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## THYLACOCEPHALANS FROM THE ANISIAN (MIDDLE TRIASSIC) OF THE CARNIC ALPS

THYLACOCEPHALA (ARTHROPODA, CRUSTACEA?)  
NELL'ANISICO (TRIASSICO MEDIO) DELLE ALPI CARNICHE

**Riassunto breve** - Sono descritti tre esemplari incompleti di Thylacocephala (Arthropoda, Crustacea?) rinvenuti nell'Anisico (Triassico medio) delle Alpi Carniche. I reperti, pur incompleti e mal conservati, confermano la diffusione di forme con carapace ornamentato a strie subverticali nei depositi Triassici, nonché la presenza nel Triassico alpino di ulteriori taxa che indicano una notevole diffusione e diversità locale di questi enigmatici artropodi.

**Parole chiave:** *Micriocaris*, *Thylacocephala*, *Arthropoda*, *Alpi Carniche*, *Anisico*.

**Abstract** - We report here the discovery of three incomplete specimens of *Thylacocephala* (Arthropoda, Crustacea?) from the Anisian (Middle Triassic) of the Carnic Alps. Although incomplete and poorly preserved, the findings confirm the diffusion of forms having a carapace ornamented with subvertical striations in Triassic deposits, as well as the presence in the Alpine Triassic of taxa indicating a relatively high local diffusion and diversity of these enigmatic arthropods.

**Key words:** *Micriocaris*, *Thylacocephala*, *Arthropoda*, *Carnic Alps*, *Anisian*.

### Introduction

Thylacocephala is a Class of extinct arthropods generally attributed to the Crustacea, albeit with uncertainty. It is characterized by a body enclosed almost completely within a bivalve phosphatic carapace, three pairs of large, anterior (thoracic?) appendages and a battery of smaller posterior (abdominal) limbs. A globular sac-like structure (after which the Class is named as *thylakos* in ancient Greek means “pouch”) protrudes from the anterior margin of the carapace. Many authors regard this structure as a giant eye (cfr. VANNIER et al, 2016) but authors of an “Italian school” consider it a “sac” of uncertain function (PINNA et al. 1985; ALESSANDRELLO et al. 1989).

Thylacocephalans are known from the Silurian to the Upper Cretaceous (SCHRAM 2014). In the Lower Triassic, thylacocephalans have been found in the Olenekian of Madagascar (ARDUINI 1990), Japan (EHIRO et al. 2015), Idaho (USA) (CARBONNIER et al. 2019) and China (JI et al. 2017). Middle and Upper Triassic thylacocephalans have been discovered in the Alps, more specifically in the Upper Anisian of Slovenia (KRIŽNAR & HITIJI 2010), at the Anisian-Ladinian boundary of Besano (I)-Monte San Giorgio (CH) (AFFER & TERUZZI 1999), in the Ladinian of the Grisons Canton (CH) (BÜRGIN et al. 1991), in the Carnian of

Austria (GLAESSNER 1931; FORCHIELLI & PERVESLER, 2013) and in the Norian of Lombardy (PINNA 1974, 1976; ARDUINI & BRASCA 1984), Carnic Prealps of Friuli (DALLA VECCHIA & MUSCIO 1990; ARDUINI 1992; DALLA VECCHIA 2012) and the central Apennines (DALLA VECCHIA 1993).

### Materials, provenance, age and taxonomical notes

The specimens described here are part of collections housed at the Museo Fruliano di Storia Naturale di Udine (MFSN gp 20559 and MFSN gp 20560) and at the Museo Geologico della Carnia di Ampezzo (MGC 332203), Udine Province, NE Italy.

They come from the Mt. Bivera Massif, a significant high ground of the Carnic Alps located between the towns of Forni di Sotto, Forni di Sopra and Sauris (upper valley of the Tagliamento River, Udine Province; Fig. 1). More precisely, specimens were discovered in the Pian delle Streghe locality (Fig. 2), a vast inclined plateau (at an altitude of 2150-2200 a.s.l.) with a particular hummocked morphology linked to the presence of extensive deposits of debris and moraines, found in an area delimited by the peaks of Mt. Bivera, Mt. Clapsavon and Mt. Zauf.

The specimens came from the Dont Formation, which is composed of about 35 m of blackish nodular limestones and pelites and is referred to the Pelsonian (Upper Anisian) (RIEPPPEL & DALLA VECCHIA 2001). In the Carnian area, this formation has yielded also radiolarians, small ammonoids, as well as *Saurichthys* and ichthyosaur remains (*Cymbospondylus* and *Mixosaurus*) (RIEPPPEL



Fig. 1 - Map with Mt. Bivera position (red dot).  
- Mappa con la posizione del M. Bivera (pallino rosso).

& DALLA VECCHIA 2001; DALLA VECCHIA 2008, 2010). The Dont Formation is a basinal unit deposited after the dismemberment and subsidence of the carbonate platform of the Popera Dolostone during the late Anisian (VENTURINI 2006).

Two of the specimens here described have a carapace ornated with dense, vertical striations, which is a type of ornamentation that is rather common in Triassic thylacocephalans. The first report of thylacocephalans with this kind of ornamentation from the Alpine Triassic was by GLAESSNER (1931), who described several specimens found in the Lunzner Beds (lower Carnian) in the central part of Austria. GLAESSNER (1931) erected the genus *Austriocaris*, containing the species *A. carinata* and *A. striata*, and the Family Austriocarididae, which he nested within the phyllocarid crustaceans. PINNA (1974) erected the genus *Microcaris*, which contains the species *M. minuta*, for the middle-upper Norian specimens discovered in the Calcare di Zorzino Formation at Cene, in the Brembo Valley (Bergamo, NW Italy). ARDUINI & BRASCA (1989) erected the genus *Atropicaris* for the specimens found in the upper Norian Argillite di Riva di Solto Formation at Ponte Giurino, in Imagna Valley (Bergamo NW Italy).



Fig. 2 - The "Pian delle Streghe" (Mt Bivera): the area from which the described specimens come.  
- Il Pian delle Streghe (Monte Bivera), l'area da cui provengono i reperti descritti.

Specimens attributed to *Atropicaris* have been reported from the Besano Formation at the Anisian-Ladinan boundary (AFFER & TERUZZI 1994) and in Grisons Canton (BÜRGIN 1991). Similar forms have been reported from the Dolomia di Forni (Norian) in the northern side of the Carnic Prealps in Friuli (DALLA VECCHIA & MUSCIO 1990) and from the Norian of Filettino, in Lazio (Central Italy; DALLA VECCHIA 1993).

Specimens with similar ornamentation, but placed in the genus *Thylacocephalus* have been found only in the Santonian (Upper Cretaceous) of Lebanon (LANGE et al. 2001).

The current study is not a detailed systematic revision; however, on the basis of the re-examination of most of the specimens described in the cited papers, which are kept at the Natural History museums of Milan, Bergamo and Udine in Italy and at the Natural History Museum of Wien and the Geological Survey of Austria, also in Wien, we have made some taxonomic considerations presented in the paragraph of the conclusions.

For the suprageneric classification, we followed that proposed by SCHRAM (2014), which although regarded as tentative by the author himself, is nevertheless use-

ful at a practical level given the current understanding of thylacocephalan relationships.

### Systematic paleontology

Class Thylacocephala PINNA, ARDUINI, PESARINI & TERUZZI, 1982

Order Concavicularida BRIGGS & ROLFE, 1983

Family Microcarididae SCHRAM, 2014

Genus *Microcaris* PINNA, 1974

*Microcaris* sp. indet.

(Fig. 3)

Material: one specimen, MGC 332203.

Description: The specimen consists of a very badly preserved bivalve carapace about 29 mm long. Anteriorly, the two valves are partially displaced. The thin carapace is reduced to a partial mosaic of still-in-place fragments. Relatively pronounced falcooid ribs are recognizable on some of the fragments. The rostrum is preserved anteriorly: it is continuous with the carapace.

Discussion: The attribution to *Microcaris* is based on the presence of the genus' characteristic ornamentation.

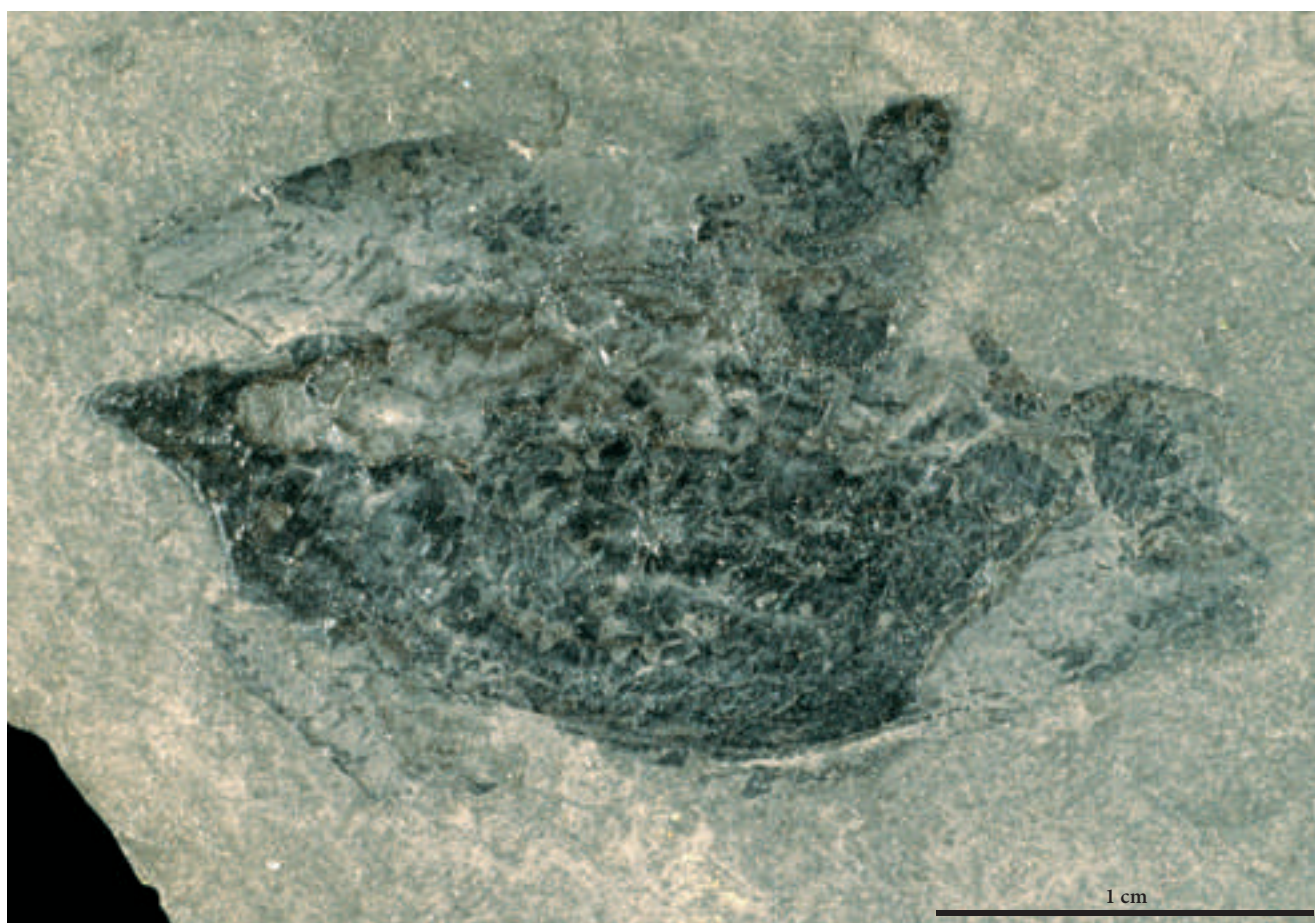


Fig. 3 - *Microcaris* sp. indet., es. MGC 332203.  
- *Microcaris* sp. indet., es. MGC 332203.

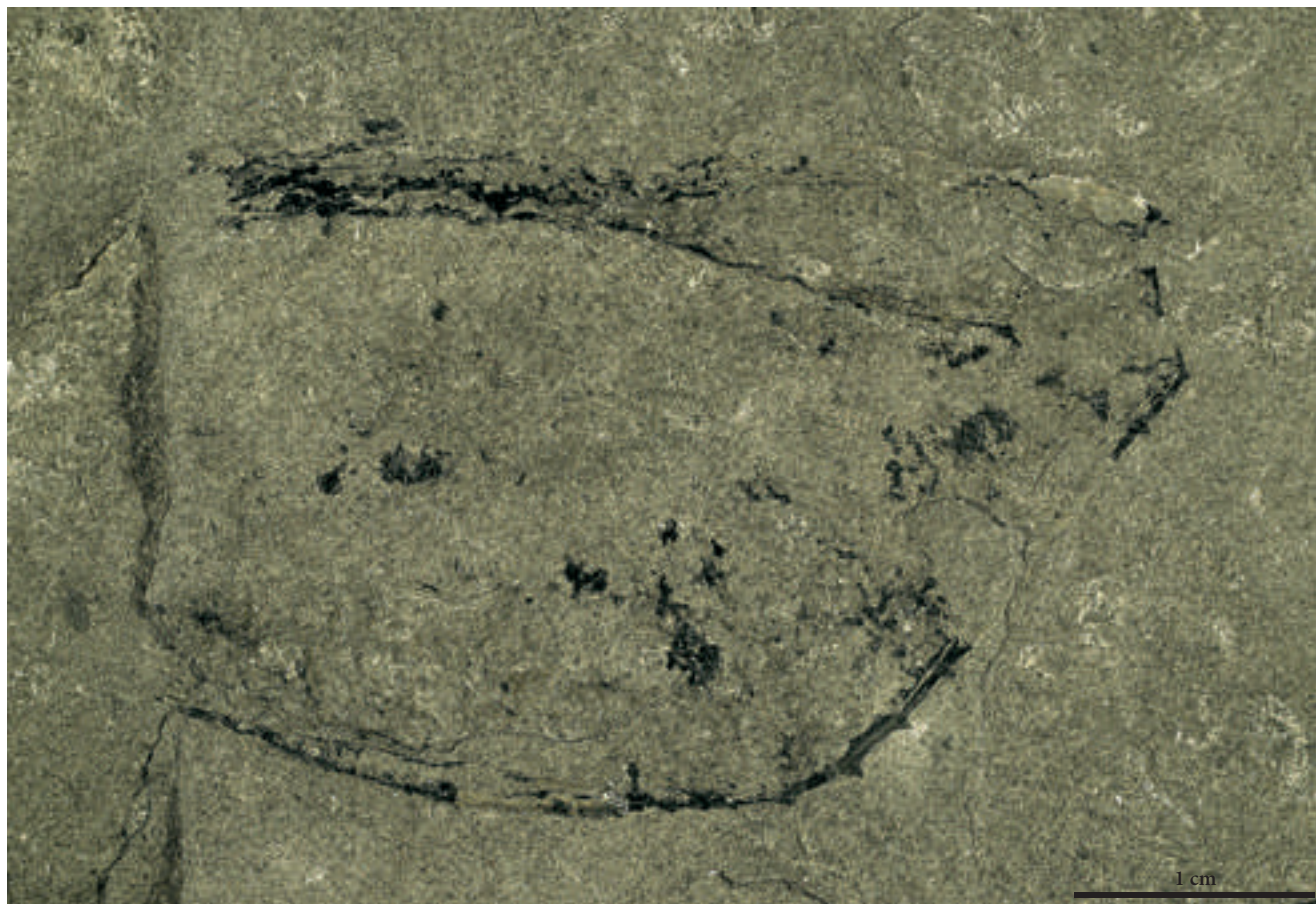


Fig. 4 - A thylacocephalan of undetermined genus and species (MFSN gp 20560).  
- *Tilacocefalo*, genere e specie indeterminata (MFSN gp 20560).

Order and Family INCERTAE SEDIS  
Genus and Species INCERTAE SEDIS  
(Figs 4-7)

Material: two specimens: MFSN gp 20559, MFSN gp 20560.

Description: MFSN gp 20560 is a poorly preserved specimen consisting of a partial carapace 37 mm long, lacking the whole of the anterior margin. Practically only the ventral and posterior margins of the carapace can be seen with sufficient clarity. However, its features are decidedly unusual, rendering this form unique among Mesozoic thylacocephalans. The dorsal margin, which is just about discernible, seems relatively straight, whereas the ventral margin is weakly convex medially and then gently curves upwards towards the posterior margin, which is narrow with respect to the height of the carapace.

What makes this form decisively particular is the presence of small spines. The spines near the curved portion of the ventral margin are barely outlined, but they then become more evident, eventually turning into triangular spines along the whole of the ventral margin as it turns upwards posteriorly. Part of the posterior third of the ventral margin is not preserved,

but a complete spine can be seen on its terminal track, whereas the base of another spine lacking a preserved point is present at the angle with the posterior margin. It can be hypothesized that spines were present also along the unpreserved portion of the ventral margin.

Description: MFSN gp 20559 is even more poorly preserved and difficult to interpret. It is a very fragmentary specimen, with just a margin partially visible about 60 mm long, which we interpret as the ventral margin. Remains of what is possibly the circular muscle scar where the long appendages typical of thylacocephalans articulated is hardly visible on the left. Owing to the bad conditions of preservation, it is difficult to ascertain with certainty whether some indentations in the median and right (i.e., posterior) portion correspond to small teeth or are just part of the fragmented ventral margin.

Discussion: We tentatively ascribe to the same species these two fragmentary specimens for showing the same degree of preservation, comparable size, a ventral margin slightly concave and with sparse teeth.

To our knowledge, the only form showing a ventral margin with denticles is *Protozoa hingeldorfi* Dames,

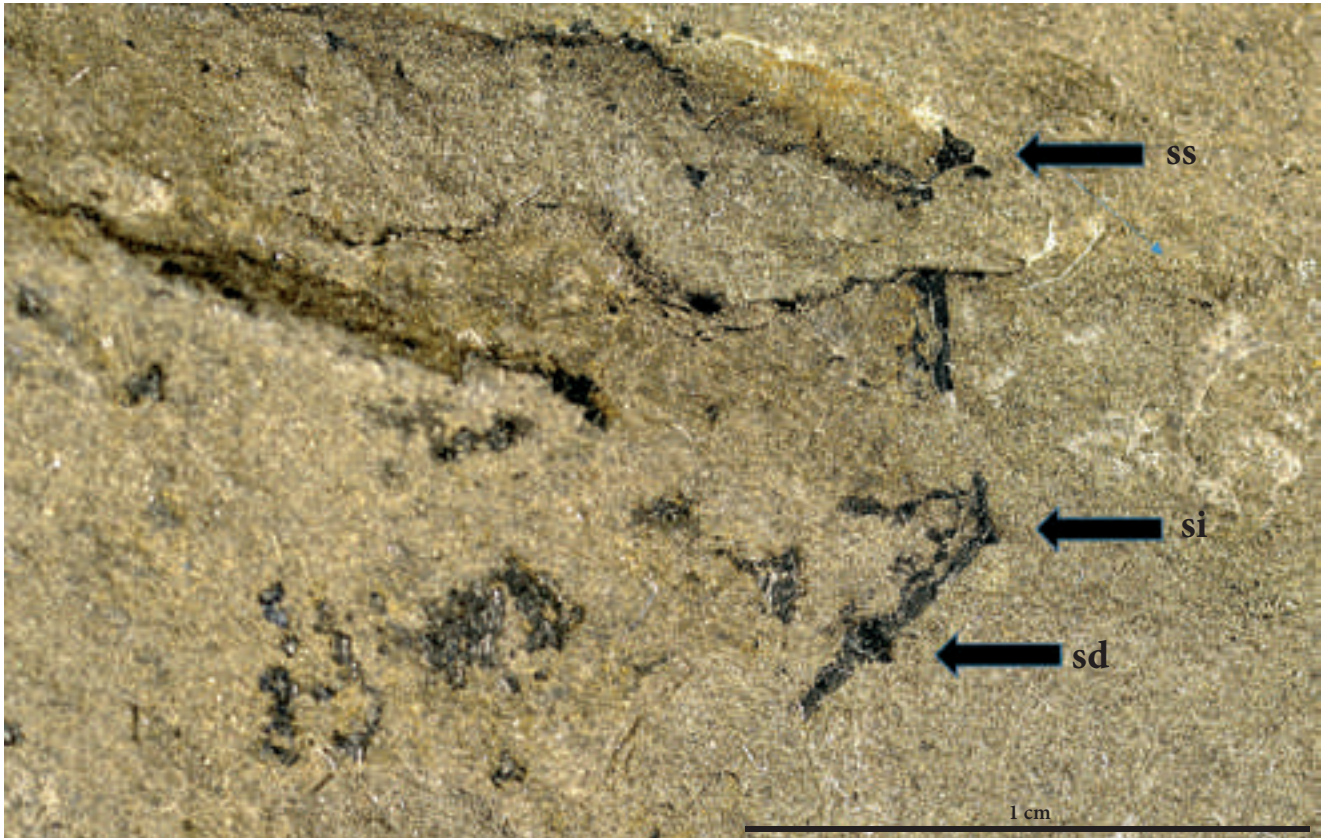


Fig. 5 - Close-up of the posterior margin of MFSN gp 20560. Abbreviations: ss, spine at the postero-dorsal corner; si, spine at the postero-ventral corner; sd, spine of the ventro-posterior margin.

- *Es. MFSN gp 20560; particolare del margine posteriorw. Abbreviazioni: ss, spina all'angolo postero-dorsale; si, spina all'angolo postero-ventrale; sd, spina sul margine ventrale posteriore.*

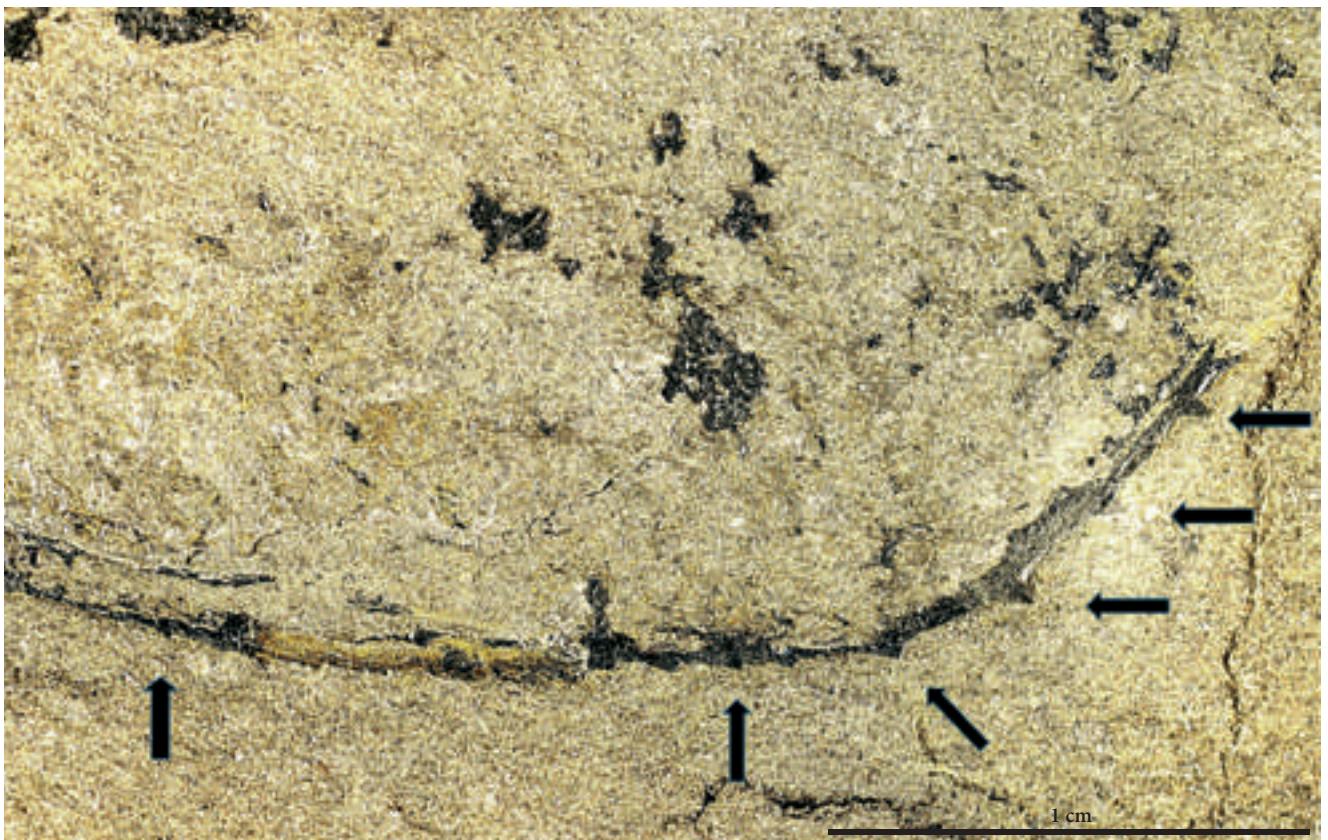


Fig. 6 - Close-up of MFSN gp 20560: arrows indicate the spines or groups of spines along the anterior and posterior portions of the ventral margin.

- *Es. MFSN gp 20560; particolare della parte anteriore e posteriore del margine ventrale; le frecce indicano i principali dentelli o gruppi di dentelli.*

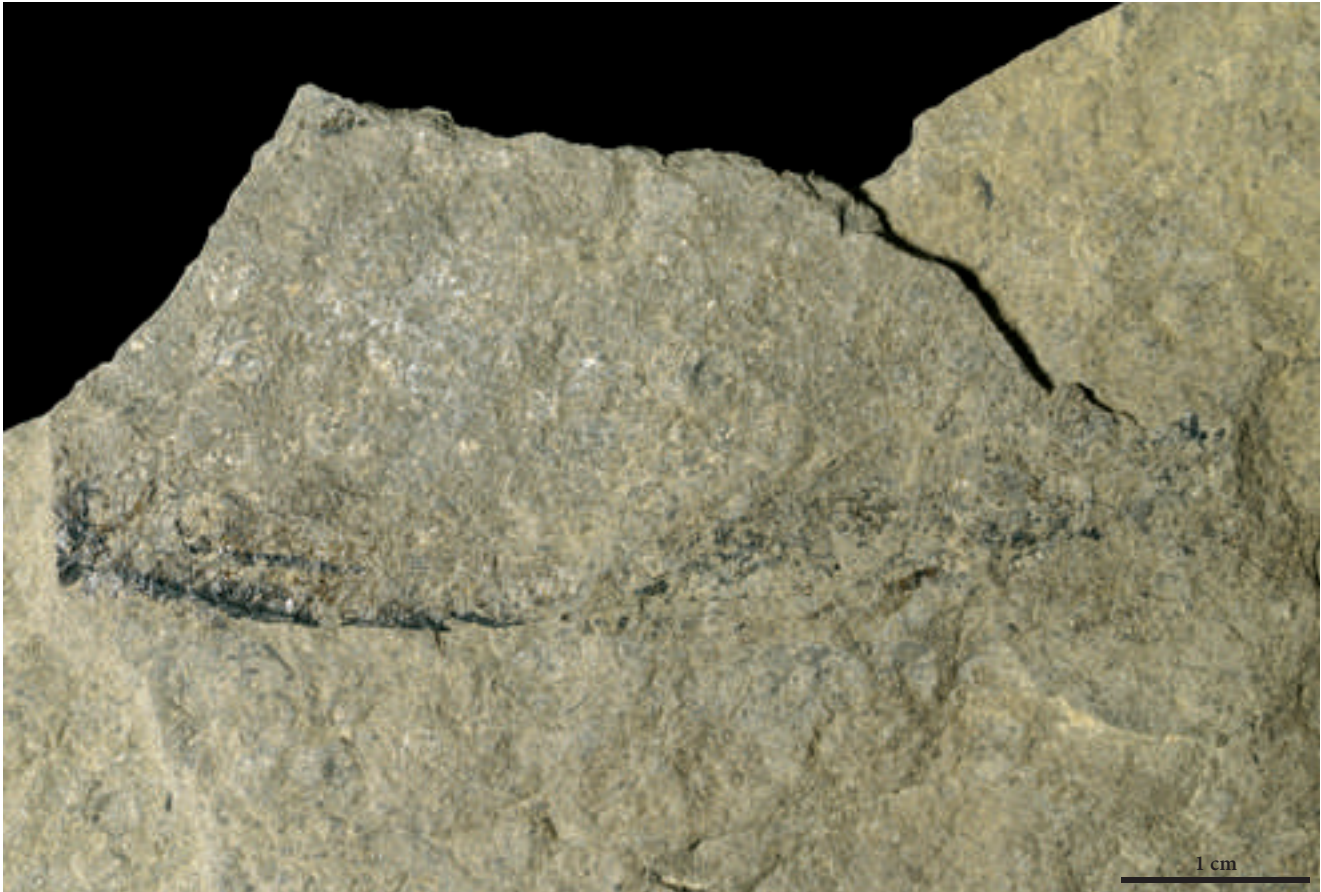


Fig. 7 - A thylacocephalan of undetermined genus and species (MFSN gp 20559).  
- *Tilacocefalo*, genere e specie indeterminati (MFSN gp 20559).

1886, from the Santonian (Upper Cretaceous) of Lebanon (SCHRAM et al. 1999). *P. hingeldorfi* is characterized by a carapace that is decidedly patent in concaved along its ventral portion, in which it is difficult to distinguish a posterior margin, which is completely absent and has a difficultly distinguishable, or completely absent, posterior margin; it also has two long spines that resemble extremely elongated anterior and posterior rostra. Our specimens differ totally from *Protozoea* in that it has a well-developed posterior margin sporting, at the angle with the dorsal margin, a small, short, retroverted spine. Moreover, the ventral margin, rather than being completely concaved, is linear and parallel to the dorsal margin in MFSN Gp 20560, with a posterior third portion that folds decisively upwards.

Without doubt, the examined specimens belong to a new taxon; however, we do not feel it is appropriate to erect a new specific entity on the basis of such partial specimens.

## Conclusions

The current study is not a detailed systematic revision; however, our re-examination of those collections

has led us to conclude that *Atropicar* ARDUINI & BRASCA, 1989, is a younger synonymous with *Microcar* PINNA, 1974, the genus to which should be ascribed also the species *Austriocar striata* GLAESSNER, 1931, as suggested by ARDUINI & BRASCA (1984).

From recent discoveries made throughout the world, it seems that ornamented thylacocephalans were very diffuse in the Triassic, along with other forms like *Ostenocar* (i.e. *Ankitokazocar* ARDUINI, 1990; *Austriocar* GLAESSNER, 1931; and other, undescribed forms): CHARBONNIER et al. (2019) reported the genus *Parisicar* from the Spathian of Idaho (US), and EHIRO et al. (2015) erected the genus *Kitakamicar* from the Spathian of Japan.

The scarce remains unearthed up to now at the Dont Formation are undoubtedly of particular interest, above all because they are evidence of new, Triassic forms. Hopefully, they will be described in more detail upon the discovery of further specimens.

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