

Note e Comunicazioni

Giovanni Pasini* & Alessandro Garassino**

Predation on brachyuran (Crustacea, Decapoda): an unique direct evidence from the Late Cretaceous (Cenomanian) of Hadjoula (Lebanon)

Abstract – We report for the first time in the fossil record the exceptional direct evidence of predation of a catfish shark (*Scyliorhinus* sp.) on a brachyuran crustacean belonging to *Paranecrocarcinus* cfr. *P. milbournei* Collins, 2010 (Necrocarcinidae Förster, 1968) from the Late Cretaceous of Hadjoula, Lebanon. It is the first report of this species out of African continent.

Key words: Predation, Decapoda, Brachyura, Late Cretaceous, Lebanon.

Riassunto – Predazione nei confronti di un brachiuro (Crustacea, Decapoda): un'eccezionale testimonianza diretta del Cretacico superiore (Cenomaniano) di Hadjoula (Libano).

Viene segnalata, per la prima volta nel record fossile la diretta predazione da parte di uno squalogatto (*Scyliorhinus* sp.) su un crostaceo brachiuro attribuito a *Paranecrocarcinus* cfr. *P. milbournei* Collins, 2010 (Necrocarcinidae Förster, 1968) del Cretacico superiore di Hadjoula, Libano. Si tratta della prima segnalazione di questa specie al di fuori del Continente africano.

Parole chiave: Predazione, Decapoda, Brachyura, Cretacico superiore, Libano.

Introduction and Geological setting

Although crustaceans represent an important component of the food chain, the evidence of direct predation rarely appears in the fossil record. Only rare reports of crustaceans have been documented, preserved in the digestive tract of predator fishes (e. g. Nybelin, 1958; Maisey, 1991; Maisey & De Carvalho, 1995; Grande,

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1984). Unfortunately these remains are usually incomplete, partially chewed, or poorly preserved, owing to the ingestion and quick alteration of the tissues by the gastric juices. Recently, Pasini & Garassino (2010) reported from Hadjoula the exceptional direct evidence of an eel-like fish with an ingested, complete and well-preserved stomatopod crustacean ascribed to *Pseudosculda* cfr. *P. laevis* (Schlüter, 1872). Another unreported interesting example consisted of some remains (three articulated posterior pleura and fragmentary appendages) of an indeterminate macruran decapod, perhaps belonging to the Penaeoidea, preserved within the digestive tract of a complete sawfish [*Libanopristis hiram* (Hay, 1903)] from Hadjoula. The specimen was observed in an old private collection, unfortunately now lost (Pasini, pers. obs., 1987).

The studied specimen comes from the sublithographic limestone quarries of Hadjoula (Lebanon), known for the rich and well-preserved fossil assemblage (“Konservat-Lagerstätten”) of the famous fish-beds layers including vertebrates and invertebrates remains, specially decapod crustaceans (for complete references see Ahyong *et al.*, 2007). Although incomplete, the studied specimen is an ingested crab, representing the unique example of direct predation on a brachyuran decapod in the fossil record.

Material

A single complete specimen of catfish shark with a crustacean prey inside. It is compressed and flattened on the bedding surface of a laminated calcareous slab. The brachyuran was carefully prepared manually both ventrally and dorsally in order to investigate the preserved morphological structures. The studied specimen is housed in the Paleontological Collections of the Museo di Storia Naturale di Milano (MSNM).

Discussion

The predator (MSNM V6907): a complete small, elongate catfish shark (260 mm long) lacking the caudal fin, exposed nearly laterally, with an ingested brachyuran crab, preserved in the gastro intestinal tract. Some characters, such as the elongate body, the short head, the pectoral fins rounded distally, the triangular dorsoventral fin placed behind the middle of the body and behind the pelvic fans (Cappetta, 1987) allow ascribing the specimen to *Scyliorhinus* sp. (Charcharhini-formes Compagno, 1973; Scyliorhinidae Gill, 1862) (Fig. 1). This genus is well documented from the Lebanon record with two species from the Hadjoula and Hakel outcrops (Cappetta, 1987), both Late Cretaceous (upper Cenomanian) in age (Dalla Vecchia *et al.*, 2002).

The prey: a small incomplete brachyuran crab (carapace: 15 mm long, 10 mm wide) in ventral view (the dorsal view was visible after cleaning the specimen), preserving strong chelipeds, gathered frontally under the body and lacking the ambulatory legs. The abdomen is poorly preserved due to the corrosive action of the digestive gastric process; only the posterolateral and the central part of the frontal region are visible. Dorsal view (Fig. 2): subpentagonal carapace, almost as long as wide; bifid rostrum; ovate orbits bearing two distinct fissures directed slightly upwards, with two marginal short spines; inclined, weakly convex anterolateral margins; posterolateral margins almost straight for about half their length before

curving to the weakly concave posterior margin, narrower than the orbitofrontal margin; cervical groove broadly V-shaped to outer angle of mesogastric lobe; protogastric lobes well marked; epibranchial lobe well developed with two tubercles; weak branchiocardiac groove starts to the base of the epibranchial lobe, recurving sharply to expand parallel with the bounding groove of the epibranchial lobe; each



Fig. 1 - MSNM V6907. General view of the predator with the ingested prey (arrow) before cleaning./
Visione d'insieme del predatore con la preda ingerita (freccia) prima della preparazione. (x 0.4).



Fig. 2 - Dorsal view of the prey after the cleaning, detail./Visione dorsale della preda dopo la preparazione, dettaglio. (x 5.3).

metabranhial lobe with three aligned tubercles, forming a raised ridge starting from the posterior angle of posterior margin; well-developed cardiac lobe with two aligned tubercles; cardiac region depressed; densely granulated dorsal surface. Ventral view (Fig. 3): well-preserved chelipeds, with chelae having subrectangular palms, higher distally, slightly compressed and with crenulated upper margin; palms with strong tubercles, arranged along three subparallel longitudinal ridges on the outer surface; some smaller, alternated, tubercles and granulations along the inferior margin of the palm; strong fixed finger slightly convex along the occlusal margin, with distal tip directed upwards; occlusal margin of fixed finger with a single first elongate distal tooth followed by three continuous, compressed cusps of which the first is higher; movable finger shorter, curved downward, with only three small proximal occlusal teeth.

Discussion. Although only partially complete, the studied specimen shows the main characters of the Necrocarcinidae Förster, 1968. As reported by Schweitzer *et al.* (2010) this family includes at present seven fossil genera and among these only *Paranecrocarcinus* Van Straelen, 1936, exhibits some morphological characters found also in the studied specimen. The fossil record of brachyurans from the Cretaceous of Lebanon is sparse and in some cases uncertain. Dames (1886) repor-



Fig. 3 - Ventral view of the prey after the cleaning, detail./Visione ventrale della preda dopo la preparazione, dettaglio. (x 10.8).

ted *Ranina cretacea* (= *Lophoranimella cretacea*). Roger (1946), reported *Geryon hadjoulae* [= *Corazzatocarcinus hadjoulae* (Roger, 1946)], a dubious *Portunus* sp. and *Notopocorystes syriacus* Withers, 1928, of uncertain provenance. Förster (1968) described *Paranecrocarcinus libanoticus* Förster, 1968, and Larghi (2004) reported *Corazzatocarcinus hadjoulae* (Roger, 1946), *Homolopsis* aff. *edwardsii* Bell, 1863, and *Telamonocarcinus gambalatus* Larghi, 2004. The studied specimen, showing some morphological characters typical of *Paranecrocarcinus*, can be compared at first with *P. libanoticus*, housed in the Bayerische Staatssammlung für Paläontologie und Geologie, Munich (BSPG) (Fig. 4). As reported by Förster (1968: 171, Text-fig. 2, Pl. 13, Fig. 1) the Lebanese species differs from the studied specimen having suboval carapace, aligned branchial and epibranchial lobes and absence of a raised ridge on the cardiac lobe. The poorly preserved orbitofrontal margin of this species doesn't allow a comparison with the studied specimen. The studied specimen also can be compared with the coeval *P. milbournei* Collins, 2010, from the Cenomanian of Nigeria, which shows more closely similar characters. In fact, as reported by Collins (2010: 16, Figs. 1.5-1.8) the African species shows some morphological characters in common with the studied specimen, such as the subpentagonal carapace, the bifid rostrum, ovate orbits, broadly V-shaped cervical groove to the outer angle of the mesogastric lobe, well defined protogastric lobes, well-developed epibranchial lobes, weak branchiocardiac groove arising at the base of the epibranchial lobe, recurving sharply to extend parallel with the bounding groove of the epibranchial lobe, each metabranchial lobe with three tubercles, and narrow ridge on the cardiac lobes. The comparison among the two specimens



Fig. 4 - *Paranecrocarcinus libanoticus* Förster, 1968. Holotype/Olotipo, BSPG 1967 I 333 (x 5.3). (Picture/Fotografia: M. Schellenberger, © BSPG Munich).

allows two considerations: 1) although the ridge on the cardiac lobe is more raised and developed in the studied specimen which can be due to the preservation style; the dorsal surface of the Nigerian species is indeed completely decorticated probably making the ridge less marked and developed. 2) the different size of the two specimens (about 35 mm for the holotype *P. milbournei* and 15 mm for the studied specimen) and the more accentuated ornamentation of the studied specimen, can probably be interpreted as different ontogenetic stages.

Unfortunately, the peculiar preservation style of the studied specimen and the absence of other specimens from the Lebanese outcrops makes difficult to confidently assign the studied specimen to *P. milbournei*. Only a comparison is possible. However, should this assignment be confirmed, not only some morphological characters of the Lebanese specimen, such as the peculiar chelipeds, would supplement the original description of the species, but its geographical range would also be expanded.

Palaeoenvironmental remarks and behavior

Many of the fishes reported from the Lebanese outcrops, including the selachians, are documented as predators. Carnivorous euteleosteans, such as *Prionolepis*, *Eurypholis*, and *Enchodus*, preserve within the intestinal tract more or less complete prey, usually smaller fishes, providing direct information on their diet, strategy of eating, and hunting environment (Boucot, 1990). The studied specimen is the first direct evidence of a decapods brachyuran within the intestinal tract of the elasmobranchian *Scyliorhinus* sp., testifying partially to the diet of this predator. Living forms of the family inhabit soft sandy bottoms of warm tropical to temperate waters, just near the coast line, where they find food consisting of mollusks, small invertebrates in general, such as marine worms and crustaceans, living on the bottom surface or nearly buried in the sand, as suggested for the fossil forms of Necrocarcinidae. So this behavior and environment of the fish is unchanged for these forms since the Late Cretaceous. The status of preservation of the prey, bitten but not chewed supports the observations that the cuticle of the carapace is thin and weak with respect to the hardness of the more strongly mineralized chelipeds. The chelae require a longer time of decay in the presence of hyper-acid microenvironment. However, it is not possible to know if the total absence of the very delicate, tiny walking legs is due to a rapid decay of the tissues, a defensive autoctomy behavior of the prey, or if the predator has previously detached the pereopods from the body before the ingestion. The studied specimen documents the presence of another crab, enlarging the number of brachyuran specimens known to date in the Lebanese outcrops, and supplies some interesting paleoecological and environmental information, such as the alimentary habits, the behavior, and the interaction among the neritic taxa, enlarging the knowledge of the Lebanese basin necessary for the reconstruction of the general scenario during the Late Cretaceous in the paleo-Mediterranean area.

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Report of *Eriphia* cfr. *E. cocchii* Ristori, 1886
(Crustacea, Brachyura, Eriphiidae)
from the Early Pliocene of Cheglio (Taino, Varese)
(N Italy)

Abstract – We report *Eriphia* Latreille, 1817 (Eriphiidae MacLeay, 1838) with *Eriphia* cfr. *E. cocchii* Ristori, 1886, from the Early Pliocene of Cheglio (Taino, Varese) (Lombardia, N Italy) by the well-preserved palm of the right cheliped, partially articulated. It is the first report of one fossil brachyuran from the Early Pliocene of Italy and from the Cenozoic of Lombardia, increasing the knowledge of the geographical distribution of the species, known to date only in Toscana.

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

Riassunto – Segnalazione di *Eriphia* cfr. *E. cocchii* Ristori, 1886 (Crustacea, Brachiura, Eriphiidea) del Pliocene inferiore di Cheglio (Taino, Varese) (Italia settentrionale).

Viene segnalata la presenza di *Eriphia* Latreille, 1817 (Eriphiidae Macleay, 1838) con *Eriphia* cfr. *E. cocchii* Ristori, 1886 nel Pliocene inferiore di Cheglio, frazione di Taino, Varese (Lombardia, Italia settentrionale), sulla base di un palmo del chelipede destro in buono stato di conservazione e parzialmente articolato. Si tratta della prima segnalazione di un decapode brachiuro fossile attribuito a livello specifico nel Pliocene inferiore e nel Cenozoico lombardo, incrementando le conoscenze sulla distribuzione della specie, sinora nota solo in Toscana, lungo l'arco più settentrionale del Golfo Padano del paleo-Adriatico.

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

Geological setting

In Lombardia, along the Prealpi Mountains, the Pliocene formations, that were originally wide and thickness, was notably eroded by glacial activity and subsequently washed by the alluvial events during the Pleistocene; consequently only some small strips of the sedimentary marine deposits were preserved in the region.

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Cheglgio village is part of the Taino municipality, located on one of the last hills before the Prealpi Mountains, near the southeastern side of the Lago Maggiore in the western of the Varese Province (Lombardia, N Italy). Here, 275 m above sea level, a small deposit of Pliocene micaceous grey-blue sands and silstones crop out. On the basis of the studied malacological fauna and geological data, the sediments have been ascribed to the Early Pliocene (Piacentian), probably deposited at the lowermost limit of a circolittoral environment (Nangeroni, 1932; Anfossi *et al.*, 1982; Brambilla & Lualdi, 1988).

Previous decapod records from Lombardia

The fossil record of the Cenozoic decapods from the Lombardia (N Italy) is almost nonexistent. The absence of data is probably due more to the specific attention and collection selection by previous researchers, directed at malacological studies than to a reflection of real absence of carcinologic remains. In fact, all the sparse old records are related to paleontologic works dedicated to different localities with rich mollusk assemblages, or to geological studies of the region without specific paleontological implications.

Parona (1883) and Nangeroni (1928) reported the presence of two chelae ascribed to *Pagurus* sp. from the Pliocene deposits of Castiglione Olona and Torba, both located in the Varese Province; this record was later confirmed by Brambilla & Lualdi (1988) who revised the ancient collections studied by Sordelli, Parona, and Nangeroni. Patrini (1930) and Guioli (2003) reported “chelipeds of crustaceans” from the locality of Colle di San Colombano al Lambro (Milano Province), from deposits ascribed to the Plio-Pleistocene. Corselli (1977, 70-71) reported “two movables fingers...from two different species of decapods crustaceans” from the pozzo di Bagoderi, Malnate (Varese Province). Finally, Pasini (2007) reported and briefly described in a short, unpublished paper the complete check list of the decapods remains (movable and fixed fingers) from the same locality. Among the fragmentary sample, some specimens were ascribed generically to the Calappoidea H. Milne Edwards, 1837 (Pasini, 2007; n° 106, 106/C, Fig.1) and to the Xanthoidea Mac Leay, 1838 (Pasini, 2007; n° 106/B, D, E, I, N, O, Q, T, U, ZA, Figs. 1-4), with two different morphotypes.

On the basis of the above-mentioned reports, the presence of *Eriphia* Latreille, 1817, was never previously formally recognized in Lombardia. Therefore this short note represents the first report of a species of decapod brachyuran from the Pliocene of Lombardia (N Italy).

Material

One right chela with fragmentary carpus exposed dorsally, nearly crushed and compressed laterally, preserved in a little block of grey-blue sand, finely granulated and containing also some small fragmentary shell and carbonized vegetable remains. The specimen was hand prepared due to the soft nature of the surrounding rock and fixed with a film of polyvinyl acetate glue for preservation. The studied specimen is housed in the Paleontological Collections of the Museo di Storia Naturale di Milano (MSNM). The systematic adopted in this study follows the recent arrangement proposed by Schweitzer *et al.* (2010).

Systematic Palaeontology
Superfamily Eriphioidea MacLeay, 1838
Family Eriphiidae MacLeay, 1838
Genus *Eriphia* Latreille, 1817
Eriphia cfr. *E. cocchii* Ristori, 1886

Geological age: Early Pliocene (Grey sands Fmt.).

Locality: Cheglio (Taino, Varese) (Lombardia, N Italy).

Occurrence and measurements: one right chela and fragmentary carpus (MSNM i27642).

MSNM i27642 – length of the palm (fixed finger included): 24 mm; maximum height of palm: 11 mm; length of movable finger: 10 mm; length of fixed finger: 9 mm

Description. Strong, subrectangular, inflated palm, higher distally; smooth inner and outer palm; gently convex upper margin; inferior margin almost straight. No tubercles or spines are present on the fragmentary carpus. Strong fingers subequal, curved distally. Movable finger with a dorsal groove parallel to the upper margin, more marked proximally with alternating small pits; curved distally and pointed downwards; occlusal margin with three cutting teeth and one elongate molariform posterior tooth slightly curved backward, partially exposed on exterior part of the finger; alternating small pits are presents along the occlusal margin. Fixed finger with two straight grooves extending parallel along the outer margin, converging toward the tip and forming an acute angle; tip of the finger curved upward; occlusal margin with three alternate salient rounded teeth; lined small pits along the grooves and the occlusal margin.

Discussion. The general shape of the strong chela, the form and dorsal ornamentation of the triangular, strong, and gently curved fingers, the movable finger



Fig. 1 - *Eriphia* cfr. *E. cocchii* Ristori, 1886, MSNM i27642. Dorsal view of the right chela./Visione dorsale della chela destra. (x 4.1).

bearing a developed, curved and molariform posterior tooth confirm placement of the studied specimen to *Eriphia* Latreille, 1817. The genus is reported in Italy from the Pliocene of Toscana (Central Italy) with *E. cocchii* Ristori, 1886, and with *Eriphia* sp. from Piemonte (NW Italy) (Garassino *et al.*, 2004). The last one consists in a fragmentary chela and one movable finger that differs from the studied specimen in having an elongate palm, acute spines dorsally, and slender and elongate fingers crossed by two deep grooves.

The studied specimen was compared to some specimens of the well-known *E. cocchii* that shows the major affinities with the studied cheliped. Some typical characters, such as the presence of granulations along the posterior dorsal part of the palm and spines on the articular distal margin of the carpus, are not present in the studied specimen, having a smooth palm and the fragmentary carpus without spines. Also the occlusal margin of the fixed finger is nearly straight, whereas in *E. cocchi* is generally more convex in the middle part. These differences are, in our opinion, not substantial, probably related to the interspecific variability in a different population, to their different growth stage, or simply due to incomplete fossilization of the external cuticle. Moreover the studied specimen was also compared with the very similar extant *E. verrucosa* (Forskäl, 1775) (Fig. 2), widespread in the Mediterranean Sea, Black Sea, and partially also in the north eastern Atlantic. For instance, among the population of *E. verrucosa* from Caldeira (Azores Islands), Koh & Ng (2008, 330) pointed out that the specimens “appear slightly smoother than the rest..... chelae of the male specimen examined are less tuberculated and pubescent with the rest smooth. The juvenile specimen is relatively smooth, with its major palm entirely devoid of tubercles. There is not reason to believe these differences on significant or to suspect these specimens are not *E. verrucosa s. str.*”.



Fig. 2 - *Eriphia verrucosa* (Forskäl, 1775). Detail of the right chela in dorsal view./Particolare della chela destra in visione dorsale. (x 2).

Conclusion

The presence of *Eriphia* in the Early Pliocene of Lombardia enlarges the areal distribution of the genus in the northern paleoAdriatic Gulf. Moreover this result to be the first description of a brachyuran in the Cenozoic of the region. If the discovery of more complete specimens permits confirmation the assignment to *E. cocchii*, it will be the first record of this species out of the Toscana basin (Central Italy). The Lombardia population may be slightly different from the typical form, reported from many classic localities from Toscana (De Angeli *et al.*, 2009), as has previously been observed for the extant Atlantic forms of *E. verrucosa* (Koh and Ng, 2008). Finally the two distal fragmentary fingers reported by Pasini (2007; Fig. 2, 106/O and Fig. 3, 106/T) from the early Pliocene of the pozzo di Bagoderi, Malnate (Varese) can also be tentatively ascribed to the same genus.

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