Geol. Mag. **144** (*6*), *2007, pp. 1021–1025.* © *2007 Cambridge University Press*
doi:10.1017/S0016756807003883 First published online 11 September 2007 *Printed in the United Kingdom*

RAPID COMMUNICATION

The spinosaurid dinosaur *Baryonyx* (Saurischia, Theropoda) in the Early Cretaceous of Portugal

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(*Received* 4 April 2007; *accepted* 26 June 2007)

Abstract

Jaw fragments bearing teeth from the Barremian of Boca do Chapim (Lisboa e Setubal Province, Portugal), originally considered as crocodilian and identified as *Suchosaurus girardi* by Sauvage, are redescribed and referred to the spinosaurid dinosaur *Baryonyx*, on the basis of comparison with *Baryonyx walkeri*, from the Barremian of England. This extends the geographical distribution of this unusual theropod genus to Portugal.

Baryonyx appears to have been a frequent component of Early Cretaceous dinosaur assemblages in the Iberian region, which may have formed a biogeographical 'stepping-stone' for baryonychine dispersal between Europe and Africa.

Keywords: Cretaceous, Portugal, dinosaurs, Theropoda, biogeography.

1. Introduction

The Boca do Chapim locality, in the coastal cliffs just north of Cape Espichel, some 40 km south of Lisbon, has been known as a source of Early Cretaceous vertebrate remains since the late 19th century (Sauvage, 1896, 1897–1898, 1898). Among the material described by Sauvage were jaw fragments which he considered crocodilian and referred to a new species of *Suchosaurus* Owen, *S. girardi.* Re-examination shows that they actually belong to the theropod dinosaur *Baryonyx*. This is the first report of this spinosaurid dinosaur from Portugal.

2. Geological setting

The fossils described below, apparently collected by Choffat, come from marly sandstones which crop out in the sea-cliffs north of Cape Espichel at a place called Boca do Chapim (Lisboa e Setubal Province, formerly Estremadura. See locality maps in Rey, 1972, 1992). In the older geological literature, this formation was called the 'grès marneux à grands sauriens' (Choffat, 1904), or 'grès marneux à dinosaures'. The more formal name 'Papo Seco Formation' was proposed by Rey (1992). Sauvage (1897–1898) and Choffat (1904) considered these marly sandstones as belonging to the Almargem Beds, of Aptian to early Albian age. Rey (1972, 1992, 2006) showed that they are in fact early Barremian in age. They are considered as lagoonal sandstones (Rey, 2006) filling a valley at the beginning of a transgressive phase (Rey, Graciansky & Jacquin, 2003). Choffat (1904, p. 15) gave an accurate position for Sauvage's *Suchosaurus* material in layers 36–38 of his section of Boca do Chapim.

As described by Sauvage (1897–1898), the vertebrate assemblage from Boca do Chapim, identified mainly on the basis of isolated teeth, included a chimaeroid fish, the purported crocodilian *Suchosaurus girardi*, the theropod *Megalosaurus superbus*, the sauropod *Pleurocoelus valdensis* and the ornithopod *Iguanodon mantelli*. In addition, Choffat (1904) mentioned the occurrence of chelonian remains. Later workers (Lapparent & Zbyszewski, 1957; Galton, 1994; Antunes & Mateus, 2003; Ruiz-Omeñaca & Canudo, 2003) have concentrated on dinosaurs but have added little to Sauvage's original list, beyond a re-evaluation of some taxon names. The hitherto described dinosaurs from Boca do Chapim can be listed as *Iguanodon* sp., Theropoda indet. and *Astrodon* cf. *valdensis* (see Carpenter & Tidwell, 2005, about the validity of *Astrodon*). The material referred to *Suchosaurus girardi* seems to have been generally neglected, probably because its crocodilian nature was not questioned.

3. *Baryonyx* material from Boca do Chapim

Sauvage (1897–1898) erected the species *Suchosaurus girardi* (without providing any diagnosis) on the basis of two jaw fragments (Sauvage, 1897–1898, pl. IV, figs 4, 5) and an isolated tooth (pl. V, fig. 6). The latter could not be located in the collection of the Museu Geologico during a recent visit, but a hitherto undescribed jaw fragment bearing tooth remains, which clearly belongs to the same taxon, was found. All bear the collective collection number 29. Letters have been added to distinguish the various specimens.

The most informative specimen (Fig. 1a,b) is a jaw fragment (29A, figured by Sauvage, 1897–1898, pl. IV, fig. 4), apparently a portion of a right dentary, showing four incomplete teeth, which are largely exposed, including the roots, because the lingual part of the bone has been destroyed. The anterior break shows the tip of a replacement tooth, with wrinkled enamel and very fine serrations on the carina. The following tooth is represented only by its root, which is long and mediolaterally flattened. The best-preserved tooth is the third from the front; its apex is broken, revealing a nearly circular cross-section, the crown being only weakly compressed mediolaterally. The crown is slightly recurved and

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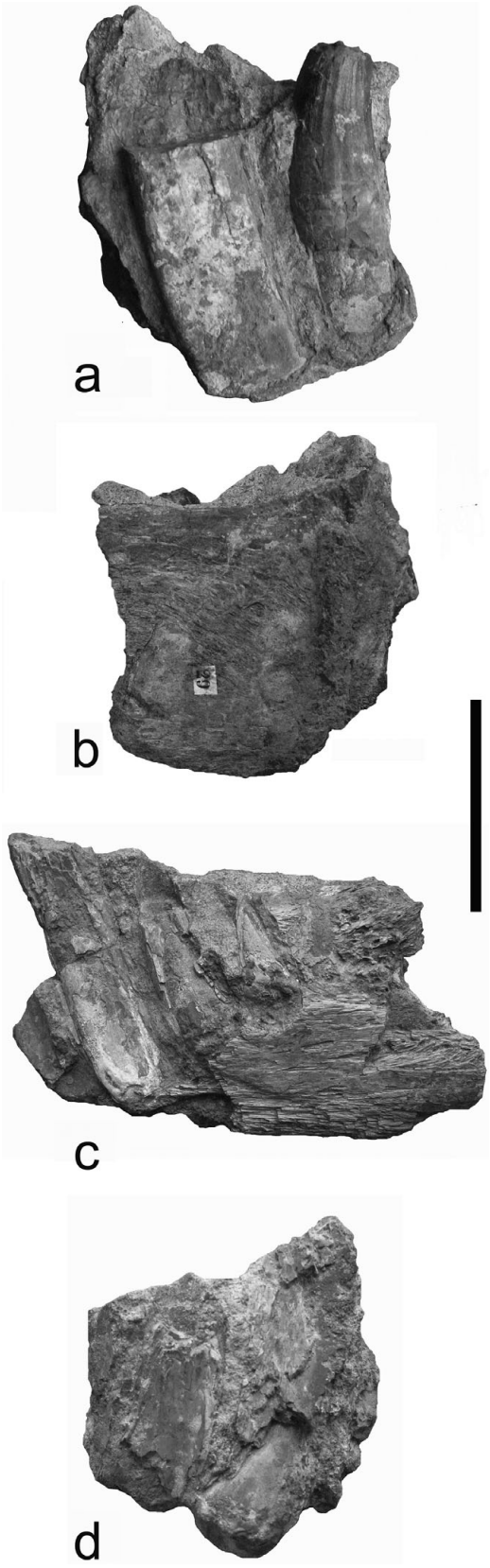

Figure 1. Material of *Baryonyx* sp. from the Barremian of Boca do Chapim, Portugal, in the collections of the Museu Geologico, Lisbon. (a) Right dentary fragment 29A in lingual view, showing a tooth with an incompletely preserved crown and the root of another tooth. (b) Right dentary fragment 29A in labial view, showing vertical ridge. (c) Right dentary fragment 29B in lingual view, showing roots of broken teeth and a replacement tooth. (d) Left dentary fragment 29C in lingual view, showing roots of broken teeth. Scale bar = 50 mm.

bears distinct ridges on both the lingual (8 ridges) and labial (7 ridges) faces. Anterior and posterior carinae are present, in the same plane as the curvature of the crown; because of wear, they show only faint indications of serrations. The surface of the enamel is distinctly wrinkled (Fig. 2a), as already noted by Sauvage (1897–1898). The posteriormost alveolus contains only fragments of a tooth. The labial face of the jaw fragment is more or less vertical, with a concave dorsal margin. Its surface is poorly preserved but shows a slightly rugose dorsoventral ridge in its anterior part.

The other jaw fragment (29B, Fig. 1c) figured by Sauvage (1897–1898, pl. IV, fig. 5), also in all likelihood from a right dentary but probably from a more posterior region, bears three teeth. The anteriormost one consists only of the root, which is long and mediolaterally compressed. The following one is a poorly preserved root. The next one is the apex of a replacement tooth, split longitudinally, but still showing the anterior carina, which is clearly serrated, with 6 to 7 serrations per millimetre (Fig. 2b). The enamel surface is strongly wrinkled. The more or less vertical labial face of the bone is poorly preserved, but shows two large vascular foramina.

The third, hitherto unreported, jaw fragment (29C, Fig. 1d) bears a dorsoventral ridge on its vertical lateral face and seems to be the counterpart of the above-described fragment (29A) on the left side. In labial view it shows remains of four close-set alveoli, two of them very incomplete, containing very poorly preserved tooth remains, with laterally compressed roots resembling those described above.

Although they cannot be fitted together, all three fragments bear teeth of similar size and may belong to a single individual.

Because of the poor preservation of the bones, any identification of this material has to be based on the teeth. They share the following characters with those of the spinosaurid dinosaur *Baryonyx walkeri* from the Barremian of England (as described by Charig & Milner, 1997): conical, recurved crown with little labiolingual compression; labiolingually compressed root; carinae in the same plane as curvature of the crown; carinae bearing fine serrations (about 7 per millimetre); a few ribs on the lingual face of the crown; densely wrinkled or granular enamel.

The teeth from Boca do Chapim thus seem to differ little from those of *Baryonyx walkeri*, except possibly in the stronger development of ribs on the crown, especially on the labial side; the teeth of the holotype of *Baryonyx walkeri* usually have a smooth labial surface, with only extremely faint labial ribbing on some of them. Other baryonychine teeth from the Wealden of England show ribs on both the lingual and labial surfaces (Martill & Hutt, 1996; personal observations at Natural History Museum, London); the same applies to baryonychine teeth from the Wealden of Burgos Province, Spain (Torcida *et al.* 1997). The Portuguese material is also reminiscent of the teeth of *Suchomimus tenerensis* (probably a species of *Baryonyx*: Milner, 2003), from the Aptian of Niger (Sereno *et al.* 1998), in the shape of the teeth, their fine serrations and the wrinkling of the enamel; no ribbing is mentioned in *Suchomimus tenerensis* teeth, however. The teeth of the spinosaurid *Spinosaurus aegyptiacus*, from the Cenomanian

https://doi.org/10.1017/S0016756807003883 Published online by Cambridge University Press

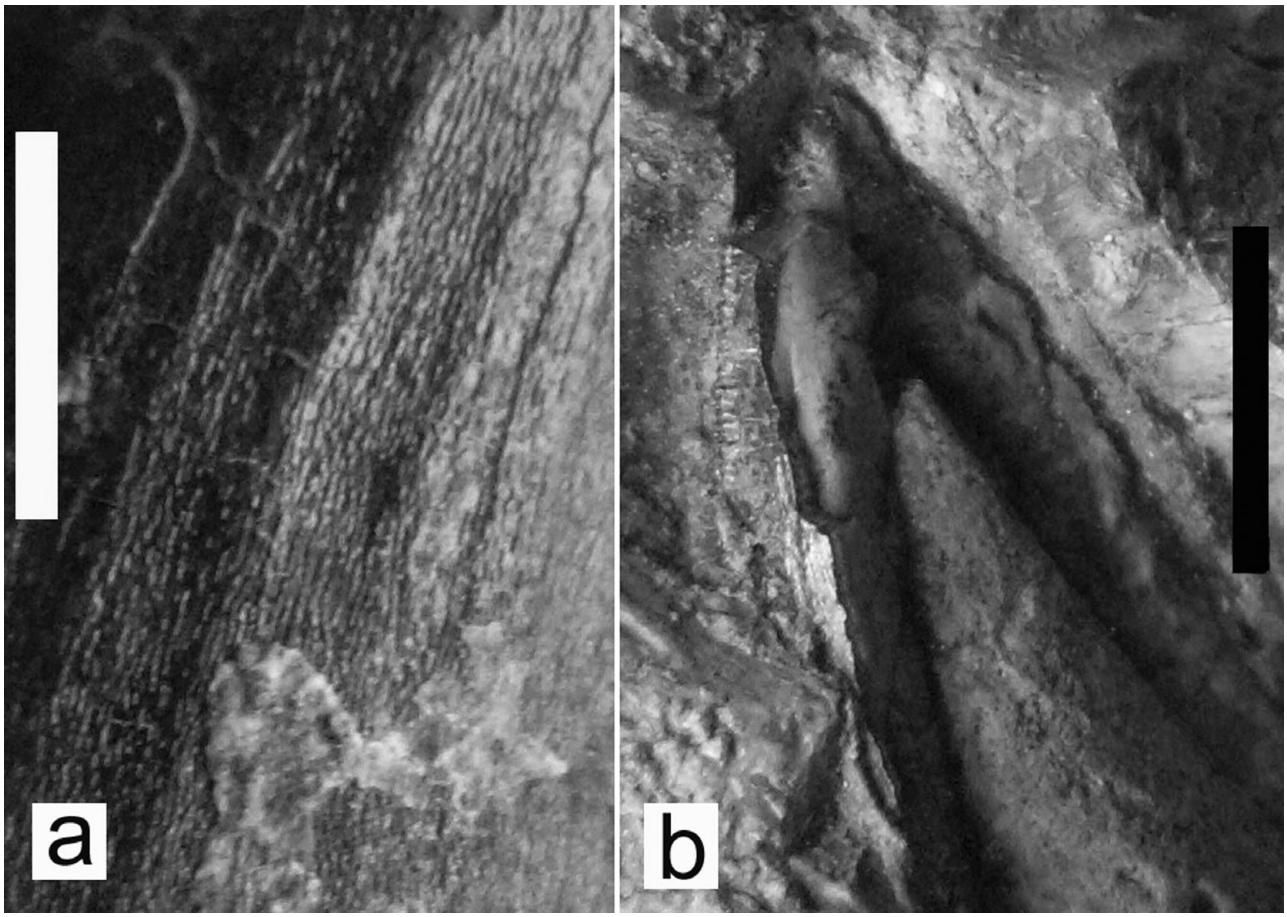

Figure 2. Enamel ornamentation in *Baryonyx* teeth from the Barremian of Boca do Chapim, Portugal. (a) Detail of the lingual surface of the large tooth in jaw fragment 29A, showing ribs and fine wrinkling. Scale bar = 5 mm. (b) Replacement tooth in jaw fragment 29B, showing fine serrations on the anterior carina (left). Scale bar = 5 mm.

of Egypt (Stromer, 1915), differ from those from Boca do Chapim in their weaker curvature, unserrated carinae and unribbed surface (it should be noted, however, that many isolated *Spinosaurus*-like teeth from the Albian of Tunisia and Cenomanian of Morocco show a distinct fluting of the crown: see Bouaziz *et al.*, 1988, about Tunisian specimens). In the spinosaurid *Irritator challengeri*, from the Albian of Brazil (Sues *et al.* 2002; see also Kellner & Campos, 1996), the teeth are straight rather than recurved, with a wrinkled enamel and fluting on both the labial and lingual surfaces, but no proper serrations on the carinae. Among the abundant spinosaurid teeth from the lower Cenomanian of Brazil (Medeiros, 2006), two morphotypes showing different kinds of ornamentation can be distinguished, but in both the carinae bear no denticles. The teeth from Boca do Chapim are rather similar to those of *Siamosaurus suteethorni*, from the Early Cretaceous of Thailand (Buffetaut & Ingavat, 1986), and to the *Siamosaurus*-like tooth from the Early Cretaceous of Japan described by Hasegawa *et al.* (2003) in general shape and wrinkling of the enamel, but their ribbing is less dense and their serrations more distinct. On the basis of these comparisons, the distinctive set of characters of the specimens from Boca do Chapim indicates that they can be referred to the genus *Baryonyx*. Because of their fragmentary condition and the above-mentioned slight differences with *Baryonyx walkeri*, it seems advisable to designate them as *Baryonyx* sp.

4. A note on *Suchosaurus*

It should be mentioned that Sauvage's attribution of the material from Boca do Chapim to the genus *Suchosaurus* was not completely unfounded, although placement among the crocodilians was wrong. The genus *Suchosaurus*, with *Suchosaurus cultridens* as type species, was erected (originally as a sub-genus of *Crocodilus*) by Owen (in the part published in 1841 of his *Odontography*, 1840–1845) for teeth from the Wealden of Tilgate Forest, Sussex, previously mentioned by Mantell (1827) as gavial-like. Owen considered them as belonging to a crocodilian, but noted that they exhibited some resemblance with those of *Megalosaurus*, notably in showing a degree of lateral compression and in the position of the anterior and posterior carinae (Owen, 1842). However, *Suchosaurus* teeth bear ribs which distinguish them from those of most theropods. As noted by Milner (2003), at least some of the teeth referred to *Suchosaurus* from the Wealden of England are identical or extremely similar to *Baryonyx* teeth. The type specimen of *Suchosaurus cultridens* (NHM, R36536, figured by Owen, 1878, pl. IV, figs 5, 6) is a tooth from the Wealden of Cuckfield, Sussex, which shows marked ribbing on both the labial and lingual surfaces, wrinkled enamel, but no distinct serrations, apparently because of wear. It is generally similar to the larger tooth from Boca do Chapim (in specimen 29A), and Sauvage's attribution was therefore founded, as the only

https://doi.org/10.1017/S0016756807003883 Published online by Cambridge University Press

teeth with such characters known at that time were those referred to *Suchosaurus*. No reasons were given, however, for the erection of a new species, *Suchosaurus girardi*, as distinct from the type species *S. cultridens*.

Suchosaurus could be regarded as a senior synonym of *Baryonyx*. However, the type specimen of *Suchosaurus cultridens* has a strongly ribbed labial surface whereas the teeth of the holotype of *Baryonyx walkeri* are smooth, or nearly completely so, labially, so that it cannot be excluded that they belong to distinct taxa. Baryonychine teeth from England (Martill & Hutt, 1996) and Spain (Canudo & Ruiz-Omeñaca, 2003) show a certain amount of variation, which, if not of an individual nature, may correspond to the occurrence of more than one taxon (the same occurs among *Spinosaurus*-like teeth from North Africa and Brazil, as mentioned above). Moreover, as the type specimen of *Suchosaurus cultridens* is a worn isolated tooth, whereas *Baryonyx walkeri* is based on a large part of a skeleton, for practical purposes it seems advisable to go on using the generic name *Baryonyx* instead of *Suchosaurus*.

5. Conclusion

The identification of *Baryonyx* at Boca do Chapim extends the distribution of this spinosaurid genus to Portugal. *Baryonyx* was originally described from England (Charig & Milner, 1986), on the basis of a skeleton from the early Barremian Upper Weald Clay of Surrey. Additional material has since then been reported from various formations of the English Wealden, ranging in age from Hauterivian to Barremian (Martill & Hutt, 1996; Charig & Milner, 1997; Milner, 2003; Hutt & Newbery, 2004; Naish & Martill, 2007). The specimens from Boca do Chapim are not the first record from the Iberian Peninsula, since baryonychines have been reported from various Spanish Early Cretaceous localities (see reviews in Canudo & Salgado, 2003; Canudo & Ruiz-Omeñaca, 2003; Ruiz-Omeñaca & Canudo, 2003), notably from the Hauterivian of Burgos (Torcida *et al.* 1997), the Barremian of La Rioja (Viera & Torres, 1995) and Teruel (Ruiz-Omeñaca, Canudo & Cuenca-Bescós, 1997; Infante, Canudo & Ruiz-Omeñaca, 2005; Sánchez-Hernández, Benton & Naish, 2007), and the Aptian of Burgos (Torcida *et al.*, 1997) and Castellon (Canudo *et al.* 2004). Clearly, baryonychines were a rather common element of the Early Cretaceous dinosaur assemblages of Europe, at least from the Hauterivian to the Aptian (they have so far never been reported from the Albian, despite the fact that Albian dinosaurs are known from several parts of Europe, including Britain and France).

In view of the presence of baryonychines in the Early Cretaceous of Africa (Sereno *et al.* 1998), the occurrence of *Baryonyx* in Portugal (and more generally in the Iberian Peninsula) may be of some palaeobiogeographical importance. Recent palaeogeographical reconstructions (Rey *et al.* 2006) show the Iberian plate in close proximity to the northern margin of Africa in the Early Cretaceous. This suggests that dispersal of baryonychines between Europe and Africa may have taken place via a route through Iberia, as already suggested by Milner (2003). Although Canudo (2006) favours vicariant evolution for spinosaurids, the very close relationships between European and African baryonychines suggest that dispersal is a more likely explanation for the distribution of this particular subfamily. However, the biogeographical history of spinosaurids in general remains obscure (see Buffetaut & Ouaja, 2002, for a review) because of gaps in their fossil record, and whether possible dispersal via Iberia may have taken place from Europe to Africa, as suggested by Milner (2003), or the reverse, is still uncertain.

Acknowledgements. Thanks to Professor Miguel Ramalho for his kind welcome at the Museu Geologico in Lisbon and for access to the material described in the present paper, and to Dr Angela Milner (Natural History Museum, London) for access to *Baryonyx* and *Suchosaurus* material in her care and for helpful discussions. Professor Jacques Rey (Toulouse) provided useful information about the geology of the Boca do Chapim locality.

References

ANTUNES, M. T. & MATEUS, O. 2003. Dinosaurs of Portugal. *Comptes Rendus Palevol* **2**, 77–95.

BOUAZIZ, S., BUFFETAUT, E., GHANMI, M., JAEGER, J. J., MARTIN, M., MAZIN, J. M. & TONG, H. 1988. Nouvelles découvertes de vertébrés fossiles dans l'Albien du Sud tunisien. *Bulletin de la Société géologique de France* **4**, 335–9.

BUFFETAUT, E. & INGAVAT, R. 1986. Unusual theropod dinosaur teeth from the Upper Jurassic of Phu Wiang, northeastern Thailand. *Revue de Paléobiologie* **5**, 217–20.

BUFFETAUT, E. & OUAJA, M. 2002. A new specimen of *Spinosaurus* (Dinosauria, Theropoda) from the Lower Cretaceous of Tunisia, with remarks on the evolutionary history of the Spinosauridae. *Bulletin de la Société géologique de France* **173**, 415–21.

CANUDO, J. I. 2006. La ambigüedad paleobiogeográfica de los dinosaurios ibéricos durante el Cretácico Inferior. In *Actas de las III Jornadas Internacionales sobre Paleontología de Dinosaurios y su Entorno* (eds F. Torcida Fernández-Baldor & P. Huerta Hurtado), pp. 21–45. Salas de los Infantes: Colectivo Arqueológico–Paleontológico de Salas.

CANUDO, J. I., GASULLA, J. M., ORTEGA, F. & RUIZ-OMEÑACA, J. I. 2004. Presencia de Baryonychinae (Theropoda) en el Aptiense inferior (Cretácico Inferior) de Laurasia: Cantera Mas de la Parreta, Formación Arcillas de Morella (Morella, Castellón). Salas de Los Infantes: III Jornadas Internacionales sobre Paleontología de Dinosaurios y su Entorno, 2 pp. (abstract).

CANUDO, J. I. & RUIZ-OMEÑACA, J. I. 2003. Los restos directos de dinosaurios teropodos (excluyendo Aves)en España. In *Dinosaurios y otros reptiles mesozoicos en España* (ed. F. Pérez-Lorente), *Ciencias de la Terra* **26**, pp. 347–74. Logroño: Instituto de Estudios Riojanos.

CANUDO, J. I. & SALGADO, L. 2003. Los dinosaurios del Neocomiense (Cretácico inferior) de la Península Ibérica y Gondwana occidental: implicaciones biogeograficas. In *Dinosaurios y otros reptiles mesozoicos en España* (ed. F. Pérez-Lorente), *Ciencias de la Terra* **26**, pp. 251–68. Logroño: Instituto de Estudios Riojanos.

CARPENTER, K. & TIDWELL, V. 2005. Reassessment of the Early Cretaceous sauropod *Astrodon johnsoni* Leidy 1865 (Titanosauriformes). In *Thunder Lizards. The Sauropodomorph Dinosaurs* (eds V. Tidwell & K. Carpenter), pp. 78–114. Bloomington: Indiana University Press.

CHARIG, A. J. & MILNER, A. C. 1986. *Baryonyx*, a remarkable new theropod dinosaur. *Nature* **324**, 359–61.

CHARIG, A. J. & MILNER, A. C. 1997. *Baronyx walkeri*, a fish-eating dinosaur from the Wealden of Surrey. *Bulletin of the Natural History Museum, Geology Series* **53**, 11–70.

CHOFFAT, P. 1904. Le Crétacique dans l'Arrabida et dans la contrée d'Ericeira. *Comunicaçoes de Commissão do Serviço Geologico de Portugal* **6**, 1–44.

GALTON, P. M. 1994. Notes on Dinosauria and Pterodactylia from the Cretaceous of Portugal. *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen* **194**, 253–67.

HASEGAWA, Y., BUFFETAUT, E., MANABE, M. & TAKAKUWA, Y. 2003. A possible spinosaurid tooth from the Sebayashi Formation (Lower Cretaceous), Gunma, Japan. *Bulletin of the Gunma Museum of Natural History* **7**, 1–5.

HUTT, S. & NEWBERY, P. 2004. An exceptional theropod vertebra from the Wessex Formation (Lower Cretaceous) Isle of Wight, England. *Proceedings of the Isle of Wight Natural History and Archaeological Society* **20**, 61–76.

INFANTE, P., CANUDO, J. I. & RUIZ-OMEÑACA, J. I. 2005. Primera evidencia de dinosaurios terópodos en la Formación Mirambel (Barremiense inferior, Cretácico Inferior) en Castellote, Teruel. *Geogaceta* **38**, 31–4.

KELLNER, A. W. A. & CAMPOS, A. de A. 1996. First Early Cretaceous theropod dinosaur from Brazil with comments on Spinosauridae. *Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen* **199**, 151–66.

LAPPARENT, A. F. DE & ZBYSZEWSKI, G. 1957. Les dinosaures du Portugal. *Mémoires du Service géologique du Portugal* **2**, 1–63.

MANTELL, G. A. 1827. *Illustrations of the geology of Sussex*. London: Lupton Rolfe, 92p.

MARTILL, D. M. & HUTT, S. 1996. Possible baryonychid dinosaur teeth from the Wessex Formation (Lower Cretaceous, Barremian) of the Isle of Wight, England. *Proceedings of the Geologists' Association* **107**, 81–4.

MEDEIROS, M. A. 2006. Large theropod teeth from the Eocenomanian of northeastern Brazil and the occurrence of Spinosauridae. *Revista Brasileira de Paleontologia* **9**, 333–8.

MILNER, A. C. 2003. Fish-eating theropods: a short review of the systematics, biology and palaeobiogeography of spinosaurs. In *Actas de las II Jornadas Internacionales sobre Paleontología de Dinosaurios y su Entorno (2001)* (eds P. Huerta Hurtado & F. Torcida Fernández-Baldor), pp. 129–138. Salas de Los Infantes: Colectivo Arqueologico–Paleontologico de Salas.

NAISH, D. & MARTILL, D. M. 2007. Dinosaurs of Great Britain and the role of the Geological Society of London in their discovery: basal Dinosauria and Saurischia. *Journal of the Geological Society, London* **164**, 493–510.

OWEN, R. 1840–1845. *Odontography*. London: Hippolyte Baillière, 655p.

OWEN, R. 1842. Report on British fossil reptiles. Part II. *Reports of the meetings of the British Association for the Advancement of Science* **11**, 61–204.

OWEN, R. 1878. Monograph on the fossil Reptilia of the Wealden and Purbeck Formations. Supplement n°VIII. Crocodilia (*Goniopholis*, *Petrosuchus* and *Suchosaurus*). *Palaeontographical Society Monographs* **1878**, 1–15.

REY, J. 1972. Recherches géologiques sur le Crétacé inférieur de l'Estramadure (Portugal). *Mémoires du Service géologique du Portugal* **21**, 1–477.

REY, J. 1992. Les unités lithostratigraphiques du Crétacé inférieur de la région de Lisbonne. *Comunicaçoes do Serviço Geologico de Portugal* **78**, 103–24.

REY, J. 2006. Stratigraphie séquentielle et séquences de dépôt dans le Crétacé inférieur du Bassin Lusitanien. *Ciências da Terra, volume especial* **6**, 1–120.

REY, J., DINIS, J. L., CALLAPEZ, P. & CUNHA, P. P. 2006. *Da rotura continental à margem passive. Composição e evolução do Cretácico de Portugal*. Lisbon: Cadernos de Geologia de Portugal, INETI, 75p.

REY, J., GRACIANSKY, P. C. DE & JACQUIN, T. 2003. Les séquences de dépôt dasn le Crétacé inférieur du Bassin Lusitanien. *Comunicaçoes del Instituto Geologico e Minero* **90**, 15–42.

RUIZ-OMEÑACA, J. I., CANUDO, J. I. & CUENCA-BESCÓS, G. 1997. Primera cita de dinosaurios barionícidos (Saurischia: Theropoda) en el Barremiense Superior (Cretácico Inferior) de Vallipón (Castellote, Teruel). *Mas de las Matas* **17**, 201–23.

RUIZ-OMEÑACA, J. I. & CANUDO, J. I. 2003. Dinosaurios (Saurischia, Ornithischia) en el Barremiense (Cretácico inferior) de la Península Ibérica. In *Dinosaurios y otros reptiles mesozoicos en España* (ed. F. Pérez-Lorente), *Ciencias de la Terra* **26**, pp. 269–312. Logroño: Instituto de Estudios Riojanos.

SÁNCHEZ-HERNÁNDEZ, B., BENTON, M. J. & NAISH, D. 2007. Dinosaurs and other fossil vertebrates from the Late Jurassic and Early Cretaceous of the Galve area, NE Spain. *Palaeogeography, Palaeoclimatology, Palaeoecology* **249**, 180–215.

SAUVAGE, H. E. 1896. Les crocodiliens et les dinosauriens des terrains mésozoïques du Portugal. *Bulletin de la Société géologique de France* **24**, 46–8.

SAUVAGE, H. E. 1897–1898. *Vertébrés fossiles du Portugal. Contribution à l'étude des poissons et des reptiles du Jurassique et du Crétacique*. Lisbonne: Direction des Travaux géologiques du Portugal, 46p.

SAUVAGE, H. E. 1898. Les reptiles et les poissons des terrains mésozoïques du Portugal. *Bulletin de la Société géologique de France* **26**, 442–6.

SERENO, P. C., BECK, A. L., DUTHEIL, D. B., GADO, B., LARSSON, H. C. E., LYON, G. H., MARCOT, J. D., RAUHUT, O. W. M., SADLEIR, R. W., SIDOR, C. A., VARRICCHIO, D. D., WILSON, G. P. & WILSON, J. A. 1998. A long-snouted predatory dinosaur from Africa and the evolution of spinosaurids. *Science* **282**, 1298–302.

STROMER, E. 1915. Ergebnisse der Forschungsreisen Prof. E. Stromers in den Wüsten Ägyptens. II. Wirbeltierreste der Baharîje-Stufe (unterstes Cenoman). 3. Das Original des Theropoden *Spinosaurus aegyptiacus*. *Abhandlungen der Königlich Bayerischen Akademie der Wissenschaften, Mathematisch-physikalische Klasse* **28**, 1–32.

SUES, H. D., FREY, E., MARTILL, D. M. & SCOTT, D. M. 2002. *Irritator challengeri*, a spinosaurid (Dinosauria: Theropoda) from the Lower Cretaceous of Brazil. *Journal of Vertebrate Paleontology* **22**, 535–47.

TORCIDA, F., FUENTES, C., IZQUIERDO, L. A., MONTERO, D. & URIEN, V. 1997. Dientes de dinosaurios terópodos (cf. *Baryonyx*) en el Weald de Burgos (España). *Studia Geologica Salamanticensia* **33**, 59–65.

VIERA, L. I. & TORRES, J. A. 1995. Presencia de *Baryonyx walkeri* (Saurischia, Theropoda) en el Weald de La Rioja (España). Nota previa. *Munibe (Ciencias Naturales)* **47**, 57–61.