Decapod crustaceans from the late Pliocene (Piacenzian) nearby Faenza (Emilia-Romagna, N Italy)

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Abstract – Several specimens of anomuran and brachyuran decapods are reported from the late Pliocene clays (Argille Azzurre Fm.) at localities nearby Faenza (Ravenna, Emilia-Romagna), located in the foothills of Romagna Apennines (NE Italy). The specimens were assigned to species already reported from the Pliocene of Italy, but never previously recorded in this area. This new report enlarges our knowledge on the composition and distribution of the brachyuran decapods along the Pliocene coastline of the Adriatic Gulf of the paleo-Mediterranean Sea.

Key words: Decapoda, Brachyura, Anomura, Pliocene, Faenza, Emilia-Romagna, Italy.

Riassunto – Crostacei decapodi del Pliocene superiore (Piacenziano) nei pressi di Faenza (Emilia- Romagna, N Italia).

Vengono descritti alcuni esemplari di crostacei brachiuri e anomuri provenienti dalle argille piacenziane (Formazione Argille Azzurre) di alcune località del margine pedeappenninico della Romagna centrale (Emilia-Romagna, NE Italia) in prossimità di Faenza (Ravenna, Emilia-Romagna). Gli esemplari sono stati assegnati a specie già note nel Pliocene italiano, ma mai segnalate precedentemente in quest'area. Questa segnalazione arricchisce le conoscenze sulla composizione e distribuzione dei decapodi brachiuri durante il Pliocene lungo le coste del golfo Adriatico del paleo-Mediterraneo.

Parole chiave: Decapoda, Brachyura, Anomura, Pliocene, Faenza, Emilia-Romagna, Italia.

INTRODUCTION AND GEOLOGICAL SETTING

The central Romagna sub-Apennine is characterized by the Argille Azzurre Formation (FAA), a largely uniform clayey unit deposited in a fully and rather deep marine basin from early Pliocene to early Pleistocene having a total thickness exceeding 3000 meters (Vai, 1989). Inside the FAA some informal heteropic members have been distinguished. Among them, in the foothills between the Marzeno and the Montone valleys crop out shallow-water limestones named "Spungone" (carbonate platforms and grain flow deposits, up to few hundreds of meters thick) of Piacenzian age (Cremonini *et al.*, 1982). The FAA deposits nearby Faenza (Ravenna, Emilia-Romagna) have been the subject of many palaeontological studies (Scarabelli, 1854; Sacco, 1937; Ruggieri, 1962; Tabanelli, 1993, among others). These authors did not report the presence of crustaceans from these fossiliferous layers, possibly due to the scarcity or to poor preservation of the specimens. The studied samples were collected from different late Pliocene FAA localities nearby Faenza: Pietramora-Ca' Castello, Pietramora-Ca' Tombarella, Podere Tombarona, Rio Albonello and Ca' Raggio. Among these fossiliferous sites, stratigraphically the older is Pietramora-Ca' Castello, a upper "Spungone" outcrop with an age of about 3.3 – 3.05 Ma (Capozzi & Picotti, 2003). The other localities overlain these deposits and thus are generically assigned to late Piacenzian and considered slightly younger (Tabanelli & Segurini, 1994). Rio Albonello locality was the subject of some bio-chronostratigraphic and micropalaeontological investigations. Indeed the fossiliferous layers, including the decapod fauna, are characterized by the presence of *Globorotalia aemiliana,* allowing us to assign these levels to an age of about 3.0 Ma (Cimatti, 1980).

Podere Tombarona (Brisighella, Ravenna) was investigated in the 1980's by one of the authors (S.M.). Here the decapod fauna is associated with some irregular echinoids (*Schizaster*) and mollusks (*Korobkovia oblonga*, *Anadara diluvii*, *Limopsis aurita*, *Cancilla scrobiculata*, *Conus antediluvianus*, *Aporrhais serresianus*, *Ringicula ventricosa*, *Heliacus moniliferus*, *Nassarius striatulus*, *Vexillum cupressinum*, *Ziba ligustica*, *Comitas dimidiata*, *Gemmula rotata*, *Charonia apenninica*, *Mitrella nassoides*, *Melanella spina*, *Sveltia lyrata*, and *Dentalium sexangulum*), representing the so called "palaeocommunity with *Korobkovia oblonga* and *Jupiteria concava*" (Ceregato *et al.*, 2007), indicative of a circalittoral-epibathyal environment (Tabanelli pers. comm., 2017).

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MATERIAL

The studied specimens were assigned to brachyuran species already reported from the Italian Pliocene, as follows: *Lyreidus* cf. *L. paronae* Crema, 1895 (Lyreididae Guinot, 1993) (3 specimens), *Retropluma craverii* (Crema, 1895) (Retroplumidae Gill, 1894) (4 specimens), *Monodaeus bortolottii* Delle Cave, 1988 (Xanthidae MacLeay, 1838) (13 specimens), *Goneplax rhomboides* (Linnaeus, 1758) (7 specimens) and *Albaidaplax* cf. *A. ispalensis* Garassino, Pasini & Castro, 2013 (1 specimen), (Goneplacidae MacLeay, 1838). Moreover one specimen was assigned to *Dardanus* sp. (Diogenidae Ortmann, 1892).

The studied specimens are housed in the Museo Civico di Scienze Naturali di Faenza (MSF).

For the higher-level classification, we follow the recent arrangement proposed by Ng *et al.* (2008), De Grave *et al.* (2009), and Karasawa *et al.* (2014).

Abbreviations – lcxp: carapace length; ld; dactylus length; li: index length; lp: palm length; wcxp: carapace width; wp: palm width.

SYSTEMATIC PALAEONTOLOGY

Infraorder Anomura Mac Leay, 1838
Superfamily Paguroidea Latreille, 1802
Family Diogenidae Ortmann, 1892
Genus *Dardanus* Paul'son, 1875

Type species: *Dardanus hellerii* Paul'son, 1875
Fossil species: see Schweitzer *et al.* (2010)

Dardanus sp.
(Fig. 1A, B)

Material and measurements: one complete right chela palm from Pietramora-Ca' Castello (MSF 2251 – lp: 21 mm; wp: 16 mm; ld: 15 mm; li: 16 mm).

Description. Subrectangular palm, longer than wide; upper margin convex, lower margin nearly straight; outer surface covered with granulated transverse and sinuous ridges; inner surface slightly convex with the same ornamentation of the outer surface on the median upper part, nearly smooth along the lower inner surface; subtriangular, robust dactylus and index with transverse ridges; index slightly longer than dactylus.

Discussion. The studied specimen shows an outer surface of the palm ornated by transverse and sinuous ridges that are a typical distinctive character of some representatives of *Dardanus* Paul'son, 1875, which the specimen is assigned to.

The studied specimen was compared with the two Plio-Pleistocene Mediterranean species of the genus, *Dardanus substriatus* (A. Milne Edwards, 1861) (fossil) and *D. arrosor* (Herbst, 1796) (extant and fossil), sharing some morphological affinities. The studied specimen, however, differs from the right palm *D. arrosor* in having less elongate palm, less coarse and more transverse ridges on the outer surface of the palm and more elongate index

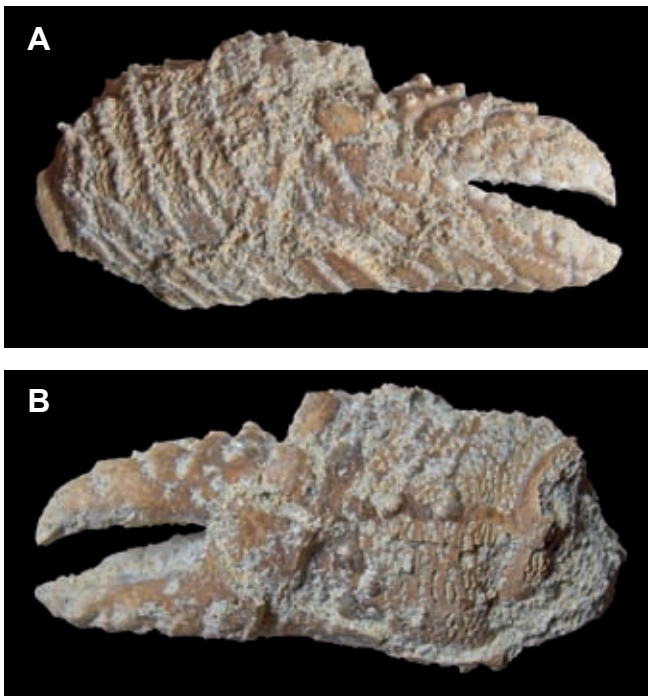

Fig. 1 - *Dardanus* sp., MSF 2251. A) right palm, outer view. B) right palm, inner view (x 2).

(for comparison see Garassino *et al.* 2014: 121; fig. 1B). Moreover, the studied specimen differs from the left palm of *D. substriatus* (the right palm is unknown), in having more subrectangular elongated palm with lower and upper margins not strongly converging anteriorly and less coarse granulated transverse, sinuous ridges (for comparison see Garassino *et al.,* 2014: 121; fig. 1C). We point out that the characters observed on the studied specimen could be also included into the variability of this species having most probably unequal chelae as all representatives of the family. Based on the limited comparisons only the discovery of additional specimens would allow us to solve the systematic position of the studied specimen.

Infraorder Brachyura Linnaeus, 1758
Section Raninoida Ahyong, Sharkey, Colgan & Ng, 2007
Superfamily Raninoidea De Haan, 1839
Family Lyreididae Guinot, 1993
Subfamily Lyreidinae Guinot, 1993
Genus *Lyreidus* De Haan, 1841

Type species: *Lyreidus tridentatus* De Haan, 1841, by monotypy.

Fossil species: see Karasawa *et al.* (2014).

Lyreidus cf. *L. paronae* Crema, 1895
(Fig. 2A)

Note: Though Crema (1895) assigned the species *paronae* to *Lyreidus*, later Garassino *et al.* (2004), De Angeli *et al.* (2009), Baldanza *et al.* (2013), and Pasini *et al.* (2014) changed the systematic position of this species,

assigning it to *Lysirude*. However, according to Karasawa *et al.* (2014) all reports of the species from Italy must be assigned to *Lyreidus* until the systematic controversy is solved.

Material and measurements: Two specimens in dorsal view, preserving chelipeds and incomplete ambulatory legs from Podere Tombarona (MSF 2202 – lcxp: 15 mm; wcxp: 10 mm; – MSF 2203 – lcxp: 24 mm; wcxp: 15 mm); one complete specimen preserving chelipeds and incomplete ambulatory legs, in part and counterpart from Rio Albonello (MSF 2240 – lcxp: 25 mm; wcxp: 16 mm).

Description. Carapace – See De Angeli *et al.* (2009). Cheliped – Flat ovoid palm higher anteriorly, convex smooth upper margin and nearly straight lower margin; pointed index deflected downward and directed-upward distally; slender dacylus gently curved downward, with small, short, pointed teeth on occlusal margin; subrectangular carpus, with a rim of small teeth along the upper margin; rectangular merus, notably elongate, long twice the carpus.

Discussion. Though poor preserved, the studied specimens have the narrow orbito-frontal margin, with one strong extraorbital spine on both margins of rostrum and the possible presence of one spine on both anterolateral margins. These characters allow us to compare the specimens to *Lyreidus paronae* Crema, 1895, already reported from the Tortonian (Miocene) of Sciolze and from the Langhian (Miocene) of S. Margherita (Torino, Piedmont) (Crema, 1895), the Pliocene of Orta San Giulio (Novara, Piedmont) (Garassino *et al.*, 2004), the early Pleistocene of Poggio I Sodi and Poggi Gialli (Sinalunga, Tuscany) (De Angeli *et al.*, 2009; Baldanza *et al.*, 2013, 2017) and Volterra (Pisa, Tuscany) (Pasini *et al.*, 2014).

Remarks. The studied specimens seem to have an unusual granulation-ornamentation on the dorsal carapace and appendages. Unfortunately the poor preservation and compression of the carapace do not allow us to understand if this apparent granulation is part of the exocuticle or if it is only the structure of the endocuticle. Moreover the deformation of the anterolateral margins does not allow us to verify the presence of one or two lateral spines. Due to the absence of these diagnostic characters we prudentially compare the studied specimens to *Lyreidus paronae.* In other way the specimens could also pertain to a new indeterminate taxa.

Section Eubrachyura de Saint Laurent, 1980
Superfamily Retroplumoidea Gill, 1894
Family Retroplumidae Gill, 1894
Genus *Retropluma* Gill, 1894

Type species: *Archaeoplax notopus* Alcock & Anderson, 1894, by monotypy.

Fossil species: see Schweitzer *et al.* (2010).

Retropluma craverii (Crema, 1895)
(Fig. 2B)

Goneplax? *craverii* Crema, 1895: 675, fig. 16.
Goneplax craverii – Glaessner 1929: 198. — Schweitzer *et al.* 2010: 135.

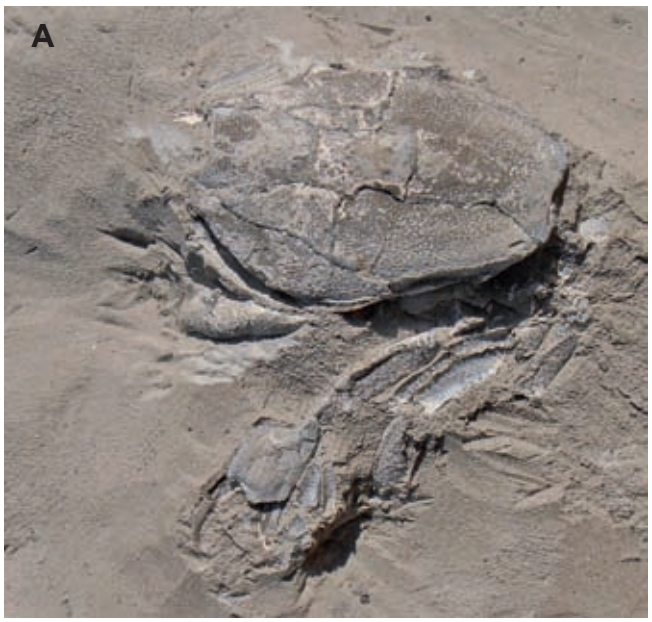

Fig. 2 - A) *Lyreidus* cf. *L. paronae* Crema, 1895, MSF 2240 (x 2). B) *Retropluma craverii* (Crema, 1895), MSF 2233 (x 2.6).

Retropluma craverii – Vía Boada 1969: 324, 326. — Vía Boada 1980: 2, 3, fig. 1. — Vía Boada 1982: 116, fig. 1. — Beschin *et al.* 1996: 95. — Larghi 2003: 58, 59. — Garassino & De Angeli 2004: 45. — Garassino *et al.* 2004: 255. — De Angeli & Garassino 2006: 52. — Schweitzer *et al.* 2010: 100. — De Angeli *et al.* 2011: 38-41, figs. 2-4. — Baldanza *et al.* 2013: 344, 345, fig. 10. — Pasini *et al.* 2014: 253, 254, fig. 8D. — Baldanza *et al.* 2017: 58, 59, Fig. 15A.

Material and measurements: Three specimens in dorsal view (MSF 2208 – lcxp: 10 mm; wcxp: 14 mm; MSF 2211 – lcxp: 10 mm; wcxp: 15 mm; MSF 2216 – lcxp: 11 mm; wcxp: 15 mm), one specimen in part and counterpart (MSF 2233a, b – lcxp: 12 mm; wcxp: 14 mm) from Podere Tombarona.

Discussion. De Angeli *et al.* (2011) revised *Retropluma craverii* based upon two specimens from the Pliocene of Reggio Emilia (Emilia-Romagna), pointing out some morphological characters not observable in the original description, such as the very elongate and narrow rostrum, the wide orbito-frontal margin distinctly sinuous, ending with a well-developed forward directed tooth, the dorsal surface of carapace, with three transverse ridges, and the very elongated, flattened legs. These characters are visible on the studied specimens that are assigned to *R. craverii*. This species was originally described by Crema (1895) from the late Pliocene (Piacenzian) of Bra (Piedmont). Garassino, Hyžný & Pasini *in* Baldanza *et al.* (2013) reported this species from the early Pleistocene (late Gelasian-early Calabrian) of Poggio i Sodi (Siena, Tuscany) and later Pasini *et al.* (2014) reported this species also from the early Pleistocene bathyal environment of Volterra (Pisa, Tuscany). Finally, De Angeli, Garassino & Pasini *in* Baldanza *et al.* (2017) reported this species also from the early Pleistocene of Poggi Gialli (Sinalunga, Tuscany). This is the second report of *R. craverii* from the Romagna Apennines.

Superfamily Xanthoidea MacLeay, 1838
Family Xanthidae MacLeay, 1838
Subfamily Euxanthinae Alcock, 1898
Genus *Monodaeus* Guinot, 1967

Type species: *Xanto couchii* Couch, 1815, by original designation.

Fossil species: *Monodaeus bortolottii* Delle Cave, 1988.

Monodaeus bortolottii Delle Cave, 1988
(Fig. 3A)

Monodaeus bortolottii Delle Cave, 1988: 123-126, Pl. 1, figs. 1, 2, Pl. 2, figs. 1-5.
Monodaeus bortolottii – De Angeli & Garassino 2006: 74. — De Angeli *et al.* 2009: 185, 195, fig. 16. — Schweitzer *et al.* 2010: 126. — Garassino *et al.* 2012: 52. — Baldanza *et al.* 2013: 347, 348, fig. 13. — Pasini & Garassino 2013a: 325, 326, fig. 5. — Pasini & Garassino 2013b: 344, 345, fig. 2. — Pasini *et al.* 2014: 254, 255, fig. 9B. — Baldanza *et al.* 2017: 60, 61, fig. 15C.

Material and measurements: One specimen from Cà Raggio (MSF 2251 – lcxp: 11 mm; wcxp: 13 mm); twelve specimens from Podere Tombarona (MSF 2209 – lcxp: 7 mm; wcxp: 10 mm; MSF 2213 – lcxp: 15 mm; wcxp: 21 mm; MSF 2214 – lcxp: 14 mm; wcxp: 14 mm; MSF 2217 – lcxp: 15 mm; wcxp: 23 mm; MSF 2221 – lcxp: 18 mm; wcxp: 22 mm; MSF 2222 – lcxp: 11 mm; wcxp: 14 mm; MSF 2225 – lcxp: 13 mm; wcxp: 16 mm; MSF 2229 – lcxp: 6 mm; wcxp: 8 mm; MSF 2229bis – lcxp: 6 mm; wcxp: 8 mm; MSF 2234 – lcxp: 16 mm; wcxp: 22 mm; MSF 2235bis – lcxp: 13 mm; wcxp: 17 mm; MSF 2235 – lcxp: 14 mm; wcxp: 18 mm).

Discussion. The studied specimens are assigned to *Monodaeus bortolottii* in having suboctagonal carapace slightly convex, wider than long; straight front margin, with a weak median incision; short convex anterolateral margin; long convergent posterolateral margin; posterior margin straight medially and convex on margins with a granular ridge; dorsal region well marked by grooves, with wide raised epigastric lobes; suboval protogastric regions well marked; subpentagonal mesogastric regions with narrow elongate anterior process between protogastric regions; cardiac region well marked by branchiocardiac grooves; small hepatic regions poorly marked; and wide well-marked branchial regions.

Monodaeus bortolottii was previously reported from the Pliocene of Volterra (Delle Cave, 1988) and Grosseto (De Angeli *et al.*, 2009). Later Pasini & Garassino (2013a, b) and Garassino, Hyžný & Pasini *in* Baldanza *et al.* (2013) reported this species from the Pliocene (Piacenzian) of Castellarano and Monticelli di Quattro Castella (Reggio Emilia, Emilia-Romagna), from the early Pliocene of Cassine (Alessandria, Piedmont), and from the early Pleistocene of the Poggio i Sodi (Siena, Tuscany). Later Pasini *et al.* (2014) reported *M. bortolottii* from the early Pleistocene of Volterra (Pisa, Tuscany), close to the type locality originally reported by Delle Cave (1988). Recently De Angeli, Garassino & Pasini *in* Baldanza *et al.* (2017) reported this species also from the early Pleistocene of Poggi Gialli (Sinalunga, Tuscany).

Superfamily Goneplacoidea MacLeay, 1838
Family Goneplacidae MacLeay, 1838
Subfamily Goneplacinae MacLeay, 1838
Genus *Goneplax* Leach, 1814

Type species: *Ocypoda bispinosa* Lamarck, 1801, by original designation.

Fossil species: see Garassino *et al.* (2013).

Goneplax rhomboides (Linnaeus, 1758)
(Fig. 3B)

Goneplax rhomboides – Pasini *et al.* 2014: 252, fig. 8B. — Baldanza *et al.* 2017: 62, fig. 16A, B.

Note: See Garassino *et al.* (2013) for complete synonymy.

Material and measurements: One specimen from Cà Raggio (MSF 2250 – lcxp: 7 mm; wcxp: 9 mm); one specimen from Pietramora-Ca' Tombarella (MSF 2242 – lcxp: 16 mm; wcxp: 20 mm – male); five specimens from Podere Tombarona (MSF 2205a, b – lcxp: 9 mm; wcxp: 12 mm; MSF 2212 – lcxp: 15 mm; wcxp: 20 mm; MSF 2227 – lcxp: 11 mm; wcxp: 14 mm; MSF 2231a, b – lcxp: 7 mm; wcxp: 9 mm; MSF 2232 – lcxp: 7 mm; wcxp: 9 mm).

Discussion. According to Garassino *et al.* (2013), *Goneplax rhomboides* has a subrectangular carapace with two transverse ridges; well-developed orbits; developed extraorbital spine; dorsal regions not marked; elongated chelipeds. The dorsal characters of the studied specimens, including individuals of different sexes and stages of growth, fit well with the variability of this species. *Goneplax rhomboides* is reported to date only in the fossil record of Italy from the Miocene to Pleistocene of Piedmont, Emilia-Romagna, Tuscany, Lazio, and Sicily, as reported by many authors (for complete references see Garassino *et al.*, 2013; Baldanza *et al.*, 2017). The species seems to be the most common, wide-spread brachyuran decapod along the Italian Plio-Pleistocene paleo-Mediterranean coast, whereas the extant representatives are widespread in the eastern Atlantic, western Africa, and Mediterranean Sea, burrowing in sublittoral shallow muddy and sandy bottoms from a few to about 100 m deep (Falciai & Minervini, 1992; Zariquey Álvarez, 1968).

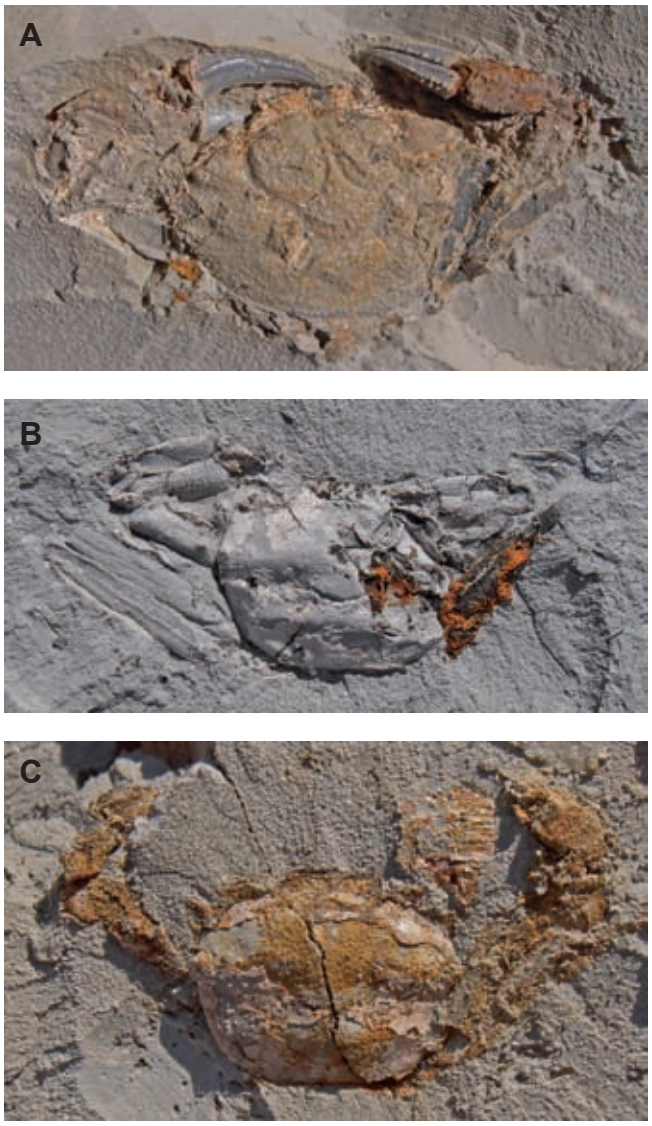

Fig. 3 - A) *Monodaeus bortolottii* Delle Cave, 1988, MSF 2234 (x 2.6). B) *Goneplax rhomboides* (Linnaeus, 1758), MSF 2250 (x 3.4). C) *Albaidaplax* cf. *A. ispalensis* Garassino, Pasini & Castro, 2013, MSF 2226 (x 3.2).

Genus *Albaidaplax* Garassino, Pasini & Castro, 2013

Type species: *Albaidaplax ispalensis* Garassino, Pasini & Castro, 2013, by monotypy.

Fossil species: *Albaidaplax ispalensis* Garassino, Pasini & Castro, 2013.

Albaidaplax cfr. *A. ispalensis* Garassino, Pasini & Castro, 2013
(Fig. 3C)

Material and measurements: one specimen in dorsal view in part and counterpart from Podere Tombarona (MSF 2226a, b – lcxp: 9 mm; wcxp: 12 mm).

Description. Carapace transversely rectangular, slightly wider than long; straight front; front as wide as the orbits; inner edge of supraorbital margin distinct; wide orbits expanded distally, with one short tooth on outer orbital angle; supraorbital margins gently sinuous, without fissures; anterolateral margins slightly convex, apparently toothless; long gently rounded posterolateral margins, strongly convergent posteriorly; long, straight posterior margin; deep gastric pits; smooth dorsal surface of carapace; slight subhorizontal ridge, moderately convex, at level of anteroposterolateral margins, without clear indication of regions; stout heavy chelipeds (P1), with moderately long merus; subtriangular spineless carpus; stout globular palm; dactylus and index slender, as long as the propodus, with smooth occlusal margin.

Discussion. Despite the poor preservation of the exocuticle, partially covered by carbonate deposits, the main morphological characters of the studied specimen, such as the shape of the carapace, the wide orbits gently expanded distally, with one short tooth on outer orbital angle, and the gently sinuous supraorbital margins, are shared with the representatives of *Albaidaplax*, recently erected by Garassino *et al.* (2013), with *A. ispalensis* Garassino, Pasini & Castro, 2013, from the Pliocene of Spain and Italy. Due to its poor preservation the specimen is here prudentially only compared with the type species. This would be the first report for the genus from the Emilia-Romagna.

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