

*Estudios Geológicos*, 62 (1)  
enero-diciembre 2006, 213-218  
ISSN: 0367-0449

## A Tylosaurine Mosasauridae (Squamata) from the Late Cretaceous of the Basque-Cantabrian Region

N. Bardet<sup>1</sup>, X. Pereda Suberbiola<sup>2</sup>, J. C. Corral<sup>3</sup>

### ABSTRACT

An isolated mosasaurid tooth from the Campanian of Álava (Basque Country), previously referred to as cf. *Mosasaurus* sp., is here reattributed to a tylosaurine. It may belong to *Tylosaurus*, a nearly cosmopolitan genus known from the Santonian-Maastrichtian. This is the first occurrence of a tylosaurine mosasaurid in the Iberian Peninsula. Moreover, it corresponds to the southernmost occurrence of this clade in the northern margin of the Mediterranean Tethys. Tylosaurinae fossils are known from North America, Europe, New Zealand, Antarctica, Africa and Asia, but remain unknown from the southern Mediterranean Tethyan margin and from tropical palaeolatitudes.

**Key words:** Mosasauridae, Tylosaurinae, Tethys Ocean, Late Cretaceous, Campanian, Palaeobiogeography.

### RESUMEN

Un diente aislado de mosasaurio procedente del Campaniense de Álava (País Vasco), previamente asignado a cf. *Mosasaurus* sp., se atribuye en este trabajo a un tilosaurino. Podría pertenecer a *Tylosaurus*, un género cuasi cosmopolita del Santoniense-Maastrichtiense. Es la primera cita de un mosasáurido tilosaurino en la Península Ibérica. Además, se trata del registro más meridional de este clado en el margen norte del Tetis mediterráneo. Los Tylosaurinae están representados por fósiles en Norteamérica, Europa, Nueva Zelanda, Antártida, África y Asia, pero carecen de registro en el margen sur del Tetis mediterráneo y en paleolatitudes tropicales.

**Palabras clave:** Mosasauridae, Tylosaurinae, Mar del Tetis, Cretácico superior, Campaniense, Paleobiogeografía.

### Introduction

Mosasaurid squamates were major components of the Late Cretaceous marine vertebrate faunas. By this time, this group was well diversified and achieved a worldwide distribution, as remains have been recovered from shallow marine deposits of all continents, including Antarctica. Mosasauridae classically include three subfamilies: Mosasaurinae, Plioplatecarpinae and Tylosaurinae (Russell, 1967; DeBraga & Carroll, 1993). Recent phylogenetical analyses recognised three major clades: Halisauromorpha, Russellosaurina (Plioplatecarpinae + Tylosaurinae) and Mosasaurinae (sensu Bell, 1997; Bell & Polcyn, 2005).

In Europe, mosasaurids are represented with more than twenty species currently considered as valid (Bardet & Pereda Suberbiola, 1996; Jagt, 2005). The richest outcrops are those of the Maastrichtian of Belgium and the Netherlands, where numerous skeletons have been recovered since the last century. However, mosasaurids are very scarcely known in the Late Cretaceous of the Iberian Peninsula. Until now, their fossils have only been reported from the “Garumnian” of Portugal (Sauvage, 1897-1898) and, recently, from the Santonian to Maastrichtian marine formations of the Basque-Cantabrian Region, where both Mosasaurinae and Plioplatecarpinae taxa have

<sup>1</sup> UMR 5143 du CNRS, Département Histoire de la Terre, Museum National d'Histoire Naturelle, 8 rue Buffon, 75005 Paris. E-mail: bardet@mnhn.fr.

<sup>2</sup> Universidad del País Vasco/Euskal Herriko Unibertsitatea, Facultad de Ciencia y Tecnología, Departamento de Estratigrafía y Paleontología, Apartado 644, 48080 Bilbao. E-mail: xabier.pereda@ehu.es.

<sup>3</sup> Departamento de Geología, Museo de Ciencias Naturales de Álava/Arabako Natur Zientzien Museoa, Siervas de Jesús, 24, 01001 Vitoria-Gasteiz. E-mail: Ccorral@alava.net.

been recognised: *Mosasaurus lemonnieri*, *Leiodon anceps*, *Prognathodon solvayi*, *Platecarpus* cf. *ictericus* and undetermined species of the genera *Mosasaurus* and *Leiodon* (Bardet *et al.*, 1993, 1997, 1999).

Here we revised a previously described tooth referred to as cf. *Mosasaurus* sp. from the Campanian of Alava (Bardet *et al.*, 1993, 1997) and reattribute it to Tylosaurinae.

## Geological context

The Basque-Cantabrian Region is a geological structure located in the northern part of the Iberian Peninsula. Marine Upper Cretaceous sediments, deposited under offshore platform environment, crop out extensively in the central part of this basin (Navarro-Cantabrian Region). The here described tooth comes from the northern flank of the Miranda-Treviño syncline, extending East-West on the Alava Province. It has been unearthed near the town of Castillo-Lasarte, in the grey-blue marls of the Vitoria Formation, which is late Campanian (*H. marroti* Zone) in age (Santamaría Zabala, 1996).

## Abbreviations

MCNA, Museo de Ciencias Naturales de Álava/ Arabako Natur Zientzien Museoa (MCNA), Vitoria-Gasteiz, Alava.

## Systematics

Squamata Oppel, 1811  
 Mosasauridae Gervais, 1853  
 Russellosaurina Bell, 1997  
 Tylosaurinae Williston, 1897  
*Tylosaurus* sp.

cf. *Mosasaurus* sp. - Bardet *et al.*, 1993, p. 32, pl. 1, figs. 2a-b.

*Mosasaurus* sp. - Bardet *et al.*, 1997, p. 22, fig. 3.2.

*Material and provenance.* MCNA 1654, an isolated tooth, Vitoria Formation, Late Cretaceous, late Campanian (*H. marroti* Zone), Castillo-Lasarte, Alava.

*Description* (fig. 1). MCNA 1654 is the crown, about 3 cm high, of a marginal tooth. In lateral view, the crown is triangular and is moderately posteriorly recurved. The basal cross-section of the crown is oval. It bears a pronounced anterior carina clearly serrated and a lingually located slight carina which serrations remain discrete. The position of the carinae indicate that it is an anterior tooth. The buccal surface is convex and bears indistinct facets ending at two thirds to three-fourths of the crown height. The lingual surface is also convex but flatter and has more than ten poorly defined facets. At the base of the crown on both faces, there are fine striations about 5 mm high.

*Comparison.* Until recently, poor attention has been paid to mosasaurid teeth, which descriptions are often vague and uninformative, precluding for detailed comparisons between taxa. However, recent studies have revealed the utility of teeth—including isolated ones—in mosasaurid taxonomy and have permitted significant results (i.e. Lindgren & Siverston, 2002; Lindgren, 2005).

MCNA 1654 was previously referred to as cf. *Mosasaurus* sp. on the basis of the presence of facets on the buccal and lingual surfaces of the crown (Bardet *et al.*, 1993, 1997). On the light of new data, the Alava tooth can be safely referred to a russellosaurine mosasaurid because the crown is faceted with basal striae on the lingual and lingual surfaces (Bell, 1997). Among Russellosaurina, the plioplatecarpines bear slender teeth strongly posteriorly recurved in lateral aspect, having fine carinae without serrations, marked facets and subcircular cross-section. With regard to tylosaurines, they exhibit large broadly triangular teeth slightly recurved in lateral aspect, bearing marked carinae which are serrated or not, and an oval to compressed cross-section (see Lindgren, 2005). Following this, MCNA 1654 belongs more probably to a tylosaurine than to a plioplatecarpine mosasaurid.

Tylosaurinae includes three genera: the near-cosmopolitan *Tylosaurus* Marsh, 1872, the European restricted *Hainosaurus* Dollo, 1885, and the southern hemisphere circum-polar *Taniwhasaurus* Hector, 1874. *Lakumasaurus* Novas *et al.*, 2002 from Antarctica is probably a junior synonym of *Taniwhasaurus* (M. Fernández, personal communication) but as this data remains unpublished, it is still considered here. The marginal teeth of *Tylosaurus* have an asymmetric oval cross-section, with a convex buccal side and a U-shape lingual one. They are

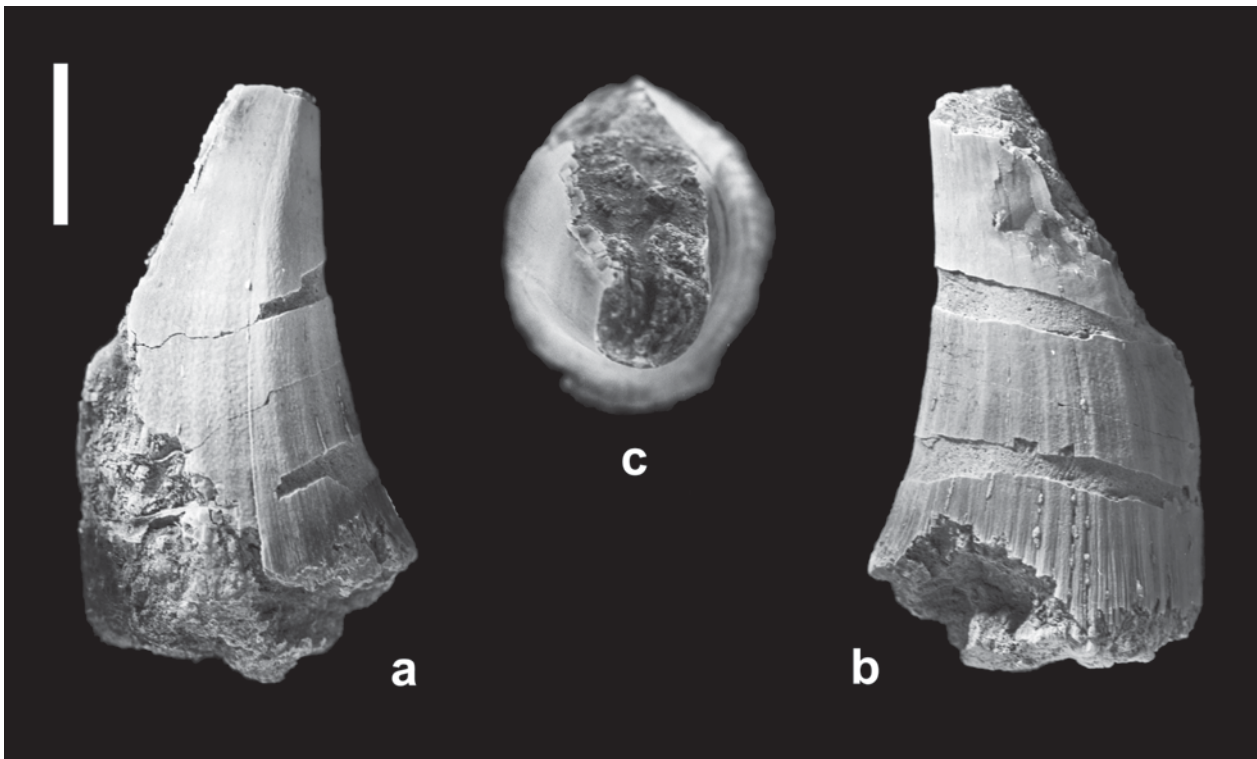


Fig. 1.—*Tylosaurus* sp., Vitoria Formation (upper Campanian), Castillo-Lasarte, Álava. MCNA 1654, tooth in labial (a), lingual (b) and occlusal (c) views. Photographs coated with ammonium chloride. Scale bar: 1 cm.

moderately posteriorly recurved in lateral view, and bear carinae, facets and basal striations slightly marked. The marginal teeth of *Hainosaurus* are bucco-lingually compressed, with a symmetric elliptical cross-section (i.e., equally developed convex surfaces), almost straight in lateral view, with marked carinae, basal striae and shallow facets. The teeth of *Taniwhasaurus* and *Lakumasaurus* are laterally compressed, slightly faceted, and bear only one anterior obtuse carina without serrations. Based on its oval cross-section, moderately defined facets and posterior curvature, the Alava tooth resembles more those of *Tylosaurus* than those of other tylosaurines.

Several species of *Tylosaurus* have been defined and are currently recognised as valid (see Lindgren & Siverson, 2002; Everhart, 2005). According to these authors, two “groups” with similar tooth morphology emerged: 1) *Tylosaurus proriger* Cope, 1869 (Campanian), *Tylosaurus nepaeolicus* Cope, 1874 (Coniacian) and *Tylosaurus kansanensis* Everhart, 2005 (Coniacian), all moderate size species from the Western Interior Seaway of North

America, have slender teeth with poorly developed carinae, being smooth or poorly faceted; anastomosed basal striations extend near the apex; 2) *Tylosaurus ivoensis* (Persson, 1963) (Campanian, Sweden), *Tylosaurus pembinensis* (Nicholls, 1988) (Campanian, Canada), and *Tylosaurus gaudryi* (Thévenin, 1896) (Santonian-Campanian, France) (see Lindgren & Siverson, 2002; Lindgren, 2005 for synonymies) are gigantic species which possess stout teeth with two strong serrated carinae bearing marked buccal facets and striations on the lingual side—and occasionally the buccal one—that do not reach the apex. Finally, the teeth of *Tylosaurus iembeensis* (Antunes, 1964) from the Turonian of Angola are striated, not faceted. No teeth are known from *Tylosaurus capensis* Broom, 1912 from the Santonian of South Africa (see Lingham-Soliar, 1992). According to the general form of the Alava tooth, it resembles more those of “*Tylosaurus ivoensis* group” than those of “*Tylosaurus proriger* group”. However, pending the discovery of further material, it is here referred as to *Tylosaurus* sp.

	AFRICA	NORTH AMERICA	EUROPE	CIRCUM POLAR	ASIA
MAA					
CMP		<i>T. nepaeolicus</i> <i>T. kansasensis</i>			
SAN	<i>T. iembeensis</i>	<i>T. proiriger</i> <i>T. peminensis</i> ?	<i>T. gaudryi</i> <i>T. ivoensis</i> <i>H. bernardi</i> <i>Hainosaurus</i> sp.	<i>T. oweni</i> <i>L. antarcticus</i>	<i>Tylosaurus</i> sp.
CON	<i>T. capensis</i>				<i>Tylosaurus</i> sp.
TUR					

Fig. 2.—Stratigraphical distribution of tylosaurine mosasaurids (*Tylosaurus*, *Hainosaurus*, *Taniwhasaurus* and *Lakumasaurus*). Main data from Caldwell *et al.* (2005), Everhart (2005), Lindgren (2005), Lindgren & Siverson (2002), Lingham-Soliar (1992), Novas *et al.* (2002).

### Palaeobiographical implications

Tylosaurines remain the less diverse mosasaurid clade, being represented only by the genera *Tylosaurus* from the Turonian-Maastrichtian of North America, Europe, Africa and Asia (see Lindgren & Siverson, 2002; Everhart, 2005); *Hainosaurus* from the Campanian-Maastrichtian of Europe (Belgium, Sweden, Poland and England) (see Lindgren & Siverson, 2002; Lindgren, 2005, Jagt *et al.*, 2005); *Taniwhasaurus* from the Campanian of New-Zealand (Welles & Gregg, 1971; Caldwell *et al.*, 2005); and *Lakumasaurus*—that could be a synonym of *Taniwhasaurus* as previously mentioned— from the Campanian-Maastrichtian of Antarctica (Novas *et al.*, 2002) (fig. 2).

The earliest and lowest latitudinally located (about 20 °S) record of tylosaurines is *Tylosaurus iembeensis* from the Turonian of Angola (Antunes, 1964; Lingham-Soliar, 1992). By Coniacian times, tylosaurines move to upper latitudes as they are known into the Western Interior Seaway of North America (40 °N and upper) by *T. nepaeolicus* and *T. kansasensis* (Russell, 1967; Everhart, 2005). During the Santonian, *T. capensis* is known from South Africa (Lingham-Soliar, 1992) and *T. gaudryi* from France (Bardet, 1990; Lindgren & Siverson, 2002). Campanian-Maastrichtian interval represents the

golden age of tylosaurines as they reach their maximal specific diversity (6 species belonging to *Tylosaurus*, *Hainosaurus* and *Taniwhasaurus*/*Lakumasaurus*) and their largest palaeobiogeographical distribution, though being restricted latitudinally. From the northern Hemisphere, under palaeolatitudes between 40-70 °N, *Tylosaurus* exhibits a large distribution, being known from North America (*T. proiriger*: Campanian of United States, Everhart, 2005; *T. peminensis*: Campanian and possibly Maastrichtian of Canada, Nicholls, 1988, Bullard, 2004, Lindgren, 2005;), Europe (*T. ivoensis*: Campanian of Sweden, Lindgren & Siverson, 2002) and Asia (*Tylosaurus* sp.: Campanian-Maastrichtian of Japan, Chitoku, 1994), whereas *Hainosaurus* seems to be restricted to Europe (*H. bernardi*: Campanian-Maastrichtian of Belgium and The Netherlands, Lingham-Soliar, 1992; *Hainosaurus* sp.: Campanian of Sweden, Poland and England, Lindgren, 2005, Jagt *et al.*, 2005; *Hainosaurus* sp.: Maastrichtian of Poland, Jagt *et al.*, 2005). From the Southern Hemisphere, only the circum-polar (around 60 °S) *Taniwhasaurus* and possibly *Lakumasaurus* are known (*T. oweni*: Campanian of New-Zealand, Welles & Gregg, 1971, Caldwell *et al.*, 2005; *L. antarcticus*: Campanian-Maastrichtian of Antarctica, Novas *et al.*, 2002).

Except their earliest occurrence in the Turonian of Angola, tylosaurines are upper latitudinally restricted



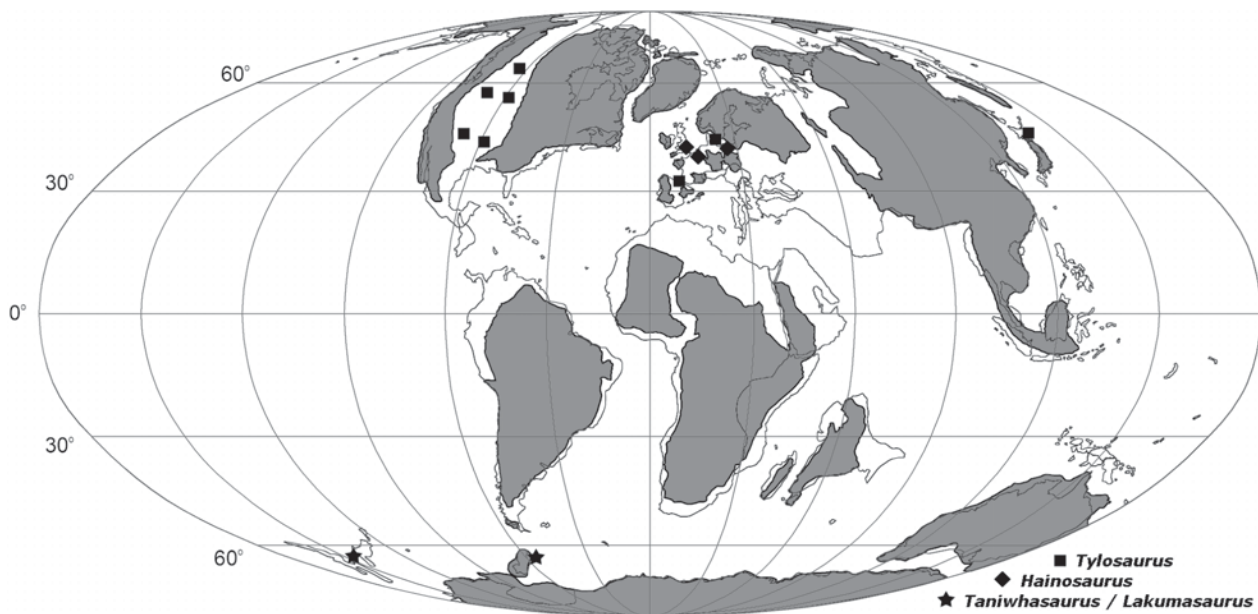


Fig. 3.—Palaeobiogeographical distribution of the tylosaurine genera *Tylosaurus*, *Hainosaurus* and *Taniwhasaurus* / *Lakumasaurus*. Main data from Caldwell *et al.* (2005), Everhart (2005), Lindgren (2005), Lindgren & Siverson (2002), Lingham-Soliar (1992), Novas *et al.* (2002). Map after Smith *et al.* (1994).

animals in either hemisphere, all their remains having been unearthed into a palaeolatitudinal belt included between 40–70° (fig. 3). On other words, no latest Cretaceous tylosaurines are known from subtropical to equatorial latitudes (30–0°). As for some living marine mammals, this distribution is probably linked to palaeoecological preferences (Bardet, 2004).

With regard to the Alava tooth, it represents the southernmost (about 35 °N) occurrence of Tylosaurinae in the northern margin of the Mediterranean Tethys, as previous European records are known from Sweden, England, Belgium, The Netherlands and Poland (about 40 °N). It confirms also the nearly cosmopolitan status of the genus *Tylosaurus* and enlarges its palaeobiogeographical distribution to the Iberian Peninsula.

#### ACKNOWLEDGMENTS

Financial support provided by the Spanish Ministerio de Educación y Ciencia (Ciencia y Tecnología) CGL2004-02338/BTE and by the Universidad del País Vasco/EHU 9/UPV 00121.310-15303/2003. The research work of N.B. was supported by the CNRS and that of X.P.S. by the Programa Ramón y Cajal (MEC, CyT). This is a contribution to the “Convenio específico de colaboración/Convention de Collaboration” between the UPV/EHU (Bilbao), the CNRS (France) and the MNHN (Paris, France).

#### References

- Antunes, M. T. (1964). *O Neocretácico e o Cenozóico do litoral de Angola*. Junta Investigações Ultramar, Lisboa, 255 pp.
- Bardet, N. (1990). Premières mention du genre *Hainosaurus* (Squamata, Mosasauridae) en France. *C. R. Acad. Sci. Paris*, 311: 751-756.
- Bardet, N. (2004). Les faunes de reptiles marins des marges Nord et Sud de la Téthys méditerranéenne durant le Crétacé supérieur: systématique et paléobiogéographie, *Habilitation à Diriger des Recherches, Univ. Paris VI*, Paris, 95 pp. (unpublished).
- Bardet, N. and Pereda Suberbiola, X. (1996). Las faunas de reptiles marinos del Cretácico final de Europa (margen norte del Mar del Tetis mediterráneo). *Rev. Esp. Paleont.*, 11: 91-99.
- Bardet, N., Corral, J. C. and Pereda Suberbiola, J. (1993). Primeros restos de reptiles marinos en el Cretácico superior de la Cuenca Vasco-Cantábrica. *Est. Mus. Cienc. Nat. de Álava*, 8: 27-35.
- Bardet, N., Corral, J. C. and Pereda Suberbiola, X. (1997). Les mosasaures (Squamata) du Crétacé supérieur du Bassin Basco-Cantabrique. *Geobios*, 20: 19-26.
- Bardet, N., Corral, J. C. and Pereda Suberbiola, X. (1999). Marine reptiles from the uppermost Cretaceous of the Laño quarry (Iberian Peninsula). *Est. Mus. Cienc. Nat. de Álava*, 14 (Núm. espec. 1): 373-380.
- Bell, G. L. Jr. (1997). A phylogenetical revision of North American and Adriatic Mosasauridae. In: *Ancient marine reptiles* (J. M. Callaway and E. L. Nicholls, edit.). Academic Press, San Diego, 293-332.

- Bell, G. L. Jr. and Polcyn, M. J. (2005). *Dallasaurus turneri*, a new primitive mosasauroid from the Middle Turonian of Texas and comments on the phylogeny of Mosasauridae (Squamata). *Netherlands J. Geosci. - Geol. Mijnb.*, 84: 177-194.
- Broom, R. (1912). On a species of *Tylosaurus* from the Upper Cretaceous beds of Pondoland. *Ann. South Afr. Mus.*, 7: 332-333.
- Bullard, T. S. (2004). Revisions to the anatomy and systematics of North American tylosaurine mosasaurs. In: *First Mosasaur Meeting* (A. S. Schulp and J. W. M. Jagt, edit.), Abstract Book and Field Guide, Maastricht, 24-25.
- Caldwell, M. W., Holmes, R., Bell, G. L. Jr. and Wiffen, J. (2005). An unusual tylosaurine mosasaur from New Zealand: a new skull of *Taniwhasaurus oweni* (lower Haumurian; Upper Cretaceous). *J. Vert. Paleont.*, 25: 393-401.
- Chitoku, T. (1994). *Tylosaurus* sp. indet. (Reptilia, Mosasauridae) from the Upper Cretaceous of the Hobetsu district, Hokkaido, Japan. *Bull. Hobetsu Mus.*, 10: 34-59.
- Cope, E. D. (1869). Remarks on *Macrosaurus proriger*. *Proc. Acad. Nat. Sci. Philadelphia*, 11: 123.
- Cope, E. D. (1874). Review of the Vertebrata of the Cretaceous period found west of the Mississippi River. *Bull. U. S. Geol. Surv. Territories*, 1: 3-48.
- DeBraga, M. and Carroll, R. L. (1993). The origin of mosasaurs as a model of macroevolutionary patterns and processes. In: *Evolutionary biology* (M. K. Hecht, R. J. Macintyre, M. T. Clegg, edit.). Plenum Press, New York, 245-322.
- Dollo, L. (1885). Le Hainosaure. *Rev. Quest. Sci.*, 18: 285-289.
- Everhart, M. J. (2005). *Tylosaurus kansasensis*, a new species of tylosaurine (Squamata, Mosasauridae) from the Niobrara Chalk of western Kansas, USA. *Netherlands J. Geosci.-Geol. Mijnb.*, 84: 231-240.
- Gervais, P. (1853). Observations relatives aux reptiles fossiles de France. *C. R. Acad. Sci. Paris*, 36: 374-377, 470-474.
- Hector, J. (1874). On the fossil Reptilia of New Zealand. *Trans. New Zealand Inst.*, 6: 333-358.
- Jagt, J. W. M. (2005). Stratigraphic ranges of mosasaurs in Belgium and the Netherlands (Late Cretaceous) and cephalopod-based correlations with North America. *Netherlands J. Geosci.-Geol. Mijnb.*, 84: 283-301.
- Jagt, J. W. M., Lindgren, J., Machalski, M. and Radwanski, A. (2005). New records of the tylosaurine mosasaur *Hainosaurus* from the Campanian-Maastrichtian (Late Cretaceous) of central Poland. *Netherlands J. Geosci. - Geol. Mijnb.*, 84: 303-306.
- Lindgren, J. (2005). The first record of *Hainosaurus* (Reptilia: Mosasauridae) from Sweden. *J. Paleont.*, 79: 1157-1165.
- Lindgren, J. and M. Siverson, M. (2002). *Tylosaurus ivoensis*: A giant mosasaur from the Early Campanian of Sweden. *Trans. Roy. Soc. Edinburgh Earth Sci.*, 93: 73-93.
- Lingham-Soliar, T. (1992). The tylosaurine mosasaurs (Reptilia, Mosasauridae) from the Upper Cretaceous of Europe and Africa. *Bull. Inst. Roy. Sci. Nat. Belgique, Sci. Terre*, 62: 171-194.
- Marsh, O. C. (1872). Note on *Rhinosaurus*. *Amer. J. Sci. Arts*, 4: 147.
- Nicholls, E. L. (1988). The first record of the mosasaur *Hainosaurus* (Reptilia: Lacertilia) from North America. *Can. J. Earth Sci.*, 25: 1564-1570.
- Novas, F. E., Fernández, M., Gasparini, Z. B. de, Lirio, J. M., Núñez, H. J. and Puerta, P. (2002). *Lakumasaurus antarcticus*, n. gen. et sp., a new mosasaur (Reptilia, Squamata) from the Upper Cretaceous of Antarctica. *Ameghiniana*, 39: 245-249.
- Oppel, M. (1811). *Die Ordnung, Familien und Gattung der reptilien als Prodom einer Naturgeschichte derselben*. Joseph Lindauer, Munich, 87 pp.
- Persson, P. O. (1963). Studies on Mesozoic marine reptile faunas with particular regard to the Plesiosauria. *Publ. Inst. Miner. Paleont. Quater. Geol.*, Univ. Lund, Sweden, 118: 1-15.
- Russell, D. A. (1967). Systematics and morphology of American mosasaurs. *Bull. Peabody Mus. Nat. Hist. (Yale Univ.)*, 23: 1-240.
- Thévenin, A. (1896). Mosasauriens de la Craie grise de Vaux-Éclusier près de Péronne (Somme). *Bull. Soc. géol. France*, 24: 900-914.
- Santamaría Zabala, R. (1996). Los ammonites del Campaniense de la Provincia de Álava. Sistemática y bioestratigrafía. *Est. Mus. Cienc. Nat. de Álava*, 10-11 [1995-96]: 5-25.
- Sauvage, H.-E. (1897-1898). Vertébrés fossiles du Portugal. Contribution à l'étude des poissons et des reptiles du Jurassique et du Crétacé. *Direction Trav. Géol. Portugal*, Lisboa, 1897-1898: 1-47.
- Smith, A. G., Smith, D. G. and Eunnell, B. M. (1994). Atlas of Mesozoic and Cenozoic coastlines. Cambridge University Press, 99 pp.
- Welles, S. P. and Gregg, D. R. (1971). Late Cretaceous marine reptiles of New Zealand. *Records Canterbury Mus.*, 9: 1-111.
- Williston, S. W. (1897). Range and distribution of the mosasaurs, with remarks on synonymy. *Kansas Univ. Quart.*, 6: 177-185.

Recibido el 20 de octubre de 2006  
Aceptado el 16 de noviembre de 2006