

A massively-constructed iguanodont from Gadoufaoua, Lower Cretaceous of Niger

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Abstract — A ponderously constructed ornithischian dinosaur, *Lurdusaurus arenatus*, nov.g., nov.sp., from the Aptian of Niger resembles extinct giant ground sloths in general body form. Details of its skeletal anatomy indicate a close affinity to European iguanodontids of Early Cretaceous age. © Elsevier, Paris.

dinosaur / iguanodontid / anatomy / Aptian / Niger

Résumé — Un iguanodontidé massif de Gadoufaoua, Crétacé inférieur du Niger. Un dinosaure ornithischien de construction massive, *Lurdusaurus arenatus*, nov.g., nov.sp. de l'Aptien du Niger ressemble aux paresseux géants fossiles par la forme générale de son corps. Les détails de l'anatomie du squelette indiquent une affinité étroite avec les iguanodontidés du début du Crétacé. © Elsevier, Paris.

dinosaure / iguanodontidé / anatomie / Aptien / Niger

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INTRODUCTION

Iguanodont skeletons, frequently capping small hillocks abraded into sands of Aptian age by desert winds, are scattered over an area of 300 square kilometers south of the Air Massif in northern Niger. The Gadoufaoua site is exceptional, not only for its abundance and quality of preservation of dinosaur skeletons, but because in no other equatorial site in the world have ornithopod dinosaurs been preserved in greater number and variety [9, 10]. The spectacularly long-spined iguanodont *Ouranosaurus nigeriensis* is a dominant element in the assemblage. Also in 1965, a scattered skeleton of a short-spined and very massively proportioned iguanodont was discovered near the type locality of this species. The presence of this ponderous form (“Iguanodontidé trapu”) at Gadoufaoua was originally noted by Taquet [11], who later recognized it as an undescribed genus which he briefly diagnosed [9]: “Le membre antérieur est extrêmement robuste avec un radius et un cubitus très courts mais extrêmement épais, la barre pubienne est courte ; les vertèbres sont énormes munies d’épines neurales particulièrement courtes, le carpe est très massif ; les métacarpiens très courts et très larges (de type graviporteur), le membre postérieur est court et massif.”

Chabli [3] described the new form in a doctoral dissertation, which remains unpublished. The purpose of the present communication is to present a brief characterization of the “Iguanodontidé trapu,” and to provide a name for this unusual dinosaur.

Family IGUANODONTIDAE Marsh 1895

Lurdusaurus, nov. gen.

Etymology: *Lurdus*: (Latin) heavy, both in weight and significance.

Sauros: (Greek) lizard.

Type species: *Lurdusaurus arenatus*, new species.

Diagnosis: The same as that of the type species.

Lurdusaurus arenatus, nov. sp.

Etymology: *Lurdusaurus arenatus*, from the Latin: *arenatus*: sandy.

Type locality: “Camp des deux arbres,” 7 km southeast of Elrhaz, 16°42' latitude 9°20' longitude. Gisement de Gadoufaoua, level GAD 5 (upper part of the Elrhaz Formation), Tégama Series, Aptian. 100 m north of the type locality of *Ouranosaurus nigeriensis* [9].

Type specimen: MNHN GDF 1700, a nearly complete skeleton.

Referred specimens: MNHN GDF 43G, dentary fragment; GDF 381, right coracoid.

Diagnosis: An iguanodontid (as indicated by co-ossified carpalia and an unguis on the hallux) of unusually massive proportions, and exhibiting the following diagnostic specializations: endocranial axis and long axis of occipital condyle approximately parallel to long axis of skull, quadrate short (about twice average length of dorsal centra), cervical centra approximately as long as dorsal centra, well-developed hypapophyses on anteroventral margin of posterior cervical centra, height of posterior dorsal centra approximately 40 % of total vertebral height, axial tendons evidently unossified, length of radius approximately 54 % of that of humerus, length of metacarpals approximately 17 % that of humerus, length of hallux unguis more than half that of radius, length of tibia 84 % that of femur.

DESCRIPTION

The skeleton is evidently that of a mature animal, although a few cervical neural arches were separated from their centra, and the suture between the scapula and coracoid was open. The left prepubis bears two transversely-oriented tooth punctures, and was partly rehealed with the distal, broken segment offset laterally (*plate III, figure 1*). With the exception of portions of the midsection of the cranium, the sacrum and much of the pes, nearly every element of the skeleton is represented. However, only those attributes which characterize the taxon or reveal its general form are cited in this preliminary note. The specimen clearly merits a monographic study.

The relatively massive structure of all ossifications and the proportions of various skeletal structures underscore the distinctiveness of the animal. *Ouranosaurus nigeriensis* [9] differs greatly from *Lurdusaurus arenatus* in the relatively short temporal region of the skull, the "T"-shaped (instead of triangular) ventral surface of the parasphenoid (*figure 1* and *plate II, figures 1a* and *b*), the greatly elongated dorsal spines, the vertically expanded prepubic blade and the relatively short and straight-shafted ischium. Descriptions, illustrations and measurements of the European iguanodonts, *Iguanodon bernissartensis* and *I. atherfieldensis*, from the monographic reviews of Norman [4, 5] serve to emphasize the peculiarities of the Saharan form. Units representing the width of the occipital condyle and an average of the lengths of available dorsal centra are used below to assess differences in bodily proportions between the Saharan species and the two European species cited.

Incomplete and abraded fragments of the anterior ends of the premaxilla and pre-dentary (*plate I, figures 2* and *3*) suggest that the snout was approximately 20 cm wide. The posterior end of the skull was about 30 cm wide, so that (as in other iguan-

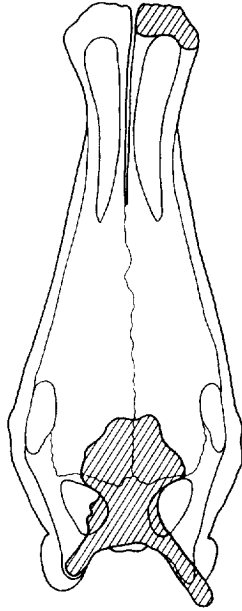


Figure 1. *Lurdusaurus arenatus* skull reconstruction in dorsal view showing the preserved portions of the skull roof and of the premaxillar.

Figure 1. *Lurdusaurus arenatus* reconstitution du crâne en vue dorsale montrant les portions conservées du toit crânien et du prémaxillaire.

odonts) the beak was probably not expanded into a duck-like bill. Unfortunately, no tooth-bearing elements were preserved. A rather massively constructed fragment of a dentary from another individual (field number 43G) contains ten alveolar rows in a space of 195 mm. A few measurements of the posterior part of the cranium in *L. arenatus* have been compared to those in the European forms (table I). The extremely low stature of the quadrate in the Saharan species is evident (plate I, figures 4a and b). In other proportions it resembles *I. bernissartensis* more closely than *I. atherfieldensis*. Applying the ratio between the total length of the skull to the length of the temporal region [4] (figure 5) to the cranium from Gadoufaoua yields an estimated cranial length of 833 mm.

Table I. Cranial measurements of iguanodonts, expressed as the ratio between the measurement and the width of the occipital condyle: (in mm).

Tableau I. Mesures crâniennes d'Iguanodontidés, exprimées selon le rapport de la mesure à celle de la largeur du condyle occipital (en mm).

	<i>Lurdusaurus arenatus</i>	<i>Iguanodon atherfieldensis</i>	<i>Iguanodon bernissartensis</i>
Height of quadrate	282	489	376
Width, paroccipital processes	385	403	292
Length of braincase	250	297	238
Length, anterior laterosphenoid to parocc. proc.	288	283	212

The anteriormost vertebra in which the parapophysis is situated above the suture between the centrum and neural arch defines the first dorsal vertebra [4, 5]. The position of the parapophysis is unclear in two cervico-dorsal vertebrae in the Saharan specimen (*plate II, figure 2*), but in neither case does it lie at the same level as the neural canal, as it does on the first dorsal of *I. bernissartensis* [4] and on the second dorsal of *I. atherfieldensis* [5]. Within the Saharan specimen are an axis centrum and 11 additional postaxial centra, implying a total number of 12 to 14 cervicals (11 are present in *I. atherfieldensis* and *I. bernissartensis*). The lengths of the cervical centra are, on average, about equal to those of the dorsal centra, while in the European species the average length of the cervical centra varies between 85–90 % of those of the dorsal centra. Incorporating all 14 segments, the neck in the Saharan form may have measured about 1 600 mm in length.

There are 28 presacral vertebrae in the two European species of *Iguanodon*; thus 14 unambiguous dorsal vertebrae may have been present in the Saharan form with a combined length of 1 600 mm. The transverse processes are not as steeply inclined dorsolaterally as in the European species. The centra are relatively larger and the neural spines relatively shorter (*plate III, figure 3*). Indistinct scars for sacral ribs on the medial surface of the ilium suggest a sacrum 600 mm long. At least 10 basal caudals bear transverse processes or rudimentary nubbins. The chevrons are not bridged dorsally, as they are in *I. bernissartensis* and *O. nigeriensis*. In length, basal caudal centra average only 80 % of dorsal centra, although they are about as long as the dorsal centra in the two European species. Assuming, as in the latter two species, 15 proximal caudals bore transverse processes in some form, the basal portion of the tail would have measured about 1 400 mm. This segment comprises a third of the

Table II. Selected measurements MNHN GDF 1700, *L. arenatus*: (in mm).

Tableau II. Sélection de mesures MNHN GDF 1700, *L. arenatus* : (en mm).

Width of occipital condyle	78
Average length of postaxial cervical vertebrae	113
Average length of dorsal vertebrae	108
Average length of basal caudal vertebrae	91
Length of scapula (as preserved)	834
Length of coracoid	310
Length of sternal	340
Length of humerus	638
Length of radius	352
Length of ulna	442
Length of metacarpal III	120
Length of ilium (as preserved)	980
Length of pubis	890
Length of ischium	1 012
Length of femur	910
Length of tibia	777
Length of fibula	683
Length of metatarsal III	109

total length of the tail in the European species; thus the tail may have exceeded 4 m in length, bringing the Saharan animal to a total length of nearly 9 m. The circumferences of the humerus (295 mm) and femur (457 mm) indicate a body weight of at least 5.5 tonnes, which is unusually heavy for an ornithopod of this length [1].

Both fore - (humerus + radius) and hindlimbs (femur + tibia) are shorter (by 60–70 %) relative to the average length of the dorsal centra than in *I. bernissartensis*. The forelimb is powerfully constructed, with the lateral terminus of the deltopectoral crest displaced distally to a midshaft position. The robust antebrachium is reduced to half the length of the humerus and provided with an enlarged olecranon process. The entire forelimb, terminating in a manus with a heavy carpal block and enlarged thumb claw, is reminiscent of a mace-and-chain (*plate III, figure 4*). It was clearly better suited to defense than to rapid quadrupedal progression. The average length of the metacarpals was less than that of the dorsal vertebrae, whereas in the European species the metacarpals were relatively twice as long.

The pelvis is more powerfully constructed than in *I. bernissartensis*, as well as being smaller relative to the average length of the dorsal vertebrae. Unlike in the European species of *Iguanodon*, the postpubic process is heavy (*plate III, figure 2*) but hardly extends behind the obturator process of the ischium. Although the latter process is very well developed and the distal end of the ischium is footed, the strongly recurved ischiadic shaft lends the element a ceratopsoid appearance. The femur is both massive and short, resembling that of ceratopsians in its slight medial recurvature, and that of sauropods in its anteroposterior flattening. As in *I. bernissartensis* (and unlike in *I. atherfieldensis* and *O. nigeriensis*) the heavily-developed fourth trochanter is located within the distal half of the femur. The tibia is unusually short relative to the length of the femur. Several small, heavily-proportioned metatarsal-like elements, if properly identified, suggest that the metatarsus was reduced to the extent that the metatarsals had lost contact with each other, and that a fleshy pad must have supported most of the weight borne by the foot.

The animal stood about 2 m high at the hips. The blade of the ilium was erect but broad enough to effectively cover the head of the femur; the greater trochanter was in close proximity to the antitrochanter above. Heavy, diverging anterior alae of the ilia, and horizontally-oriented posterior thoracic ribs suggest a flat back more than a metre across. Articulated anterior thoracic ribs confirm that the anterior part of the rib cage was at least as wide. Here, the distal ends of the rib pairs indicate that the ventral surface of the body lay at least 890 mm below the apex of the neural spines. The femur and tibia, articulated, imply that at its most elevated position (above the pelvis), the ventral surfaces of the centra were about 1.6 m off the ground. Farther anteriorly, the ventral surface of the body in quadrupedal pose was less than 70 cm above the ground.

In its squat posture the animal must have somewhat resembled ankylosaurs [2]. However, its relatively small skull, circular chest, powerful and heavily clawed fore-

limbs, transversely flattened femoral shaft and generally massive skeletal elements probably even more strikingly recalled the form of giant ground sloths.

CONCLUSION

In recent years, the phylogeny of the Ornithischia has been reviewed [8] and the Iguanodontia have usually been separated into three groups [6, 7, 12, 13], the basal iguanodontians (*Tenontosaurus*, dryosaurids and camptosaurids), the iguanodontids which are approximately intermediate in position, and the more derived hadrosaurids. The classification of iguanodontians proposed by Norman [6] is used here as a means of assessing the relationships of *Lurdusaurus* within the Iguanodontia.

The presence of a posterolaterally directed process on the sternum (*plate II, figure 1*), the distal expansion of the pubis (though not extreme), the reduction of the posterior process of the pubis, and the strongly opisthocoelous cervical and anterior dorsal vertebrae all support the position of *Lurdusaurus* among intermediate and higher iguanodontians. It is excluded from the hadrosaurids by the presence of a first digit in the manus, a well-ossified carpal block, and an open intercondylar groove on the femur. The genus is somewhat ambiguous in possessing a femoral fourth trochanter which is very nearly pendant (as in the lower iguanodontians) and a large number of cervical vertebrae (as in hadrosaurids). Nevertheless, in the light of existing information on ornithopod evolution, *Lurdusaurus* is best placed within the Iguanodontidae.

Lurdusaurus was not a typical iguanodontid. Its elongated neck, massively constructed forelimb and thumb spike, bulky body, and relatively short tail and hind limbs imply habits and habitus very different from those of its more ordinary relatives. It is hoped that descendant forms will be identified in African strata of Upper Cretaceous age so that the evolutionary implications of its strange form will be more apparent.

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*LURDUSAURUS ARENATUS***Plate I**

- Figure 1.** Skull roof. **a.** Dorsal view. **b.** Ventral view.
Figure 2. Right premaxillar, dorsal view.
Figure 3. Predentary, dorsal view.
Figure 4. Left quadrate. **a.** Lateral view. **b.** Posterior view.

Planche I

- Figure 1.** Toit crânien. **a.** Vue dorsale. **b.** Vue ventrale.
Figure 2. Prémaxillaire droit. vue dorsale.
Figure 3. Prédentaire. vue dorsale.
Figure 4. Carré gauche. **a.** Vue latérale. **b.** Vue postérieure.

Plate II

- Figure 1.** Left sternal bone, ventral view.
Figure 2. Cervical vertebrae, left lateral view.

Planche II

- Figure 1.** Os sternal gauche, vue ventrale.
Figure 2. Vertèbre cervicale, vue latérale gauche.

Plate III

- Figure 1.** Right pubis, medial view. with a hole on the repaired part of the prepubis.
Figure 2. Left pubis, external view.
Figure 3. Posterior dorsal vertebra. **a.** Posterior view. **b.** Left lateral view.
Figure 4. Left anterior limb, posterior view.

Planche III

- Figure 1.** Pubis droit, vue médiale. Avec un trou dans la partie resoudée du prépubis.
Figure 2. Pubis gauche, vue externe.
Figure 3. Vertèbre dorsale postérieure. **a.** Vue postérieure. **b.** Vue latérale gauche.
Figure 4. Membre antérieur gauche, vue postérieure.

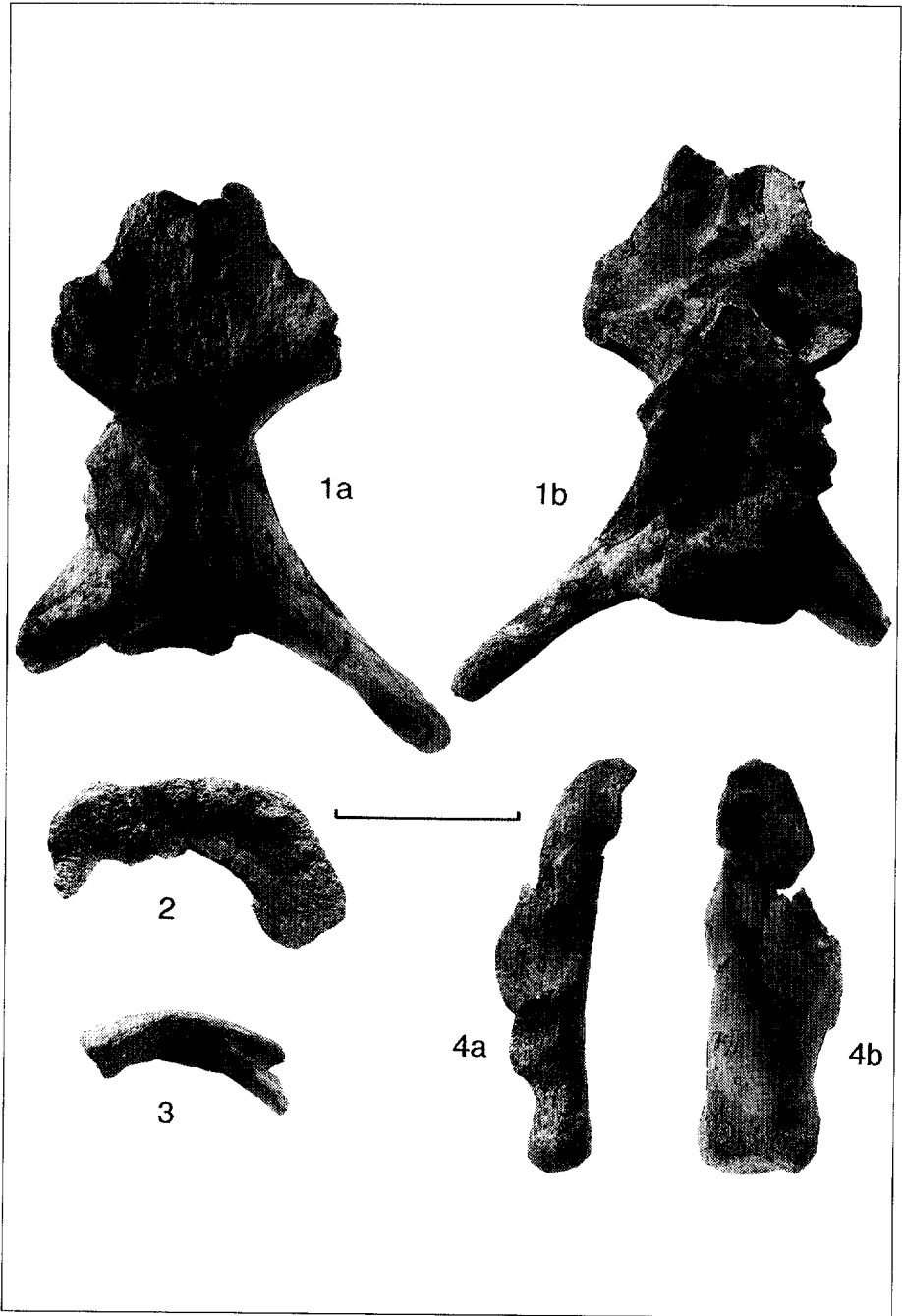


Plate I

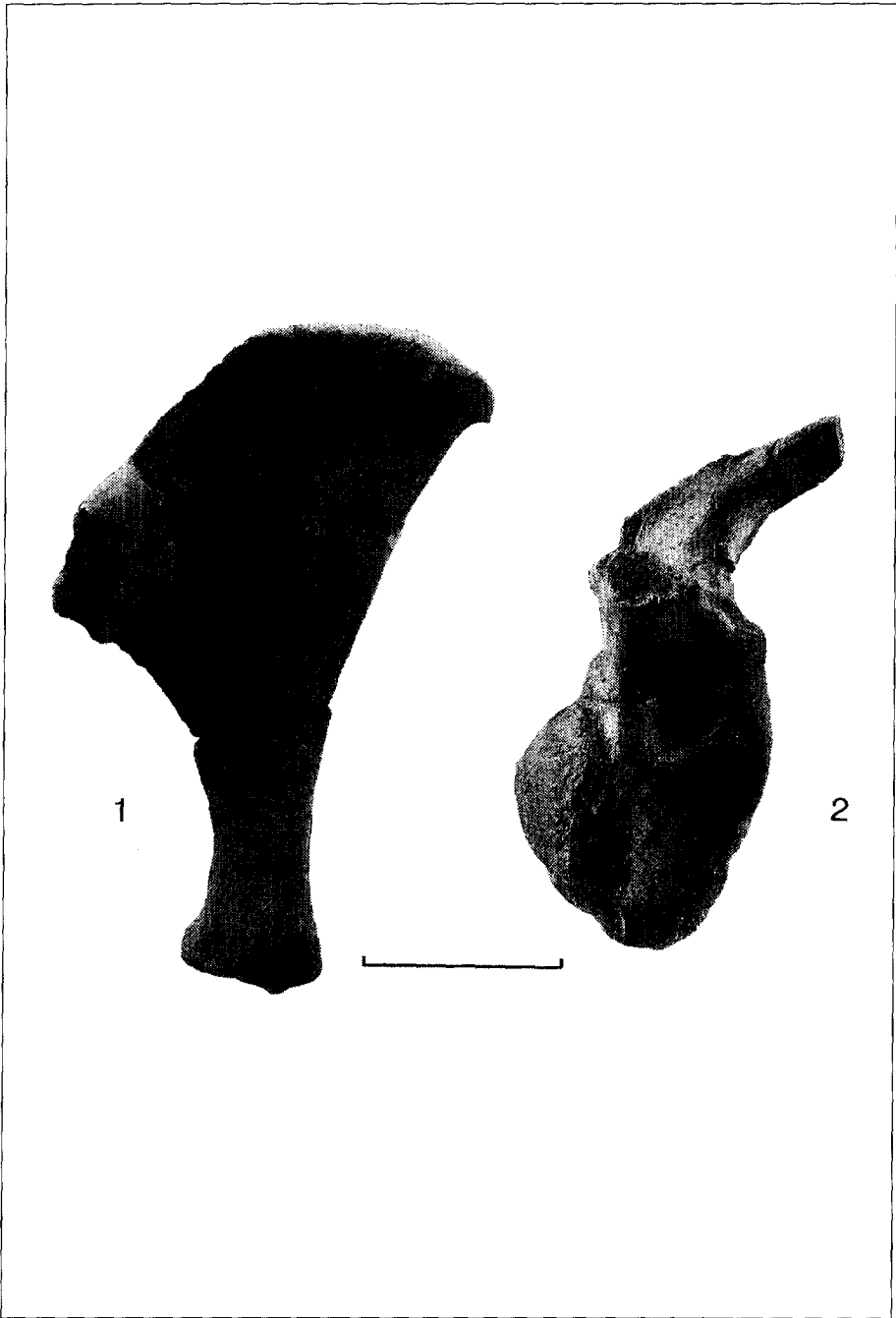


Plate II

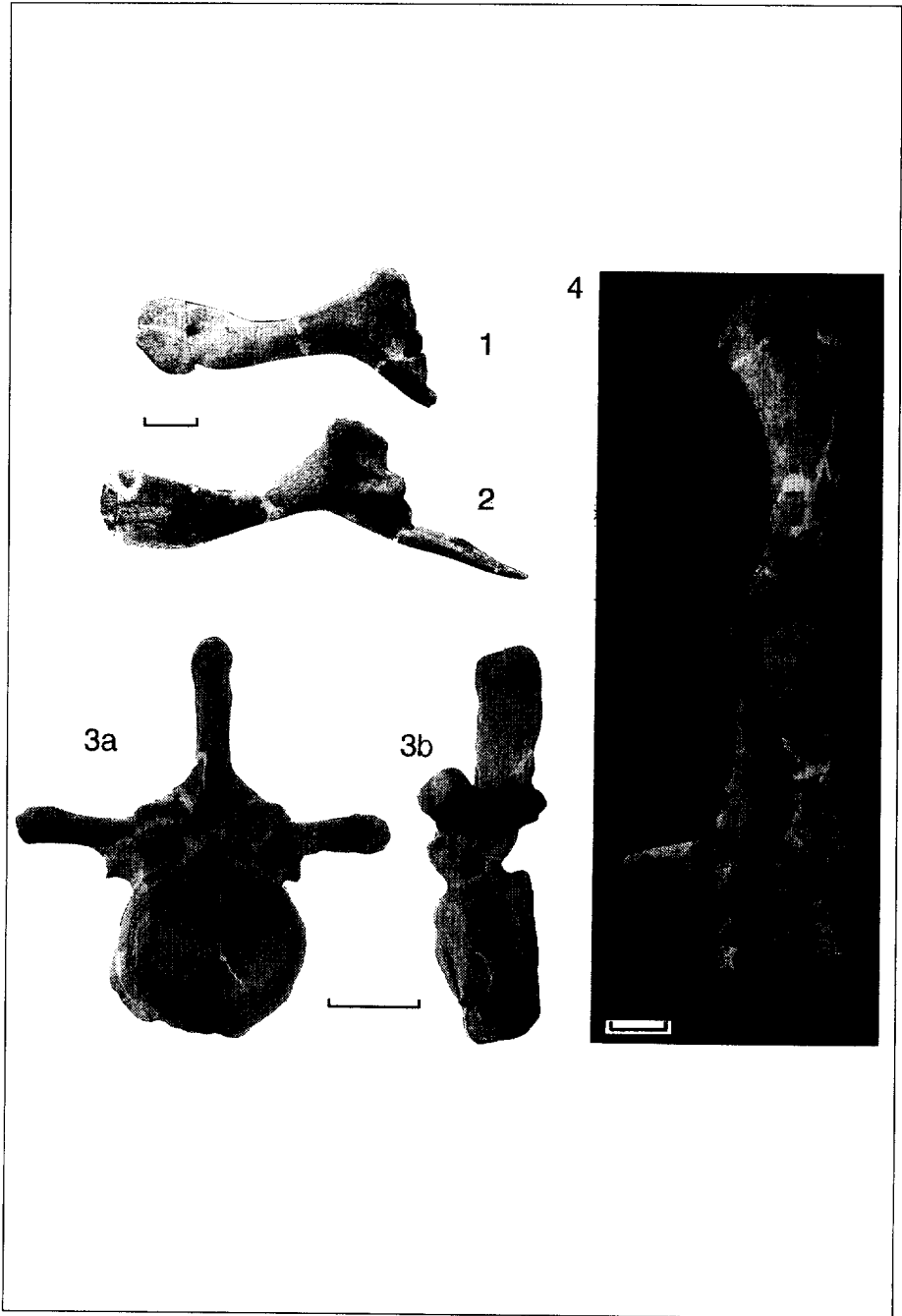


Plate III