
The demosponge *Leptomitrus* cf. *L. lineatus*, first occurrence from the Middle Cambrian of Spain (Murero Formation, Western Iberian Chain)

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ABSTRACT

The Middle Cambrian Murero Formation in the Iberian Chain (NE Spain) has yielded a small collection of soft-bodied fossils (palaeoscolecid worms, onychophorans, algae), a host of fossils from organisms with mineralized skeletons such as trilobites and brachiopods, and some trace fossils. This paper deals with the description of the only specimen of the demosponge *Leptomitrus* known so far from Spain and its association with the brachiopod *Micromitra*, showing a probable case of commensalism by the latter over the former. The taphonomical study indicates that there was little or no disarticulation of the sponge spicules and suggests that a rather complex series of alteration processes has occurred since these organisms were buried.

KEYWORDS | Porifera. Burgess Shale-type biota. Commensalism. Taphonomy. Caesaraugustian Stage.

INTRODUCTION

More than a century ago Verneuil (1862) discovered the first fossils in the Rambla de Valdemiedes, just north of the town of Murero and described its abundant and well-preserved trilobites. Several studies dealing with the fossil fauna of this area have been published since including, among others, the landmark monograph on trilobites "Das Kambrium Spaniens-Teil 2" (Sdzuy, 1961). Nevertheless, no mention of soft-bodied fossils was reported from this locality until the publication of Conway Morris and Robison (1986). Later contributions by Gámez Vintaned (1995), García-Bellido Capdevila and Liñán (1996), Liñán et al. (1996) and García-Bellido Capdevila (1997, 1999) reported new findings, calling attention to the presence of a diverse Burgess Shale-type biota in the Cambrian of Murero: sponges, priapulids, onychophorans and algae. This paper deals with the paleoecological and taphonomical information that can be extracted from some of the fossils of this unique Burgess Shale-type locality in Spain.

GEOGRAPHIC AND GEOLOGICAL SETTING

Some of the most extensive outcrops of Cambrian sequences in Europe occur in the Iberian Peninsula. These outcrops form a part of the Iberian Massif and the core of some alpine chains (the Pyrenees, the Betic Ranges and the Catalan Coastal Ranges). The Iberian Massif was divided by Lotze (1945) into six tectonostratigraphical zones (Fig. 1A). Eastward extensions of the Western Asturian-Leonese Zone and the Cantabrian Zone occur in the Iberian Chain (Fig. 1B). Thus, the Badules Unit (i.e. a Western Asturian-Leonese Zone equivalent) comes into contact with the Mesones Unit (i.e. a Cantabrian Zone equivalent) through the northwest-southeast oriented Jarque Fault, which stretches along the whole Iberian Chain. The locality where the fossils were found, the Rambla de Valdemiedes, near Murero, lies within the Badules Unit, in the western branch of the Iberian Chain.

The town of Murero is located 80 Km southwest of Zaragoza, in the Daroca area (41° 10' N, 1° 29' W). A little

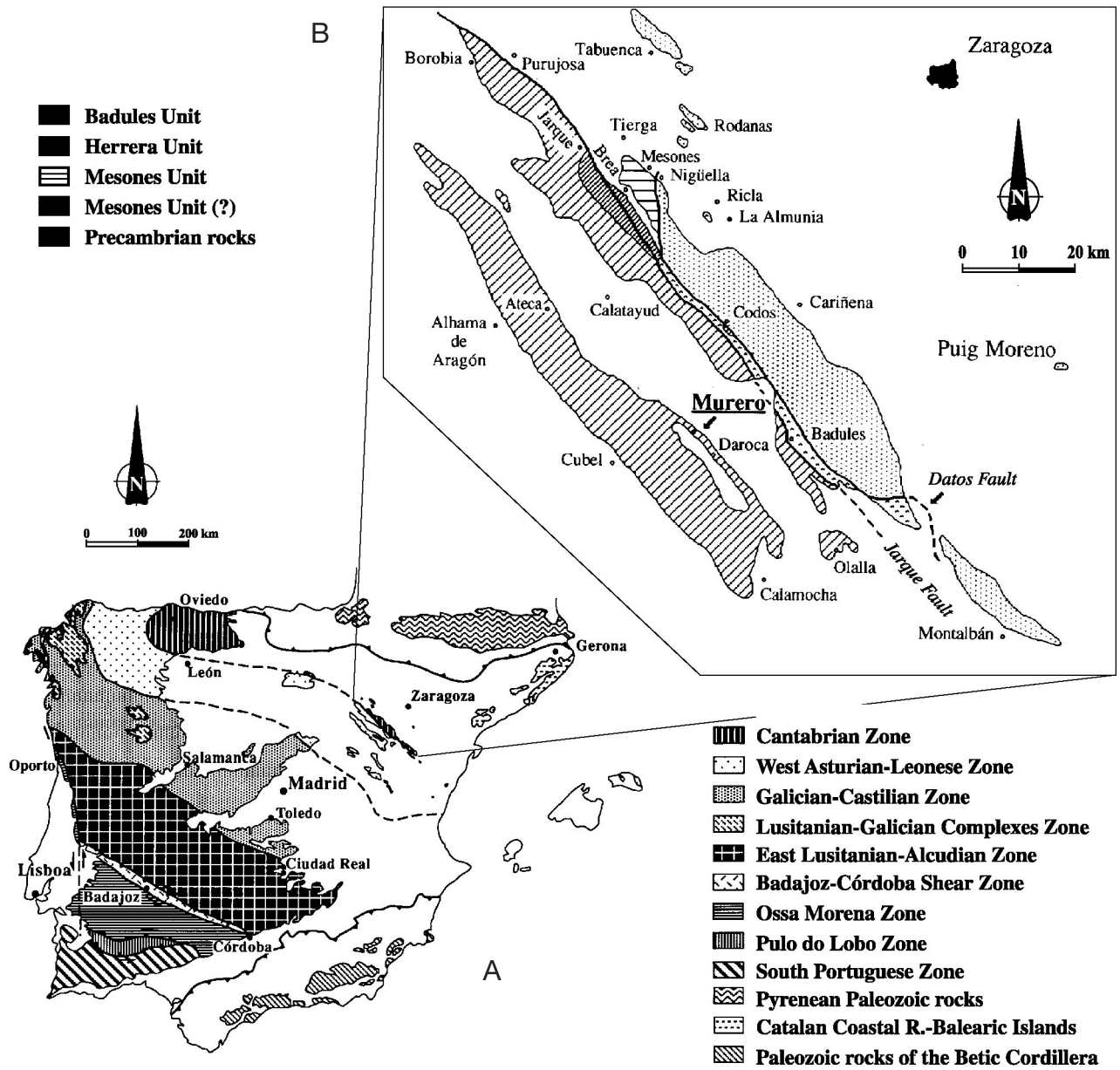


FIGURE 1 | A-Geological sketch of the Iberian Peninsula showing the tectonostratigraphical zones of the Hercynian Massif and the distribution of other Paleozoic outcrops (after Liñán, 1996). B- Geological setting of Pre-Cambrian and lower Paleozoic units in the Iberian Chains (after Gámez Vintaned, 1995).

gully called the Rambla de Valdemiedes runs north of Murero. This locality shows an almost complete Lower and Middle Cambrian succession (Fig. 2). The fossil sponge described here was collected in a slab of shale found, on the talus slope at the southern bank of the Rambla de Valdemiedes, along with trilobite fossils of the genus *Pardailhania* and *Solenopleuropsis*, which would enable to place it in the Middle-Late Caesaraugustian Stage (Liñán, pers. com. 2000). The rocks where the fossil was found are included in the Murero Formation, which overlies the dolomitic levels of the Mansilla Formation and underlies the interbedded sandstones and shales of the Borobia For-

mation (Acón Group). The thickness of the Murero Formation ranges from 50 to 250 m (Gozalo, 1995). It consists mainly of green or blue-grey shales and marly shales, with some interbedded fine sandstone levels. A few carbonate nodule-bearing levels also occur. The Murero Formation extends along the Middle Cambrian Caesaraugustian Stage (Fig. 3). The paleoenvironmental reconstruction (Gozalo, 1995) suggests that the mud-dominated deposition took place during a transgressive pulse that produced deep-sublittoral or maybe circalittoral environmental conditions. These depositional conditions would have produced an unprotected environment, a fact also inferred from the

presence of oligomeric trilobites (e.g. Agnostidae), considered as pelagic organisms typical of open waters.

SYSTEMATIC PALEONTOLOGY

Phylum: Porifera GRANT, 1836
Class : Demospongea SOLLAS, 1875
Order: Monaxonidas SOLLAS, 1883
Family: Leptomitidae de LAUBENFELS, 1955

Genus *Leptomit* WALCOTT, 1886

Type species: *Leptomit zitteli* WALCOTT, 1886

Leptomit cf. *Leptomit lineatus* (WALCOTT, 1920)
 Figures 4A to 4C

- 1920 *Tuponia lineata* Walcott, pp. 272-274, pl. 62, figs. 1, 1a-b, pl. 63, figs. 1, 1a-c.
 1920 *Tuponia flexilis* Walcott, pp. 275-276, pl. 65, figs. 1, 1a-d.
 1920 *Tuponia flexilis* var. *intermedia* Walcott, pp. 276-277, pl. 64, figs. 1a-b.
 1938 *Leptomit lineata* (Walcott), Resser and Howell, pp. 210-211.
 1938 *Leptomit flexilis* (Walcott), Resser and Howell, pp. 210-211.
 1944 *Leptomit lineata* (Walcott), Shimer and Shrock, p. 51, pl. 15, figs. 1-2.
 1955 *Leptomit lineata* (Walcott), De Laubenfels (In R.C. Moore, ed.), p. E70, figs. 52.11a-b, 53.1
 1985 *Leptomit lineatus* (Walcott), Whittington, p. 50, fig. 4.5.
 1986 *Leptomit lineatus* (Walcott), Rigby, pp. 22-24, text-figs. 11A, 12B, pl. 1, fig. 1, pl. 4, figs. 1-5, pl. 5, figs. 1-8.
 1994 *Leptomit lineatus* (Walcott), Briggs et al., p. 75, pls. 25. 26.
 1997 *Leptomit* cf. *L. lineatus* (Walcott), García-Bellido Capdevila, pp. 24-26; fig. 8; pl. 5, figs. 4, 5.
 1999 *Leptomit* cf. *L. lineatus* (Walcott), García-Bellido Capdevila, p. 90, pl. 1, fig. 2.
 2002a *Leptomit* cf. *L. lineatus* (Walcott), García-Bellido Capdevila, pp. 68-69, pl. 1, figs. 1, 2.
 2002b *Leptomit* cf. *L. lineatus* (Walcott), García-Bellido Capdevila, pl. 1, fig. 1.

Material: Single specimen, without counterpart (MPZ-97/423), from the Rambla de Valdemiedes, near the town of Murero, Zaragoza (Spain).

Diagnosis (Rigby, 1986: p. 23): Long, tubular, thin-walled sponges with a spongocoel that extends the full length. Wall composed of monaxial spicules, largely oxeas, arranged in three series. Primary coarse en echelon

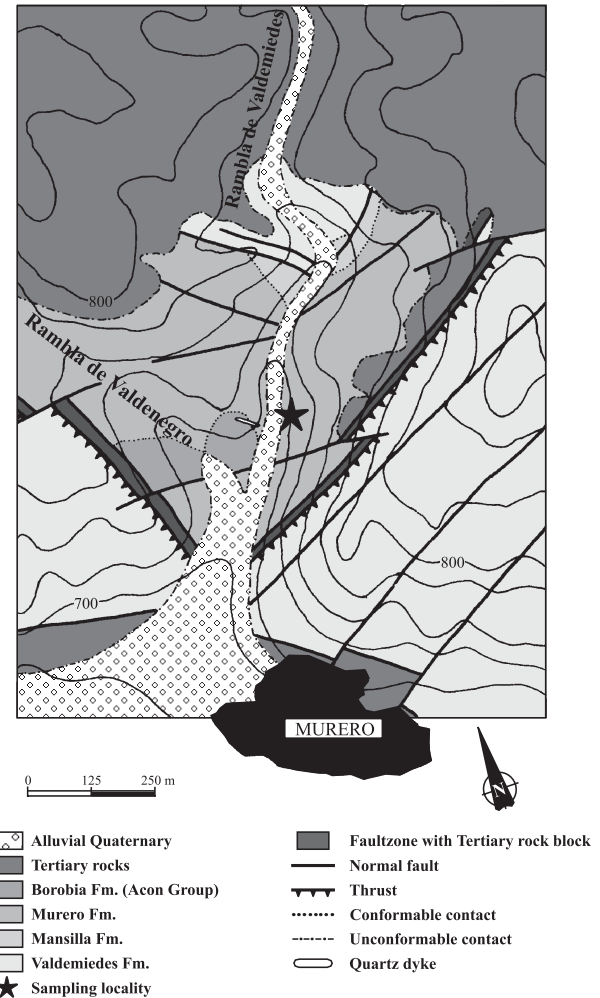


FIGURE 2 | Geological map of the Murero area (modified from Liñán and Gozalo, 1986).

oxeas, up to 0.10 mm in diameter, form uniformly parallel, vertically continuous, rodlike structures that separate intermediate areas of fine vertical thatch. Thatch spicules up to 0.03 mm in diameter. Inner skeleton of horizontally-arranged, unclumped monaxial spicules 0.01-0.015 mm in diameter. Oscular margin generally terminates in tufts composed mainly of fine intermediate vertical spicules. Base may be rounded. Sponge smooth except for weak horizontal ridges and prominent vertical rods.

Description: The specimen is 13 cm long and approximately 6 mm wide with a maximum flattened width of 9 mm. The fossil corresponds to an individual lacking the base and the osculum due to rock breakage (see Fig. 4C for comparison). The spicules that form the outer wall of the sponge are slightly tilted sideways, as if the specimen had been slightly twisted around its axis, in a similar way to the lectotype USNM 66448 (Briggs et al., 1994: p. 74). There is a specimen of the brachiopod *Micromitra* sp. apparently attached to the

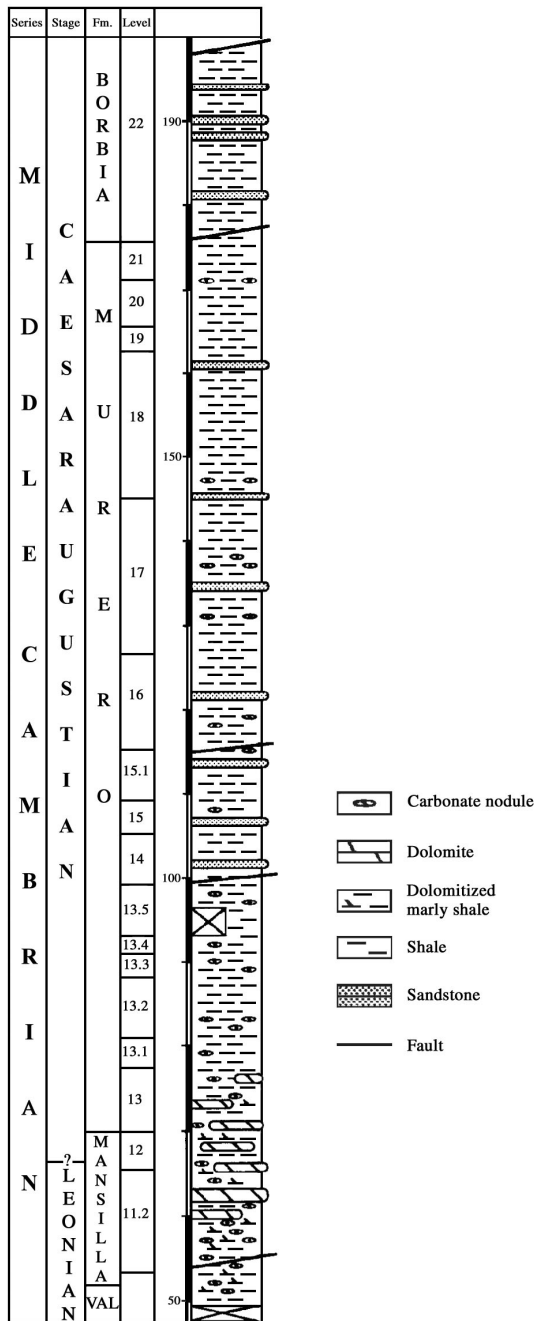


FIGURE 3 | Stratigraphical section of the Rambla de Valdemiedes (RV-1) (modified from Gozalo et al., 1996).

side of the sponge. This seems to be the case since it extends above and below the plane defined by the sponge. It is located at a distance of 4 and 9 cm from the tips of the fossil (Fig. 4A).

Observations: The state of preservation of the sponge does not allow for unequivocal measurement of the length of its spicules or the number of oxea rods per centimetre. Neither the inner layer of spicules nor the horizontal wrinkles described in North American specimens can be rec-

ognized in this specimen. These facts force us to leave the assignation of the species open.

Stratigraphic distribution: Murero Formation, Caesaraugustian Stage, Middle Cambrian.

PALEOECOLOGY AND TAPHONOMY

The sponge *Leptomitrus* stood vertically on the sea floor and could grow up to 36 cm in length (Rigby, 1986). The specimen of the brachiopod *Micromitra*, attached at some distance from the base of the sponge, was certainly gaining height above the sea floor. The long fine setae that fringe the mantle of this brachiopod in some specimens from the Burgess Shale (Briggs et al., 1994: p. 102) suggest an epifaunal mode of live, since living on the sea floor would have clogged its filter-feeding apparatus. Living attached to the higher parts of the sponge would enable it to access food particles in suspension and maybe to take advantage of the water currents created by the sponge itself (Whittington, 1985). However, the case for the latter is somewhat more feeble. In any case, this position may be an advantage over other brachiopods, most of them sessile and epibenthic. The relationship apparently did not produce any advantage, nor harm, to the sponge and can thus be considered a case of commensalism. This is not the first example of this type of interspecific relationship. Such cases are known in several fossils from the Burgess Shale. The association between the sponge *Pirania* and the brachiopods *Nisusia*, *Micromitra* and *Dyctionina* is well documented (Rigby, 1986), but it has also been observed between the sponge *Vauxia gracilentia* and *Micromitra* (García-Bellido Capdevila, 2000).

A taphonomic study of the fossil (Fig. 5), following the categories used by Fernández-López (2000), allows us to determine that none of the remains show the original components of the producing organisms and that they have gone through complex transformations. When the sponge died, it came to lie horizontally on the sea floor. Since the specimen does not show any sign of disarticulation or fracture of its spicules, it was probably autochthonous or was not transported far from where it lived. Soon after its death, with no time for scavengers to tear it and feed on it, it was buried and bacteria decomposed its organic matter. This process left no trace of such structures as the pedicle and mantle setae of the brachiopod and the dermal layer and spongin that bound the spicules of the sponge together (Rigby, 1986: p. 22). Due to the loss of the organic matrix, the unfused spicules of the sponge gave way under the weight of overlying sediments, and the cylindrical body collapsed, making the surrounding sediment a flat replica of the original spicules. During early diagenesis, the siliceous

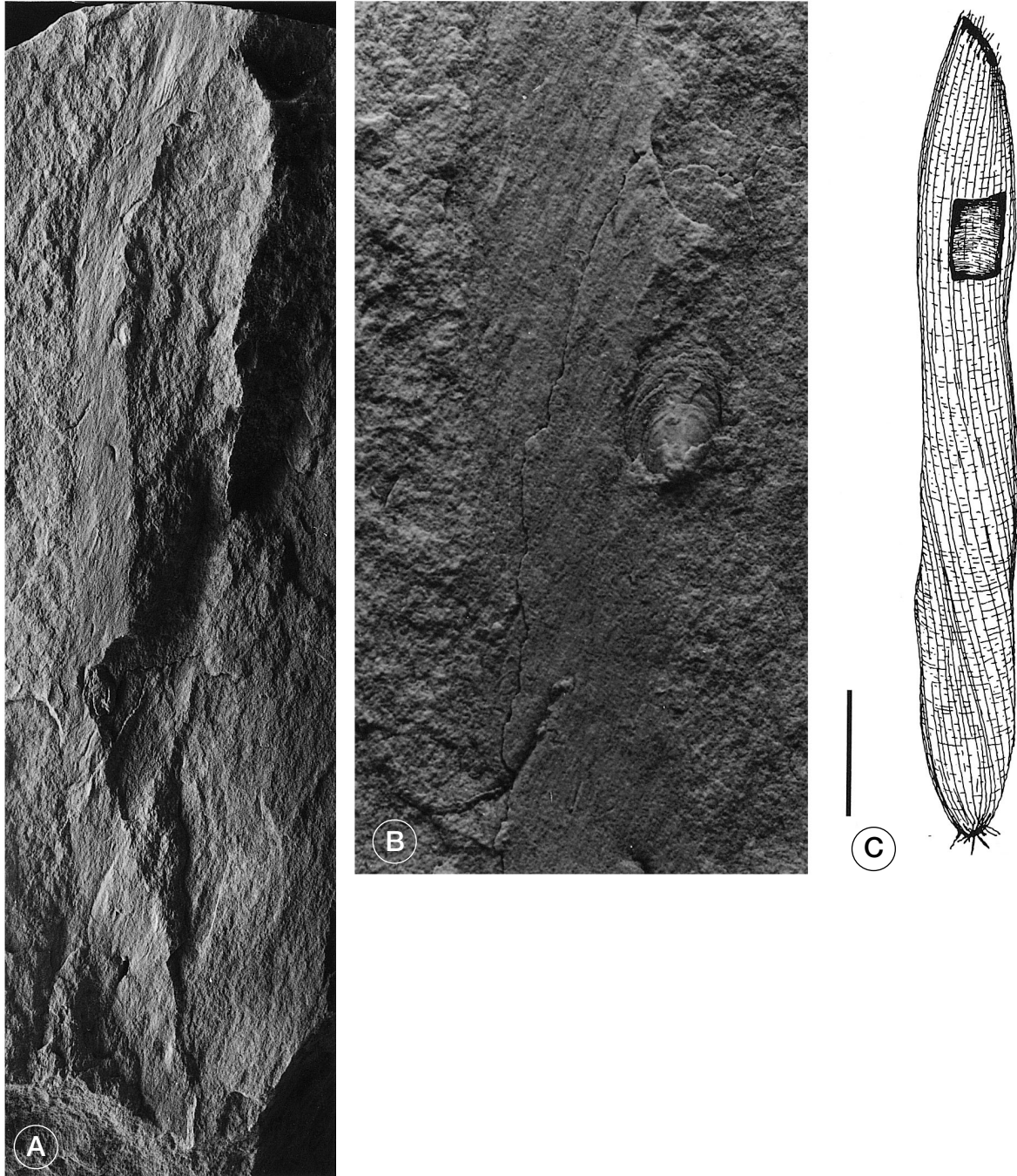


FIGURE 4 | **A-** *Leptomitus* cf. *L. lineatus* (MPZ 97/423) (x 1.4). **B-** Detail of the brachiopod *Micromitra* sp. attached to the sponge (x 5). **C-** Generalized restoration of *Leptomitus lineatus* (Walcott, 1920), from Rigby (1986) (scale bar: 5cm).

macroscopicules were dissolved, leaving cavities that were later filled and cemented by chlorite. The dissolution and recrystallization probably took place under the higher temperature and pressure conditions produced during advanced diagenesis in the late Paleozoic and Mesozoic. In later diagenesis, the moldic porosity left by the dissolution of more recalcitrant bioclasts, such as trilobites and brachiopods, was filled in by pyrite, which later

weathered to iron oxides and hydroxides that now show the characteristic rusty brown colour of limonite.

CONCLUDING REMARKS

The Middle Cambrian rocks that crop out at the Rambla de Valdemiedes in Murero have delivered not just the

PROCESSES OF TAPHONOMIC ALTERATION and results	BIOSTRATINOMIC PHASE	FOSSILDIAGENETIC PHASE			
		EARLY		ADVANCED	LATE
	AUTOCHTHONOUS	WITH ORGANIC MATTER	WITHOUT ORG. MATTER		
BIODEGRADATION Absence of soft-parts	■ ■ ■ ■ ■	■ ■ ■ ■ ■			
REORIENTATION Specimen lays horizontally on sea-bottom	■ ■ ■ ■ ■				
BURIAL Sedimentary replica of skeletal remains		■ ■ ■ ■ ■			
DISSOLUTION Absence of skeletal remains (macrospicules) Moldic porosity of other bioclasts			■ ■ ■ ■ ■		■ ■ ■ ■ ■
DIAGENETIC COMPACTION Compressed specimen		■ ■ ■ ■ ■	■ ■ ■ ■ ■		
MINERALIZATION Cementation by chlorite Replacement by ferric oxides and hidroxides				■ ■ ■ ■ ■	■ ■ ■ ■ ■

FIGURE 5 | Main taphonomic processes undergone by the studied fossils. Dashed lines indicate partial activity of those particular processes.

typical Cambrian forms, such as trilobites, brachiopods and hyoliths, but also soft-bodied animals, as well as other rare fossils. This is the case of the articulated demosponge *Leptomit* and the attached *Micromitra* brachiopod described here. This peculiar preservation, almost unique of this locality for the Cambrian of Spain, enables us to observe palaeobiological features, such as interspecific relationships, that would otherwise have been lost. In this case, commensalism between the brachiopod and the sponge can be inferred.

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