

ENROLMENT IN MIDDLE CAMBRIAN SOLENOPLEUROPSINAE TRILOBITES

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INTRODUCTION

Trilobites are arthropods capable of enrolling. However trilobite enrolment mechanism has only been well studied in post-Cambrian specimens (Chatterton and Campbell, 1993; Clarkson and Whittington, 1997). The mechanism of enrolment is possible thanks to the presence of coaptatives structures. These structures have been recognized since Cambrian times.

According to Bergström (1973) there are two basic types of enrolment: incomplete and complete. Incomplete enrolment has been observed in some Lower Cambrian trilobites, whose enrolment comprises the coiled posterior part of a thorax (Bergström, 1973). Complete enrolment is the most common since Ordovician; although it is unusual in Cambrian trilobites, there are figurations since 19th Century (see Prado *et al.*, 1860: pl. VI fig. 8).

The complete enrolment has been subdivided into two subtypes: sphaeroidal and spiral (Bergström, 1973). In the first one, the pygidium leans on the ventral surface of the cephalon and in the second one the pygidium is undercovered by the cephalon. The sphaeroidal subtype, also could be subdivided in three types: cylindrical, *Asaphus*-type and inverted spiral (*Placoparia*-type). In the cylindrical enrolment, the most common in the Paradoxididae family (Middle Cambrian), pleurae do not close laterally the exoskeletal basket. *Asaphus*-type and inverted spiral enrolment (*Placoparia*-type) are the typical enrolment among post-Cambrian trilobites (Bergström, 1973; Speyer, 1988; Chatterton and Campbell, 1993; Bruton and Hass, 1997).

There are some complete Cambrian enrolled trilobites described in several species from North America (Palmer, 1958; Robinson, 1964; Stitt, 1983; Whittington, 2005) and Morocco (Geyer, 1990), most of them belonging to the spiral type. Sphaeroidal enrolment is very unusual in Cambrian specimens and we describe herein an example registered in two genera of Solenopleuropsinae.

Sixteen specimens of *Solenopleuropsis* and *Pardailhania* excellently preserved in 3D have been recently found in the Cadenas Ibéricas. This type of enrolment has not been described before in Cambrian species. The coaptatives structures observed and its role in the enrolment mechanism will also be analysed and discussed.

GEOLOGICAL FRAMEWORK AND PRESERVATION OF FOSSILS

The studied material has been found in the localities of Murero and Purujosa (Cadenas Ibéricas, NE Spain, fig. 1A). Fossils were collected in the levels of the Murero Formation (Caesaraugustan-Languedocian, Middle Cambrian; fig. 1B). This Formation consists of a siliciclastic succession with interbedded carbonate nodules deposited under sublittoral marine conditions in the western margin of Gondwana. Levels from both localities specially those from Purujosa are related with orobryon deposits. Fossil assemblages are composed of echinoderms, brachiopods, trilobites and sponges.

The enrolled trilobites studied here are preserved as casts of the skeletons in authigenic verdine-type clay minerals. As a result of this preservation, specimens can be observed in three dimensions, a very atypical preservation style on middle Cambrian trilobites.

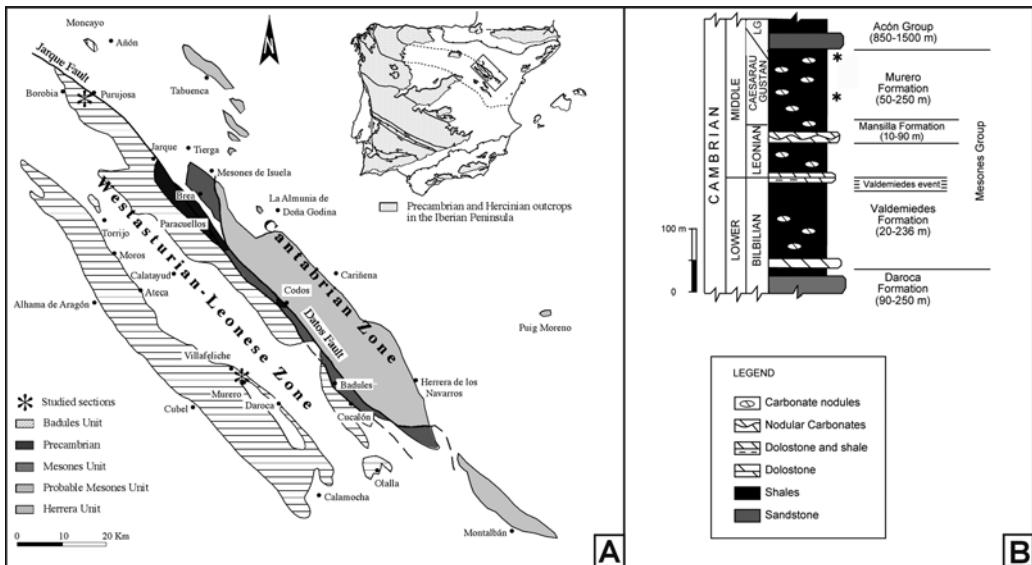


Figure 1. A, Geological framework of the Cadenas Ibéricas showing the studied localities (modified from Liñan *et al.*, 1996). B, Stratigraphy of the upper lower to middle Cambrian, Mesones Group (modified from Liñan *et al.*, 1996).

COAPTATIVE STRUCTURES

The different types of complete enrolment depend on morphological features called coaptative structures, which provide close interlocking of the opposing surfaces. The specimens of *Pardailhania* and *Solenopleuropsis* studied here have specific coaptative structures belonging to the *Asaphus* type of enrolment. These structures are localized in the cephalon, thorax and pygidium and they are briefly described below.

Cephalon: The cephalon has a concave anterior border with an upturned anterior margin. The ventral side bears a smooth vincular furrow and it is placed behind the cephalic doublure.

Thorax: The thoracic segments are arch on arches. The thorax bears articulation points placed between

the axial rings (articulating half ring) and between adjacent pleurae, (fig. 2A). The axial rings show a preannulus that is divided into two parts: the articulating furrow and the intra annular furrow, which is very smooth and points the contact with the next thoracic segment (Harrington, 1959; Speyer, 1988; Bruton and Hass, 1997). The pleurae were articulated by fulcra joints with soft tissues connecting their inner margin of double as “ball and socket connection” (marginal connective device *sensu* Bergström, 1973) (fig. 2B). Thoracic pleurae doublures bears panderian protuberances consisting on elongated ridgelike protuberances.

Pygidium: It is very short and narrow with a little vincular hook fitting on the vincular furrow.

These coaptative structures make possible the mechanism of enrolment in Solenopleuropsinae trilobites. In this process pygidium rests with its dorsal side on the cephalic margin doublure. As a result cephalon and pygidium are in a opposite position.

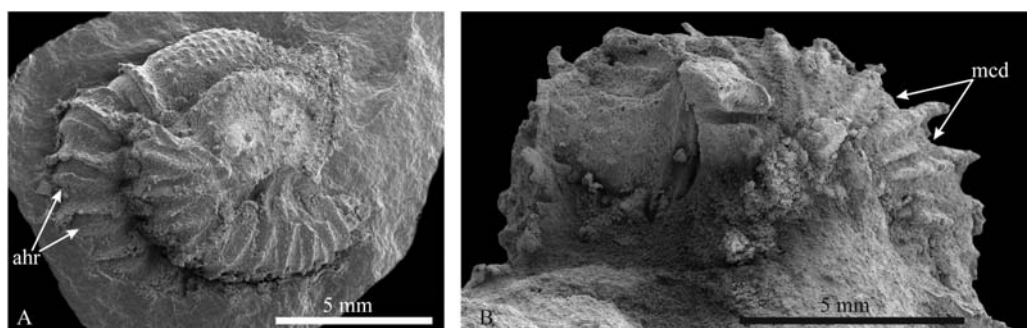


Figure 2. A, *Solenopleuropsis* sp., incomplete enrolled specimen in lateral view. ahr: articulating half ring. SEM picture of a latex cast. B, *Pardailhania* specimen enrolled in lateral view. mcd: marginal connective devices. SEM picture of a latex cast.

ENROLLING MECHANISM

The enrolment begins at the first articulation, between the occipital ring and the first axial ring, by the articulating half ring that allows the thorax bending. In the rest of the thorax, the ball and socket connections in pleurae execute the articulation between pleurae till they meet laterally the pygidium. Finally the most posterior thoracic segments have to fit the ventral the cephalon on its ventral part, through the vincular furrow, closing completely the trilobites.

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