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NOTES AND MEMOIRS

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PALEONTOLOGICAL STUDY OF THE VERTEBRATES OF THE JURASSIC OF EL MERS (Middle Atlas)

by

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SUMMARY

INTRODUCTION

El Mers, whose name was once famous for the combat that was delivered to it in 1926, is located 85 km south of Fez as the bird flies, in the western Middle Atlas (fig. 1). It is reached from Boulemane, either by a mule track that rises rather high in Jebel Tichoukt, or by a 50 km auto *piste* that circumvents the buttresses of this mountain to the south.

H. TERMIER indicated the Bathonian age of the red and green series of El Mers in his thesis [1936]. They are marine sediments, very littoral, where red and green clays predominate, topped with sandy or calcareous banks with oysters and other coastal molluscs and vegetation; the thickness of the Bathonian is on the order of 500 m. Some vertebrate remains are found in all the beds of this series, but they are more particularly frequent toward the middle.

In 1927, H. TERMIER had found enormous dinosaur bones south of the El Mers post office, discovered by two Moghaznis, which were brought to the sheriff's scientific Institute in Rabat by J. BOURCART. Moreover, H. TERMIER noted the abundance of vertebrate remains in all the El Mers series; in 1939, he undertook methodical excavations with the help of Mr. H. DUROLLET, who was charged with making a 1/20,000 map of the fossiliferous sector. At this point in time, on his authority I carried out two paleontological missions in El Mers in 1940 and 1941, to methodically explore the Bathonian outcrops and proceed to exploit the most important localities. One hundred and seventy-five fossiliferous points were thus located, of which twenty-one constituted true localities, having furnished pieces deemed of interest. G. CHOUBERT and M. ROYER, who had come to El Mers to look for heavy cases with a van, and the faithful SAID, who accompanied me to all the localities, are entitled to my recognition each for his part. The bones, initially stored at Rabat, were finally conveyed to the Muséum National d'Histoire Naturelle in Paris, where it was easier to study them.

While waiting for a stratigraphic description of the El Mers region, for which H. TERMIER agreed to associate to me with his work, I publish today the paleontological study of the vertebrates of El Mers and some other Jurassic localities, a publication that for many reasons was much delayed.

List of principal vertebrate localities in the Jurassic of El Mers (fig. 2)

The vertebrates recovered in the Jurassic of El Mers belong to the following groups:

Fishes:	a marine holostean.	
Reptiles:	Dinosaurs:	a terrestrial theropod;
		a terrestrial sauropod.
	Crocodilians:	a marine teleosaurian.

Map nos.	Localities	Vertebrates	Bony pieces	Excavations
1	Primitive locality	*Cetiosaurus*	vertebrae, long bones, unguals; single individual	TERMIER, 1927
2	Tissenfelt	*Steneosaurus*	snout	TERMIER, 1939
3	Taghrout	*Cetiosaurus*	single individual (see fig. 5)	LAPPARENT, 1940 and 1941
4	Oued El Mers	*Lepidotes*	single individual	LAPPARENT, 1941
5	Tizi n'Jullierh	*Megalosaurus*	single individual	TERMIER and DUROLLET, 1939; LAPPARENT, 1940
6	Tamguert n'Tarit	*Cetiosaurus*	long bones	LAPPARENT, 1940
7	Aïn ou n'Jourh	*Cetiosaurus*	long bones	LAPPARENT, 1940
8	Tamguert n'Tarit	*Cetiosaurus*	fore-part of a single individual (see fig. 4)	TERMIER and DUROLLET, 1939; LAPPARENT, 1940 and 1941
9 to 12	Tichou Moulay Saïd	remains of fishes and sauropods		
13	Oued Tamemecht	*Steneosaurus*	vertebrae, ribs; single individual	TERMIER and GUBLER, 1939
14	Tirardine	*Steneosaurus*	dermal plates	LAPPARENT, 1941
15	Bou Iferaoun	*Steneosaurus*	two teeth	LAPPARENT, 1941
16	Bou Iferaoun	*Steneosaurus*	skull	LAPPARENT, 1941
17	Tamguert r'Tane	*Cetiosaurus* *Steneosaurus*	left femur various bones	LAPPARENT, 1940 and 1941
18	Botane	*Steneosaurus*	various bones	LAPPARENT, 1941
19	Djmila	*Steneosaurus*	carapace and plastron; single individual	LAPPARENT, 1941
20	Botane	*Megalosaurus*	two teeth	LAPPARENT, 1941
21	Darak	*Steneosaurus*	plate and various bones	LAPPARENT, 1941

CHAPTER I

THE FISHES

Order Holostei

Suborder Semionotidae

LEPIDOTES sp.

Some ganoid scales, with brilliant black or bluish enamel, reveal the presence of the genus *Lepidotes* (= *Lepidotus*), which was living rather abundantly in the Bathonian not far from the coast in the El Mers region.

In Oued El Mers (locality no. 4 north of El Mers) (1), we have found remains of a single fish, unfortunately rather dispersed in a locally pyritic, green marl. Of this large *Lepidotes*, whose size could have reached one meter, we have:

— twenty lateral anterior scales, of quadrangular shape, associated in a characteristic pattern;

— some very numerous rhomboidal scales, covering the rest of the body;

— a certain number of smaller scales, in elongated rhomboid, coming from the back or the tail;

— a fragment of jaw with small teeth of the *Lepidotes* type;

— a very interesting endocranium (natural mold in limestone), which is the object of a description shared with a specialist.

Some scales of *Lepidotes* coming from the Bathonian of Oxford were referred by J. PHILLIPS [1871] to the species *L. tuberculatus* AG. But other species names were created for scales of the same type: *L. unguiculatus* AG., *L. laevis* AG., *L. palliatus* AG. One knows the practical impossibility of defining species in the vast genus *Lepidotes*, which seems to have hardly evolved, and of which we have not, besides, a modern revision. Also we take care not to want to specify the species of the El Mers ganoid on only the pieces recovered.

(1) The numbers of the localities are on the map fig. 2.

CHAPTER II

THE DINOSAURS

Order Saurischia

I — Suborder Theropoda

MEGALOSAURUS MERSENSIS nov. sp.

The presence of theropod carnivores at El Mers was revealed to us initially by three teeth, unfortunately very incomplete. Their flattened form, in the slightly arched blade of a saber, makes them belong to *Megalosaurus*. The enamel is ornamented with fine, regular longitudinal striations, as in *Megalosaurus bucklandi*, but the serrations on the edges are not visible. Their size does not exceed 5 cm in length.

Others of these teeth having been recovered isolated, locality no. 5, situated 2 km NNW of the El Mers post office as the bird flies, N of the Tizi n'Jullierh locality, has provided 23 vertebrae, of which the first lay one following the others. This is therefore a notable part of the vertebral column of a single individual, which gives some idea about this dinosaurian carnivore.

The two first vertebrae represent the atlas and axis, more or less fused together (length 11 cm). Whereas the axis has an elongated vertebral centrum (fig. 3) that is hollowed out ventrally, the atlas is reduced to an incomplete ring, closed toward the top and widened in the inferior part; it is joined ventrally the axis. This arrangement is comparable to that of crocodilians, and was also described in theropods [Gilmore, 1920, fig. 17, p. 33].

With the continuation come 5 cervical vertebrae, whose centra measured 6 to 7 cm long (pl. III, fig. 5); three of them have their processes preserved. Therefore with these 7 vertebrae one would have a nearly complete neck, since the best-known theropods have a total of 9 cervical vertebrae.

The dorsal vertebrae are represented by:

— five anterior dorsals, with straight centra hollowed ventrally; the length of the centrum varies from 7 to 8 cm; one of them preserves its very wide diapophysis (Pl. III, fig. 6);

— three dorsals from the middle of the back (Pl. III, fig. 8).

More posteriorly are found two fused fragments of sacral vertebrae and a centrum attributable to a posterior sacral.

Finally, from the tail of this carnivore we have two anterior caudals (length: 7.5 cm) (Pl. III, fig. 7), two middle caudals (length: 6 cm) and a fragment of a posterior caudal.

Let me add that a dorsal vertebra (length: 10.5 cm), recovered isolated in 1929 in the vicinity of El Mers, shows the same characters, in particular the ventral hollowing, but belongs to an individual of slightly larger size.

The large theropod carnivores of the Jurassic are sufficiently few so that one can compare our specimen to them, however incomplete it is.

Two or three species have been noted in the Lias, which are poorly known besides. In the Upper Jurassic, there are some forms of large size, both in Europe and America, that differ notably from the El Mers animal. In contrast, it seems rather close to the two species of *Megalosaurus* known in the Bathonian; that of England: *Megalosaurus bucklandi* [Owen, 1876], and that of Caen, *Megalosaurus poikilopleuron* [Deslongchamps, 1837]; however, the teeth and vertebrae of these animals are constantly of larger size. We think that the Moroccan animal belongs to a third species of dinosaurian carnivore, 5 to 6 m long, for which we propose the name *Megalosaurus mersensis* nov. sp.

2 — Suborder Sauropoda

CETIOSAURUS MOGREBIENSIS nov. sp.

The study of the bones of sauropods from El Mers will be greatly facilitated by the fact that we ourselves have made msot of the excavations during the course of two successive expeditions (1940 and 1941). A precise plan of the localities could therefore be made for the interpretation of elements; moreover, those bones discovered which fell into dust at the time from removal, and could not all be reconstituted subsequently, were drawn and photographed in place. The attentive plan of 175 points which had furnished vertebrate bones (see the map fig. 2), it arises that a very special interest is attached to three sites, in each of which numerous bones from a single individual were fossilized. These are: the Tamguert n'Tarit locality (no. 8); the Taghrout locality (no. 3); and the primitive locality (no. 1). We will also begin to describe separately each of these three animals, which belongs to the same genus and species, and whose parts are mutually complementary. Following this we will consider several bones recovered isolated at other points.

A. — THE TAMGUERT N'TARIT LOCALITY
(No. 8)

The number 8 on the map designates the most interesting of all the sites, situated at the "Tamguert n'Tarit" locality, 2 km N of the El Mers post office, as a result a short distance from the locality of *Megalosaurus mersensis* and at the same stratigraphic level. Discovered by Mr. G. DUROLLET while making the topographic map, this locality was subsequently exploited methodically by us, initially in April 1940, and then in August and September 1941.

The bones outcropped on a hillside in the green marls with *Protocardia likechkachensis* and small oysters, which were often stuck on the bones themselves. The beds plunge to the north; we sometimes worked with dynamite to widen the excavation as

we advanced along the flank of the mountain. The plan of the site (fig. 4, see also Pl. I) shows how we uncovered the nearly complete fore-part of a single individual of very large size. It is reasonable that the animal was once complete; but the erosion of the hill which affected the bones had removed posterior part of the skeleton; in fact, in the depth of the ravine we still recovered some bones that had been brought down by the undermining of the terrain.

Vertebral column

We have uncovered 23 large vertebra lying one following the other. The two last that we reached among the anterior cervicals had started to decrease in size; they indicate the approach of the head, which we could hope to encounter soon by deepening the excavation of this side. Unfortunately, although having still dug widely beyond the last vertebra, we found no trace of bones. The head must have been separated from the end of the neck at the level of the very fragile first cervical vertebrae before the burial of the carcass.

We have 10 successive cervical vertebrae. The first should correspond to the 6th and 7th, by comparison with the reconstruction of *Diplodocus* by J. B. HATCHER [1901]. The 8th, 9th, 10th and 11th are strongly opisthocoelous, and their very elongated vertebral centra measure 35 cm long by 20 cm in diameter. The following vertebrae, from the 12th to the 15th, were highly damaged.

Following the 15th cervical comes the first of 13 preserved dorsal vertebrae. These and the two following have much more massive vertebral centra than those of the cervicals. The 4th, 5th, 6th, 7th and 8th dorsals are the best preserved; their centra measure 18 cm long for a diameter of 20 to 22 cm. The 9th, 10th and 11th were in very poor condition. In the 12th and 13th, the centrum becomes more robust, and this fact indicates the immediate approach of the sacral region; but there the preserved part of the vertebral column ends.

Ribs

Very numerous fragments of ribs were observed scattered around the vertebrae. We have been able to reconstruct certain portions, whose average width is 8 to 9 cm for the largest, being those from the middle of the thorax; the reinflated distal ends attain a width of 10 cm. These measurements place our animal among the largest sauropods known. Some other, more slender, ribs end in a club and belong to the first and last thoracic ribs.

Pectoral girdle

The right scapula (Pl. IV, fig. 4) is complete and was found in articulation with the corresponding humerus. The left scapula was complete in the locality, lying alongside the left humerus. Their length is only 115 cm and their curvature is rather accentuated. By these two characters, the scapulae of this animal differ from those of

Bothriospondylus and *Diplodocus*, but approach those of *Cetiosaurus oxoniensis* [Owen, 1875, p. 32].

The left coracoid could be entirely reconstructed (Pl. IV, fig. 5); this bone, oval in shape, measures 60 x 45 cm. It recalls enough that of *Cetiosaurus* [Owen, *op. cit*., fig. 8, p. 39].

Forelimb

The nearly complete bones of the two forelimbs lay to the left and right of the vertebral column respectively, which evidently makes their determinations easier than in the ordinary cases of scattered bones.

The right humerus (Pl. II, fig. 2 and Pl. IV, fig. 3) is a beautiful, complete element measuring 137 cm long, or 40 cm more than that of *Diplodocus*. The deltoid process is very salient (10 cm), with the form of a fairly sharp crest. The head of the humerus is strongly widened and measures 45 cm in diameter; the distal end, perhaps a little flattened by crushing, has a diameter of 30 cm.

The right ulna (Pl. V, fig. 1) measures 106 cm long. The furrow of the proximal part is widened and the posterior crest is very pronounced, which gives it a markedly triangular cross-section.

The right radius was lying across the preceding ulna, but lacked its proximal part.

A carpal bone with a rugose superior surface was recovered (Pl. IV, fig. 6); in contrast, the inferior part is smooth and articulates with metacarpals IV and V. This bone would represent $c^4 + c^5$ according to H. F. OSBORN [1904]. Its diameters are 13 x 11 cm, with a maximum thickness of 7.5 cm, which denotes the very large size of the forefoot.

The five right metacarpals were found a little distance from one another; they are assembled perfectly by their proximal parts (Pl. V, fig. 4); their anterior and posterior ends are ornamented with very accentuated rugosities. They are notably more elongate and powerful than the corresponding bones of *Diplodocus*. By the size and shape, they are very close to those of *Bothriospondylus* from Damparis (Jura) [Lapparent, 1943], and a little larger than those of *Bothriospondylus* from Madagascar (Paleontology Gallery, Muséum, Paris). Their lengths are as follows and give the scale of the reconstruction in fig, 10 (p. 25).

mtc V	mtc IV	mtc III	mtc II	mtc I
?	?	37 cm	38 cm	36 cm

Finally, a phalanx from digit II and a phalanx from digit IV complete this forefoot (Pl. IV, fig. 7 and 8).

The left humerus is a little more poorly preserved than its homologue. It is similar for the left ulna (Pl. V, fig. 3), whose proximal furrow appears very deep, perhaps as a result of crushing due to fossilization.

The left radius is complete and measures 100 cm long (Pl. V, fig. 2). Rather slender regarding the shaft, its two ends are reinflated into the shape of a triangular club. It thus differs notably from the radius of *Diplodocus* and also that of *Bothriospondylus*.

The end of the left forefoot is only represented by a proximal portion of an unspecified metacarpal and the distal portion of metacarpal III (Pl. V, fig. 7).

Pelvis

Several bones from the pelvis were found behind the left forelimb; but they were in a rather poor state, having been exposed to the infiltrations of water. Thus some debris which cannot be reconstituted can be attributed to an ilium.

In contrast, the left ischium is recognizable (Pl. I, fig. 2, the top to the right); its club-shaped distal part resembles that of *Bothriospondylus*, but it is more powerful in our animal. Of the right ischium we have only fragments of the proximal part.

The left pubis, which could be partly extracted, was widened in its proximal part, as is that of *Bothriospondylus* [cf. Hatcher, 1903, Pl. IV, fig. 1]; the region delimiting the acetabulum is characteristic of this bone. The distal part lay a little behind; it is very inflated and more powerful than the corresponding bone of *Brontosaurus* and *Bothriospondylus*; it is of the type of *Apatosaurus* [Marsh, 1896, Pl. XXXVI, fig. 2] and conforms to the drawing given by F. VON HUENE in his reconstruction of *Cetiosaurus* [1932, Pl. 55].

Locality No. 8 did not furnish any caudal vertebrae or hind limb bones. This gap will be partly filled by the two sites that we will describe below.

B. — THE TAGHROUT LOCALITY
(No. 3)

This site is situated 3 km W of El Mers, on a shoulder than traverses the Boulemane trail. The bones were hardly inserted in the ground; in contrast, they were partially seized in a calcareous crust, which was damaging to their preservation and made their extraction difficult (fig. 5 and Pl. II, fig. 1).

Vertebral column

The locality first presented 8 vertebrae in series. 7 dorsal vertebrae can be recognized, reduced to the vertebral centra. Then one comes to a large vertebral centrum, probably the last dorsal, immediately preceding the sacrum; moreover, this latter was not recovered.

Pectoral girdle

A 125 cm long scapula was uncovered. The characters are less clear than in the specimen from locality 8.

Forelimb

A nearly complete right humerus (Pl. IV, fig. 2) offers the same dimensions and characters as that from locality 8. It presents over that specimen the advantage of not having been deformed. Alongside was found the right ulna, more deeply inserted into the

rock and which could only be incompletely extracted. The uncompressed shaft permits recognizing the same cross-section (fig. 6) as in *Cetiosaurus* [Owen, *op. cit*., fig. 5, p. 34]; the two larger diameters measure 11 x 9.5 cm. Still further two ends of the right radius were found in poor condition.

Pelvis

The right ischium measures 90 cm long; the shaft has a characteristic cross-section; the distal end is inflated into the shape of a club. It rested on a large flat bone that must represent an ilium, but which could not be reconstructed.

Hind limb

The complete right femur is an enormous bone, 160 cm long and currently weighing 114 kg as a result of fossilization. It is not deformed and its diameters are 46 cm for the distal end, 32 cm for the middle of the shaft, and 47 cm for the head (Pl. IV, fig. 1).

The Taghrout individual was thus a little larger than that from Tamguert n'Tarit.

On the north flank of the Tamguert n'Tane butte (no. 17 on the map), 3.5 km north of El Mers, we found a left femur having exactly the same dimensions. It is broken at its proximal end, but the condyles of the distal end are better preserved (fig. 7) than on the Taghrout specimen. It is the same species of sauropod but not the same individual; the two localities are situated one in the lower series, the other in the upper series of the Bathonian.

The femora of diverse families of sauropods are not very sufficiently characteristic; in contrast,these finds have the interest of permitting a comparison between the respective lengths of the fore- and hind limb, which is a very important point.

C. — THE PRIMITIVE LOCALITY
(No. 1)

We thus designate the very first fossiliferous point that drew the attention of H. TERMIER in 1927. An accumulation of enormous bones was seen 3 km SW of El Mers, near the Tich Niouine hill (no. 1 on the map). This geologist had them collected by the Moghaznis, and J. BOURCART brought them to Rabat. We made some new collections ourselves at the locality. But in studying these pieces, it was apparent that here was still a single individual; in spite of the very unpolished state of the bones, pasted within the "calcareous crust", we found there material that happily completed the information from the previously described sites.

Vertebral column

The primitive locality furnished a total of 35 vertebrae that made a length of fifty-five meters set end to end; but there were significant gaps and the length of the animal was evidently much more considerable.

Initially there are 3 opisthocoelous anterior cervical vertebrae; their relatively small size compared to their length attributes them to the anterior part of the neck. Two of them are continuous, and both measure 20 cm long; they represent perhaps the 6th and 7th (Pl. III, fig. 4).

After a gap that can be supplemented by the information from locality no. 8, we then come to 8 dorsal vertebrae. An anterior dorsal is recognizable by its strongly convex anterior. It is broken in two and the very thin median partition (4 mm) can thus be observed separating the two vast cavities that excavate the centrum (fig. 8); this character is given as typical of *Bothriospondylus* but it seems to exist also in *Cetiosaurus*. Six dorsals from the middle of the back are less convex in front, but their vertebral centrum is still rather elongate (17 to 20 cm) (Pl. III, fig. 1-3). It is hollowed into two vast, symmetrical lateral cavities (15 cm long and 5 cm deep) that seem to be situated higher on the centrum than in *Bothriospondylus*. The appearance of these dorsal vertebrae matches that of *Cetiosaurus oxoniensis* figured by Owen [1875, Pl. X]. A posterior dorsal is shorter (15 cm). A neural arch of a dorsal vertebra comes from this locality. The undeformed neural canal measures 42 x 42 mm, or a spinal cord diameter comparable to that of *Bothriospondylus* from Damparis [Lapparent, 1943, p. 17].

The sacrum is unknown. But 18 platycoelous anterior caudal vertebrae are present; the first are very large (Pl. V, fig. 6): diameter of the vertebral disc: 26 to 30 cm. From the long sauropod tail there are only: 5 middle caudals (centrum length; 12 to 13 cm), massive in aspect and similar to the vertebra of *Cetiosaurus* figured by J. PHILLIPS [1871, p. 265]; a posterior caudal (length 9.5 cm), equally taller and less gracile than the corresponding vertebrae of *Diplodocus* and *Titanosaurus*.

Limbs and girdles

Moreover, the primitive locality has furnished a series of enormous bones, none of which are doubled, and therefore which belong to a single individual, the one from which we have described the vertebrae. We were thus able to recognize, in more or less complete fragments, although the median part of the long bones were generally destroyed:

— the two humeri, two ulnae, left radius, proximal part of right metacarpal IV: all these bones are very similar, in shape and size, to those from locality 8; let us add the unguals from the left second and third digits (fig. 9) recovered by H. TERMIER in this locality; these objects, recognizable by their particular shape, although a little incomplete, would have had the size of the unguals of *Diplodocus*; but, whereas these latter were flattened by fossilization, ours preserved their thickness and conical shape;

— portions of the right ilium and pubis;

— the femora, two tibia, two fibulae; note the enormous articular surface of the tibia which supported the corresponding femoral condyles.

D. — OTHER LOCALITIES

Among the numerous bones scattered in the El Mers region, many were only fragments. However, the following pieces were recognized as belonging to the sauropod from which we described three individuals.

Vertebral column

Three anteriorly convex anterior dorsal vertebrae; two small posterior caudals (5 cm), whose elongation is notably less than in *Diplodocus*; a powerful chevron (haemal arch) from an anterior caudal vertebra, remarkable for the rectilinear shape of the centrum, its strength and its size (more than 30 cm), all characters that approach those of *Cetiosaurus oxoniensis*; the widened proximal part of the right 5^{th} or 6^{th} thoracic rib (Pl. V, fig. 9); a distal end of the left 2^{nd} or 3^{rd} thoracic rib.

Pectoral girdle

Some important fragments of the central part of a scapula; the distal ends of two scapulae.

Forelimb

The distal ends of a humerus and ulna; the proximal end of another ulna; the ends of some metacarpals (Pl. V, fig. 10): left II, III and V, right III and IV.

Pelvis

A fragment of ilium.

Hind limb

Proximal ends of two tibiae, the two ends of a left fibula; the distal end of a right fibula.

The purpose of this enumeration is to show the abundance of individuals of the same reptile species, which lived on the emergent terrains bordering the El Mers gulf to the exclusion of all other sauropods.

SIMILARITIES AND DIFFERENCES

In spite of the homogeneity of the group, sauropods are commonly classified into six families. None being known with certainty in the Lias, there are:

— in the *Middle Jurassic*, primitive sauropods, the Cetiosauridae and Brachiosauridae, not known except in America;

— in the *Upper Jurassic*, moreover, more specialized forms prospered: Diplodocidae, Atlantosauridae, Camarasauridae, especially abundant in America;

— in the *Cretaceous*, finally, the ubiquitous family Titanosauridae spread out.

To which of these families does the El Mers animal belong?

From the first, it is necessary to draw aside the Titanosauridae, Diplodocidae and Atlantosauridae as very different. There is a little more relationship with the Camarasauridae. But our animal obviously approaches the Cetiosauridae and Brachiosauridae, whose representatives from the Dogger, *Cetiosaurus* and *Bothriospondylus*, are likewise very close to one another.

In numerous traits, the El Mers animal seems very close to *Cetiosaurus oxoniensis* PHIL., a gigantic sauropod from the Bathonian of the environs of Oxford, and whose bones are preserved in the Museum of the University of this town. The principal characters which make us classify it in the genus *Cetiosaurus* are the following:

— elevated position of the lateral cavities of the dorsal vertebrae; same powerful form of the anterior caudal chevrons; massive aspect of the middle caudals; reduced size and curvature of the scapula; identical nature of the humerus; same type of cross-section of the ulna; the radius is different from that of *Bothriospondylus*; ischium very elongated and inflated into a club; massive pubis, very strongly inflated in its proximal part; identical nature of the femur.

The length ratios between the fore- and hind limbs are some of the elements that distinguish the various groups of sauropods. The forelimb reconstruction of the Moroccan sauropod shows that this limb was a little more than 3 meters long:

humerus	137 cm
ulna	106 cm
carpal bone	7 cm
metacarpal	37 cm
phalanx III	5(?) cm
ungual III	10 cm
	302 cm

Without doubt, it lacks the elements needed for exact comparison with the hind limb, the tibiae and fibulae being broken in their median part and the metatarsals not having been found. However, if the humerus and femur of the same animal are compared (in cm):

	humerus	femur	difference
El Mers sauropod…….	137	160	23
Cetiosaurus oxoniensis…….	130	160	30
Bothriospondylus from Damparis….	133	146	13

Note that the bones of the hind limb were proportionally shorter than in *Bothriospondylus*. In contrast, a ratio of the same order, but still more accentuated, exists in *Cetiosaurus oxoniensis*. But it is exactly the same species? It is interesting to consider the following table (dimensions in cm):

	humerus	ulna	femur	tibia	scapula	ischium
El Mers sauropod……..	137	106	160	95	115 to 120	90
Cetiosaurus oxoniensis…..	130	95	160	95	120	90
Bothriospondylus madagascariensis……	133	90	146	87	137	73

It is clearly seen that the Moroccan sauropod more closely approaches *Cetiosaurus* than *Bothriospondylus*. However, some real differences with the Oxford type invite the thought that it is a slightly different animal, let us say another species. We give it the name *Cetiosaurus mogrebiensis* nov. sp., without wanting to attach too absolute a value to the term *species* when applied to sauropods.

The attempt at reconstruction that can be made based on the elements from Morocco (fig. 10) shows an animal with a shorter tail than *Diplodocus*; but it was even larger and higher on its legs. The reconstruction differs a little from that attempted by F. VON HUENE [1932, pl. 25), using only the bones from Oxford: note, in particular, the less elevated attitude of the anterior part and the more gracile nature of the neck.

CONCLUSION

Putting aside some isolated vertebrae of doubtful attribution, the essentially Jurassic genus *Cetiosaurus* is now known from four species, of which one sufficient description has been published. Three are European: *C oxoniensis* PHILLIPS from the Bathonian of Oxford [Owen, 1875, p. 27], *C. leedsi* HULKE from the Oxfordian of Peterborough [Woodward, 1905], and *C. greppini* HUENE from the Malm of the Bernois Jura (Switzerland) [Huene, 1922]; one is African, *C. mogrebiensis* LAPPARENT from the Bathonian of El Mers (Morocco).

African sauropods are still rather rare:

— in the Middle Jurassic, *Cetiosaurus mogrebiensis* from Morocco was thus contemporaneous with *Bothriospondylus madagascariensis* from Madagascar;

— in the Upper Jurassic, the Tendaguru beds (East African) have furnished magnificent skeletons of more specialized forms, shown in the Berlin Museum: *Dicraeosaurus*, *Tornieria* and the enormous *Brachiosaurus* with disproportionate forelimbs;

— finally, in the Cretaceous the titanosaurids extend to the Cape and Madagascar.

Thus it is seen that the discovery of the El Mers sauropod brings an important contribution to our understanding of the terrestrial vertebrates of the African continent.

CHAPTER III

THE CROCODILIANS

Family Teleosauridae

THE *STENEOSAURUS* FROM EL MERS

Around El Mers, the remains of marine crocodilians belonging to the family Teleosauridae are frequently encountered. We possess the following pieces:

Head

We have recovered at Bou Iferaoun (locality no. 16, SE of El Mers) a portion of skull that permits recognizing: the frontal; the departure of the two nasals; the anterior frontals; the parietals. The partially preserved endocranial mold is the object of a shared study. All the bones are rather wide and indicate the subgenus *Steneosaurus*, the most widespread type of teleosaurian.

Moreover, H. TERMIER found the medial part of a snout on the slope of Tissenfelt (no. 2, north of El Mers). The piece is 20 cm long; the cross-section is rectangular, a character of *Steneosaurus*, and measures 39 x 43 mm anteriorly, 53 x 56 mm posteriorly. This fragment indicates a long-snouted form [cf. THÉVENIN, 1903], comparable to *Steneosaurus megistorhynchus* GEOFF. from the Bathonian of Caen. A dozen teeth are visible preserved there. These are long, pointed, and posteriorly recurved; the enamel is ornamented with rather well-spaced striations.

Two other teeth, offering the same characters, were recovered isolated at Bou Heraoun (no. 15).

Vertebrae

In 1939, J. GUBLER had carefully collected the remains of a single individual, but lacking its head, in the green marls on the left bank of the Oued Tamemecht (no. 13, E of El Mers). In spite of the fragility of these bones, there were preserved: five dorsal vertebrae; three anterior caudal vertebrae; twenty posterior caudals; some slender ribs. Amphicoelous vertebrae such as these characterize the teleosaurian family, whereas true crocodiles have procoelous vertebrae.

Moreover, several dozen vertebrae have been recovered, dispersed in several localities and presenting analogous characters. In this lot, we note a very small posterior caudal coming from the end of a tail; 3 cm long, it has all the characters of these same vertebrae in teleosaurians.

Long bones

Locality no. 13, cited previously, has furnished the head of a humerus and the head of a femur. We also have the head of a right femur from Tamguert r'Tane (no. 17). These bones clearly have the characters of crocodilians, but they do not indicate one genus rather than another among them.

Dermal plates

Teleosaurians have the body covered in dermal plates, grouped to form a dorsal shield and a ventral plastron. These plates, hollowed with fossae, are frequently preserved, and we have recovered a hundred of them (Pl. III, fig. 9). But they were most often dissociated at the death of the animal and lay scattered. The largest measure 5 to 10 cm and belong to the dorsal shield. They are very similar to those of the genus *Steneosaurus*.

The Djmila locality (no. 19, NW of El Mers), already presented, includes some important fragments of the shield of a single individual, preserved in their original position in a bluish, extremely hard marine limestone. Fig. 11 indicates the appearance of this specimen and its proportions (70 cm long).

At Darak (no. 21, SW of El Mers) on the one hand, and at Tirardine (no. 14, E of El Mers) on the other, we have found several dermal plates connected to various bony fragments of an animal of the same type.

SIMILARITIES AND DIFFERENCES

The remains that have been described from the Bathonian of El Mers reveal that a marine crocodilian of the teleosaurian family, surely belonging to the genus *Steneosaurus*, was represented by numerous individuals which swam in the sea not far from the coast. Their average size could have been around 1.5 m. But their fragile remains were dispersed at the time of fossilization. As a result, we do not have sufficiently complete and characteristic material to affirm that this fossil represents a new species, in spite of the rather particular form of the teeth: in effect, the determination of teleosaurian species is practically impossible as long as there is not an entirely complete skull. In the Bathonian of Oxford, J. PHILLIPS [1871] noted the presence of two species: *Steneosaurus brevidens* and *S. subulidens*, certainly very close to that of El Mers. However, imitating the wise reserve of a former author, M. LARRAZET [1889], who had studied analogous material under the direction of A. GAUDRY, we will speak only of the "*Steneosaurus* from El Mers".

CHAPTER IV

OTHER JURASSIC LOCALITIES OF MOROCCO

Although the richest, El Mers is not the only region to furnish remains of Jurassic dinosaurs in Morocco. In effect, the patient collection of various indices led H. TERMIER [1942] to discover a second region with great reptiles, where the bones of dinosaurs were found in red beds referred to the Dogger. The localities are located in the first links to the southern Middle Atlas, sixty kilometers south of Kasba Tadia.

THE ISSEKSI LOCALITY

We note first a locality that is probably the same age as that of El Mers, but constituted of entirely continental beds. We have indicated [Bourcart, Lapparent and Termier, 1942] how the red beds are presented in the Sgat-Taguelft basin, 10 km NE of Ouaouizert; they have furnished some sauropod bones near Isseksi. The fragments indicate an animal of very large size, but cannot usually lend to a more precise determination. Some vertebral discs 15 to 20 cm in diameter, a posterior caudal vertebra (9 cm), some rib fragments, long bones and flat bones, and debris of the skull bones are recognized there. However, portions of identifiable metacarpals are found in the recovered lot: they are similar in size and shape to those of the El Mers animal. They are: left metacarpal II (proximal part) (Pl. V, fig. 8); left metacarpal IV (proximal part); right metacarpal II (distal part).

It can therefore be thought that at Isseksi the remains of *Cetiosaurus mogrebiensis* which in Bathonian times populated this region like that of El Mers, were buried by floods in a continental basin in the process of subsiding. The arrival of the bones must have begun at the edge of a sea, because we have found a 25 cm fragment of bone in the Bathonian marine limestone with *Zeilleria digona*, a fish tooth and a teleosaurian tooth; then bone became abundant in the red pelites and conglomerates of purely continental origin that surmount the marine limestone. This was repeated sporadically in successive red beds, and we still found bony remains in a conglomerate at the top of the red series, just below the terminal basaltic plateau.

However, we note that following the detailed study of the Isseksi region, Mr. Abbey G. DUBAR thinks that the red pelites and basalts are instead of Cretaceous age [1952, p. 24]. It would result from this that the sauropod bones that we believe could belong to *Cetiosaurus mogrebiensis* would have been altered in the subjacent Bathonian beds.

THE AZILAL REGION

3 km SW and 1 km east of Azilal, a series of sandstones and red pelites furnished several portions of large long bones and ribs that indicate a large sauropod [Termier, 1942].

On the other hand, some fragments of bluish bones were noted by H. TERMIER in a conglomerate bound with analogous red pelites, 200 m SW of the old indigenous Affairs Bureau of Bin el Ouidane.

But up to now, significant remains have not been found in this region, much less any that merit attentive prospecting.

CONCLUSION

The stratigraphic and paleontological observations made at El Mers permit thinking that the western Middle Atlas region, during Bathonian times, was covered by a shallow sea, whose bottom was in the process of subsiding; on the coast emerged great rivers, bringing abundant turbulence.

Some ganoid fishes and numerous marine crocodilians frequented the waters not far from the shores. Simultaneously, gigantic sauropods, sometimes pursued by agile carnivores of the genus *Megalosaurus*, lived in the marshes of a low, flat terrain. From time to time, the rivers brought to the sea the nearly complete carcass of one of these terrestrial animals, in the silty sediments of the delta.

From these same beds, henceforth uncovered, hardened and carried to 1,600 m altitude by the Atlas foldings, we have had the pain and joy of exhuming the fossil remains that we come to describe.

230 km from there, thanks to several bones found at Isseksi and Azilai, we suspect that some similar animals lived at the same time in the confines of the southern Middle Atlas and High Atlas.

Thus in Morocco we partially discover a page from the history of life, 150 million years old.

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EXPLANATION OF PLATE I

El Mers: Tamguert n'Tarit locality (no. 8)
Bones of a single individual of *Cetiosaurus mogrebiensis*

FIG. 1 and 2: various stages of advancement of the excavations. Compare with the plan of the site in fig. 4, p. 15.

EXPLANATION OF PLATE II

El Mers

FIG. 1 — Excavation of the Taghrout locality (no. 3); at the bottom, alternation of marls and limestones of the Bathonian beds.

FIG. 2 — Tamguert n'Tarit locality (no. 8). Right humerus of *Cetiosaurus mogrebiensis*

EXPLANATION OF PLATE III

Cetiosaurus mogrebiensis nov. sp.

FIG. 1-3. — Individual from the primitive locality (no. 1): three dorsal vertebrae from the middle of the back. x 1/6.

FIG. 4. — Individual from the primitive locality (no. 1): anterior cervical vertebrae (6^{th} and 7^{th}?). x 1/6.

Megalosaurus mersensis nov. sp.

FIG. 5. — Atlas and axis (from the right), followed by 5 cervical vertebrae. x 1/4.

FIG. 6. — Anterior dorsal vertebra having preserved its left diapophysis. x 1/4.

FIG. 7. — Anterior caudal vertebra. x 1/4.

FIG. 8. — Dorsal vertebrae from the middle of the back. x 1/4.

Steneosaurus from El Mers

FIG. 9. — Dermal plates, hollowed by fossae on the external face. x 1/3.

EXPLANATION OF PLATE IV

Cetiosaurus mogrebiensis nov. sp.

FIG. 1. — Individual from Taghrout (locality no. 3): right femur, posterior face. x 1/10.

FIG. 2. — — id. — : right humerus. x 1/10.

FIG. 3. — Individual from Tamguert n'Tarit (locality no. 8): right humerus. x 1/10.

FIG. 4. — — id. — : right scapula. x 1/10.

FIG. 5. — — id. — : left coracoid. x 1/10.

FIG. 6. — — id. — : carpal bone, right forelimb. x 1/10.

FIG. 7. — — id. — : phalanx from digit II. x 1/10.

FIG. 8. — — id. — : half-phalanx from digit IV of the same foot. x 1/6.

EXPLANATION OF PLATE V

Cetiosaurus mogrebiensis nov. sp.

FIG. 1. — Individual from Tamguert n'Tarit: right ulna. x 1/10.

FIG. 2. — — id. — : left radius. x 1/10.

FIG. 3. — — id. — : left ulna. x 1/10.

FIG. 4. — — id. — : the five right metacarpals. x 1/6.

FIG. 5. — — id. — : 7th dorsal vertebra. x 1/10.

FIG. 6. — Individual from the primitive locality: anterior caudal vertebra. x 1/6.

FIG. 7. — Individual from Tamguert n'Tarit: left metacarpal III, distal part. x 1/6.

FIG. 8. — Isseksi locality: left metacarpal II, proximal part. x 1/6.

FIG. 9. — Diverse localities from the environs of El Mers: proximal part of a right thoracic rib. x 1/6.

FIG. 10. — — id. — : left metacarpal. x 1/6.

FIGURE CAPTIONS

FIG. 1. — Map of Morocco, showing the Jurassic dinosaur localities.

FIG. 2. — Map of the environs of El Mers, indicating the placement of the principal vertebrate localities (according to the topographic works of Mr. H. DUROLLET).

FIG. 3. — *Megalosaurus mersensis*: fused atlas and axis (locality no. 5). (x 1/2).

FIG. 4. — Plan of the Tamguert n'Tarit locality (no. 8) indicating the position of the bones: c^6 to c^{15} cervical vertebrae; d^1 to d^{13} dorsal vertebrae; *t* ribs; *Sc* scapula; *Cor* coracoid; *Hu* humerus; *Cu* ulna; *Ca* carpal bone; *Mtc* metacarpals; *Il* ilium; *Is* ischium; *Fe* femur; *X* indeterminate flat bone (sternum?). The bones of the left side are marked with an apostrophe. The arrow indicates the front of the animal.

FIG. 5. — Plan of the Taghrout site (no. 3): d^6 to d^{13} dorsal vertebrae; *Sc* scapula; *Hu* humerus; *Cu* ulna; *Fe* femur; *Il* ilium; *Is* ischium.

FIG. 6. — *Cetiosaurus mogrebiensis*: cross-section of the right ulna (locality no. 3). (x 1/2).

FIG. 7. — *Cetiosaurus mogrebiensis*: left femur, distal part, posterior face (locality no. 17). (x 1/9).

FIG. 8. — *Cetiosaurus mogrebiensis*: anterior dorsal vertebra; front portion of the centrum, viewed from above and shoring the thin median partition (c). (x 1/2).

FIG. 9. — *Cetiosaurus mogrebiensis*: two unguals from the left forelimb (locality no. 1). (x 1/2).

FIG. 10. — Attempt at reconstruction of *Cetiosaurus mogrebiensis* (inspired by F. VON HUENE, with some corrections). (x 1/60 natural size).

FIG. 11. — *Steneosaurus* from El Mers, individual from Djmila (locality no. 19). x 1/5.