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# New decapod assemblage from the Upper Cretaceous (Cenomanian-Turonian) of Gara Sbaa, southeastern Morocco

**Abstract** – The report of decapod crustaceans from the "Hamada des Kem Kem" slope (SE Morocco) has previously been limited to only one report by Garassino *et al.* (2006). The recent discovery of macrurans, anomurans, and brachyurans from a new quarry, located at the top of a small mesa called Gara Sbaa, increases the carcinologic knowledge from the Upper Cretaceous (Cenomanian-Turonian) of this area. The macruran specimens include *Cretapenaeus berberus* Garassino, Pasini & Dutheil, 2006 (Penaeidae Rafinesque-Schmaltz, 1815) and *Glyphea garasbaaensis* n. sp. (Glypheidae Zittel, 1885). The anomuran specimens include *Galathea sahariana* n. sp., *Paragalathea africana* n. sp., and *Cretagalathea exigua* n. gen., n. sp. (Galatheidae Samouelle, 1819). The brachyuran specimens include *Corazzatocarcinus* cfr. *C. hadjoulae* (Roger, 1946) (Necrocarcinidae Förster, 1968) and *Telamonocarcinus* cfr. *T. gambalatus* Larghi, 2004 (Dorippidae MacLeay, 1838) recently described from the Upper Cretaceous (Cenomanian) of Lebanon.

**Key words**: Crustacea, Decapoda, Upper Cretaceous, Morocco.

**Riassunto** – Nuova associazione a crostacei decapodi del Cretacico superiore (Cenomaniano-Turoniano) del Gara Sbaa, Marocco sudorientale.

Il rinvenimento di crostacei decapodi lungo le falde della "Hamada des Kem Kem" (SE Marocco) era finora limitata alla sola segnalazione da parte di Garassino *et al.* (2006). La recente scoperta di macruri, anomuri e brachiuri da un nuovo affioramento, localizzato sulla cima di una piccola mesa, localmente nota come Gara Sbaa, incrementa le conoscenze carcinologiche del Cretacico superiore (Cenomaniano-Turoniano) di quest'area. Gli esemplari di macruri sono attribuiti a *Cretapenaeus berberus* Garassino, Pasini & Dutheil, 2006 (Penaeidae Rafinesque-Schmaltz, 1815) e *Glyphea garasbaaensis* n. sp. (Glypheidae Zittel, 1885). Gli esemplari di anomuri sono attribuiti a *Galathea sahariana* n. sp., *Paragalathea africana* n. sp. e *Cretagalathea exigua* n. gen., n. sp. (Galatheidae Samouelle, 1819). Gli esemplari di brachiuri sono attribuiti a *Corazzatocarcinus* cfr. *C. hadjoulae* (Roger, 1946) (Necrocarcinidae Förster, 1968) e *Telamonocarcinus* cfr. *T. gambalatus* Larghi, 2004 (Dorippidae MacLeay, 1838), recentemente descritti nel Cretacico superiore del Libano.

**Parole chiave**: Crustacea, Decapoda, Cretacico superiore, Marocco.

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**Résumé** – Une nouvelle assemblage à Crustacés Décapodes du Crétacé Supérieur (Cénomanien-Turonien) au Gara Sbaa (SE du Maroc).

Dèpuis le début du siècle, la connaissance sur les Crustacés Décapodes provenant de la falaise de l'"Hamada des Kem Kem" (SE du Maroc) se bornait à un unique travail publié par Garassino *et al.* (2006). Récemment, la découverte d'un nouvel affleurement, repéré au sommet d'une petite mesa connue sous le nom de Gara Sbaa, et riche en macrures, anomures et brachyoures, permet faire avancer remarquablement nos connaissances carcinologiques du Crétacé Supérieur dans la région et en Afrique du nord. Les macrures sont attribué à *Cretapenaus berberus* Garassino, Pasini & Dutheil, 2006 (Penaeidae Rafinesque-Schmalz, 1815) et à *Glyphea garasbaaensis* n.sp. (Glypheidae Zittel, 1885). Les anomurans sont attribué à *Galathea sahariana* n. sp., *Paragalathea africana* n. sp. et *Cretagalathea exigua* n. gen., n. sp. (Galatheidae Samouelle, 1819). Enfin, les échantillons de brachyoures sont attribué à *Corazzatocarcinus* cfr. *C. hadjoulae* (Roger, 1946) (Necrocarcinidae Förster, 1968) et *Telamonocarcinus* cfr. *T. gambalatus* Larghi, 2004 (Dorippidae MacLeay, 1838), décrit de la carcinofaune du Crétacé Supérieur du Liban.

**Mots clés**: Crustacea, Decapoda, Cretacé superior, Maroc.

## Introduction, geological setting, and faunal assemblage

The studied specimens were discovered in deposits recently identified at the top of Gara Sbaa slope (Figs. 1, 2, 3), located in SE Morocco, along the "Hamada des Kem Kem", close to the Algerian border. These fossiliferous levels are known in

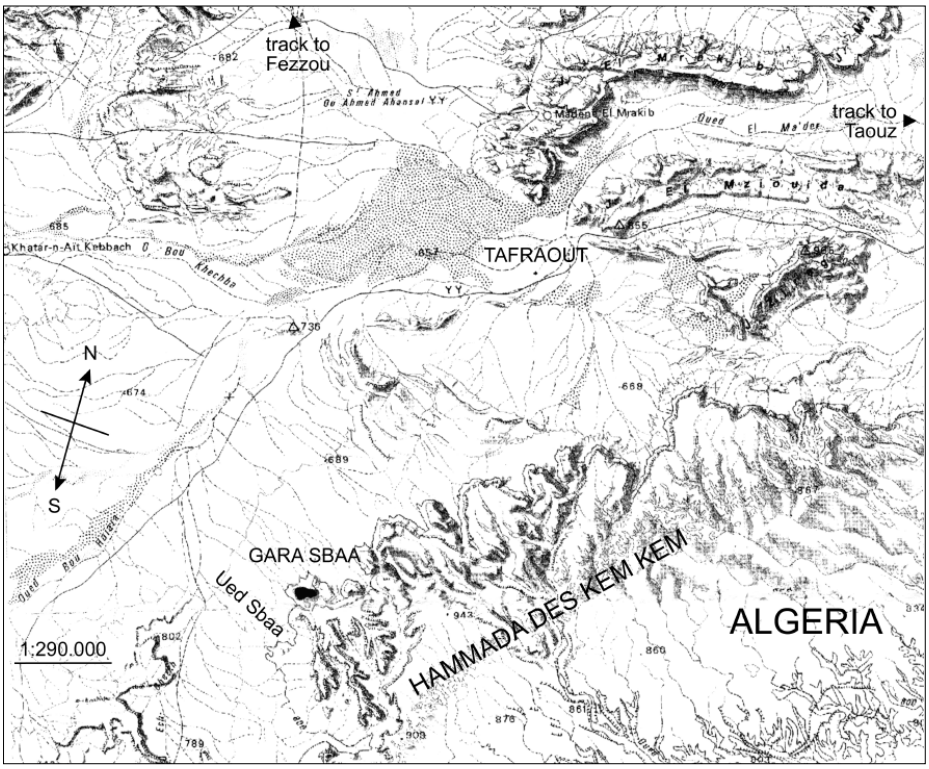


Fig. 1 – Geographic map of the "Hamada des Kem Kem" area (mappa geografica dell'area della "Hamada des Kem Kem").

literature as the Upper Cretaceous Kem Kem beds (Sereno *et al.*, 1996). The sediments, shaping a wide arc, emerge from NE to SE for an extension of 250 km and they are marked to N by Tafilalt area, to E by "Hamada du Guir", to S by "Hamada des Kem Kem", and to W by Precambrian formations and Paleozoic of Anti-Atlas. The studied area, located SW of Taouz, 26 km S-SW of Tafraout (on the western border of Hamada), along the Oued Sbaa, is formed by a poorly sedimentary series, located at the top of a small mesa, known as Gara Sbaa.

Fig. 2 – Gara Sbaa slope (scarpata del Gara Sbaa).

Fig. 3 – Top of the Gara Sbaa slope where the new outcrop is located (cima della scarpata del Gara Sbaa dove è ubicato il nuovo giacimento).

The Kem Kem beds rest unconformably on Paleozoic deposits and they are divided into two units (lower and upper units) (Choubert, 1948), with a total thickness of 200 m (Lavocat, 1954). The non-marine lower unit includes the dinosaur bed-bones, while the upper unit is made of sandstones, detrital channels, clay-beds and dinosaur track key bed on the top (Garassino *et al.*, 2006). The upper unit is covered by marine deposits of platfom (limestones) of the transgression Cenomanian-Turonian. Sereno *et al.* (1996) and Dutheil (2000) suggested a Cenomanian age for the Kem Kem beds (corresponding to the "Infracénomanien" by Clariond, 1933) by the palaeontological data (Elasmobranch biostratigraphy), lacking radiometric and magnetostratigraphic survey.

The Pre-African platform of Morocco was recently subject of geomorphologic analysis in some localities between Erfoud and Errachidia (200 km to N of Kem Kem beds), above all on Cenomanian and Turonian deposits. The lithology and the faunal assemblage suggest an environment of inshore lagoon during Albian-Cenomanian age, with the formation of an enclosed proximal reef of wide platform during the Cenomanian-Turonian age (Ettachfini & Andreu, 2004). In particular the Aoufous Formation is probably the lithologic equivalent of the upper unit of the Kem Kem beds, Albian-Cenomanian in age (Ettachfini & Andreu, 2004). Finally, the authors pointed out that the lower part of the Akrabou Formation, in the Kem Kem basin, is upper Cenomanian in age by the presence of *Neolobites vibrajeanus* and the ichthyofauna assemblage (Basse & Choubert, 1959). Previously, Cavin & Dutheil (1999) suggested a probable late Cenomanian age for the ichthyofauna assemblages discovered in the area of "Daoura assemblage" (Kem Kem beds), not far from the studied locality. Another locality, located always to the western margins of the Kem Kem beds area, "close to Gara Sbaa", was supposed Cenomanian in age, without specific investigations (Garassino *et al.*, 2006).

The new sedimentary levels, covering the upper unit of Kem Kem beds, lay directly on the Cenomanian-Turonian limestones. These levels, having a small extension (about 500 sq m) and 1.80 m thick, show at the bottom sublithographic laminated limestones (60-70 cm thick), including the faunal assemblage, subject of this study (Fig. 4).

Besides the decapod crustaceans, xiphosurans (first report in N Africa), isopods, tanaideacean peracarids, rare insects (Orthoptera and Omoptera), traces of marine worms, rare pelagic crinoids (Comatulidae), rare teeth of Chondrichthyes Lamniformes, and many well-preserved specimens of Actinopterygians are present. Among the marine vertebrates, we report many specimens of the Order Amiiformes still indeterminate. Finally, well-preserved leafy branches and leaves are also discovered. All fossil specimens have a high level of preservation and they are usually articulated, resembling the same taphonomy of other "*Lagerstätten*" quarries (Figs. 5-8).

The Department of Invertebrate Palaeontology of the Museo di Storia Naturale di Milano has carried on a field research by one of the author (G. P.) in October 2006 in the new locality along the Oued Sbaa in order to verify the geology and the faunal assemblage. The results of this field research pointed out the presence of a lithofacies, having a local character, not yet reported in the southern Kem Kem, and a marine faunal assemblage, including many new taxa. The lack of deepened paleobiologic, geologic, radiometric, and stratigraphic data, suggested to date the new faunal assemblage as Cenomanian-Turonian in age.

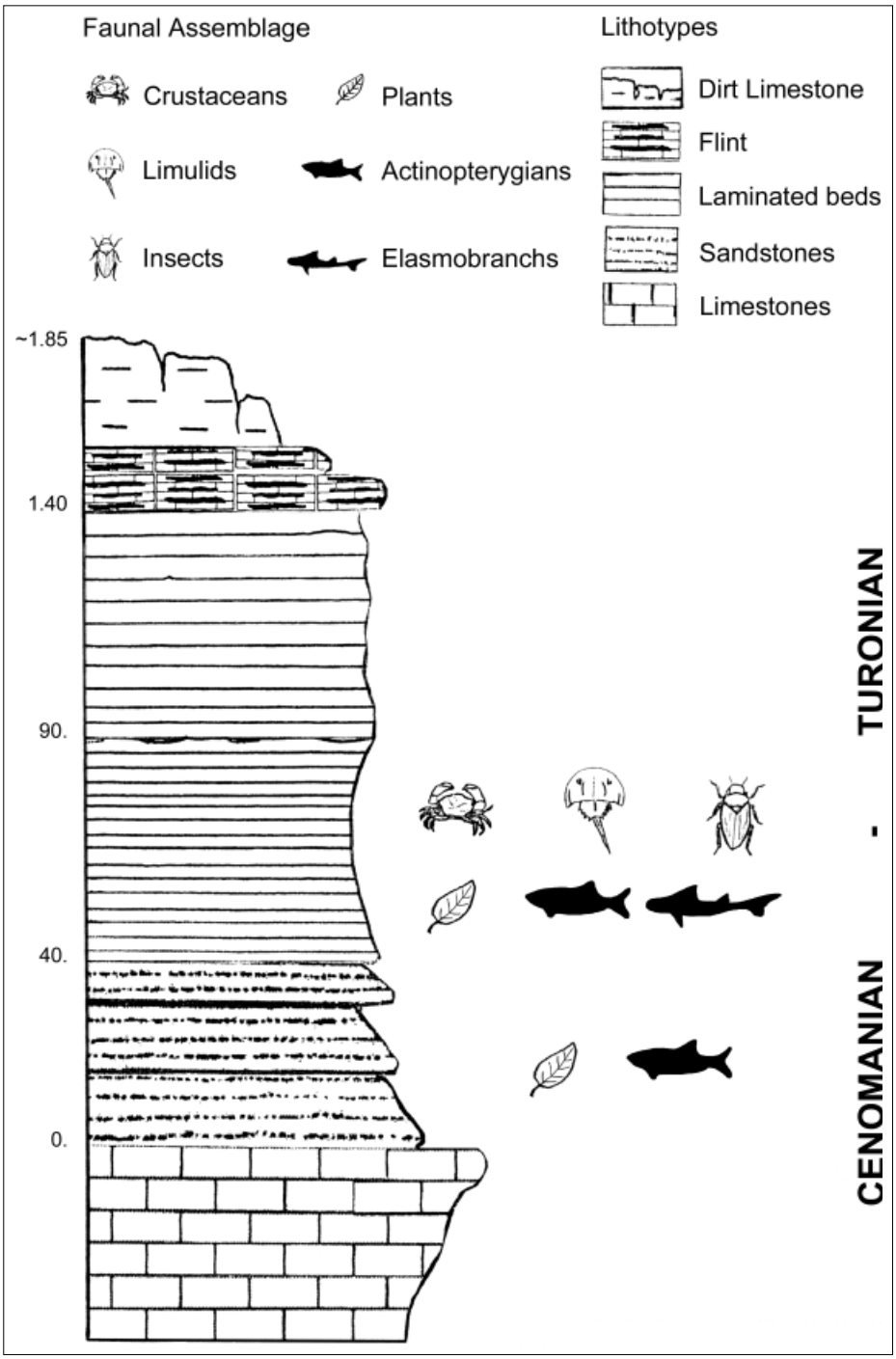


Fig. 4 – Stratigraphic section of the studied fossiliferous area (sezione stratigrafica dell'area fossilifera presa in esame).

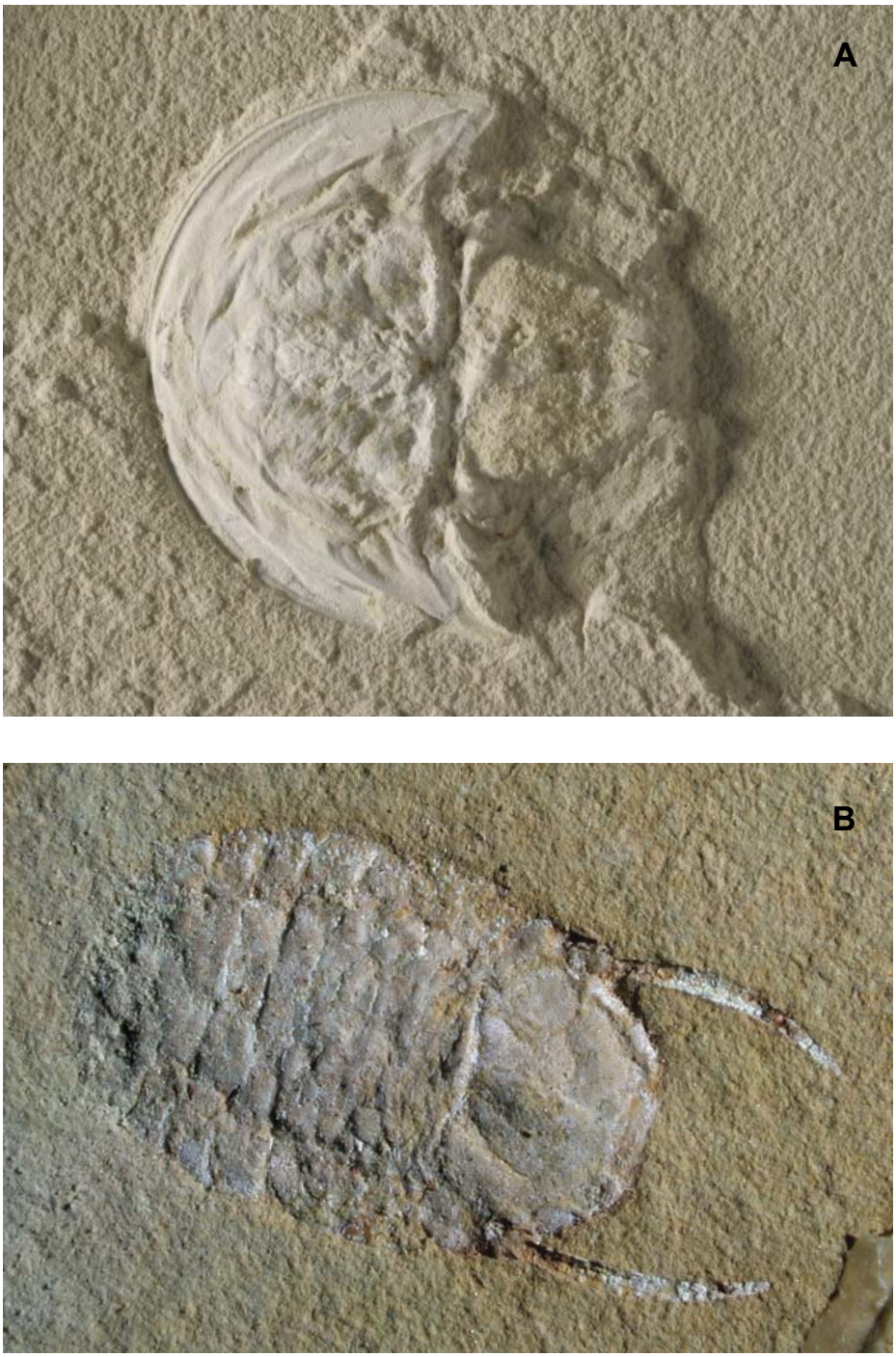


Fig. 5 – A) Indeterminate xiphosuran (xifosuro indeterminato), MSNM i26844 (x 2). B) Indeterminate isopod (isopode indeterminato), MSNM i27033 (x 8).


Fig. 6 – A) Indeterminate omopteran (omottero indeterminato), MSNM i26846 (x 5). B) Indeterminate comatulid crinoid (crinoide comatulide indeterminato), MSNM i27034 (x 3).

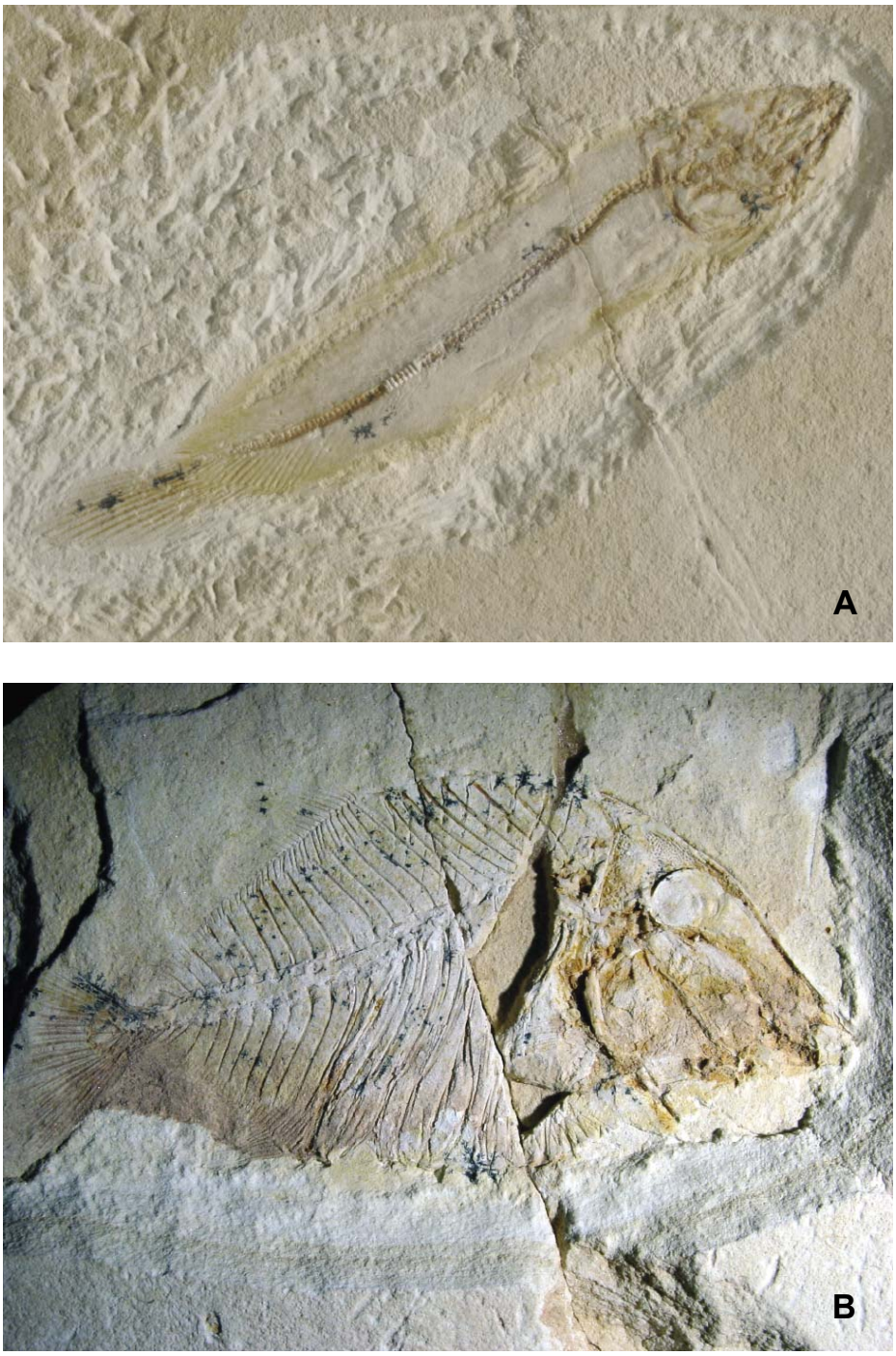


Fig. 7 – A) Indeterminate amiiform (amiiforme indeterminato), MSNM V6130 (x 1.5). B) Indeterminate pycnodont (picnodonte indeterminato), MSNM V6242 (x 2.2).

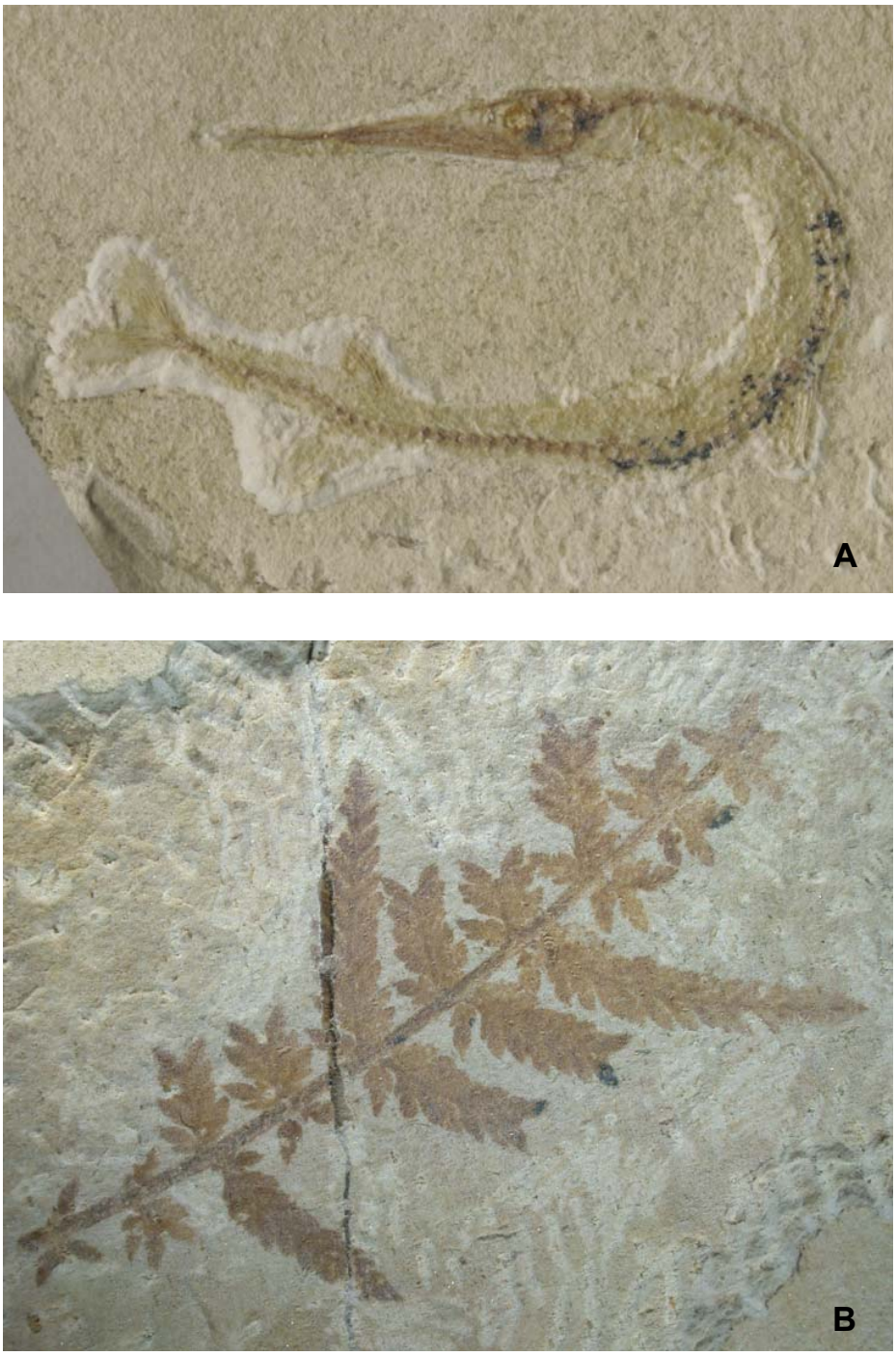


Fig. 8 – A) Indeterminate rhynchodercetid (rincodercetide indeterminato), MSNM V6128 (x 2.5). B) Indeterminate leafy branch (fronda indeterminata), MSNM B3813 (x 3.5).

**Previous reports of Cretaceous decapods from Morocco**

The previous reports of decapods from the Upper Cretaceous of Morocco are limited to two discoveries of "pinces de crabes" respectively from the Cenomanian of the Akrabou section of Ziz Formation (C1 unit), and from the upper Cenomanian of the Goulmina section (C2 unit – upper part), both located in Errachidia region (Ettachfini & Andreu, 2004). Dutheil (1999) reported the presence of decapod crustaceans in the faunal assemblage of the locality "close to Gara Sbaa", in the upper part of the Kem Kem beds (Cenomanian). Garassino *et al.* (2006) described *Cretapenaeus berberus*, a freshwater decapod crustacean, by the specimens gathered by Dutheil from this locality, located more at northern to "Gara Sbaa" in sediments older in age.

**Material**

The studied sample includes 34 specimens of macrurans, anomurans, and brachyurans. We identified some specimens as belonging to species already known from the Upper Cretaceous, and others as belonging to a new genus and new species. The specimens are more or less flatted on the layer surface and their preparation was easy as a result of the softness of the surrounding rock.

The superfamily Penaeoidea Rafinesque-Schmaltz, 1815, includes *Cretapenaeus berberus* Garassino, Pasini & Dutheil, 2006 (3 specimens), and one indeterminate penaeid. The infraorder Caridea Dana, 1852, includes one indeterminate caridean. The infraorder Astacidea Latreille, 1802, includes *Glyphea garasbaaensis* n. sp. (15 specimens), and one indeterminate astacidean. The infraorder Anomura MacLeay, 1838, includes *Galathea sahariana* n. sp. (4 specimens), *Paragalathea africana* n. sp. (1 specimen), and *Cretagalathea exigua* n. gen., n. sp. (3 specimens). The infraorder Brachyura Latreille, 1802, includes *Corazzatocarcinus* cfr. *C. hadjoulae* (Roger, 1946) (2 specimens) and *Telamonocarcinus* cfr. *T. gambalatus* Larghi, 2004 (1 specimen). Finally, the discovery of some brachyuran specimens which preserved the thoracic sternum with particular diagnostic features not resembling those of fossil and extant brachyurans families known to date, allowed to describe a new family (see Guinot *et al.*, 2008, in the same volume). The studied sample is housed in the Palaeontological Collections of the Museo di Storia Naturale di Milano (MSNM).

The sizes of the specimens are expressed in millimetres.

## Systematic Palaeontology

Order Decapoda Latreille, 1803
Superfamily Penaeoidea Rafinesque-Schmaltz, 1815
Family Penaeidae Rafinesque-Schmaltz, 1815
Genus *Cretapenaeus* Garassino, Pasini & Dutheil, 2006

Type species: *Cretapenaeus berberus* Garassino, Pasini & Dutheil, 2006, by monotypy

*Cretapenaeus berberus* Garassino, Pasini & Dutheil, 2006

2006 – *Cretapenaeus berberus* Garassino, Pasini & Dutheil; p. 10, Text-figs. 7-11

2007 – *Cretapenaeus berberus* Garassino, Pasini & Dutheil *in* Garassino, De Angeli & Pasini; p. 45

**Geological age**: Upper Cretaceous (Cenomanian-Turonian).
**Type locality**: Gara Sbaa (Kem Kem).
**Material**: three complete specimens in lateral view. MSNM i26825 a-b, i26854, i26866 a-b.
**Discussion**. Some morphological characters of the studied specimens, such as the subrectangular carapace, elongate rostrum with forwardly directed dorsal teeth, a prominent epigastric tooth, weak cervical groove, absence of hepatic and branchiocardiac grooves, absence of antennal spine, a narrow ocular incision, weak antennal and pterigostomial angles, subrectangular somites I-III of equal length with smooth tergal surface, and large eye with a short eyestalk, allowed to ascribe them to *Cretapenaeus berberus* Garassino, Pasini & Dutheil, 2006, recently reported from the Upper Cretaceous (Cenomanian) of the upper unit of the Kem Kem beds (southeastern Morocco) (Garassino *et al.*, 2006).

Genus and species indeterminate

**Geological age**: Upper Cretaceous (Cenomanian-Turonian).
**Type locality**: Gara Sbaa (Kem Kem).
**Material**: three incomplete specimens in lateral view. MSNM i26817 a-b, i26840 a-b, i26862.
**Discussion**. The state of preservation of the studied specimens did not allow their morphological description. They are ascribed to the Penaeidae for the pleura of somite II not overlapping that of somite I. Only the discovery of better preserved specimens will more precisely clarify the systematic position of what for the moment is limited to a simple report.

Infraorder Caridea Dana, 1852
Family, genus, and species indeterminate

**Geological age**: Upper Cretaceous (Cenomanian-Turonian).
**Type locality**: Gara Sbaa (Kem Kem).
**Material**: one complete specimen in lateral view. MSNM i26815 a-b.
**Discussion**. The specimen has been ascribed to the Caridea for the subrounded pleura overlapping those of somites I and III. Even though it shows some morphological characters, such as the subrectangular carapace, a short rostrum, a subrectangular somite VI longer than the others, a triangular telson, pleopods with subrectangular simpodite having two multiarticulate flagella, we prefer to leave it indeterminate for the lack of some diagnostic characters useful for the comparison with known Cretaceous genera and species. Moreover, its ascription to one living or fossil family is not possible for the lack of pereiopods. Presently, we recognize nine genera of Cretaceous carideans from Europe (Germany, Spain, and Italy), Arabian Peninsula (Lebanon), S America (Brazil), and China (Garassino & Jakobsen, 2005). So, even though the studied specimen is indeterminate, it represents the first report of carideans from Africa.

Infraorder Astacidea Latreille, 1802
Superfamily Glypheoidea Zittel, 1885
Family Glypheidae Zittel, 1885
Genus *Glyphea* v. Meyer, 1835

Type species: *Palinurus regleyanus* Desmarest, 1822, by original designation

Included fossil species: *G. alexandri* Taylor, 1979; *G. arborinsularis* Etheridge Jr., 1917; *G. australensis* Feldmann, Tshudy & Thomson, 1993; *G. bathonica* De Ferry, 1865; *G. bohemica* Fritsch & Kafka, 1887; *G. calloviensis* H. Woods, 1927; *G. carteri* Bell, 1863; *G. christeyi* Feldmann & Maxwell, 1999; *G. crassa* Oppel, 1861; *G. cretacea* McCoy, 1854; *G. damesi* Garassino, 2001; *G. eureka* Damborenea & Mancenido, 1987; *G. foresti* Feldmann & de Saint Laurent, 2002; *G. georgianus* Taylor, 1979; *G. gussmanni* Schütze, 1907; *G. jeletzkyi* Feldmann & McPherson, 1980; *G. liasina* v. Meyer, 1840; *G. lyrica* Blake, 1876; *G. muensteri* (Voltz, 1835); *G. michelae* Schweitzer & Feldmann, 2001; *G. oculata* J. Woods, 1957; *G. prestwichi* H. Woods, 1929; *G. pseudoscyllarus* (Schlotheim, 1822); *G. regleyana* (Desmarest, 1822); *G. reticulata* Feldmann & Gazdzicki, 1997; *G. rigoi* Garassino, 2000; *G. robusta* Feldmann & McPherson, 1980; *G. rostrata* (Phillips, 1829); *G. stiwelli* Feldmann, 1993; *G. tomesi* Woodward, 1868; *G. tonelloi* Garassino, 1997; *G. tricarinata* Garassino, 1996; *G. udressieri* v. Meyer, 1840; *G. vectensis* H. Woods, 1927; *G. viohli* Polz, 2000; *G. willetti* (Woodward, 1878); *G. yoshiakii* Kato & Karasawa, 2006

*Glyphea garasbaaensis* n. sp.
Figs. 9, 10

2007 – Glypheidae n. sp. *in* Garassino, De Angeli & Pasini; p. 45, Fig. 1A

**Diagnosis**: carapace subcylindrical laterally compressed; rostrum short with tuberculate upper and lower margins; cervical, postcervical and branchiocardiac grooves deep; antennal, hepatic and ventral grooves weak; one tuberculate carina extending in gastric and antennal regions; pereiopod I subchelate; pereiopods II-V achelate; uropodal exopod with diaeresis.

**Etymology**: the trivial name alludes to Gara Sbaa slope where the studied specimens were discovered.

**Holotype**: MSNM i26818.

**Paratypes**: MSNM i26819 a-b, i26824 a-b, i26855 a-b.

**Geological age**: Upper Cretaceous (Cenomanian-Turonian).

**Type locality**: Gara Sbaa (Kem Kem).

**Material**: 15 well preserved specimens in dorsal and lateral view, 10 to 50 mm long.

MSNM i26814 a-b, i26818, i26819, i26820 a-b, i26821, i26822, i26823, i26824 a-b, i26830 a-b, i26837 a-b, i26841 a-b, i26842 a-b, i26855 a-b, i26864 a-b, i26865 a-b.

**Description**. Moderate-sized glypheid with strongly tuberculate exoskeleton.

Carapace. Carapace subcylindrical, laterally compressed, strongly tuberculate. Rostrum short with tuberculate upper and lower margins. Cervical, postcervical, and branchiocardiac grooves deep. Antennal, hepatic, and ventral grooves weak. One longitudinal carina strongly tuberculate extending in gastric and antennal regions. Ocular incision narrow with weakly developed antennal and pterigostomial angles.

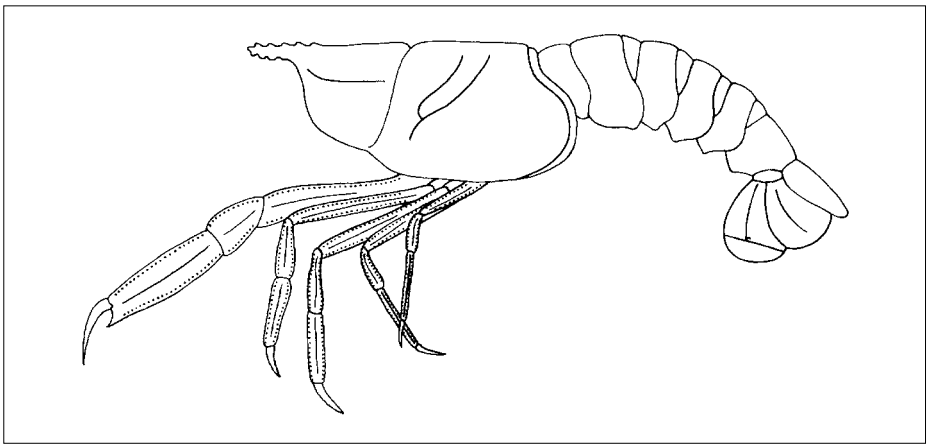

Fig.9 – *Glyphea garasbaaensis* n. sp., incomplete reconstruction (ricostruzione parziale).

Fig. 10 – *Glyphea garasbaaensis* n. sp., holotype (olotipo), MSNM i26818 (x 2).

Abdomen. Somites I-V subrectangular of equal length and with tuberculate tergal surface. Somites I-V with subrounded pleurae. Telson not preserved. Uropodal endopod smooth. Uropodal exopod with strong median longitudinal carina extending in distal spine. Diaeresis rounded.

Cephalic appendages. Eyestalk short, stout. 3rd maxilliped and antennulae not preserved. 2nd and 3rd antennae articles short, stout.

Thoracic appendages. Pereiopod I subchelate; merus subrectangular; propodus strong, elongate; carpus subtriangular, short. Movable finger thin and elongate. Lower margin of propodus with a spine strong and elongate. Dorsal surface of pereiopods I-V strongly tuberculate. Merus, carpus, and propodus of pereiopods I-V with a weak median longitudinal groove. Upper and lower margins of merus, carpus, and propodus of pereiopods I-V with a row of small tubercles. Pereiopods II-V achelate.

Abdominal appendages. Pleopods not preserved.

**Discussion**. Feldmann & de Saint Laurent (2002) highlighted the main characters of *Glyphea* v. Meyer, 1835: carapace subcylindrical laterally compressed, anterior part of carapace with longitudinal carinae, cervical groove steeply inclined, branchiocardiac groove well-developed, postcervical groove present but variably developed, well-developed pereiopod I, pseudochelate or achelate.

The main characters of *Glyphea* can be observed in the studied specimens in order to justify their ascription to this genus.

Feldmann & de Saint Laurent (2002) gave a check list of 29 species included in this genus. Among these species, *G. squamosa* (Münster, 1839), is now considered the type species of *Squamosoglyphea* Beurlen, 1930 (Schweigert & Garassino, 2005; Garassino & Schweigert, 2006). Moreover, the authors did not include seven species, described by Damborenea & Mancenido (1987), Garassino (1996, 1997, 2000, 2001), Polz (2000), and Schweitzer & Feldmann (2001): *G. eureka* Damborenea & Mancenido, 1987, *G. tricarinata* Garassino, 1996, *G. tonelloi* Garassino, 1997, *G. rigoi* Garassino, 2000, *G. viohli* Polz, 2000, *G. damesi* Garassino, 2001, and *G. michelae* Schweitzer & Feldmann, 2001. As reported by Glaessner (1929), *Glyphea* could include more species. However, since this genus has never been reviewed, probably many species could be synonym for some morphological characters, such as the path of the grooves, the number of carinae in gastric and antennal regions and the structure of pereiopod I. Unfortunately, this review is made difficult for the problems of finding the original samples and for the loss of many original specimens. On the basis of this reflection, today *Glyphea* includes 37 species from the Upper Triassic (Norian) to Eocene (Bartonian) of Europe (Germany, France, Great Britain, Poland, Italy, Spain), Lebanon, E Africa, N and S America, New Zealand, Australia, and Antarctic Peninsula.

Among the species of *Glyphea*, we recognize five species from the Upper Cretaceous: *G. bohemica* Fritsch & Kafka, 1887 (Turonian – Boemia), *G. cretacea* McCoy, 1854, and *G. willetti* (Woodward, 1878) (Cenomanian – Great Britain), *G. damesi* Garassino, 2001 (Cenomanian – Lebanon), and *G. foresti* Feldmann & de Saint Laurent, 2002 (Cenomanian – Australia).

If the reconstruction of *G. bohemica*, made by Fritsch & Kafka (1887) is correct, the new species differs from the Hungarian species for the presence of one only carina in gastric and antennal regions, for the lack of strong spines along the upper and lower margins of merus, and along the lower margin of propodus of pereiopod I, and for the lack of subchela in pereiopod II.

*Glyphea garasbaaensis* differs from *G. cretacea*, known by only some carapaces, for the presence of one only carina in gastric and antennal regions instead of two carinae, and from *G. willetti* for the presence of one only carina instead of three carinae and for the lack of strong spines along the lower margin of propodus of pereiopod I.

The new species differs from *G. damesi*, known by one only complete specimen, for the presence of one only carina in gastric and antennal regions instead of two, for the tuberculate dorsal and ventral margins of rostrum, smooth instead in *G. damesi*

and for the different shape of propodus of pereiopod I, lacking of spines along the upper and lower margins, present instead in the propodus of Lebanese species.

Finally, *G. garasbaaensis* differs from *G. foresti*, known by two complete specimens, for the presence of one only carina in gastric and antennal regions instead of three, and for the lack of spines along the upper, lower, and outer margins of propodus of pereiopod I.

*Glyphea garasbaaensis* represents the first well preserved species of glypheids from the Cretaceous of Africa, since the first report of *Glyphea* with *G.* sp. from the Upper Cretaceous (Senonian) of Cameroun by Guillemain & Harbort (1909) is represented by one poorly preserved specimen.

Family, genus, and species indeterminate

**Geological age**: Upper Cretaceous (Cenomanian-Turonian).

**Type locality**: Gara Sbaa (Kem Kem).

**Material**: one incomplete specimen in dorsal view. MSNM i26816 a-b.

**Discussion**. The poor state of preservation of the studied specimen does not allow to carry out its detailed morphological description and its certain generic and specific ascription. We ascribe it to the Astacidea for the pereiopods I-II with thin and elongate propodus of the chelae having movable and fixed fingers slightly bent at the distal extremity. The pereiopod III has a short and stout chelae. The dorsal surface of pereiopods is strongly tuberculate. Only the discovery of better preserved specimens will more precisely clarify the systematic position of what for the moment is limited to a simple report.

Infraorder Anomura MacLeay, 1838
Superfamily Galatheoidea Samouelle, 1819
Family Galatheidae Samouelle, 1819
Subfamily Galatheinae Samouelle, 1819

Genus *Galathea* Fabricius, 1793

Type species: *Cancer strigosus* Linneaus, 1761, by original designation

Included fossil species: *G. affinis* Ristori, 1886; *G. berica* De Angeli & Garassino, 2002; *G. keiji* Karasawa, 1993; *G. spitzbergica* Gripp, 1927; *G. squamifera* Leach, 1815; *G. strigifera* von Fischer-Benzon, 1866; *G. valmaranensis* De Angeli & Garassino, 2002; *G. weinfurteri* Bachmayer, 1950

*Galathea sahariana* n. sp.
Figs. 11, 12

2007 – Galatheidae n. sp. *in* Garassino, De Angeli & Pasini; p. 45, Fig. 1B

**Diagnosis**: carapace wider than long (without rostrum), narrower anteriorly, convex transversely; lateral margins serrate; dorsal surface with transverse subparallel cristae; rostrum subtriangular, wide at bottom, bearing spines along lateral

margins; elongate chelipeds of equal size having granulate cristae and spiny tubercles; first abdominal somites with transverse cristae.

**Etymology**: the trivial name alludes to the Sahara desert.

**Holotype**: MSNM i26827 a-b.

**Paratypes**: MSNM i26828 a-b, i26829 a-b, i26836 a-b.

**Geological age**: Upper Cretaceous (Cenomanian-Turonian).

**Type locality**: Gara Sbaa (Kem Kem).

**Material**: four well preserved specimens in dorsal view. MSNM i26827 a-b, i26828 a-b, MSNM i26829 a-b, i26836 a-b.

MSNM i26827 a-b – width of carapace: 3.8 mm
length of carapace (without rostrum): 3.4 mm
MSNM i26829 a-b – width of carapace 3.7 mm
length of carapace (without rostrum): 3.3 mm.

**Description**. Small-sized galatheid with cristate exoskeleton.

Carapace. Carapace small, wider than long (without rostrum), narrower anteriorly, convex transversely. Anterior margin wide. Rostrum subtriangular, wide at base. Lateral spines and median spine of rostrum not preserved. Only holotype preserves two strong spines on the left margin. Dorsal surface of rostrum depressed on the median part having some tubercles. Supraorbital margin relatively wide, marked by an outer spine. Lateral margins elongate, divaricate anteriorly, almost parallel medially, convergent posteriorly, with small triangular teeth turned forwards. Posterior margin wide, convex, superficially carinate. Dorsal regions well marked by cervical and branchiocardiac grooves, with transverse subparallel cristae. Frontal region marked posteriorly by two oblique epigastric rises, divided by a median groove extending along margins of narrow mesogastric anterior process. Meso- and metagastric regions create a weak subtriangular rise. Protogastric regions marked posteriorly by cervical groove. Gastric regions with 5-6 cristae. Hepatic regions small. Epibranchial regions subtriangular, well marked by cervical and branchiocardiac grooves, with 3-4 short sinuous cristae. Cardiac region poorly marked by branchiocardiac groove, with 4 straight, parallel cristae extending also on branchial regions. Posterior branchial regions with 3 discontinuous cristae.

Abdomen. Some specimens preserve the first wide abdominal somites, having transverse cristae, curved ventrally.

Cephalic appendages. Not preserved.

Thoracic appendages. Chelipeds strongly elongate with equal sizes. Merus elongate, subcylindrical, wider anteriorly, having granulate surface and margins with small spines. Carpus as long as wide, having granulate surface. Propodus subcylindrical, very elongate, with granulate surface. Fixed finger elongate, granulate on lower margin. Movable finger elongate, narrow, with weakly curved upper margin. Movable and fixed fingers with slightly serrate occludent margins. Ambulatory legs II-IV with merus, carpus, and propodus having small transverse cristae. Ambulatory leg V short, located subdorsally.

Abdominal appendages. Not preserved.

**Discussion**. The morphological characters of the family Galatheidae with the fossil species known to date were recently discussed by Schweitzer & Feldmann (2000a). *Galathea* Fabricius 1793, includes many Recent and fossil species with carapace having transverse cristae, subtriangular rostrum, and dentate or serrate lateral margins.

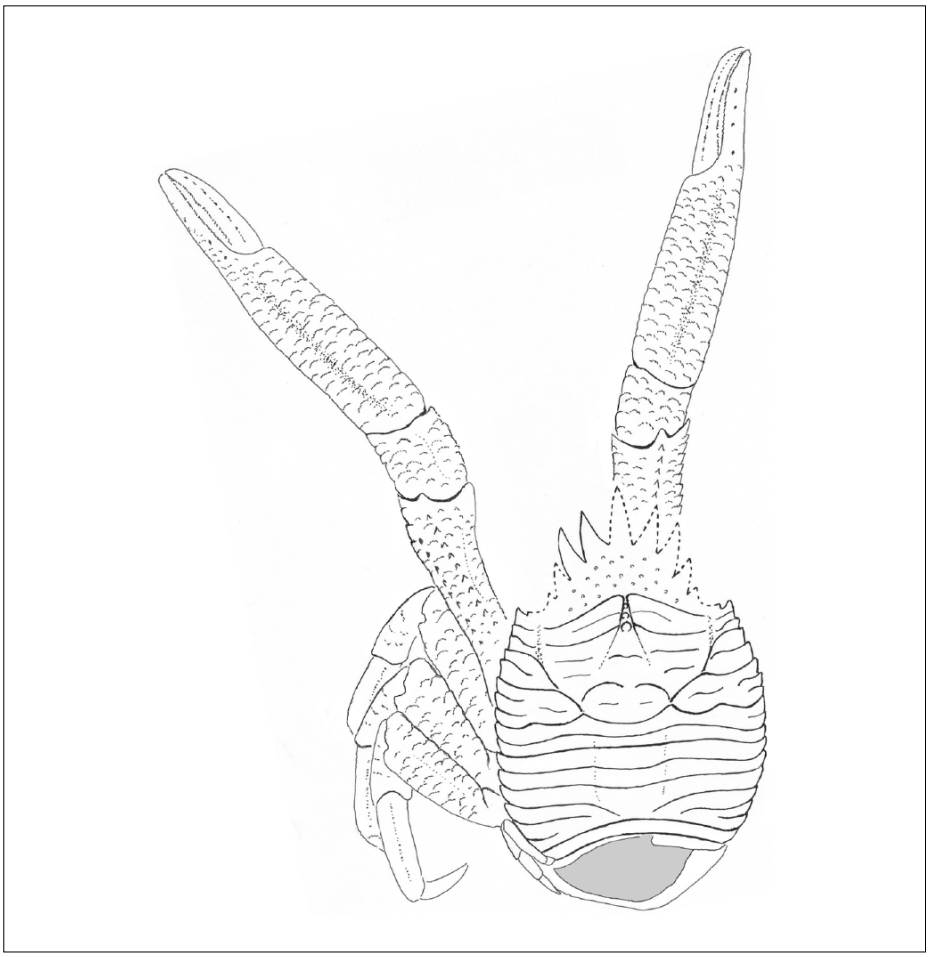

Fig. 11 – *Galathea sahariana* n. sp., incomplete reconstruction (ricostruzione parziale).

To date, the fossil species are the following: *G. strigifera* von Fischer-Benzon, 1866 (Danian – Denmark); *G. berica* De Angeli & Garassino, 2002 (Priabonian – Italy); *G. valmaranensis* De Angeli & Garassino, 2002 (Oligocene – Italy); *G. weinfurteri* Bachmayer, 1950 (Badenian – Poland, Hungary and Austria); *G. keiji* Karasawa, 1993 (Miocene – Japan); *G. spitzbergica* Gripp, 1927 (middle Miocene? – Spitzbergen Islands); *G. squamifera* Leach, 1815 (Messinian – Spain); *G. affinis* Ristori, 1886 (Piacenzian – Italy) (De Angeli & Garassino, 2002).

*Galathea cretacea* Stenzel, 1945, from the Albian of United States was included in *Luisogalathea* Karasawa & Hayakawa, 2000 (Karasawa & Hayakawa, 2000); *Galathea weinfurteri* Bachmayer, 1950, from the lower Oligocene of Valmarana and Perarolo (Vicenza) (Vicariotto & Beschin, 1994; De Angeli & Messina, 1997) was included in *G. valmaranensis* De Angeli & Garassino, 2002, and *Galathea* sp. from the lower Eocene of Gecchelina di Monte di Malo (Vicenza) (Beschin *et al*., 2000) was included in *Lessinigalathea* De Angeli & Garassino 2002.

Fig. 12 – *Galathea sahariana* n. sp., holotype (olotipo), MSNM i26827 (x 9).

Even though the studied specimens preserved partially the rostrum and its spines, they show morphological characters comparable with this genus, such as the transverse cristae of the carapace and the triangular shape of the rostrum. However, *Galathea sahariana* n. sp. differs from the other fossil species for a short carapace, cristae almost rectilinear and continuous until the lateral margins, and very developed spines of the rostral margins.

## Genus *Paragalathea* Patrulius, 1960

Type species: *Galathea verrucosa* Moericke, 1899, by original designation

Included fossil species: *P. miyakoensis* Takeda & Fujiyama, 1983; *P. multisquamata* (Via Boada, 1981); *P. neocomiensis* (Van Straelen, 1936); *P. ornatissima* Patrulius, 1966; *P. ruizi* (Van Straelen, 1940); *P. straeleni* (Ruiz de Gaona, 1943); *P. substriata* (Blaschke, 1911); *P. ubaghsi* (Pelseneer, 1886); *P. verrucosa* (Moericke, 1897)

*Paragalathea africana* n. sp.
Figs. 13, 14

2007 – Galatheidae n. sp. *in* Garassino, De Angeli & Pasini; p. 45, Fig. 1C

**Diagnosis**: carapace subsquare, wider than long (without rostrum), convex transversely, wider posteriorly; rostrum wide; lateral margins convex, continuous; posterior margin wide, weak concave; dorsal regions weak marked; cervical groove present; epigastric lobes well raised; dorsal surface of carapace with small tubercles aligned transversely; ambulatory legs II-V strong.

**Etymology**: the trivial name alludes to Africa Continent where the studied specimens were discovered.

**Holotype**: MSNM i26863 a-b.

**Geological age**: Upper Cretaceous (Cenomanian-Turonian).

**Type locality**: Gara Sbaa (Kem Kem).

**Material**: one well preserved specimens in dorsal view. MSNM i26863 a-b.

MSNM i26863 a-b – width of carapace: 6.3 mm
length of carapace (without rostrum): 5.7 mm
length of carapace with rostrum: <6.7 mm.

**Description**. Small-sized galatheid with exoskeleton weakly cristate.

Carapace. Carapace subsquare, wider than long, convex transversely, and wider posteriorly. Fronto-orbital margin filling entire anterior margin. Rostrum wide at bottom with supraorbital margins continuous and spineless, and wide distal part having a pair of spines along the margins (median spine not preserved). Dorsal surface of rostrum with a longitudinal depression and small granulate, transverse cristae. Supraorbital margin concave with one extraorbital spine. Lateral margins elongate, convex, continuous, spineless, weakly carinate superficially. Posterior margin wide, weakly concave. Dorsal regions weakly marked. Cervical groove shallow, marking hepatic and gastric regions. Gastric regions weakly raised. Epigastric lobes divided by a median groove extending posteriorly along narrow mesogastric anterior process. Dorsal surface with small granules aligned in transverse cristae, more evident on branchial regions.

Abdomen. First wide abdominal somites, having transverse cristae, curved ventrally.

Cephalic appendages. Not preserved.

Thoracic appendages. Only merus of cheliped preserved. Ambulatory legs II-V strong, with subcylindrical merus having one granulate carina along outer upper margin; propodus elongate, depressed longitudinally with a small proximal spine; movable finger subtriangular, short.

Abdominal appendages. Not preserved.

**Discussion.** Via Boada (1981, 1982) discussed the morphological characters of *Paragalathea* Patrulius, 1960, giving a first check list of the known fossil species. This genus has a transversely raised carapace, a wide, tridentate rostrum without median carina, and the dorsal surface with rounded granules. To date, the fossil species are the following: *P. multisquamata* (Via Boada, 1981), *P. ruizi* (Van Straelen, 1940) and *P. straeleni* (Ruiz de Gaona, 1943) (= *Galathea alsasuensis* Van Straelen, 1944) (Coniacian – Spain); *P. substriata* (Blaschke, 1911) and *P. verrucosa* (Moericke, 1897) (Tithonian – Moravia); *P. ornatissima* Patrulius, 1966 (Tithonian – Moravia; Hauterivian – Poland); *P. neocomiensis* (Van Straelen, 1936) (Hauterivian – France); *P. ubaghsi* (Pelseneer, 1886) (Maastrichtian – The Netherlands); *P.*

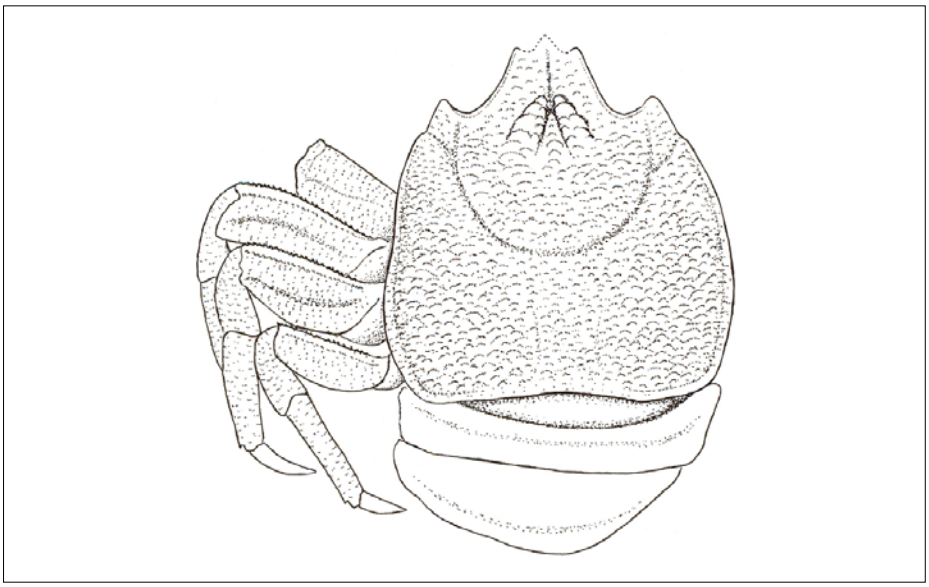

Fig. 13 – *Paragalathea africana* n. sp., incomplete reconstruction (ricostruzione parziale).

Fig. 14 – *Paragalathea africana* n. sp., holotype (olotipo), MSNM i26863 (x 10).

*miyakoensis* Takeda & Fujiyama, 1983 (Aptian – Japan) (Pelseneer, 1886; Moericke, 1897; Blaschke, 1911; Van Straelen, 1936, 1940, 1944; Ruiz de Gaona, 1943; Patrulius, 1960, 1966; Via Boada, 1981, 1982; Takeda & Fujiyama, 1983).

The carapace of *P. africana* shows some affinities with that of *P. ruizi* for the lateral margins continuous without lateral spines, and the dorsal surface with small granules aligned transversely. However, the granules are more frequent and located in numerous transverse cristae in *P. ruizi*. *Paragalathea straeleni*, *P. multisquamata*, *P. ornatissima*, *P. neocomiensis*, and *P. substriata* differ from the new species in that the carapace is longer and the dorsal granules are more evident and raised. Moreover, *P. ornatissima* has a wider rostrum. *Paragalathea verrucosa* differs from the new species in that the carapace is longer and the anterior gastric regions are not distinct. *Paragalathea miyakoensis*, known by an incomplete carapace, differs from *P. africana* in that the carapace is longer, branchial grooves are well marked, and dorsal granules are more raised. Even though, *P. ubaghsi* does not preserve the rostrum, it differs from the new species in that the carapace is longer with lateral margins having some spines and dorsal regions are marked by cervical and branchial grooves.

To date, *Paragalathea* is known in the fossil record from the Upper Jurassic to the Upper Cretaceous of Europe, N Africa, and Japan.

## Genus *Cretagalathea* nov.

**Diagnosis**: carapace subsquare, as long as wide (without rostrum), weakly convex transversely; fronto-orbital margin 0.55 of maximum carapace width; anterolateral margins divergent, concave until the epibranchial spine; lateral margins long, parallel with small teeth; dorsal regions well marked by cervical and branchiocardiac grooves with transverse cristae; chelipeds and ambulatory legs II-IV long, thin.

**Type species**: *Cretagalathea exigua* n. sp.

**Etymology**: from Cretaceous, geological period of the studied specimens, and *Galathea* that shows most morphological affinities with the new genus.

**Description**: as for the type species.

**Discussion**. Even though the studied specimens do not preserve the front and rostrum, the morphological characters of the carapace do not resemble those of the other galatheids known to date. In fact, this new genus has the strongly restricted anterior part of the carapace; fronto-orbital margin is wide about 0.55 of the maximum width of the carapace; anterolateral margins are concave and strongly divergent until the small spine of the epibranchial angle; the lateral margins of the carapace have small teeth; and transverse cristae of the median and posterior parts of carapace do not reach the lateral margins. The shape of the carapace and the presence of transverse cristae resemble those of *Galathea* and genera strictly similar to *Galathea*. This pecularity allows to include the studied specimens among the Galatheinae, since in the Munidopsinae Ortmann, 1898, gastric and cardiac regions are more raised, the front is not delimited by an epigastric prominence, and dorsal regions have small scaly cristae.

To date, the Mesozoic genera included in Galatheinae are the following: *Calteagalathea* De Angeli & Garassino, 2006, *Galathea* Fabricius, 1793, *Eomunidopsis* Via Boada, 1981, *Luisogalathea* Karasawa & Hayakawa, 2000, *Mesogalathea* Houša, 1963, *Munida* Leach, 1820 (= *Austromunida* Schweitzer & Feldmann, 2000), and *Paragalathea* Patrulius, 1960.

The stratigraphic distribution of the Galatheoidea by Schweitzer & Feldmann (2000a, fig. 1, Pl. 1) includes *Palaeomunida* Lőrenthey, 1902, from the Upper Jurassic-Eocene. However, as reported by De Angeli & Garassino (2002), this genus must be referred only to Cenozoic (upper Eocene and lower Oligocene) and the Jurassic species included in *Palaeomunida* (*P. neojurensis*, *P. zitteli, P. eutecta*) by Patrulius (1960) must be referred to *Eomunidopsis* (Via Boada, 1981, 1982).

*Cretagalathea exigua* n. sp.
Figs. 15, 16

2007 – Galatheidae n. gen., n. sp. *in* Garassino, De Angeli & Pasini; p. 45, Fig. 1D

**Diagnosis**: as for the genus.

**Etymology**: from *exiguus –a –um* (lat.), referred to the small size of the studied specimens.

**Holotype**: MSNM i26856 a-b.

**Paratypes**: MSNM i26826, i26838 a-b.

**Geological age**: Upper Cretaceous (Cenomanian-Turonian).

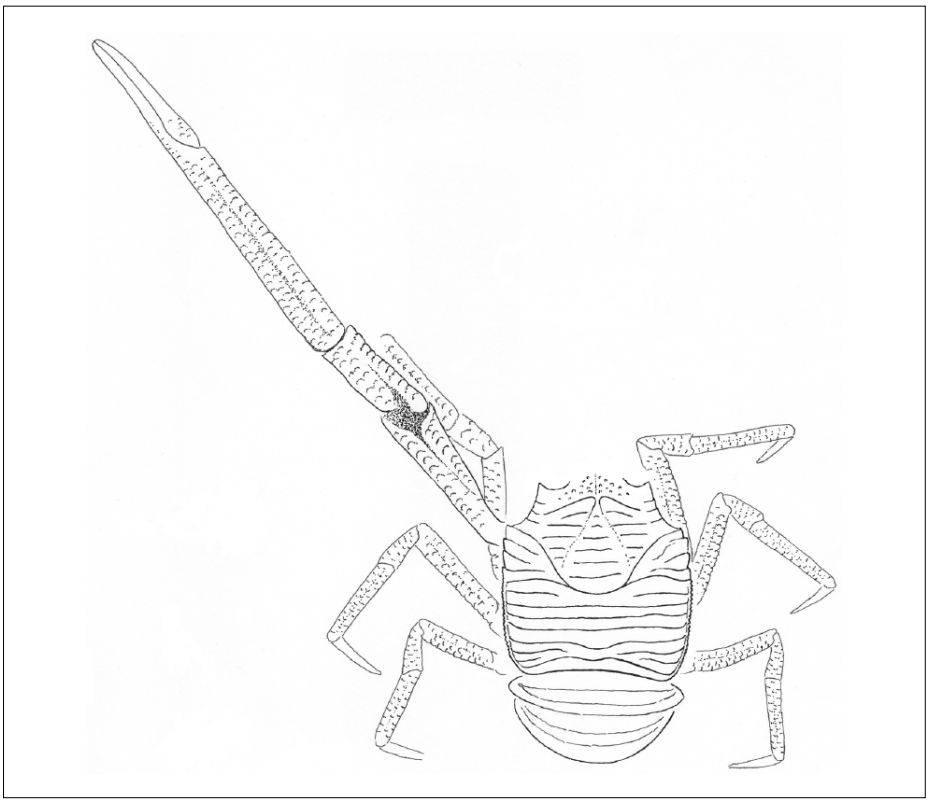

Fig. 15 – *Cretagalathea exigua* n. gen., n. sp., incomplete reconstruction (ricostruzione parziale).

**Type locality**: Gara Sbaa (Kem Kem).

**Material:** 3 specimens in dorsal view. MSNM i26826, i26838 a-b, i26856 a-b.
MSNM i26856a-b – width of carapace: 4.4 mm
length of carapace (without rostrum): 4.7 mm

**Description**. Small-sized galatheid with cristate exoskeleton.

Carapace. Carapace subsquare, longer than wide, weakly convex transversely. Fronto-orbital margin 0.55 of maximum width of carapace. Rostrum not preserved. Orbits marked by a weak extraorbital spine. Anterolateral margins relatively short, strongly divergent, concave until the small spine of epibranchial angle. Lateral margins straight, parallel, converging to posterior margin. Lateral margins with some small teeth on epibranchial and posterior branchial margins. Posterior margin wide, concave. Dorsal regions marked by cervical and branchiocardiac grooves. Frontal region, incomplete anteriorly, marked posteriorly by two oblique epigastric raises. Surface of frontal region depressed in median part, with small granules. Two epigastric raises divided by a groove marking narrow mesogastric anterior process. Gastric regions well developed, but weakly raised. Epibranchial regions subtri-

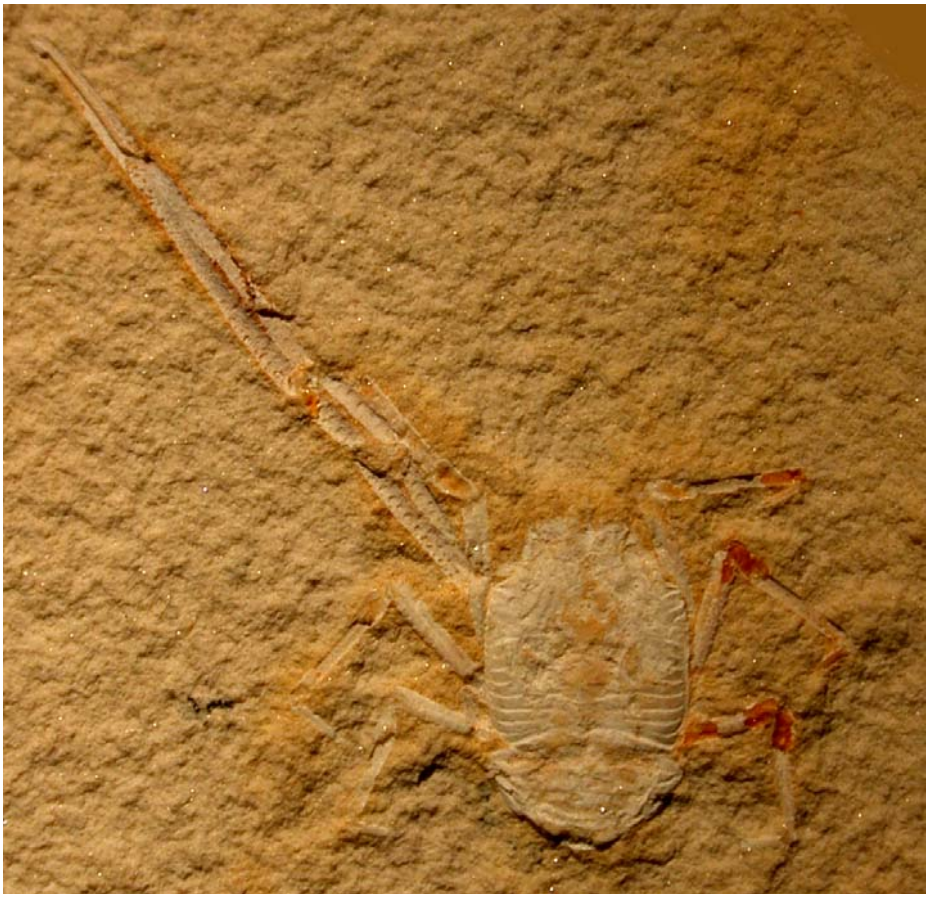

Fig. 16 – *Cretagalathea exigua* n. gen., n. sp., holotype (olotipo), MSNM i26856 (x 6).

angular, well marked by cervical and branchiocardiac grooves, with three-four cristae. Cardiac and posterior branchial regions with transverse cristae continuous, parallel. These cristae not reaching margins, stopping on a thin marginal carina.

Abdomen. First wide abdominal somites, having transverse cristae, curved ventrally.

Cephalic appendages. Not preserved.

Thoracic appendages. Chelipeds of equal size, slender, very long. Merus and carpus subcylindrical, elongate, with granules. Propodus elongate, narrow, having outer surface with longitudinal depression and granules. Movable and fixed fingers elongate. Movable finger with upper margin convex in distal part.

Abdominal appendages. Not preserved.

Infraorder Brachyura Latreille, 1802
Section ?Podotremata Guinot, 1977
Superfamily Uncertain
Family Necrocarcinidae Förster, 1968
Genus *Corazzatocarcinus* Larghi, 2004

Type species: *Geryon hadjoulae* Roger, 1946, by original designation
Included fossil species: *C. hadjoulae* (Roger, 1946)

*Corazzatocarcinus* cfr. *C. hadjoulae* (Roger, 1946)

1946 – *Geryon hadjoulae* Roger; p. 43, pl. 8 (fig. 1)
1955 – ?*Cenomanianocarcinus* cf. *vanstraeleni in* Stenzel *et al*.; p. 314
2000 – *Orithopsis hadjoulae* (Roger) *in* Larghi & Garassino; p. 53, Text-fig. 1
2004 – *Corazzatocarcinus hadjoulae* (Roger) *in* Larghi; p. 531, Text-figs. 2-4
2007 – *Corazzatocarcinus hadjoulae* (Roger) *in* Garassino, De Angeli & Pasini; p. 45

**Geological age**: Upper Cretaceous (Cenomanian-Turonian).

**Type locality**: Gara Sbaa (Kem Kem).

**Material**: two incomplete specimens in dorsal and ventral view. MSNM i26832 a-b, i26833 a-b.

**Discussion**. Even though the two specimens are incomplete, they show morphological affinities with *Corazzatocarcinus hadjoulae* (Roger, 1946) from the Cenomanian of Lebanon. Larghi (2004) described this necrocarcinid by many specimens from Hadjula, housed in the collection of the Museo di Storia Naturale di Milano. The studied specimens have the thin pereiopods II-III with a long merus having the spiny border and styliform dactylus. One specimen (MSNM i26832 a-b) preserved in ventral view, show portions of sternum and abdominal somites, while the second (MSNM i26833a-b) preserves instead the posterior part of the carapace.

Necrocarcinidae Förster, 1968, includes exclusively fossil decapods from the Cretaceous. The systematic position of this family is still discussed. In fact, some authors included the necrocarcinid in the Calappoidea De Haan, 1833 (Förster, 1968, Wright & Collins, 1872, Schweitzer & Feldmann, 2000b, Fraaije, 2002),

while others in the Dorippoidea MacLeay, 1838 (Schweitzer, 2003). At present, this family is ascribed with reserve to the Podotremata (Jagt *et al*., 2000; Collins & Williams, 2004; Guinot & Breton, 2006).

Section Eubrachyura de Saint Laurent, 1980
Subsection Heterotremata Guinot, 1977
Superfamily Dorippoidea MacLeay, 1838
Family Dorippidae MacLeay, 1838
Subfamily Telamonocarcininae Larghi, 2004
Genus *Telamonocarcinus* Larghi, 2004

Type species: *Telamonocarcinus gambalatus* Larghi, 2004, by the original designation

Included fossil species: *T. gambalatus* Larghi, 2004; *T. binodosus* (Collins, Kanie & Karasawa, 1993)

*Telamonocarcinus* cfr. *T. gambalatus* Larghi, 2004

2000 – Indeterminate crab (*sic*) *in* Larghi & Garassino; Text-fig. 2
2003 – Genus and species indeterminate *in* Schweitzer *et al*.; p. 890, Text-figs. 1-2
2004 – *Telamonocarcinus gambalatus* Larghi; p. 539, Text-figs. 5, 6 (1-11), 7 (2-8)
2007 – *Telamonocarcinus gambalatus* Larghi *in* Garassino, De Angeli & Pasini; p. 45

**Geological age**: Upper Cretaceous (Cenomanian-Turonian).

**Type locality**: Gara Sbaa (Kem Kem).

**Material**: one complete specimen in dorsal view. MSNM i26857.

**Discussion**. The studied specimen has a small carapace subpentagonal with well marked granulate dorsal regions, a subtriangular, trilobate front, wide orbits marked by an extraorbital spine, posterior lateral margins strongly convex, very long pereiopods II-III with flattened podomeres, and first abdominal somites.

The morphological characters of the studied specimen resemble those of *Telamonocarcinus gambalatus* Larghi, 2004, from the Cenomanian of Lebanon. An indeterminate necrocarcinid from the Upper Cretaceous of Egypt described by Schweitzer *et al*. (2003) could be ascribed also to this species. In fact, this specimen has also a carapace of small sizes and well developed, elongate pereiopods II-III.

**Palaeogeographic, palaeoenvironment, and paleobiological notes**

Recently, the studies of the Pre-African Cretaceous platform in the region of Erfoud-Errachidia, partially correlated with the Kem Kem beds, allow to summarize the main events of Cenomanian-Turonian (Ettachfini & Andreu, 2004) and the relative known icthyofaunas (Ferrandini *et al.*, 1985; Cavin & Dutheil, 1999). In the upper Cenomanian, a wide platform was established in the basin with the opening of a marine channel with ENE, permitting a link with the Tethys for a short period. Ferrandini *et al.* (1985) pointed out that a Meso-Tethyan fish fauna with the presence of endemic invertebrates occurred in this period. An important transgressive phase took origin in the lower Turonian, producing the increase of

the depth, the opening of the Atlas Gulf, and the communication with the Central Atlantic, even though the communication remains with the Tethys (Ettachfini & Andreu, 2004). In fact, the fish fauna from the Turonian shows typical Meso-Tethyan elements mixed with organisms having S America affinities (Cavin & Dutheil, 1999).

As pointed out by Dutheil (comm. pers.), the fish fauna from the Gara Sbaa is a mix of organisms already present in the Tethys (above all with those from the Cenomanian of Lebanon) with some freshwater taxa (e.g. amiiformes) with affinities with the Cretaceous faunas from S America. The presence of different taxa of pycnodonts is very interesting because it shows deeper morphological affinities with some Cenozoic forms, distinguishing clearly from the typical forms from the Cenomanian of Lebanon (Capasso, comm. pers.). Moreover, it is very interesting to point out the medium size of the fishes (usually maximum 10 cm long) and the lack of sharks or big predators, excluding the discovery of small isolated teeth of indeterminate selachian lamniformes. The lack of predators and pelagic forms suggests that the faunal assemblage of Gara Sbaa is typical of a meso-littoral environment with shallow, quiet water, subject to periodical contribution of freshwater and protected by a reef. The discovery of three species of galatheids, inhabitants of recifal environments, could confirm the hypothesis of the presence of a probable reef. Other terrestrial and marine arthropods are present in the laminate limestone of Gara Sbaa: two groups of insects are identifiable (Orthoptera and Omoptera), the second report of Cretaceous insects in N Africa (their very good state of preservation suggests that the mainland was close to the marine environment); two specimens of xiphosurans, first report of these arthropods in N Africa; one specimen belonging to the superorder Peracarida, order Tanaidacea; the isopods (Flabellifera, Sphaeromonidae group) are very common and preserved more or less three-dimensionally; one specimen of crinoid echinoderms, Comatulidae (strictly similar to *Geocoma*) present also in the Lebanese fauna; finally, rare worms probably belonging to the nematods. The presence of mainland close to the marine environment is also attested by some specimens of plants, represented by isolated leaves and small leafy branches belonging to indeterminate angiosperms.

The fossils are usually rare in the sublithographic laminated limestone (Fig. 4) where they appear scattered and spaced out. Usually the limestone is very rich of isopods, associated with fishes. In the sandstone levels on the contrary there are some heaps of small teleosteans (maximum 3-4 specimens) associated with small leafy branches or isolated leaves. The malacofauna is completely absent, except for a small disarticulated valve of bivalve and a small gastropod, associated with a brachyuran.

**Taphonomic notes**

The taphonomy of the faunal assemblage of the laminate micritic limestone of the Gara Sbaa is comparable with that of the classic lithographic limestone from the Jurassic of Germany (Baviera) and S France. Events of ipersalinity, ought to heating and evaporation of the waters in arid and sub-tropical climates, supported the seasonal development of cyanobacterial carpets and the consequent precipitation of the carbonates on the bottom. These events gave origin to the subsequent lamitation of the layers and good preservation of the organisms.

Later, the re-mineralization of the carbonates into the cavities of the vertebrates (fishes) and decapods and the deposition of the manganese oxides around the organisms or free on the surfaces of some layers of the series occur. The plants, preserved as a film, show the details of the venations and the thinner vascolarizations. Fishes and arthropods are usually in anatomical connection, testifying the quick hollow depression in the thin sediments and subsequent diagenesis, attesting also the lack of streams on the bottom and the transport *post mortem* of the organisms. The organisms are usually isolated rarely in association in the same layer, suggesting the lack of anoxic events or the presence of particular critical events into the water column.

## Conclusion

The faunal assemblage of Gara Sbaa indicates different possible palaeoenvironments, as pointed out by different families, genera, and species of decapods, other groups of arthropods, and groups of fishes, suggesting an essentially marine ecosystem, subject to freshwater contributions coming from the lands with their respective faunae and florae. Moreover, the presence of durophagous fishes and three different species of galatheids could suggest the existence of an old reef, actually not identifiable probably for the incomplete data gathered to date or for the erosive processes. The laminate micritic limestone of the Gara Sbaa probably took origin from a thin rhythmic sedimentation with a quick hollow depression of the organic remains. The presence of cyanobacterial carpets supported the good preservation of the organisms. Probably this limestone has been deposited during the Turonian transgression, along the southern platform of the Atlas Gulf, inside of a peripheric lagoon, subject to freshwater contributions and with local character. Here macrofaunas with Atlantic affinities coming from W met organism already present previously in the Meso-Tethyan coming from N-E nearby to some local endemisms, as already reported by some authors (Ferrandini *et al.*, 1985; Cavin & Dutheil, 1999; Ettachfini & Andreu, 2004).

## Acknowledgements

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