

Systematic palaeontology (Vertebrate palaeontology)

# A stegosaur vertebra (Dinosauria: Ornithischia) from the Callovian (Middle Jurassic) of Sarthe, western France

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## Abstract

A dinosaur vertebra found in the course of road works in the “Chevain Marls” (marine Callovian) of the Vermont outlier, near the village of Béthon (Sarthe, Pays-de-la-Loire, western France) is described and referred to a stegosaur (cf. *Lexovisaurus*). It is the first record of a dinosaur in the Middle Jurassic of that area. The specimen was probably derived from the floating carcass of an animal that had lived on the emerged areas of the Armorican Massif, near which the Chevain Marls were deposited. This fossil is an addition to the short list of stegosaur remains reported from France. **To cite this article: E. Buffetaut, N. Morel, C. R. Palevol 8 (2009).**

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## Résumé

**Une vertèbre de stégosaure (Dinosauria: Ornithischia) du Callovien (Jurassique moyen) de la Sarthe, Ouest de la France.** Une vertèbre de dinosaure découverte lors de travaux routiers dans les « Marnes du Chevain » (Callovien marin) de la butte de Vermont, près du village de Béthon (Sarthe, Pays-de-la-Loire, Ouest de la France), est décrite et attribuée à un stégosaure (cf. *Lexovisaurus*). Il s'agit de la première mention d'un dinosaure dans le Jurassique moyen de cette région. Il est probable que le spécimen provient du cadavre, entraîné en mer, d'un animal ayant vécu sur les terres émergées du Massif armoricain, à proximité desquelles se sont déposées les Marnes du Chevain. Ce fossile vient s'ajouter à la courte liste des restes de stégosaures connus en France. **Pour citer cet article : E. Buffetaut, N. Morel, C. R. Palevol 8 (2009).**

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## 1. Introduction

Although a number of dinosaur remains are known from the Middle Jurassic marine beds of Normandy [1,2], there was so far no record of such finds in the equivalent deposits of the Sarthe area, farther to the south. We describe below a stegosaur ver-

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tebra from the Callovian of that region, which is a welcome addition to the scanty French record of stegosaurs.

## 2. Discovery, geological and palaeoenvironmental setting

The specimen was discovered at a locality known as Vermont, near the village of Béthon, about 40 km north of Le Mans (département Sarthe, Pays-de-la-Loire region), in western France. The locality is a small outlier rising some 30 m above the surrounding plain. The hill is 800 m long (east-west) and 750 m wide (north-south). During the building of the A 28 motorway, the Vermont outlier was dug out and levelled over a width of 50 m to provide a passage for the carriageways. The resulting outcrop was excavated in July 2000 by Mr Charles Malherbe, an amateur palaeontologist, who discovered the vertebra described below. The bone was discovered in the road cutting at the time it was dug, about 5 m below the original surface of the hillside. The vertebra was carefully extracted on 29 July, 2000. Further research the next day did not reveal any further bone fragments. A week later, the site of the discovery had been completely destroyed by road works. Further investigations by Mr Raboeuf, of the Musée Vert in Le Mans, did not lead to additional finds.

The anterior face of the vertebra, as discovered by Mr Malherbe, was not connected with other skeletal elements. However, the posterior face had been exposed by road works and the discovery farther down the slope of a natural cast of part of a neural canal indicates that the vertebra originally was not isolated, but associated with at least one more vertebra.

The Vermont outlier consists of marls locally known as the “Marnes du Chevain” [19,20]. This formation is dated as Early Callovian (*Macrocephalites macrocephalus* zone), and thus about 160 Ma old. It overlies Bathonian strata and consists of alternating grey marls and beds of clayey limestone. The vertebra was found in one of the limestone horizons.

In terms of palaeogeography, this area corresponds to the boundary between the eastern margin of the Armorican Massif, which largely remained above sea level during the Mesozoic, and the western part of the Paris Basin, which during that time was characterised by succeeding transgressions and regressions.

After its formation during the Palaeozoic, the Armorican Massif was subjected to an intense post-Hercynian erosion. However, because of the highly heterogeneous

nature of its rocks and of late tectonic events, the continental surface of the “Armorican Island” apparently still exhibited notable reliefs at the beginning of the Jurassic. In the area in question, the Jurassic transgression begins with Toarcian deposits which rest unconformably on the Palaeozoic basement. Thereafter, up to and including the Bathonian, the various depositional sequences are characterised by littoral conditions (coarse sands, oolitic limestones interspersed with hardgrounds or erosional surfaces, palaeosols and many gaps in sedimentation). It is only in the Early Callovian, when the vertebra was buried in marine sediments, that a new transgressive episode led to the disappearance of littoral deposits, which were replaced by dominantly argillaceous deposits indicative of fully marine sedimentation [20,21]. The present westward limit of the Early Callovian is about 10 km from Vermont. The vertebra was thus deposited in an open sea environment, but at a short distance from the shore. This is confirmed by abundant fossil wood of continental origin in the Callovian deposits of the Vermont outlier.

## 3. Description and identification

The specimen (Fig. 1), kept in the collections of the Musée Vert, Le Mans (no. MHNLM 2008.13.1), is a dorsal vertebra consisting of the complete centrum and part of the neural arch, which is broken just below the parapophyses. In ventral view, the centrum shows a strong constriction, giving it a hourglass-shaped outline. In lateral view, its ventral outline is markedly concave. The anterior and posterior ventral edges of the centrum bear strong rugosities. The articular faces are oval in outline, with a vertical greater axis; they are both slightly concave. The flanks of the centrum are excavated by distinct but shallow depressions.

The neurocentral suture is almost completely obliterated, suggesting an adult or nearly adult animal. The neural canal is teardrop-shaped in anterior and posterior views, and shows only a moderate dorsoventral elongation. In anterior view, the bases of the neural pedicels bulge on both sides of the neural canal. On the right side of the neural arch, the inception of an oblique ridge can be seen, issuing posteriorly from the base of the arch and rising in an anterior direction (this region is not preserved on the left side); this ridge probably buttressed the parapophysis. More posterodorsally, a ridge forming a buttress below the postzygapophysis is visible on the right side.

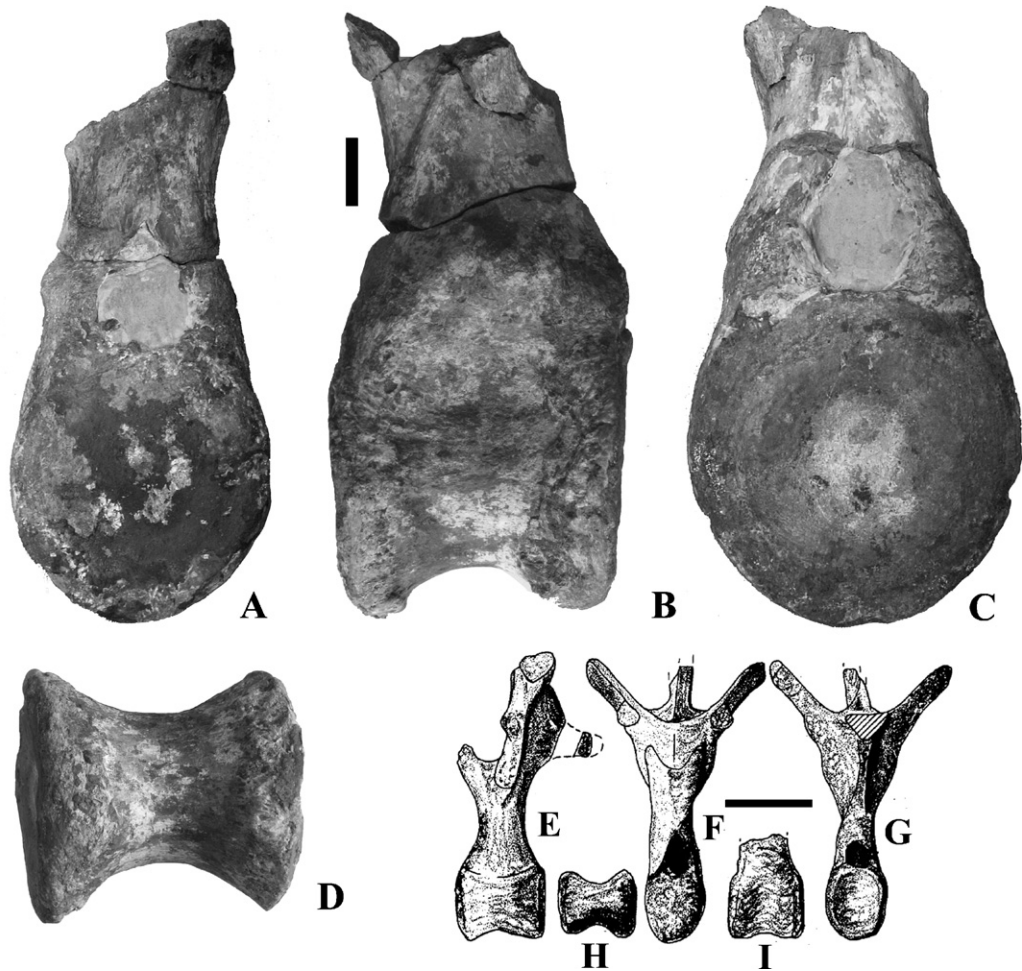


Fig. 1. **A** à **D**: stegosaur vertebra, cf. *Lexovisaurus*, from the Callovian of the Vermont outlier, near Béthon, Sarthe (western France), Musée Vert, Le Mans, no. MHNLM 2008.13.1. **A**: posterior view; **B**: right lateral view; **C**: anterior view; **D**: ventral view. Scale bar: 20 mm; **E** to **I**: dorsal vertebrae of the *Lexovisaurus* skeleton from Argences, Calvados (Muséum d'Histoire Naturelle du Havre, MHBR 0001), for comparison; **E** to **G**: fourth dorsal vertebra in left lateral (**E**), anterior (**F**) and posterior (**G**) views; **H**, **I**: seventh dorsal vertebra in ventral (**H**) and left lateral (**I**) views. Scale bar: 100 mm (after Galton et al. [10]).

Fig. 1. **A** à **D**: vertèbre de stégosaure, cf. *Lexovisaurus* du Callovien de la butte de Vermont près de Béthon, Sarthe (Ouest de la France), Musée Vert, Le Mans, n° MHNLM 2008.13.1. **A**: vue postérieure; **B**: vue latérale droite; **C**: vue antérieure; **D**: vue ventrale. Barre d'échelle: 20 mm; **E** à **I**: vertèbres dorsales du squelette de *Lexovisaurus*, d'Argence, Calvados (musée d'Histoire naturelle du Havre, MHBR 0001) pour comparaison; **E** à **G**: quatrième vertèbre dorsale en vue latérale gauche (**E**), antérieure (**F**) et postérieure (**G**); **H**, **I**: septième vertèbre dorsale en vue ventrale (**H**) et latérale gauche (**I**). Barre d'échelle: 100 mm (selon Galton et al. [10]).

#### Measurements:

Length of the centrum	85 mm
Height of anterior articular face	84 mm
Height of posterior articular face	88 mm
Maximum height of vertebra, as preserved	191 mm
Maximum height of neural canal (anterior view)	47 mm
Maximum width of neural canal (anterior view)	35 mm

Although not complete, this specimen shows characteristic features of stegosaur vertebrae. The centrum is proportionally short, being as long as it is wide (anteriorly). Although incompletely preserved, the neural

arch clearly was tall, as in most stegosaurs except the most basal forms such as *Huayangosaurus* from China [30] and *Dacentrurus* from England [7]. The fact that the parapophysis was located on the neural arch rather than on the centrum shows that it is a dorsal vertebra. A teardrop-shaped neural canal can be observed in the anterior dorsal vertebrae of stegosaurs such as *Stegosaurus* [26, pl. 14, p. 263], *Chungkingosaurus* [5] and *Lexovisaurus* [8]. What is left of the neural arch suggests that it was not as tall as in the posterior dorsals of relatively advanced stegosaurs. It therefore

seems likely that the vertebra from Béthon is an anterior dorsal.

A precise identification of this stegosaur vertebra is difficult because of the fragmentary nature of the material. As mentioned above, it differs from the dorsal vertebrae of basal stegosaurs in the greater height of its neural arch. Carpenter et al. [3] have subdivided stegosaurs dorsal vertebrae into different “styles” of neural arch (“low”, “medium” and “tall” neural arch). From this point of view, the neural arch of the Béthon vertebra is taller than those of *Huayangosaurus*, *Dacentrurus* and *Hesperosaurus* [3]. The Béthon vertebra does not show the considerable vertical elongation of the neural canal and pedicels seen in the forms showing the “tall” style of neural arch, such as *Stegosaurus* [26], *Kentrosaurus* [6,13] and *Wuerhosaurus* [4]. It is more reminiscent of the “medium” style exemplified by the Chinese Jurassic stegosaurs *Chialingosaurus*, *Chungkingosaurus* and *Tuojiangosaurus* [5], and also by *Lexovisaurus*, from the Callovian of England and France [7,8]. *Lexovisaurus* is of particular significance for a possible identification of the specimen from Béthon, because of stratigraphical and geographical proximity between the Vermont site and the localities that have yielded *Lexovisaurus* remains in England [7] and, especially, in Normandy [8,12,14,16]. *Lexovisaurus* is currently the only stegosaur taxon identified in the Callovian of Europe [11]. In a recent revision, Maidment et al. [22] have considered that the type material of *Lexovisaurus durobrivensis* [18] is undiagnostic and that therefore, *Lexovisaurus* is a *nomen dubium*; they propose a new genus, *Loricatosaurus*, to include the specimen originally described by Nopcsa [24] as *Stegosaurus priscus* and the stegosaur skeleton from Argences described by Hoffstetter and Brun [15,16], Galton et al. [12] and Galton [8]. However, when he erected the genus *Lexovisaurus*, Hoffstetter [14] explicitly included “*Stegosaurus priscus*” in it (see also Hoffstetter and Brun [16]). In the interest of the stability of nomenclature, it therefore seems preferable to continue using the generic name *Lexovisaurus*, and to refer to the diagnostic specimens from the Callovian of England and France as *Lexovisaurus priscus* (Nopcsa, 1911) [25] rather than *Loricatosaurus priscus* as suggested by Maidment et al. [22]. The vertebra from Vermont closely resembles anterior dorsals of *Lexovisaurus priscus*, as described and illustrated by Galton [7,8] and Galton et al. [12], in the proportions of the centrum, the outline of the neural canal and the height of the pedicels of the neural arch (Fig. 1). However, this isolated, incomplete vertebra is not sufficient for a precise identification, therefore the stegosaur vertebra from Vermont is here referred to as cf. *Lexovisaurus*.

#### 4. Stratigraphical, taphonomical and palaeobiogeographical implications

As noted by Galton [8], the *Lexovisaurus* specimen from Argences (Calvados), in Normandy, is from the uppermost zone (*Sigaloceras calloviense* zone) of the Lower Callovian, and thus slightly older than the material from the Lower Oxford Clay of Fletton (England), which is very probably from the lowermost zone (*Kosmoceras jason* zone) of the Middle Callovian. The vertebra from Béthon appears to be somewhat older than the incomplete skeleton from Argences, since the *Macrocephalites macrocephalus* zone antedates the *Sigaloceras calloviense* zone [29]. If the Béthon vertebra does belong to *Lexovisaurus*, it may thus be the oldest known representative of that genus. Galton and Powell [10] tentatively referred to *Lexovisaurus* a juvenile stegosaur femur from the Bathonian of England originally described by Huene [17] as *Omosaurus vetustus*, but this taxon is now considered as a *nomen dubium* [11,22].

Stegosaurs were terrestrial animals and the presence of a stegosaur vertebra in the marine “Marnes du Chevain” therefore requires an explanation. As noted by Buffetaut [1], dinosaur remains are not uncommon in marine sediments. The marine Callovian marls and clays of Normandy have yielded remains of theropods, sauropods and stegosaurs [2]. In addition to these dinosaur groups, the Callovian Lower and Middle Oxford Clays of England also contain remains of ornithopods and ankylosaurs [23]. Specimens vary from isolated bones and teeth to partly articulated skeletons (a good example of such a specimen being the *Lexovisaurus* skeleton from Argences). All these specimens can be considered as originating from carcasses that slowly decomposed when floating on the surface of the ocean, probably after being carried out to the sea by streams. During the process of decay, isolated bones or fragments of skeletons occasionally dropped to the bottom and were buried there. Observations of carcasses of marine mammals in the North Sea have shown that they can drift for many days and be carried over long distances by currents [28]. In the case of the stegosaur vertebra from Béthon, the land area where the stegosaur lived in all likelihood was the Armorican Massif; as mentioned above, the coastline was apparently not very distant from the place of burial of the stegosaur vertebra.

#### 5. Conclusion

Although the specimen from Béthon is an isolated vertebra, it is a significant find in view of the scarcity

of stegosaur remains in the Middle Jurassic of France. Whereas *Lexovisaurus* is known in England from a number of specimens from the Oxford Clay [7], the French record of stegosaurs from the Callovian was so far restricted to the partial skeleton from Argences. Generally speaking, few remains of stegosaurs have been reported from France; in addition to the remains from the Callovian, they include the partial skeleton from the Kimmeridgian of Octeville (Seine-Maritime) described by Nopcsa [25] as *Dacentrurus lennieri* (a synonym of *D. armatus* [27] according to Galton and Upchurch [12] and Maidment et al. [22]), which was destroyed in World War II, and an isolated femur from the same area described by Galton and Boiné [9]. The vertebra from Béthon is a welcome addition to this meagre record.

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The discovery of the stegosaur vertebra from Béthon illustrates once more the need to keep a close watch on road works and the importance of cooperation between amateurs, natural history museums and professional palaeontologists. We are especially grateful to Mr Malherbe, without whose intervention the specimen would have been irretrievably lost. E.B. thanks J.P. Watté for access to the *Lexovisaurus* skeleton in the Natural History Museum in Le Havre.

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