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# Oxfordian sponge association from the Neuquén basin, Mendoza, west central Argentina

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**Abstract**

This paper describes an Upper Jurassic association of siliceous sponges from the Neuquén basin, southern Mendoza province, at Río Potimalal. Wackestones crop out in this stratigraphic section, and massive sponge-bearing micritic limestones of the La Manga formation (*Plicatilis* zone) have been deposited in outer shelf to slope settings. Sponges are regularly preserved as whole bodies. Their skeletons are mostly calcified, but the skeletal siliceous structure is sometime preserved. The siliceous sponges belong to the Order Hexactinosa (Class Hexactinellida, Subclass Hexasterophora) (*Laocoetis* sp., *L. parallela*, *L. procumbens*, *Cribrospongia* sp., *C. clathrata*, *C. cucullata*, *Ordinatus* sp., *Linonema calyx*) and Lyssakinosa (*Poligonatyum sphaeroides*). The majority of the sponge specimens correspond to the Families Cribrospongiidae (genus *Cribrospongia*) and Laocoetidae (genus *Laocoetis*). The Upper Jurassic carbonates are interpreted as deposits of a highstand systems tract, similar to other Oxfordian sequences found around the world.


*Keywords:* Oxfordian sponge; Mendoza province; Neuquén basin

**Resumen**

El presente trabajo describe una asociación de esponjas silíceas de la cuenca Neuquina, en el sur de la provincia de Mendoza, en la sección del Río Potimalal. En esta sección afloran wackestones y calizas micríticas masivas con esponjas de la Formación La Manga (Zona de *Plicatilis*) depositadas en ambiente de plataforma externa y talud. Las esponjas están regularmente preservadas como cuerpos enteros. La estructura espicular silícica se ha preservado en algunos especímenes aunque generalmente está calcificada. Las esponjas silíceas pertenecen a la Clase Hexactinellida, Subclase Hexasterophora, Order Hexactinosa (*Laocoetis* sp., *L. parallela*, *L. procumbens*, *Cribrospongia* sp., *C. clathrata*, *C. cucullata*, *Ordinatus* sp., *Linonema calyx*) and Order Lyssacinosa (*Poligonatyum sphaeroides*). La mayoría de los especímenes corresponden a la Familia Cribospongiidae, género *Cribospongia* y a la Familia Craticularidae, género *Laocoetis*. Se interpreta que los carbonatos del Jurásico superior se depositaron durante un estadio de mar alto, similar a otras secuencias oxfordianas del mundo.


## 1. Introduction

The Río Potimalal section is located 93 km south–southwest of Malargüe, close to Bardas Blancas, Mendoza Province (Fig. 1). The Bardas Blancas region is characterized by a north–south-oriented basement uplift known as the Bardas Blancas anticline, which is deeply dissected by the Río Grande. The western flank of the anticline has been deformed by a back thrust that affects the Choyoi group. Similarly, the Jurassic–Cretaceous sedimentary cover plunges westward, forming a series of small anticlines and synclines ancillary to the main structure.

Oxfordian carbonate strata of the La Manga formation, at Río Potimalal, contain small bioherms. The association of siliceous sponges was collected from these biohermal limestones. The bioherms, composed of bodily preserved sponges, are built from massive limestones and range in age from Plicatilis to Bifurcatus (Stipanicic, 1951, 1965; Riccardi, 1984).

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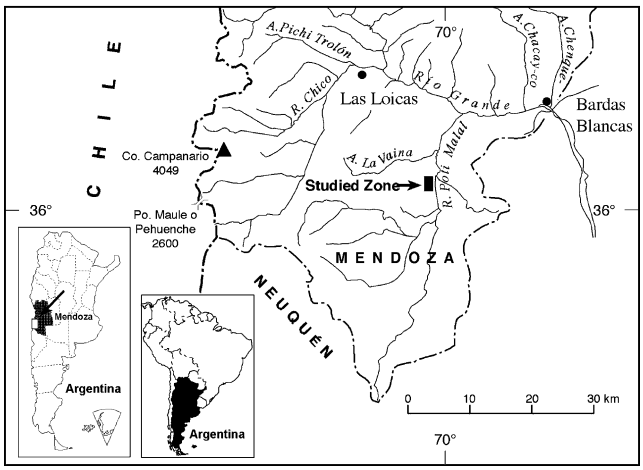


Fig. 1. Location of the studied Potimalal section, Mendoza, Argentina. Maps of South America and Mendoza province, central west Argentina.

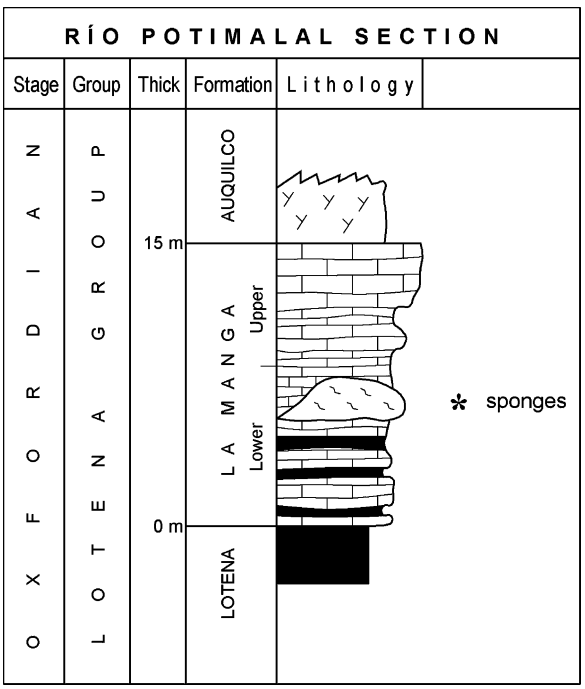


Fig. 2. Stratigraphic column from the La Manga formation exposed at Río Potimalal, southern Mendoza province. The asterisk indicates the position of the sponge bioherms.

The benthic assemblage consists almost exclusively (95%) of siliceous sponges. It includes species of the Hexactinellida, which account for 90% of the total number of sponges. These sponges inhabited a deeper shelf environment. The sponge assemblage comprises both hexactinellids (Hexactinosa 73% and Lyssacinosa 17% of the sponge fauna) and demospongiae (primarily lithistids 10%). Herein, only the Hexasterophora (Hexactinellida) were studied. The complete systematic part of this study will be included in a subsequent work.

For the purpose of this study, the Río Potimalal section was sampled. Almost all the sponge skeletons found at this Potimalal section were calcified, though several sponges were preserved in their original siliceous form. Relatively well-preserved siliceous spicules have been obtained from samples processed by etching in a weak acid solution.

Oxfordian sponges of the Neuquén basin have not been previously described. Data on sponge facies in this basin of western Argentina are scarce in the general geological literature. Legarreta (1991) mentioned siliceous sponges and sponge spicules as skeletal components of the sedimentary facies of the La Manga formation. The most recent reports of these fossils may be found in Beresi (1998, 1999, 2002).

## 2. Geological setting

Oxfordian carbonates are exposed throughout the Mendoza and Neuquén provinces, located in central west Argentina, and form part of the Cordillera Principal. During the Lower and Middle Oxfordian, part of the region was extensively flooded as a result of a relative sea level rise (Uliana and Biddle, 1988). Shelf carbonate facies dominated in southern Mendoza. Toward the end of the Lower Oxfordian and the base of the Upper Oxfordian, carbonate sedimentation spread to the whole basin as a result of the steady sea level rise.

The Upper Jurassic is represented by the Lotena and Mendoza groups in the Potimalal section. The Lotena, La Manga, and Auquilco formations compose the Lotena group (Fig. 2). The carbonate shelf facies is known as the La Manga formation. In southern Mendoza, the carbonate facies may have been deposited in a ramp that evolved to a carbonate platform environment with a clearly defined shelf edge (Legarreta, 1991).

In the Potimalal section, the La Manga formation consists of 10–15 m of fossiliferous deep-water deposits. It is lithologically composed of basinal and slope micritic limestones and black shales with brachiopods. In the La Manga formation, Gulisano and Gutiérrez Pleiming (1994) defined two units. The lower unit is 2.5 m thick with a sharp base lithologically composed of skeletal wackestones and olive-grey calcareous claystones, stratified in tabular beds of medium thickness and partly massive. The upper unit is 11 m thick, and the base has a sharp contact. This unit is olive-grey skeletal to intraclastic (packstone–wackestone), stratified in thick to medium beds. The fossil content is characterized by bivalves and ammonites. Sponges were found in small bioherms of the lower unit of the La Manga formation. Sponge facies correspond to siliceous sponge framestones. Bioherms at Río Potimalal are characterized by massive and moderately bored limestones with small sizes, about 0.5 m wide by 1.2 m high. Almost all the sponges from this Oxfordian section are hexactinellids

(most of which are dictyds); very few specimens of lithistid sponges were found.

## 3. Sponge facies

The facies, depositional sequences, and global sea level changes of the Callovian–Oxfordian carbonate margin in the Neuquén basin were analyzed in depth by Legarreta (1991), who focused on identifying sequence and system tract boundaries. Ammonites have provided most of the biostratigraphic evidence for the correlation of these rocks with sections in other localities of the Neuquén basin (Riccardi, 1984).

For this work, the facies of sponge-biohermal limestone are defined according to Legarreta's (1991) following facies analysis:

> Facies 2: Pelecypod floatstone with skeletal wackestone and siliceous sponge framestone
> *Facies 2b: siliceous sponge framestone. This unit consists of grey and moderately bored buildups, made of sponges (hexactinellids and lithistids), and associated serpulid worms and rare bryozoans. The matrix is a skeletal wackestone consisting of small oysters and pelecypod fragments, gastropods, and spicules, and with a subordinate participation of echinoids, forams and calcispheres. Buildups are massive with variable dimensions and geometry. Shapes are primarily pyramidal and range from small bodies with sizes from 0.5 m wide and 0.3 high to larger bioherms being 5 m wide and 3–5 m high. The buildup cores are surrounded and covered by crudely stratified pelecypod floatstones.The presence of siliceous sponges buildups situated in a micrite rich-limestone mass indicates relatively deep and quiet water. The palaeo-water-depth estimates derived from the stratigraphic reconstruction suggest that the sponge buildups developed around 50 m below sea level.

According to Legarreta (1991), this facies corresponds to the second sequence 105.5–149.5 Ma and consists of a 15 m thick, ramp-shaped depositional wedge that also thins into basinal deposits less than 5 m thick west of Bardas Blancas. This second depositional sequence was laid down during the Middle Oxfordian Plicatilis (Stipanicic, 1965; Riccardi, 1984). For more details on the other facies, sequences, and fauna, see Legarreta (1991).

## 4. Association of sponges from the biohermal limestones

In the investigated locality (Fig. 2), a total of 67 sponge specimens have been collected, including complete sponges and larger fragments. Of the specimens 55% have been identified to the genus or family level, and nine species have been recognized. Among the remaining 45%, represented by poorly preserved sponge specimens, approximately 15% could not be precisely identified (Figs. 3–6).

Siliceous sponges commonly exhibit calcareous preservation and comprise both hexactinellids (Order Hexactinosa 73% and Lyssacinosa 17% of the sponge fauna) and demospongiae (primarily lithistids 10%) (Fig. 7). Hexactinosa are the most common among the studied sponges of the Potimalal section. This group became very diversified and common in the Late Jurassic (Trammer, 1982, 1989; Pisera, 1997).

The dominant growth forms (Fig. 8) are cylinders (45%) and tubes (35%, e.g. *Laocoetis*). Cup-shaped forms are less common (20%). Cylinders grow up to 200 mm in size, whereas cups are smaller than 120 mm.

Sponges with a rigid skeleton are embedded in a micritic matrix in the bioherms that developed by an abundant accumulation of sponges, more abundant than in the surrounding rocks. The matrix is hard and compact micritic limestone. Texturally, the matrix of the bioherms is composed of a medium-grey fine skeletal wackestone with scattered fragments of small oysters and pelecypods. A fauna with low diversity, but rich in specimens of hexactinellids (most of which are dictyds), is the dominant component of the biota.

Most sponges are in a living position inside the bioherms and are preserved as larger fragments. Only a few sponges have encrustation of serpulids and brachiopods. No microbial crusts overgrew the sponges. No isolated root tuffs have been seen in the massive limestones.

The Oxfordian sponge-bearing limestones of the Neuquén basin are considered to have originated in outer-shelf environments and below the storm wave base. This is suggested by the absence of sedimentary structures, indicative of wave action, and the sponge fauna typical of deep-shelf habitats. There are not corals, gastropods, or calcareous sponges in this facies.

The lithological and paleontological analyses suggest that the sponge associations grew in a deep-water environment characterized by a firm substrate, low rates of sedimentation, and low to moderate water energy, which represents a slight deepening of the platform. The taxonomic composition, dominance of hexactinellids, and absence of calcareous sponges and corals, as well as the very low proportion of encrusters, also suggests deep-water environments. Consequently, the environment was optimum for the growth of sponges but not of other faunal elements. The assemblage was situated on the outer shelf with normal marine salinity and a very low sedimentation rate that enabled the growth of these sponge types, which formed small bioherms. The occurrence of the siliceous sponge faunas is associated with high sea level.

This is in agreement with the important global rise of sea level that took place during the Early Oxfordian. The resulting transgression induced an unusually low sedimentation rate. The sea floor was colonized by this

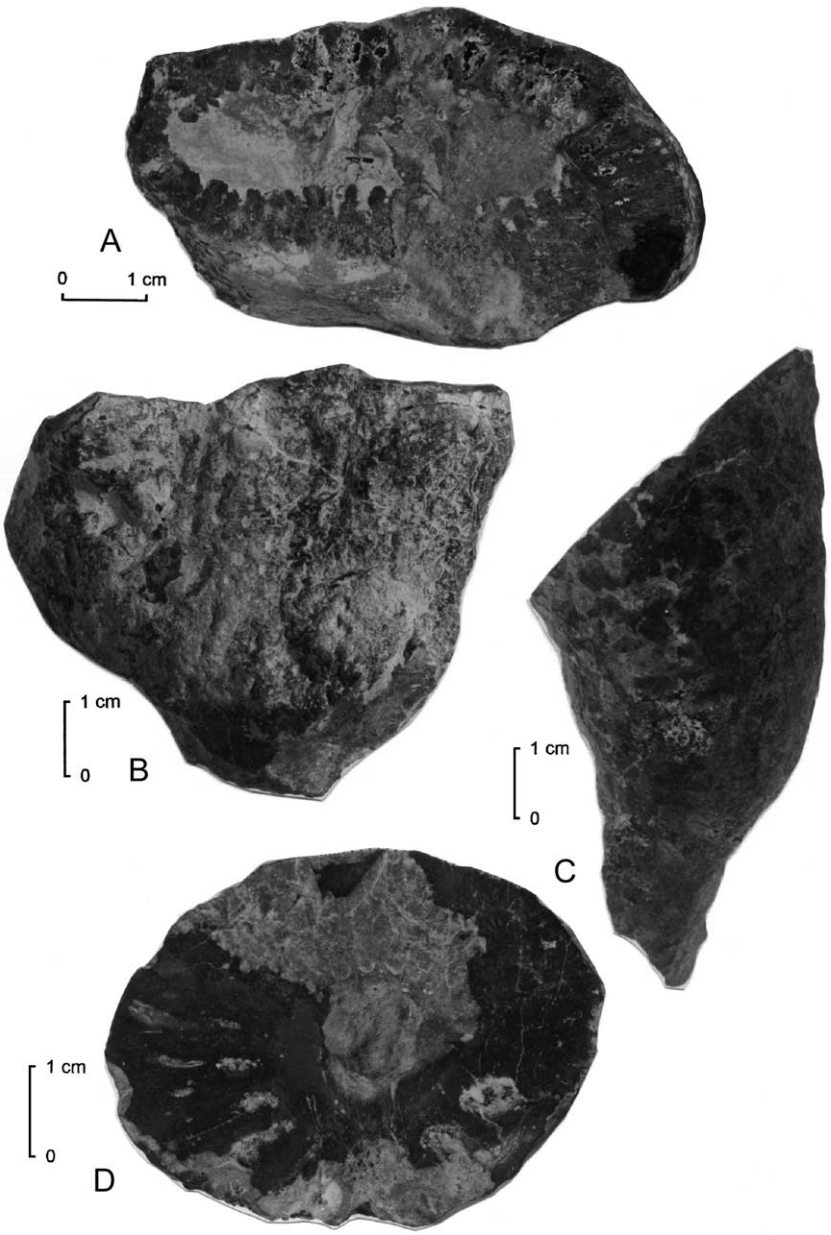


Fig. 3. (A) Upper view of the narrow osculum and folded wall in a cribospongiid sponge. (B) Lateral view of *Laocoetis clathrata*. (C) Lateral view of *Laocoetis* sp. (D) Upper view of the same sponge showing the thick wall and the small circular osculum.

type of sponge during periods of zero or low sedimentation, thereby producing an indurate sea floor.

The siliceous sponge bioherms from the La Manga formation in the Neuquén basin characterize a deep platform and a cold water environment in the *Plicatilis* zone.

## 5. Systematic

The siliceous sponges are represented almost exclusively by hexactinellids. Most of the collected sponges is representative of the Order Hexactinosa Schrammen, 1903. Only sponges with fused choanosomal skeletons composed of dictyonal strands are included here (following Pisera (1997)).

Most of the specimens belong to the genus *Cribrospongia* D'Orbigny, 1849 ( = *Tremadictyon* Zittel, 1877). These specimens include sponges that show the skeleton structure and canal-opening arrangement in diplorysis *Quincunx* (Krautter, 1997).

The most common sponges of to the Family Cribrospongiidae are cup-shaped (*Cribrospongia reticulata*), tubular, and conical. Only a few specimens are triangular in shape and compressed (*Cribrospongia cucculata*) up to 130 mm high and 70 mm wide, with a very narrow paragaster as a fissure of $45 \times 11$ mm$^2$ in diameter. The dermal side, with large oval to rounded canal openings from

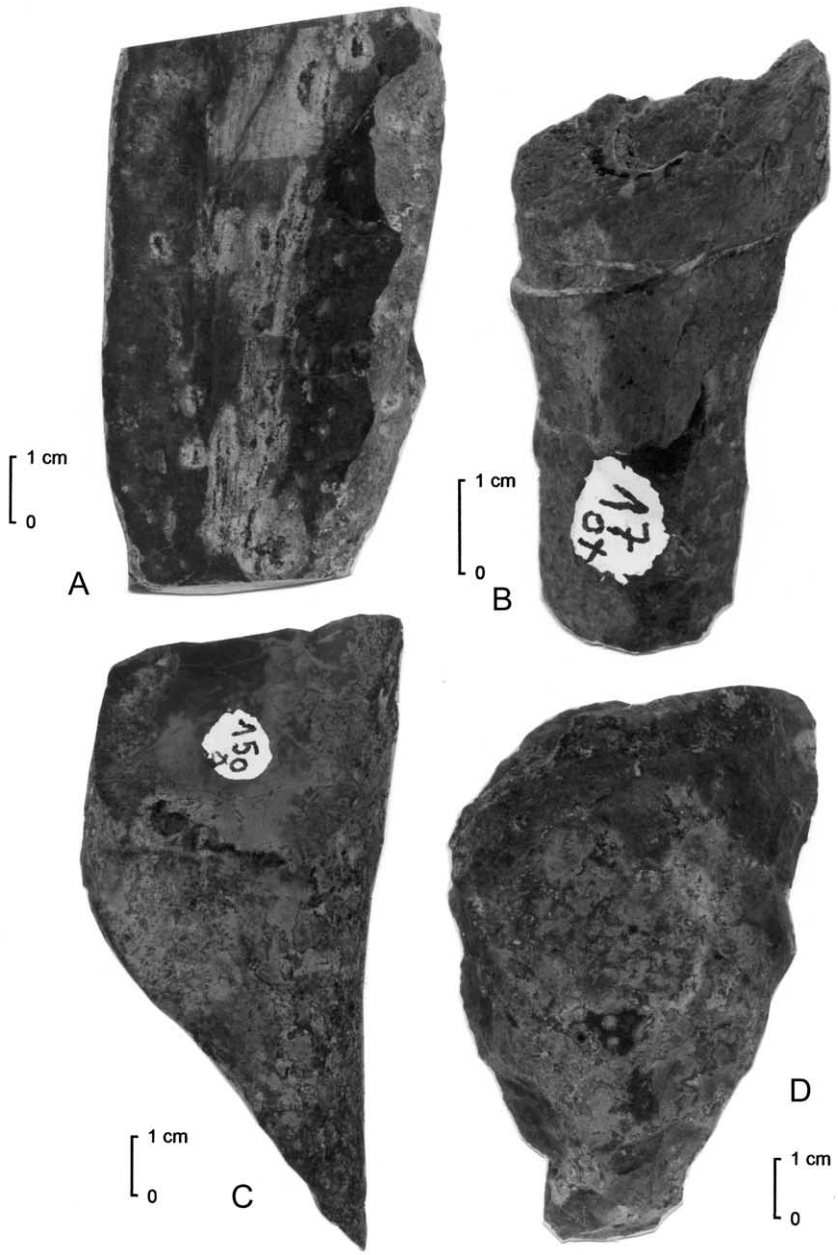


Fig. 4. (A) Longitudinal section of a tubular cribrospongiid sponge. (B) *Laocoetis procumbens*, lateral view. (C) Lateral view of a cylindrical sponge. (D) Lateral view of *Cribrospongia cucculata*.

$2 \times 2.5$ to $2.7 \times 3.5$ mm$^2$, follow a cribrospongidae pattern. The dictyonal skeleton has regular meshes measuring $0.2 \times 0.3$ mm$^2$.

The 10% of the Oxfordian sponge fauna analyzed from the Potimalal section belongs to the genus *Laocoetis* (= *Craticularia* Zittel, 1877; *emend.* Schrammen, 1937). These specimens are fragments of cylindrical to tubular sponges with heights varying between 100–200 mm and widths up to 85 mm with a wide simple osculum at top. The sponges have walls up to 16 mm thick. The external surface is pierced by canal openings of 0.9–1.0 mm in diameter. The dermal surface of the dictyonal skeleton is pierced by rounded and oval canal openings that measure in various specimens from 0.6 to 4 mm in diameter, organized in a typical laocoetid diplorhisys pattern. They are separated by very regular longitudinal skeletal bands 0.8–1.3 mm wide, giving the impression that they are organized in longitudinal rows. Dictyonal skeletons with normally rectangular meshes measure $0.2 \times 0.3$–$0.5 \times 0.6$ mm$^2$. Dictyonal strands diverge toward both surfaces and arch toward the outer margin.

Loose disassociated spicules of large hexactines (pentactines) and rhabdoactines from three specimens have been obtained through processing with an acid solution. The hexactine spicules are smooth and straight with square sections (0.4–0.6 mm wide). The large opaline siliceous

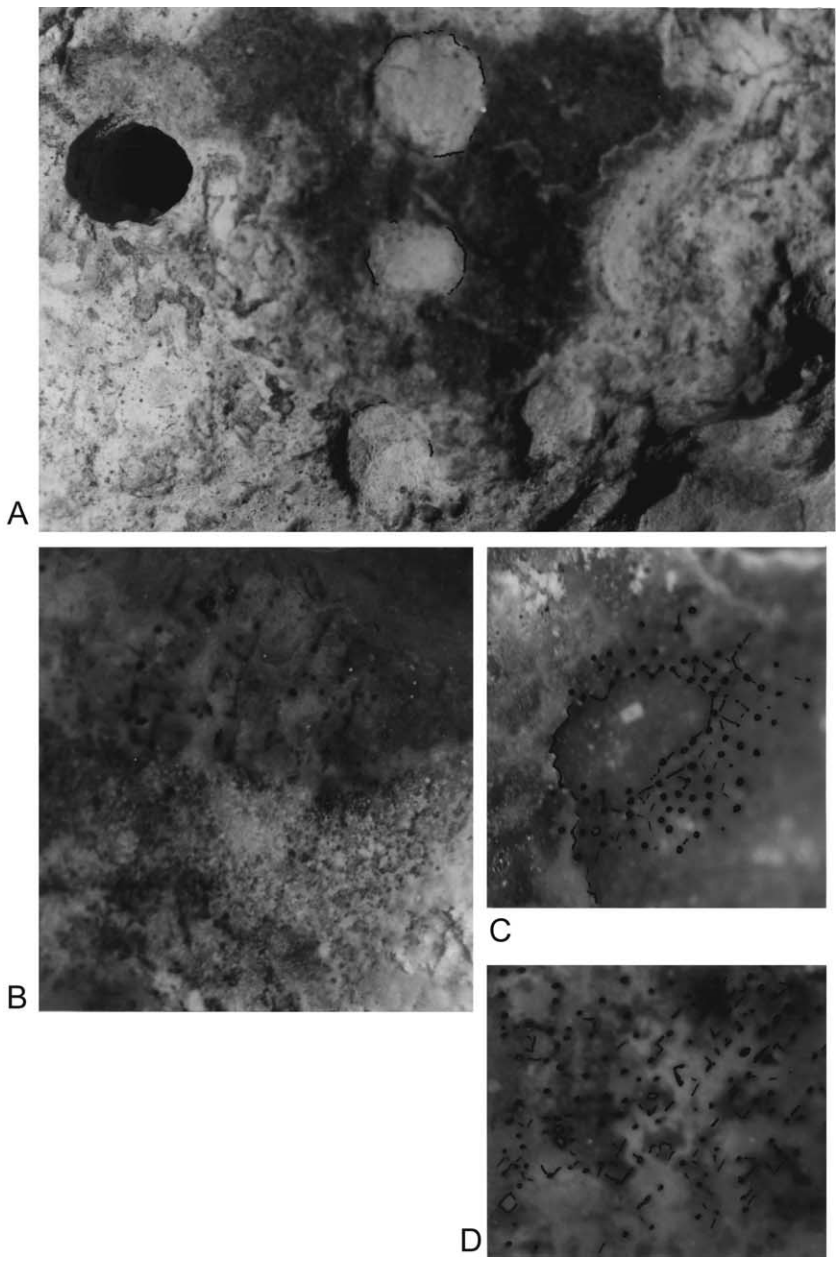


Fig. 5. Craticulariid sponges. (A) Dermal surface showing the alternating nature of circular canal openings (craticulariid diplorhysis). (B) Dictyonal strands bent toward the dermal surface. (C) Spicules around a canal opening on dermal surface. (D) Dictyonal strands inclining toward the dermal surface. Lower left canal opening.

hexactines are normally broken at the extremes; they appear up to 2.7 mm long. The rhabdoactines measure from 1.8–2.2 mm long and 0.3 mm wide. These spicules belong to the Subclass Hexasterophora Schulze, 1887, Order Lyssacinosa Zittel, 1877. The presence of hexactines and rhabdoactines is indicative of the genus *Polygonatium*, according to Schrammen (1937) and Pisera (1997).

Only siliceous hexactinellid sponges have been included in the following list; no lithistid sponges have been studied so far. Sponges are stored in the collection of the Departamento de Paleontología y Geología del IANIGLA-Cricyt, Mendoza (IANIGLA-PI 924-981).

### *5.1. Faunal list of the sponge taxa at Río Potimalal section*

Hexactinosa

*Cribrospongia* ( = *Tremadictyum*) sp.
*Cribrospongia* ( = *Tremadictyum*) *reticulata* (Goldfuss, 1826)
*Cribrospongia* ( = *Tremadictyum*) *cucullata* (Quenstedt, 1878)
*Laocoetis* ( = *Craticularia*) *paradoxa* (Goldfuss, 1833)
*Laocoetis* ( = *Craticularia*) *parallela* (Goldfuss, 1826)
*Laocoetis* ( = *Craticularia*) *procumbens* (Goldfuss,

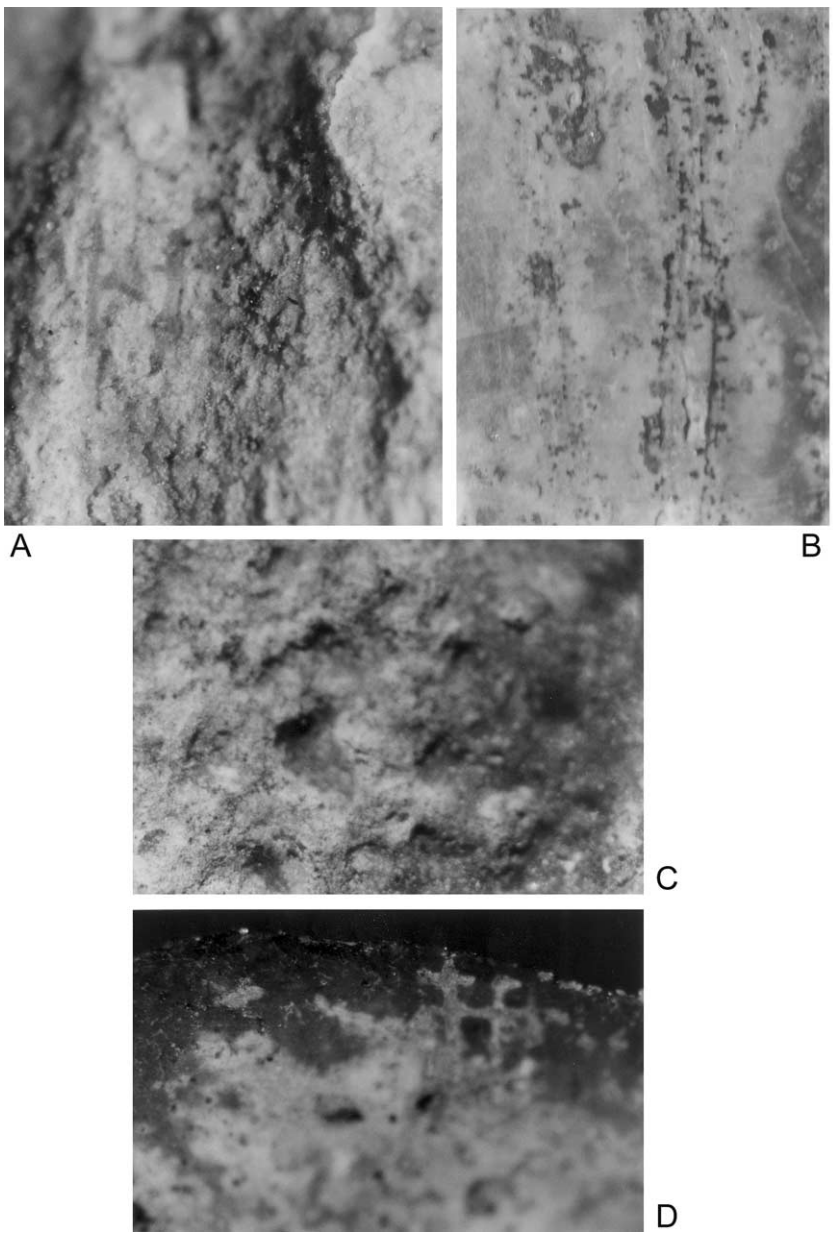


Fig. 6. Cribrospongiid sponges. (A) Rectangular meshes on gastral surface, 25 × . (B) Dictyonal strands, 8 × . (C) Canal pattern in *Cribrospongia* sp., 3 × . (D) Rectangular meshes on the dermal surface, around the osculum, 25 × .

1826)
*Laocoetis* ( = *Craticularia*) sp.
*Linonema calyx* (Schrammen, 1937)
*Ordinatus* sp.

Lyssacinosa

*Polygonatium sphaeroides* (Schrammen, 1937).

## 6. Final remarks

The sponge bioherms of the Río Potimalal section represent a small fraction of the space occupied by carbonates in the La Manga formation (Neuquén basin).

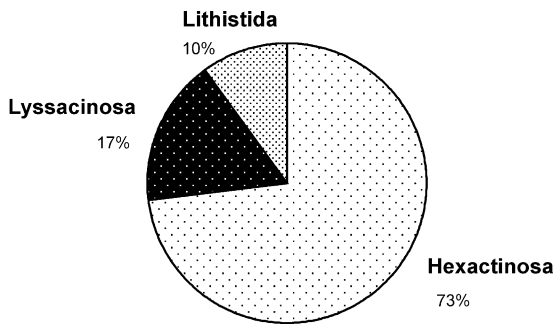


Fig. 7. Composition of sponge association in the biohermal facies of the La Manga formation.

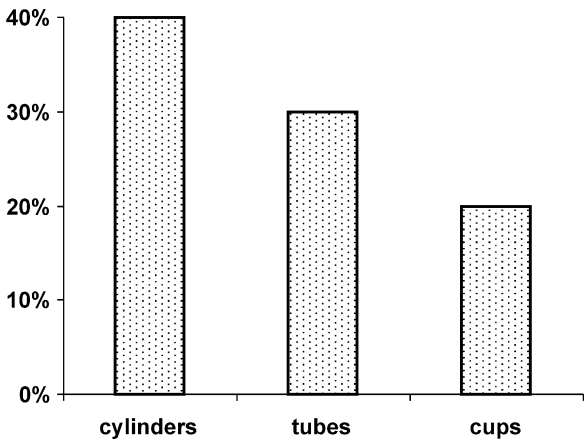


Fig. 8. Relative abundance of the most common sponge forms from the bioherm.

However, these small bioherms contain abundant siliceous sponges. The abundance or dominance of hexactinellid sponges in the range of the Oxfordian Plicatilis zone in the Neuquén basin is a common pattern of several geographic areas of the European sponge megafacies (Trammer, 1982, 1989; Pisera, 1997), as well as in the thick Middle to Late Oxfordian sequences of Poland. The occurrence of the sponge facies is correlated with a high sea level during the Oxfordian.

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