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Marocarcinidae, a new eubrachiuran family,
and *Marocarcinus pasinii* n. gen., n. sp. from the
Upper Cretaceous (Cenomanian-Turonian)
of Gara Sbaa, southeastern Morocco
(Crustacea, Decapoda, Brachyura)

Abstract – A new family, Marocarcinidae with *Marocarcinus pasinii* n. gen., n. sp. is described for several specimens from the Upper Cretaceous (Cenomanian-Turonian) of the “Hamada des Kem Kem” escarpment (SE Morocco). Dorsal carapace, pereopods, and the well preserved structure of the thoracic sternum, with distinct sutures, are present. Conspicuous vulvae on sixth thoracic segment indicate a placement in the Eubrachiura. The interrupted sternal sutures 4/5 and 5/6, complete suture 6/7, and interrupted suture 7/8, the carapace outline, the pronounced heterochely, even in the female, do not fit with characters of any known eubrachiuran fossil or extant family. The closest crabs are *Trichopeltarion* and affiliated genera, a fossil and extant group, still unnamed and called here «*Trichopeltarion* group». The family Marocarcinidae n. fam. and the «*Trichopeltarion* group» are easily distinguished from the family Atelecyclidae emend. (monotypic, with *Atelecyclus*), which is transferred to the Cancroidea.

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

Riassunto – Marocarcinidae, una nuova famiglia di eubrachiuri, e *Marocarcinus pasinii* n. gen., n. sp. del Cretacico superiore (Cenomaniano-Turoniano) del Gara Sbaa, Marocco sudorientale (Crustacea, Decapoda, Brachyura).

Viene descritta la nuova famiglia Marocarcinidae con *Marocarcinus pasinii* n. gen., n. sp. per alcuni esemplari del Cretacico superiore (Cenomaniano-Turoniano) della “Hamada des Kem Kem” (SE Marocco). Gli esemplari conservano il carapace, i pereopodi e le strutture ben conservate dello sterno toracico con suture distinte. Vulve ben sviluppate localizzate sul sesto segmento toracico permettono di collocare gli esemplari tra gli Eubrachiura. Le suture sternali 4/5 e 5/6 interrotte, la sutura 6/7 completa, la sutura 7/8 interrotta, il profilo del carapace e la spiccata eterochelia, evidenzia

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perfino negli esemplari femminili non rientrano nei caratteri di nessuna famiglia eterotremata, fossile o vivente. I brachiuri che mostrano maggiori affinità sono *Trichopeltarion* e generi affini, un gruppo che comprende forme fossili e viventi, ancora innominato e qui chiamato con l'appellativo di «gruppo *Trichopeltarion*». La famiglia Marocarcinidae n. fam. e il «gruppo *Trichopeltarion*» sono facilmente distinguibili dalla famiglia Atelecyclidae emend. (monotipica, con *Atelecyclus*), trasferita nell'infraordine Cancroidea.

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

Résumé – Marocarcinidae, une nouvelle famille eubrachyurienne, et *Marocarcinus pasinii* n. gen., n. sp. du Crétacé supérieur (Cénomaniens-Turonien) de Gara Sbaa, sud-est du Maroc (Crustacea, Decapoda, Brachyura).

Une nouvelle famille, Marocarcinidae, est décrite pour accueillir *Marocarcinus pasinii* n. gen., n. sp. pour plusieurs spécimens du Crétacé (Cénomaniens-Turonien) de Gara Sbaa, dans le sud-est du Maroc. La face dorsale de la carapace, les périopodes et le sternum thoracique qui est la structure la mieux préservée, avec des sutures très distinctes, sont présents. La présence de vulves bien visibles sur le sixième segment thoracique permet une attribution aux Eubrachyura. Les sutures sternales 4/5 et 5/6 interrompues, la suture 6/7 complète, et la suture 7/8 interrompue, la forme de la carapace, l'hétérochélie prononcée, même chez la femelle, ne correspondent pas aux caractères d'une famille connue de crabes hétérotèmes, fossiles ou actuels. Les crabes les plus proches sont, *Trichopeltarion* et les genres affiliés un groupe actuel et fossile, à ce jour non nommé et appelé ici «groupe *Trichopeltarion*». La famille des Marocarcinidae n. fam. et le «groupe *Trichopeltarion*» se distinguent aisément de la famille des Atelecyclidae emend. (monotypique, avec *Atelecyclus*) qui est ici transférée dans les Cancroidea.

Mots clés: Crustacea, Decapoda, Brachyura, Crétacé superior, Maroc.

Introduction

As already reported by Garassino *et al.* (2008), the studied specimens were discovered in deposits recently discovered at the top of Gara Sbaa escarpment located in SE Morocco, along the “Hamada des Kem Kem”, close to the Algerian border. These fossiliferous levels are known in literature as Kem Kem beds (see Sereno *et al.*, 1996) from the Upper Cretaceous. 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, along the Oued Sbaa, is formed by a poorly sedimentary series, located at the top of a small mesa, known as Gara Sbaa.

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 m²) and 1.80 m thick, show at the bottom sublithographic laminated limestones (60-70 cm thick), including the brachyurans, subject of this study.

Material

The studied sample includes nine specimens of brachyurans in dorsal and ventral view for which the family Marocarcinidae n. fam., with *Marocarcinus pasinii* n. gen., n. sp. is erected. The specimens are more or less flattened on the layer surface and their preparation was easy as a result of the softness of the surrounding rock. The studied specimens are housed in the Paleontological Collections of the Museo di Storia Naturale di Milano (MSNM).

Abbreviations

The following abbreviations are used in the text: mxp3, external maxillipeds; P1-P5, first to fifth pereopods (P1 = chelipeds; P2 to P5 = ambulatory legs).

Systematic Palaeontology

Infraorder Brachyura Latreille, 1802
Section Eubrachyura de Saint Laurent, 1980
Subsection Heterotremata Guinot, 1977
Family Marocarcinidae n. fam.

Type genus by present designation: *Marocarcinus* n. gen.

Diagnosis: carapace slightly wider than long, subovate in outline; front slightly depressed, with four lobes, two median close to each other and more protruded than lateral ones; orbits narrow; supraorbital margin short, continuous, and concave; anterolateral margins with four teeth including the marked extraorbital ones; posterolateral margins long, almost parallel, only converging posteriorly; posterior margin slightly concave; dorsal surface of carapace with regions hardly distinct; thoracic sternum ovoid in outline, narrow, sternites 1 to 8 in the same plane; sternites 1 to 3 forming narrow shield; sternites 1 and 2 fused, sternite 3 well delimited; sternite 4 with a strong constriction on lateral margins; sternites 5 to 8 with gently convex lateral margins (sternum ovoid in this place) then decreasing in width posteriorly, sternite 7 narrow, sternite 8 very small; sternites 6 to 8 with a similar inclination and shaped in a manner that completes the ovoid outline of the sternum; sternite 8 being the smallest in width; sutures 2/3 and 3/4 complete, 4/5 and 5/6 interrupted, 6/7 complete, 7/8 interrupted; median line extending on sternites 7 and 8; sternoabdominal cavity (female) shallow; male abdomen subtriangular, (probably) with all segments free; chelipeds remarkably robust with strong heterochely and probable heterodonty in both sexes, merus and carpus thick; major cheliped with broad palm and markedly gaping fingers, even in the female; minor cheliped probably without gap between prehensile margins of the long, pointed fingers; P2-P5 elongate, strong, with tapering dactylus; P5 well developed.

Remarks. Despite the relatively poor preservation of the dorsal carapace in our material, the exceptionally well preserved thoracic sternum, with sutures and distinct vulvae, which does not correspond to that of any known extinct or recent family, justifies the establishment of a new family. The chelae and pereopods are additional characters, which allows the description of a new family. The affiliation of the family Marocarcinidae n. fam. to the Eubrachyura is ascertained by the presence of conspicuous vulvae on sternal segment 6. The study is based on nine specimens, with practically all essential parts that are preserved and permit a reconstruction (Fig. 1).

Genus *Marocarcinus* n. gen.

Diagnosis: as for the family.

Type species by present designation: *Marocarcinus pasinii* n. sp.

Etymology: from Morocco, from where the studied specimens were discovered, and from *Carcinus*, crab.

Description: as for the type species.

Marocarcinus pasinii n. sp.

Figs. 1-3

2007 – Bellidae [sic] n. gen., n. sp. *in* Garassino, De Angeli & Pasini; p. 45, Text-fig. 1 (E, F)

Diagnosis: as for the family.

Etymology: dedicated to Giovanni Pasini who has gathered the material from the new quarry.

Holotype by present designation: MSNM i26831 a-b (female, ventral view).

Paratypes: MSNM i26839 (male, ventral view), i26858 a-b (female, dorsal view), i26861 a-b (female, dorsal view).

Other material: i26834 a-b (indeterminate sex, ventral view), i26835 a-b (indeterminate sex, dorsal view), i26859 a-b (? male, ventral view), i26860 a-b (indeterminate sex, dorsal view).

Geological age: Upper Cretaceous (Cenomanian-Turonian).

Type locality: Gara Sbaa (Kem Kem).

Description: Medium-sized eubranchyuran crab, with smooth exoskeleton.

Carapace slightly wider than long, convex transversely. Fronto-orbital margin 0.4 of maximum width of carapace. Front bearing four rounded lobes, median lobes more protruding than lateral ones. Orbits small and rounded. Orbital margin continuous, strongly concave. Anterolateral margins bearing four teeth, one marked extraorbital tooth and three pointed teeth, close to each other, directed anteriorly. Posterior margin 1/3 of maximum width of carapace, weakly concave, with a thin marginal carina. Dorsal surface smooth, with weakly delimited regions. Frontal region marked by a longitudinal groove, delimiting two weak epigastric prominences. Anterior mesogastric process narrow. Protogastric regions slightly raised and well separated from hepatic regions. Cervical groove well marked only on margins. Cardiac region wide, well marked on margins by two branchiocardiac depressions. Branchial regions raised on outer margins.

Thoracic sternum ovoid, narrow, elongate in outline. All sternites 1 to 8 on the same plane, very narrow anteriorly, then widened to diminish progressively from sternites 5 to 8. Sternites 1 to 3 forming a narrow shield, intercalated between the bases of mxp3; sternites 1 and 2 fused, delimited posteriorly by the complete suture 2/3. Sternite 3 (on each side a lateral expansion on which mxp3 articulates) well delimited posteriorly by complete suture 3/4. Sternite 4 long, proximal portion constricted, distal portion (bearing large P1) widened, thus sternite 4 showing a strongly concave lateral margin; episternite 4 well developed, not limited by complete suture. Sternite 5 limited anteriorly by incomplete and approximately horizontal suture 4/5. Sternites 6 to 8 with a similar incurved shape and convex lateral border. Sternites 6 and 7 of similar size and shape, sternite 8 narrower, their arrangement in such a manner that completes the ovoid outline of the half posterior part of the sternum. Sutures 4/5 and 5/6 interrupted, separated by a relatively large space. Suture 6/7 complete. Suture 7/8 incomplete, both parts separated by large gap. Sternite 8 obliquely directed, narrower than the preceding ones, probably completely concealed by abdomen in males. Sutures 5/6 to 7/8 with about the same inclined course (but 6/7 complete). Median line extending along sternites 7 and 8.

Sternoabdominal cavity shallow, without a median depression. Male abdomen subtriangular. Female abdomen with broad segments, found not folded under

cephalothorax in two specimens (MSNM i26858, i26861). Large vulvae on somite 6, close to sutures 5/6. No trace of scars of abdominal locking structures in female.

Chelipeds strong, with very large chela even in the female (heterochely); probable heterodonty. Merus elongate, curved. Carpus suboval, swollen superficially, with a weak apical spine. Propodus longer than wide, strong, swollen. Fixed and mobile fingers elongate, largely gaping (at least on major cheliped), and tapering, with teeth on occlusal margin. P2-P5 elongate and strong, with elongate and tapering dactylus.

Remarks. The Marocarcinidae n. fam. is close to four genera presently attributed to the family Atelecyclidae Ortmann, 1893, viz. *Peltarion* Hombron & Jacquinot, 1846 (for the authorship and date, see Holthuis, 2002), *Pteropeltarion* Dell, 1972, *Trichopeltarion* A. Milne Edwards, 1880, and *Podocatactes* Ortmann, 1893. Indeed, these four genera must be removed from the Atelecyclidae Ortmann, 1893 and deserve their own family, still unnamed and called here for convenience «*Trichopeltarion* group» (Cleva & Tavares, in preparation).

The Marocarcinidae n. fam. differs from the «*Trichopeltarion* group» as well as from *Atelecyclus* (*Atelecyclidae* emend.) by the suture 7/8 which is interrupted. Another distinctive character of the Marocarcinidae is the complete sutures 2/3 and 3/4.

The Atelecyclidae emend. consists only of *Atelecyclus* Leach, 1814, as type and sole genus, presently known by only two extant species, *Atelecyclus rotundatus* (Olivier, 1792) and *Atelecyclus undecimdentatus* (Herbst, 1783). The Atelecyclidae emend. is here transferred to the Cancroidea Latreille, 1802. The Cancroidea, as generally envisioned, is polyphyletic and should be restricted to Cancridae Latreille, 1803, and Atelecyclidae Ortmann, 1893, emend., both with

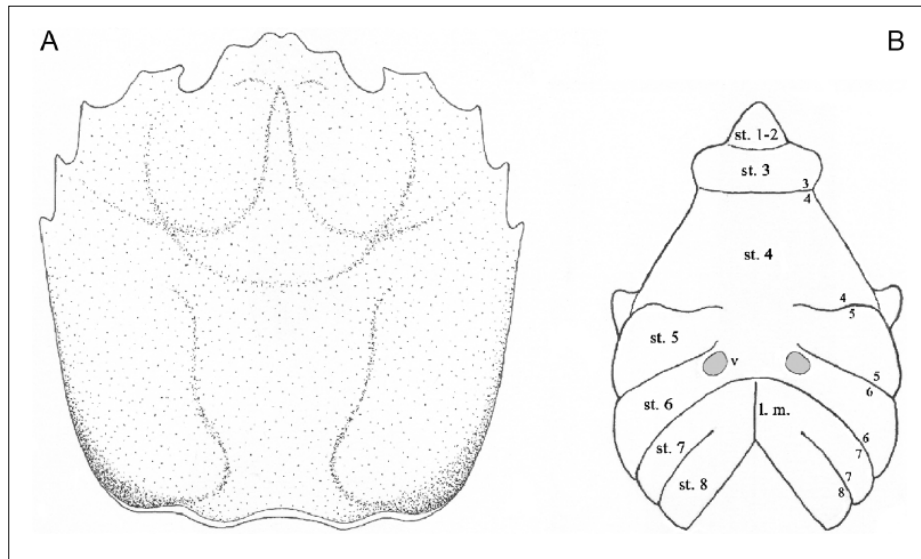


Fig. 1 – *Marocarcinus pasinii* n. gen., n. sp. A) carapace in dorsal view (carapace in norma dorsale); B) thoracic sternum (sterno toracico); st: sternite; v: vulva; l. m.: median line (linea mediana).

fossil and extant representatives. The closeness between the Cancridae and Atelecyclidae is supported by several features. Those based upon the ventral surface morphology are as follows: the thoracic sternum is regularly metamerized, never much widened (narrow in Atelecyclidae, versus more ovoid, in particular at level of segment 4, in Cancridae); an anterior sternal part (segments 1 to 3) is distinct (forming a narrow shield in Atelecyclidae, triangular in Cancridae); the lateral margins of sternites 4 to 8 with lateral margins are parallel (Atelecyclidae) or roughly parallel (Cancridae); only a narrow portion of sternite 7 is visible dorsally on each side of male abdomen, when folded; the suture 1/2 is absent; the sutures 4/5 to 7/8 are complete, approximately horizontal and equidistant; a median line extends from distal part of sternite 4 to sternite 8; the sternoabdominal cavity, longitudinally grooved, is without flat median part; male abdominal segments 1 and 2 are positioned dorsally. Atelecyclidae and Cancridae may be distinguished by some characters, including the chelipeds (subequal in Cancridae; homochely and homodonty in Atelecyclidae), the male abdominal segments 3 to 5 (fused in Atelecyclidae, sutures still partially visible in Cancridae), and the sternal suture 2/3 (marked laterally in Atelecyclidae, absent in Cancridae).

The Marocarcinidae n. fam. and the «*Trichopeltarion* group» [(see Guinot & Bouchard, 1998, fig. 14A: *Peltarion spinulosum* (White, 1840)], which are not cancroid families, share several characters, as follows: the thoracic sternum is relatively narrow and slightly widened at level of sternites 4 (half distal part only), 5 and 6, then narrower at level of sternite 7, the sternite 8 being the smallest; sternites 1 to 3 form a narrow shield, with the marks of the sutures more or less distinct (sometimes only a decalcified line) but never complete; the sternite 4 has strongly concave lateral margins; the sutures 4/5 and 5/6 are interrupted; the suture 6/7 is complete; the sternite 8 is narrower than preceding sternites and probably concealed by abdomen in both sexes; both P4 and P5 are close together and leave only a narrow space for first abdominal segments; a median line is present along sternites 7 and 8; a female sternoabdominal cavity has a flat median portion; the chelipeds show heterochely and probably heterodonty.

The Marocarcinidae n. fam. and the «*Trichopeltarion* group» are easily distinguished from the Atelecyclidae emend. (*Atelecyclus*) by characters, as follows: thoracic sternum ovoid and sternite 4 with concave lateral margins (sternum narrow and sternite 4 with straight margins in Atelecyclidae emend.); sutures 4/5 and 5/6 interrupted (complete in Atelecyclidae emend.); sternoabdominal cavity gently excavated, with a flat median portion, and median line present only along sternites 7 and 8 (with subvertical slopes, without flat median portion, and longitudinally grooved along sternites 4 to 8 in Atelecyclidae emend.); males strikingly heterochelous and heterodontous (homochelous and homodontous in Atelecyclidae emend.).

The Marocarcinidae n. fam., the «*Trichopeltarion* group» and the Atelecyclidae emend. (*Atelecyclus*) share a similar anterior shield of the thoracic sternum formed by segments 1 to 3, with fused somites 1 and 2. The suture 2/3 is complete in the Marocarcinidae, slightly or partially marked in the «*Trichopeltarion* group», and indistinct in the Atelecyclidae emend. The suture 3/4 is complete in the Marocarcinidae, well marked laterally, with a median interruption, in the Atelecyclidae emend., shortly marked laterally in the «*Trichopeltarion* group».

A distinctive character of Marocarcinidae n. fam. is the similarly inclined course of the sternal sutures 5/6 to 7/8. That is, to our knowledge, a character relatively rare in the Eubrachyura. Such a disposition is present for example in the Calappidae De Haan, 1833 [(see Guinot, 1979, pl. 14, fig. 2 for *Calappa granulata* (Linnaeus, 1758)]. It is difficult to ascertain if in *Marocarcinus* the distance between both P4 and P5 is weak (a narrow sternoabdominal cavity at this level) and if the sternite 8 is completely concealed by male abdomen, as in the «*Trichopeltarion* group» and in *Atelecychus*.

The pattern with incomplete sutures 4/5 and 5/6 followed by a complete suture 6/7 and by an incomplete suture 7/8 is rare in the Eubrachyura. Such a condition exists only in the extinct fossil Lithophylacidae Van Straelen, 1936, characterised by an extremely short suture 7/8 (see Guinot & Breton, 2006: 621, fig. 9B) and in the Goneplacinae MacLay, 1838, emend. (see Castro, in press). The genus *Goneplax* Leach, 1814, *sensu stricto*, viz. *Goneplax rhomboides* (Linnaeus, 1758) and the few allied species (see Guinot & Castro, 2007) shows, as *Marocarcinus*, a short suture 7/8. However, in *Goneplax* all sutures 4/5 to 7/8 are incomplete, 4/5, 5/6 and 7/8 being separated by a large gap, while the sutures 6/7 are separated by a small gap. Therefore the condition in Marocarcinidae n. fam. is quite unusual in the Brachyura.

Marocarcinus is characterised by marked heterochely and (probably) heterodonty in both sexes. Even the female of *M. pasinii* (Fig. 3 A, B) shows a very large major chela, with a dilated palm and widely gaping fingers, so that it resembles that of a male. The heterochely is a rule in all the genera of the «*Trichopeltarion* group», often resulting in an enormous major cheliped in the males. However, an occurrence of handedness in adult females (i.e. the growth of one of the chelipeds, generally at right, resulting in a strong asymmetry), is unusual in the Eubrachyura. A female heterochely is encountered in the family Belliidae Dana, 1852, for example in *Acanthocycclus* Lucas, 1844 (see Guinot, 1976: 34, pl. 1, figs. 8, 9). The existence of asymmetry in female chelipeds of these crabs eliminate a role in the reproductive behaviour and evokes an implication in the food predation or, simply, as an armament. The question of the origin of asymmetry (for discussion see McLaughlin, Lemaitre & Tudge, 2004: 180) in primitive crabs as the Belliidae, Atelecyclidae, and Marocarcinidae needs further investigation.

A complete ventral part is rarely known in Cretaceous eubrachyuran crabs. On the contrary it is well preserved in our material, with apparent vulvae on sternite 6. Also all pereopods are preserved.

The suite of diagnostic characters of the Moroccan crab makes it possible recognition of a new family. Marocarcinidae n. fam. is a typical eubrachyuran family, with all sternites 1 to 8 in the same plane; a dorsal location of first abdominal segments is probable. The primitive condition is shown by the elongate and ovoid thoracic sternum, only widened in its mid-part and narrowing posteriorly, the small anterior shield (sternites 1 to 3), the complete sutures 2/3 and 3/4, the similar oblique course of sutures 5/6 to 7/8, the shallow abdominal cavity.

An unnamed Albian crab from Montana preliminarily described by Feldmann *et al.* (2007: 28), with incomplete carapace but in which the preserved thoracic sternum is described with large orifices on somite 6 interpreted to be vulvae, represents also an eubrachyuran crab. It is, however, completely different

because the sternites 7 and 8 are «reduced in width and length» and «rotated dorsally» so that, according to these authors, the Albian crab is supposed to have reduced P4 and smaller, dorsal P5. That is not the case of *Marocarcinus pasinii*. In the unnamed Albian crab the «sternites 4 and 5 are fused axially and sutured laterally» (see Feldmann *et al.*, 2007: 28), that means a median interruption of sternal sutures 4/5 and 5/6 (inconsistent, however, with the indication – probably through inadvertence - of complete sutures 4/5 and 5/6). Anyway, we may suppose that sternites 4, 5 and 6 are roughly similar in the Albian crab and *Marocarcinus*, and that both have also similar complete 6/7 sutures. However, the two crabs markedly differ by the suture 7/8, which is complete in the Albian crab (see Feldmann *et al.*, 2007) and incomplete in *Marocarcinus* (Fig. 2 A, B). Moreover, the preliminary description of the Albian crab does not mention presence of a median line on last sternites, and adds another distinctive character, i.e. the reduced and subdorsal/dorsal P4 and P5, P5 being the smallest. We agree with the assertion of a primitive condition of the Albian crab with respect to the elongate, narrow triangular anterior sternum (sternites 1 to 3) and to the reduced and subdorsal/dorsal last pereopods (if the hypothesis that reduced and dorsal last pereopods really represent a plesiomorph condition), that limits the choice of the extant and fossil eubranchyuran families to which it may be assigned. The interruption of sutures 4/5 and 5/6 of the Albian crab indicates a more advanced state than that found in *Thia* Leach, 1815, *Nautilocorystes* H. Milne Edwards, 1837, *Kraussia* Dana, 1852, or *Corystes* Bosc, 1802, and *Gomezia* Gray, 1831 (see Guinot, 1979: figs. 20A, 20B, 22A, pl. 9, fig. 1; Guinot & Bouchard, 1998: figs. 12 A, B, D). The Jurassic *Hebertides* Guinot, De Angeli & Garassino, 2007 (see Guinot *et al.*, 2007a; 2007b), assigned to the Corystidae Samouelle, 1819, is supposed to have, as *Corystes* to which *Hebertides* is very close, a thoracic sternum regularly metamerised and crossed by complete sutures in most part. *Hebertides* is the most primitive crab presently known in the radiation of the Eubranchyura and represents a successful evolutionary event since the family Corystidae is always extant. It provides evidence that the Eubranchyura may have appeared much earlier than previously thought.

As the Corystidae, the Marocarcinidae n. fam. belongs to a primitive stock of heterotreme crabs, with «normal» P4 and P5, and a narrow thoracic sternum. In the Corystidae, however, the thoracic sternum is even narrower than in the Marocarcinidae n. fam. and the sutures 4/5 to 7/8 are complete, horizontal, and equidistant.

A small size characterizes the unique representative of the family presently known, *Marocarcinus pasinii*, in which the mature female, with developed vulvae and large chela, has only 16.4 mm carapace length.

Acknowledgements

We wish to thank A. A. Aaronson for the useful help and the report of the new fossiliferous locality during the field trip in 2006, H. Karasawa, Mizunami Fossil Museum, Japan, for careful review and criticism; M. Tavares, Museo de Zoologia, Universidade de São Paulo, Brazil, and R. Cleva, Département Milieux et Peuplements aquatiques, Muséum national d'Histoire naturelle, Paris, for fruitful discussions; D. Affer, Museo di Storia Naturale di Milano, for the careful preparation of the studied specimens.

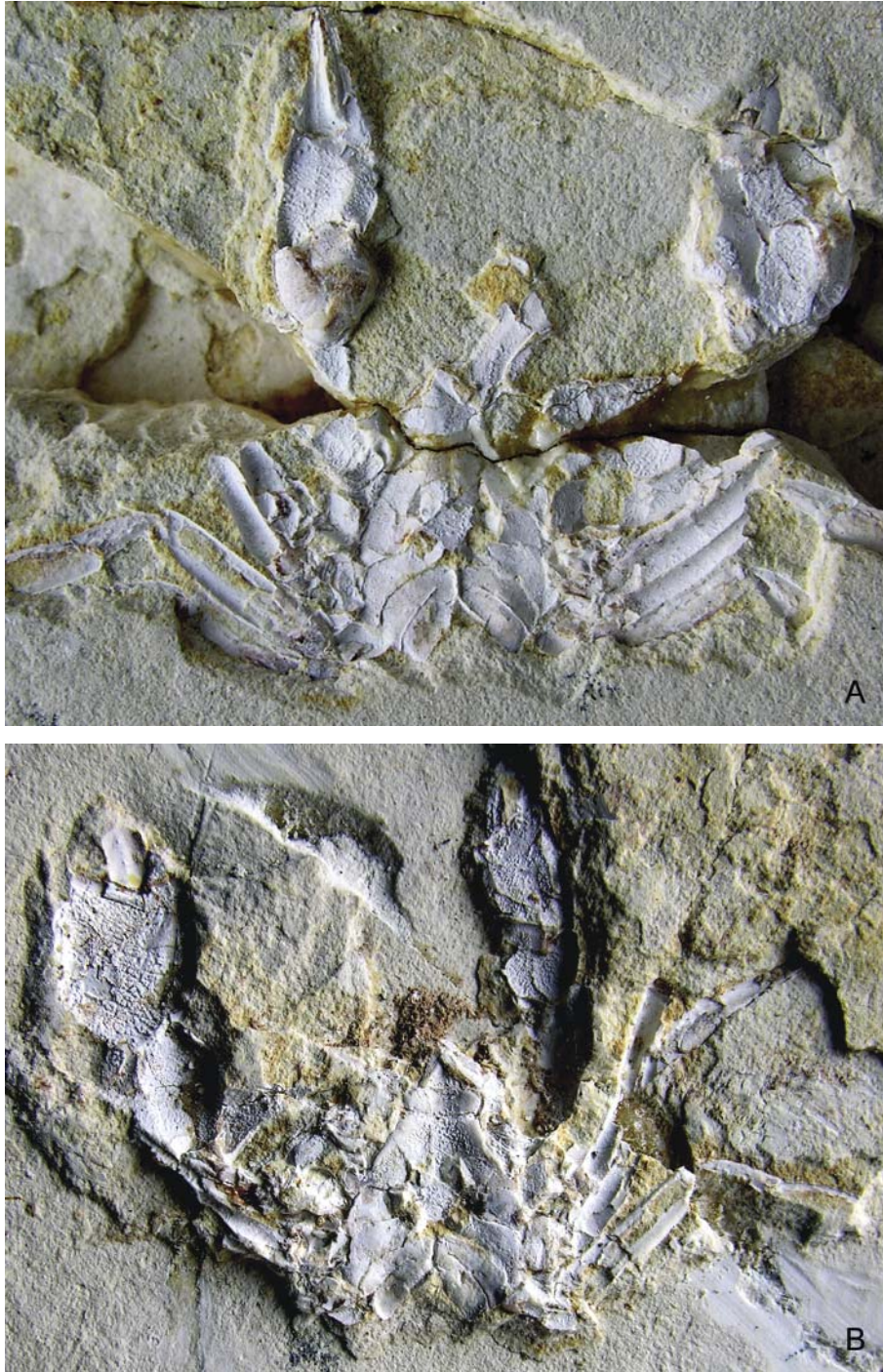


Fig. 2 – *Marocarcinus pasinii* n. gen., n. sp., holotype (olotipo), MSNM i26831. A) part (impronta) (x 4). B) counter-part (controimpronta) (x 4).

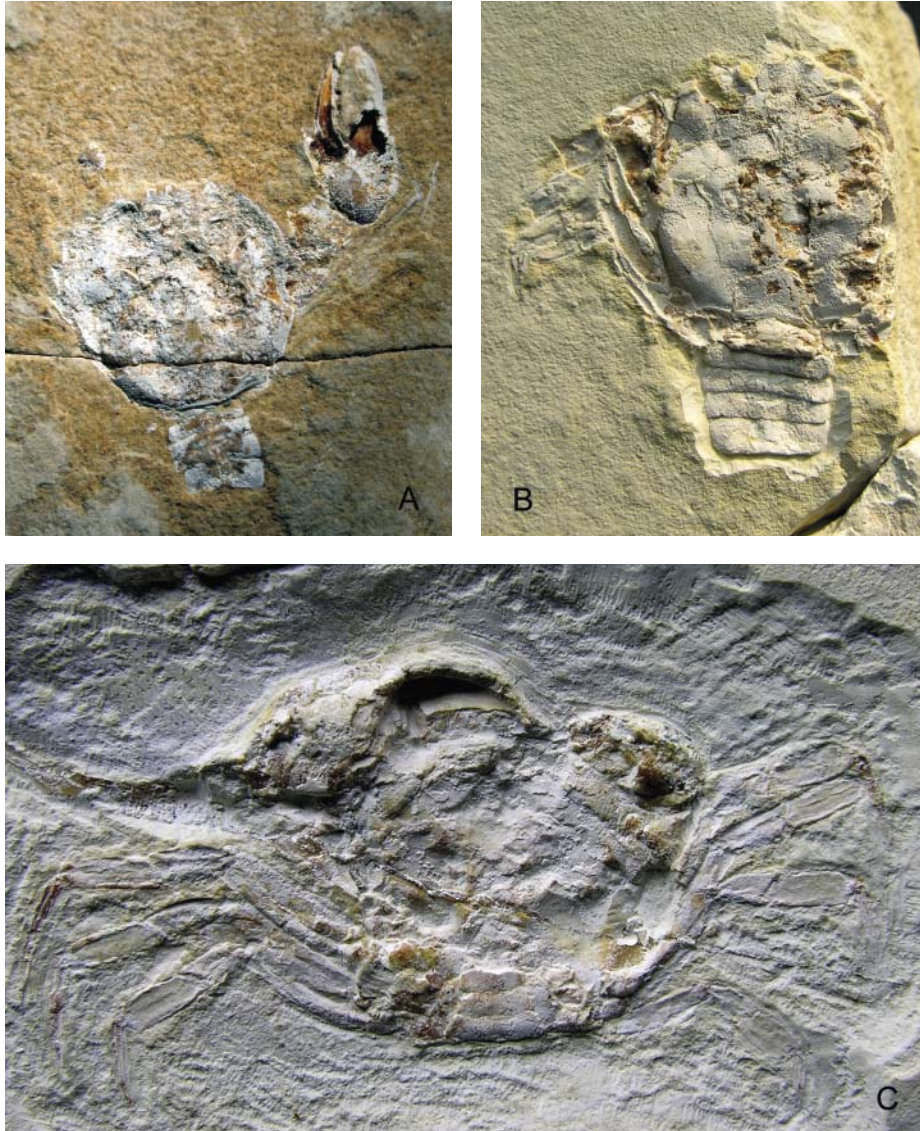


Fig. 3 – *Marocarcinus pasinii* n. gen., n. sp. A) MSNM i26858, female (femmina) (x 2.5). B) MSNM i26861, female (femmina) (x 2.5). C) MSNM i26839, male (maschio) (x 2.5).

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Ricevuto: 13 luglio 2007

Approvato: 14 agosto 2007