## Short Communication

# Evidence of mysid swarm behaviour (Crustacea: Malacostraca) from the Cenomanian (Late Cretaceous) of Hakel, Lebanon

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**Abstract** - A mass mortality assemblage of mysid crustaceans is herein reported from the Cenomanian (Late Cretaceous) sublithographic limestone of Hakel (Lebanon). The studied specimens documented a mass mortality event attesting mysid swarm behaviour, herein briefly described and discussed. Though their poor preservation does not allow a specific assignment, this new record is remarkable, resulting the first formal report of Mysida Boas 1883 (Crustacea, Malacostraca) from the rich crustacean fossil fauna from the Late Cretaceous of Lebanon and from the worldwide Cretaceous record.

**Key words**: behaviour, Eumalacostraca, Mysida, Mysidacea, taxonomy.

**Riassunto** - Testimonianza di un comportamento gregario di misidi fossili del Cenomaniano (Cretacico superiore) di Hakel, Libano.

Una mortalità di massa di crostacei misidacei è documentata nel calcare sublitografico del Cenomaniano (Cretacico superiore) di Hakel (Libano). Gli esemplari studiati documentano una mortalità di massa che conferma un comportamento gregario tra i misidi, brevemente descritto e discusso nella presente nota. Anche se lo stato di conservazione degli esemplari non permette una loro assegnazione sistematica, questa scoperta è rilevante in quanto trattasi della prima segnalazione del sottordine Mysida Boas 1883 (Crustacea, Malacostraca) nella ricca associazione a crostacei del Libano e nel record fossile mondiale del Cretacico.

**Parole chiave**: comportamento, Eumalacostraca, Mysida, Mysidacea, tassonomia.

## INTRODUCTION

Mysids are small shrimp-like crustaceans that, in addition to their ecological importance, are primary prey for marine and estuarine fish (for full discussion on biology and ecology see Mauchline, 1980; Morgan, 1982; Meland *et al.*, 2015 among others).

Though the extant Mysidae Haworth 1825 includes about the 90% of the mysid genera, the fossil record is very scarce mainly due to their soft and thin, membranous body scarcely prone to fossilization (Meland *et al.*, 2015). Therefore, their evolutionary history is still poorly documented. The Lebanese fossiliferous outcrops (Hakel, Hadjoula, En Nammoura, and Sahel Alma) include a well-known differentiated rich marine crustacean fauna mainly including decapods and stomatopods (Charbonnier *et al.*, 2017; Garassino & Pasini, 2020; Pasini et *al.*, 2020 among others), whereas the other minor crustacean orders are still scarcely known or unreported.

Indeed, *Palaeognathophausia libanotica* Charbonnier, Audo, Garassino & Hyžný 2017 (Lophogastrida Boas 1883) is the only species known to date from the Santonian (Late Cretaceous) of Sahel Alma (Charbonnier *et al.*, 2017: 216). Other worldwide Mesozoic records are limited to some specimens from the Triassic and Jurassic more or less related to the Lophogastrida (Meland *et al.*, 2015). According to Meland *et al.* (2015) the earliest fossil Mysida are *Elder unguiculata* Münster 1839 and *Francocaris grimmi* Broili 1917 from the Jurassic of Bavaria (Germany), the latter recently re-described by Pazinato *et al.* (2021) based on exceptionally preserved specimens. At the same time, there are some fossil Mysida with amazing similarity to extant forms, such as *Siriella antiqua* Secrétan & Riou 1986 and *S. carinata* Secrétan & Riou 1986 from the Middle Jurassic of France (Secrétan & Riou, 1986).

Moreover, Van Straelen (1938: 396, pl. 24) reported a slab ("le no. 432 de la collection générale des Crustacés fossils") kept at the Muséum d'histoire naturelle (Geneva, Switzerland) from the Hakel layers with several poorly preserved specimens, which he strongly believes to be Stomatopoda larvae ("il est possible de se rendre compte qu'il s'agit de larves de Stomatopodes"). These specimens were briefly described and the original slab poorly illustrated by the author. Unfortunately, despite repeated attempts to obtain high-resolution photographs of the slab studied by Van Straelen for comparison with our sample, we never got an answer from the Museum of Geneva. In our opinion, based on the sole figure found in Van Strael-

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en's paper, the specimens might better represent a possible assemblage of Mysida than of Stomatopoda. However, only a direct examination of the slab could confirm this possible interpretation.

Finally, Roger (1946) reported some specimens as *Eucopia* sp. (Lophogastrida Boas 1883). However, according to Charbonnier *et al.* (2017) these specimens, though their state of preservation does not allow for a more precise identification, could be juvenile stages of *Carpopenaeus syriacus* (Roger 1946) based on the long, incurved, spiny rostrum.

In conclusion, this report from the Hakel outcrop results to be the first formal record of Mysida shrimp-like from the Cretaceous fossil record.

## MATERIAL

The studied specimens are preserved mainly overlapping each other, on the surface of an irregular slab, showing a fossilized swarm of mysid crustaceans as the result of a mass mortality event. Over 150 phosphatized almost complete individuals are preserved (Fig. 1). Single selected specimens were photographed under UV light to investigate the delicate thin structures. The slab was collected from Hakel, about 30 km northeastern of Byblos (Lebanon) where fossiliferous levels from the Cenomanian (Late Cretaceous) are exposed (Charbonnier *et al.*, 2017: 17).

The studied slab is housed in the palaeontological collections of the Museo di Storia Naturale di Milano (Italy) (MSNM).

### Abbreviations

lcxp: carapace length (in dorsal view);
lpl: pleon length;
lt: total length; P1-P5: pereiopods 1 to 5;
wcxp: carapace width.

**Note**: The systematics of the Mysidacea is still debated and unclear. Indeed, according to Meland *et al.* (2015: 19) "many of the molecular phylogenetic studies of the Mysidacea have found significant incongruence between phylogenetic and taxonomic structure". However, this discussion is not the purpose of this short note.

Herein we follow the systematic arrangement proposed by Meland *et al.* (2015: 16).

## SYSTEMATIC PALAEONTOLOGY

Subclass Eumalacostraca Grobben 1892
Order Mysidacea Boas 1883
Suborder Mysida Boas 1883
Family, genus and species undetermined
Figs. 1-2

**Material and measurements**: Over 150 specimens poorly preserved on a sublithographic limestone slab (MSNM i29340: *c.* 130 x 230 mm), mostly overlapped each other, in dorsal, ventral and lateral views. Only selected isolated specimens were measured (indicatively, lcxp: from 5.5 mm to 7.5 mm; lpl: from 10 mm to 12 mm; lt: from 14 mm to 17.5 mm; wcxp: 4 mm to 4.5 mm).

**Description** (based on several specimens). *Carapace* - Elongate sub-ovoid carapace with rounded frontal margin without rostrum (as preserved); carapace enveloping the thorax by posterior lateral smooth, and rounded margins; deep concave dorsal margin covering only the first four thoracic segments; three sub-parallel longitudinal striae (one median and two lateral). *Thorax* - Only four thorax segments exposed. *Pleon* - Elongate pleon; square s1-s6 similar in size with dorsal transverse striae; truncate subtriangular telson poorly preserved. *Cephalic appendages* - Not preserved. *Thoracic appendages* - P1-P5, scarcely preserved in some specimens only (not figured). *Pleonal appendages* - Pleopods not preserved; uropods partially preserved; slender ellipsoidal-shaped uropodal exopod and endopod.

**Discussion**. Based upon Vilas-Fernández (2015), several characters present in the best preserved specimens, such as the carapace covering the thorax, only leaving

Fig. 1 - MSNM i29340. The mass mortality event, natural light. (x 0.6). / L'evento di mortalità di massa, luce naturale. (x 0.6).

visible the last four thoracic somites; the thorax composed by eight thoracic somites; and the pleon with six somites, allow us to assign the studied specimens to the Mysidacea and, according to Meland *et al.* (2015) to the Mysida Boas 1883, based on the morphological generic characters of the carapace and absence of a long protruding rostrum and pointed spines on the lower lateral posterior margins, characters typical of the Lophogastrida Boas 1883.

Uropodal statocyst (balance organ in the endopod of the uropods) is not clearly visible in the studied specimens (as preserved) (Meland *et al.*, 2015: Fig. 1). Moreover, it is hard to identify other characters of the studied specimens, such as the cephalic, thoracic, and pleonal thin appendages due to the poor state of preservation. The possible absence of uropodal endopod statocyst could be a character shared with the representatives of the Petalophthalmidae Czerniavsky 1882, including mainly extant bathypelagic species. However, this datum does not match with the palaeoenvironmental reconstruction for the Hakel limestone, considered as probably deposited in small, shallow basins comprising intra-shelf depressions (Charbonnier *et al.*, 2017: 17). In any case, the lack of other distinctive characters makes a precise assignment of the studied specimens very difficult and uncertain.

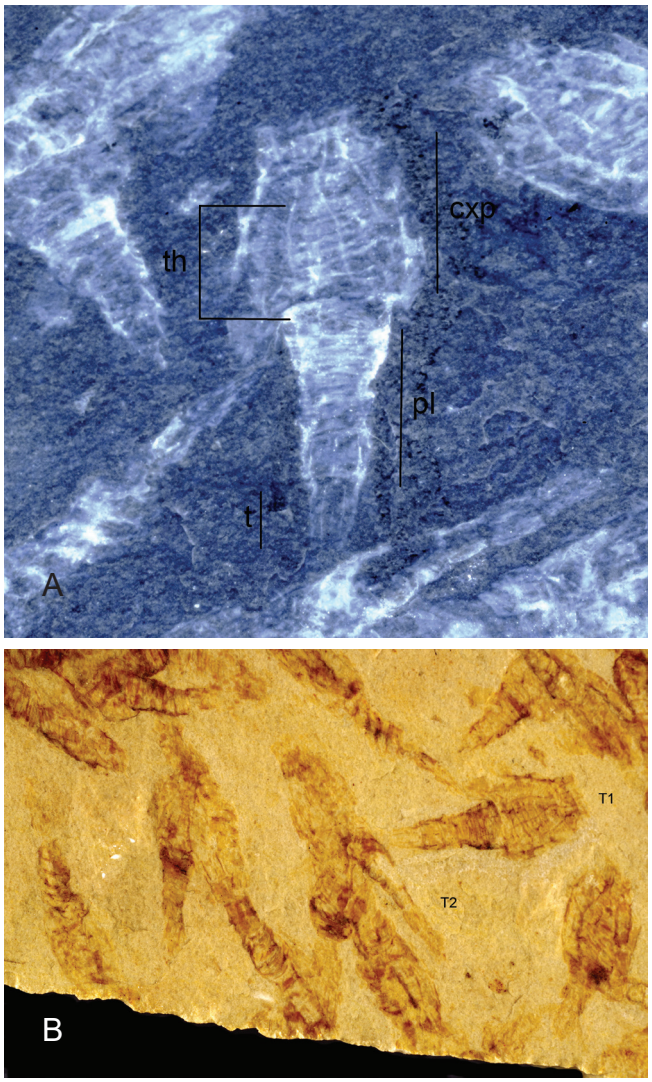


Fig. 2 - MSNM i29340. Selected specimens. A) close-up of morphotype 1. (x4). B) morphotype 1 (T1) and morphotype 2 (T2), natural light. (x 1.6) Abbreviations: cxp) carapace, th) thorax, pl) pleon, t) telson. / Esemplari selezionati. A) ingrandimento del morfotipo 1. (x4). B) morfotipo 1 (T1) e morfotipo 2 (T2), luce naturale. (x 1.6) Abbreviazioni: cxp) carapace, th) torace, pl) addome, t) telson.

The swarm aggregation seems to include specimens with two different morphological characters: a first and more common having sub-ovoid carapace and relatively short pleon (type 1) and a second, less common, with more slender, ellipsoidal carapace (as preserved) and more elongate pleon (type 2) (Fig. 2B). These two typologies could be interpreted as 1) different kind of compression/distortion of the body during the diagenesis; 2) intraspecific sexual variability; 3) presence of different growth stages within the aggregation; 4) presence of two different taxa within Mysida sharing the same fossil palaeoenvironment. The lacking of substantial characters useful for a closer comparison with fossil and extant species leaves open the question.

Mass mortality events are not uncommon from the Hakel laminate layers, interpreted as due to rhythmic or seasonal occurrence of catastrophic events (anoxia or disoxia) in the basin waters (Pasini & Garassino, 2010: 8). Similar slabs with these peculiar crustacean assemblages were previously reported by Pasini & Garassino (2010), and regarded as a fossil evidence of the schooling behaviour of indeterminate macruran decapod, probably pre-adults penaeidean and caridean shrimps and of other minor groups of crustaceans (possibly including also mysidaceans).

## CONCLUSIONS

Though the poor preservation of the studied specimens does not allow a precise systematic assignment, this new report is remarkable resulting the first formal report of Mysida from the Cretaceous covering the fossil gap of records behind the Mid-Jurassic and Cenozoic, enlarging the poor knowledge on the presence and distribution of the mysid shrimp-like during the Mesozoic. Moreover, a first gregarious/swarm behaviour among mysids from the Late Cretaceous is testified by this fossil evidence.

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