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New report of the coral-associated decapods from the early Messinian (Late Miocene) of Acquabona, Rosignano Marittimo (Toscana, Italy)

Abstract - We report a coral-associated decapods from the early Messinian (Late Miocene) of Acquabona, Rosignano Marittimo, Livorno (Toscana, Italy). This study allowed to identify these species, as follows: *Galathea* cfr. *G. squamifera* Leach, 1814 (Galatheidae Samouelle, 1819), *Pisidia kokayi* (Müller, 1974) (Porcellanidae Haworth, 1825), *Pilumnus* cfr. *P. mediterraneus* (Lörenthey, 1897) (Pilumnidae Samouelle, 1819), *Actaea calzadai* Müller, 1984, *Xantho moldavicus* (Yanakevich, 1977), *Haydnella* cfr. *H. steiningeri* Müller, 1984, and *Liomera bagaglioii* n. sp. (Xanthidae MacLeay, 1838). The studied fauna has some affinities with the Miocene faunas of Mediterranean area, especially with the fauna from the Neogene of Catalonia (Spain). It is the first report of coral-associated decapods from the Miocene of Italy.

Key words: Crustacea, Decapoda, Late Miocene, Italy.

Riassunto - Nuova segnalazione di crostacei decapodi di ambiente corallino del Messiniano (Miocene superiore) di Acquabona, Rosignano Marittimo (Toscana, Italia).

Viene segnalata una fauna a crostacei decapodi di ambiente corallino del Messiniano inferiore (Miocene superiore) di Acquabona, Rosignano Marittimo, Livorno (Toscana, Italia). Questo studio ha permesso d'identificare le seguenti specie: *Galathea* cfr. *G. squamifera* Leach, 1814 (Galatheidae Samouelle, 1819), *Pisidia kokayi* (Müller, 1974) (Porcellanidae Haworth, 1825), *Pilumnus* cfr. *P. mediterraneus* (Lörenthey, 1897) (Pilumnidae Samouelle, 1819), *Actaea calzadai* Müller, 1984, *Xantho moldavicus* (Yanakevich, 1977), *Haydnella* cfr. *H. steiningeri* Müller, 1984, and *Liomera bagaglioii* n. sp. (Xanthidae MacLeay, 1838). La fauna mostra affinità con le faune mioceniche dell'area mediterranea ed in particolare con la fauna del Neogene della Catalonia (Spagna). Si tratta della prima segnalazione di una fauna a crostacei di ambiente corallino nel Miocene italiano.

Parola chiave: Crustacea, Decapoda, Miocene superiore, Italia.

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Introduction and geological setting

The studied specimens were collected in the '70 years of the last century from a limestone quarry, today disused, located near Acquabona, in the eastern part of the Monti Livornesi, at N of the Rosignano Marittimo, Livorno (Toscana, Central Italy). Here the Calcari dell'Acquabona unity, assigned to the early Messinian (Late Miocene), crop out (Fravega *et al.*, 1994). The unity pertains to the Cenozoic (Miocene) bio-construction of the Calcare di Rosignano Formation, originated by the pull down and next recrystallization of small scattered coralline communities (patch-reef) having a small extension (under 2 km) in a circumlittoral environment with shallow and oxygenated waters (Fravega *et al.*, 1994). The reef community includes also bivalves, gastropods and red algae. Beside the strong diagenetic process, the studied specimens are preserved three dimensionally, generally slightly compressed, someone preserve the original outer cuticle and ornamentation. All specimens are ascribed to the early Messinian (Late Miocene) (Fravega *et al.*, 1994).

Material

The studied sample includes forty decapod crustaceans, housed in the Palaeontological Collections of the Gruppo Paleontologico "C. De Giuli" (GPDG) (Biblioteca Comunale Vallesiana, Castelfiorentino, Firenze). The specimens are three-dimensionally preserved within a biocalcarenitic rock from the early Messinian (Late Miocene) of Calcari dell'Acquabona unity, Acquabona, Rosignano Marittimo, Livorno (Toscana, Italy).

The infraorder Anomura H. Milne Edwards, 1832, includes *Galathea* cfr. *G. squamifera* Leach, 1814 (3 specimens), *Pisidia kokayi* (Müller, 1974) (5 specimens). The infraorder Brachyura Linnaeus, 1758, includes *Pilumnus* cfr. *P. mediterraneus*

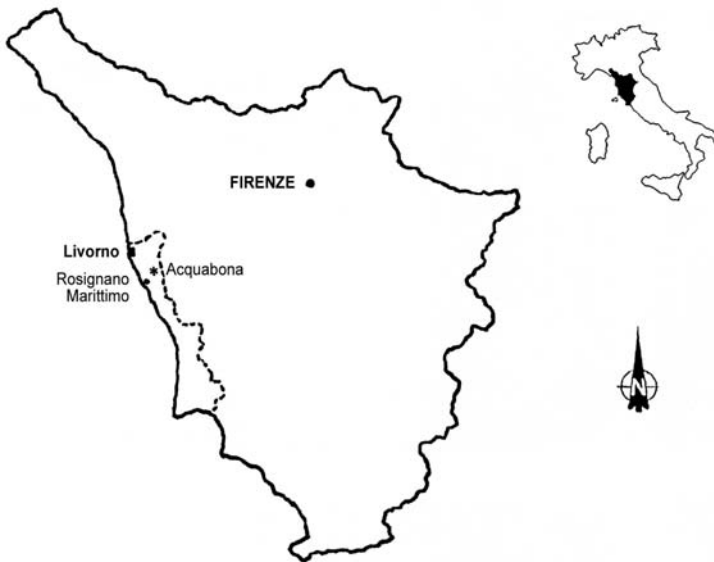


Fig. 1 - Toscana region with Acquabona fossiliferous locality (*). / Regione Toscana con la località fossilifera di Acquabona (*).

(Lörenthey, 1897) (1 specimen) (Pilumnidae Samouelle, 1819), *Actaea calzadai* Müller, 1984 (8 specimens), *Xantho moldavicus* (Yanakevich, 1977) (2 specimens), *Haydnella* cfr. *H. steiningeri* Müller, 1984 (2 specimens), *Liomera bagaglioii* n. sp. (12 specimens), and indeterminate pereopods (7 specimens) (Xanthidae MacLay, 1838).

For higher-level classification, we follow De Grave *et al.* (2009) and Schweitzer *et al.* (2010).

Systematic Palaeontology

Order Decapoda Latreille, 1802
 Infraorder Anomura MacLay, 1838
 Superfamily Galattheoidea Samouelle, 1819
 Family Galatheididae Samouelle, 1819
 Genus *Galathea* Fabricius, 1793

Type species: *Cancer strigosus* Linnaeus, 1793, by original designation

Included fossil species: *G. affinis* Ristori, 1886; *G. antiqua* Risso, 1815, *G. berica* De Angeli & Garassino, 2002; *G. dispersa* Bate, 1859 (fossil and extant); *G. keijii* Karasawa, 1993; *G. lupiae* Robineau-Desvoidy, 1849; *G. sahariana* Garassino, De Angeli & Pasini, 2008; *G. spitzbergica* Gripp, 1927; *G. squamifera* Leach, 1815 (fossil and extant); *G. strigifera* Fischer-Benzon, 1866; *G. valmaranensis* De Angeli & Garassino, 2002; *G. weinfurteri* Bachmayer, 1950

Galathea cfr. *G. squamifera* Leach, 1814
 Fig. 2

Geological age: early Messinian (Late Miocene).

Material and measurements: three specimens (GPDG 0104, 0118, 0128).

GPDG 0104 – carapace length (excluding rostrum): 3.8 mm; carapace width: 3.7 mm

GPDG 0128 – carapace length (excluding rostrum): 3.9 mm; carapace width: 3.8 mm

GPDG 0118 – not measurable.

Description. Subrectangular carapace, with spines on lateral margins, transverse ridges on dorsal surface, and regions marked by cervical and branchiocardiac grooves. Subtriangular rostrum, gently elongate, with short spines on margins diverging anteriorly. Dorsal surface of rostrum with some tubercles. Postfrontal ridge with small spines.

Discussion. Müller (1984b) and Georgiades-Dikeoulia & Müller (1984) reported *Galathea* cfr. *G. squamifera* from the Messinian (Late Miocene) of Iraklion (Greece). Later, Müller (1993) described some specimens of *Galathea* cfr. *G. squamifera* from the Langhian (Middle Miocene) of Olérdola (Spain). The studied specimens show strong affinities with the specimens of Olérdola, described by Müller (1993) in the size of the carapace, in the shape and length of rostrum, and in the disposition of the transverse ridges of the carapace.

Galathea is widespread in the Atlantic and Mediterranean areas with ten extant species, living rock bottoms with corals or hydrozoans or living on *Posidonia* grassland, at a depth from few metres to 750 metres (Falciai & Minervini, 1992). The Italian fossil species are, as follows: *Galathea berica* De Angeli & Garassino, 2002

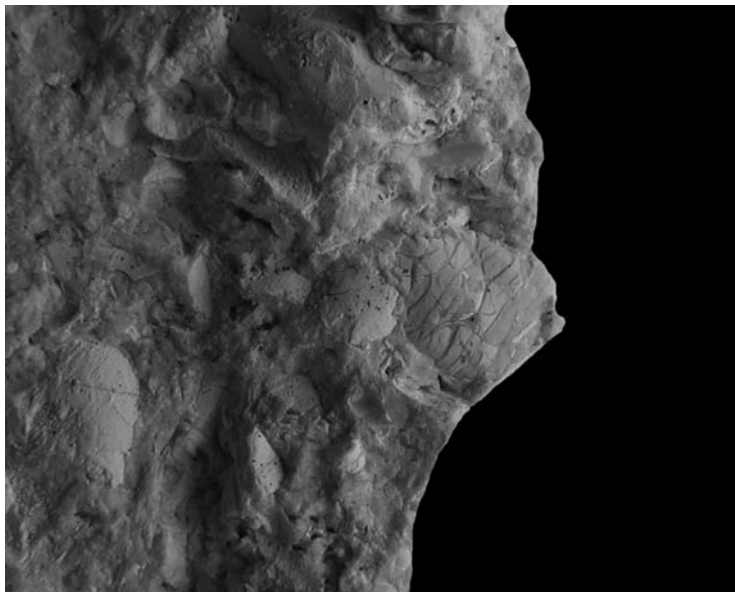


Fig. 2 - *Galathea* cfr. *G. squamifera* Leach, 1814, GPDG 0104, dorsal view/visione dorsale (x 4).

[Late Eocene (Priabonian), Vicenza]; *G. valmaranensis* De Angeli & Garassino, 2002, and *G. cfr. G. weinfurteri* Bachmayer, 1950 (Early Oligocene, Vicenza); *G. affinis* Ristori, 1886 [Late Pliocene (Piacenzian), Sicilia and Sardegna]. *Galathea* sp. reported by Fabiani (1910, 1915) has been assigned to *G. valmaranensis* De Angeli & Garassino, 2002.

Galathea sp. reported by Beschin *et al.* (2000, Pl. 1, fig. 4) has been instead assigned to *Lessinigalathea regale* De Angeli & Garassino, 2002 (De Angeli & Garassino, 2002).

Family Porcellanidae Haworth, 1825
Genus *Pisidia* Leach, 1820

Type species: *Cancer longicornis* Linnaeus, 1767, by original designation

Included fossil species: *P. dorsosinuosa* De Angeli & Garassino, 2002; *P. kokayi* (Müller, 1974); *P. viai* Müller, 1984

Pisidia kokayi (Müller, 1974)
Fig. 3 A, B

1974 – *Porcellana (Pisidia) kokayi* Müller; p. 121, Pl. 1 (figs. 1-2, non figs. 3, 4)

1979 – *Porcellana kokayi* Müller in Müller; p. 274

1984a – *Pisidia kokayi* Müller in Müller; p. 61, Pl. 27 (figs. 1-5)

1996 – *Pisidia kokayi* Müller in Müller; p. 9, Pl. 1 (fig. 6)

2010 – *Pisidia kokayi* Müller in Schweitzer *et al.*; p. 51



Fig. 3 - *Pisidia kokayi* (Müller, 1974), A) GPDG 0105, dorsal view/visione dorsale (x 2.4); B) GPDG 0106, dorsal view/visione dorsale (x 2.7).

Geological age: early Messinian (late Miocene).

Material and measurements: five specimens (GPDG 0105, 0106, 0107, 0119, 0120).

GPDG 0105 – carapace length: 6.8 mm; carapace width: 6.4 mm

GPDG 0106 – carapace length: 6.3 mm; carapace width: 5.9 mm

GPDG 0107 – carapace length: 3.3 mm; carapace width: 3.5 mm

GPDG 0119 – carapace length: 5.5 mm; carapace width: 5.2 mm

GPDG 0120 – carapace length: 4.5 mm; carapace width: 4.3 mm

Discussion. The studied specimens show some characters, typical of *Pisidia kokayi* Müller (1974). The carapace is rounded, square, and convex dorsally in both sides, and is ornamented with short ridges or tubercles; the front is trilobate, not very prominent.

Pisidia kokayi has been described from the late Badenian (Middle Miocene) of Budapest (Hungary) (Müller, 1974). This species is also known from the late Badenian of Poland (Müller, 1996).

Other fossil species reported in the Mediterranean area are, as follows: *Pisidia dorsosinuosa* De Angeli & Garassino, 2002 [Priabonian (Late Eocene), Monti Berici, Vicenza, NE Italy], *P. viai* Müller, 1984 [Langhian (Middle Miocene), Olérdola, Catalonia, Spain; Messinian (Late Miocene), Santa Pola, Spain].

Infraorder Brachyura Linnaeus, 1758
 Section Eubrachyura de Saint Laurent, 1980
 Family Pilumnidae Samouelle, 1819
 Genus *Pilumnus* Leach, 1816

Type species: *Cancer hirtellus* Linnaeus, 1761, by original designation

Including fossil species: *P. cucaoensis* Feldmann, Schweitzer & Encinas, 2005; *P. fookimensis* Collins, Lee & Noad, 2003; *P. hirtellus* (Linnaeus, 1761) (fossil and extant); *P. hirtellus* var. *villosa* Risso, 1826; *P. mediterraneus* (Lörenthey, 1898);

P. olivellai Müller, 1993; *P. subequus* Rathbun, 1919; *P. sayi* Rathbun, 1898 (fossil and extant); *P. aff. P. pannosus* Rathbun, 1898 (fossil and extant); *P. scaber* Gat & De Angeli, 2010; *P. aff. P. spinosissimus* Rathbun, 1898 (fossil and extant); *P. villosissimus* (Rafinesque, 1814) (fossil and extant)

Pilumnus cfr. *P. mediterraneus* (Lörenthey, 1897)

Fig. 4

Geological age: early Messinian (Late Miocene).

Material and measurements: one specimen partially decorticated (GPDG 0108).

GPDG 0108 – carapace length: 12.8 mm; carapace width: 15.8 mm

Description. Elliptic carapace, wider than long, longitudinally convex. Orbito-frontal margin poorly preserved. Bilobate front, marked by a median incision. Short, convex anterolateral margin, with three strong spines. Posterolateral margin gently longer than anterolateral one and slightly convex. Wide posterior margin, slightly convex, and superficially carinate. Dorsal surface mostly preserved as inner mould. Regions slightly distinct, except for meso- and metagastric ones marked by weak grooves; a pair of tubercles present on margins of these regions. Narrow, subrectangular cardiac region, with apex turned posteriorly and three small granulate ridges.

Discussion. The presence of smooth regions slightly marked by grooves and three strong spines on anterolateral margins allow comparing the studied specimen with *Pilumnus mediterraneus* (Lörenthey, 1897) from the Badenian of Hungary, Austria, and Poland (Müller, 1984a, 1996, 1998). The carapace of *Pilumnus mediterraneus* is similar to that of *P. olivellai* Müller, 1993, from the Langhian (Middle Miocene) of Olérdola (Spain) showing wider posterior regions, and the shorter, more oblique postfrontal ridge (Müller, 1993). *Pilumnus scaber* Gat & De Angeli, 2010, from the Messinian (Late Miocene) of Malta has instead dorsal surface with small spiny tubercles (Gat & De Angeli, 2010).

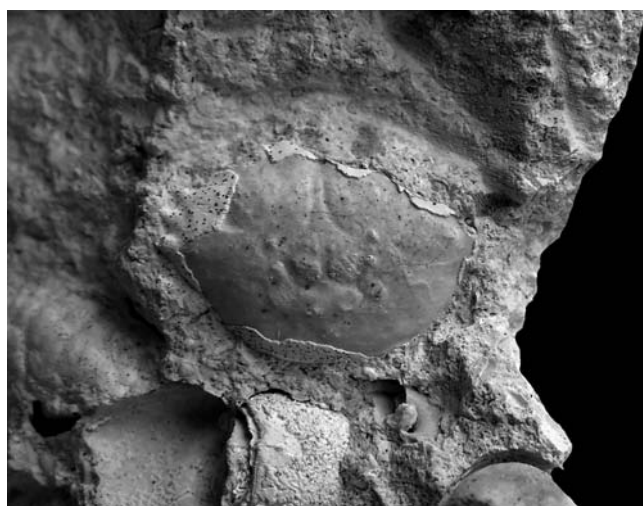


Fig. 4 - *Pilumnus* cfr. *P. mediterraneus* (Lörenthey, 1897), GPDG 0108, dorsal view/ visione dorsale (x 1.6).

Superfamily Xanthoidea MacLeay, 1838
 Family Xanthidae MacLeay, 1838
 Genus *Actaea* De Haan, 1833

Type species: *Cancer granulatus* Audouin, 1826, subsequent designation by Rathbun, 1922.

Included fossil species: *A.?* *acantha* (H. Milne Edwards, 1834) (fossil and extant); *A.?* *bifrons* Rathbun, 1898 (fossil and extant); *A. calzadai* Müller, 1984; *A. cretacea* Rathbun, 1935; *A. persica* A. Milne Edwards, 1865; *A. polyacantha* (Heller, 1861) (fossil and extant); *A. pura* Stimpson, 1859 (fossil and extant); *A. semblatae* Guinot, 1976 (fossil and extant); *A. tropicana* Hu & Tao, 1996; *A. turcocampestris* Müller, 1984

Actaea calzadai Müller, 1984
 Fig. 5 A, B

1984b – *Actaea calzadai* Müller; p. 29, Pl. 1 (figs. 1, 2)

2010 – *Actaea calzadai* Müller in Schweitzer *et al.*; p. 124

Geological age: early Messinian (Late Miocene).

Material and measurements: eight specimens: five with incomplete carapace (GPDG 0109, 0111, 0121, 0122, 0123) and three with complete carapace (GPDG 0110, 0124, 0125).

GPDG 0110 – carapace length: 7.5 mm; carapace width: 10 mm

GPDG 0124 – carapace width: 12.6 mm

GPDG 0125 – carapace width: 11 mm

Discussion. The studied specimens belong to *Actaea calzadai* Müller, 1984, reported from the Messinian (Late Miocene) of Santa Pola (Spain) (Müller, 1984b). The carapace is indeed elliptic-shaped and slightly convex, with well distinct, raised dorsal regions. The thick, homogenous ornamentation is present on epibranchial and hepatic regions.

Actaea turcocampestris Müller, 1984, from the early Badenian (Middle Miocene) of Austria and Hungary and from the Middle Miocene of Catalonia (Spain) has

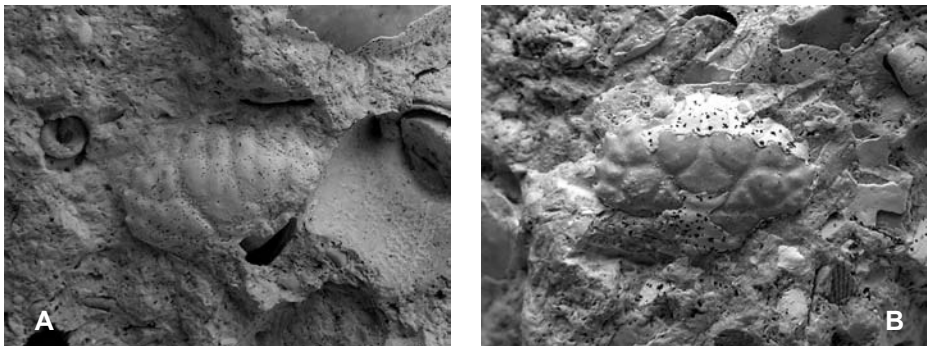


Fig. 5 - *Actaea calzadai* Müller, 1984, A) GPDG 0110, dorsal view/visione dorsale (x 3.7); B) GPDG 0109, dorsal view/visione dorsale (x 3.5).

carapace characters most like those of this species, while the anterior process of mesogastric lobe is more elongate between the protogastric regions (Müller, 1984a, 1993).

Genus *Xantho* Leach, 1816

Type species: *Cancer incisus* Leach, 1814, by original designation

Include fossil species: *Xantho agassizi* Robineau-Desvoidy, 1849; *X. hydrophilus* (Herbst, 1790) (= *X. floridus* Montagu, 1813; *X. incisus* Leach, 1814) (fossil and extant); *X. lovisatoi* (Lörenthey, 1907); *X. moldavicus* (Yanakevich, 1977); *X. vitiensis* (Rathbun, 1945)

Xantho moldavicus (Yanakevich, 1977)

Fig. 6

- 1928 – *Titanocarcinus vulgaris* in Glaessner; p. 185, 189, Pl. 3 (fig. 11) (*Partim*)
 1953 – *Titanocarcinus vulgaris* in Glaessner – Bachmayer; p. 254, Pl. 4 (figs 1-9), Pl. 5 (figs. 1, 2)
 1974a – *Xantho* cf. *incisus* Leach in Müller; p. 123, Pl. 3 (fig. 1, 2)
 1974b – *Xantho* cf. *incisus* n. ssp? in Müller; p. 280
 1976a – *Xantho* cf. *incisus* Leach in Müller; p. 510
 1976b – *Xantho* cf. *incisus* Leach in Müller; p. 152
 1977 – *Medaeus moldavicus* Yanakevich; p. 80, Pl. 10 (fig. 4)
 1979a – *Xantho* cf. *vulgaris* (Glaessner) in Förster; p. 100, Pl. 3 (figs 1-3), Pl. 4 (figs 1-4)
 1979b – *Xantho* cf. *vulgaris* (Glaessner) in Förster; p. 263, Pl. 3 (figs 1-3), Pl. 4 (figs 1-4), text-fig. 11
 1979a – *Xantho* cf. *incisus* Leach in Müller; p. 274, Pl. 20 (figs 1-5)
 1984a – *Xantho moldavicus* (Yanakevich) in Müller; p. 92, Pl. 85 (figs. 5-8), Pl. 86 (figs. 1-5), Pl. 87 (fig. 1)
 1989 – *Xantho moldavicus* (Yanakevich) in Solé & Via Boada; p. 35
 1991 – *Xantho moldavicus* (Yanakevich) in Marras & Ventura; p. 110, Pl. 2 (fig. 2)
 1996 – *Xantho moldavicus* (Yanakevich) in Müller; p. 11, Pl. 2 (fig. 6)
 1998 – *Xantho moldavicus* (Yanakevich) in Müller; p. 34
 2006 – *Xantho moldavicus* (Yanakevich) in Radwański *et al.*; p. 96, Pl. 2 (figs. 5, 6)
 2010 – *Xantho moldavicus* (Yanakevich) in Schweitzer *et al.*; p. 128
 2010 – *Xantho moldavicus* (Yanakevich) in Gatt & De Angeli; p. 1339, figs. 8G-K

Geological age: early Messinian (Late Miocene).

Material and measurements: two specimens with complete carapace (GPDG 0112, 0126).

GPDG 0112 – carapace length: 7 mm; carapace width: 9.3 mm

GPDG 0126 – carapace length: 5.2 mm; carapace width: 6.4 mm

Discussion. The studied specimens have strictly affinities with *Xantho moldavicus* (Yanakevich, 1977) for the wider carapace and for the dorsal surface of carapace with well-marked regions.

This species is widespread in the European Miocene, as reported by different authors (Glaessner, 1928; Bachmayer 1953; Förster, 1979a, b; Müller, 1984a, 1996, Marras & Ventura, 1991; Radwański *et al.*, 2006; Gatt & De Angeli, 2010).

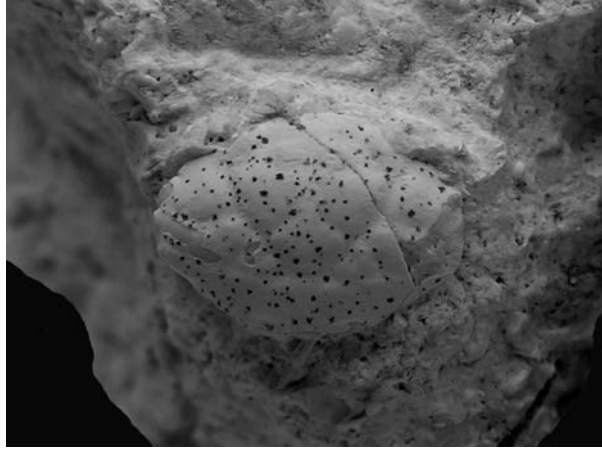


Fig. 6 - *Xantho moldavicus* (Yanakevich, 1977), GPDG 0112; dorsal view/visione dorsale (x 6).

Some carapaces from the Miocene of Catalonia (Spain) have been ascribed to *Xantho* aff. *moldavicus* (Müller, 1996) and a propodus and dactylus from the Miocene of Oran (Algeria) have been assigned to *Xantho* cf. *moldavicus* (Saint Martin & Müller, 1988; Moissette & Müller, 1990).

Genus *Haydnella* Müller, 1984

Type species: *Haydnella steiningeri* Müller, 1984, by original designation

Include fossil species: *Haydnella maladensis* Beschin, Busulini, De Angeli & Tessier, 2007; *H. oligocenica* De Angeli & Beschin, 2008; *H. pulchellus* (A. Milne Edwards, 1864); *H. steiningeri* Müller, 1984

Haydnella cfr. *H. steiningeri* Müller, 1984

Fig. 7

Geological age: early Messinian (Late Miocene).

Material and measurements: two specimens with complete carapace (GPDG 0113, 0127).

GPDG 0113 – carapace length: 7 mm; carapace width: 8.5 mm

GPDG 0127 – carapace length: 6.2 mm; carapace width: 7.3 mm

Description. Subhexagonal carapace, wider than long, mainly convex longitudinally. Wide orbito-frontal margin, finely granulate. Straight, bilobate, grained front, marked by a weak median incision. Supraorbital margin separated from the front by an incision. Concave supraorbital margin marked by two narrow fissures. Short, convex anterolateral margins, with two spiny teeth (we suppose that probably four teeth were present). Converging posterolateral margins longer than anterolateral ones. Posterior margin relatively wide, straight. Dorsal regions well marked by grooves. Wide epibranchial lobe well distinct.



Fig. 7 - *Haydnella* cfr. *H. steiningeri* Müller, 1984, GPDG 0113, dorsal view/visione dorsale (x 6.5).

Discussion. The studied specimens are strictly related with *Haydnella steiningeri* Müller, 1984, although the lack of complete anterolateral teeth doesn't allow a correct ascription to this species. *Haydnella steiningeri* has been described from the Badenian (Middle Miocene) of Hungary, Austria, and Poland (Müller, 1984a, 1996, 1998).

Genus *Liomera* Dana, 1851

Type species: *Liomera lata* Dana, 1852, by monotypy

Included fossil species: *L. cinctimana* (White, 1847) (fossil and extant); *L. laevis* (A. Milne Edwards, 1873) (fossil and extant); *L. monticulosa* (A. Milne Edwards, 1873) (fossil and extant); *L. rubra* (A. Milne Edwards, 1865) (fossil and extant); *L. sublensis* (Rathbun, 1945); *L. stimpsonii* (A. Milne Edwards, 1965) (fossil and extant); *L. transversa* (Hu, 1983); *L. venosa* (H. Milne Edwards, 1834 (fossil and extant)

Liomera bagaglioii n. sp.

Figs. 8, 9

Diagnosis: suboval, convex carapace, wider than long; bilobate front, slightly protruded anteriorly; supraorbital margin marked by two narrow fissures; elongate, raised infraorbital tooth, distinct from front; convex anterolateral margins, with four flat, rounded lobes; posterolateral margin strongly converging to posterior margin; hepatic and anterior branchial regions marked by transverse grooves, pointing out three wide, relatively rounded lobes.

Etymology: the trivial name alludes to Luigi Bagagli, recently deceased, who has discovered the studied specimens.

Holotype: GPDG 0094.

Paratype: GPDG 0092, 0093, 0095, 0096, 0097, 0098, 0099, 0100, 0101, 0102, 0103.

Geological age: early Messinian (Late Miocene)

Type locality: Acquabona, Rosignano Marittimo (Livorno)

Material and measurements: twelve specimens: nine with incomplete carapace (GPDG 0092, 0095, 0096, 0097, 0098, 0100, 0101, 0102, 0103), three with complete carapace (GPDG 0093, 0094, 0099).

GPDG 0093 – carapace width: 29.6 mm

GPDG 0094 – carapace width: 34.3 mm

GPDG 0099 – carapace length: 9.2 mm; carapace width: 14.5 mm

Description. Suboval, convex carapace, wider than long (length carapace/width carapace = 0.63). Orbito-frontal margin wide (orbito-frontal margin/width carapace: 0.41). Bilobate front, slightly notched medially, slightly protruding from orbits. Oval, small orbits. Concave supraorbital margin marked by two narrow fissures. Elongate, raised infraorbital tooth, distinct from front by an incision. Elongate, convex anterolateral margins, with four wide, rounded lobes: small first lobe slightly protruding; wide, rounded second and third lobes; sharp fourth lobe located on anterolateral angle. Posterolateral margins shorter than anterolateral ones, slightly convex, strongly converging to posterior margin. Straight posterior margin 1/3 of maximum width of carapace. Dorsal surface smooth. Wide, raised epigastric lobes slightly oblique. Wide protogastric regions marked by a longitudinal groove. Mesogastric regions subpentagonal in outline. Anterior mesogastric process narrow. Metagastric region well distinct, poorly developed in length. Urogastric region well distinct poorly developed in length. Wide cardiac region poorly marked by branchiocardiac grooves. Hepatic and anterior branchial regions marked by transverse grooves, pointing out three wide lobes relatively rounded.

Discussion. *Liomera* includes 30 extant species of which twenty valid and ten dubious (Ng *et al.*, 2008) and inhabits in rocky beat, coral reefs, and shallow waters (Sakai, 1976).

The fossil species known to date are rare. Rathbun (1945) described *Liomera sublensis* (Rathbun, 1945) (= *Carpiloides*) from the Miocene of Manua Mbalavu

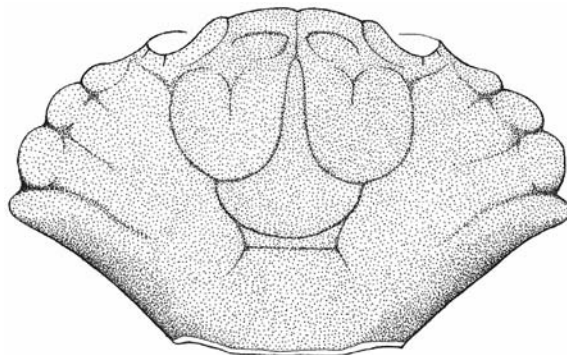


Fig. 8 - *Liomera bagaglioi* n. sp., reconstruction of the carapace/ricostruzione del carapace.

(Fiji Islands). Hu (1983) reported *Liomera transversa* (Hu, 1983) (= *Carpiloides*), and Hu & Tao (1996, 2000) described *L. venosa* (H. Milne Edwards, 1834), *L. bella* (Dana, 1825), *L. laevis* (A. Milne Edwards, 1873), and *L. cinctimana* (White, 1847) from the Cenozoic of Taiwan. Karasawa (2000) reported *Liomera* aff. *L. laevis* (A. Milne Edwards, 1873), *L. monticulosa* (A. Milne Edwards, 1873), *L. rubra* (A. Milne Edwards, 1865), *L. stimpsonii* (A. Milne Edwards, 1965), and *Liomera* aff. *L. venosa* (H. Milne Edwards, 1834) in the coral-associated decapods from the Pleistocene of Ryukyu Islands (Japan).

Liomera bagaglioii n. sp. shows affinities with the extant Indo-Pacific *L. laevis* (A. Milne Edwards, 1873) having carapace very wide, four wide, rounded antero-lateral lobes, hepatic and branchial lobes distinct by weak grooves.

Neoliomera? n. sp. described by Müller (1993, fig. 9G), from the Langhian of Can Sala (Catalonia, Spain) is similar to the present new species by having anterolateral margins with rounded lobes and branchial regions with transverse reliefs. Therefore, the Spanish specimen could be assigned to *Liomera bagaglioii* n. sp., representing the first fossil report of this genus in the Mediterranean basin.

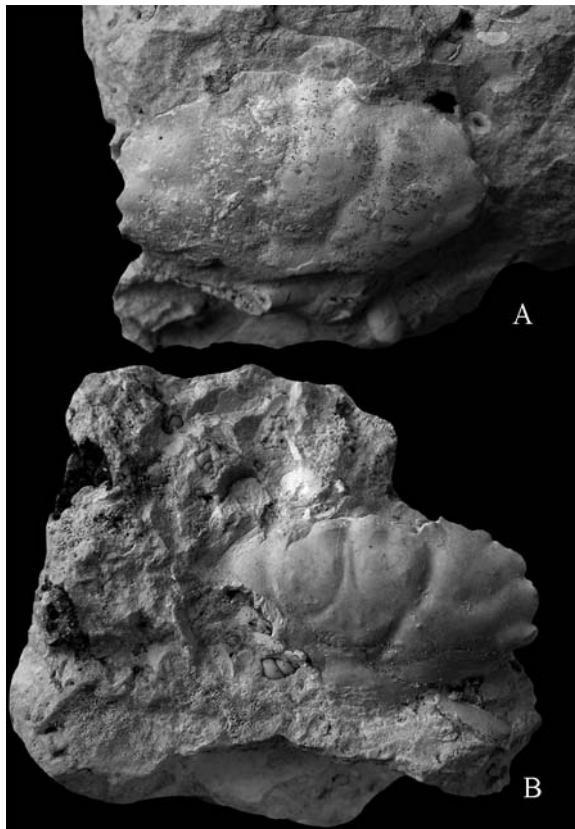


Fig. 9 - *Liomera bagaglioii* n. sp., A) holotype/olotipo GPDG 0094, dorsal view/visione dorsale (x 1.3); B) paratype/paratipo GPDG 0092, dorsal view/visione dorsale (x 1.5).

Indeterminate propodi

Fig. 10 A-C

Geological age: early Messinian (Late Miocene).

Material and measurements: four propodi of right chelipeds (GPDG 0114, 0115, 0116, 0129), two propodi of left chelipeds (GPDG 0130, 0131), and one dactylus (GPDG 0117).

GPDG 0114 – propodus length (with index): 21.8 mm; palm length: 11.8 mm; palm height: 11.4 mm

GPDG 0115 – propodus length (with index): 18.4 mm

GPDG 0116 – propodus length (with index): 32 mm; palm length: 29.3 mm

GPDG 0117 – dactylus length: 21.8 mm

GPDG 0129 – propodus length (with index): 26.4 mm; palm length: 16.2 mm; palm height: 13 mm

GPDG 0130 – portion of right propodus

GPDG 0131 – propodus length (with index): 21.2 mm; palm length: 10.5 mm; palm height: 8.2 mm

Description. Strong, elongate propodus. Subcylindrical palm, longer than wide, with dorsal and ventral margins converging posteriorly. Smooth, inflated outer surface. Elongate index with occlusal margin having some rounded teeth. Elongate, curved dactylus, with occlusal margin having three strong, rounded teeth.

Discussion. The studied propodi isolated inside the matrix could be belong probably to *Liomera bagaglioii* n. sp. This kind of propodus is indeed present in some extant species of *Liomera*, such as *L. tristis* (Dana, 1852), *L. laevis* (A. Milne Edwards, 1873), and *L. edwardsi* Kossmann, 1877.

Conclusion

Müller (2004) gave a check list of the most important coral-associated decapods from the Cenozoic of Europe.

The increase of coral environments during the Miocene promoted the development and the widespread of decapods in Mediterranean and Parathetid areas.

The most important coral-associated decapod faunas from the Miocene of Parathetid are reported in Austria (Glaessner, 1924, 1928; Bachmayer & Tollmann, 1953; Friebe, 1987; Müller, 1998), Poland (Müller, 1996; Górka, 2002), Hungary, Bulgaria, Slovenia (Lörenthey & Beurlen, 1929, Müller, 1979, 1984a) and Ukraine (Radwański *et al.*, 2006). Many species from the Miocene of Mediterranean area are reported from the late Burdigalian of Olérdola and Can Sala (Catalonia, Spain) (Müller, 1993), from the Messinian of Santa Pola (Spain) (Müller, 1984b) and Oran (Algeria) (Saint-Martin & Müller, 1988), from the Late Miocene of Balearic Islands (Garcia Socias, 1989-1990), from the Late Miocene (Messinian) of Greece (Georgiades-Dikeoulia & Müller, 1984) and Malta (Gatt & De Angeli, 2010).

The most important Italian coral-associated decapod faunas have been reported from the Ypresian (Early Eocene), Priabonian (Late Eocene) and Early Oligocene of Vicenza area (NE Italy) (Beschin *et al.*, 2000, 2007; Beschin *et al.*, 2001; De Angeli & Beschin, 2008; De Angeli & Garassino, 2002; De Angeli *et al.*, 2010).

The discovery of the coral-associated fauna from the Messinian of Rosignano Marittimo is a novelty for the Miocene of Italy. Some species (*Galathea* cf. *G. squa-*

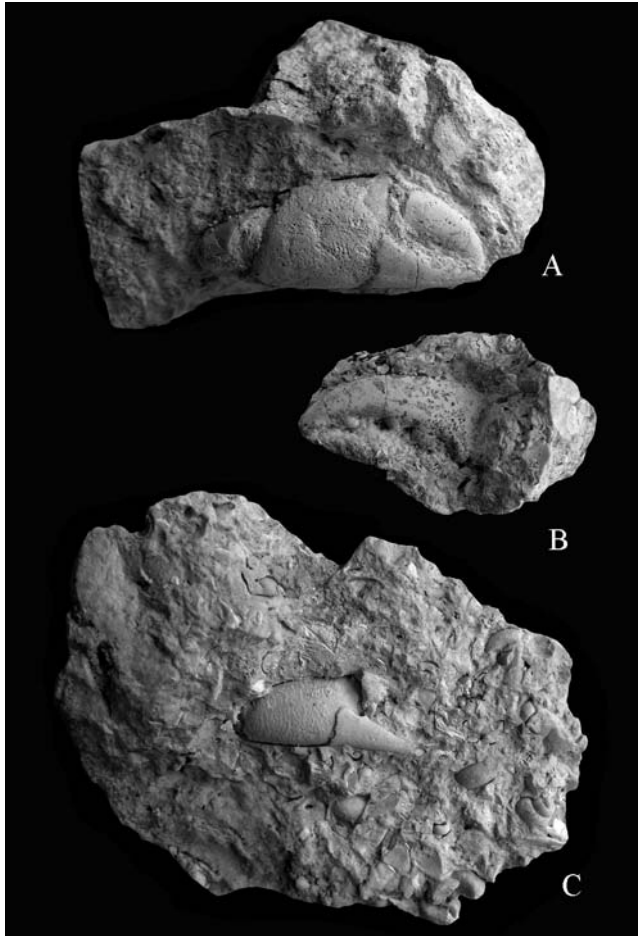


Fig. 10 - Indeterminate propodi, A) GPDG 0114, right propodus/propodo destro (x 1.4); B) GPDG 0117, dactylus/dattilo (x 1.2); C) GPDG 0115, right propodus/propodo destro (x 1.3).

mifera and *Actaea calzadai*) show morphological affinities with others species from the Langhian and Messinian of Spain, Greece, and Malta, others (*Pisidia kokayi*, *Pilumnus* cfr. *P. mediterraneus*, *Haydnella* cfr. *H. steiningeri*) are known from the Badenian of Hungary, Austria, and Poland. *Xantho moldavicus* was a widespread species from the Miocene of Mediterranean and Parathetid areas. Indeed, specimens of this species have been reported from Hungary, Poland, Ukraine, Germany, Austria, Malta, Italy (Sardegna), Spain, and Algeria.

The fossil carapaces of *Liomera bagaglioii* n. sp. are frequent in the levels of Rosignano Marittimo and probably the abundant chelae discovered in the same levels could belong to this species. *Liomera* was known to date only from the Miocene-Pleistocene of Japan, Fiji Islands, and Taiwan. *Liomera bagaglioii* n. sp. is the first report of this genus from the Mediterranean area and probably it was also present from the Langhian of Catalonia (Spain).

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