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The Middle Eocene siliceous sponges from Val di Chiampo (Lessini Mountains, northern Italy)

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Abstract

The Lower Lutetian hyaloclastites cropping out in the Val di Chiampo (Vicenza, northern Italy) contain a very rich and diversified siliceous sponge fauna. In this paper we give preliminary determinations and illustrations of 23 siliceous sponge species. The most abundant are the Lychniscosa, with ten species, followed by Hexactinosa, with seven species, and Lithistida, with six species.

Twelve species are in open nomenclature, five are identical or similar to species described by Pisera and Busquets (2002), from the Bartonian of the Ebro Basin (Spain), and five are compared with species described by Pomel (1872) from the Miocene of Algeria. From a paleoecological point of view, it is supposed that the sponge fauna inhabited the euphotic zone.

Keywords: siliceous sponges, Middle Eocene, northern Italy.

Introduction

Generally, the Tertiary sponges are poorly known, probably because inadequately investigated.

For the Eocene, in particular, Catullo (1856) has been the first to describe some siliceous sponges from Lessini Mountain (Veneto, northern Italy) and Menin (1972) illustrated six species collected in Val di Chiampo (Vicenza, North Italy) near Zanconato and Cengio dell'Orbo quarries, from where comes the spongiofauna described in the present study.

Outside Italy, we can mention the fauna of the Castle Hayne Limestone from North Carolina (Rigby 1981; Finks 1983, 1986) from Western Australia (Chapman and Crespin 1934; de Laubenfels 1953; Pickett 1983), the faunas described recently by Pisera and Busquets (2002) from the Ebro Basin (Catalonia, Spain), and Kelly et al. (2003) from the Ototara Limestone of Otago (New Zealand), and the fauna under study by Pisera and Sierra-Kiel from the Ilerdian of southern Pyrenees. There are further reports of Tertiary siliceous sponges of various ages from North America by Rigby and Jenkins (1983), Rigby and Albi (1996), Rigby and Goedert (1996). All these faunas include siliceous sponges and have a clear Cretaceous character at the genus level (Pisera and Busquets 2002). Squires and Demetrion (1989), on the contrary, described a new pharetronid calcareous species fron the lower Eocene portion of the Bateque Formation, Baja California Sur, Mexico.

For the Oligocene, Wiedenmayer (1994) reported a small hexactinellid and lithistid fauna from Antigua, Rigby and Goedert (1996) described a spongiofauna from the Lincoln Creek Formation, Canyon River, Southern Olympic Peninsula (Washington), whereas recently Pisera (2000) described a small lithistid fauna from Zaprozhnoye, Dinepr River (Ukraina), and Bruckner et al. (2003) described a small hexactinellid sponge fauna from the "Septarienton"

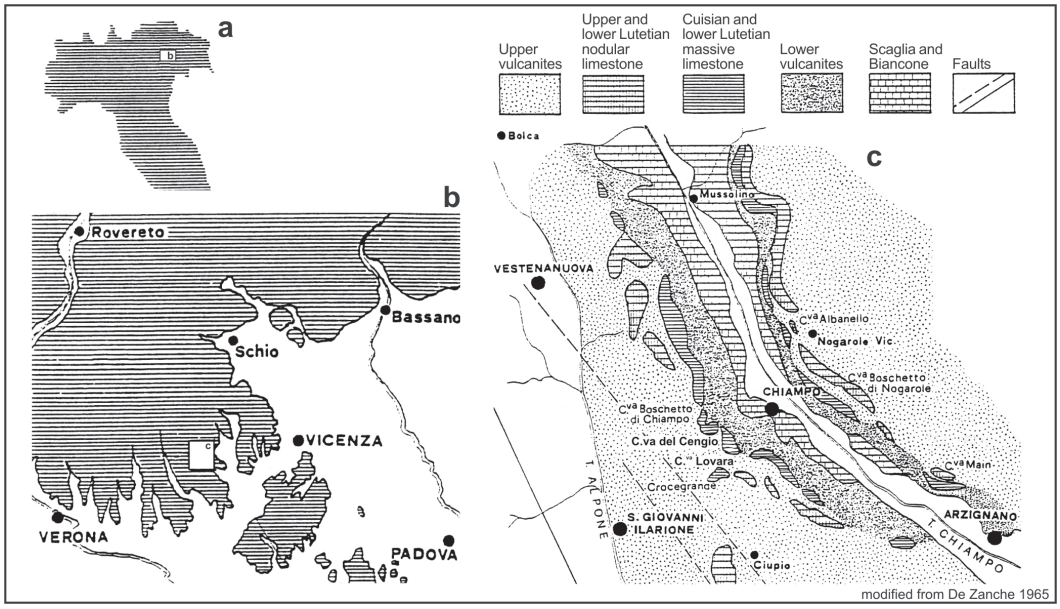


Fig. 1. a, b, Location of study area; c, geological map of study area (modified from De Zanche 1965).

(Rupelian, Oligocene) of "Kirchenziegeleigrube" near Bad Freienwalde (NE Germany).

As concerns the Miocene, the studies are more numerous. A rich Miocene spongiofauna from Algeria has been described by Pomel (1872), Moret (1926) and Moissette et al. (1984). Ott d'Estevou and Termier (1978, 1981), and Brimaud and Vachard (1985, 1986a, b) described rich and diverse Miocene siliceous spongiofaunas from Spain. Italian Miocene sponges have been studied by Mazzetti and Manzoni (1879), Manzoni (1880), Malfatti (1900), Giattini (1910), Matteucci (1979), and Carboni et al. (1982). Pliocene siliceous sponges were recorded by Malfatti (1895) and Matteucci (1989).

The aim of this study is a preliminary description of a rich and diverse siliceous sponge fauna from a lower Lutetian of two adjacent, abandoned quarries, named "Cengio dell'Orbo" and "Zanconato", just north of the still active quarry "Lovara", near the village of Chiampo (Vicenza, eastern Lessini).

Geological and stratigraphical setting

The "Val di Chiampo" is located in the central part of the Lessini Shelf, a Tertiary carbonate platform (Bosellini 1989). The Lessini Shelf is superimposed on the Jurassic Trento Platform, a structural domain of the Adria Plate (or African Promontory), which reacted rigidly during the Alpine collision, was segmented into various uplifted blocks and punctuated by several volcanic piles. These topographic highs acted as centers of initiations of shallow water carbonates which then gave rise to the Lessini Shelf (Bosellini 1998).

The Valley is crossed by Chiampo stream, a tributary of Adige River. Many authors studied this area from geological and cronostratigraphic point of view (Munier-Chalmas 1891; Fabiani 1915; Schweighauser 1953; Hottinger 1960; Schaub 1962; Piccoli 1964; De Zanche 1965).

Above the Mesozoic substrate, there is a complex of volcanic rocks (about 200 m thick), which pertain to Tertiary Venetian Volcanism and range in age from the Paleocene to the Oligocene (Figs. 1-2).
Intercalated among these volcanic rocks, there are the thick beds called "Calcari di Chiampo". These limestones are carbonate beds, alternating with levels of volcanic debris. Generally they are well bedded biocalcarenites and limestones, rich in nummulitids, calcareous algae, rare scleractinians, echinoids, and molluscs. The "Calcare di Chiampo" can be divided into two members (Fig. 2). The Lower Member, Cuisian in age, light brown or pink coloured, is rich in nummulitids (*Nummulites pratti*), discocyclinids, calcareous algae, echinoids, rare planktic foraminifera.

Above this limestone member there is a tuff and hyaloclastites level, 50-200 cm thick, green in colour, rich in iron silicates, with smaller (benthic and planktic) and larger foraminifera. The spongiofauna studied here comes from this level (Fig. 3). Among the smaller foraminifera the most

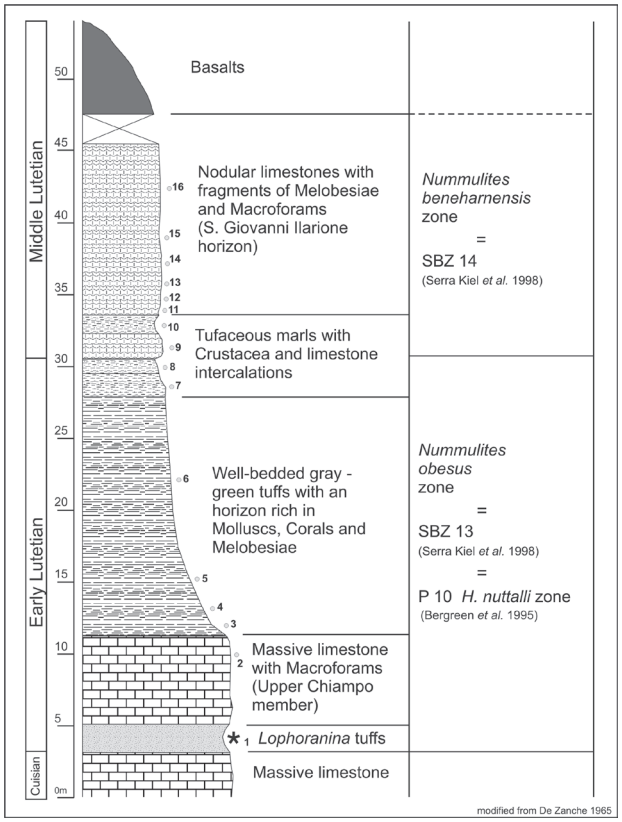


Fig. 2. Stratigraphical section of the quarry "Cencio dell'Orbo" near Chiampo (modified from De Zanche 1965). The star indicate the position of the layer rich in sponges.

common species are: *Reussella terquemi, Acarinina bullbrooki, A. rotundimarginata, A. spinuloinflata, Subbotina linaperta, Globigerinatheka senni, Morozovella aragonensis, Turborotalia frondosa,* which allow us to ascribe these sediments to zone P10 (*Hantkenina nuttalli* zone, in Bergreen et al. 1995) corresponding to SBZ 13 of Sierra-Kiel et al. (1998). Above this level there are 10-15 m thick beds of nummulitic limestones, which constitute the Upper Member, followed by 15-20 m of grey-green tuffs, with intercalated a limestone level rich in molluscs, scleractinians, and calcareous algae. Also these sediments are lower Lutetian. Upsection, there are about 15-20 m of nodular limestones rich in red algae and larger foraminifera (S. Giovanni Ilarione horizon), middle Lutetian in age for the presence of *Nummulites millecaput* and *Alveolina munieri*.

The sequence is capped by a basaltic flow.

The sponge fauna

As pointed out above, the sponge fauna collected

Fig. 3. Cencio dell'Orbo Quarry. From the top to the bottom: a) upper volcanites, b) upper member of the "Chiampo Limestone", c) volcanites with *Lophoranina* and sponges, d) lower member of "Chiampo Limestone" (bottom of the quarry).

in the Val di Chiampo is very abundant and diverse; it is the richest and most diversified siliceous assemblage known.

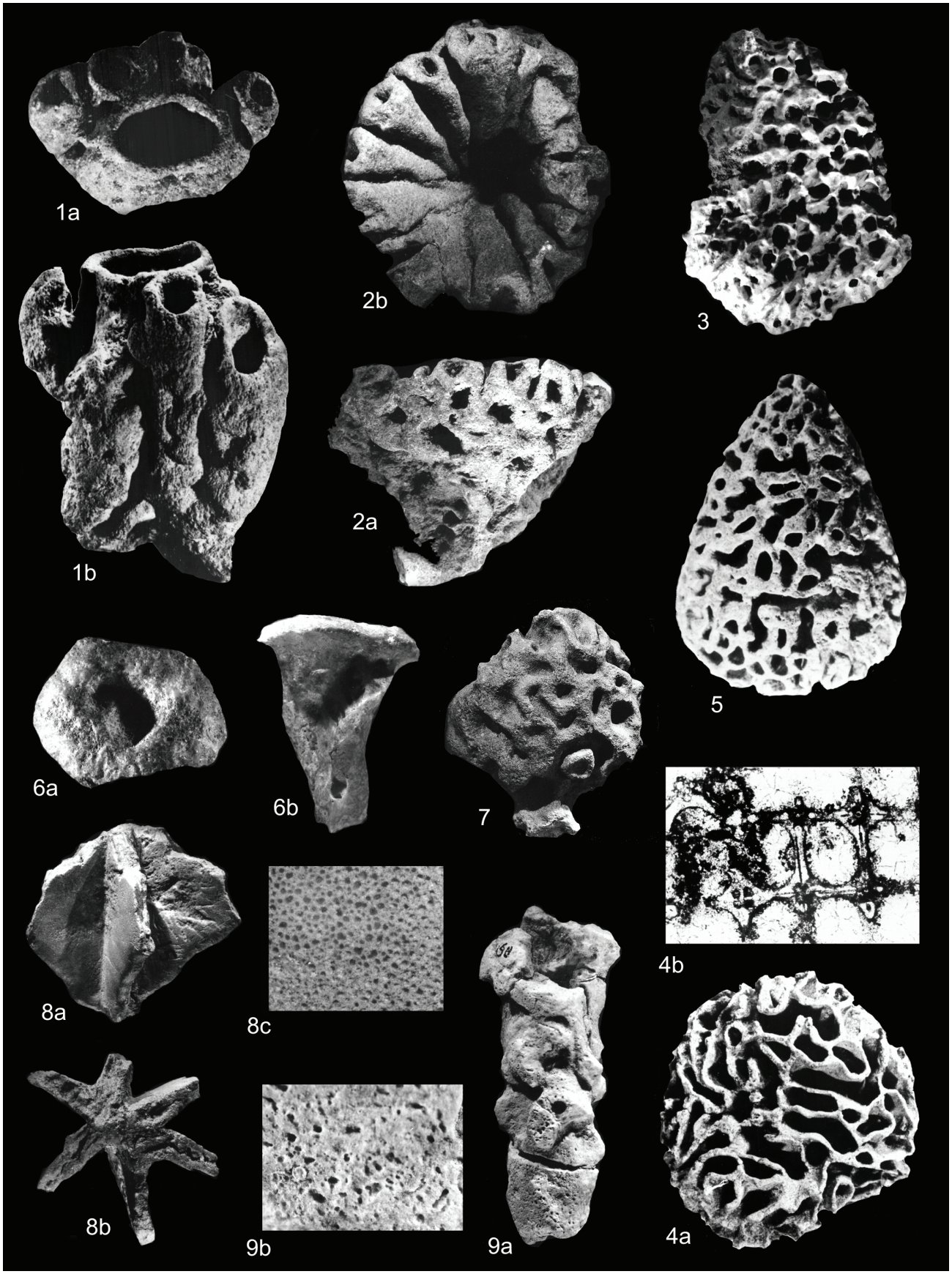
The sponge fauna is present in different outcrops located in abandoned and active quarries west side of Chiampo village. The better known quarries are Cava del Cengio, Cava Zanconato and Cava Bovara. The specimens are very well preserved and their skeletons are complete. Generally they are in life position, very few are overturned. The other associated faunas are larger foraminifera, especially *Asterocyclina, Discocyclina* and *Nummulites*, benthic foraminifera like *Cibicides* and *Globocassidulina*, rare gastropods and nautiloids, and very rare specimens of *Ranina*.

The sponges are the most abundant faunal component present in the tuffs and hyaloclastites intercalated between the Lower and the Upper Members of the Chiampo Limestone.

In this preliminary study we briefly describe only part of the sponge fauna (23 sponge species); the new species (some described here in open nomenclature) and some new genera will be treated in a next publication.

The most abundant genera are *Guettardiscyphia, Brachiolites, Pleuroguettardia, Rizocheton* and *Jereopsis*. Common are *Laocaetis*, *Becksia*, *Brachiolites*, *Callicylix*, *Ventriculites, Paracraticularia* and *Centrosia*.

Among the known species, 7 are identical or similar to species described from the Bartonian of Ebro Basin (Spain). Six are compared with species described by Pomel (1872) from the Miocene of Algeria, the others are left in open nomenclature.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The more abundant are the Lychniscosa (10 species), followed by Hexactinosa (7 species) and Lithistida (6 species).

Aphrocallistes, a very common Cretaceous to Recent genus, is apparently absent.

As pointed out by Pisera and Busquets (2002) for the sponge fauna from the Ebro Basin, Spain, also the present fauna has a clearly Cretaceous character at the genus level.

Palaeoecological remarks

The literature, mainly based on data of living sponges, generally considers siliceous sponges as deep-water inhabitants. Pisera (1997) and especially Pisera and Busquets (2002) gave a detailed analysis on their palaeoecology. The latter authors consider that the sponges present in the marls of the La Guixa Member are indicative of a depth of 200 and more metres. In addition, they point out some differences in the composition of the spongiofaunas of the various localities.

The deepest setting is suggested for Munter, Tona and Sta. Cecilia, and shallower setting for St. Roc and Vespella, with Gurb in an intermediate position.

In Munter, Tona e Sta. Cecilia the common sponges species are *Guettardiscyphia thiolati* and *Brachiolites munterensis*, whereas *Pleuroguettardia* and *Hexactinella* are less frequent. In Munter, in addition to the species previously cited, are also common *Laocaetis* and *Reguantella.* The St.Roc spongiofauna is constituted by the common species *Rizocheton* and *Phlyctia expansa*, and less common are *Laocaetis* and *Pleuroguettardia* or *Guettardiscyphia*. In Vespella there are Lithistids, *Rizocheton*, *Callicylix*, *Pleuroguettardia* and *Hexactinella*. The Gurb sponge fauna is dominated by *Rizocheton*, while *Laocaetis, Brachiolites* and *Pleuroguettardia* are of secondary importance.

Our palaeoecological considerations are based on part of the sponge fauna; however, using also the associated fauna, we can draw some conclusions. In Val di Chiampo the larger foraminifera are very abundant in the hyaloclastites including the sponge fauna. Furthermore, these sediments are interbedded between two calcareous member rich in coralline algae and zooxanthellate corals. In comparation with the Ebro Basin described by Pisera and Busquets, we can observe that the most common species belong to *Rhizocheton*, *Jereopsis*, and *Pleuroguettardia*, that are present particularly in Gurb and Vespella outcrops, which are indicated by Pisera and Busquets (2002) as shallower than Munter, Tona and Sta. Cecilia. The sponges fauna of Vespella has been interpreted by these authors as deposited in euphotic conditions, as confirmed by the presence of a much richer benthic fauna, which includes larger foraminifera.

Nevertheless, in our assemblage is very frequent *Guettartischyphia*, which is considered by Pisera and Busquets (2002) as particulary abundant in deep, aphotic conditions.

Gammon et al. (2000) have interpreted large Eocene Australia deposits of spiculites and spongolites as typical of shallow and warm water deposits. The sponges were much more abundant than calcareous benthos because the seas were very rich in nutrients due to continental runoff. More recently, Kelly et al. (2003) described an Eocene siliceous sponge similar to *Pleroma aotea* Kelly, a living species in the deep water of New Zealand. For Kelly et al. (2003), nevertheless, the Eocene species lived in shallow and warm water because of the presence of volcanic activity, which enriched the environment with silica.

Based on our observations we think that similar conditions were present in Val di Chiampo in the early Lutetian.

Conclusions

The very well preserved Eocene sponge fauna from Val di Chiampo, represents probably the

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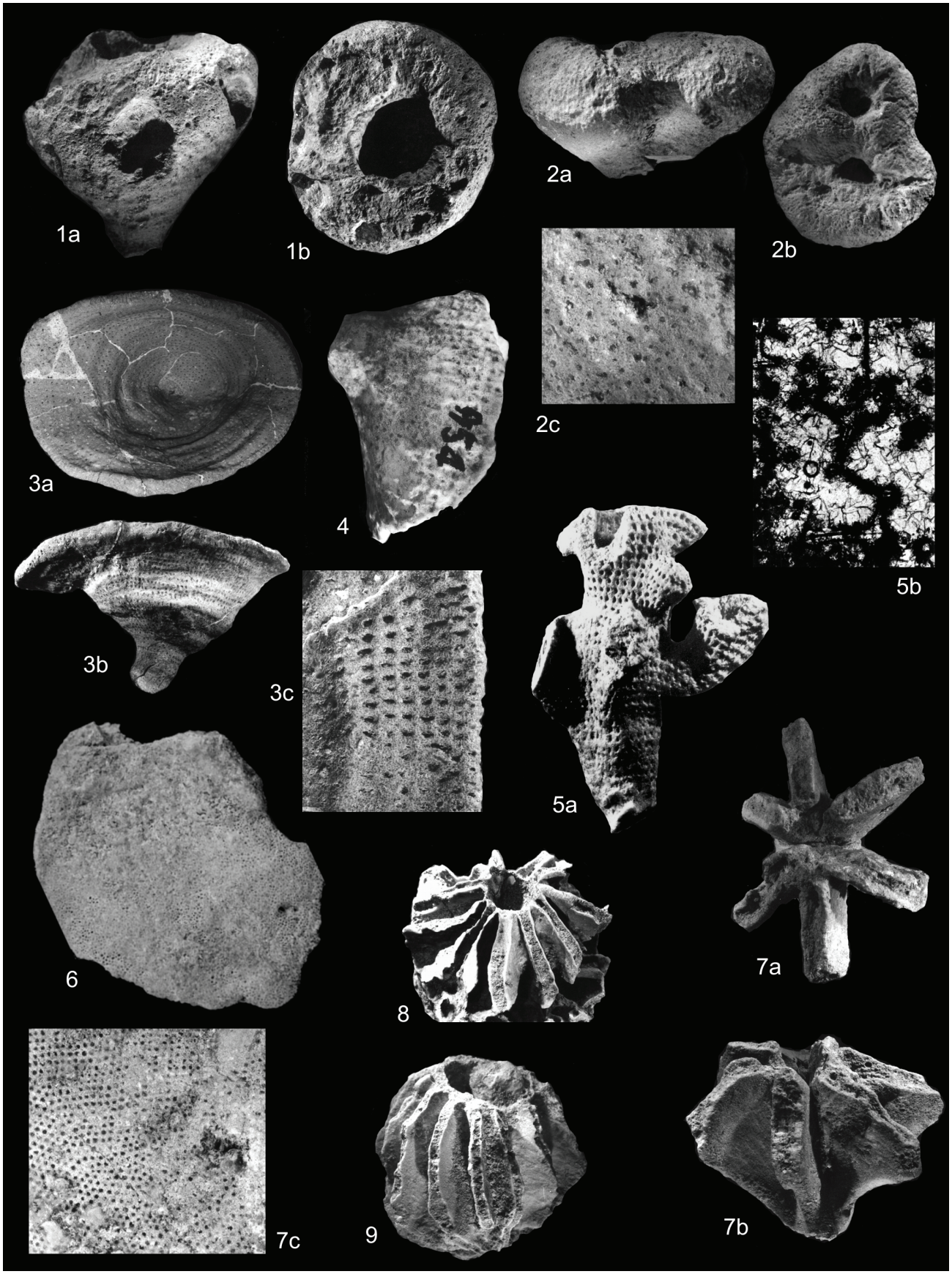
Plate 1

Figs. 1a, b, *Becksia* (?) sp; 1a, from above view; 1b, from side view. x 0.5. Figs. 2a, b, *Brachiolites* sp; 2a, from above view; 2b, from side view. x 0.5. Fig. 3, *Callicylix* aff. *eocenicus* Pisera and Busquets. From above view. x 0.6. Figs. 4a, b-5, *Centrosia* aff. *viquensis* Pisera and Busquets; 4a, from above view, x 0.5; 4b, thin section showing a lychniskid nodes, x 50; 5, from above view, x 0.5. Figs. 6a, b, *Chenendopora* sp.; 6a, from above view; 6b, from side view, x 0.5. Fig. 7, *Eurete* sp.; from side view, x 0.5. Figs. 8a-c, *Guettardischyphia thiolati* (d'Archiac); 8a, from side view; 8b, from above view, x 0.5; 8c, detail of surface showing organization of canal openings, x 2. Figs. 9a, b, *Jereopsis* (?) cf. *clavaeformis* Pomel; 9a, from side view, x 0.5; 9b, detail of surface showing organization of canal openings, x 1.5.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richest till now known for the whole of Tertiary. In the present paper we report only part of this fauna, namely 23 siliceous sponges. The more abundant are the Lychniscosa with 10 species, followed by the Hexactinosa, with 7 species, and the Lithistida with 6 species. Among the known species, there is a strong similarity with the fauna of the Ebro Basin, described by Pisera and Busquets (2002) even if species abundance is quite different. Almost all the genera seem to show a clear Cretaceous character. From the palaeoecological point of view, we interpret this fauna as inhabiting the euphotic zone.

Short notes on figured species

a) Lychniscosa

Becksia (?) sp. (Pl. 1, Figs. 1a, b)- Compressed, conical sponge with one, two or more circular oscules, 1.5-3 cm large. External surface knobby and perforated.

Brachiolites sp. (Pl. 1, Figs. 2 a, b)- Large, conical sponge, with a deep central depression, pedunculate. Externally, irregular, contorted and anastomosing tubes.

This species is very similar, in shape, to *Plocoscyphia tenuilobata* Leonhard, 1897, from the Cretaceous of Upper Silesia, Poland.

Callicylix aff. *eocenicus* Pisera and Busquets, 2002 (Pl. 1, Fig. 3)- Lamellar, encrusting sponge, constituted by thin-walled anastomosing tubes. Dictyonal skeleton with very regular lychniskid nodes. Our specimens differ from those described by Pisera and Busquets species in having more closely spaced and regularly distributed tubes.

Centrosia cf. *viquensis* Pisera and Busquets, 2002 (Pl. 1, Figs. 4a, b-5)- Subcircular to amigdaloid sponges composed of anastomosing tubes, which are irregular, elongated and meandriform in shapes. Our specimens differ from Pisera and Buquets species in the shape of tubes.

Rhizocheton lobata (Catullo, 1856) (Pl. 3, Figs. 2a, b)- Irregularly cylindrical, with stout and short branches on the base and on the top of the sponge body. Osculum circular. Presence of canal openings on the outer surface. Choanosomal skeleton composed of lychniskid nodes.

Rhizocheton sp. 1 (Pl. 3, Figs. 3a-c)- Compressed turbinate-shaped sponges supported probably by a stem. Very long elliptic osculum. In the outer surface canal openings of two sizes. Choanosomal skeleton composed of lychniskid nodes.

Rhizocheton sp. 2 (Pl. 3, Figs. 4a, b)- This species differs from the previous one in having a regular cylindrical shape.

Rhizocheton sp. 3 (Pl. 3, Figs. 5a, b)- This species differs from *Rhizocheton* sp. 1 in having a less com pressed shape and a much larger external canal opening

Ventriculites sp. 1 (Pl. 3, Figs. 6-7a, b)- Large, vase–shaped sponge, pedunculate, with rhomboid external canal openings. The shape of our specimen is similar to *Napaea striata* Schrammen.

Ventriculites sp. 2. (Pl. 3, Figs. 8a, b)- This species differs from the previous one to be larger and to have the wall thinner.

b) Hexactinosa

Eurete sp. (Pl. 1, Fig. 7)- Vase-shaped sponge; paragaster absent, constituted of tick-walled contorted tubes and folds; attached to substratum with a large and irregular surface. Our specimens resemble *Eurete clava* Pisera and Busquets, 2002, and *Eurete labyrinthica* (Schrammen 1912) from which they differ in the general shape and their more

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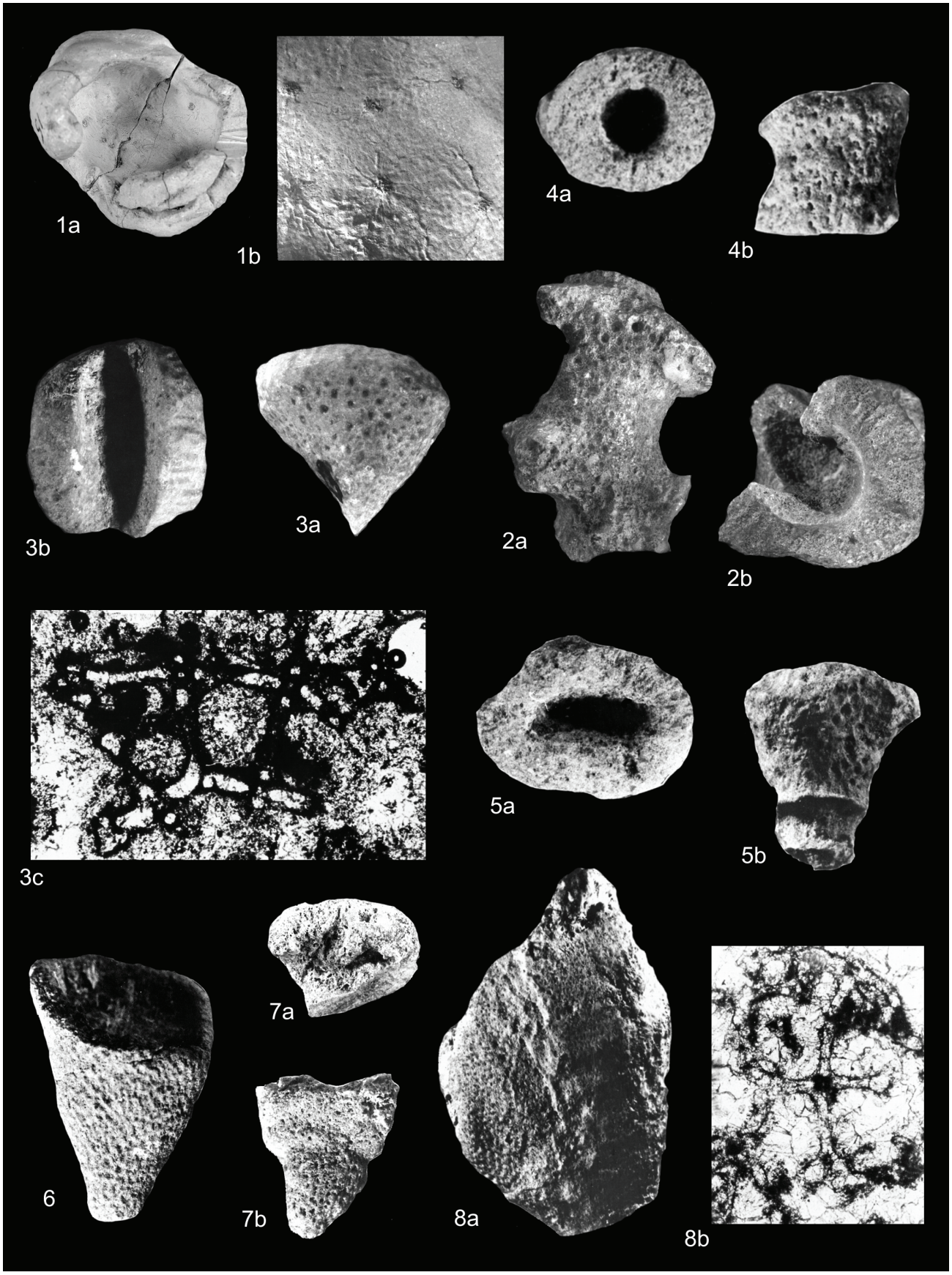
Plate 2

Figs. 1a, b, *Jereopsis* (?) *inaequalis* Pomel; 1a, from above view; 1b, from side view. x 0.5. Figs. 2a-c, *Jereopsis* (?) *sobolifera* Pomel; 2a, from above view; 2b, from side view. x 0.5; 2c, detail of surface showing organization of canal openings, x 1.5. Figs. 3a-c, *Laocaetis patula* Pomel; 3a, from above view; 3b, from side view. x 0.3; 3c, detail of surface showing organization of canal openings, x 2.5. Fig. 4, *Laocaetis* sp., from side view, x 0.6. Figs. 5a, b, *Paracraticularia* sp.; 5a, from side view, x 0.65; 5b. thin section, showing a dyctional skeleton, x 40. Fig. 6, *Phlyctia* (aff.) *expansa* Pomel, from side view, x 0.5. Figs. 7a-c, *Pleuroguettardia* aff. *iberica* Pisera and Busquets; 7a, from side view; 7b, from above view, x 0.6; 7c, detail of surface showing organization of canal openings, x 12. Figs. 8-9, *Pleuroguettardia* sp., from above view, x 0.5.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regular tubes.

Guettardiscyphia thiolati (d'Archiac, 1846) (Pl. 1, Figs. 8a-c)- Very abundant species. Our specimens are identical to specimens illustrated by d'Achiardi (1846) and Pisera and Busquets, 2002. The star-shape, in the upper part, may show 5-7 wings (generally 6). The canal openings in external surface are irregularly distributed.

Laocaetis patula Pomel, 1872 (Pl. 2, Figs. 3a-c)- Large cup-shaped sponges with rectangular canal openings on the outer surface, and oval openings on the inner surface.

Laocaetis sp. (Pl. 2, Fig. 4)- Turbinate-shaped sponge with oval canal openings on both surfaces.

Paracraticularia sp. (Pl. 2, Figs. 5a, b)- Bush-shaped sponge, with central tube subcylindrical, from which, starting from half length, split out 3 or 4 minor tubes.

Pleuroguettardia aff. *iberica* Pisera and Busquets, 2002 (Pl. 2, Figs. 7a-c)- Star-like sponges with 5-8 wings, which can be entirely separated and flattened tubular; parietal oscula on the edges of the wings. Canal openings, on outer and inner surfaces, in regular quadrangular pattern. Our specimens are similar to the species described by Pisera and Busquets (2002) but are considerably smaller.

Pleuroguettardia sp. (Pl. 1, Figs. 8-9)- Petaliform, radial or globose sponges, with 11-14 wings distributed around a central paragaster. The shape of our specimens is completely different from the other described species. Canal openings, on outer and inner surfaces, in regular quadrangular pattern.

c) Lithistids

Chenendopora sp. (Pl. 1, Figs. 6a, b)- Conical sponge, with a subcircular osculum. External surface finely perforated. Our specimens resemble the Cretaceous *Chenendopora fungiformis* Lamarck, 1821, from which it differs in being more cylindrical and having a less bell-shaped top.

Jereopsis (?) cf. *clavaeformis* Pomel, 1872 (Pl. 1, Figs. 9a, b)- We refer provisionally to this taxon our specimen because of the cylindrical shape and cribriform osculum.

Jereopsis (?) cf. *inaequalis* Pomel, 1872 (Pl. 2, Figs. 1a, b)- Our specimens differ from *J.* (?) cf. *clavaeformis* to have a turbinate shape and deeper osculum.

Jereopsis (?) cf. *sobolifera* Pomel, 1872 (Pl. 2, Figs. 2a-c)- Our specimens differ from previous species because of the presence of different oscula.

Phlyctia (?) aff. *expansa* Pomel, 1872 (Pl. 2, Fig. 6)- Flat fragment of an unknown shape of the sponge, with both surface pierced by small and irregular canal openings. Our fragment is similar to Pomel's species.

Pliobalia (?) *vermiculata* Pomel, 1872 (Pl. 3, Figs. 1a, b)- Subglobose, cup-like sponges. Presence in the inner and outer surfaces of astrorhizae-like canals. The particular habitus is very similar to the species described by Pomel.

Plate 3

Figs. 1a, b, *Pliobalia* (?) *vermiculata* Pomel; 1a, from side view, x 0,4; 1b, detail of internal surface showing shape and organization of astrorhize-like canal, x 1. Figs. 2a, b, *Rhizocheton lobata* (Catullo); 2a, from side view; 2b, from above view, x 0.6. Figs. 3a-c, *Rhizocheton* sp. 1; 3a, from side view; 3b, from above view, x 0.7; 3c, thin section, showing a lychniskid meshes, x 60. Figs. 4a, b, *Rhizocheton* sp. 2; 4a, from above view; 4b, from side view, x 1. Figs. 5a, b, *Rhizocheton* sp. 3; 5a, from above view; 5b, from side view, x 0.7. Figs. 6, 7a-b, *Ventriculites* sp. 1; 6, from side view, x 0.7; 7a, from above view; 7b, from above view, x 0.7. Figs. 8a, b, *Ventriculites* sp. 2; 8a, from side view, x 0.5; 8b, thin section, showing a lychniskid meshes, x 40.

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Riassunto

[Le spugne silicee dell'Eocene medio di Val di Chiampo (Monti Lessini, Italia settentrionale)]

Vengono presentati i risultati preliminari dello studio di una associazione a silicosponge dell'Eocene medio (Luteziano inferiore) della Val di Chiampo, Vicenza che, probabilmente, è una delle più ricche e diversificate al mondo tra quelle finora note per l'intero Terziario. Le specie descritte, molte a nomenclatura aperta, appartengono alle Lychniscosa (10 specie), alle Hexactinosa (7 specie) e alle Lithistida (6 specie). Le silicosponge si rinvengono, insieme a frequenti micro- e macroforaminiferi, in un livello vulcanoclastico intercalato a calcari a Nummuliti dell'Eocene inferiore e tufiti alternate a calcari biocostruiti, e sono riferibili al Luteziano inferiore. Da un punto di vista paleoecologico si presume per queste spugne silicee un ambiente di acque calde e poco profonde.

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