

LOWER DEVONIAN STROMATOPOROIDS FROM THE NORTHERN OBEJO-VALSEQUILLO-PUEBLA DE LA REINA DOMAIN (BADAJOZ AND CÓRDOBA PROVINCES, SOUTHERN SPAIN)

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ABSTRACT

The stromatoporoid fauna from three locations in the “Peñón Cortado Limestone” (Pragian to Upper Emsian) from the area of Quintana de la Serena (Badajoz Province) and Peñarroya-Pueblonuevo (Córdoba Province) in the Obejo-Valsequillo-Puebla de la Reina Domain (Sierra Morena, Southern Spain) were investigated. The 71 stromatoporoid specimens collected belong to 11 different species.

The “Peñón Cortado” section in the Córdoba Province contains two different stromatoporoid-bearing horizons with very different fauna (bed 14 and bed 19b). In the older bed 14 dominates *Plectostroma salairicum* (Javorskij, 1930), meanwhile in the younger bed 19b *Actinostroma compactum* Ripper, 1933 and *Pseudotruperostroma anacontentoae* May, 2005b dominate. The fauna of the younger bed 19b of the location “Peñón Cortado” correlate well with the stromatoporoid-bearing beds of the locations “Guadámex II” and “La Chamorra” in the Badajoz Province.

The absence of stromatoporoids with branched skeletons and the scarcity of stromatoporoids of the type which forms thin-layered crusts probably inhibited reef development. A possible explanation for this may be a relatively low water temperature.

Biogeographically, the fauna of the Sierra Morena belong to the Old World Realm and is closely related to Emsian fauna of Australia and Canada. The fauna indicate an Emsian age for the stromatoporoid-bearing beds in the “Peñón Cortado Limestone”. Furthermore, the stromatoporoids from the locations “Guadámex II” and “La Chamorra” suggest an Upper Emsian age much more strongly than a Lower Emsian age.

Keywords: Stromatoporoidea, reefs, Obejo-Valsequillo-Puebla de la Reina Domain, Devonian, Emsian, Biostratigraphy, Biogeography, Spain.

RESUMEN

Se han estudiado los estromatoporoideos de tres localidades en las “Calizas del Peñón Cortado” (Pragiense a Emsiense superior) de la cuenca de Quintana de la Serena (prov. de Badajoz) y Peñarroya-Pueblonuevo (prov. de Córdoba) en el Dominio Obejo-Valsequillo-Puebla de la Reina (Sierra Morena, Sur de España). Los 71 ejemplares de estromatoporoideos recogidos pertenecen a 11 especies diferentes.

La sección de la localidad “Peñón Cortado” en la provincia de Córdoba contiene dos horizontes diferentes con estromatoporoideos, que representan faunas muy distintas: En el horizonte más antiguo, nivel 14, domina *Plectostroma salairicum* (Javorskij, 1930), mientras que en el horizonte más moderno, nivel 19b, situado 51 m por encima de la capa 14, dominan *Actinostroma compactum* Ripper, 1933 y *Pseudotruperostroma anacontentoae* May, 2005b. La fauna de este último nivel se correlaciona muy bien con los horizontes con estromatoporoideos de las localidades “Guadámex II” y “La Chamorra” de la provincia de Badajoz.

La ausencia de estromatoporoideos con esqueletos ramificados y la escasez de estromatoporoideos que se incrustaban en capas finas inhibieron, probablemente, la construcción de arrecifes. Una explicación posible podría ser en relación con una temperatura relativamente baja del agua.

Biogeográficamente, la fauna de estromatoporoideos de Sierra Morena pertenece al Reino del Mundo Viejo (*Old World Realm*) y presenta afinidades muy estrechas con las faunas del Emsiense de Australia y Canadá. Dicha fauna indica una edad Emsiense para los horizontes con estromatoporoideos en las “Calizas del Peñón Cortado”. Además, los estromatoporoideos de las localidades “Guadámex II” y “La Chamorra” en la provincia de Badajoz sugieren con más fuerza una edad Emsiense superior que una Emsiense inferior.

Palabras clave: estromatoporoideos, arrecifes, Dominio Obejo-Valsequillo-Puebla de la Reina, Devónico, Emsiense, Bioestratigrafía, Biogeografía, España.

INTRODUCTION

Despite of some modern monographic treatments (e.g.: Webby *et al.*, 1993; Webby & Zhen, 1993; Prosh & Stearn, 1996; Webby & Zhen, 1997; May, 2005a), little is known of the evolution of stromatoproids during the Lower Devonian epoch. During this epoch, in the time between the Silurian reefs and the huge Givetian-Frasnian reefs, both stromatoproids and reefs were rather scarce.

On the other hand, the Sierra Morena in Southern Spain was known to contain Lower Devonian biostromal and biohermal limestones with both corals and stromatoproids (Rodríguez García, 1978; Moreno-Eiris *et al.*, 1995; García-Alcalde *et al.*, 2002). However, these stromatoproids of the Sierra Morena have never been examined in detail. Consequently, it was fortunate for me that Prof. Dr.

Sergio Rodríguez (Madrid) invited me to investigate them. This paper includes results of our current investigations.

STUDY AREA

The study area lies in the northern part of the Obejo-Valsequillo-Puebla de la Reina Domain (OVPRD) in the Sierra Morena in Southern Spain. The most recent overview of the Devonian of the OVPRD was given by García-Alcalde *et al.* (2002: 82).

In the part of the OVPRD investigated, the Devonian succession commences with sandstones and shales, overlain by Emsian siltstones with calcareous beds. These calcareous beds are named “Peñón Cortado Limestone” (Rodríguez García, 1978; Moreno-Eiris *et al.*, 1995). They contain abun-

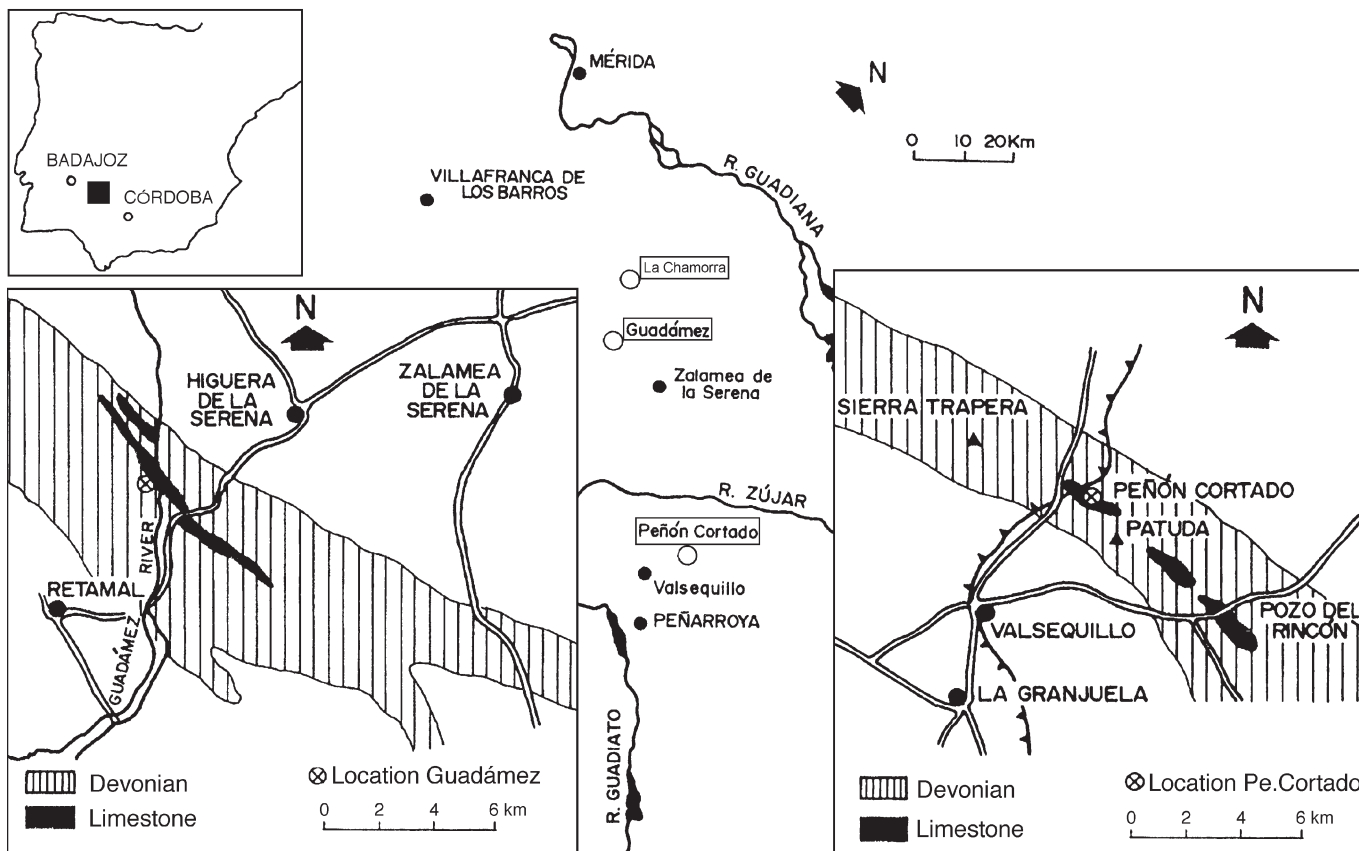


Figure 1. Geographical positions of the investigated locations in the Sierra Morena (modified after Moreno-Eiris *et al.*, 1995).

dant tabulate corals, common rugose corals, and stromatoporoids. A part of these calcareous beds are biostromes. Other beds were interpreted as being products of the destruction of buildups. However, no true buildups were recorded in the study area (Moreno-Eiris *et al.*, 1995: 19).

Rodríguez García (1978) and Moreno-Eiris *et al.* (1995) assign an Upper Emsian age to the “Peñón Cortado Limestone”. However, Miguel V. Pardo Alonso (Universitat de València, oral communication) found in the lower part of the “Peñón Cortado” section brachiopods of the Pragian.

A detailed description of all investigated locations in the “Peñón Cortado Limestone” is provided by Rodríguez García (1978). Furthermore, an updated description of the locations “Peñón Cortado” and “Guadámex II” is provided by Moreno-Eiris *et al.* (1995: 43-44). Consequently, the following contains only a short description of the locations. The geographical position of the locations is shown in figure 1.

Location “Guadámex II”

The “Guadámex II” section is located in the Badajoz province on the western bank of the Guadámex River, two kilometres to the northwest of kilometre 12 of the road from Campillo de Llerena to Higuera de la Serena. The outcropping sequence, some 85 metres thick, of fossiliferous limestones and marls was subdivided into 22 beds by Rodríguez García (1978) and Moreno-Eiris *et al.* (1995). A lithostratigraphical column of the location is given in figure 2. Miguel V. Pardo Alonso (oral communication) found in the upper part of the sequence brachiopods of probable Upper Emsian age.

All 32 stromatoporoid specimens were collected from bed 19 and, directly below, from the uppermost metre of bed 18. Bed 19 is a massive limestone, 3.5 metres thick, consisting of a biostrome. Bed 18 is a marlstone, 7 metres thick, which contains in its uppermost metre many *Thamnopora* layers and laminar reef-builders (favositids and stromatoporoids). Favositids and stromatoporoids increase in importance upwards towards the top of bed 19 where bulbous stromatoporoids dominate.

The stromatoporoids belong to the species *Actinostroma compactum* Ripper, 1933, *Schistodictyon* n. sp. aff. *amygdaloides* (Lecompte, 1951), *Stromatoporella granulata* (Nicholson, 1873), *Clathrocoilona* sp., *Stromatopora* ex gr. *polaris* (Stearn, 1983), *Pseudotrurpetostroma anacontentoae* May, 2005b, *Syringostromella zintchenkovi* (Chalfina, 1960), and *Parallelostroma sinense* Yang & Dong, 1979. In the lower part of bed 19 prevail the stromatoporoids *Stromatopora* ex gr. *polaris* (Stearn, 1983) and *Pseudotrurpetostroma anacontentoae* (May, 2005b), while in the upper part of bed 19 *Actinostroma compactum* (Ripper, 1933) and *Parallelostroma sinense* Yang & Dong, 1979 prevail. Remarkable is the occurrence of the syringoporid tabulate coral *Syringocystis* sp. in the upper part of bed 19. Bed 19 contains small amounts of the cal-

careous alga *Rothpletzella* spec. and crusts of spongiostromate calcareous algae.

The material is relatively well preserved and shows only very slight tectonic deformation.

Location “La Chamorra”

The outcrop “La Chamorra” is located in the Badajoz province, 4 kilometres to the northnorthwest of kilometre 4 of the road from Valle de la Serena to Puebla de la Reina. The outcrop is between “Cerro del Membrillo” and “Cerro Paliza” on the southwestern slope of the hill. (It is in the southernmost of the two northern limestone bands on the geological map.) It is few hundreds meter southeast of the profile published by Rodríguez García (1978: fig. 2). Because of the poor preservation of the outcrop a direct comparison with the profile of Rodríguez García (1978: fig. 2) is not possible. However, it is clear that the collected material is from the upper part of this sequence.

The limestones contain abundant different types of tabulate corals (favositids, alveolitids, coenitids, and heliolitids). Stromatoporoids and solitary rugose corals are frequent. Bryozoans and cerioid rugose corals are relatively rare. A large part of the 23 stromatoporoid skeletons collected is more or less strongly affected by recrystallization and/or tectonic deformation. Nevertheless, it was possible to identify the following species: *Actinostroma* cf. *stellulatum* Nicholson, 1886, *Stromatopora* ex gr. *polaris* (Stearn, 1983), *Pseudotrurpetostroma anacontentoae* May, 2005b?, *Salairrella* sp., and *Syringostromella zintchenkovi* (Chalfina, 1960).

Location “Peñón Cortado”

The “Peñón Cortado” section is located in the Córdoba province, 5 kilometres north of Valsequillo, at the Córdoba-Almorchón railway cutting (at kilometre 35.5 of the railway). The outcropping sequence, some 110 m thick, consists of fossiliferous limestones, marls, and shales. A subdivision of the section into 19 beds was made by Rodríguez García (1978) and Moreno-Eiris *et al.* (1995). A lithostratigraphical column of the location is given in figure 2. Miguel V. Pardo Alonso (oral communication) found in the lower part of the sequence brachiopods of the Pragian; however, an Emsian age of the stromatoporoid-containing beds (which are located in the middle and upper part of the sequence) is possible.

Despite the great effort made in the search for stromatoporoids, it was only possible to find them in the beds 14 and 19b. However, instead of stromatoporoids, fistuliporid bryozoans occur in the base of bed 9 and in bed 12.

In bed 14 were found eleven stromatoporoid specimens. Dominating among the stromatoporoids is *Plectostroma salairicum* (Javorskij, 1930), *Syringostromella zintchenkovi* (Chalfina, 1960) occurs only rarely. Bed 14 is a 13.5 m thick, massive limestone with large colonies of favositids, stromatoporoids, and the colonial rugose

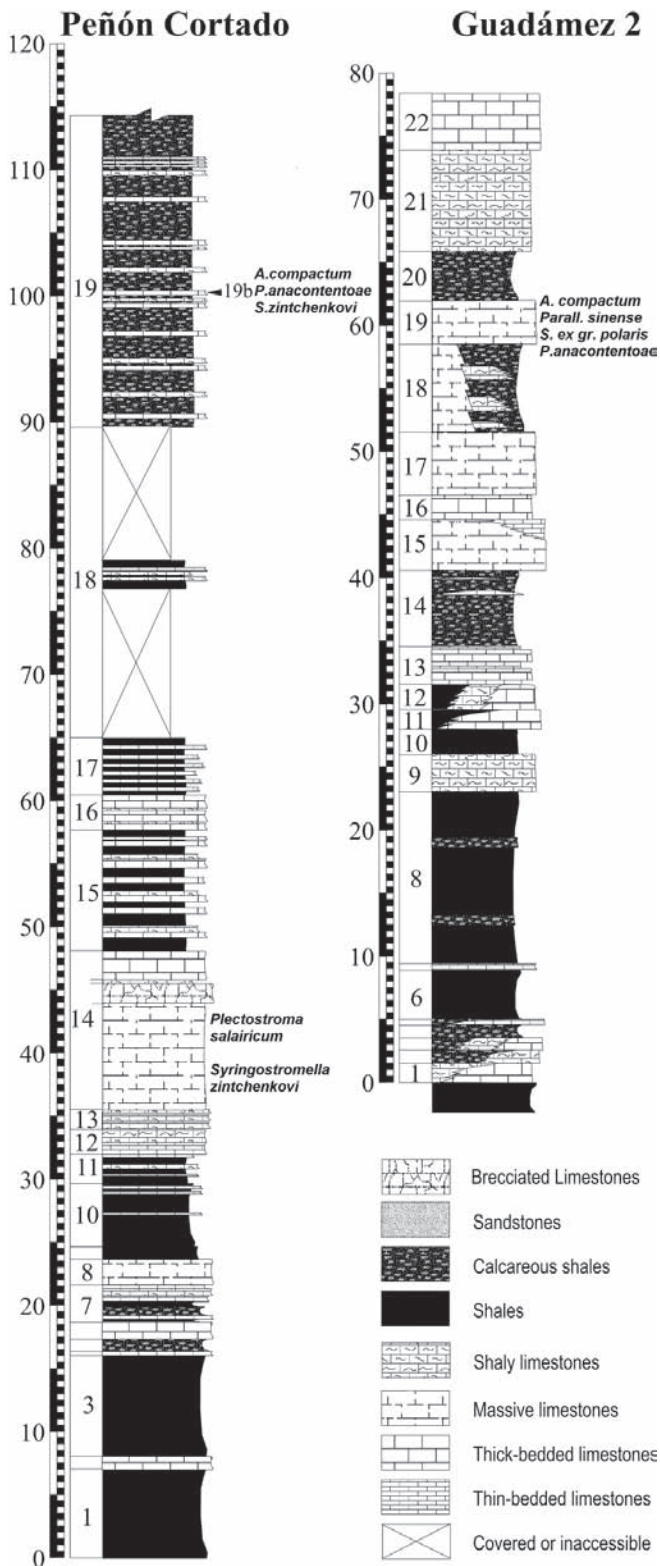


Figure 2. Lithostratigraphical columns of the locations “Guadamez II” (Badajoz province) and “Peñón Cortado” (Córdoba province) in the OVPRD in the Sierra Morena (provided by Sergio Rodríguez). The stromatoporoid-bearing beds are marked by the names of found stromatoporoid species. The scale is metres.

coral *Hexagonaria soraufi* Rodríguez García, 1978. In some parts auloporid tabulate corals and bryozoans occur. Moreno-Eiris *et al.* (1995: p. 44) regarded bed 14 as a product of the destruction of build-ups.

Five stromatoporoids, belonging to the species *Actinostroma compactum* Ripper, 1933, *Pseudotrurpetostroma anacontentoae* May, 2005b, and *Syringostromella zintchenkovi* (Chalfina, 1960), were collected from bed 19b, a 1.5 m thick layer of thick-bedded limestone 10 m above of the base of bed 19. Bed 19b is about 51 m above the top of bed 14.

All collected stromatoporoids are relatively well preserved and show only very slight tectonic deformation.

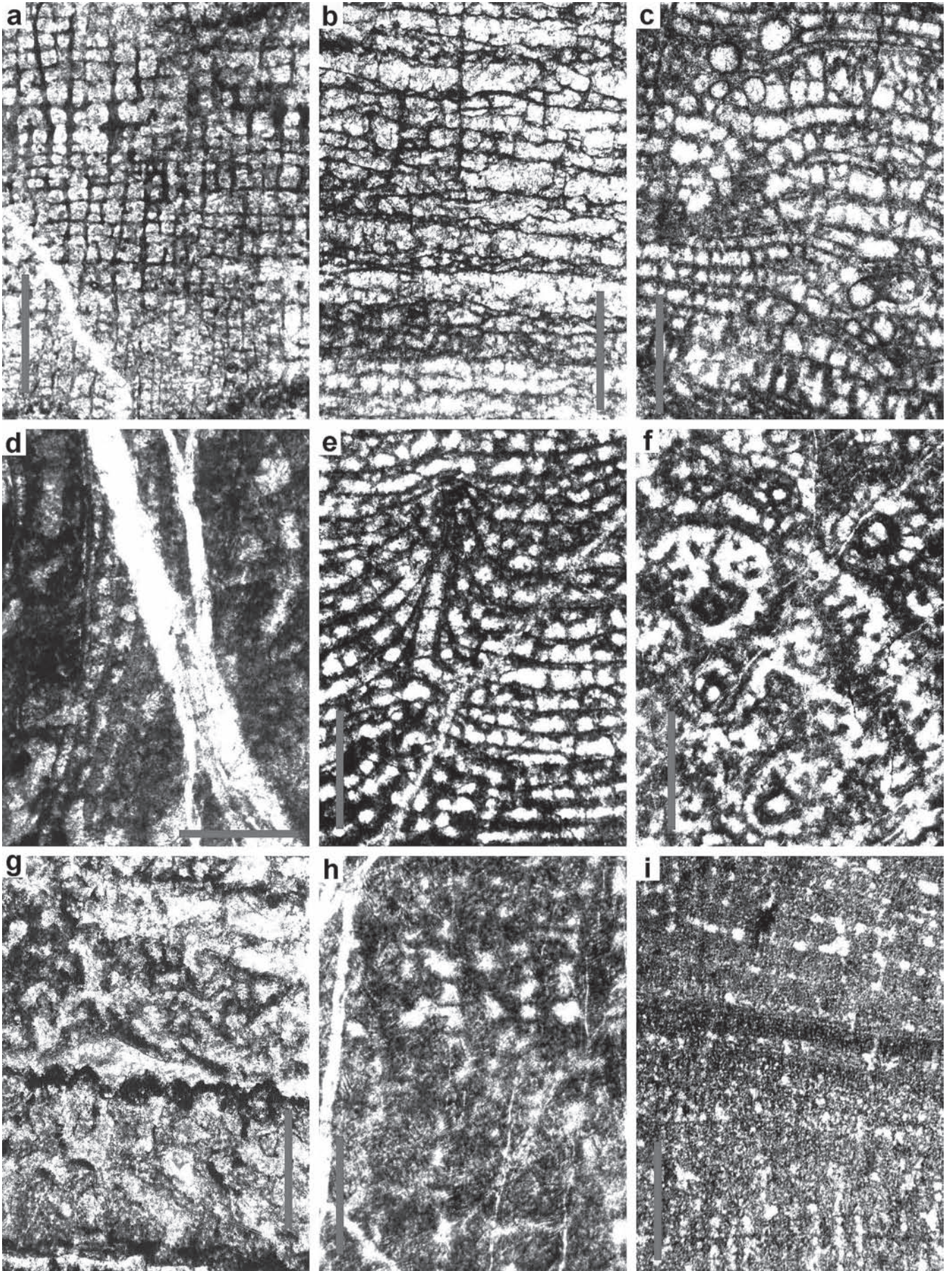
MATERIAL AND METHODS

Longitudinal (=vertical) and tangential thin sections have been taken from all stromatoporoid specimens collected. A list of the species found and the number of specimens of each species is given in table 1. The most important species are represented in figure 3. The methodology, terminology, and classification (including the genus definitions) follow those of Stearn *et al.* (1999). The material is stored in the Departamento de Paleontología, Universidad Complutense, Madrid.

STRATIGRAPHICAL CORRELATION BETWEEN THE LOCATIONS BY STROMATOPOROID SPECIES

One important question for our investigations is: how can the location “Peñón Cortado” (Córdoba province) be correlated to the locations in the Badajoz province? Be-

Figure 3. Important stromatoporoids of the “Peñón Cortado Limestone” (Emsian) in the OVPRD in the Sierra Morena. The scale is always 1 mm long. **a**, *Actinostroma compactum* Ripper, 1933, longitudinal section (DPM-00276/S11); location “Guadamez II”. **b**, *Plectostroma salairicum* (Javorskij, 1930), longitudinal section (DPM-00276/S1); location “Peñón Cortado”. **c**, *Schistodictyon* n. sp. aff. *amygdaloides* (Lecompte, 1951), longitudinal section (DPM-00276/S6); location “Guadamez II”. **d**, *Clathrocoilona* sp., longitudinal section (rotated by 90°) (DPM-00276/S16); location “Guadamez II”. **e**, *Pseudotrurpetostroma anacontentoae* May, 2005b, longitudinal section (holotype, DPM-00276/S15); location “Guadamez II”. **f**, *Pseudotrurpetostroma anacontentoae* May, 2005b, tangential section (holotype, DPM-00276/S15); location “Guadamez II”. **g**, *Stromatopora* ex gr. *polaris* (Stearn, 1983) longitudinal section (DPM-00276/S9); location “Guadamez II”. **h**, *Syringostromella zintchenkovi* (Chalfina, 1960), longitudinal section (DPM-00276/S3); location “Peñón Cortado”. **i**, *Parallelostroma sinense* Yang & Dong, 1979, longitudinal section (DPM-00276/S7); location “Guadamez II”.



tween “Peñón Cortado” and the locations in the Badajoz province is a distance of about 54 kilometres. Intuitively one might expect that the stromatoporoid-bearing beds in the Badajoz province are equivalent to the thick fossiliferous bed 14 of the location “Peñón Cortado” (Fig. 2).

Table 1 shows clearly, that bed 14 of the location “Peñón Cortado” has only the ubiquitous *Syringostromella zintchenkovi* (Chalfina, 1960) in common with the stromatoporoid-bearing beds of the locations “Guadámex II” and “La Chamorra” in the Badajoz province. The dominant stromatoporoid of bed 14, *Plectostroma salairicum* (Javorskij, 1930), occurs only here. Consequently, bed 14 of the location “Peñón Cortado” can not be stratigraphically correlated to the stromatoporoid-bearing beds of the locations in the Badajoz province.

However, the younger bed 19b of the location “Peñón Cortado” (Fig. 2) correlates very well to the location “Guadámex II” in the Badajoz province, because *Actinostroma compactum* Ripper, 1933 and *Pseudotrurpetostroma*

anacontentoae May, 2005b are the dominant stromatoporoids in the bed 19 (and in the uppermost part of bed 18) of the location “Guadámex II” as well as in the bed 19b of the location “Peñón Cortado”.

The correlation of the stromatoporoid-bearing beds of the location “La Chamorra” to the bed 19 of the location “Guadámex II” and the bed 19b of the location “Peñón Cortado” can be justified by following observations:

- *Stromatopora* ex gr. *polaris* (Stearn, 1983) and *Pseudotrurpetostroma anacontentoae* May, 2005b occur in the location “La Chamorra” as well as in the location “Guadámex II”. (Unfortunately, the *P. anacontentoae* of “La Chamorra” is poorly preserved.)

- *Actinostroma* cf. *stellulatum* Nicholson, 1886, the dominant stromatoporoid of the location “La Chamorra”, is closely related to *Actinostroma compactum* Ripper, 1933.

To continue, bed 19b of the location “Peñón Cortado” can be correlated stratigraphically with bed 19 (and the

Species in the Sierra Morena	Peñón Cor. – Bed 14	Peñón Cor. – Bed 19b	Guadámex II	La Chamorra	Bohemia	Victoria	Canada
<i>Actinostroma compactum</i> Ripper, 1933	-	2 specimens	10 specimens	-	Genus	Species	Genus
<i>Actinostroma</i> cf. <i>stellulatum</i> Nicholson, 1886	-	-	-	10 specimens	Genus	Genus	Genus
<i>Plectostroma salairicum</i> (Javorskij, 1930)	10 specimens	-	-	-	Genus	Genus	Species
<i>Schistodictyon</i> n. sp. aff. <i>amygdaloides</i> (Lecompte, 1951)	-	-	2 specimens	-	Genus	Genus	Genus
<i>Stromatoporella granulata</i> (Nicholson, 1873)	-	-	1 specimen	-	Genus	Genus	Genus
<i>Clathrocoilona</i> sp.	-	-	3 specimens	-	-	-	Genus
<i>Stromatopora</i> ex gr. <i>polaris</i> (Stearn, 1983)	-	-	3 specimens	3 specimens	-	Species	Species
<i>Pseudotrurpetostroma anacontentoae</i> May, 2005b	-	2 specimens	7 specimens	1 doubtful specimen	-	Genus	-
<i>Salairilla</i> sp.	-	-	-	3 specimens	Genus	Genus	Genus
<i>Syringostromella zintchenkovi</i> (Chalfina, 1960)	1 specimen	1 specimen	1 specimen	2 specimens	Genus	Species	Species
<i>Parallelostroma sinense</i> Yang & Dong, 1979	-	-	5 specimens	-	-	-	-
Indeterminable stromatoporoids	-	-	-	4 specimens			
Total number of specimens	11	5	32	23			

Table 1. Compilation of the stromatoporoid species found in the OVPRD in the Sierra Morena. The columns “Peñón Cortado – Bed 14” to “La Chamorra” give the number of specimens collected there. To the right there follows a comparison of the stromatoporoid fauna of the OVPRD with the stromatoporoid fauna of the Middle Pragian of Bohemia (May, 1999, 2002, 2005a), the Pragian to Lower Emsian of Victoria (Australia) (Webby *et al.*, 1993) and the Lower Emsian to Lower Eifelian of Arctic Canada (Prosh & Stearn, 1996). The entry “Species” signifies that the same species occurs as in the OVPRD. The entry “Genus” signifies that the same genus occurs as that of the OVPRD, although not the same species.

uppermost part of bed 18) of the location “Guadámex II” and the stromatoporoid-bearing beds of the location “La Chamorra”.

BIOSTRATIGRAPHY AND BIOGEOGRAPHY

Literature data of the found stromatoporoid species

Descriptions of *Actinostroma compactum* Ripper, 1933 were given by Webby *et al.* (1993: 123–125), Webby & Zhen (1997: 17) and May (1999b: 99–100). Beside its occurrence in the OVPRD in the Sierra Morena, *Actinostroma compactum* has not been found outside the Pragian and Lower Emsian of Victoria and Queensland in Australia (Webby *et al.*, 1993; Webby & Zhen, 1997).

Actinostroma stellulatum Nicholson, 1886 occurs widespread in the Eifelian to Frasnian of Europe, Asia and Australia (Lecompte, 1951: 111–118; May, 1993: 29–30). Furthermore it is known from the late Emsian to early Eifelian of the Cantabrian Mountains (Méndez-Bedia, 1999: 124). Webby & Zhen (1993: 331–332; 1997: 16–17) describe closely related material from the Upper Emsian of New South Wales and Queensland (Australia) as *Actinostroma* aff. *stellulatum*.

Descriptions of *Plectostroma salairicum* (Javorskij, 1930) by Javorskij (1930: 489–490) and Prosh & Stearn (1996: 15–16) prove the occurrence of the species in the uppermost Emsian and lowermost Eifelian of Western Siberia and in Arctic Canada. Beside the occurrence in the uppermost Emsian and lowermost Eifelian, Stearn (2001: fig. 1) indicates a doubtful occurrence of *Plectostroma salairicum* in a middle part of the Emsian in Canada.

Schistodictyon n. sp. aff. *amygdaloides* (Lecompte, 1951) has been described by May (1999b: 100–101) from the the location “Guadámex II”. It is similar to *Schistodictyon amygdaloides* (Lecompte, 1951), which occurs in the Lower Eifelian to Lower Givetian beds of Belgium, Germany, and Australia (Lecompte, 1951: 141–145; Avlar & May, 1997: 108–109).

Stromatoporella granulata (Nicholson, 1873) is known from the Eifelian and Givetian of Belgium, France, Moravia, Siberia, and Canada (Lecompte, 1951: 160–163; May, 1993: 32–33). Sleumer (1969: 38–40) describes *Stromatoporella granulata* (Nicholson, 1873) from the late Emsian to the Givetian of the Cantabrian Mountains.

The encrusting stromatoporoid genus *Clathrocoilona* Javorskij, 1931 is distributed worldwide in the reef complexes of the Middle Devonian and Frasnian. First occurrences were reported from Emsian beds in Canada, Austria, and Russia (Prosh & Stearn 1996: 28–30; Stearn *et al.*, 1999: 39).

Stromatopora polaris (Stearn, 1983) has been found in the Emsian of Canada (Stearn, 1983: 551–552; Stearn, 1990: 507; Prosh & Stearn, 1996: 31; Stearn, 2001: 14–

15). However, a very closely related form from the Lower Emsian of Victoria (Australia) was described as *Stromatopora* aff. *polaris* (Stearn, 1983) by Webby *et al.* (1993: 158–161).

Pseudotrurpetostroma anacontentoae May, 2005b is up to now only known from the OVPRD (May, 2005b). The genus *Pseudotrurpetostroma* Chalfina & Javorskij, 1971 is known from the Emsian to the Givetian in Australia, Asia, and Canada (Stearn *et al.*, 1999: 48).

Descriptions of *Syringostromella zintchenkovi* (Chalfina, 1960) are given by Chalfina (1960: 327–328), Webby *et al.* (1993: 163), and Prosh & Stearn (1996: 34). Hitherto *Syringostromella zintchenkovi* has been found in the Upper Lochkovian of Russia (Chalfina, 1960: 327–328), the Pragian of Victoria (Australia) (Webby *et al.*, 1993: 163), and the Lower Emsian of Arctic Canada (Prosh & Stearn, 1996: 34).

Salairella Chalfina, 1960 occurs from the Pragian to the Frasnian in Australia, Canada, Asia, and Europe (Stearn *et al.*, 1999: 51; Stearn, 2001: 10–11; May, 2005a: 14, 84–90).

Parallelostroma sinense Yang & Dong, 1979 is described by Yang & Dong (1979: 73) from the Emsian of Guangxi (China). Dong & Wang (1989: 272, 290) found *Parallelostroma sinense* Yang & Dong, 1979 in the early Middle Devonian of Guangxi (China).

Age of the stromatoporoid-bearing beds

Compiling the known stratigraphical distributions of the species found, the different stromatoporoid faunas always indicate an Emsian age for the stromatoporoid-bearing beds in the “Peñón Cortado Limestone”. Even in the case of bed 14 of the “Peñón Cortado” section, where only two species occur, the occurrence of *Syringostromella zintchenkovi* (Chalfina, 1960) with a stratigraphical range from Upper Lochkovian to Lower Emsian is counterbalanced by the stratigraphical range of *Plectostroma salairicum* (Javorskij, 1930) from a middle part of the Emsian to the lowermost Eifelian.

Furthermore, the fauna of bed 19 (and the uppermost part of bed 18) of the location “Guadámex II” and the stromatoporoid-bearing beds of the location “La Chamorra” suggest much more an Upper Emsian age than a Lower Emsian age. This results from several species and genera whose stratigraphical range commences in the (Upper) Emsian (or Lower Eifelian) with a main distribution in the Middle Devonian [*Actinostroma stellulatum* Nicholson, 1886, *Schistodictyon amygdaloides* (Lecompte, 1951), *Stromatoporella granulata* (Nicholson, 1873), *Clathrocoilona* Javorskij, 1931, *Pseudotrurpetostroma* Chalfina & Javorskij, 1971, *Parallelostroma sinense* Yang & Dong, 1979].

Indeed, the dating of the stromatoporoids is consistent with the stratigraphical assignment of Rodríguez García (1978) and Moreno-Eiris *et al.* (1995). The brachiopods

found by Miguel V. Pardo Alonso (oral communication) fit in this picture: He found in the upper part of the sequence of the location “Guadámex II” brachiopods of probable Upper Emsian age. Even the fact, that he found in the lower part of the “Peñón Cortado” section brachiopods of the Pragian, does not speak against an Emsian age of the stromatoporoid-bearing beds in the middle to upper part of the sequence.

The occurrence of the syringoporid tabulate coral *Syringocystis* sp. in the upper part of bed 19 of the location “Guadámex II” supports the stratigraphical assignment and the biogeographical classification made by the stromatoporoids, because *Syringocystis* Deng, 1966 is known from the Emsian, Eifelian, and Givetian of Europe and Asia (Birenheide, 1985: 131-135).

Biogeography

All genera found in the OVPRD in the Sierra Morena are known from beds of Emsian age in other parts of the Old World Realm (Stearn *et al.*, 1999). The Old World Realm extended from Australia over Asia and Europe to Canada (Boucot, 1988; Pedder & Oliver, 1990; Stock, 1990, 1997). Almost all stromatoporoid species collected in the OVPRD are not known from other parts of Spain. Nevertheless, almost all species are known from beds of Emsian age in other parts of the Old World Realm. Furthermore, the closest relatives of *Schistodictyon* n. sp. aff. *amygdaloides* (Lecompte, 1951) and *Pseudotrurpetostroma anacontentoae* May, 2005b lived in the Old World Realm.

On the other hand, the fauna of the OVPRD do not show any relation to that of the Eastern Americas Realm: The stromatoporoid fauna of the Eastern Americas Realm are characterized by the occurrence of *Habrostroma* and by the absence of species of the order Actinostromatida (Stock, 1990: 258; Stock, 1994; Stock, 1997: 285). However, the stromatoporoid fauna of the Sierra Morena do not contain any *Habrostroma*, but with *Actinostroma compactum* Ripper, 1933 and *Plectostroma salairicum* (Javorskij, 1930) two species of the order Actinostromatida.

After establishing the classification within the Old World Realm, the logical next step is to compare the stromatoporoid fauna of the OVPRD with faunas from recently investigated sites of Lower Devonian age in other parts of the Old World Realm. However, it is not easy to find stromatoporoid-bearing sites, whose Lower Devonian stromatoporoid fauna are sufficiently well investigated. For example, it is well known, that the Cantabrian Mountains (Northern Spain) contain rich Lower Devonian stromatoporoid fauna. Nevertheless, these fauna are insufficiently known, because the publication of Sleumer (1969) is outdated, the publication of Méndez-Bedia (1984) is a short notice, Méndez-Bedia & Mistiaen (1997) describe only species of *Stromatoporella* in open nomenclature and Méndez-Bedia (1999) describes only species of *Actinostroma*.

As a consequence of similar circumstances only one Lower Devonian stromatoporoid-bearing site in Europe is appropriate for a comparison with the stromatoporoid fauna of the OVPRD: the Middle Pragian of Central Bohemia. On a world-wide level the situation is not much better, so that I elected the following recently investigated Lower Devonian stromatoporoid-bearing sites in the Old World Realm for a comparison:

- Middle Pragian of Central Bohemia (May, 1999a, 2002, 2005a);
- Pragian to Lower Emsian of Victoria (Australia) (Webby *et al.*, 1993);
- Lower Emsian to Lower Eifelian of Arctic Canada (Prosh & Stearn, 1996).

Table 1 compares the stromatoporoid faunas of these three sites with the stromatoporoid fauna of the OVPRD.

The stromatoporoid fauna of the OVPRD display the least amount of conformity with the Middle Pragian of Bohemia, in spite of the small geographical distance between them. This is probably a result of the stratigraphical distance between them.

However, the stromatoporoid fauna of the OVPRD display a high level of conformity with the more or less synchronous fauna in Victoria (Australia) and Arctic Canada. Such close connections between very distant sites are most remarkable because the Emsian was the time of the strongest faunal provincialism during the Devonian period (Boucot, 1988: 211–212, 219; Pedder & Oliver, 1990: 267; Oliver & Pedder, 1994: 185; May, 1995: 39; May, 1997: 293). Nevertheless, it would be rash to construct migratory pathways for stromatoporoids based on these observations; because it is possible, that the Lower Devonian stromatoporoids were generally more cosmopolitan than several other groups of benthos organisms – this phenomenon is known from Middle Devonian stromatoporoids (Stock, 1990: 264; May, 1997: 298-299).

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In the Lower Devonian of the OVPRD in the Sierra Morena, stromatoporoids occur only in very few beds. The comparison of the different beds in the three investigated locations and a fourth locality without stromatoporoids (outcrop “Arroyo del Lobo” south of Monterrubio de la Serena, Badajoz province) shows clearly, that the stromatoporoids were immediately substituted by encrusting bryozoans (e.g. fistuliporids), if the environment was not conducive to them. This observation is remarkable, because the same pattern can be observed within the Pragian reef complex of Koneprusy (Bohemia) (May, 2005a). On the other hand, Middle Devonian reef complexes normally don’t show such a substitution of stromatoporoids by encrusting bryozoans.

In the OVPRD, stromatoporoids with branched skeletons are totally absent and stromatoporoids of the type which forms thin-layered crusts are very rare. (Only the *Clathrocoilon* from “Guadamez II” formed thin-layered crusts). However, these same growth forms occur nearly everywhere in the Givetian–Frasnian reefs. Perhaps these morphotypes of stromatoporoids were very important for the Givetian–Frasnian reefs, and their absence in the Lower Devonian of the OVPRD was a reason for the absence of true reefs in the OVPRD. Furthermore, up to now no stromatoporoid specimen with *Syringopora* commensalism has been found in the OVPRD.

It is remarkable that May (2005a) describes the same patterns (abundance of bryozoans, absence of branched stromatoporoids, scarcity of stromatoporoids of the type which forms thin-layered crusts, and scarcity of *Syringopora* commensalism) from the Pragian reef complex of Koneprusy (Bohemia). As a possible explanation May (2005a) proposes a reduced water temperature. Similarly it is possible, that upwelling cold water hindered reef development in the OVPRD, as Carls (1999) assumed to be the case in the Lower Devonian of Central Spain. This hypothesis could also explain the large differences between the stromatoporoid fauna of bed 14 at location “Peñón Cortado” and the other (= younger) stromatoporoid fauna (bed 19b of location “Peñón Cortado”, locations “Guadamez II” and “La Chamorra”; compare table 1). The explanation would be that bed 14 of “Peñón Cortado” section was built during a time of relatively low water temperature, while the diverse stromatoporoid fauna of bed 19b of “Peñón Cortado” section (and its equivalents in the Badajoz province) reflect a time of higher water temperature. Clearly, much more investigations are necessary to support or discard this hypothesis.

As a counter-argument to the hypothesis, that relatively low water temperatures in the OVPRD hindered reef development, one might state, that in Central Bohemia reef development was possible at relatively low water temperatures. However, it is only one reef, the Koneprusy reef, known, which is isolated and relatively small, and far away from any input of terrigenous sediments. The most important reef builders in the Pragian reef complex of Koneprusy are corals, stromatolites and solenoporacean calcareous algae (May, 2005a). Up to now, stromatolites and solenoporacean calcareous algae are not known from the Lower Devonian of the OVPRD – maybe the amount of sedimentary input was too high for them.

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