Preliminary study of isolated siliceous sponge spicules from Monte Duello, Montecchia di Crosara (Lessini Mountains, Verona, NE Italy)

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Abstract

Bartonian marls of Monte Duello, Montecchia di Crosara (Verona, NE Italy), contain isolated siliceous sponge spicules here described and illustrated for the first time. The spicules were observed under optical microscopes and their identification performed by comparison with Recent sponges. Nearly all spicules belonged to Demospongiae Sollas, 1885 class, mostly "soft sponges" but also the rigid skeleton 'lithistids'. Moreover, some Hexactinellida Schmidt, 1870 spicules were also found. Spicules are preserved as opaline silica but very fragmented .To achieve a more precise taxonomic assignment further studies are necessary using scanning-electron microscope (SEM) and extracting spicules from the rock with more adequate methods.

Keywords: *siliceous sponges, Demospongiae, Hexactinellida spicules, Eocene, Lessini Mountains, Monte Duello, Italy.*

Riassunto

Le marne bartoniane del Monte Duello, Montecchia di Crosara (Verona, NE Italia), contengono spicole isolate di spugne silicee qui descritte e illustrate per la prima volta. Le spicole sono state osservate con microscopi ottici e la loro identificazione è stata effettuata tramite il confronto con spugne attuali. Quasi tutte le spicole appartengono alla classe Demospongiae Sollas, 1885, per la maggior parte alle "spugne molli" ma anche ai "litistidi", spugne dallo scheletro rigido. Sono state inoltre trovate alcune spicole di Hexactinellida Schmidt, 1870. Le spicole appaiono molto frammentate e conservate in silice opalina originaria. Per ottenere una determinazione tassonomica più accurata sono necessari ulteriori studi utilizzando il microscopio elettronico a scansione (SEM) ed estraendo le spicole con metodi più adeguati.

Parole chiave: spugne silicee, Demospongiae, Hexactinellida spicole, Eocene, Monti Lessini, Monte Duello, Italia.

Introduction

Sponges are among the most ancient extant multicellular animals (Hooper & van Soest, 2002). Due mostly to the low preservation potential of many taxa, especially those with organic skeleton only, sponge fossil record is rather incomplete. Moreover, Cenozoic siliceous sponges are insufficiently studied (Pisera, 1999 and 2006). Regarding the Eocene, the wordwide record of siliceous sponges is quite scarce and includes Spain (Pisera and Busquets, 2002), North Carolina (Finks et al., 2011 and literature herein) SW Australia (Gammon et al., 2000 and literature herein), New Zealand (Hinde and Holmes, 1892; Kelly and Buckeridge, 2005).

In Italy, there is only one (Middle) Eocene reported occurrence of siliceous sponges, in Chiampo Valley (Lessini Mountains, NE Italy) (Menin, 1972; Visentin, 1994; Matteucci and Russo, 2005 and 2011).

This study reports the presence of siliceous sponge spicules found during excavations at Monte Duello, Montecchia di Crosara (Verona, NE Italy) in Bartonian marls (Fig. 1). The aim of this note is to give a preliminary account of this assemblage, with description and illustration of the isolated spicules found this far.

Materials and methods

The spicules described were studied under optical microscopes.

Two methods were used:

1. Preparation for optical binocular microscope, reflected light
   At Padova University, Micropalaeontology Laboratory, bulk rock samples were broken in pieces of 1-2 cm of diameter, treated with H_20_2 15% (Bonci et al., 1997) and then washed on 125 and 63 µm sieves. Some samples were dissolved in 10% HCl to verify if the spicules were siliceous. The spicules were picked under a Leica MZ 125 binocular microscope. Photos were taken with Nikon D300, software Nikon CAMERA CONTROL PRO2
2. Optical microscope, trasmitted light
   At Museu Nacional of Universidade Federal do Rio de Janeiro (Brazil), Porifera laboratory, bulk rock

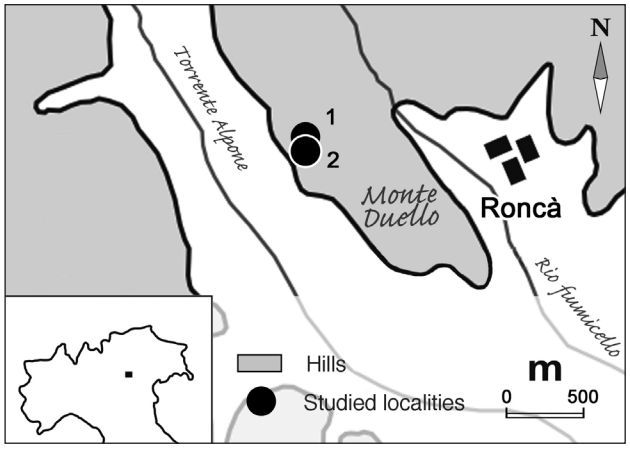

Fig. 1 – Geographical location of the Monte Duello site (Verona).

samples were broken in pieces of approximately 0.5 cm of diameter. Afterwards the sediment was put in a glass tube with 70% ethanol, positioned inside an ultrasonic bath for 10 min. Slides were prepared using Canada Balsam. Observation and documentation of slides were done at CNR- Institute for Geosciences and Earth Resources at Padova University, using a Leica DMLB optical microscope, with a LEICA DFC 300 digital camera and LEICA FireCam 1.7.1. software. This method was used to check for microscleres, often washed away with the first method.

The identification of the sponges was performed by comparison with characteristic spicules of Recent sponges (Pisera et al., 2006). Terminology of spicules morphology follows that in Boury-Esnault & Rutzler (1997) and Hooper and Van Soest (2002).

All the investigated sponge spicules are housed in Museo di Archeologia e Scienze Naturali "G. Zannato"- Montecchio Maggiore (Vicenza), Italy, palaeontological collection, number MCZ (acronym of Museo Civico Zannato) 3473.

Results

The spicules were found in the marls at excavation of Monte Duello, Montecchia di Crosara (Lessini Mountains, Verona; North-East Italy), level C/0 (Fig. 2 and Fig. 3).

Siliceous sponge spicules are in these marls the most common biogenic elements present, so common that the horizon is substantially a spiculite. A low-diversity small benthic foraminiferal assemblage was also observed and the taxa recognized are: cibicids, *Pararotalia* cf. *audouini* (d'Orbigny, 1850), bolivinids, miliolid and ?*Asterigerina*. Associated with small benthic foraminifera were found small gastropods, ostracodes and echinoids spines. Based on the presence of *Pararotalia* and the absence of planktonic foraminifera, we suggest an innner shelf depositional environment (Murray, 1991).

Preliminary qualitative analysis of the spicules from Monte Duello is presented in Table 1. Most of the megascleres were fragmented, so their measurements offer only a baseline idea of the original dimensions. Still, we decided to report the measures here to give at least an idea of the size range.

Nearly all spicules observed belonged to Demospongiae Sollas, 1885. Spicules were mainly monaxial and tetraxial, thus characteristic for Demospongiae (Hooper and Van Soest, 2002). Monaxial fragments (Fig. 4 A-D; Fig. 5 A-D) dominated in the examined material. Diactinal spicules such as oxeas (pointed on

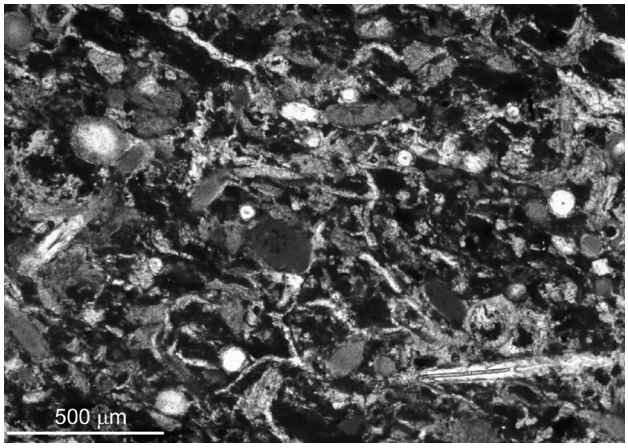

Fig. 2 – Thin section of Monte Duello marls: spiculitic packstone with argillaceous matrix.
Fig. 3 – Monte Duello. Bartonian marls layers with siliceous sponge spicules.

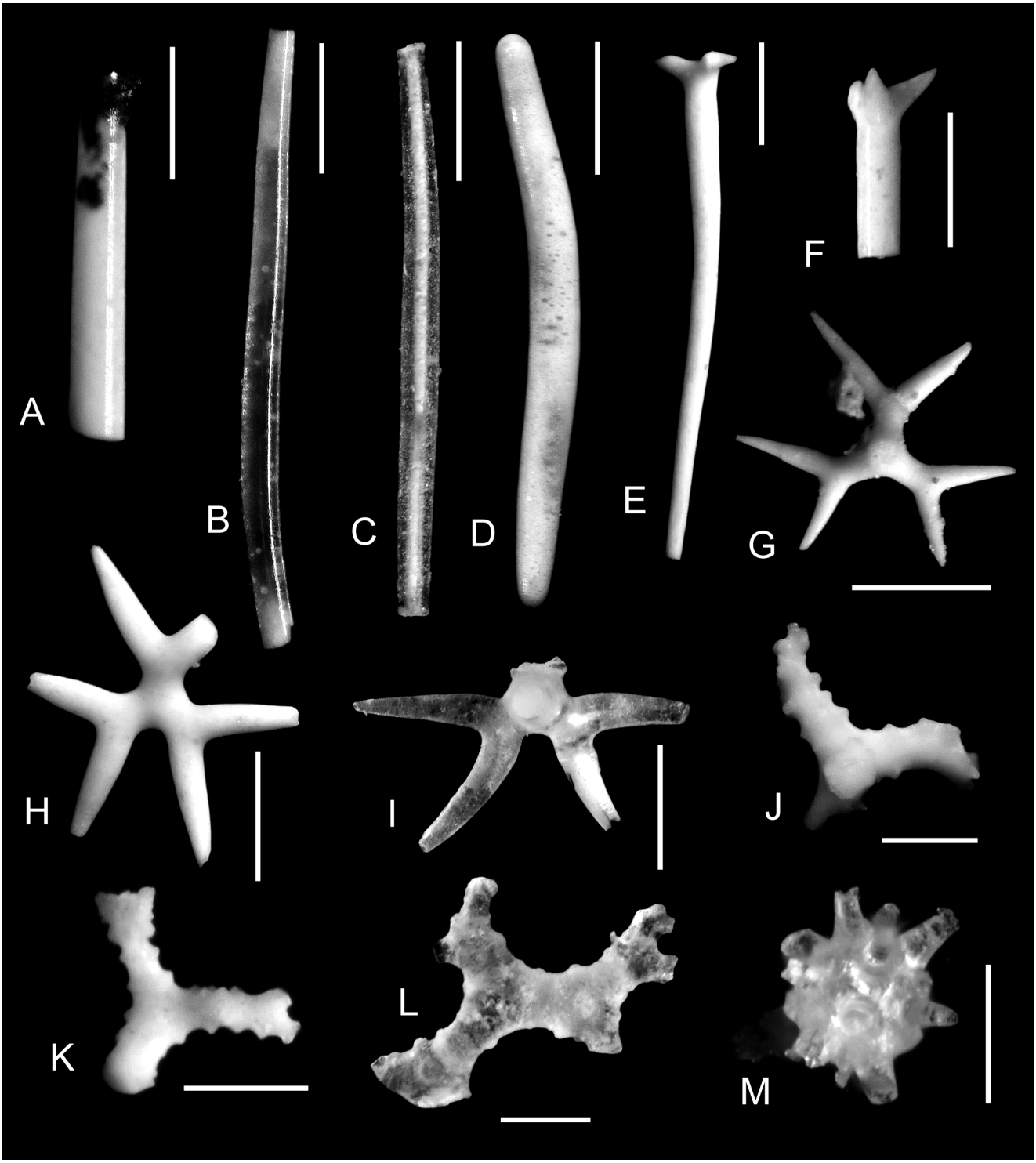

Fig. 4 – A-B Monaxial spicules: A is completely milky; B shows two different kinds of preservation -the central part is translucent while the terminations are milky-; C Monaxial spicule, note axial canal; D Strongyle, note different kind of preservation on the same spicule; E Triaene fragment; F Plagiotriaene fragment; G-H-I Dichotriaene fragments; J-K Tetraxial? desmas fragments. One ray is broken in both cases; L Monaxial? Desma fragment; M Spheraster. Scale bars: A-I 250 µm; J-M 125 µm. Reflected light photos.

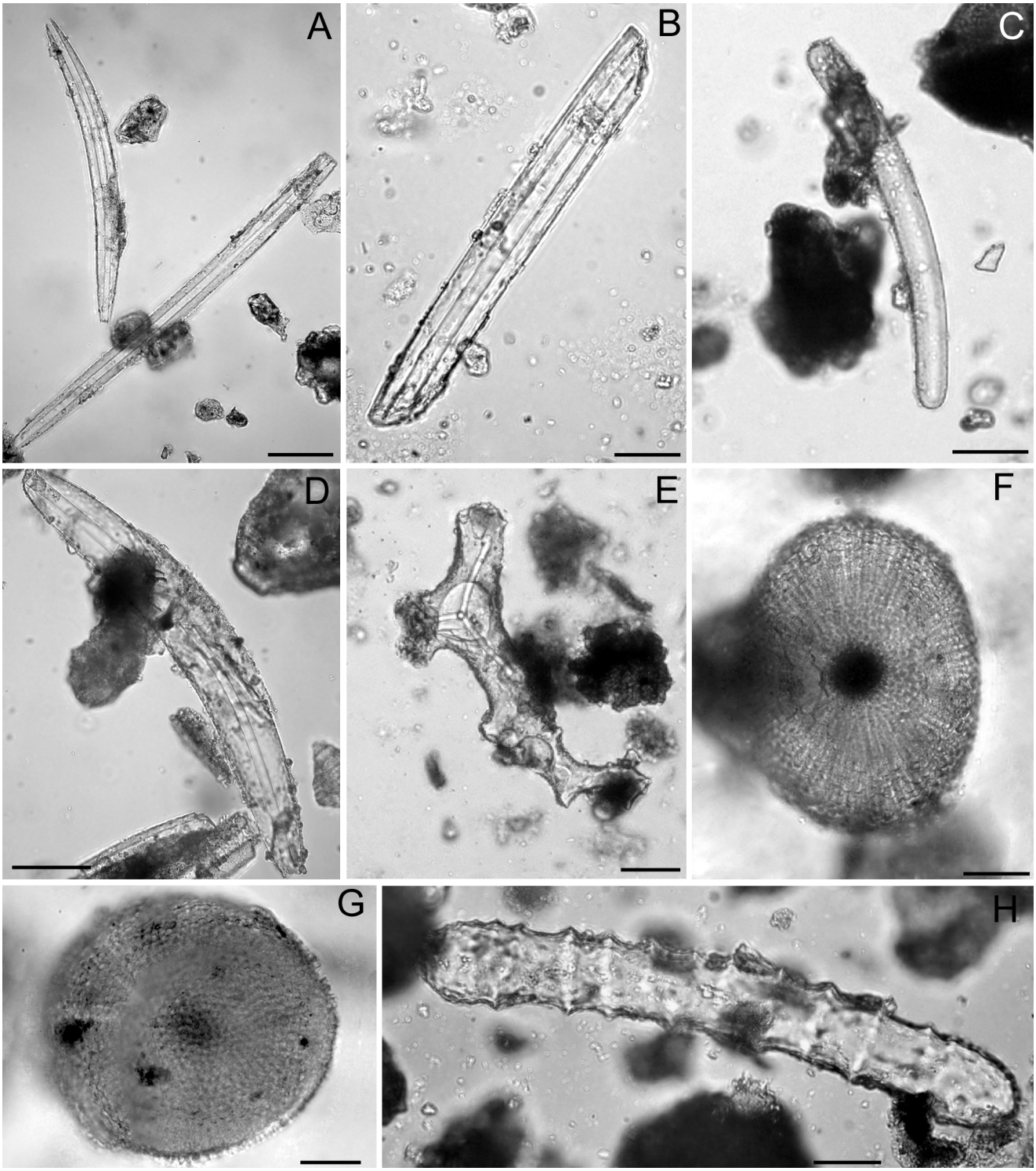

Fig. 5 – A Monaxial spicules: complete amphioxea (left) and a fragment (right), note axial canals in both spicules; B Monaxial spicule fragment; C Strongyle; D Amphioxea, note axial canal; E Desma fragment , note tetraxial canal (one canal is perpendicular to the photo); F-G Sterraster; H Acanthostrongyle. Note verticillate structure. Scale bars: A 200 µm; B-E 50 µm ; F-H 25 µm. Transmitted light photos.

both ends) (Fig. 5 A, D) were rather common. This kind of spicule is widely distributed in several demosponge lineages, and apart from a tendency to be smaller within the Haplosclerida, there is no clearcut way of differentiating the oxeas which occur in several distinct demosponge orders (Pisera et al., 2006). Diactinal megascleres with rounded ends (strongyles) were abundant too and with a very large size range, from 100 to 1000 µm. Tetractinal megascleres were abundant, especially triaenes, the ones having one unequal ray (rhabd) that is commonly much longer than the other three (three cladi form the cladome). Sometimes it was possible to distinguish various kinds of triaenes (e.g. plagiotriaene, dichotriaene) (Fig. 4 F-I).

Infrequently, acanthostrongyles were observed (Fig. 5 H). Their spines were arranged in whorls so they could be defined as "verticillate acanthostrongyle". These types of spicules are not common in Demospongiae. They are found in poecilosclerid genera such as *Antho, Julavis* and *Zyzzya*, but only the latter bearing characteristic verticillated acanthostrongyles. Such spicules had been previously recorded from New Zealand Eocene/Oligocene by Hinde & Holmes (1892). There are only five Recent species considered valid in *Zyzzya*, with records stretching from Australia´s Great Barrier Reef, through the Central Indian Ocean, Mediterranean, NE and NW Atlantic, and the Caribbean. Their acanthostrongyles are mostly 120 to 250 µm long, but spicules as large as 590 µm have already been reported from *Z. fuliginosa* (as *Paracornulum atoxa* Vacelet et al., 1976; sensu Van Soest et al., 1994). The Roncà acanthostrongyle, 150-210 µm long, falls perfectly in this group.

Asters (possibly sterrasters) (Fig. 5 F, G). were dominant in the examined material. Sterraster is defined (Boury-Esnault & Rutzler,1997) as spherical or ellipsoidal microsclere in which the numerous rays are fused and end in stellate terminations. In the case of the Monte Duello spicules, the stellate terminations are only faintly visible. Size range was also considerably larger than the typical microscleres. Clearly, the observation of the overall morphology — and particularly the surface sculpture of sterrasters — should be strongly improved by using a Scanning Electron Microscope (SEM). Actually, for both study and illustration of spicules, SEM should be the instrument of choice (Finks, 2003, p. 299). This equipment is in fact essential to study spicules three-dimensional shape, structure and sculptures which can lead to a more precise taxonomic assignment.

The observed sterraster are very similar to those forming the cortical skeleton of sponges in the family Geodiidae Gray, 1867. Today, geodiid sponges occur word-wide, generally on soft bottoms and have wide bathymetric ranges (Uriz, 2002). Even if some questionable sterrasters of Geodiidae have been reported in thin sections from rocks as old as Cambrian (Reitner & Mehl, 1995, cited in Pisera, 2006), their evident fossil range is from the Jurassic to the Miocene (Pisera, 2006). In Eocene, geodiid spicules were reported from Australia (Hinde, 1910), New Zealand (Hinde and Holmes 1892) and North Carolina (Finks et al., 2011). In Italy, geodiid spicules were reported from the Miocene of Cappella Montei (Alessandria) (Bonci et al., 1997; Quierolo et al., 2002).

Scarce demosponge spherasters were also observed (Fig. 4 M). Large spherasters, as the one found here, are known in Recent sponges of the family Tethyidae. The apparently large rays exhibited by the Monte Duello spicule suggest it might have been a spheroxyaster or spherostrongylaster.

Desmas are more or less irregular articulated spicules, once thought diagnostic for lithistid demosponges now considered as polyphyletic (Pisera and Lèvi, 2002). Only a few desmas have been found in the studied material, some of them being tetraxial (Fig. 4 E). Other possibly tetraclones (Fig. 4 J-K) or monaxial desmas were found (Fig. 4 L) but we should be cautionious as they were extremely fragmented.

There are also probably some triaxons characteristic for Hexactinellida Schmidt, 1870, but they are too fragmented to be sure about their assignment.

The studied spicules appear preserved in original opaline silica. The majority of spicules showed the axial canals (Fig. 4 C; Fig. 5 A, B, D, E). Some spicules were glassy translucent- often with axial canals- while others are milky. Both types of preservation were sometime observed in the same spicules (Fig. 4 B, D). This was already noticed in the Eocene sponges from SW Australia (Pisera, personal comm.), and could be explained by a crystallization of the opaline silica.

Conclusions

Bartonian (Eocene) marls of the Monte Duello contain numerous siliceous spicules and it is the first record of siliceous spiculite from the Italian Eocene. The majority of the spicules belong to "soft" (nonlithistid) demosponges. The most common are sterraster spicules that are very similar to those forming the cortical skeleton of Geodiidae Gray, 1867. Lithistid demosponge spicules were also found, as well as some triaxial spicules of Hexactinellida.

Further analysis empolying various methods of spi-

Spicule type	Dimension (length, in µm)	Abundance (dominant, abundant, common, scarce, rare)
Monaxial (broken)	Up to 900	Dominant
Sterraster	100-300 (maximum diameter)	Dominant
Plagiotriaene (broken)	Up to 1500	Abundant
Triaene (broken)	Up to 700	Abundant
Amphioxea	250-300-600-700-1200	Abundant
Strongyle	100-200-1000	Abundant
Triaxon (broken)	Up to 120	Common
Dichotriaene (broken)	300 (ray length: 100)	Scarce
Desma (broken)	Up to 200	Scarce
Acanthostrongyle	150-210	Scarce
Spheraster	70-180 (maximum diameter)	Scarce

Table 1 – Preliminary qualitative analysis of Monte Duello siliceous sponge spicules. List of the spicule types found, their dimensions (size range, or the commonest length measures), abundance.

cules extraction and their SEM study should allow for more detailed taxonomic attribution of these spicules.

Moreover, a detailed microfacies analysis and the study of both macro and micro palaeontological associatons have to be undertaken. Only after this is established some paleoenvironmental and paleoecological hypotheses may be formulated.

The study of Monte Duello material seems promising for various reasons: the presence of a large variety of spicules, their good preservation and the fact that is the first record of siliceous spiculite from the Italian Eocene.

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