

Note e Comunicazioni

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First direct predatory evidence of an eel-like fish on *Pseudosculda* cfr. *P. laevis* (Crustacea, Stomatopoda, Unipeltata) from the Late Cretaceous (Cenomanian) of Lebanon

Abstract - We report for the first time in the fossil record exceptional direct evidence of predation of an eel-like fish on a stomatopod crustacean, *Pseudosculda* cfr. *P. laevis* (Schlüter, 1872), from the Late Cretaceous (Cenomanian) of Hadjula (Lebanon).

Key words: Crustacea, Stomatopoda, Predation, Late Cretaceous, Lebanon.

Riassunto - Prima segnalazione di predazione di un anguilliforme su *Pseudosculda* cfr. *P. laevis* (Crustacea, Stomatopoda, Unipeltata) del Cretacico superiore (Cenomaniano) del Libano.

Si segnala per la prima volta nel record fossile l'eccezionale testimonianza di predazione di un anguilliforme su un crostaceo stomatopode, *Pseudosculda* cfr. *P. laevis* (Schlüter, 1872), del Cretacico superiore (Cenomaniano) di Hadjula (Libano).

Parole chiave: Crustacea, Stomatopoda, Predazione, Cretacico superiore, Libano.

Geological setting

The sublithographic limestone of Lebanon is known for rich and well-preserved fossil assemblage ("Konservat-Lagerstätten") of the famous fish-beds including vertebrate and invertebrate remains from different localities (for complete references see Ahyong *et al.*, 2007). Hadjula village and its quarries are located about 10 km NE of Byblos, on the geographic ridges extending parallel to the Mediter-

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reanean Sea coast, where the Late Cretaceous strata crop out. The biostratigraphic studies by Dubertret (1959, 1966), Hückel (1970, 1974a, 1974b), and Saint-Marc (1974) placed the sequences of Hadjula at the early-middle Cenomanian boundary. According to Hemleben (1977), Hadjula is younger; he dated this quarry as late Cenomanian. Moreover, Dalla Vecchia *et al.* (2002) considered Hadjula assemblages to be early-late Cenomanian in age. On the basis of these data, we assigned the studied specimen to the late Cenomanian (Late Cretaceous).

Predation

Even though the crustaceans represent an important component of the food chain, the evidences of their direct predation in the fossil record are very rare. In fact only rare reports of crustaceans have been documented in the digestive tract of predators. Some fish from Wyoming, United States (Green River Formation - Eocene) (Grande, 1984), Brazil (Santana Formation - Early Cretaceous) (Maisey, 1991, 1995) and from the lithographic limestone (Late Jurassic) of Bavaria (Germany) (Nybelin, 1958) are the only reports known to us. Unfortunately, these crustaceans are usually poorly preserved, disarticulated, and incomplete owing to the ingestion and quick alteration of the tissues by the gastric juices of the predator. For this reason, the studied specimen represents an extremely rare example not only for its very good preservation but also because it is possible to make systematic determination. It is, in fact, the only example of predation of a stomatopod reported in the fossil record.

Material

A single complete specimen of an eel-like fish with a swallowed crustacean prey inside. It is well preserved, compressed, and flattened on the bedding surface. Its preparation was easy because of the softness of the calcareous, yellow, fine grained-laminated rock. The specimen is housed in the Palaeontological Collections of the Museo di Storia Naturale di Milano (MSNM).

Discussion

The predator (MSNM V6136): a complete eel-like fish (17 cm long), exposed dorso-laterally showing in the gastrointestinal tract an ingested, nearly complete mantis shrimp. The flat triangular skull, with small eyes and pointed snout, the elongate dorsal and anal fins extending along the posterior parts of the body forming a low fringe connected to the caudal fin, the eight rays of the pectoral fins and the general body-arrangement allowed identification of the specimen as *Anguilla quadripinnis* Hay, 1903 (Anguillidae) (Fig. 1).

The prey: a well-preserved and articulated mantis shrimp, elongated in lateral view, 4 cm long, (about $\frac{1}{4}$ of the total length of the fish), headed anteriorly. The specimen shows partially some distinctive characters of *Pseudosculda* Dames, 1886 (Fig. 2). To date, only three specimens of stomatopods have been reported from the Late Cretaceous of Lebanon: *Pseudosculda laevis* (Schlüter, 1872), *Archaeosculda phoenicia* Ahyong, Garassino & Gironi, 2007 (Pseudosculdidae Dames, 1886) and *Sculda syriaca* Dames, 1886 (Sculdidae Dames, 1886). Cladistic analyses of the Stomatopoda have recognized Pseudosculdidae and Sculdidae as stem-lineage unipeltatans,

with the pseudosculdids as sister to crown-group Unipeltata (Hof, 1998; Ah Yong & Harling, 2000). Among these species the most common is *P. laevis*, known also from the coeval Haqel quarry of Lebanon. The specimen, eaten by *A. quadripinnis*, shows similar characters to *P. laevis*, such as the subcylindrical form of the body and ornamentation, the dactylus of the second raptorial claw without accessory denticles, the elongate telson, indistinct primary lateral teeth, and broad uropodal endopod. The form and ornamentation of the tail fan differs notably from the other two Lebanese species. Based upon these characters, we refer the studied specimen to *P. laevis*.

Palaeoenvironmental remarks and behavior

Direct evidences of predation are relatively rare in the fossil record (Bishop, 1975). However, many fishes discovered in the Lebanese outcrops were documented predators. Carnivorous teleosteans, for instance *Prionolepis*, *Euryphoils*, and *Enchodus*, preserve within the intestinal tract more or less complete preys,



Fig. 1 - General view of the specimen MSNM V6136, *Anguillavus quadripinnis* Hay 1903, with the ingested prey. / Visione d'insieme dell'esemplare MSNM V6136, *Anguillavus quadripinnis* Hay 1903, con la preda ingerita (x 0.7).



Fig. 2 - Detail of the prey, *Pseudosculda* cfr. *P. laevis* (Schlüter, 1892). / Dettaglio della preda, *Pseudosculda* cfr. *P. laevis* (Schlüter, 1892) (x 2.2).

usually other marine vertebrates (small fishes). This provides direct information regarding their diet and strategy of eating the different species (Boucot, 1990). The studied specimen is the first evidence of a stomatopod preserved within the intestinal tract of a predatory fish, despite the rapid digestive processes with the consequent decomposition of the ingested prey. The state of preservation of the studied specimen confirms the observations and the experiments made on the preservation and decay of the cuticle of some extant stomatopods, pointing out their greater fossilisation potential than the decapods, even though decapods are more frequent in the fossil record (Cees & Briggs, 1997). So, the poorly and generally fragmentary record of fossils stomatopoda "... must be a function of factors other than decay and degradation." (Cees & Briggs, 1997). The good state of preservation of the studied specimen could be also be due to the rapid death of the predator. Thus interrupting its digestive processes. Moreover, it is interesting to point out the technique used in the attack of the prey. It is similar to those used in the attack of complete fishes, usually ingested starting from the head (Boucot, 1990). It is not yet verified if this behaviour, used for the most part by vertebrates, is innate and instinctive or the result of one sort of learning. Greene (1976) pointed out that "... at least in living small snakes this is a learned behaviour." The discussion is still opened. Finally, the studied specimen also provides some interesting paleoecological/environmental indications, such as the alimentary habits, the behaviour, and the interaction among the different neritic taxa of the Lebanese basin during the Late Cretaceous.

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Ebalia nux A. Milne Edwards, 1883
(Crustacea, Decapoda, Brachyura, Leucosiidae)
from the late Pliocene (Gelasian) of S. Polo d'Enza
(Reggio Emilia, N Italy)

Abstract – We report some fragmentary leucosiid crabs from the late Pliocene (Gelasian) of S. Polo d'Enza (Reggio Emilia, N Italy), assigned to *Ebalia nux* A. Milne Edwards, 1883 (Leucosiidae Samouelle, 1819). This report enlarges the fossil record of this species, known to date from the Pleistocene of S Italy. *Ebalia nux* is known to date only in the fossil record of Italy.

Key words: Crustacea, Decapoda, Brachyura, Pliocene, Italy.

Riassunto – *Ebalia nux* A. Milne Edwards, 1883 (Crustacea, Decapoda, Brachyura, Leucosiidae) del Pliocene superiore (Gelasiano) di S. Polo d'Enza (Reggio Emilia, N Italia).

Segnaliamo alcuni resti frammentari di leucosidi del Pliocene superiore (Gelasiano) di S. Polo d'Enza (Reggio Emilia, N Italia), attribuiti a *Ebalia nux* A. Milne Edwards, 1883 (Leucosiidae Samouelle, 1819). Questa segnalazione allarga il record fossile di questa specie, conosciuta finora nel Pleistocene dell'Italia meridionale. *Ebalia nux* è conosciuta finora solo nel record fossile d'Italia.

Parole chiave: Crustacea, Decapoda, Brachyura, Pliocene, Italia.

Introduction and geological setting

The Cavalmagro (S. Polo d'Enza, Reggio Emilia) blue clays crop out 1 km NW of the Cava Moja locality, previously studied by Marasti & Raffi (1977) for the rich malacological fauna.

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To date, no detailed stratigraphic data have been published for the little deposit of Cavalmagro, so the only correlations are with the section and the faunal assemblage of the near by Cava Moja outcrop from the Piacentian (Marasti & Raffi, 1977), even though there are some peculiar differences.

In fact the malacological association of Cavalmagro is very similar to the assemblage of the section between 90-180 m of Cava Moja (Marasti & Raffi, 1977). The faunula is characterized by the presence of two “circalittoral” species of *Nassarius* (*Amyclina*) and by *Trophon squamulatus* (Brocchi, 1814), both very commons; one *Mitrella* sp. and some smalls Turridae. Moreover rare taxa from deeper (epibathyal) environment are also presents (e.g. *Propeleda hoernesii* (Bellardi, 1875), *Neilo isseli* (Bellardi, 1875), *Zealeda elegans* La Perna *et al.*, 2004) (Bertolaso, pers. comm., 2009). The studied specimens were obtained by washing and sieving the sediment within a gastropod shell correlated with these associations.

On the basis of these data we propose a general circalittoral environment for the studied specimens and a late Pliocene (Gelasian) age.

Finally, we point out that the stratigraphic position of the Gelasian as the first stage of the Pleistocene, is at present the subject of discussion by the members of the IUGS (International Union of Geological Sciences) and INQUA (International Union for Quaternary Research). Waiting for an official review, we retain the Gelasian as late Pliocene in this paper.

Previous reports of *Ebalia* from Italy

At present, six species of *Ebalia* Leach, 1817, are known from the Miocene to Pleistocene of Italy.

One species is known from the middle Miocene (Langhian), *E. lamarmorai* Lörenthey, 1909, from Sardinia (Lörenthey, 1909).

Two species are known from the Pliocene, *E. cfr. E. deshayesi* Lucas, 1846, and *E. fucinii* Ristori, 1892, from Tuscany (for complete references, see De Angeli & Garassino, 2006; De Angeli *et al.*, 2009).

Two species are known from the Pliocene-Pleistocene, *E. cranchii* Leach, 1817, from Emilia Romagna, Tuscany, Lazio, and Sicily; *E. tuberosa* (Pennant, 1777), from Lazio and Sicily (for complete references, see De Angeli & Garassino, 2006; De Angeli *et al.*, 2009).

One species is known from the Pleistocene, *E. nux* A. Milne Edwards, 1883, from the Montalbano Jonico (Basilicata, S Italy) (Soldani & Girone, 2000).

Material

The sample, including one complete carapace and some separated elements of chelipeds and walking legs, is housed in the Palaeontological Collections of the Museo di Storia Naturale, Milano (MSNM i27519). These fragmentary specimens have been ascribed to *Ebalia nux* A. Milne Edwards, 1883 (Leucosiidae Samouelle, 1819).

The systematic arrangement used in this paper follows the recent classifications proposed by De Grave *et al.* (2009) and Schweitzer *et al.* (2010).

Systematic Palaeontology

Section Eubrachyura de Saint Laurent, 1980

Superfamily Leucosioidea Samouelle, 1819

Family Leucosiidae Samouelle, 1819

Subfamily Ebalinae Stimpson, 1871

Genus *Ebalia* Leach, 1817

Type species: *Ebalia bryerii* Leach, 1817, subsequent designation by Rathbun, 1922.

Included fossil species: see Schewitzer *et al.* (2010).

Ebalia nux A. Milne Edwards, 1883

Figs. 1-4

Discussion. The electronic pictures of the studied specimens document an oval outline of the carapace and ornamentation with large flat tubercles evenly distributed on the surface of the carapace and cheliped, characters typical of the extant *E. nux* to which the fossil sample has been assigned. As reported by Zariquey Alvarez (1968: 328) and Falciai Minervini (1992: 184) this species is widespread in the eastern Atlantic, from Great Britain to Cape Verde Islands, and in the Mediterra-

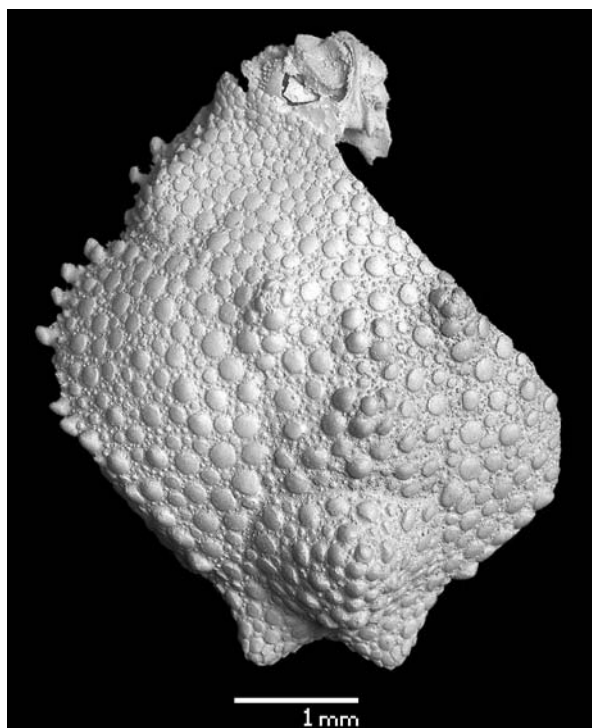
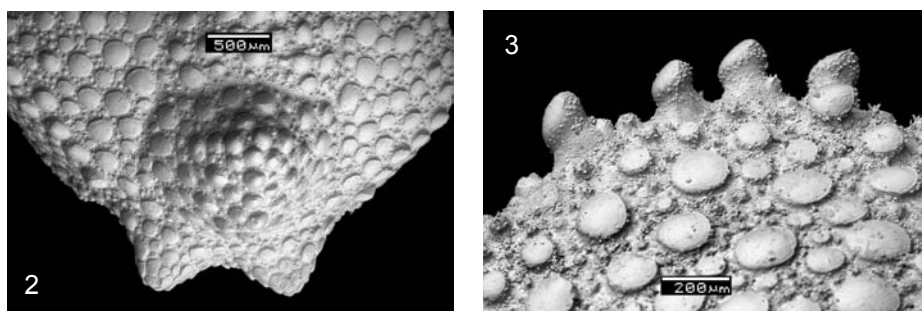


Fig. 1 - *Ebalia nux* A. Milne Edwards, 1883, carapace.

nean Sea. Moreover, as reported by the same authors, among the extant species of *Ebalia*, only *E. nux* is a deep water species, living between 80 and 2500 m on muddy bottoms, as also attested by the fossil specimens of this species from the Pleistocene of Montalbano Jonico, discovered in association with vertebrates and invertebrates of mesobathial and epibathial environments (D'Alessandro *et al.* 2000). The discovery of *E. nux* from the Pliocene enlarges the fossil record of this species, known to date only in southern Italy.

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Figs. 2-3 *Ebalia nux* A. Milne Edwards, 1883. 2) detail of the posterior part of carapace/dettaglio della parte posteriore del carapace. 3) detail of the anterolateral margin with ornamentation/dettaglio del margine anterolaterale con ornamentazione.

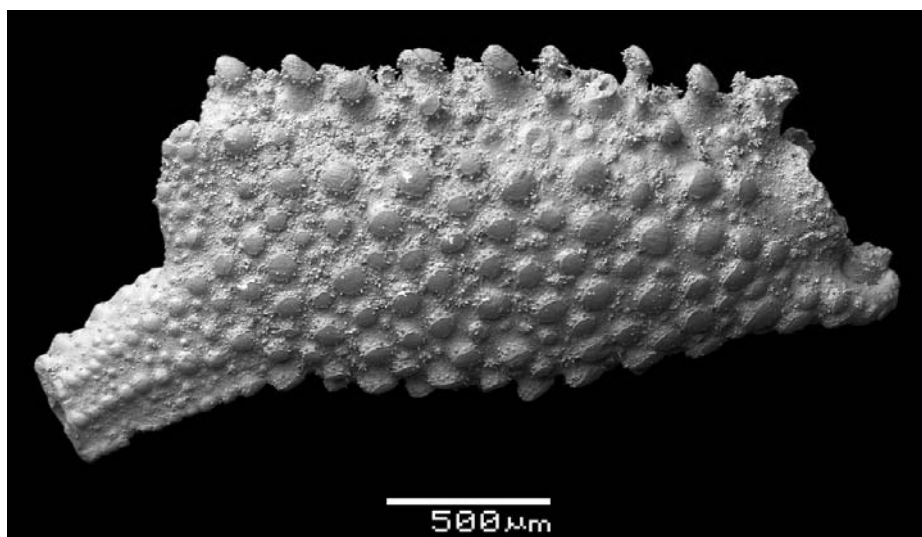


Fig. 4 - *Ebalia nux* A. Milne Edwards, 1883, cheliped/chelipede.

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