First report of decapod crustaceans from the middle–late Miocene of Valmarecchia, Romagna Apennines (Emilia-Romagna, Italy)

GIOVANNI PASINI, ALESSANDRO GARASSINO & FRANCESCO PIZZOLATO

Abstract

Axiidean and brachyuran decapods are reported from the middle–late Miocene pre-evaporitic deposits of several localities along the Valmarecchia (Rimini) in the Romagna Apennines (Emilia-Romagna). Goneplax rhomboides (Linnaeus, 1758), already known from the Miocene of Italy, has not been recorded previously in this area, while the record of Chlinocephalus demissifrons Ristori, 1886 expands the stratigraphic range of the genus, previously known only from the Pliocene and Pleistocene of Italy. Moreover, some specimens are assigned in open nomenclature to Lobocarcinus Reuss, 1857, already known from the Miocene of Italy. Finally, some loose chelae are assigned to the families Callianassidae and Eucalliacidae, respectively, without generic and specific assignment. The Valmarecchia decapod assemblage enlarges the knowledge on the composition and distribution of the decapod fauna along the palaeo-Adriatic Gulf before the Messinian Salinity Crisis of the Mediterranean Basin.

Key words: Crustacea, Axiidea, Brachyura, taxonomy, Miocene, Italy.

1. Introduction

The Valmarecchia, located in the SW Romagna Apennines and surrounding areas, is well-known for the rich fossiliferous laminated layers ranging from the Miocene to the Pliocene, mainly for its marine vertebrate fauna (mainly fish) (Sorbini 1987; Bagli 2004). No crustacean records were previously reported from these layers, except for a single decapod caridean assigned to Palaeomon monsdamarum Pasini & Garassino, 2018, from the Messinian tripoli of Mondaino (Rimini, Emilia-Romagna) (Pasini & Garassino 2018). Other previous reports of Miocene decapods from the Romagna Apennines are limited to some anomurans, axiideans, and brachyurans from two localities nearby Brisighella (Ravenna, Emilia-Romagna), which belong to the early–middle Messinian (Pasini et al. 2019). Hence, the new report from Valmarecchia outcrops enhances the scarce knowledge on the presence and distribution of crustaceans around the palaeo-Adriatic Gulf during the middle–late Miocene prior to the onset of the Mediterranean Salinity Crisis.

2. Fossiliferous localities

The Romagna Apennines are generically characterized by an outcropping succession of autochthonous early Miocene to Pleistocene mainly siliciclastic deposits that represent the infill of a fore deep basin. This part of the Apennine margin is characterized, mainly in the western area, by the strong evaporitic outcrop of Primary Lower Gypsum, the so-called Vena del Gesso romagnola, which is Messinian in age. Pre-evaporitic deposits crop out usually below the gypsum sequence. These deposits are composed by a unit straddling the Tortonian–Messinian boundary made up of finely interbedded organic and diatomite rich laminites and mudstones, informally named “euxinic shales”. These deposits span a 1.2 Ma time interval (early Tortonian–early Messinian), show a cyclic pattern and record the palaeoceanographical changes associated with the ensuing Messinian Salinity Crisis (started at 5.96 Ma) (Roveri et al. 2006). The studied specimens have been collected from the following localities located along the Valmarecchia (Fig. 1):

I Monti quarry, Campiano (Novafeltria, Rimini, 43°54′17.46″N 12°17′10.88″E), located on the left orographic side of the Valmarecchia; it consists of two distinct fronts close to each other, herein formalized as MEQ (Eastern quarry) and MWQ (Western quarry). In the MEQ quarry, the fossiliferous green-grey limestones and glauconitic yellow-greenish sandstones pertaining to the Monte Fumaiolo Formation (middle Miocene: Langhian-Serravallian) intercrops with the San Marino Formation (middle Miocene: Burdigalian–Langhian) (Bagli 2004). One single specimen was collected from these layers (MUSNAF/GEO7188). The MWQ carves into the light blue grey sandy clays of the Argille di Casa i Gessi (Moroni 1955; Ruggieri 1970; Bagli 2004), assigned to the early Messinian (late Miocene) and which are rich in circum littoral molluse shells preserved as inner moulds (Pizzolato, pers. obs. 2019) (13 specimens: MUSNAF/GEO7183-87; 7190-96).
Montebello (Rimini, 43°58’18"N 12°22’06"E), located along the left orographic side of Marecchia River fossiliferous marly clays assigned to the middle Miocene (Langhian–Tortonian) are exposed (Moroni 1957; Bagli 2004) (two specimens: MUSNAF/GEO/7189a, b, 7197a, b).

Maciano (Rimini, 43°50’08.5"N 12°15’00"E) along the Marecchia Road (SP258), on the right orographic side of Marecchia River. Some poor, indeterminate crustacean remains have been collected from the gray-greenish clays of the Monte Fumaiolo Formation (middle Miocene: Langhian–Serravallian), associated with small incomplete echinoderms (Bagli 2004). We point out that among these not illustrated specimens there are some loose and poorly preserved straight, elongate dactyls, transversally flattened, with the occlusal margin bearing a rim of small (broken) teeth resembling the pectinate dactyls of some shrimp genera (MUSNAF/GEO/7198a–d).

3. Material

The studied specimens are mostly fragmentary and usually preserved as three-dimensionally inner moulds, due to the dissolution of the original exoskeleton, or simply as external casts. They have been assigned as follows: Callianassidae genus & species indet. (2 specimens), Eucalliacidae genus & species indet. (3 specimens), Lobocarcinus sp. (1 specimen), Goneplax cf. G. gulderti Bachmayer, 1953 (4 specimens), Goneplax rhombooides (Linnaeus, 1758) (3 specimens), and Chlinocephalus demissifrons Ristori, 1886 (1 specimen). Moreover, a single complete carapace was assigned to an indeterminate carpilioid brachyuran. The studied specimens are housed in the palaeontological collection of the Museo di Storia Naturale dell’Accademia dei Fisiocritici (Siena) (MUSNAF).

For the higher-level classification, we follow the arrangements proposed by Ng et al. (2008), De Grave et al. (2009) and Schweitzer et al. (2010).

Abbreviations: lcxp: carapace length; lpa: palm length; P1: pereiopod 1; wpa: palm width; wcxp: carapace width.

Fig. 1. Map of Emilia-Romagna with the location of the fossiliferous localities along the Valmarecchia. 1: Montebello; 2: Novafeltria (1 Monti quarry); 3: Maciano. Scale bar equals 45 km.
4. Systematic palaeontology

Order Decapoda Latreille, 1802

Infraorder Axiidea de Saint Laurent, 1979

Family Callianassidae Dana, 1852

Genus & species indet.

Fig. 2A

Occurrence: MWQ, Campiano (Valmarecchia, Rimini).

Material and measurements: Two poorly preserved incomplete chelae (dactyli not preserved) in lateral view (MUSNAF/GEO/7183 (left chela) – lpa: 7.5 mm; wpa: 5 mm; MUSNAF/GEO/7184 (right chela) – wpa: 6 mm).

Description: Subrectangular flattened palm, longer than wide, with upper and lower margins apparently smooth; elongate index with hook-shaped pointed tip upturned; occlusal margin of index smooth.

Discussion: Based on Poore et al. (2019), the outline shape of the studied propodi seems to fit with the diagnostic characters of the Callianassidae to which they are herein tentatively assigned. Due to their poor preservation, we cannot recognize the main generic and specific characters useful for comparison. Pasini et al. (2019: 28, fig. 1A) reported similar propodi from the early–middle Messinian (late Miocene) of Brisighella (Ravenna, Emilia-Romagna) tentatively compared with Callianassa subterranea (Montagu, 1808). The affinities of the studied propodi with the genera of the Callianassidae cannot be solved without additional well-preserved specimens. Therefore, their presence is simply recorded in the early Messinian of Valmarecchia.

Family Eucalliacidae Manning & Felder, 1991

Genus & species indet.

Fig. 2B

Occurrence: MWQ, Campiano (Valmarecchia, Rimini).

Fig. 2. A – Callianassidae genus & species indet., MUSNAF/GEO/7183, left chela, lateral view (scale bar equals 2.5 mm). B – Eucalliaeidae genus & species indet., MUSNAF/GEO/7184, right chela, lateral view (scale bar equals 1.7 mm). C – Lobocarcinus sp., MUSNAF/GEO/7188, left palm and carpus (scale bar equals 30 mm). D – ?Carpilioidea, family, genus & species indet., MUSNAF/GEO/7189, carapace dorsal view (scale bar equals 7 mm).
Material and measurements: Three poorly preserved incomplete right chelae (dactyli not preserved) in lateral view (MUSNAF/GEO/7185 – lpa: 6 mm; wpa: 6 mm; MUSNAF/GEO/7186 – lpa: 6 mm; wpa: 5.5 mm; MUSNAF/GEO/7187 – lpa: 4 mm; wpa: 4 mm).

Description: Subrectangular flattened palm, as long as wide, with upper and lower margins smoothly; lower part of palm with a relatively strong crest, extending medially in the index; elongate index with straight pointed tip; occlusal margin of index slightly sinuous and smooth.

Discussion: Based on Poore et al. (2019), the outline shape of the studied propodi seems to fit with the diagnostic characters of the Eucalliacidae, to which they are tentatively assigned herein. Due to their poor preservation, we cannot recognize the main generic and specific characters useful for comparison. Pasini et al. (2019: 28, fig. 1B) reported similar propodi from the early–middle Messinian (late Miocene) of Brisighella (Ravenna, Emilia-Romagna) assigned to Calliach sp. The affinities of the studied propodi with the genera of the Eucalliacidae cannot be solved without additional well-preserved specimens. Therefore, their presence is simply recorded in the early Messinian of Valmarecchia.

Infraorder Brachyura Linnaeus, 1758

Section Eubrachyura de Saint Laurent, 1980

Family Cancridae Latreille, 1802

Subfamily Lobocarcininae Beurlen, 1930

Genus Lobocarcinus Reuss, 1857

Type species: Cancer paulinowuertembergensis v. Meyer, 1847, by original designation.

Lobocarcinus sp.

Fig. 2C

Occurrence: MEQ, Campiano (Valmarecchia, Rimini).

Material and measurements: One incomplete palm and carpus three-dimensionally preserved (MUSNAF/GEO/7188 – lpa: 28 mm; wpa: 21 mm; MUSNAF/GEO/7189 – lpa: 22 mm; wpa: 22 mm). The convex carapace is partially preserved (MUSNAF/GEO/7189a, b – lcxp: 22 mm, wcxp: 32 mm).

Description: The convex carapace is partially preserved as an internal mould, slightly compressed dorso-ventrally; carapace wider than long, ovoid in outline, domed with a finely granulate dorsal surface; narrow front; sub-elliptic orbits poorly marked; convex anterolateral margins with some spines/tubercles; posterolateral margins converging to the posterior margin; posterior margin apparently narrow; dorsal regions undifferentiated.

Discussion: The general shape of the carapace (as preserved) resembles that of some Carpilioidea Ortmann, 1893, especially that of the representatives of Palaeocarpilus A. Milne-Edwards, 1862 having a fossil range from the Eocene to the Miocene. However, the poor preservation of the carapace ornamentation and margins and the absence of the chelipeds do not allow a more confident systematic assignment of this specimen.

Superfamily Goneplacoidea MacLeay, 1838

Family Goneplacidae MacLeay, 1838

Subfamily Goneplacinae MacLeay, 1838

Genus Goneplax Leach, 1814

Type species: Ocyypoda bispinosa Lamarck, 1801 [= Goneplax rhomboides (Linnaeus, 1758)], by original designation.

Fossil species: Goneplax gulderi Bachmayer, 1953; G. rhomboides (Linnaeus, 1758).

Goneplax cf. G. gulderi Bachmayer, 1953

Fig. 3A

Occurrence: MWQ, Campiano (Valmarecchia, Rimini).

Material and measurements: Four incomplete carapaces in dorsal view (MUSNAF/GEO/7190 – lcxp: 17 mm; wcxp: 22 mm; MUSNAF/GEO/7191 – lcxp: 18 mm, wcxp: 22 mm; MUSNAF/GEO/7192 – lcxp: 18 mm, wcxp: 23 mm; MSUSNAF/GEO/7193 – not measurable).
Fig. 3. A – *Goneplax* cf. *G. gulderi* Bachmayr, 1953, MUSNAF/GEO/7191, carapace, dorsal view (scale bar equals 4.5 mm). B – *Goneplax rhomboides* (Linnaeus, 1758), MUSNAF/GEO/7194, carapace, dorsal view (scale bar equals 4.5 mm). C, D – *Chlinocephalus demissifrons* Ristori, 1886, MUSNAF/GEO/7197a, b, carapace, dorsal view (part and counterpart) (scale bar equals 14 mm).
**Discussion**: The studied specimens fit with the generic characters of *Goneplax Leach*, 1814 in showing the typical carapace dorsal proxy characters *sensu* Schweitzer (2003), as pointed out by Garassino et al. (2013: 357). Although the specimens are incomplete, some characters, such as the subtrapezoidal carapace; the frontal margin slightly wider than the orbits; the dorsal carapace with raised transverse ridges, and the pointed triangular extraorbital spine, suggest a comparison with *G. gulderi* Bachmayer, 1953 (Garassino et al. 2013: 357), previously recorded from the Miocene and Pliocene of Piedmont, Tuscany, Emilia-Romagna, and Sardinia (for an updated list see Garassino et al. 2013; Pasini et al. 2019).

*Goneplax rhomboides* (Linnaeus, 1758)

Fig. 3B

*1758 Cancer rhomboides. –* Linnaeus, p. 626.

2013 *Goneplax rhomboides*. – Garassino et al., pp. 359–361, figs. 1B, C, 2 [with synonymy].

2014 *Goneplax rhomboides*. – Pasini et al., p. 253, fig. 8B.

**Occurrence**: MWQ, Campiano (Valmarecchia, Rimini).

**Material and measurements**: Two carapaces in dorsal view (MUSNAF/GEO/7194 – lcxp: 12 mm; wcxp: 19 mm; MUSNAF/GEO/7195 – not measurable), and one right propodus fit with the main characters of *G. rhomboides* (Linnaeus, 1758) (Garassino et al. 2013: 359–361). According to Garassino et al. (2013) and Pasini et al. (2014), this species is widespread from the Miocene to the Pleistocene of several Italian regions, such as Piedmont, Emilia-Romagna, Tuscany, Lazio, and Sicily.

**Family Euryplacidae** Stimpson, 1871

**Genus Chilonechopus** Ristori, 1886

**Type species**: *Chilonechopus demissifrons* Ristori, 1886, by monotypy.

**Fossil species**: *Chilonechopus demissifrons* Ristori, 1886.

*Chilonechopus demissifrons* Ristori, 1886

Fig. 3C, D

*1886 Chilonechopus demissifrons. –* Ristori, p. 101, pl. 2, figs. 5, 6.

1929 *Chilonechopus demissifrons*. – Glæssner, p. 113.

1969 *Chilonechopus demissifrons*. – Glæssner, p. R517.

2003 *Chilonechopus demissifrons*. – Karasawa & Kato, tab. 5.

2004 *Chilonechopus demissifrons*. – Garassino et al., pp. 275–278, figs. 15, 16.

2006 *Chilonechopus demissifrons*. – De Angeli & Garassino, p. 64.

2009 *Chilonechopus demissifrons*. – De Angeli et al., p. 195.

2010 *Chilonechopus demissifrons*. – Schweitzer et al., p. 133.

2012 *Chilonechopus demissifrons*. – Garassino et al., p. 52.

2018 *Chilonechopus demissifrons*. – Baldanza et al., pp. 11, 27.

**Occurrence**: Montebello (Valmarecchia, Rimini).

**Material and measurements**: One complete carapace and legs in dorsal view; MUSNAF/GEO/7197a, b (part-counterpart) – lcxp: 24 mm, wcxp: 28 mm.

**Discussion**: According to Garassino et al. (2004: 276), the morphological characters of the studied specimen fit with those of *Chilonechopus demissifrons*, to which it is assigned. The species has been previously recorded from the Pliocene of Liguria, Piedmont, Emilia-Romagna, and Tuscany (Garassino et al. 2004) and from the Pleistocene of Umbria (Baldanza et al. 2018). Based upon the fossil record of this species, it is the first record from the Miocene, expanding its stratigraphic range back to the middle Miocene (Langhian–Tortonian).

5. **Conclusions**

The studied assemblage result to be the first record from the Romagna Apennines of Valmarecchia (Rimini), enlarging the knowledge of the scarcely reported decapod communities living in the Mediterranean just before the late Miocene evaporitic event with dramatic reduction of the Basin and significant ecological repercussions. The ghost shrimps as burrowers are represented by loose, poorly preserved propodi, tentatively assigned to the families Callianassidae and Eucallialliidae, respectively, not assignable at specific level. Among the Brachyura, *Chilonechopus demissifrons* is herein reported for the first time from the Miocene, expanding the stratigraphic range for this species. Interesting is the presence of a possible representative of Carpilioidea, and the representatives of the Goneplacidae seem to be the more common decapod crustaceans within the studied fauna. Unfortunately, as previously observed for the other studied assemblages from the Miocene of the Romagna Apennines, the usually poor preservation of the specimens consisting of isolated propodi or a single disarticulated (or incomplete) carapace, indicates that this assemblage is most probably not representative for the real original bio-community, but seems to be limited by burial events and post-mortem transportation of the specimens in a disturbed environment (Pasini et al. 2019: 32).

**Acknowledgements**

We wish to thank G. Manganelli (Museo di Storia Naturale dell’Accademia dei Fisiocritici, Siena, Italy), who gave us the permission to study the specimens, G. Teruzzi (Museo di Storia Naturale di Milano, Italy), for photographs of specimens, M. Mura (Museo di Storia Naturale di Milano, Italy), for the settlement of the iconographic apparatus, M. Hýzny, (Department of Geology and Palaeontology, Faculty of Natural Sciences, Comenius University, Bratislava, Slovakia) for useful suggestions on the Axiidea specimens; H. Karasawa, (Mizunami Fossil Museum, Yamanouchi, Akoyo, Mizunami, Japan) and an anonymous reviewer for their careful reviews and criticism.
6. References

BACHMAYER, F. (1953): Goneplax guilder, eine neue Crustaceen-
Species aus dem dortonischen Teilg des Wiener Beckens. – Päl-
äontologische Zeitschrift, 27 (3–4): 143–145.

BALDANZA, A., BIZZARRI, R., FAMIANI, F., GARASSINO, A., PASINI, G., CHERIN, M. & ROSATINI, F. (2018): The early Paleocene
whale-fall community of Bargiano (Umbria, Central Italy): Pale-
eoeological insights from benthic foraminifera and brachyuran
crabs. – Palaeontologia Electronica, 21.1.11A 1-27.
doi: 10.26879/779

BAGLI, L. (2004): Fossili, siti paleontologici e Musei di Geologia
fra Romagna e Marche. 160 pp.; Riccione (Museo del terri-
torio “Luigi Ghirotti”).

BEURLEN, K. (1930): Vergleichende Stammesgeschichte, Grund-
lagen, Methoden, Probleme unter besonderer Berücksichti-
gung der höheren Krebse. – Fortschritte in der Geologie und Päl-
äontologie, 8: 317–586.

DANA, J. D. (1852): Conspectus Crustaceorum, & Conspectus of the Crustacea of the Exploring Expedition under Capt.
Wilkes, U.S.N. Macoura. – Proceedings of the Academy of
Natural Sciences of Philadelphia, 6: 10–28.

DE ANGELI, A. & GARASSINO, A. (2006): Catalog and bibliography
of fossil Stomatopoda and Decapoda from Italy. – Memorie
della Società italiana di Scienze naturali e del Museo civico
di Storia naturale di Milano, 35 (1): 3–88.

DE ANGELI, A., GARASSINO, A. & PASINI, G. (2009): New reports
of anomurans and brachyurans from Cenozoic of Tuscany
(Italy). – Atti della Società italiana di Scienze naturali e del
Museo civico di Storia naturale in Milano, 150 (2): 163–196.

DE GRAVE, S., PENTCHEFF, N. D., AHYONG, S. T., CHAN, T.-Y., CRANDALL, K. A., DWORSCHAK, P. C., FELDER, D. L., FELDMAN, R. M., FRANSEN, C. H. J. M., GOULDING, L. Y. D., LEMAITRE, R., LOW, M. E. Y., MARTIN, J. W., NG, P. K. L., SCHWEITZER, C. E., TAN, S. H., TSUDY, D. & WETZER, R. (2009): A classification of living and fossil genera of deca-
pod crustaceans. – The Raffles Bulletin of Zoology, Supple-
ments, 21: 1–109.

GARASSINO, A., DE ANGELI, A., GALLO, L. M. & PASINI, G. (2004): Brachyuran and anomuran fauna from the Cenozoic of Pied-
mont (NW Italy). – Atti della Società italiana di Scienze naturali
ed del Museo civico di Storia naturale in Milano, 145
(2): 251–281.

GARASSINO, A., PASINI, G. & CASTRO, P. (2013): Revision of fos-
sil species of Goneplax Leach, 1814 (Crustacea, Decapoda,
Brachyura, Goneplacidae). – Boletin de la Sociedad Geol-
ógica Mexicana, 65 (2): 355–368.

GARASSINO, A., PASINI, G., DE ANGELI, A., CHARBONNIER, S., FAMIANI, F., BALDANZA, A. & BIZZARRI, R. (2012): The deca-
pod community from the Early Pliocene (Zanclean) of “La
Serra” quarry (San Miniato, Pisa, Toscana, central Italy):
sedimentology, systematics, and palaeoenvironmental
implications. – Annales de Paléontologie, 98: 1–61.

GLAESNERR, M. F. (1929): Crustacea Decapoda. – In: POMPECKJ, F.
(ed.): Fossilium Catalogus, I: Animalia, 41: 464 pp.

GLAESNERR, M. F. (1969): Decapoda. – In: MOORE, R. C. (ed.):
Tretratise on Invertebrate Paleontology, R (4) (2): R400–R533,
R626–R628; Boulder & Lawrence (Geological Society of
America & University of Kansas Press).

KARASAWA, H. & KATO, H. (2003): The family Goneplacidae
McLeay, 1838 (Crustacea: Decapoda: Brachyura): system-
atics, phylogeny, and fossil records. – Palaeontological Re-
search, 7 (2): 129–151.
community from the early Pleistocene of Volterra (Pisa, Tuscany, central Italy). – Neues Jahrbuch für Geologie und Paläontologie, Abhandlungen, 271 (3): 243–259.

Pasini, G., Garassino, A., Sami, M. (2019): Decapod assemblage from the late Miocene (early–middle Messinian) of the Reggiano Apennines nearby Brisighella, Emilia-Romagna (N Italy). – Natural History Sciences – Atti della Società italiana di Scienze naturali e del Museo civico di Storia naturale in Milano, 6 (1): 27–32.

Poore, G. C. B., Dworschak, P. C., Robles, R., Mantelatto, F. L. & Felder, D. L. (2019): A new classification of Callianassidae and related families (Crustacea: Decapoda: Axioidea) derived from a molecular phylogeny with morphological support. – Memoirs of the Museum Victoria, 78: 73–146.

Reuss, A. E. (1857): Zur Kenntnis fossiler Krabben. – Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften, 27: 161–166.

Ristori, G. (1886): I crostacei brachiuri e anomuri del Pliocene italiano. – Bollettino della Società Geologica Italiana, 5: 93–128.

Roveri, M., Lugli, S., Manzi, V., Gennari, R., Iaccarino, S. M., Grossi, F. & Taviani, M. (2006): The record of Messinian events in the Northern Apennines foredeep basins. – Acta Naturalia de l’Ateneo Parmense, 42: 3.

Ruggieri, G. (1970): Note illustrative della Carta Geologica d’Italia alla scala 1:100000. Foglio 108 Mercato Saraceno. 56 pp.; Roma (Servizio Geologico d’Italia).

Saint Laurent, M. de (1979): Sur la classification et la phylogénie des Thalassinides: définitions de la super-famille des Axioidae, de la sous-famille des Thomassiniinae et de deux genres nouveaux (Crustacea, Decapoda). – Comptes rendus hebdomadaires de séances de l’Académie des sciences, (D), 288: 1395–1397.

Saint Laurent, M. de (1980): Sur la classification et la phylogénie des Crustacés Décapodes Brachyures. II. Heterotremata et Thoracotremata Guinot, 1977. – Comptes rendus hebdomadaires des séances de l’Académie des sciences, (D), 290: 1317–1320.

Schweitzer, C. E. (2003): Utility of proxy characters for classification of fossils: an example from the fossil Xanthoidea (Crustacea: Decapoda: Brachyura). – Journal of Paleontology, 77 (6): 1107–1128.

Schweitzer, C. E., Feldmann, R. M., Garassino, A., Karasawa, H. & Schweigert, G. (2010): Systematic list of fossil decapod crustacean species. – Crustaceana Monographs, 10: 1–222.

Sorbini, L. (1987): Biogeography and climatology of Pliocene and Messinian fossil fish of eastern-central Italy. – Bollettino Museo Civico di Storia Naturale di Verona, 14: 1–85.

Stimpson, W. (1871): Preliminary Report on the Crustacea dredged in the Gulf Stream in the Straits of Florida, by L. F. de Pourtales, Assist. U.S. Coast Survey. Part I. Brachyura. – Bulletin of the Museum of Comparative Zoology, 2: 109–160.

Addresses of the authors:

GIOVANNI PASINI, Via Alessandro Volta 16, 22070 Appiano Gentile (Como), Italia; e-mail: giovannialdopasini@gmail.com

ALESSANDRO GARASSINO, Research Adjunct, Department of Earth and Biological Sciences, Loma Linda University, Loma Linda, CA 92354, USA; e-mail: alegarassino@gmail.com

FRANCESCO PIZZOLATO, Via Cimabue 54, 52100 Arezzo, Italia; e-mail: arch.pizzolatofrancesco@gmail.com

Manuscript received: 11 December 2019; revised version accepted: 25 February 2020.