was able to notice in a Mabouïa gecko, length around four inches: the vertebrae (dorsals) have the centra smaller than the annular portion, so that the neural canal is smaller than the vertebral centrum; their two ends are pierced by a hole that passes from one to the other, retaining the same diameter. Thus the vertebral centrum is traversed by an open canal at its two ends. This canal is so small that I could not introduce a medium-sized pig hair into it, but I successfully passed a human hair into it.

Teleosaurus which belongs to the same time as turtles and crocodiles, at the same time as they have several strange characters, has, as is known, the centra of its vertebrae planar or slightly concave on both ends; in this regard I have an observation that seems to connect to the hypothesis with which I was preoccupied. In effect, I had found, among the diverse elements of several nearly complete skeletons of these animals, an elongate, flattened bone, truncated at one end and pointed on the other, curved along its thickness, whose position in the skeleton I had ignored, and which was revealed to me only when I could have a well-settled opinion on the rib pieces of my large fossil: I then made a branchial piece of it.

All was going well until then in my hypothesis; but in continuing my manual excavation work, the discovery of new V-shaped bones, their symmetrical shape announcing that they should have been placed on the median line, the discovery finally of several other bony pieces having articular relationships with them, all this together presented neither resemblance nor analogy with a branchial apparatus whatsoever, but rather well with these supplementary ribs surrounding the abdomen, as seen in marbled lizards, chameleons, anoles, and likewise crocodiles (see plates III and IV and the following chapter). Thus the principal fact was found erroneous, {45} the hypothesis of the particular configuration of the vertebral centra, subordinate to the presence of branchials, no longer rested only on suppositions deprived of positive proof; and according to my manner of seeing, I only attached little importance there. Some new discoveries perhaps gave the answer to the enigma[(1)].

In the vertebrae of the first series, the centrum is nearly circular at the two ends (see plate II, figure VII); it approaches more an oval form of large vertical diameter in those of the second series (figures VIII and IX); this last form is so much more pronounced that one considers them more likely as backwards. The edge for the attachment of the exterior layers of articular fibro-cartilage is very pronounced (figures I, IV, VI, III), and more spread out underneath for articulation of chevrons that touched simultaneously the edges of two contiguous vertebrae. The middle portion of the centrum differs in the two series; it is compressed and flattened out in the first, so as not to have more than half the width present on the two ends. In the narrower portion,

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[(1)] Mr. Geoffroy-St.-Hilaire, in speaking of the *Proteus*, admits as probable that the reptiles of the ancient world had two kinds of respiratory organs. "This reptile (the *Proteus*), deprived there (in the underground that it inhabits) of feeling the influence of light and drawing there energy of a free practice of aerial respiration, remains perpetually a larva or tadpole; but besides it can always transmit to its descendants without difficulty these restrained conditions of organization, conditions of its species *that were perhaps those of the first state of existence of reptiles, when the* at the junction of the centra with the annular part, is a large and superficial groove, the superior edge of which is proportionally more prominent than the very considerable transverse process which begins at this edge (figure I). The ratio between the length of the centrum and its greater width is 3 to 2.

The centrum of the vertebrae of the second series is triangular rather than rounded in its middle part, and a little compressed; the difference in the width of the centrum between the middle and the ends was not, in the 11th (fig. IV, V, VI), in a ratio of 4 to 5; the ratio of its length is to its greater width is 5 to 2. The lateral groove situated between the centrum and the {46} annular portion is wide and well-pronounced (fig. IV), and its inferior edge is more elevated. On each vertebra, this groove describes a light curve whose convexity faces inferiorly, and the series of these grooves forms an undulatory line whose two alternative curves correspond one to the conjugating foramen and the other to the middle of the centrum of each vertebra.

In the two series, a large medullary cavity is excavated into the centrum of the vertebrae (fig. II*d*, and V*b*), and spongy tissue only exists at the two ends; there is a foramen for the passage of nutrient vessels on each side, in the lateral groove.

The annular portion is not at all distinguished by a suture on the centrum.

Cuvier gives, as one of the essential characters of crocodilian vertebrae, that of having the annular portion united to the centrum by a suture always apparent at all ages; this is very true for the cervical, dorsal, lumbar, and sacral vertebrae in the fossil as well as living species. With regard to the caudals, this character suffers from exceptions; in living crocodiles, they have their sutures obliterated early, judging by those of my two pointed-snouted caimans, one five feet long and the other four, where the suture is visible only in the first two; the third shows the trace of another suture anteriorly that unites the transverse process to the centrum of the vertebrae at a very young age. In our crocodilians from the environs of Caen, the suture of the annular portion is preserved on a greater number of caudal vertebrae. I recovered them on some vertebrae whose placement must be further from the middle part of the tail; it likewise appeared that only the last of these was of a single piece: I have made these observations on individuals of various ages and species.

The anterior vertebrae of the first series have their annular portion wider than the

world was everywhere submerged." (*Fourth memoir of the Academy of Sciences*, 28 March 1831, *On the influence of the surrounding world for modifying the kinds of animals, etc., art. VI*).

centrum; this widened part, from which the transverse process begins, starts at the base of the anterior articular process and ends posteriorly below the indentation that contributes to forming the conjugation foramen; this is wide and deep, and the anterior is very much smaller. Above the transverse processes, which are flat and slightly inclined backwards, the suddenly {47} compressed annular portion forms a sharp keel, beginning by a small jutting lamina at the level of the prezygapophysis [= "anterior articular process"] (fig. 1, *a a*, etc.), and degenerating soon into a very compressed spinous process whose posterior edge slightly surpasses the level of the vertebral centrum; its anteroposterior extent or its width is not much more than one quarter of this.

The prezygapophyses have the form of a triangular pyramid slightly bent outwards, whose external face is a bit concave, and the inferior and internal are nearly planar; the superior edge is rounded and extended up to the origin of the keel, from which the spinous process begins; the inferior-internal border, shorter than the superior, is united to that of the opposite side by a thin bony lamina that separates the vertebral canal from a fairly deep funnel-shaped hole, situated at the beginning of the process and below the origin of the keel (fig. VII, *a*). The oval articular facets are directed inwards and slightly above.

The postzygapophyses [= "posterior articular processes"], situated at the base of the spinous process, are only evident in front and above; their articular faces are directed in the opposite direction from those of the preceding.

The annular portion of the vertebrae of the second series (I take here still the 11th, fig. IV, V, VI, as an example) is narrower than the middle part of the centrum; it is rounded above and ends posteriorly by being slightly compressed by two very indistinct articular facets, and directed entirely outwards; on the median line is a small crest more perceptible at its point of origin in front and at its termination in back, where it forms a rudimentary spinous process (fig. IV, *c c*, etc.), than at the middle part. The prezygapophyses are excessively long (more than half the length of the centrum); they are triangular, but the inferior side is very much narrower than the two others; the articular facets are little distinct, situated towards the base and turned directly inwards. There is no infundibuliform gap between the bases of these two prezygapophyses. The furrows of the conjugation foramina resemble those of the first series.

{48} One imagines that the differential characters observed in the vertebrae of these two series should be varied successively in passing from the first to the last: but, as delineated previously, our two series each have their characters little modified between the last vertebra of the one and the first of the other, it necessarily follows that we are lacking a rather numerous series of vertebrae between these two series; one understands that it can hardly be fewer than twelve or fifteen, if one notes that the last vertebra of the first series still has a very long spinous process, whereas the first of the other has this process almost nonexistent; or one knows that, in the reptiles of the saurian and crocodilian orders, the length of the spinous process diminishes only very slowly in going from the base of the tail towards its end.

§. XVI. *Chevrons*.

In freeing the vertebrae of the first series, I found six complete chevrons and the base of a seventh in natural articulation with their corresponding vertebrae. Their shaft is a little compressed and bowed, and the concavity is in the rear; they are proportionally shorter and stronger than in living crocodiles; they differ from the chevrons of fossil crocodilians in the same manner, and many times I have had occasion to see them in this state. They do not resemble the chevrons of lizards very closely, by which I mean those of the monitor figured by Cuvier, and that of a small skeleton of *Tupinambis*? that I possess; I am unaware of the condition in others. They seem to me to compare strongly with those of some dolphins that I have had occasion to examine, although these were proportionally shorter.

The two rami are broader anteroposteriorly than from dorsoventrally; they correspond to the interval between two vertebrae and at the same time encroach upon both. Their articulation with the two vertebrae is very remarkable; in effect the two rami are reunited at their end by a transversely-concave bony plate (fig. X, *a, b*) {49} having two facets, one inclined anteriorly (*a*) and the other posteriorly (*b*), and separated by a blunt stop: these correspond to the intervertebral cartilage; the anteriorly inclined facet corresponds to the preceding vertebra, and that inclined posteriorly to the following vertebra. The bony plate does not entirely reconnect to the end of the rami, but only to the posterior half. The shaft of the chevron has its anterior face flat above and rounded below; the posterior is excavated by a groove near the separation of the rami; the free end is blunt and covered by rugosities.

I am unaware if chevrons thus shaped are found in living nature,. I do not believe that this posterior union of the two rami is an effect of age; it seems to result from this conformation that these bones must have enjoyed a rather great anteroposterior mobility, at the same time that the extended surface that holds the two vertebrae would have become a solid fulcrum for the attached muscles; that finally the vertical movement of the tail must have been more frequent and more extended than movement in the lateral direction.

§. XVII. *Comparison of the vertebrae of* Poekilopleuron *with those of several living or fossil reptiles.*

To clarify the affinities of the animal to which these vertebrae belonged, I have compared them to those of living and fossil crocodilians, to lizards, and in particular to *Megalosaurus*.

It is without doubt that the vertebrae of our large fossil have little relationship with those of crocodilians; and if left to the deductions drawn from their forms alone, our animal would be removed from this family of reptiles. In living crocodiles all the caudal vertebrae, up to the last, have spinous processes; our vertebrae only have spinous processes in the anterior region of the tail; these processes are very compressed and begin only on the posterior half of the annular portion: in living crocodiles, the spinous processes of the anterior region of the tail occupy the entire {50} length of the annular portion, and are as fortified by a sort of bony axis taking its origin towards the middle of this same annular portion. The fossil crocodilians from the environs of Caen also have spinous processes on all their caudal vertebrae; but instead of shrinking gradually and becoming nearly cylindrical as they approach the last ones, as in living crocodiles, these processes remain compressed and as extensive as the annular portion.

In living and fossil crocodilians, the caudal vertebral centrum has the form of a four-sided prime, more and more compressed as one examines them more posteriorly; the inferior face is narrower than the lateral ones and is separated from them by two very pronounced angles. The vertebral centrum of our great fossil does not have this form; it is cylindrical in the first series, strongly reduced in the middle, without angular lines; in the last, the centrum is nearly triangular, with one of the angles situated below and the two others in front of the lateral grooves; these angles are rounded. The first vertebrae of the second series have their centra decidedly less triangular than the last and approach the cylindrical form observed in the first series; but nothing in either recalls the tetrahedral form of crocodilians.

No vertebra of these latter animals, living or fossil, has presented prezygapophyses as elongated as my great reptile, above all the vertebrae of the latter series.

There are more characters than necessary to remove the animal of La Maladrerie from the crocodilians, at least by its vertebrae. I do not mention its size, which notably surpasses that of well-known living and fossil crocodilians up to the present; however we possess some isolated teeth[1] and a posterior portion of the ramus of the lower {51} jaw signaling crocodilians of equal and perhaps still more considerable size than the animal with which I presently occupy myself.

The crocodilians excluded, we return our animal to the lizards; but to which family of this great order could it belong, or at least be attached? A minute comparison with known species perhaps could clarify the question; but the lack of subjects renders this task impossible for me. One can besides affirm *a priori* that it would lead only to not very precise results, and that our great lizard belonged to a family that had only distant analogs in living nature. In effect, it is known that all fossil reptiles of the ancient terrains form a group apart, if it can be expressed thus; I am persuaded that our great animal *does not have near relations in this world*.

Comparison made between its vertebrae and the caudals of my small *Tupinambis*, and according to what Cuvier said about these same bony elements of the monitor, I did not find important differential characters; on the contrary I see a marked analogy in the form and disposition of the spinous processes and the vertebral centrum. On my fossil, I did not see that the vertebral centrum was divided vertically, as in living lizards; I found no trace of suture or other mark announcing that this division had existed in youth; I have already made the remark that these vertebrae present a large interior medullary cavity analogous to those of the long bones. I abstract here a slightly concave figure of the two ends of the fossil vertebral centrum; I have spoken previously of this important difference, p. 75, which appears as constant for ancient reptiles as the concave and convex form is for living species.

It remains for me to compare the vertebrae of my fossil to those of the equally fossil great lizards of which Cuvier speaks in his researches, because I have not made any with the other saurians recently described or distinguished in Germany.

It is evident that there is no comparison with *Mosasaurus* or the great animal from Maastricht.

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[1] I have figured (pl. VI, Fig. 8) one of these teeth at natural size. Although its characters suggest a crocodilian, it would not be impossible that it belonged to the species of animal described here. There exist three or four in the collections of Caen; they come from all the quarries of the village of Allemagne, and were found isolated. That which I have figured belongs to M. Tesson.

Lacerta gigantea (Soemm.) from Monheim (*Geosaurus*, Cuv.) has {52} offered, it seems, only the dorsal vertebrae; but the difference in size of these vertebrae, compared to mine announces strongly different animals. In effect, the length of the vertebrae of *Geosaurus* is only 0.35 m, while the largest of my animal is 0.105 m, equivalent to a size nearly four times larger.

By this, the considerable volume of vertebrae of my saurian gives them relationships with those attributed to *Megalosaurus bucklandii*. Cuvier (*Oss. foss., vol. V, pl. XXI, Fig. 14, 15, and 16*) figured a group of 5 vertebrae viewed from the side and one isolated viewed from the side and above. This last must be a caudal, according to the form of its transverse processes; it is difficult to judge, by means of Cuvier's figure, to which region the others belonged, and this subject is not explained in the text. Mine are proportionally much longer and have their spinous processes much more slender and also longer. It still would not be impossible that this difference in length, compared to the diameter, comes from the difference of position in the vertebral column; in effect, according to the observations I was able to make, either in living and fossil crocodiles or in several lizards, I find that the length of the centrum of all the vertebrae, with the exception of those from the end of the tail, is a little nearer the same, but that the lower diameter of the majority of caudals makes these seem longer. Nonetheless, to take all this together, the difference between the vertebrae of my fossil and those figured by Cuvier seem too strong to admit, without restriction, that the two belonged to the same species of animal.

On the other hand, it is wise not to lose sight of the fact that only the teeth are decidedly reported there, as *Megalosaurus*; because the other bony elements that are referred to this genus agree with this by their size and because they were found in the same banks, but not in the same block. (For this subject, see the remark made on p. 39.) It could well be possible that *Megalosaurus* was not the only giant reptile contained in the Stonesfield quarries, and that these attributed to it only must be divided among several species; this dissent could be applied particularly to the vertebrae, which do not show relationships with those of crocodiles.

{53} Thus, I then draw from the unquestionable lights of the examination above on the identity of my fossil with *Megalosaurus bucklandii*. The examination of the other parts of the skeleton will diminish the uncertainty left by the caudal vertebrae. Unfortunately we do not have teeth found in the same place as our bones from La Maladrerie, and the little certainty which reigns on the subject of the known bones of *Megalosaurus* renders the necessary determination of our fossil a little problematic.

§. XVIIIth. *Remarks on the form of the tail of* Poekilopleuron.

I end these remarks by searching for that region of the tail belonging to the second series of vertebrae; I will try equally to appreciate the length of this tail and simultaneously the total length of the animal, according to the data furnished by the vertebral column; finally, the particular form, principal movements, and consequently the use of the tail of our great lizard.

The first series of vertebrae evidently formed part of the first half of the tail, and its approximate place in this half can be simultaneously determined, by means of the transverse processes. These processes stop at the seventh, counting from anterior to posterior (pl. II, fig. I, II, III): in living crocodiles, the transverse processes stop at the 16th or 17th, counting from the last sacral; this character appears constant; however I have not been able to verify this in our fossil crocodiles. I do not know if there is any constancy in this regard for living lizards; but I find that the transverse processes stop at the 20th in my small skeleton of *Tupinambis*. Proceeding from this last fact, it 13 vertebrae would therefore be lacking in front of our first series.

But our vertebrae are each around a decimeter in length; by adding 6 millimeters for each intervertebral space, our first series gives 0.954 m length; by the same reasoning, the 13 vertebrae missing in front form a length of 1.378 m, or 2.332 m for the first half of the tail.

Our second series is formed from 12 vertebrae; supposing for each of them a length equal to those of the first, and counting {54} the intervertebral spaces, they give a length of 1.272 m. But it has been seen, for the reasons related on p. 80, that 12 to 15 vertebrae must be lacking between the first and second series; suppose 12; these 24 vertebrae, or the last half of the tail, gives 2.544 m; which added to that given by the first half forms a length of 4.876 m, or nearly 15 feet.

However a certain number of vertebrae must still be lacking following our last series; but it is entirely impossible to guess how many, because the number of caudal vertebrae in lizards varies prodigiously according to the species; however we have 21 vertebrae present, and we are justified in supposing 25 absent, this makes 46. There could not have been fewer than 50, and more if the tail was tapered.

It is impossible to use the length of the tail to understand approximately the length of the trunk and consequently the total length of the animal, because that of the tail varies greatly in the order of lizards; but another method can be tried that should lead to a rather exact approximation. The number of trunk vertebrae is much less variable than that of the tail vertebrae: by using the table given by Cuvier *(Oss. foss., vol. V, p. 288)*, I found that the more usual number of vertebrae, not including the tail, is 25 to 30; the normal number in crocodiles is 26. Suppose this number for our animal; recall that the length of the trunk vertebrae, isolated, is in general the same as that of the first of the tail, and according to this principle a length of 2.756 m will be found. The head could not have less than quarter of this extent, or 0.689 m; this would give 8.321 m for the total length of the animal; and as it assuredly lacks a certain number of vertebrae behind the second series, the large saurian of La Maladrerie must have been around 25 feet long. All these numbers and measurements are taken at the low end, and according to this work, it can be seen that they are on this side of reality, and that my lizard could not have been less than 30 feet long.

The tail, supplied with its muscles and skin, should have been rounded and {55} devoid of crests, at least in its last half; the shape of the vertebrae indicates it positively. In only paying attention to the vertebrae of the first half, it could be believed that the tail was compressed, according to the vertical measurement given by the spinous processes and chevrons, compressed to the same extent as the transverse processes; but it is necessary to recall that we only have these six last processes here and the region where they end; anteriorly they were more developed. Finally if the tail had been compressed, the vertical extent of the centra of the last vertebrae would have been more considerable, this exists in the same way in crocodiles whose last vertebrae are very compressed and provide a spinous process that is missing here.

The principal movement of this tail should have been vertical; I justify this first on the extreme length of the prezygapophyses that constrained lateral movement, while leaving all freedom to the contrary movement and guaranteeing much solidity in this sense; second on the mode of articulation of the chevrons.

I do not ignore that this form and these movements are not those that aquatic reptiles show in general, and everything supports believing that our animal passed a part of its life in the water; but one could remark that the great extent of vertical movement could all also greatly favor rapid swimming via the lateral movement. Cetaceans are not seen to swim with as much ease as fish, although the movement of the tail is horizontal in one and vertical in the other.

Besides, in our animal this part should have been endowed with great strength; the roughness situated at the base of the chevrons, the lengths of the zygapophyses, etc., must have given attachment to a muscular mass as powerful as complex. It is probable that this vigorous motor was at the same time a formidable weapon by means of which the large lizard stunned and killed its enemies.

{56} RIBS.

§. XIXth. *General remarks*.

All the ribs come from the block transported to Mouen[1]; they are numbered and offer several remarkable peculiarities.

They were in disorder to the middle of the stone and mixed together; I could only free them in pieces, and although I provided the greatest care to number them for reconnection, there were some for which I could not find a place, or that did not fit exactly because some small intermediate pieces had been lost in the excavation. I have also recognized that more considerable pieces must remain in the quarry or in the blocks transported to other stockyards, because it is lacking the superior or vertebral portion of most of the ordinary ribs[2].

The first piece that I restored had highly unusual characters (pl. IV, fig. 1, 2, 7). It is bent in a V-shape at its middle; one of the branches is slightly twisted into an italic *S* and excavated by a superficial groove near one of its edges; the other branch is bifurcated at some distance from the forked curvature, and the two portions of the bifurcation, less twisted than the single branch, progress by deviating slightly apart: both are excavated by a superficial groove near one of their edges, and end by thinning.

This peculiar bony element embarrassed me very much, I did not know what to make of it; I did not suspect at first that it could be attached to a system of ribs; the idea came to me that it could have been a branchial bone, and with this idea my imagination quickly went to work. (In this regard see p. 75, 76.)

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(1) See p. 43 and 44.
(2) I designate thus the ribs that are attached to the vertebrae (whether they reach or not the sternum), in order to distinguish them, without paraphrase, from the other costal elements, very numerous and very varied in their forms, that occupied the walls of the abdomen without attaching to the vertebrae.

{57} I soon recovered six other more or less complete bony pieces (pl. IV, 1, 2, 3, 4, 5, 6), curved into a V as the preceding, but different in that the two sides were simple. I soon understood that all these pieces must have related to some ribs situated in the middle of the abdominal muscles, and that the curved point must have been found on the median line, because the two branches or sides were hardly similar. Nevertheless the bifurcation of one of the branches that I had found first (seventh of the restored series) still left me doubts.

In continuing my readjustment of fragments, I restored another series of ribs different from the first (pl. IV, 8, 9, 10, 11, 12, 13, 14). At one of their ends was a sort of head or tuberosity (*b, b, etc*.) whose shape, different for each of them, did not closely resemble this part of the ribs in any known animal; around this head more or less pronounced rugosities were visible that continue to become the attachment points of muscles or ligaments; the trunk or body of the ribs had a more or less prismatic and triangular form; some were nearly straight, others a little arched toward the small, gradually thinning end; some were slightly twisted in elongate spirals reminiscent of the form of certain antelope horns. All display a wide, superficial groove, analogous to the those already noted in the preceding series.

For a long time I guessed that the place that these ribs should have occupied was no less extraordinary than the first. It was not very presumable that they were vertebral ribs; the bizarre shape of their heads, their various curvatures, and finally their small size, were all opposed to attributed this position to them. I finally recognized that they should have been placed following the preceding series, based on several remarks that I will soon make understood.

Some other costal elements, much smaller, nearly cylindrical, at least in their middle part, thin at their two ends, variously twisted, some nearly straight, did not worry me for long; I soon saw that they should have been situated in {58} the superficial grooves observed on the ribs of the two preceding series. The small costal element figured in pl. IV, fig. 2, 7, *e e*, was placed within the stone very near the V-shaped rib on which it was applied in the skeleton; in placing it on the groove (as is indicated on the shaft *f, f*), it touches there by all its points as if it had been molded above. The small costal element (figure 10, *e, e*, and on the shaft *f, f*) was still more decisive, since it was joined during life to the rib that supported it within part of its extent, so that it *rested in place.* Within some points the joining is complete, within others there exists a slight interval where the matrix had penetrated.

These small rib pieces were therefore from the sort of extensions partly situated in the grooves, and which surpass the end of the principal piece by one part of their length. I have recovered very many fragments belonging to these extensions, but they were so fragile that it was very difficult for me to restore these small pieces without altering their curvatures; and, if one excepts the two that I cited, the others were not applied very exactly. On my plate I have figured only those whose place I easily found (fig. 2, 1, *e*, 3, *c*, *e*, 4, *e*, *e*, 5, *e*, *e*); but beyond the fragments that I was able to readjust, I have several other extensions that I believed useless to figure.

Costal extension 7, *e, e* was well recognized as similar, and its position was equally well determined by connection to the piece that it supported, the extension that was fixed on a rib of another form (10, *e, e*) therefore indicated, for this last, an analogous situation within the skeleton to that of the first; as a result, the tuberosity must have been on the median line and the thin end directed outside. I will indicate further on another remark that confirms the preceding regarding the position of these abdominal ribs.

I finally restored several other ribs by means of the fragments that remained, which were those whose diameter was the most considerable; one is very nearly entire; the others are more or less imperfect: all lack the end by which they were attached to the vertebrae. In my blocks, I have not at all found {59} fragments that would compare to these ends; these ends remained in the quarry or were brought with other blocks into some stockyard; always it is that they are lost. It is easy to recognize that these are the ordinary or vertebral ribs (pl. V, fig. 1-15). They are easy to characterize by their shape, size, curvature, and also because several among them have, in a point of their posterior edge (*g, g, etc*.), a planed, irregular imprint that served as insertion of a cartilaginous appendage analogous to those shown in several of the ribs of crocodiles, and that represent the bony appendage or process recurring in the ribs of birds.

There are therefore four series of very distinct ribs whose position in the skeleton I believe to have rediscovered, and that I will examine in detail and describe successively; but first it must be necessary to throw a glance on the species of living or fossil reptiles that are supplied with costal systems situated in the middle of the abdominal muscles; the differences and similarities of our great animal will then become clearer and easier to understand.

§. XXth. *Remarks on the reptiles whose abdomen is enclosed with bony elements or abdominal ribs.*

I think without doubt that such a complicated costal apparatus, exposed previously, was situated in the middle of the abdominal muscles; my great saurian could thus be compared under this relationship first to crocodiles, second to chameleons, third to marbled lizards, fourth to anoles, and fifth to geckos, among living reptiles; sixth to ichthyosaurs, seventh to plesiosaurs, and eighth to *Teleosaurus*, among the fossils. I ignore whether other reptiles are provided with a costo-abdominal apparatus.

I had to research, in the works that I was able to consult, that which had been known regarding this apparatus. What I found is extremely concise, often little exact and not very constant on its presence in the genera of animals cited previously. There is what was surprising to some: one of the principal reasons that led naturalists to dwell on the details of the configuration of such or other {60} pieces of the skeleton, was the need to establish a rigorous comparison between them and the analogous elements belonging to fossil species, finally to make clear the generic and specific differences or to report their identity by means of the objects compared. Up to here the presence of a costo-abdominal apparatus had not been known in the fossils, as in the plesiosaurs, animals whose structure is so particular that it is not at all necessary to resort to a comparison of their abdominal ribs to generate some analogy or important difference, still less as a character of specialty. At least, I explain this little importance in the description of the abdominal ribs of reptiles lacking this apparatus.

Chance having directed my researches on a great animal furnished with a very developed costo-abdominal apparatus and given to a high degree of complication, and this chance having well served me, so that if I do not possess all the pieces of which the apparatus was composed, I am only lacking very few, I had to dedicate myself to making it well known and to compare it carefully with the analogy offered by living nature. I hope that from this work a new fact of antediluvian organization will arise and be acquired by science; that the data regarding the mode of existence of the great saurian of La Maladrerie will be added to those that could furnish the other elements of the skeleton; that the description and the exact figures of this apparatus will provide the possibility of determining the isolated or mutilated pieces whose isolation had rendered unidentifiable or caused to be falsely attributed to another region; finally these researches will perhaps not be without interest for proper comparative anatomy. I will shortly indicate what they furnished about living reptiles, in comparing my results with those that anatomists and herpetologists have related on the same subject.

A. *Abdominal ribs, ordinary ribs and sternum of living crocodiles.*

The abdominal ribs are essentially bony by nature, and not of cartilages more or less penetrated by calcareous salts, as are the sternum, ordinary cartilages, and elongations of the ribs in this family {61} of reptiles. They can be compared to the aponeurotic intersections of the straight abdominal muscles of mammals, if one wishes to find analogies to them with any force; but they are not at all extended from the sternum, as has been said: there would be as much value in making them an extension from the pubis, because there is no reason to make them depend on one rather than the others. The idea of considering the elements nearer to the median line (pl. III, fig. 1, *a a a*, etc.) as together forming an abdominal sternum, and the elements that terminate them outside (*bbb*, etc.) as ribs that did not reach up to the vertebrae, seems to me a confusion in the terms and in the structures.

After having removed the skin and cellular tissue that covered up the middle region of the abdomen, one perceives the abdominal ribs traversing an aponeurosis, with oblique fibers, that covers them and adheres there strongly enough. These removed, one sees a muscular plane with longitudinal fibers intersected by small ribs to which these fibers are attached on their anterior and posterior edges; above this muscular plane exists another with equally longitudinal fibers that is not attached to the ribs, and that separates them from the peritoneum. Such is the disposition that I have observed on three individuals of pointed-snouted caiman that I have dissected, and that are most probably reproduced in the other species of living crocodilians[(1)].

[(1)] Here are considered and described these abdominal ribs by the authors that I have been able to consult.

Cuvier, *Anat. comp*., 1st edit., vol. I, p. 210. "The sternum…goes to be united to the pubis and furnishes, to the *walls of the abdomen, eight cylindrical cartilages*."

Id., *Reg.* an., 2nd edit., vol. II, p. 18. "Outside the ordinary ribs and the false ribs, there is that which protects the *abdomen without climbing again up to the spine, and which seem to be products by ossification of the tendinous inscriptions of the straight muscles*."

Id., *Oss. foss*., 11th edit., vol. V, 1st part, p. 100, "and under the belly there are *five pairs of cartilages* without ribs that are fixed by the aponeuroses of the muscles and of which the two last go to terminate at the pubis."

Id., id. ibid., same page. "Along the entire length of the linea alba, which is purely ligamentous, are then attach the *ventral cartilages*, so particular to crocodiles, *similar to those of the ribs*, but which lack vertebral ribs. There are *six* or *seven pairs* of this sort protecting the entire belly below, and the last touches the external edge of the pubis by its external ends, which are recurved to this effect. Each of these *cartilaginous* rami is composed of two elements"

Meckel, *Anat. comp*., French translation, vol. II, p. 609. "Their sternum…becomes still straighter below the level of the eighth rib in the *abdominal cavity*, but is widened again considerably toward its posterior end, and is applied by its posterior edge onto the anterior edge of the pubis. This part facing the lumbar vertebrae undoubtedly

I count seven pairs of abdominal ribs on each side of two {62} of my skeletons; the first six are straight and depressed, the last is larger and more rounded. In my third skeleton, there is a small bony stylet in back of these announcing a rudimentary pair (pl. III, fig. 1, *a*). They come to be joined on the medial line by means of fairly loose ligaments, and each is formed of two elements that overlap over a fairly large extent by touching their edges, without reciprocal configuration, as I will remark on the analogous elements in the great reptile of La Maladrerie. I will not speak here of the curves and fitting of the costo-abdominal elements of crocodiles; the figure that I have given reproduces them sufficiently.

The sternum is composed of three elements: two cartilaginous, more or less penetrated with calcareous grains according to the age; a third essentially osseous (fig. 1, *c*, *c*). This elongated, flattened element, terminated anteriorly by a small subcircular disk, is simply juxtaposed on the anterior cartilaginous element that passes beyond in front; it is easily removed, with the perichondrium, after some days of maceration. The anterior cartilaginous element (fig. *d, d*), lacking the preceding, is flattened, subhexagonal (if one takes {63} care to leave intact the thin edges of the small fossa destined to receive the coracoid of the shoulder), and pierced in its middle by a circular trough[(1)]; it is articulated with two rib extensions, and with the posterior cartilaginous element entirely in back,. This element (*e, e, e*), equally flattened, has the form of an iron arrow: six rib extensions (*f, f*) are articulated there.

I find twelve vertebral ribs in my skeletons. The first and last (*g, g*) are very short, do not have a cartilaginous appendage, and are far from reaching the sternum; the second and penultimate (*h, h*) are more developed and have a short cartilaginous appendage, but which does not reach the sternum; the eight others, lacking cartilaginous appendages (*i, i, i, etc.*), reach this bone by means of eight equally cartilaginous extensions (*f, f, etc.*) articulated with it. The union of the appendages with the extensions (*k, k, etc.*) form an angle whose sinus is turned forward;

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corresponds to the last sternal element of other saurians, which is here more strongly developed; it *supports* eight pairs of cartilaginous costals, which terminate freely in back and to which the vertebral ribs do not correspond."

Duméril and Bibron, *Erpet. gén*., vol. I, p. 30, and vol. III, p. 16. "This pectoral bone (sternum) is extended in crocodiles up to the pubis."

Id. ib., vol. II, p. 609. "…it is even some species such as the crocodiles that have a sort of *middle sternum* under the abdominal viscera, which receives other lateral *cartilages* similar to the ribs that do not rejoin the vertebrae, and thus we represented it on plate IV in this work."

The sternum is represented on this plate with the abdominal ribs, reunited to each other as well as to the sternum and pubis, *by means of a portion of the hardened abdominal muscles*. The drawing represents eight pairs of ribs of which the most anterior is indicated as formed from two elements of each rib. This apparatus is given as coming from the pointed-snout caiman.

[(1)] This trough is not apparent in the figure of our drawing; it is masked by the osseous element.

this is a veritable diarthrosis recalling those of the ribs of birds and cetaceans, with the difference that in them all are osseous.

The six ordinary middle ribs, that is from the fourth up to the ninth inclusive, bear a point from their posterior edge, very near the origin of their cartilaginous appendage, a small plate (*m*, *m*, *etc*.) equally cartilaginous recalling evidently the recurrent process of the ribs of birds. When they were removed, this small plates leave some rugosities at the point they occupied; their traces are very apparent on the ribs of our *Teleosaurus* from the Caen limestone; they are also very visible on the ordinary ribs of our great saurian of La Maladrerie, but they are much more elongated from the sternal end than they are in *Teleosaurus* and living crocodiles.

I saw nothing similar in the small number of lizards that I had dissected; it would be possible that, given their small size, I was not able to perceive the traces, despite the fact that my attention was directed on this {64} object. In the works that I have consulted, I have not found at all that any indicated this particularity of organization in lizards. If this character belongs exclusively to crocodiles, it would be a new trait of resemblance between our great saurian and this family of animals.

B. *Abdominal ribs, ordinary ribs and sternum of the common chameleon..*

The abdominal ribs of the chameleon differ notably from those of crocodiles, and as in them do not make a separate series: these are evidently the extensions of the ordinary ribs. Here is what I have remarked about the individual that I have dissected[1]: the ordinary ribs do not

[1] This chameleon had, unfortunately, a part of the abdominal walls a little altered; I cannot entirely answer as to the number of abdominal ribs.

Here is that which I found in the authors at my disposition, regarding the costo-abdominal and sternal apparati of the chameleon.

Cuv., *Anat. comp*., vol. I, p. 211. “Nearly all its ribs (the chameleon) receive cartilages that, being brought toward the median line, are united with their opposites.”

Id., *Reg. anim*., vol. II, p. 59, 2nd edit. “Their first ribs are rejoined to the sternum, the following are continued each to its corresponding one to envelop the abdomen by a complete circle.”

Id., *Oss. foss*., vol. V, 11th part, p. 237. “Instead of simply ventral ribs as are observed in the crocodile, several subgenera, the marbled lizards, anoles and chameleons, according to the ribs that are united to the sternum, have some others that are united mutually to their corresponding ones and thus enclose the abdomen by complete circles…A long time ago I pointed out that this singularity appears specific to the subgenera that change color.”

Meckel, *Anat. comp.*, French translation, vol. II, p. 603. “In some genera, notably the chameleons and marbled lizards (*Polychrus*), most of the posterior ribs, with the exception of the last which are very short, are united to their congenerics by the ligamentous substance on the median line, however without being united from front to back by a bone analogous to the sternum.”

have cartilaginous extensions; five are united to the sternum by means of bony extensions; only I believed to remark that near the articulation of the extension with the rib (pl. III, fig. 1, *k, k, etc.*) {65} the ends of these two bones were softer and more flexible. The five successive ribs have articulated extensions, but these extensions do not abut at all with the sternum, they are reunited together on the median line; the state of preservation of the individual that I dissected did not permit me to assure whether this is by means of ligaments or a bony suture.

The sternum seemed entirely bony: it is very straight in the region that receives the five elongate costals; it is terminated in front by a large, lozenge-shaped disk, a little raised toward its anterior end. The hyoid bone and the muscular apparatus destined to move the tongue are applied on the inferior face of this disk, which is a little inclined forward; they are nevertheless separated by the laryngeal bladder.

C. *Abdominal ribs, ordinary ribs and sternum of the marbled lizard of Guiana*[(1)].

The sternum has the ordinary form in lizards, that is to say it is reduced to a cartilaginous, lozenge-shaped disk (pl. III, fig. 3, *d, d*) and to an unpaired, T-shaped bone (*c*). It seemed that this element, as in the crocodile, is solely applied on the cartilaginous disk and only connects to the perichondrium.

Six ribs reach the sternum by means of extensions, not bony as in the chameleon but cartilaginous. It seemed there was a synchondral or perhaps arthrodial articulation between the rib and its extension (*k, k, etc.*). The three first arrive separately at the posterior edge of the sternum; the three following are united to those of each side (*f, f, f*) very near the medial line, and come to reach the posterior angle of this bone at a single point.

The seven ribs that follow have their extensions united on the medial line with their correspondents of the other side, each pair of reunited extensions is shown as a single symmetrical element, bent, forming a very open angle, with the sinus directed posteriorly, and

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Duméril and Bibron, *Erpet. gén.*, vol. I, p. 28. "The chameleons and *Polychrus* (marbled lizards) are lacking a sternum, and the cartilages of their ribs, strongly developed besides, are borne directly under the body and end by being sutured to one other on the median line."

Id., *id.*, *ibid.*, vol. III, p. 164. "The ribs are numerous, from 18 to 20. They are united together toward the middle line inferior to and under the skin by a cartilaginous substance that simulates a sort of linear sternum. In the hypogastric region the ribs are sutured by forming a reentrant angle on the side of the head."

[(1)] The apparatus is described here according to what I observed on a marbled lizard that I dissected. See the preceding note relative to what I found on this subject in the authors.

having anteriorly {66} a sort of appendage (*m, m*) as much longer as they are more posterior; they are cartilaginous as the extensions of the preceding ribs. In back of them are seen two other extensions sutured and of the same form, but not reaching their corresponding ribs; they are nevertheless united to them by means of fibrous connections.

D. *Abdominal ribs of anoles and geckos.*

I have not had the occasion to dissect *Anolis*, and I only have of knowledge on their abdominal ribs based on the assurance of their presence given by authors.

It seems that this arrangement or prolongation of the ribs around the abdomen is again found in some geckos. According to Meckel (*loc. cit., vol. II, p.* 604), "Among the 17 ribs shown in the fringed gecko, only the first four reach the sternum, the 13 posterior pairs meeting on the median line, and at the point of reunion each of them give off a small, anterior tongue-like strip that diminishes in length anteroposteriorly and does not reach the preceding pair. This strip is lacking on the last pair which is situated immediately in front of the pubis, but instead this pair presents a small hook on its posterior edge."

I have not found prolongation of the ribs across the abdomen in the Mabouia gecko (*Hemidactylus mabouia*, Cuv.). According to Mssrs. Duméril and Bibron (*loc. cit.*, vol. III, p. 259), "the small-spotted gecko has seven other pairs posterior to its six sternal ribs, which by their free or abdominal end seem to be bent forward at an obtuse angle, *without being joined together on the middle line*, as in the chameleons[1]."

{67} E. *Abdominal ribs of ichthyosaurs and plesiosaurs.*

These reptiles, contemporaneous with our great animal and like it inhabitants of the seas of these remote times, had, like it and like the living genera which came to be examined, the abdomen furnished below with bony elements; this circumstance of organization is still only very probable regarding ichthyosaur species, but is real and well known in plesiosaurs, at least in

[1] It seems to me that one can still infer this lack of junction for the banded gecko by what the authors said (*same page*), although they use the expression *free or abdominal* ribs to designate the ribs situated behind those that reach the sternum. But I think that by *abdominal ribs*, these gentlemen mean the ordinary asternal or floating ribs, and they do not attach to this expression the idea of bony or cartilaginous elements, articulated or not with the ribs, and

the most common species (*Plesiosaurus dolichodeirus*, Burk).

I omit the ichthyosaurs here, and content myself with succinctly retracing the arrangement of the bony abdominal elements in the genus *Plesiosaurus*.

One ignores whether some ribs are articulated to the sternum and how they were adjusted there; but one knows that the abdomen was enclosed by a fairly large number of bony circles formed of five pieces each (pl. IV, fig. 3): two *b b* formed by the ordinary ribs, two extensions *d d* articulated head to head (*f f*) with the ribs, and one unpaired piece *c* in a very open forked shape, united by overlapping *e e* with the extensions.

In the following article where the fitting of the abdominal ribs of *Poekilopleuron* is described, it will be noted that this resembles more that of the plesiosaur than those of living reptiles previously cited, although by its other characters, *Poekilopleuron* had evident relationships with these genera and little or none with the plesiosaur. I have already remarked (p. 76) that *Teleosaurus*, so different from lizards and plesiosaurs and similar to crocodiles, by all probability had some abdominal ribs. According to these facts, it would seem that the presence of similar bony elements, existing in types so diverse as these three fossil genera, was necessitated by some important modification in the functions of reptiles living in this epoch, and that this modification was probably related to respiration. The existence of a peritoneal channel in modern crocodiles and marine turtles is perhaps connected in one manner or another to this suspected modification.

{68} In any event, this organization doubtless also coincided with the strongly extended lungs and with the possibility of dilating and contracting them well, even instantaneously. Cuvier remarked (see the note p. 96) that the existence of bony hoops encircling the abdomen was proper to the reptilian subgenera that change the color of their skin instantaneously; he said further, in speaking of the ribs of the plesiosaur, (*Oss. foss., vol. V, 11th part, p. 480*)…"That which could lead us to conjecture that the lungs of the plesiosaur were strongly extended, and perhaps that at least it did not have very thick scales, and changed the color of its skin, like chameleons, marbled lizards and anoles, as it made more or less strong inspirations."

§. XXIst. *Abdominal ribs of* Poekilopleuron.

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situated amidst the muscles of the abdomen, as I did in this memoir for more precision and for want of a more convenient expression.

I reviewed them in the order that they are arranged on plate IV, but I do not assert that such was their arrangement in nature; the only analogies that have been able to guide me are not entirely protected from contesting.

A. *Symmetrical V-shaped ribs*

These are seven in number. The first six, hardly alike between them, are curved in the direction of their greater thickness and form an angle at the rounded top, whose opening, larger on the last than the first, is oriented towards the pelvis; they are also slightly curved in the direction of their flatness, with each ramus turned up a bit towards its free end; they thin gradually from their middle portion up to this end, which ends in a blunt point. The inferior or cutaneous face of each branch (pl. IV, fig. 1) offers a wide, slightly deep, oblique depression towards the middle portion (*c, c, c, etc.*), which appears to have served as temporary support for the following rib, when the animal violently contracted its abdominal muscles. There is a {69} rather deep depression in the curved portion (*a, a, etc.*), directed backwards, which also could have served as point of support to the projecting portion of the curve of the following rib, at the time of the same movements. The presence of these depressions, and the function that I attribute to them, tends to demonstrate that the abdominal walls were very mobile, and that the sides that supported them would come to pile up on one other (so to speak), either during strong exhalations or in large movements, when the body of the animal was bent in an arc and then re-straightened suddenly and rushed forward.

The superior face (fig. 2) is flat and a little rounded in and near the bent spot (*b, b, b, etc.*); it is excavated by a groove on the rest of the extent of the rami (*a, a, a, etc.*), closer to the anterior edge than to the posterior, intended to receive the bony stylets whose curvatures were arranged to accommodate the rami. The posterior edge is blunt and rounded; in the bent region the anterior bears rugosities for the attachment of muscular or ligamentous fibers; it is slender on the rami and forms the edge of the aforementioned groove.

The seventh is not symmetrical; its left ramus resembles those of the preceding, however it is a little more curved and its anterior edge is less elevated, so the groove of the superior face is narrower, nearly flat and directed forward. The right ramus, thicker at its origin, is soon bifurcated, and the two pieces of the bifurcation, much less curved than on the left ramus, proceed almost parallel to one another; their superior faces are each excavated by a groove (7, *a*, *a*) to lodge two bony stylets; their edges are arranged as on the preceding.

This singular bony element tormented me for a long time: one can see, p. 76, that having repaired it first, I took it for a branchial bone. This hypothesis abandoned, I did not know how to make it agree with the six first ribs, which are nearly symmetrical. Attentive examination of the superior face helped remove my trouble, at the same time that it permitted me to assign the position {70} of the following elements with some probability. In effect, one sees in *d*, fig. 7, that the posterior piece of the right ramus indicates, in its union with the other, some rather pronounced rugosities and a sort of very distinct heel that was also noted on the inferior face (fig. 1, 7, *d*), as if a very close isolated piece was fused early to the principal one. The suture is in fact complete, or rather these two elements probably were never distinct; all this leads one to believe that this is an individual arrangement here, but it is permitted to speculate a sort of accessory element there, and to suppose that the following ribs (8, 9, 10, etc.), instead of being fused to their corresponding ones to form a forked bone, remained distinct and united only by ligaments. The symmetry of the right and left sides thus would be less injured, if I may express myself so. Similar dissimilarities are encountered rather frequently in nature: besides, what to make of this piece, and where to place it, if one does not reconcile it with the accounts that I gave.

For the relative position of all these ribs, I was guided by the degree of opening of the angles; I placed those whose right ramus is bifurcated in the last row, 1st because its angle is the most open, 2nd because it seems to announce the isolation of each ramus in the following pieces.

B. *Asymmetrical ribs, situated on each side*.

I have been led to admit seven pairs (fig. 1, 2, 8, 9, 10, 11, 12, 13, 14). Two costal elements from the right side and one from the left, indicated by the simple feature on the plate, could not be restored: however there remain several pieces and very many fragments that I could not correct; evidently they belonged to the missing ribs, at least in part, because it is possible that there were more than seven pairs. To orient myself and distinguish right from left, I placed the groove (*a, a, a, etc*.) above, the sharp edge in front, the large end inside, and the pointed and curved end outside: in this manner I had recognized five from the right and six from the left.

{71} To pair them, I put in touch those whose curvatures and shapes corresponded; but I have only recognized a rather imperfect resemblance between the right and left of each pair; whether I was misled in this approach, or in reality the left did not completely resemble the right, are both rather possible. It would also be possible that, instead of being arranged in pairs and placed precisely one facing or opposed to the other, they alternated, each corresponding to the interval between two others. I had placed the thinner and more curved(1) in front, the straighter and larger in back. Each pair is rather different from the following or preceding one; the first are flattened in such a way as to have a superior face and an inferior one; the next-to-last is triangular; the last, cylindroid. The internal end of all these ribs is marked by very pronounced rugosities, rather different for each, which should have given attachment to strong ligaments; the external end terminates in a very tapered point.

It is not certain that my two last ribs (14) were very legitimate in their placement here. One of their ends is lacking from both: by a happy chance, what is lost from one is found on the other; the internal end has less pronounced rugosities than the same part of the preceding pairs; they do not have any groove for lodging the bony stylet, and perhaps they were devoid of it. However one finds a sort of suture towards the middle of their posterior side (*h, h, etc*.), distinct for an extent of several lines [mm], but that soon disappears. It could have been that the external portion of these bones represents the bony stylet of which I will soon speak, and their internal portion the abdominal rib itself; these two portions, representing the bony stylet and the rib in the strict sense, would have been of different forms and proportions from the same parts in the other pairs, and were sutured early on.

{72} C. *Bony stylet or accessories of the abdominal ribs*.

I collected a considerable number of pieces and fragments belonging to these small bones, but they are so fragile that it was not possible to remake more than five or six of them completely (fig 2, *e, e*, 1, 3, 4, 5, 7, 10); there must have been at least twenty-six.

Some are curved into an italic S, and others nearly straight, a little curved toward one or both of their ends; in general they are cylindrical or cylindroid, larger at their middle than at their two ends where they are attenuated gradually, and arranged besides one another to be applied

(1) The first pair is curved in an elongate spiral, recalling the shape of the horns of certain antelopes. This singular

along the internal half of their length against their corresponding abdominal ribs; they were applied onto the groove that I remarked on earlier. One of the better preserved, whose curvatures are more pronounced, was applied onto the left ramus of the V-shaped bone (fig. 2, 7, *c e*, and *f f*, *in outline,* applied on the ramus); it lay in the stone along this ramus, from which it was only several lines [mm] distant; it was reapplied perfectly. That of piece 10 (fig. 2, *e e*, in connection with its rib; and *f f, in outline,* to better indicate its form) is more interesting still, because it is sutured (or better, ankylosed) in the groove of this piece; this is fractured in *g* and the end is lost. The portion of the stylet bone that was spread out beyond the abdominal ribs was doubtlessly submerged amidst the flesh and did not reach the ordinary ribs.

§. XXIInd. *Comparison of the abdominal ribs of* Poekilopleuron *with those of other reptiles presenting analogy.*

The comparison of the arrangement of the bony abdominal elements of our *Poekilopleuron* with those seen previously in other animals points out the unequivocal analogies and very pronounced differences, or better puts in evidence a particular organization, of a group whose scattered traits we do not find again in living or fossil nature.

{73} The unpaired forked bones have some resemblance to the abdominal elements that follow the sternal ribs in the marbled lizard and perhaps also the chameleon, only in the first they are cartilaginous; but they come to be articulated directly with the end of the ordinary ribs: however it is necessary to except the two last abdominal elements of the marbled lizard.

The small abdominal ribs of crocodiles have a certain analogy with the last seven abdominal ribs of our animal, lacking their stylets. One recalls that the abdominal ribs of crocodiles are formed on each side by two elements overlapping one on the other in a certain extent and connected by their periosteum. The external elements, which can be compared to the bony stylets of *Poekilopleuron*, equal or surpass the internal elements in volume, whereas our fossil has its stylets much smaller than the bony elements on which they are applied.

Plesiosaurus has some unpaired forked elements that recall evidently those of the first abdominal ribs of our saurian, and some elongated, articulated by overlapping, that represent fairly well its bony stylets. But in *Poekilopleuron,* these terminate in a point and seem not to

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arrangement could not be well rendered in the drawing.

have reached up to the corresponding ordinary rib, whereas the extensions of the unpaired costal bones of *Plesiosaurus* are truncated at their external end and articulated directly with the corresponding rib.

One could make some objection on the arrangement that I attribute to the abdominal ribs of my saurian: in admitting this, the region of the abdomen must be very long, the sternal very short, the true ribs very small in number, the false floating ribs, on the contrary, must be many. Would it not have been simpler to suppose that the last seven pairs of abdominal ribs, instead of following the forked elements, are fitted to the end of them by their tapered part, the stylet bone serving both to unite them and to permit a certain mobility? The large end, which I place on the median line, was outside and articulated with the end of the vertebral rib; this arrangement reduced the supposed length of the {74} abdominal region and approached that in *Plesiosaurus*; only the extension was united to the forked element by the stylet bone, and the bony circle encircling the abdomen was composed of seven elements instead of the five in *Plesiosaurus*.

This arrangement was the first idea that came to me when I began to perceive something in this maze of costal elements: after mature examination and numerous tentative fittings, I do not think that it can be allowed. The large end of each of these last seven paired ribs is covered by very pronounced rugosities, its tissue is very firm, and it does not seem configured to be articulated by arthrodial or syndesmosis with the end of the ordinary ribs; what is known of this does not seem any longer to announce any mode of union whatsoever; in effect this end presents no rugosities, nor an articular surface; at this point the rib is friable and crushed under the pressure of any finger as should present itself, to the fossil state, a cartilaginous portion penetrated only by bony grains. But the greatest difficulty, to my view, would be to make the curvature of two elements that are brought together thus agree, as well as those of the stylet bone which should be applied on each by its two halves. I have tried to make these comparisons to the rest, in presenting successively all the paired elements to each of the rami of the forked bones. Whether I put them in a manner following the direction of the rami, or I fixed them to come in front by meeting the ordinary ribs, nothing satisfying resulted but the bizarre curvatures, such that the surface of an abdomen thus made had to be irregularly embossed, which is not at all admissible. In similarly supposing the possibility of adjusting them head to head, I find for result that the animal must have had the enormous diameter of five or six feet in the abdominal region; the other bony elements are far from suggesting similar dimensions. I suppose, according to the first arrangement in agreement with the rest of the skeleton, that the diameter must not have been more than three feet, which is already not bad for a lizard.

I thus believe that the arrangement presented had nothing improbable and seems to me the same natural enough.

{75} If it was as I figured it, the inferior wall of the abdomen must have been susceptible to very extended movements; the forked bones bear very evident marks on their inferior face, because they must have been applied and nearly stacked one on the other at the time of muscle contraction. The ends of most of the ribs were free, and one of the stylet bones was also, the movements should not at all have been awkward, and the muscular forces possessed very great force, as viewed from the numerous bony intersections. This considerable extent of movement of the abdominal walls led me to suppose that vast lungs were nearly necessary; the animal was able to inflate them and empty them to its liking, the volume of its body varied according to the state of the lungs; without doubt it often turned to these differences of volume and the relative weight of its hydrostatic station depending on whether it wished to remain at the surface of the waters or swim in their midst. It also is clear that this possibility of bringing the sternum and the pelvis together should have given a great energy of impulse to all the movements: that, in effect, the trunk is figured strongly as arched by the contracted abdominal muscles, the hind limbs flexed and brought in front, then straightening up again suddenly like an immense spring, and this rapidity should provide a similar power stroke to this magnificent animal when it pursued its prey between two waters, and it should make these bounds to their surface; because it was not able to employ these energetic movements with surety on land, a similar mass was folded there during springing; it crouched/crawled there or marched tranquilly. It has already been seen, in speaking of the vertebrae, that vertical movement should be the most frequent and the most extended in the caudal region; the arrangement of the abdominal ribs confirm these first data.

It could still be inferred from this mobility of the abdominal walls that the skin in this region did not have bony scales as *Teleosaurus*, nor wide horned compartments as living crocodiles; similarly, when viewed from the extent of the movements of the vertebral column, it is doubted that bony scales existed on the skin of the back. What is very positive is that I did not find any vestige of scales among all the bones that I had disengaged one by one.

{76} §. XXIIIrd. *Ordinary ribs.*

Although chance has not been as very useful in regard to these ribs as for those of the abdominal wall, I think that those I possess are sufficient to give a glimpse of the costo-lateral apparatus of our great saurian.

According to those that I possess, the ribs were rather numerous, and a certain quantity must be lacking. I have only a single one that is nearly entire; the vertebral end is lacking on all the others, which consist only of variably long ends. In general, their size appears proportional to that of the animal, although they must have been nevertheless a little thin; but I possess a certain number of ends suggesting some very small ribs; without doubt these were located in the lumbar region; according to this it is probable that our animal, like most living lizards, had ribs from the head down to the pelvis.

All the ribs appear to me to have forms which are particular to them: they differ very much from those of *Teleosaurus*, which are very strong and very short; owing to their gracile nature, they would have more connection with those of *Steneosaurus* from Quilly, which is stored in the Caen cabinet; they also appear to me to be thinner and longer than those of living crocodiles. With regard to the ribs of living lizards, I do not know; we lack the vertebral end, which could have provided several clarifications on this subject: the only rib nearly complete to this end is in a poor state (pl. V, fig. 1, *a*); it suggested a crocodilian rather than lacertilian form. Be that as it may, the ribs of our great animal could be ranged under three series, with regard only to the diverse forms that present the end opposed to the vertebral: first, those where this end is nearly cylindrical; second, those where it is nearly triangular; third, those where it is flattened.

{77} A. *Ribs whose end opposed to the vertebral is cylindrical.*

I possess a nearly complete left (pl. V, fig. 1, 2, 3) in four pieces that do not reconnect perfectly; I have two other portions of ribs of the same character, of which one is from the left side and the other from the right; thus there are at least four ribs of this form, two from each side.

The posterior face (fig. 1) is excavated by a wide gutter that originates near the vertebral end and terminates near the inferior third; on this same face and on the anterior are seen two rough imprints (*e, f*) brought together at the angle of the rib; the one situated on the posterior face is more salient and more extended than the other; they must have given attachment to some muscles. It is not necessary to confuse these imprints with those that the following ribs offer and that must have given attachment to a cartilaginous element; on the contrary, it is necessary to remark that the ribs with cylindrical ends do not have an imprint indicating the presence of a cartilaginous plate at the point where they must have existed. In all probability, the position of these ribs was in front of those that have been described; perhaps they were the ones that abutted the sternum.

B. *Ribs whose end opposed to the vertebral is nearly triangular.*

I have four from the right side (fig. 4, 5, 6, 7), two from the left (fig. 8, 9), and, further, a great number of fragments whose side is difficult to specify and that I have not figured at all. The free end opposed to the vertebral is subtriangular; but in the rest of their extent, these ribs are a little flattened mediolaterally; however one of them (fig. 4), whose free end is lacking, offers to its opposed end a triangular rather than flattened section, similar to those of the preceding ribs at the same point; without doubt it followed them immediately.

The ribs of the series which we possess have a rough imprint {78}, about an inch long, on their posterior edge and at a fairly great distance from their free end (*g, g, g, etc.*), and that supported, during the life of the animal, a cartilaginous appendage as is seen in living crocodiles and which recalls the recurrent [uncinate?] process of the ribs of birds. This character is found again in the genus *Teleosaurus*, only the position of this imprint comes much closer to the end of the rib than in *Poekilopleuron*; in living crocodiles it is equally nearer to this end. The lizards that I have had occasion to dissect, indeed of small or medium size, did not show similar appendages; the workers of comparative anatomy that I was able to consult were quiet in this regard. If lizards are deprived of this character, its presence in our great reptile compares with the family of crocodilians.

C. *Ribs whose end opposed to the vertebral is flattened.*

I have a fairly great number of ends of ribs thus conformed; these are also wider than the preceding ones and much less than the others; without doubt they came after the preceding ones and in order of size; I have figured (pl. V, fig. 10, 11, 12, 13, 14, 15) six of these ends, to better judge their diverse widths.

According to the great number of ribs and the diversity of their configurations, it is presumable that all the vertebrae, from the atlas to the sacrum, were provided with these bony appendages; a character that is found again in the majority of lizards, which belongs equally to *Teleosaurus*, but which living crocodiles do not show in their lumbar vertebrae.

§. XXIV. *Remarks on the distinctive characters of* Poekilopleuron, *on the naming of this genus, and on the great conical teeth coming from the Caen limestone.*

It may be seen, by that which preceded, that the bones of our animal show a mixture of characters belonging to crocodiles and lizards; what {79} remains to examine will still offer a mixture of these two types. At present, we can pronounce that this curious fossil formed a proper link to connect these families more directly.

An important question presents itself: must the animal of la Maladrerie be referred to *Megalosaurus bucklandii* or must it be erected within a particular genus?

I have already remarked, p. 38, 39, on the reasons that could provide some foundation to the first opinion, and at the same time the uncertainty that still reigns on the determination of the bony elements that have been referred to this animal, in so much as they must be considered as connected to the teeth and jaw fragments on which alone the genus *Megalosaurus* was founded. But it has already been seen, p. 84, 85, that one could almost draw no induction from the comparison of the vertebrae, or to say it better, that it appeared to result in non-resemblance rather than resemblance. As much can be said of two ribs figured by Cuvier (*Oss. foss., vol. V, pl. XXI, fig. 25, 26*), when compared with ours. Thus reasons are not lacking to regard the animal of la Maladrerie as unknown to naturalists.

The great number of its ribs, their diversity of forms and arrangements, finally the complexity of this entire apparatus, larger than in any known animal, seemed to furnish me a good indication of the generic name. I have thus named it POEKILOPLEURON, from Ποικιλοσ expressing the diversity, and from Πλευρον, rib; I have given it the specific name of BUCKLANDII that *Megalosaurus* bears equally, so that if new discoveries made known the identity of *Poekilopleuron* with this latter, only the generic denomination would be made to disappear from the domain of science.

In diverse periods, in the quarries of the village of Allemagne, some large teeth have been found, always isolated, offering all the characters of those of crocodiles. I figure one, pl. VI (natural size, fig. 8, reduced one quarter from natural size, fig. 9, in order to better judge its relative dimensions with the bones of *Poekilopleuron* that are all reduced to the same proportion); they have a conical interior cavity; their surface, covered with enamel up to a certain distance from their base, is {80} ornamented with longitudinal striations in relief, of unequal length, of which only two, situated at the ends of the same diameter, reach the point. The size of these teeth agree well with that of our animal, nor it is contrary to attribute it to crocodilian teeth; but nothing else could suppose that they could have belonged to this species. I thought useful to make them known at the same time as my saurian; without doubt the future will teach us if I was well- or poorly-inspired in attempting this comparison.

LARGE FLAT BONE PRESUMED TO BELONG TO THE PELVIS.

This bone (pl. V, fig. 16, 17) is strongly mutilated and gave me much pain to reconstruct, because it was in small pieces. One of its edges (*b*), nearly straight, is thicker than the opposing one (*a*), which is nearly trenchant and must have been curved; its two faces are smooth; it is a little arched towards its flattening: one of its ends is thin; the other, much thicker, must have been located in front, but I did not succeed in re-forming it, the fragments being mostly lost.

I am blocked in its identification: it cannot form part of the shoulder; it is evidently much too large for the humerus; I see only the pelvis to which it could be referred, because the pelvis must have been very large, according to the size of the femur; among the pelvic elements, it can only be the pubis; but it does not entirely resemble the pubis of lizards that I know, and it resembles that of crocodiles very little.

On the same plate (fig. 18, 19), I figured a portion of bone still less easy to identify, but that, according to certain resemblances of tissue that I acquired through the habit of reassessing all these fragments, in my view could have formed part of the bulged portion or head of the previously examined bone. It was detached from the piece to which it belonged along direction *a b*, fig. 19, because this face is a fracture and the spongy tissue is evident. The surface represented by figure 18 is irregularly rounded and traversed obliquely by a sort of furrow or wide pulley. But this surface was not ginglymoid; reptiles do not have such strongly expressed articular surfaces, above all on their large bones.

{81} This bony fragment is interesting in that its spongy tissue is filled with spathic barite sulfate. (See p. 62.)

FORELIMB.

§. XXVth. *Shoulder*.

In the debris of the Mouen block, I recovered several portions of a large, flat bone that perhaps belonged to the shoulder; all my attempts to reconstitute the fragments have been in vain; I could not manage other ideas of its form, other than that it was very flat, thinner in several places, and a bit twisted; its imperfect state prevented me from providing a figure.

§. XXVIth. *Arm*.

The humerus (pl. VII, fig. 1, 2, 3) is very well preserved, except at its superior end where it is a little fractured; I have most of its fragments, and doubtless I could have reformed the head of this bone if my patience to restick the pieces had not been exhausted.

This bone comes from the Mouen block and is situated below the ribs, thus it belongs very certainly to our animal; however it would be tempting to believe that it is strange when its dimensions are compared to those of the femur and the mass of the animal, which can easily be appreciated from the collection of other bones.

It is a nearly general fact that the forelimbs of crocodilian and lacertilian reptiles are shorter and weaker than the hind limbs; in several species the difference is very pronounced. But our fossil reptiles from the environs of Caen display a much stronger disproportion still between these limbs: *Poekilopleuron, Steneosaurus* from Quilly, and *Teleosaurus* furnishing the proof. These latter above all have excessively small forelimbs; the two pairs of limbs differ from one another perhaps more than in gerbils and kangaroos.

{82} To return to our *Poekilopleuron,* this difference in the length and strength of the limbs should give it a unique form and influence its habits. The weakness of the forequarters, as much as the great strength of the hindquarters, confirms the remark suggested by the study of the vertebrae and ribs, namely that *Poekilopleuron* could have sprung with a prodigious force like a spring that relaxes itself; but this could not be on a solid plane, the forelimbs having been too weak to resist the shock produced by so heavy a mass when it fell: all this energy was employed for rapid and vigorous swimming in a sea that the atmospheric circumstances at that time may have rendered subject to frequent and violent storms, or for making jumps to its surface when it was tranquil.

The humerus is from the left side: its superior end or head had a straight oval shape and was continuous with the deltoid crest, which was extended down to near the middle of the bone and made a considerable projection in front. The nearly cylindrical body of the bone was widened transversely near the base to form the inferior end. Posteriorly there exists a wide, slightly deep, triangular depression representing the olecranon fossa; anteriorly there are depressions and rugosities for attachment of the ligamentous capsule. The articular surface (fig. 4) is separated into two parts by a slightly deep furrow; the external, corresponding to the radius, is nearly square with a rounded border; the internal, straighter anteroposteriorly and longer transversely, has its edges equally rounded.

One can see by this description and by figures 1, 2, 3, 4, from plate VII, that the humerus of *Poekilopleuron* differs from those of crocodiles and lizards: it is more collected in its forms; its deltoid crest is more developed and extended farther onto the body of the bone; its inferior end is wider transversely and less straight anteroposteriorly than in crocodiles, but its articular pulley is less pronounced and above all less directed anteriorly than in lizards; by the vagueness of its configuration it most resembles that of crocodiles: together these are characters that again announce an intermediate type between the two families.

{83} The humerus of *Teleosaurus* is much more slender; its very flat head is continuous with the slightly pronounced and very short deltoid crest; the inferior end is strongly straight and slightly wider than the body of the bone; the articular pulley is a little more marked[(1)]. I only know the superior end of the humerus of *Steneosaurus* from Quilly; it resembles well that of the

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[(1)] Until now I have seen neither the forearm nor the rest of the forelimb of these very anomalous crocodilians; but, if I can judge from the very narrow articular end of the humerus, the radius and ulna must be excessively small, and consequently the manus (if however there was one) was reduced nearly to nothing. The forelimb in *Teleosaurus* was evidently rudimentary; nevertheless I do not believe that it was hidden in the flesh; considered separately the shoulder is more developed than the humerus, and would not make it suppose this, and the articular cavity formed by the two elements of the shoulder is fairly pronounced and seems to announce fairly extended movements on the part of the arm. If I were to believe my presentiments, I would suppose that the forelimb of *Teleosaurus* was a sort of straight and slender fin, covered everywhere with skin and without distinct digits.

same bone of *Teleosaurus*, but it shows relatively greater proportions.

Thus, according to the relationships of its forelimb, *Poekilopleuron* is more similar to living crocodiles and lizards than to the crocodilians of its epoch.

§. XXVIIth. *Forearm*.

The radius and ulna (pl. VII, fig. 5, 6, 7, 8, 9, 10, 11) of the left side are found in the same block as the humerus and a little distance from it; they were not in relation to one another: I obtained them perfectly whole, however after having reattached their fragments, because I was not able to extract them without breaking them. Although it was obvious that these two bones formed the forearm, it was fairly difficult for me to distinguish which was the radius, which was the ulna, and which of their ends were superior or inferior; the configuration of the articular surfaces relative to the humerus could not guide me, because in many reptiles the articular surfaces are known to be vague and lack the reciprocity shown by the bones of mammals and birds. This vagueness is made more sensitive by the absence of cartilages that, in the fresh state, contribute much to making the contact of the surfaces more intimate.

{84} I stopped with the result presented in fig. 5, where the radius, *a*, is placed relative to the ulna, *b*, against one other as viewed from their anterior face, which corresponds to the palm of the manus; I took the largest bone for the ulna, and regarded the more voluminous end as superior, guided in these determinations by that shown by the forearm bones of crocodiles and lizards. In the fossil, these two bones are, as the humerus, more compact in size and more robust than in their living analogs.

The superior end of the ulna (fig. 10, *b*) is triangular, a little depressed and much larger than the inferior (fig. 11, *b*), which is subtriangular with a rounded border; there is no salient olecranon as shown in monitors; in this *Poekilopleuron* resembles crocodiles. Fig. 8 shows the ulna from its posterior face, and Fig. 9 from its internal.

The two ends of the radius are almost equally voluminous: the superior, fig. 10, *a*, is triangular and flattened; the inferior, fig. 11, *a*, is nearly oval, directed slightly forwards, flat on the side of the palmar face of the bone, and rounded on the dorsal side. The body of the bone is cylindrical; near its middle, its internal border shows a salient, compressed tuberosity that resembles the bicipital tuberosity of certain mammals. Lizards and crocodiles have nothing similar; as one knows, they do not have the biceps muscle proper, but one or several flexors, variable according to the genus and species. No doubt the radial tuberosity of *Poekilopleuron* would give attachment to a forearm flexor: was this a biceps?… I acknowledge that the presence of this tuberosity led me to decide to place it on the inside, and as a result to situate it above the end *a*, fig. 10; I could have not improbably turned the bone end for end to put the tuberosity on the outside. However it is wise to note that the face of the radius (fig. 5, *a*) shows, in the part that I regard as inferior, two superficial furrows that seem to signal the presence of digital flexor tendons and could confirm the position that I have adopted. Fig. 6 presents the radius from its posterior face; fig. 7 from its internal edge.

{85} §. XXVIIIth. *Manus*.

A. *Carpal bone.*

I came with sorrow to extract two small, whole, spongy bones (pl. VII, fig. 12, 13, 14, 15); I obtained pieces announcing other similar, but larger bones that I was not able to reattach; I regarded them as carpal bones, although they seemed to me a little small. Perhaps they are sesamoids developed in the tendons; I can say nothing precise in this regard.

B. *Phalanges.*

I have found nothing that belongs to the metacarpals.

I have a very little thing relative to the phalanges, but this little thing is interesting in that it fixes our ideas on the separation of the digits, and indicates equally the principal differences of these digits from those of the pes.

Two mutilated pieces belong to these bones: the first (fig. 16, 17) is an anterior part of the ungual phalanx. It was whole; unfortunately the blow that chanced to discover it reduced its posterior part to powder, but the imprint remained; thus I can give the form of the entire phalanx. It is compressed and strongly arched; it differs from those of the pes by these two characters, as well as by its great disproportion in size. The form of this phalanx suggests hooked and even acute unguals; but how would they have preserved their point if they were used to support a mass as heavy as that of their owner on the ground? One would be led to believe that they were retractable as those of geckos; it is evident that they could not serve to support the animal, but served to seize or hold prey.

The other phalanx (fig. 18) that I attribute to the manus, because of its small size, is in very poor condition; its two ends are broken and lost, only a portion of the shaft of the body remains so the character of a phalanx can hardly be recognized there.

{86} HIND LIMB.

§. XXIXth. *General remarks.*

I have enough material to give a nearly complete idea of this part of my animal. I have some bones from all the regions: 21 phalanges of which several are perfectly whole, some from the right pes, others from the left; several portions of the metatarsals; two astragali, of which the right side is nearly whole; another complete tarsal bone to which I can assign neither the analogous name nor the side; three other incomplete and indeterminate tarsals; several fragments of the left tibia, others more considerable from the right tibia, and among them the perfectly intact inferior end; the two ends of a fibula, probably the right, lacking the middle portion; the inferior end of the femur, in poor condition but sufficient to characterize this bone.

This limb gave me more evil than all the rest, both for distinguishing the fragments belonging to each bone, and for determining the bony pieces, of which some had only a very distant analogy of form with the same parts of living or fossil reptiles.

Thus at first, for a long time I took the inferior end of the tibia for the superior end of the femur. This part, which I had disengaged from the block from the Rue de la Bayeux by employing all available precautions, was obtained with its articular surface perfectly preserved. It is true that it hardly resembled the superior end of the femur of any known animal, but nearly all the osteology of my *Poekilopleuron* had accustomed me to strange forms; however, it is all also paradoxical when considered as the inferior end of the tibia: the considerable size of this piece led me naturally to refer it to a femur, for what I possessed of this latter bone was not in a good enough state to make me suspect a mistake at first.

I had found, in the same block where the inferior end of the tibia lay, some spongy and very fragile tarsal bones; I succeeded in obtaining {87} three of them nearly complete, of which two completely resembled each other nearby, one was from the right side and the other from the left; despite their strange and bizarre form, the attentive examination of their articular surfaces left me no doubt that they could only have been astragali. If the idea had come to me to juxtapose one of these bones on the articular end of the tibia, I would not have taken the latter for an end of the femur for such a long time; but one easily conceives that, being preoccupied of the idea that my bone was a femur, I did not advise myself to try to apply an astragalus, or at least a bone that could not come from the pelvis, on its articular surface.

While reading again, for editing this part of my memoir, the researches of Cuvier on fossil reptiles and studying the plates reported there, I believed that I recognized, in *fig*. 35, *letter* a *from pl*. XXI, a bone similar to one of my astragali; the description reported there leaves me no doubt as to their resemblance. With difficulty I would have recognized, in figures 34 and 35 alone, the identity of my pretend end of the femur with the inferior end of the gigantic tibia represented there, because, in *fig*. 35, the ascending process of the astragalus partly hides there the form of the articular cavity where it is lodged. But the description made me promptly suspect what it was; I tried my astragalus on my bone: one of the two fit perfectly; and the oblique line, more undulatory in my specimen than expressed in *fig*. 35 of Cuvier, was the exact counterpart of one of the edges of the astragalar ascending process.

More doubt now on the determination of my bony piece: this is certainly the inferior end of the tibia; and my *Poekilopleuron* had already had one of its fragments described and figured by our great naturalist. He indicates its piece as from the clays of Havre or Honfleur: without doubt it was part of the collection of the Abbey Bachelet.

A part of my memoir was already imprinted when I made this important correction to my first identifications. I announced, p. 41, *the upper end of a femur*: thus it is *the inferior end of a tibia* that it is necessary to substitute for this.

I should acknowledge that one of the reasons that led me to see {88} my animal as a genus other than *Megalosaurus* was based on this same tibial end, which I had made a femur, and which under this hypothesis could not refer to that which Cuvier figured, *pl*. XXI, *fig*. 18, 19. This reason thus became null; but it is not alone, as one can see in the course of this writing. On another side, how can the identity or non-identity of my animal with *Megalosaurus* be determined, since chance desired that, among the numerous pieces of the skeleton that I had recovered, there not be a single one among them with which a rigorous comparison can be made? If there was some lightness in the establishment of the genus *Poekilopleuron* on my part, there would have been imprudence in referring my pieces back to *Megalosaurus*. With such doubt, it is better to furnish a nominal genus than to confuse distinct objects. However my goal was not the glory of attaching my name to the establishment of a genus, but to make known with details one of the more curious types of organization of the ancient world, so fruitful in wonder of this nature.

§. XXXth. *Femur*.

The debris of this bone came from the block transported to Mouen. An imprint of the posterior part of the condyles is best characterized; I molded this imprint in plaster and represent these condyles, pl. VI, *fig*. 1, *a, a, a*, reconnected with two truncations, of which the inferior *b* is applied exactly on the imprint; they were fairly projecting posteriorly. The truncation *c*, as imperfect as it is, seems to me to belong to the femur in light of its large dimensions; and to the inferior end, because of a depression or large furrow signaling the origin of the separation of the condyles, which is found on truncation *b*, despite the fact that the fractures of these two truncations were no longer configured in a manner to be applied exactly. The medullary canal was very large; the thickness of the compact tissue, in *d*, is around 0.015 m. The length of this piece, thus restored, is around 0.33 m; based on the small thickness of the compact tissue compared to the greatness of the medullary cavity, it is clear that the end that I represent did not form more than a third of the length of {89} the bone, and that the latter should have around a meter in length; in this inferior third, the femur is a little more extended transversely than anteroposteriorly. I have a very great number of fragments, some fairly large, which seem to me to have formed part of this bone: it was impossible for me to reconnect them, either to each other or to the two figured truncations.

§. XXXIst. *Leg*.

A. *Tibia.*

I noted previously how I came to determine the inferior end of this bone, which came from the block from the Rue de la Bayeaux; furthermore I had a fairly great number of fragments found in the Mouen block, some of which belong to the right tibia and others to the left.

The inferior end is strongly laterally compressed and nearly trenchant behind; although the body of the bone may also be compressed, it is less so than the end and above all extended anteroposteriorly.

In placing the cavity with oblique border, which lodged the ascending process of the astragalus, outside as it must have been (pl. VI, fig. 3, *a*), it is evident that the end of the tibia figured is from the right side; that which Cuvier figured is from the same side[(1)]. The portion of the external face situated above the oblique border is rounded and smooth above; some rugosities appear near this border, but they are little pronounced. The portion situated in back and below the oblique border only forms a cavity in front, the rest is flat and a little convex. The internal face (fig. 4, *below*) is rounded in front and flat behind; fig. 5 shows the rounded anterior face, inferiorly it offers a salient portion *b*, and fig. 4, *b*, made more sensible by a depression; fig. 6 shows this same inferior fragment viewed from behind; one sees the astragalar {90} fossa and the beginning of the salient line that must have extended along the entire tibia: this bone was to have a triangular prismatic form, and the anterior face was rounded. A part of the posterior salient line is mutilated in my piece, but is better preserved in Cuvier's; I have besides found traces of this line on several of my fragments and in particular on that of fig. 3, *c*. Fig. 7 shows the configuration of the articular surface inferiorly.

The medullary canal is large; the compact substance is very thick, above all on the side of the anterior face where it attains 0.02 m at least. Fragment *c* (fig. 3, 4) belongs to the external face of the superior part, preserving a portion of the salient line behind; one also sees there a furrow for the passage of the nutrient vessels, whose direction is from top to bottom. Although this fragment does not fit with the inferior, it is easy enough to see: by examining the very thick compact tissue below, much less above where is found spongy tissue, that such was its situation;

[(1)] Cuvier named *internal* the face of the bone that I regard as *external*, but his manner of seeing seems to me erroneous: the astragalus of crocodiles has a sort of posterior process that resembles that of our animal, although differently formed; it is placed between the tibia and fibula. The posterior face of the tibia of crocodiles corresponds to the external of *Poekilopleuron*. (See below, p. 124, the note concerning the position of the calcaneum.)

by its diameter and its configuration, that it was only able to fit the tibia; finally by the presence of the furrow for nutrient vessels, that this fragment belongs to the external face.

Among my numerous pieces that must belong to the tibia and that I was not able to reattach, I had a very large one that belonged to the superior part of the internal face of the left. I reached this result by the analogous comparisons that I came to mention; it was useless to figure this piece, but it served me to establish that the two tibiae existed in my blocks.

B. *Fibula?.*

Figures 10 and 11, from plate VI, represent the end of a long bone, very compressed, having one of its edges trenchant and the other rounded, that could well have formed part of the fibula; the end that I suppose to be the inferior is widened and a little swollen; it is not completely intact. The face that Fig. 10 represents (the internal?) shows rugosities and a longitudinal salient {91} inferiorly, destined undoubtedly to fix this bone against a neighboring bone by means of ligaments.

I have another fragment (fig. 10, 11, *b*, *b*) that must equally belong to a compressed long bone; this fragment comes from an end because it has only compact tissue near *c*; one of its edges is trenchant, the other rounded, and these edges are arranged in the same direction as those of the preceding fragment; might this be its superior end? Entirely by chance, I presented these two pieces facing each other, but prejudged nothing as to their provenance. I have several other fragments that could belong to these ends of bones, but I was not able to reconnect them; they all come from the Mouen block.

Cuvier figures *(pl. XXI*, *fig*. 39) an end of a compressed long bone, coming from the clays of Havre or Honfleur, as his tibia and astragalus; it is shown to look like the fibula of his tibia. It is not without some resemblance to my figures 10 and 11, but the ends, whole in Cuvier's bone and mutilated in mine, could not be arranged according to the direction of their flattened portions.

Although all this seems to agree in making a fibula of the bone that I described, it is not impossible that it was a metacarpal; that from the fourth digit, for example? I do not have sufficient data to resolve this question.

§. XXXIInd. *Pes*.

A. *Tarsus*.

One of my two astragali, the left[1], is nearly complete; the right is less so; I represent the latter restored, pl. VI, fig. 12, 13, 14, {92} finally to make better understood its relationships with the tibia and render its description more intelligible. It has a very bizarre form: its superior face (pl. VII, fig. 21) is irregularly concave in order to be applied against the inferior end of the tibia; it is separated from the external by a very considerable compressed, triangular ascending process. The sinuous anterior border of this, about one centimeter thick (pl. VI, fig. 12, *a*), is applied along the corresponding border of the inferior end of the tibia; its truncated summit *b* and the posterior border *c* are free; its internal face was supported against the tibia in the astragalar fossa, and its external face was undoubtedly partly covered by the inferior end of the fibula. The external face of the astragalus, situated below the ascending process, presents a wide articular pulley from which the posterior side (fig. 13, *a*) is very salient, while the less pronounced anterior side comes to merge with the anterior end of the bone, too narrow to merit being called a face; the valley of the pulley (fig. 12, *d*), anteroposteriorly concave and dorsoventrally convex, is continuous below with the inferior face: I suppose that this pulley was articulated with the calcaneum which, according to that, must have had dimensions as considerable and proportional to the pes of the animal[1]. The transversely wide internal face must have been anteroposteriorly narrow (fig. 13, 14, *b, b*, viewed from the side); this part is mutilated in my two astragali; it is

[1] This astragalus is represented on plate VII, Fig. 19-24, but it was found in a reversed position. This plate was drawn before I had noticed Figs. 34, 35, of Cuvier which had put me on the track; I had well presumed that this bone was an astragalus, but I could not know if it was right or left, and in which *position* it needed to be placed: misfortune desired that I had represented it on my plate precisely in an inverse sense from what needed to be given; but in turning the plate over end for end, the bone regained its position: thus Fig. 19 represents its external face, Fig. 20, the internal, 21 the superior, 22 the inferior, 23 the posterior, 24 the anterior.

[1] Cuvier supposed that the calcaneum was articulated with the posterior face (Pl. VI, Fig. 13, *a*) which is small and concave; although in part mutilated on my right astragalus, one can see that it is covered by a thin bed of compact tissue and that thus it does not have the appearance of the other articular surfaces; a calcaneum articulated on this facet was necessarily very small and entirely disproportionate with the pes of the animal. Cuvier, supposing that the face of the bone represented in *Fig*. 35 *of his plate XXI* was the internal, could not have placed a calcaneum on this face *a* of his astragalus; but in adopting the same idea of Cuvier, knowing that his *Fig*. 35 represented the internal face of the tibia, the place of his calcaneum on the small posterior face of the astragalus was still incorrect, because the calcaneum was found in the extension of the internal edge of the pes, which is contrary to all analogy. One could object to me in turn, that in placing the calcaneum on the external face of my astragalus, I have turned the first entirely outside: I respond that the face of the tibia of my saurian, which I describe as external to conform to a

represented as very narrow in Cuvier's plate (*fig*. 34), perhaps it was also {93} mutilated, because it seems to me too narrow in our two specimens to be articulated with the first bone of the metatarsus or with the tarsal bones.

Cuvier very well felt that despite its singular form, this astragalus recalled those of the crocodile, from which it differs above all by its great flatness; in the crocodile one finds in effect on this bone a salient part in back, articulated with the fibula, that appears to me to recall the ascending process of the astragalus of *Poekilopleuron*.

I found another tarsal bone (pl. VII, fig. 25, 26). It is complete, roughly quadrilateral, flattened and everywhere of slightly equal thickness, although its two faces are a little distorted. I seems to me to differ from that figured by Cuvier (*loc. cit., Fig*. 38)[1].

{94} B. *Metatarsus*.

I have a certain number of fragments that could belong to the metatarsal bones. These figures pl. VIII, fig. 1 and fig. 2, belonged to the end near the tarsus; they are convex on one side and flat on the other; they have a fairly considerable medullary cavity. Fig. 3 represents the posterior end of one of these bones; this end is completely spongy and has a form similar to the

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methodical determination, should be turned as much back as outward, as are the tibiae in most saurians; besides the calcaneum could be obliquely situated on its astragalus, as it is a little in crocodiles.

[1] Cuvier, reckoning the length of the animal to whom belonged the end of the tibia and the tarsal bone of which I have widely spoken, and which is found to have the same dimensions as those which I possess, admits that it could not have been less than 36 feet, in supposing it was proportioned like gavials, and 46 feet in taking for comparison the proportions of a monitor; these dimensions seem to me too great. But Cuvier could only judge according to the proportions of the hind limb; he could only guess that the forelimb was very small. In the relative proportions of all the parts of the skeleton of *Poekilopleuron* the small volume of the forelimbs is compensated (so to speak) by the very considerable volume of the hind limbs. Thus one would necessarily be mistaken on the size of certain mammals, whose forelimbs are excessively small while the hind limbs are very large, if one wishes to deduce their dimensions from examination of one or another of these limbs only.

Cuvier believed he was able to attribute to the species of animal to which belonged the end of the tibia of his *plate XXI*, some large vertebrae coming from the same clays, of which he gave the description, *loc. cit*., p. 352, 353, *and figure plate XXII, fig.* 1, 2. If I judge from the region occupied on these vertebrae by their transverse processes, they are dorsals or at least anterior to the pelvis; without speaking of their entirely different proportions from those of ours, because they are larger and longer, the disposition of their articular processes suffices, in my opinion, to prevent accepting the sentiment of Cuvier. These processes are remarkably small and come together one to another for each pair, whereas those of *Poekilopleuron* have an entirely different disposition; the difference of the vertebral region cannot restore reason from this diversity; I believe on the contrary that the articular processes are always farther apart in the back than in the tail.

Cuvier gave, in *pl. XII, Fig*. 4, the figure of one bone of the lower jaw of a large saurian that he supposed could belong to *Megalosaurus*; one finds in the text relating to this bone, p. 354, that it was found in the quarries of the *Caen oolites*. I know the origin of this element: it was given to Cuvier by Lamoroux, it was found in the quarries preceding ones. Fig. 4 shows a metatarsal? of different form: very compressed and a little widened at its end *a* (posterior?); the body of the bone is convex on one side and convex on the other, and it does not have a medullary cavity. Fig. 5 represents a portion of the body of a bone similar to the preceding one, that is, convex on one side, concave on the other, and without a medullary cavity. All these pieces are in too poor a state to attempt drawing part of it; it suffices to have noted their presence.

C. *Phalanges*.

The phalanges are of highly unequal size, indicating a great inequality in the length and size of the digits; this is to such a point that it would be difficult to believe that they belonged to the same animal, if they had not been found all together and in a hardly extended corner of the same block of stone. They are shorter and more compact than those of crocodiles and above all monitors, indicating a shorter and more robust pes.

The presence of two astragali could have made me suppose that two pedes could have been found among my phalanges; attentive examination of these numerous elements did not delay in convincing me that it was so, and I came easily enough to distinguish the rights and lefts.

The ungual phalanges could not leave doubt as to their identification, and there are five; the first phalanges likewise do not present any serious difficulty, because their posterior ends offer {95} a flat or concave surface[(1)], not partitioned in the middle by an obtuse perpendicular crest; two showed this character. Thirteen intermediate phalanges remain whose true places were difficult to recognize with regard to each digit and each side; their length and relative size helped me refer them approximately to their rows and digits, but I could not avoid some arbitrariness in this arrangement. In the following paragraph are seen the inductions that led me

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of Quilly where the stone exploited is the *limestone* called *Caen*. I add, supporting the supposition of our great anatomist, that a tooth of *Megalosaurus* was found afterwards in these quarries. (See p. 38 of this memoir.)

[(1)] This character incontestably indicates *a first phalanx*, but one must not infer that I attribute a concave, arthrodial articular surface to every first phalanx, and as a general and absolute character. Without speaking about several mammals whose first phalanges form a tight ginglymus with the metacarpals or metatarsals, in birds the posterior end of the first phalanges does not have a different configuration from that of the second or third. Crocodiles merit attention under this relationship: the anterior end of their metatarsals, convex from top to bottom, is nearly straight transversely; only a slight depression in the middle, more marked below than above, indicates a tendency towards the form of a ginglymoid pulley. *Fig.* 16 *of plate IV* of Cuvier (*loc. cit.*, *vol. V*), representing the pes of a living crocodile, seems to me to slightly exaggerate this arrangement. In monitors the configuration of the head of the metatarsal and that of the posterior end of the first phalanges are more clearly arthrodial; *Figs*. 45 *and* 50 *of pl. XVII* of Cuvier indicate well this character; it is strongly evident on my small skeleton of *Tupinambis*.

to admit, first, the number of five digits as in lizards, rather than four as in crocodiles; second, the number of phalanges for each digit; third, the row in each digit to which I attribute each phalanx.

I proceed to describe the phalanges succinctly, following the order that I attribute to them according to this restoration.

First phalanges.

The first phalanges, three in number, are referred to the left pes; those of the pollex and external digit are complete; their posterior ends leave no doubt at all about their row; the other phalanx that I refer to the fourth digit is considered as first only by its very great size; because it is only represented by the external part of its anterior end.

The first phalanx of the pollex (pl. VIII, fig. 7) is of a very {96} bizarre form and such undoubtedly that no known animal presents it thus conformed; it is irregularly cubical. Its superior face *a* is almost planar, inclined inward, and shows the superior end of two fairly projecting condyles in front, separated by a wide groove or furrow. The inferior face *b* is concave from back to front and inclined inward like the superior face; the condyles there are more projecting and elongate than on the other face, indicating a greater extent of movement for the ungual phalanx in this direction and justifying its given position as inferior, because flexion of the digits always occurs below. The external face *c* is the most extended of all, and it is divided in two by an obtuse projection that passes from the superior border to the inferior; the portion of the face situated behind the projection is rugose and applied onto a tarsal bone or the second metatarsal; this arrangement indicates that this phalanx enjoys a little movement; the portion of the face situated in front of the projection is restricted into the form of a neck, and is inclined from the internal side. The internal face *d*, much shorter and straighter than the external, is rounded in back and a little excavated in front, at the level of the condyle. The posterior face *e* is triangular and irregularly concave; the anterior *f* presents an articular pulley with well-developed condyles separated by a wide, deep groove; the external condyle is situated more in front than the internal, or in other terms, the pulley is directed inwards. It results from this arrangement: that the pollex must be very short, that the ungual phalanx, directed entirely inwards, alone was mobile, and that its movement was very extended.

It is evident that this bone did not at all form part of a digit situated between two others, but a digit free on one side: according to the shape of the phalanx, this digit could only be that of the pollex of the left pes or the external digit of the right pes. I would have been at a loss to say which of the two, if I had not had another first phalanx whose small size more willingly recalled the external digit; it was not difficult to recognize that it must have been from the same pes as that already described: or if the one belonged to the external digit, the other necessarily formed part of the pollex. Although other small observations could {97} still support my manner of seeing, I suppose that one is enough.

The first phalanx of the fifth digit (Fig. 8) is a little longer than that described previously, but of a diameter around half less; like that one, it is perfectly preserved. Its superior face *a* is rounded and presents two transverse tubercles, perhaps accidental; the inferior *b* is rounded and has a wide, rough imprint in back for attachment of some muscular portion; the condyles of the anterior articular pulley are extended well onto this face, whereas they are hardly seen above. The internal face *d* is wider in back than the external *c*, which forms a slight projection in this place. The posterior end *e* is concave; the anterior *f* shows the articular pulley whose groove is slightly deep, and whose external is condyle wider than the internal.

The very small size of this first phalanx makes me see it as belonging to the external digit, and I found myself on the analogy of what is seen in all animals with digits, and particularly in saurians.

One wonders perhaps why I attribute this phalanx to the pes rather than to the manus; its small size seemed in better agreement with the proportions of the latter, proportions that could be estimated according to the dimensions of the arm bones, the forearm and the two phalanges that I described in the paragraph concerning the manus. I remarked at first that I had found this phalanx among all the others which belonged to the hind foot; I will admit, if it is desired, that the manual phalanges, being no longer united together at the moment when the bones of the animal were seized by the matrix, could have been found mixed with those of the pes, and that the situation where I recovered it does not prove absolutely that they belong to a pes; another consideration seems to me to confirm my manner of seeing: this phalanx comes from a free digit, a pollex or external digit; if one admits that there was a great inequality in the manual digits, as there was in those of the pes, and as analogy with living species indicates, it seemed to me too strong for the manus.

{98} I regard this phalanx as belonging to the left pes, because I can distinguish that its external or free side is left, which would be the contrary if it belonged to the right side.

Three characters helped me to recognize the side from which it came: one is characteristic to it and draws from the backward projection of one of its faces, the two others are common to all the phalanges that I recovered, except the unguals.

In examining the anterior ends or articular pulleys of all these phalanges, it is easy to see that the groove is not precisely at the middle and that one of the condyles is a little more extended transversely than the other. Those of the phalanges whose resemblance is such that they must have occupied the same position in the corresponding digit of each side, have their condyles more widely arranged in the opposite sense. The small fossae placed laterally behind each condyle, and destined to give insertion to the lateral articular ligaments, are strongly expressed on the phalanges of *Poekilopleuron*, and the one corresponding to the wider condyle is always deeper than the one found behind the narrower condyle. Already, several remarks tend to make me admit that the wider condyle and the deeper fossa are always placed outside, and that by this it should be easy to distinguish the phalanges of the right pes from those of the left. I tested the value of these characters on my crocodile skeletons: I saw a fairly sensible difference in width between the two phalangeal condyles, and the wider is constantly turned outside: as for the fossae, it seemed less evident that the deeper always corresponded to the wider condyle; however, on several phalanges it was not doubted that it was so. My monitor skeleton is too small to serve in this sort of study.

The first phalanx of my fifth digit, having the larger side of its pulley turned to the left and outside, is thus from the left pes. The fossa for the lateral external ligament is so deep that it penetrates more than half the diameter of the bone.

I regard the fragment in fig. 6 as belonging to the first phalanx {99} of the fourth digit; it was enormous; it is .065 m in *c* from one asterisk to the other, and the external half of its pulley measures 0.0045 m; I have fragments that seem to belong to its posterior end, but the body of the bone is lost. I suppose, as is seen, that the fourth digit of my fossil was the longest and the strongest; I am guided in this by the analogy offered by the pedes of lizards with very unequal digits: but the digits of my fossil evidently had this character; why did fourth digit not follow the rule that is shown us in living nature?

I have five ungual phalanges, three complete and two a little damaged in their posterior part; they are not of equal size, but the difference between the largest and the smallest is not very considerable. They greatly resemble those of crocodiles; they are only a little shorter, more elevated in back and a little curved below. If they were all from the same pes, it is evident that this pes had all its digits armed with unguals, and the number of these digits was not sought. It was thus important to be assured whether they came from two pedes, as I had become nearly certain of for the other phalanges, and as the presence of two astragali had given proof of this possibility. I did not have to wait to acquire the conviction that it was so: the inferior face of my phalanges, concave from back to front, is not transversely horizontal but a little oblique; the point is not entirely in the direction of the axis of the bone, but directed to the side opposite that where the inferior face is raised: three of my phalanges had their inferior face inclined to one side, and two had turned it to the opposite side. These characters are found evidently in my crocodile skeletons: the raised side of the inferior face looks outward while the point is directed inward; from which it results that three of my ungual phalanges belonged to the right pes and two to the left pes.

As for the intermediate phalanges, although each of them has a particular form that could permit describing them separately, to abridge things I will not do it; the figures that I give are enlarged and scrupulously exact enough so that one can get {100} a precise idea of what these bony elements are; I will remark only that their articular surfaces are very pronounced, which indicates well determined movements.

§. XXXIIIrd. *Restoration of the digits.*

I indicated the characters by which I distinguished the right phalanges from the left; this operation terminated, I worked to refer them to each digit according to its size and the number of bones composing it. I do not hide the fact that the results obtained are problematic enough; I was missing too many elements to be protected from the chances of error; I warn that I attach little importance to this restoration, I have only tried in the hope of obtaining some data on the number of digits and to know thus whether the pes of *Poekilopleuron* resembled those of crocodiles or lizards. In every case, this arrangement has already been very useful for me, serving only to designate my phalanges without circumlocution.

My point of departure is that *Poekilopleuron* could not have the pes arranged, regarding the essentials, like that crocodiles or lizards.

That of crocodiles has four digits; the number of phalanges for each digit is, starting from the internal: two for the first, three for the second, four for the third, four for the fourth; in all, 13.

That of lizards has five digits; starting from the internal, there are two phalanges for the first, three for the second, four for the third, fifth for the fourth, three for the fifth; in all, 17. (*After Meckel*.)

When surely even I would not have managed to find, by other means, that my phalanges came from two pedes, the number of 20 that I had recovered told me: I had 8 from the right side, 11 from the left, plus that figured in pl. VIII, fig. 21, whose side I could not determine by the process used for the others; this is the one which is affected by decay and of which I spoke on p. 64. Nevertheless, I believe it is from the right side, judging by the posterior end where the larger facet is on this side.

{101} Let us admit the pes of our fossil as established according to the crocodilian type, and so on this model we search to reform the left pes, of which we possess eleven phalanges.

As recognized, we have the first phalanx of the pollex, fig. 7, that of the external digit, fig. 8, and a first phalanx of an intermediate digit, fig. 6; two ungual phalanges, fig. 22, 23; a third ungual, which we lack, could not be confused with one of the others from this pes, and we can count as if we possess it: six total, of which five are present and one is absent.

The fourth digit in crocodiles has its phalanges very easy to recognize, it was only by their small size and gracile nature compared to the others. We are assured that the phalanges of the external digit of our fossil (in the supposed case, the fourth) should be small, because the phalanx that we have of this digit is smaller than the others, and likewise its form is different; it is certain that the small phalanges that must have supported them are not among those that I attribute to the left pes, and the same with those of the right, because their small size would have alerted us to them promptly; these absent phalanges were three in number; thus we would have nine phalanges whose position would be found; thus more than four would not be lacking: or we have seven more of them of available, that is three too many to complete the thirteen of a crocodilian pes: this type was thus not that of *Poekilopleuron*.

It is true that the phalangeal fragments, fig. 18, 19, 20, are not very considerable so that one could establish with enough certainty the side to which they belonged; but I must remark that in neglecting them, the phalanges that we have restored to place could not, in view of their size and too diverse forms, enter into the composition of the two digits that we have restored to completion.

I have tried to reform the right pes equally according to the crocodilian type, following the same functioning as for the left, and restoring by that thought the phalanges that are absent on this side but are present on the left side; the impossibility of a crocodilian pes, according to {102} the number of phalanges, should be still more evident. I have minutely done all these tentative things, and one will undoubtedly be grateful to me for not developing them here.

These results are confirmed by other considerations. The four digits of the crocodilian pes differ from them by their length: undoubtedly those of *Poekilopleuron* were in contrast strongly unequal; the singular shape of the first phalanx, fig. 7, and its lesser length, does not permit comparison with the first digit of living crocodiles.

There is thus a great probability of admitting that *Poekilopleuron* had five digits in the hind foot, as in lizards. I have tried this combination with the elements that I possess and proceeding in the manner indicated above in the research on the crocodilian pes; I have thus remade the two pedes, and all my elements were placed without effort. One can judge from the obtained result by throwing the eyes on fig. 27 of plate VIII, where the left pes is represented remade and reduced to a sixth of natural size; the letters indicate the elements figured on plate VIII. (See the table following and the explanation of plate VII.)

One can see by this remade pes, that the form which I attribute to it is anomalous among the diverse forms offered by lizards. I should explain in a few words what led me to admit this extraordinary form.

If the phalanx figured in pl. VIII, fig. 7, is truly the first of an internal digit, this digit was necessarily very short and nearly rudimentary; it was provided of an inwardly-directed ungual phalanx, the depth and the direction of the pulley being evidence of it; moreover, this pulley announces that, entirely short as it was, this digit entered often into exercise and that its function was efficacious.

I suppose the fifth digit is without an ungual phalanx; a little arbitrariness enters here undoubtedly: however my opinion is justified, to my eyes, by the entirely particular form of the first phalanx that we possess, fig. 8: it is proportionally much longer, more cylindrical and narrower than the others; these characters likewise refer it to the first phalanx of the external digit {103} of crocodilians, which is without the ungual. I should add that the constant study of the bones of my fossil having always showed a singular mixture of crocodilian and lacertilian forms, this preoccupation entrained me to be more willing to admit a digit without an ungual than the phalanx much favored by this supposition.

I have made one of the digits very large and very strong, because I have some enormous phalanges that indicate this to me; I have placed it as the fourth, by reason of evident analogy, because it is nearly always the fourth digit that is the longest and strongest in lizards; I have made the others highly unequal, still guided by the size of the phalanges and the analogy deduced from living species.

As for the length of the tarsal bones, I cannot justify it completely; I sought to proportion them with that of the digits that they supported, while holding count of the value of the fragments that I possess.

It is conceived that it is most important to have given the strong presumptions that my animal had five digits in the hind foot like lizards, while preserving a certain crocodilian aspect. It is possible that the digits were not successive in order of size as I suppose, or that I have attributed to one digit one or several phalanges belonging to another; the essential thing, to my eyes, would be that the main result was exact; I would hold the rest cheaply.

Table indicating the phalanges of each digit in the two pedes.

(Obs.) The figure expressed in each case refers to the same no. of plate VIII. The cases marked with a zero only indicate that the phalanx is lacking on that pes and is found on the other; the zero accompanied by an asterisk indicates that the phalanx is lacking in both pedes.

LEFT PES.						RIGHT PES.				
5th digit	4th digit	3rd digit	2nd digit	1st digit		5th digit	4th digit	3rd digit	2nd digit	1st digit
	Fig. 22				5th phalanx				Fig. 24	
	Fig. 18?	Fig. 23			4th phalanx			Fig. 25	Fig. 17	
0*	Fig. 12	Fig. 16	0*		3rd phalanx		0*	Fig. 20	Fig. 11	0*
0*	Fig. 9	Fig. 13	Fig. 20?	0	2nd phalanx	Fig. 26	Fig. 15	Fig. 14	Fig. 10	0*
Fig. 8	Fig. 6	0*	0*	Fig. 7	1st phalanx	0	0*	0*	0	0

{104} **EXPLANATION OF PLATES**

AND MEASUREMENTS OF THE PRINCIPAL BONY ELEMENTS REPRESENTED.

ESSENTIAL ADVICE.

Most of the figures are reduced to one-quarter. In choosing an equal measure for the large bony elements as well as the small ones, my goal was to better capture their relationships, either between them or for the group. The small ones have undoubtedly lost to this uniformity, which does not permit rendering their details; but this inconvenience is more than compensated by the advantage noted initially.

All the elements have been represented geometrically so to speak, that is rigorously in profile or facing view; thus losing the side of the picturesque effect (much less important in similar material), but they gain infinitely in exactness of aspect, because it is nearly impossible, at least from an extreme perfection in the manner of which the drawing is shaded, that some bones will be perfectly captured with their nuances of specific forms when seen in positions other than those that I indicated.

I have completed the mutilated pieces by a simple outline, so as to give an idea of what they are in their integrity; without this outline, which emphasizes them better, the fractured pieces would often be left to guessing with difficulty their true forms; because for the very reduced objects, the cracks are often difficult to express well, and one can take them for natural surfaces. As for their completion by an outline, I restored this one either by means of the left side for the right-hand side and reciprocally, or by the prolongation of the curves of the lines, or by the imprints left on the stone, etc. However, the outline cannot induce error, and one is a master to add to it the degree of confidence that one will want.

I am not afraid to multiply the figures so that none of the pieces represented remain undecided. How many times has it not happened that one rests in uncertainty in comparing the natural pieces to some figures, because the author only figured the object on a single side.

One can count on the exactness of these plates: the objects have initially been figured by an outline of natural size and measured everywhere by compass, while paying great attention to the measures of short cuts; I do not need to say which errors this omission could entrain. The figures were reduced by proportional squares, and the shadows were put on the reduced figures.

As happens often to those who are charged to lithograph the drawings and to copy them without much care, while making a pass over their features sometimes in-inside, sometimes in-outside those of the original, for the small and already reduced figures, {105} deformations result where greatest severity was necessary; I wanted to eliminate this inconvenience, so I copied the drawings myself and transferred them to the stone; thus I retained the contours. I copied the shadows by a draughtsman; unfortunately, my plates did not become the chief-works and are far from returning finished and far from the delicacy of the original drawings. All told, the time and circumstances have not permitted us to do better.

I did not speak of the time of the interminable maneuvers demanded of me; I sought to offer to the paleontologists a work made in conscience; I would be recompensed enough for my efforts, if they did not judge that it rested too far from the goal that I had proposed.

Pl. Ist.

Fig. 1. *Ammonites giganteus*? Sow., variety lacking furrows; reduced to one third. *a, a,* portions of the siphon resting in their position. *b, b, b*, other portions of the siphon a little displaced. The place where the debris of the siphon rests (remarkable for its small diameter given the great size of this ammonite) is flat, the partitions have disappeared, only some traces of the central turns remain. The entire surface is papered with small calcareous crystals.

Fig. 2. The same species? Variety with radiating furrows; reduced to one third. The second turn is replaced by a mass of quartz penetrated by prismatic cavities of pointed barite sulfate, which were established on disappeared crystals. *b*, cut of the last turn.

Fig. 3. Outline of a crystal of pointed barite sulfate; indeterminate size.

Fig. 4. *Belemnites hastatus*? Blain. view of the side of the median furrow; natural size. *a*, traces of partitions remain visible on the spathic stone that replaced the alveolus. *b, b, b*, elongation of the base.

Fig. 5. The same with the outline, side view to show: 1st, the difference between the two diameters; 2nd, the point where the alveolus terminates; 3rd, the direction that the elongation of the base takes, from the opposite side to the furrow or back of the shell.

Fig. 6. Tooth of *Cestracion*; natural size. *a*, view of face, *b*, view of profile.

Fig. 7. *Mya scripta*? Sow. (interior mold), natural size. *a*, left valve in side view. *b*, the same viewed from above. The right valve, delineated, is supposed in relation to the left, to better make known the form of this shell and its broad opening behind.

Fig. 8. *Nucula nucleus*. Nob., natural size. *a*, left valve, outside view. *b*, the same view of the internal face and showing the hinge. *c*, the two valves reunited, viewed from the hinges. This specimen comes from the ferruginous oolite of Bayeux. *d*, internal mold showing the imprint of the hinge and that of the posterior muscle; from the limestone of Caen.

Fig. 9. Left or inferior valve of *Avincula digitata*. Nob., natural size.

{106} Pl. II.

All the figures reduced to one quarter.

Fig. 1, 2, 3. First series of caudal vertebrae, lateral views, from below and above.

b, b, Exostoses and ankylosed chevron – *c, c, c*, saw-marks which cut some vertebrae obliquely. *d, d, d*, chevron.

Fig. 4, 5, 6. Second series of caudal vertebrae. *c*, *c*, *c*, rudimentary spinous processes.

Fig. 7. Second vertebra from the first series and chevron, viewed from the anterior end.

Fig. 8. Eleventh vertebra from the second series viewed from the anterior end.

Fig. 9. The same viewed from the posterior end.

Fig. 10. Chevron viewed from above.

Dimensions of the second vertebra from the first series.

Length of centrum: 0.105 m. – Width of ends: 0.067 m. – At the middle: 0.034 m. – taken from the bottom of the lateral gutters: 0.028 m. – Width of the annular portion above the transverse processes: 0.052 m. – Width of the transverse process: 0.035 m. – Thickness of the same at its origin: 0.015 m. – Length of the same, taken outside the annular portion: 0.050 m. – Length of the spinous process, taken at the level of the transverse process: 0.105 m. – Width, from front to back, near the summit: 0.035 m. – Thickness: 0.008 m. – Depth of the posterior notch (from the conjugating foramen): 0.018 m. – Of the anterior: 0.006 m. – Distance between the two postzygapophyses, taken from their external surfaces: 0.033 m. – Distance between the prezygapophyses, taken from their internal surfaces: 0.036 m. – Length of the prezygapophyses, taken at the level of the bottom of the foramen: 0.036 m. – Diameter of the neural canal: 0.017 m.

Dimensions of the third chevron.

Length: 0.105 m. – Width in the middle: 0.020 m. – At the base: 0.040 m. – Thickness at the middle: 0.015 m. – At the base: 0.042 m. – Width of the transverse lamina that unites the two rami: 0.021 m.

Dimensions of the eleventh vertebra of the second series.

Length of centrum: 0.082 m. – Width at the ends: 0.032 m. – Height at the same points: 0.035. – Width at the middle: 0.024 m. – Taken at the base of the gutters: 0.019 m. – Depth of the posterior notch (of the conjugating foramen): 0.014 m. – From the anterior: 0.018 m. – Length of the prezygapophyses: 0.045 m. – Diameter of the neural canal: 0.007 m.

{107} Pl. III.

Sterno-costal and abdominal rib apparatus of the pointed-snout caiman, the common chameleon and the marbled lizard of Guiana.

(Obs.) The apparatus belonging to the crocodile and from an individual five feet long was reduced by half, and the two others augmented, so that all would be of equal size, and finally to allow better judgement of the relative dimensions of the diverse elements composing these apparati, compared to those of analogous elements from *Poekilopleuron* represented in the two following plates.

Fig. 2. Pointed-snout caiman. – *a, a, a, etc*. Internal pieces of the abdominal ribs. – *b*. External pieces. – *c, c*. Bony piece of the sternum. – *d, d*. – Anterior cartilaginous piece of the same bone. – *e, e*. – Posterior cartilaginous piece of the same. – *f, f*. Cartilaginous elongations of the ribs. – *k, k*. Articulation of the elongations with the cartilaginous appendages. – *i, i*. Cartilaginous appendages having some elongations corresponding to them. – *g, g*. Ribs lacking appendages. – *h, h*. Appendages having no corresponding elongations. – *m, m*. Cartilaginous plates adherent to the posterior border of six middle ribs.

Fig. 2. Common chameleon. – *f, f*. Bony elongations of the ribs; the five first reach the sternum, the last are reunited with their corresponding elements on the median line. – *k, k*. Articulation of the ribs with their elongations.

Fig. 3. Marble lizard of Guiana. – *c*. Bony piece of the sternum. – *d, d*. Cartilaginous disk. – *f, f, f*. Three elongations which are reunited by abutting at a single point of the cartilaginous disk. – *f', f'*. Elongations reunited on the median line, but which do not reach their corresponding ribs. – *k, k*, etc. Articulations of the ribs with their elongations. – *n, n*. Anterior prolongation of the elongations to the point where they are reunited on the median line.

Pl. IV.

Figs. I and II reduced to one quarter.

Fig. I. Abdominal ribs of *Poekilopleuron* viewed from their inferior or cutaneous face. – 1, 2, 3, 4, 5, 6, 7. Unpaired or fused pieces on the median line. – *a, a, a*, etc. Strongly distinct depression that could have served to support the salient angle of the following rib medially. – *b, b*, etc. Rugosities destined to provide attachment for some ligamentous or muscular fasciae. – *c, c*, etc. Wide, superficial depression situated obliquely on the two rami of each rib of this series, against which the superior face of the following rib must have been applied medially. – *d*. Heel or prolongation of the anterior ramus of the rib, no. 7. (See the same rib, fig. 2*d*). – 8, 9, 10, 11, 12, 13, 14. Paired elements that must only have been reunited on the median line by means of ligaments. – *h, h*. Trace of sutures or ankyloses as if the two pieces 14 had been formed each from portions {108} overlapping one on the other in a certain extent. (See the description of these elements, page 103). – *e*. Elongation or bony stylet sutured accidentally to abdominal rib 10, and of which traces of union remained very visible; the point of the rib is broken in *g*. – *f, f*. Shaft of preceding bony stylet, supposed separated from its rib to better indicate its curvature and length.

Fig. II. Abdominal ribs viewed from their superior or peritoneal face. – 1, 2, 3, 4, 5, 6, 7. Unpaired elements. – *a, a*, etc. Gutters where the bony stylets were lodged in part. – *b, b*. Irregularities for attachment of muscles or ligaments. – *d*. Heel or prolongation that seems to belong to the anterior ramus of this singular rib, bifid of the right side, as if this ramus, free at the origin, was sutured early to the rest of the bone. *c, c, c*, etc. Bony stylets that were applied by a portion of their length on the gutters, *a, a*, etc. 8, 9, 10, 11, 12, 13, 14. Paired elements. – *a, a*, etc. Gutters where the bony stylets were applied. – *b, b*, etc. Rugosities for the attachment of muscles or ligaments. – *h, h*. Trace of suture of pieces 14. – *e, e*. Bony stylet sutured onto its rib broken in g. – *f, f*. Shaft of preceding.

Dimensions of some of the abdominal ribs.

No. 7. Length of the simple ramus, without following the curvatures: 0.285 m. – Width at *c*: 0.022 m. – Thickness at the same point: 0.013 m. – Length of the double ramus: 0.240 m. – Width at d: 0.028 m. – Thickness at the same point: 0.019 m.

No. 14. Length of the fragment: 0.235 m. – Width at h: 0.029 m. – Thickness at the same point: 0.016 m.

Stylet bone (Fig. II, no. 7). Length of the fragment: 0.207 m. – Thickness in the middle: 0.010 m.

Fig. III. Shaft representing the circle of bony elements surrounding the chest or abdomen of *Plesiosaurus dolichodeirus* (indeterminate size). *a*, vertebra. – *b, b*. Ordinary ribs. – *c*. Symmetrical bony element, placed on the median line. – *d, d*. Elongations that unite the preceding element with the ordinary ribs.

Pl. V.

All the figured reduced to one quarter.

Fig. 1. *a, b, c, d*. Left rib of the first series, nearly complete, viewed from its posterior face. – *f*, rugosities for the attachment of muscles.

Fig. 2. Fragment *b*, viewed from its superior face. – *c*. Rugosities for the attachment of muscles.

` Fig. 3. The same viewed from its external face. – Length of fragment b: 0.225 m. – Width at the middle: 0.042 m. – Thickness of the same: 0.032 m. – Length of fragment *c*: 0.217 m. – Width at the middle: 0.030 m. – Thickness of the same: 0.024 m. – Length of fragment *d*: 0.210 m. – Width at the small end: 0.015 m. – Thickness: 0.012 m.

Fig. 4, 5, 6, 7. More or less considerable fragments of left ribs from the 2nd series. *a*. External face. – *b*. Posterior edge. *g*. Rough imprint having provided {109} attachment for a cartilaginous plate that recalls the recurring process on the ribs of birds.

Fig. 8, 9. Fragments of right ribs from the same series.

Dimensions of fragments. Fig. 6. Length: 0.396 m. – Width near the wide end: 0.030 m. – Thickness of the same: 0.017 m. – Length of the rough surface g: 0.044 m.

Fig. 10, 11, 12, 13, 14, 15. Fragments of ribs belonging to the 3rd series. – *a*. External face. – *b*. Anterior edge. – Width of fragment in fig. 10: 0.037 m. – Thickness: 0.013 m. – Width of fragment in fig. 15: 0.013 m. – Thickness: 0.006 m.

Fig. 16. Large flat bone, perhaps the pubis. – *a*. Thin or trenchant edge. – *b*. Rounded edge.

Fig. 17. The same viewed from the trenchant edge. – Length: 0.461 m. – Width at the middle: 0.117 m. – Thickness at the same point of the side of the rounded edge: 0.030 m.

Fig. 18, 19. Fragment of bone filled with spathic barite sulfate, having perhaps belonged to the preceding.

Dimensions of *a* to *b* fig. 19: 0.087 m.

Pl. VI.

All the figures reduced to one quarter, except the eighth.

Fig. 1. Fragments belonging to the inferior end of the femur, viewed from the posterior face.

Fig. 2. The same viewed from the side. *a, a*. Condyles (molded from an imprint). – Width of the interval that separated the two condyles: 0.055 m. – Height of one of the condyles: 0.110 m. – Length of fragments *b, c*, reunited: 0.335 m. – Anteroposterior diameter, at the truncation: 0.090 m. – Thickness of the compact tissue at the same point: 0.016 m.

Fig. 3. Portions of the right tibia, external face. – *a*. Edge of the astragalar fossa. – *b*. Angular salient existing inferiorly on the anterior face. – *c*. Salient posterior line.

Fig. 4. The same, internal face; fragment *c* is viewed from the medullary cavity.

Fig. 5. Inferior fragment, anterior face.

Fig. 6. The same viewed from behind.

Fig. 7. Articular end of the same, viewed from below.

Length of the inferior fragment: 0.200 m. – Extent from back to front (below): 0.165 m. – Width transversely, taken at the level of *a* (Fig. 5): 0.080 m. – Width at the level of the truncation: 0.066 m. – Thickness of the compact tissue in front, at the truncation: 0.022 m.

Fig. 8. Tooth found isolated in the limestone of Caen, presenting characters of crocodilians, and that could have belonged to *Poekilopleuron*. Natural size.

Fig. 9. The same at the shaft, reduced to one quarter.

Fig. 10. Fibula? viewed from its internal face.

Fig. 11. The same viewed from the straight edge. – Length of fragment *a*: 0.200 m. – Width below: 0.096 m. – Width above: 0.050 m. – Thickness below: 0.048 m. – {110} Thickness above: 0.028 m. – Length of fragment b: 0.144 m. – Thickness: 0.033 m.

Fig. 12. Right astragalus viewed from its external face. – *a, b, c*, ascending process. – *d*, pulley.

Fig. 13. The same viewed by its posterior face.

Fig. 14. The same viewed by its anterior face (For the dimensions see the explanation of the following plate).

Pl. VII.

All the figures reduced to one quarter, except the 27th.

Fig. 1. Left humerus viewed from in front. Fig. 2. The same viewed from behind. Fig. 3. The same viewed from the internal side. Fig. 4. Articular end of the same, viewed from below. – Length: 0.300 m. – Width at the middle: 0.054 m. – Inferiorly: 0.120 m. – Salient of the deltoid crest: 0.044 m. – Thickness of the articular end in

the point corresponding to the radius: 0.050 m. – To the ulna: 0.035 m.

Fig. 5. Left radius a, and ulna b reunited; viewed by their anterior faces. Fig. 6. Radius viewed by its posterior face. Fig. 7. The same viewed by its internal face. Fig. 8. Ulna viewed by its posterior face. Fig. 9. The same viewed from its internal face. Fig. 10. Upper ends, *a* from the radius, *b* from the ulna. Fig. 11. Inferior ends, *a* from the radius, *b* from the ulna.

Length of the radius: 0.170 m. – Width of the upper end: 0.074 m. – Thickness: 0.048 m. – Large diameter at the middle: 0.035 m. – Small diameter: 0.025 m. – Width of the inferior end: 0.058 m. – Thickness: 0.045 m. – Length of the ulna: 0.180 m. – Width of the upper end: 0.090 m. – Thickness: 0.055 m. – Large diameter at the middle: 0.037 m. – Small diameter: 0.027 m. – Width of the inferior end: 0.055 m. – Thickness: 0.035 m.

Fig. 12, 13. Carpal bone? Largest width: 0.038 m. – Thickness: 0.015 m.

Fig. 14, 15. Another carpal bone? Dimensions a little more equal to those of the preceding.

Fig. 16. Ungual phalanx of the manus, viewed from the side. Fig. 17. The same viewed from above. Length of fragment: 0.040 m. – Thickness: 0.010 m. – Height in back: 0.028 m.

Fig. 18. Fragment of phalanx? from the manus.

Fig. 19-24. Left astragalus viewed in a reversed position. 19. External face. 20. Internal face. 21. Superior face. 22. Inferior face. 23. Posterior face. 24. Anterior face. Transverse extent: 0.145 m. – Height of the ascending process: 0.067 m. – Width at its base: 0.090 m. – Thickness: 0.020 m. – Width of the posterior face of the bone: 0.055 m.

Fig. 25, 26. Tarsal bone. Largest width: 0.065 m. – Thickness: 0.022 m.

Fig. 27. Digits of the left pes restored (reduced to one sixth). The letters refer in the same way as those following in the figures of plate VIII. *a* [(1)] Fig. 7. – *b* Fig. 20. – *c* Fig. 13. – *d* Fig. 16. – *e* Fig. 23. – *f* Fig. 6. – *g* Fig. 9. – *h* Fig. 12. – *i* Fig. 22. – *k* Fig. 8.

{111} Pl. VIII.

All the figures reduced to one quarter.

Fig. 1. Fragment of metatarsal? Length of fragment: 0.110 m. *a*. Convex face. – *b*. Posterior end.

Fig. 2. Fragment of metatarsal? Length of fragment: 0.140 m. – *a*. Convex face. – *b*. Truncated end.

Fig. 3. Posterior end of metatarsal? Length of fragment: 0.095 m. – Width 0.070 m. – Thickness: 0.035 m. – *a*. Convex face. – *b*. Flat face. – *c*. Side. – *d*. End.

Fig. 4. Fragment of metatarsal? Length of fragment: 0.195 m. – Width of d: 0.055 m. – Of c: 0.042 m. – *a*. Concave face. – *b*. Convex face. – *c*. Truncated end. – *d*. Equally truncated posterior end.

Fig. 5. Fragment of metatarsal? Length of fragment: 0.145 m. – Width: 0.042 m. – Thickness: 0.22 m. – *a*. Concave face. – *b*. Convex face. – *c*, *d*. Truncated ends.

Fig. 6. First phalanx of the fourth digit, left pes. Length of fragment: 0.094 m. – With of the part of the pulley: 0.045 m. – Height of the pulley between * and *: 0.066 m. – *a*. Superior face. – *c*. External side. – *f*. Pulley.

[(1)] This letter was put on the ungual phalanx in error; it should refer to the first phalanx.

Fig. 7. First phalanx of the first digit, left pes. Length of external side: 0.058 m. – Of the internal side: 0.048 m. – Width of the pulley: 0.044 m. – Height of the same: 0.037 m. – Width of the posterior end: 0.038 m. – Height of the same: 0.045 m. – *a*. Superior face. – *b*. Inferior. – *c*. External. – *d*. Internal. – *e*. Posterior end. – *f*. Pulley.

Fig. 8. First phalanx of the fifth digit, left pes. Length: 0.073 m. – Width of the pulley: 0.027 m. – Height of the same: 0.025 m. – Width of the posterior end: 0.035 m. – *a*. Superior face. – *b*. Inferior. – *c*. External. – *d*. Internal. – *e*. Posterior end. – *f*. Pulley.

Fig. 9. Second phalanx of the fourth digit, left pes. Length of fragment: 0.105 m. – Width of the pulley: 0.068 m. – Height of the same: 0.044 m. – *a*. Superior face. – *b*. Inferior. – *d*. Internal face. – *f*. Pulley.

Fig. 10. Fragment of the second phalanx, of the fourth digit, right pes. Length of fragment: 0.023 m. – Height of the left side of the pulley: 0.046 m. – *a*. Superior face. – *d*. Internal face. – *f*. Pulley.

Fig. 11. Third phalanx of the fourth digit, right pes. Length: 0.098 m. – Width of the posterior end: 0.067 m. – Height of the same: 0.046 m. – Width of the pulley: 0.055 m. – Height of the same: 0.038 m. – *a*. Superior face. – *b*. Inferior. – *d*. Internal. – *e*. Posterior end. – *f*. Pulley.

Fig. 12. Fragment of the third phalanx of the fourth digit, left pes. Length of fragment: 0.070 m. – Width of the pulley: 0.055 m. – Height of the same: 0.040 m. – *a*. Superior face. – *b*. Inferior. – *c*. External. *f*. Pulley.

{112} Fig. 13. Second phalanx of the third digit, left pes. Length: 0.085 m. – Height of the posterior end: 0.039 m. – Length of the pulley inferiorly: 0.046 m. – Superiorly: 0.025 m. – Height of the same: 0.031 m. – *a*. Superior face. – *b*. Inferior. – *d*. Internal. – *e*. Posterior end. – *f*. Pulley.

Fig. 14. Fragment of the second phalanx of the third digit, right pes. Length of fragment: 0.060 m. – Length of the pulley inferiorly: 0.047 m. – Superiorly: 0.026 m. – Height of the same: 0.033 m. – *a*. Superior face. – *c*. External.

Fig. 15. Second phalanx of the second digit, right pes. Length: 0.075 m. – Height of the posterior end: 0.048 m. – Height of the pulley: 0.035 m. – *a*. Superior face. – *c*. External. – *e*. Posterior end. – *f*. Pulley.

Fig. 16. Third phalanx of the third digit, left pes. Length: 0.060 m. – Width of the posterior end: 0.048 m. – Height of the same: 0.037 m. – Width of the pulley: 0.042 m. – Height of the same: 0.032 m. – *a*. Superior face. – *b*. Inferior. – *c*. External. – *d*. Internal. – *e*. Posterior end. – *f*. Pulley.

Fig. 17. Fourth phalanx of the fourth digit, right pes. Length: 0.070 m. – Width of the posterior end: 0.035 m. – Height of the same: 0.048 m. – Width of the pulley: 0.047 m. – Height of the same: 0.035 m. – *a*. Superior face. – *b*. Inferior. *c*. External. – *d*. Internal. – *e*. Posterior end. – *f*. Pulley.

Fig. 18. Fragment of the external side of the pulley of the 4th phalanx? of the 4th digit.

Fig. 19. Fragment of a pulley from an indeterminable phalanx.

Fig. 20. Fragment of the second phalanx? of the second digit?, left pes. Length of fragment: 0.045 m. – Height of the pulley: 0.035 m. – *c*. External face.

Fig. 21. Fragment of the third phalanx? of the third digit?, right pes (affected DE CARIE). Length of fragment: 0.045 m. – Width of the posterior end: 0.047 m – *a*. Superior face. – *b*. Inferior. – *d*. Internal. – *e*. Posterior end.

Fig. 22. Ungual phalanx of the fourth digit, left pes. Length: 0.125 m. – Height of the posterior end: 0.050 m. – Width of the same: 0.038 m. – *a*. Superior face. – *b*. Inferior. – *c*. External. – *e*. Posterior end.

Fig. 23. Ungual phalanx of the third digit, left pes. Length: 5.100 m. – Height of the posterior end: 0.040 m. – Width of the same: 0.035 m. – *a*. Superior face. – *b*. Inferior. – *c*. External. – *e*. Posterior end.

Fig. 24. Fragment of ungual phalanx of the fourth digit, right pes. Length of fragment: 0.098 m. – *b*. Inferior face. – *d*. Internal.

Fig. 25. Ungual phalanx of the third digit, right pes. Length: 0.100 m. – Height of the posterior end: 0.040 m. – Width of the same: 0.035 m. – *a*. Superior face. – *b*. Inferior. – *c*. External. – *e*. Posterior end.

Fig. 26. Fragment of ungual phalanx of the first digit?, right pes. Length of fragment: 0.064 m. – *a*. Superior face. – *b*. Inferior. – *d*. Internal.

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