A new family of brachyuran (Crustacea: Decapoda: Goneplacoidea) from the Eocene of Java, Indonesia

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A new family, Martinocarcinidae, must accommodate the monotypic genus *Martinocarcinus* Böhm, 1922. The genus displays a unique combination of dorsal, sternal and abdominal characters justifying placement in a new family. The Martinocarcinidae joins several other now extinct Eocene families that flourished at that time, supporting the long-held view that the Eocene was a time of radiation within the Brachyura.

Contents

Introduction

The systematic status of *Martinocarcinus* Böhm, 1922, has been problematic since it was originally named. Böhm (1922) placed the genus within the family Cyclometopa, a now arcane term used for more derived crabs. Glaessner (1929) placed the genus within the Xanthidae MacLeay, 1838; he later referred it to "Brachyura of uncertain systematic position or status" (1969, p. R532). Van Straelen (1931, 1938) placed the genus within the Xanthidae in his summary of Cenozoic decapods from the Dutch East Indies and confirmed the Eocene age. Indeed, many features of the dorsal carapace and sternum are reminiscent of extinct crabs referred historically to the Xanthidae *sensu lato* or Xanthoidea *sensu lato*, such as *Lobonotus* A. Milne-Edwards, 1864, and *Xanthilites* Bell, 1858, *sensu lato*. Careful examination of the type and sole specimen, which is well preserved, indicates that *Martinocarcinus* cannot be accommodated in any currently defined family and, thus, is a member of a new family within the Goneplacoidea MacLeay, 1838, allied with the Vultocinidae Ng & Manuel-Santos, 2007.

Age of deposits

Böhm (1922) reported the specimen of *Martinocarcinus ickeae* as having been collected from Kali Poeroe (Kali Puru in more recent literature), near Jogjakarta and of late Eocene age, based upon the work of Martin in the same volume (pp. 535-538) and other works by Martin. Martin (1922, pp. 535-536) apparently based his Eocene age on foraminifera, including *Nummulites*, as well as the molluscan fauna of the area (Martin, 1916) and referred the Kali Poeroe locality near Jogjakarta to the 'Nanggoelan.' Oppenoorth & Gerth (1929) studied the larger foraminifera from the Nanggulan area, assigned it a late Eocene age and summarized the palaeontology then known from the region. Siregar & Pringgoprawiro (1981) studied the planktonic foraminifera from what had historically been regarded as the Nanggulan area and formally defined the Nanggulan Formation as Eocene-Oligocene. Fish otoliths from the Nanggulan Formation were referred to the Bartonian (middle Eocene) (Nolf & Bajpai, 1992). Vermeij (2001) revised several groups of gastropods, including some from the same locality from which *Martinocarcinus* (Kali Puru, Nanggulan Beds) was collected. He referred the rocks to the Lutetian (middle Eocene). Thus, it seems best to bracket the age of *Martinocarcinus* as middle - late Eocene, as the various micro- and macrofossils have yielded that range of ages for the unit.

Other decapod faunas of Indonesia and surrounding areas

De Man (1902-1904) provided early descriptions of Neogene crabs from Celebes. Böhm (1922) described several species of Decapoda from the Eocene and Miocene of Java. Van Straelen (1923) added new species from the Eocene and Oligocene of Borneo, and described a new portunid from probably Miocene rocks of what is now Sulawesi, located east of Borneo (1924). He reported (1927) subfossils from Merauke, Indonesia, and summarized fossil occurrences from the region (1931). Later, Van Straelen (1938) described Eocene through Pliocene species from what he called the Dutch East Indies, including Java, the island of Madura (north of Java), Sumatra, the island of Soemba (south of Java), and the island of Warakat (apparently near Papua New Guinea). Beets (1950) added new descriptions of several taxa from the Neogene of Madura and Java, and Remy (1952) described sub-fossil occurrences of extant taxa from New Caledonia. Most recently, Morris & Collins (1991) and Collins *et al*. (2003) described large faunas from the Neogene of Sabah, Sarawak and Brunei. David & Nyborg (2007) additionally noted a fauna from the Pliocene of Java. A bit further afield, the fossil decapods from Taiwan were summarized by Hu & Tao (1996) and the sub-recent occurrences in Guam were summarized by Schweitzer *et al.* (2002). All of the occurrences in India, Pakistan and Bangladesh were summarized by Schweitzer *et al.* (2004). Thus, the fossil decapod crustaceans from the area are well-known and have been relatively recently summarized.

Systematic palaeontology

Remarks — Abbreviations include KSU D, Kent State University Decapod collection; RGM, Rijksmuseum van Geologie en Mineralogie, now part of the Nationaal Natuurhistorisch Museum, Naturalis, Leiden, The Netherlands; USNM, United States National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A.

Order Decapoda Latreille, 1802
Infraorder Brachyura Latreille, 1802
Section Heterotremata Guinot, 1977
Superfamily Goneplacoidea MacLeay, 1838
Family Martinocarcinidae fam. nov.

Type and sole genus — *Martinocarcinus* Böhm, 1922.

Diagnosis — Carapace wider than long; orbits shallow, with two intra-orbital spines and two notches; one suborbital spine; anterolateral and posterolateral margins confluent, anterolateral portion with five spines excluding outer-orbital spine of varying sizes ornamented with spinelets, posterolateral portion with at least three spines ornamented with spinelets, weak constriction between anterolateral and posterolateral portions; first anterolateral spine set at same level as orbits so that anterior margin of carapace is broad; carapace regions well marked by broad grooves and tumid, granular central areas; male sternum broadly ovate, granular; sternites 1 and 2 fused; sternite 3 clearly separated from sternite 4 by deep groove and with deep axial groove; sternite 4 directed weakly anterolaterally, with swelling parallel to anterior margins that may be fused episternal projections of sternite 3, with concave, ungranulated area adjacent to swellings; sternite 5 directed laterally; sternite 6 directed weakly posterolaterally; sternite 7 directed posterolaterally; sternite 8 unknown; male abdomen with somites 4, 5 and 6 apparently unfused; basal articles of antennae and eyestalks well calcified; tips of fingers of cheliped black.

Discussion — The sole specimen of the sole genus and species referred to the Martinocarcinidae was compared to a broad array of families. The presence of anterolateral and posterolateral spinelets suggested comparison with the members of the Cancroidea Latreille, 1802. However, the sternum of *Martinocarcinus* is much broader than in any family within the Cancroidea (Pl. 1, fig. 2). In addition, the orbits of the Atelecyclidae Ortmann, 1893, and Cheiragonidae Ortmann, 1893, are composed of numerous spinelets, a feature not seen in *Martinocarcinus*. Thus, the Cancroidea was excluded. The spinose posterolateral margin suggested comparison with members of the Calappoidea H. Milne Edwards, 1837, but again, the sterna of the contained families are extremely narrow (Pl. 1, fig. 1). Other spinose groups such as the Majoidea Samouelle, 1819, and Parthenopoidea MacLeay, 1838 (Pl. 1, fig. 3), simply cannot accommodate crabs with sterna and dorsal carapaces of the nature of *Martinocarcinus*. Members of the Palicidae Bouvier, 1898, and the Plagusiidae Dana, 1851 (Pl. 1, fig. 6), have similar overall carapace shapes to *Martinocarcinus*, at least superficially, but details of the regions and sterna exclude *Martinocarcinus* from these families. The specimen bears a superficial similarity to the extinct retroplumid *Archaeopus* Rathbun, 1908, but that genus is characterized by a very narrow front, very broad orbits and marked ridges on the sternum which *Martinocarcinus* lacks. This also excludes it from the Retroplumidae Gill, 1894, as a family. Members of the Belliidae Dana, 1852, possess narrow sterna and generally longer than wide carapaces, excluding *Martinocarcinus*.

The families with genera to which *Martinocarcinus* is most similar are the Tumidocarcinidae Schweitzer, 2005, recently rediscussed by Schweitzer *et al*. (2007), and the

Vultocinidae Ng & Manuel-Santos, 2007. Members of both the Tumidocarcinidae and the Vultocinidae are characterized by several features which are seen in *Martinocarcinus*, which include an apparently quadrilobed front; rimmed orbits that may have two fissures or notches; anterolateral spines; well-defined regions of the dorsal carapace; a sternum with deep grooves between sternites 3 and 4, and axially on sternite 3; and a male abdomen with apparently all free somites (Pl. 1, fig. 5). However, *Martinocarcinus* differs from members of the Tumidocarcinidae in possessing two infra-orbital spines; in having the orbits and first anterolateral spine at the same level as the front instead of positioned markedly posterior to the front; presence of posterolateral spines (Pl. 2, fig. 4); presence of spinelets ornamenting the anterolateral spines; and sternites 4 through 6 that are subparallel instead of oriented at rather high angles to one another. These are rather major differences and would greatly expand the definition of the Tumidocarcinidae.

Ng & Manuel-Santos (2007) erected the monotypic Vultocinidae, placed within the Goneplacoidea MacLeay, 1838, for a new Indo-Pacific genus. Comparison of the sole species of *Martinocarcinus* to the sole species within the Vultocinidae, *Vultocinus anfractus* Ng & Manuel-Santos, 2007, indicates that whereas they display some similarities to one another, they are not referable to the same family. *Martinocarcinus* and *Vultocinus* have remarkably similar abdomina and sterna as mentioned above. They also appear to be similar in having intra-orbital spines and notches and a suborbital spine. However, the similarities end there. They are quite different from one another in the conformation of the dorsal carapace regions and chelipeds. The chelae of *Vultocinus* are flattened and delicate, and the movable finger appears to be deeply cleft and short (Ng & Manuel-Santos, 2007, fig. 3D). The fingers of *Martinocarcinus* are robust and long, and the movable finger does not exhibit such a cleft. The orbits of *Martinocarcinus* are wider and less ornamented than those of *Vultocinus*, and the anterolateral margins of *Martinocarcinus* are better ornamented. The abdominal and sternal similarities suggest that they are related to one another at the superfamily level; however, with only one species from each genus known, this hypothesis is difficult to test. Thus, we elect to erect a new family for *Martinocarcinus*, for now placing it within the same superfamily as *Vultocinus*.

Whereas the naming of a new family for only a single genus and species may seem precipitous, *Martinocarcinus* cannot be accommodated by any existing groups. The presence of a unique combination of characters in an Eocene taxon is not surprising. The Eocene was a time of radiation within the Brachyura. Some now extinct families were at their peak, such as the Zanthopsidae Vía, 1959, Orithopsidae Schweitzer *et al*., 2003, and Tumidocarcinidae Schweitzer, 2005. Dozens of now extinct genera flourished in the Eocene oceans. Similar to the Jurassic and Cretaceous times, when even more extinct families within the Brachyura roamed the oceans (Schweitzer & Feldmann, 2008; Feldmann *et al*., 2008), the Eocene was a time of 'experimentation' of body plans with the Brachyura, resulting in an array of then-successful, but now extinct lineages.

Genus *Martinocarcinus* Böhm, 1922

Type species — *Martinocarcinus ickeae* Böhm, 1922, by monotypy.

Diagnosis — As for the family.

Martinocarcinus ickeae **Böhm, 1922**

Pl. 1, fig. 4; Pl. 2.

Material examined — Holotype, RGM 11762, deposited in the Department of Geology, Nationaal Natuurhistorisch Museum, Leiden, The Netherlands.

Occurrence — The specimen is labelled as Eocene, collected from Kali Poeroe, Jogjakarta, sometimes spelled Djokjakarta or Yogyakarta, from the Nanggulan Formation, Java (Böhm, 1922). Examination of more recent literature suggests that the specimen should be regarded as middle or late Eocene, as discussed above.

Diagnosis — As for the family.

Description — Carapace ovate, wider than long, length about 75% maximum carapace width, widest about half the distance posteriorly on carapace; carapace moderately vaulted transversely and longitudinally; regions well-defined by wide grooves and inflated, granular, central areas.

Front broken, about 24% maximum carapace width; axially notched; appearing to have had granular projections; with weak projection at inner orbital angle and perhaps just distal to axial notch. Orbits shallow, directed forward, broadly rimmed; upper orbital margin granular, with intraorbital spine just distal to inner orbital angle, second intraorbital spine bounded on either side by short notches just proximal to outer orbital angle; outer orbital angle produced into narrow triangular spine; suborbital margin with bifid spine at inner orbital angle, remainder of suborbital margin granular; frontoorbital width about 47% maximum carapace width.

Anterolateral and posterolateral margins confluent; anterolateral portion with at least five larger spines excluding outer orbital spine and several smaller granules; posterolateral portion with one larger projection followed posteriorly by increasingly smaller spinelets and granules; posterior margin with granular rim.

Epigastric regions tabular, trapezoidal, widest anteriorly. Protogastric regions broad anteriorly, narrowing posteriorly, with longitudinal, granule-free depression posterior to position of epigastric regions. Mesogastric region with long anterior projection, inflated and ornamented with granules posteriorly. Urogastric region separated from mesogastric region by muscle scars and two deep pits, anterior margin weakly concave, posterior margin markedly concave and constricted axially. Metagastric region depressed below level of cardiac and urogastric regions, defined laterally by deep branchiocardiac groove. Cardiac region long, with two large spherical swellings anteriorly, two arcuate projections extending laterally and posteriorly from anterior end, parallel to lateral margin of region; cardiac region extending posteriorly, terminating in smaller spherical swelling. Intestinal region poorly defined and depressed below level of cardiac region.

Hepatic region triangular, with oblique sharp ridge subparallel to anterolateral margin. Epibranchial region separated into two parts; one portion extending anteromedially from last anterolateral spine, with sharp ridge parallel to long axis; second portion triangular, directed at cardiac region. Mesobranchial region broadly inflated, with sharp spine centrally. Metabranchial region depressed below level of other branchial regions, with small spine near posterior corner.

Male sternum broadly ovate, ornamented with bead-like granules; sternites 1 and 2 fused, separated from sternite 3 by complete suture; sternite 3 short, with deep, broad axial groove, fused with, but separated from, sternite 4 by deep notches at lateral margins and deep groove along remainder of articulation; sternite 4 long, with inflated areas parallel to coxae of pereiopod 1 that may be fused episternites of sternite 3, triangular depressed area adjacent to inflation without granules, sternite 4 directed weakly anterolaterally; sternite 5 directed laterally, with very weak transverse keel; sternite 6 directed posterolaterally, with very weak transverse keel; sternite 7 about as long as wide, directed posterolaterally. Sternite 8 unknown.

Male abdomen narrow, with weakly concave lateral margins. Somites 4, 5 and 6 free; somite 6 longer than wide; telson triangular; sterno-abdominal cavity reaching to anterior of sternite 4. Other somites unknown.

Basal article of eyes and antennae strongly calcified.

Major cheliped short; fingers with black tips.

Measurements — Measurements taken on the holotype of *Martinocarcinus ickeae* are as follows: maximum carapace width, 42.4 mm; maximum carapace length, 32.9 mm; fronto-orbital width, 19.8 mm; frontal width, 10.1 mm; and length to position of maximum width, 15.1 mm. Maximum width measurement is approximate due to lateral crushing and expansion of various areas of the dorsal carapace.

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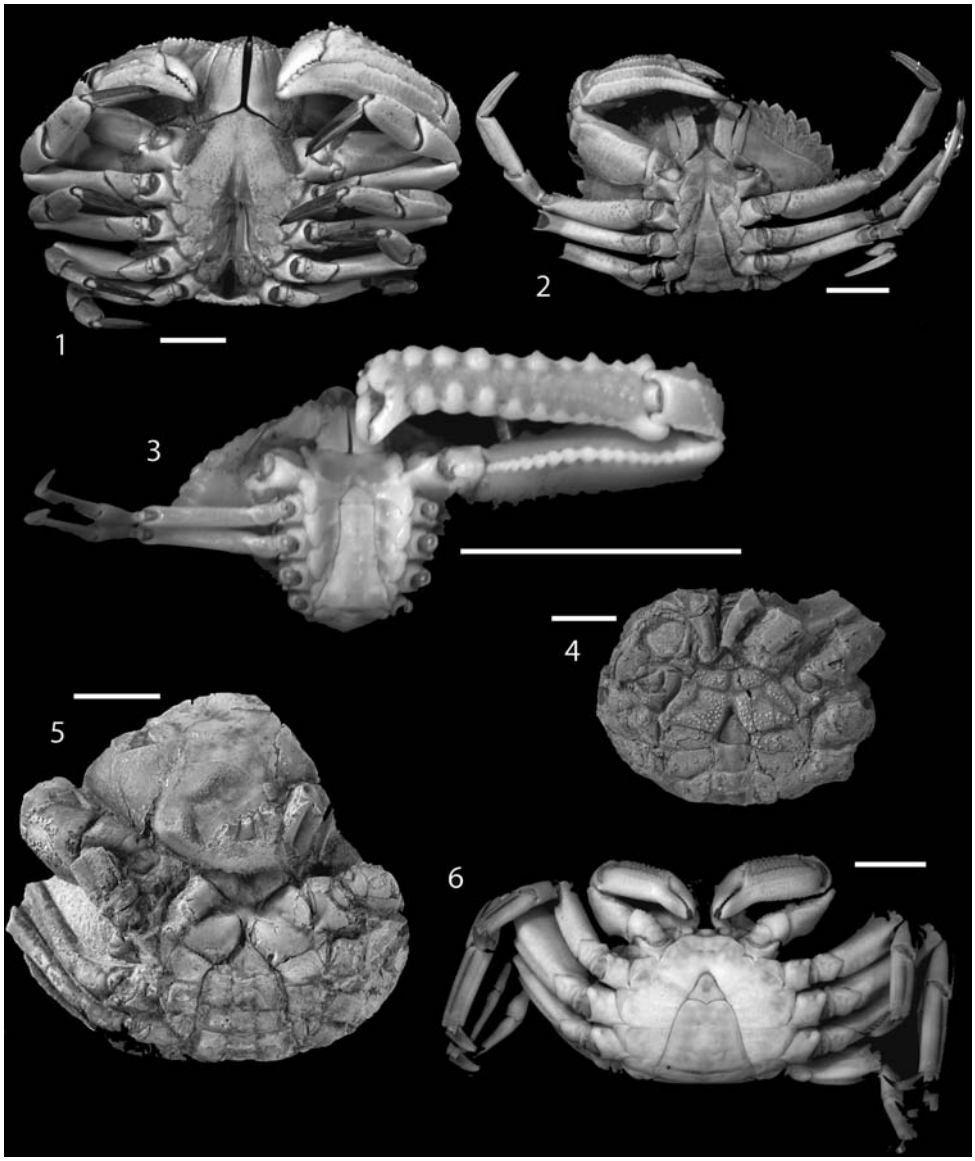

Plate 1
Sterna representative of various families and superfamilies to which *Martinocarcinus* was compared.

Fig. 1. Ventral view of *Hepatus epheliticus* (Linnaeus, 1758), KSU D760.
Fig. 2. Ventral view of *Romaleon gibbosulus* (de Haan, 1835), KSU D317.
Fig. 3. Ventral view of *Mesorhoea* sp., KSU D867.
Fig. 4. Ventral view of *Martinocarcinus ickeae* Böhm, 1992, RGM 11762, holotype.
Fig. 5. Ventral view of *Pulalius dunhamorum* Schweitzer *et al*., 2000, USNM 508357.
Fig. 6. Ventral view of *Plagusia dentipes* (de Haan, 1835), KSU D342.

Fossil specimens (Figs. 4, 5) coated with ammonium chloride for photography. Scale bars represent 10 mm.

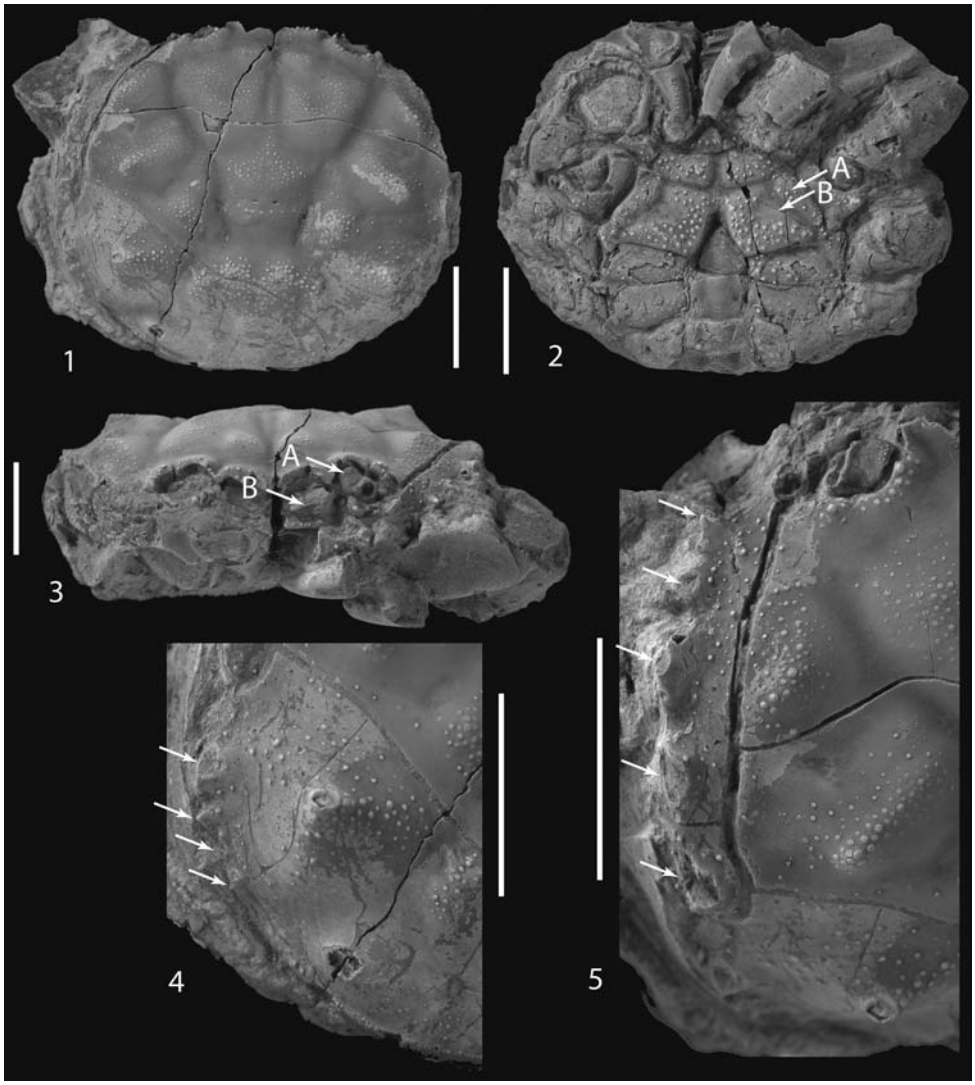

Plate 2
Martinocarcinus ickeae Böhm, 1922, RGM 11762, holotype.

Fig. 1. Dorsal carapace.
Fig. 2. Ventral surface showing male abdominal somites 4, 5, 6 and telson. Arrow A indicates swelling parallel to lateral margin of sternite 4; arrow B indicates flattened area adjacent to swelling.
Fig. 3. Anterior view showing bases of antenna (arrow B) and eyestalk (arrow A).
Fig. 4. Oblique close-up of portion of posterolateral margin showing posterolateral spines and swellings (arrows).
Fig. 5. Oblique close-up of portion of anterolateral margin showing broken bases of anterolateral spines (arrows).

Specimen coated with ammonium chloride for photography. Scale bars represent 10 mm.