Available online http://amq.aiqua.it
ISSN (online): 2279-7335

Alpine and Mediterranean Quaternary, Vol. 31 (Quaternary: Past, Present, Future - AIQUA Conference, Florence, 13-14/06/2018), 193 - 197

https://doi.org/10.26382/AIQUA.2018.AIQUAconference

OSTRACOD ASSEMBLAGES FROM THE PALAEOLAKE TIBERINO (PIACENZIAN-GELASIAN, CENTRAL ITALY): A SYNTHESIS

Marco Spadi

Dipartimento di Scienze, Università Roma Tre, Roma, Italy
Corresponding author: M. Spadi <marco.spadi@uniroma3.it>

ABSTRACT: This research provides a synthesis of the studies on the non-marine ostracods recovered from the early infillings (Piacenzian-Gelasian) of the Tiberino Basin. Ostracods were collected from the Fosso Bianco Formation, deposited in a huge and deep lake (Palaeolake Tiberino), and Ponte Naja Fm. that represents alluvial fan deposits that prograded into the lake. The studied ostracods are referable to 23 species, including 8 endemic species. They group in separate assemblages referable to several ecological niches, suggesting a complex lacustrine environment. This contribution permits to enlarge the dataset of non-marine ostracods distribution in central Italy during the Plio-Pleistocene.

KEYWORDS: Non-marine ostracods, Quaternary, ancient lake, palaeoenvironmental reconstruction, tiberino basin

1. INTRODUCTION

The present paper aims to provide an updated overview of the non-marine ostracod data available from the Pliocene-Early Pleistocene deposits of the Tiberino Basin. In detail, ostracods are used as the main proxy for the palaeoenvironmental reconstruction of the different lacustrine palaeoenvironments.

The Plio-Pleistocene basin-fill succession of the South Tiberino Basin is around 500 m thick and consists of siliciclastic and carbonate lacustrine and fluvial deposits (Fig. 1). The infilling started with the Fosso Bianco Fm. that is composed of clays with associated silty -sand laminae, sedimented in a lacustrine environment. According to Basilici (1997), three sedimentological facies associations related to different depositional environments compose this formation: 1) facies association A, which is made up by fine-grained clays and marls deposited in a deep lacustrine setting; 2) facies association B that includes sands and silts corresponding to a Gilbert-type delta system prograding into the lake; and 3) facies C that mainly consists of clays deposited in a marshy coastal margin with “Taxodiaceae” trunks in life position. The former facies association extensively crops out from Todi to San Gemini, the facies association B outcrops are limited to the eastern border of the palaeolake (Martani Mts.) whereas the facies C crops out in the Dunarobba Fossil Forest area (Basilici, 1997) (Fig. 1). The entire formation is aged late Piacenzian-Gelasian, based on the magnetostratigraphical, palynological and palaeocarpological analyses (Abbazzi et al., 1997; Pontini & Bertini, 2000; Napoleone et al., 2003; Martinetto et al., 2014).

The Ponte Naja Fm. is composed of fine-grained sheet flow deposits with palaeosols, and is probably heteropic to the upper portion of the Fosso Bianco Fm. (Basilici, 1995; 1997). According to Basilici (1997), the Ponte Naja Fm. is characterised by the facies association D, which consists of clayey silts. It corresponds to the deposition of the distal or middle distal end of an alluvial fan dominated by unchannelized flows and immature palaeosols (Basilici, 1995). The large and small mammal remains collected in this unit constrain the age of the formation to the late Gelasian (Coste San Giacomo Faunal Unit) (Abbazzi et al., 1997), between 2.1 and 1.9 Ma (Bellucci et al., 2014).

These two formations are unconformably overlain by the S. Maria di Ciciliano Fm., which is composed of sandy beds and interposed laminated clays deposited in an alluvial plain with dispersed swampy areas, dated to the latest Gelasian to Calabrian (Ambrosetti et al. 1995a;

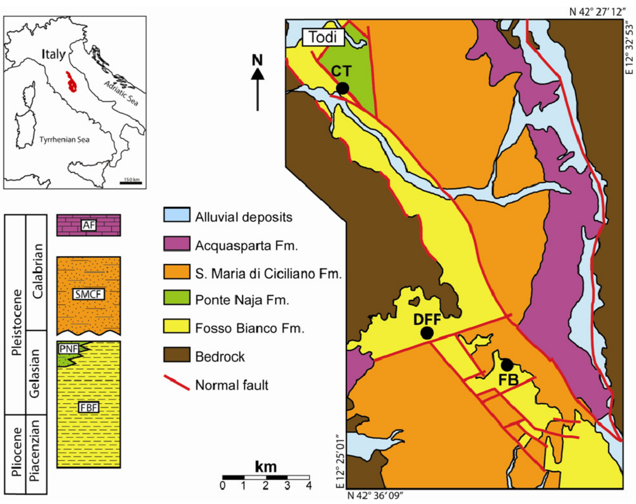

Fig. 1 - Location and geological setting of the study area, with the studied sections, **FB:** Fosso Bianco section, **DFF:** Dunarobba Fossil Forest area, and **CT:** Cava Toppetti section; modified from Basilici (1997).

Basilici, 1997; Girotti et al., 2003). Finally, along the borders of the Tiberino Basin crops out the Acquasparta Formation, dated Calabrian or Middle Pleistocene, made of continental limestones and travertines that were deposited in small shallow lakes (Ambrosetti et al., 1995a; Basilici 1997).

2. MATERIAL AND METHODS

The freshwater ostracods studied in the Tiberino Basin were collected from four different section: Fosso Bianco (thickness 86 m, 19 samples) and Cava Toppetti I (thickness 107 m; 68 samples) (Fosso Bianco Fm., facies association A), Dunarobba Fossil Forest area, (39 scattered samples) (Fosso Bianco Fm., facies association C), and Cava Toppetti II section (thickness 150 m; 68 samples) (Ponte Naja Fm., facies association D) (Fig. 1). The frequency matrix of the recovered autochthonous species was analysed with the Cluster Analysis (Morisita distance measure and the unweighted pair group method using arithmetic average - UPGMA).

3. RESULTS

The autochthonous ostracods recovered in the sedimentological facies association A of the Fosso Bianco Fm. includes 6 species: *Caspiocypris basilicii*, *Caspiocypris perusia*, *Caspiocypris posteroacuta*, *Caspiocypris tiberina*, *Caspiocypris tuderis* and *Paralimnocythere umbra* (Spadi et al., 2018).

The ostracod fauna recovered in the facies association C of the Fosso Bianco Fm. includes 17 species referable to 12 genera: *Darwinula stevensoni*, *Vestalenula cylindrica*, *Candona* (*Candona*) *improvisa*, *Candona* (*Neglecandona*) *angulata*, *Candona* (*Neglecandona*) *neglecta*, *Candona* (*Neglecandona*) *paludinica*, *Candonopsis kingsleii*, *Cyclocypris ovum*, *Ilyocypris bradyi*, *Ilyocypris decipiens*, *Cypris granulata mandelstami*, *Zonocypris membranae quadricella*, *Potamocypris fulva*, *Cyprideis crotonensis*, *Cyprideis rectangularis*, all well-known species, as well as two species recovered only in this facies, *Hemicypris lomastroi* and *Paralimnocythere turgida* (Spadi et al., submitted).

The majority of the samples from the Ponte Naja Fm. are barren or gave only juveniles and/or broken adult valves of different species (allochthonous assemblages) pertaining to both shallow and deep waters; 9 scattered samples bore very few autochthonous species (adults and instars): *C.* (*N.*) *neglecta*, *I. bradyi*, *P. umbra,* and *C. rectangularis*

4. DISCUSSION AND CONCLUSIONS

The ostracod from the Tiberino Basin, collected in the sediments associated to the deposition of the Palaeolake Tiberino (Fosso Bianco and Ponte Naja formations) were referable to 13 genera split into 23 species, 8 of which have been recovered only in this palaeolake. Most of them were collected in the deep lacustrine (facies A) of the Fosso Bianco Fm. (6 endemic species, five of which pertaining to a *Caspiocypris* species flock) (Spadi et al., 2018), while in the swampy lacustrine margin of the facies C of the Fosso Bianco Fm., cropping out in the Dunarobba Fossil Forest area, only 2 exclusive species out of 17 were recovered.

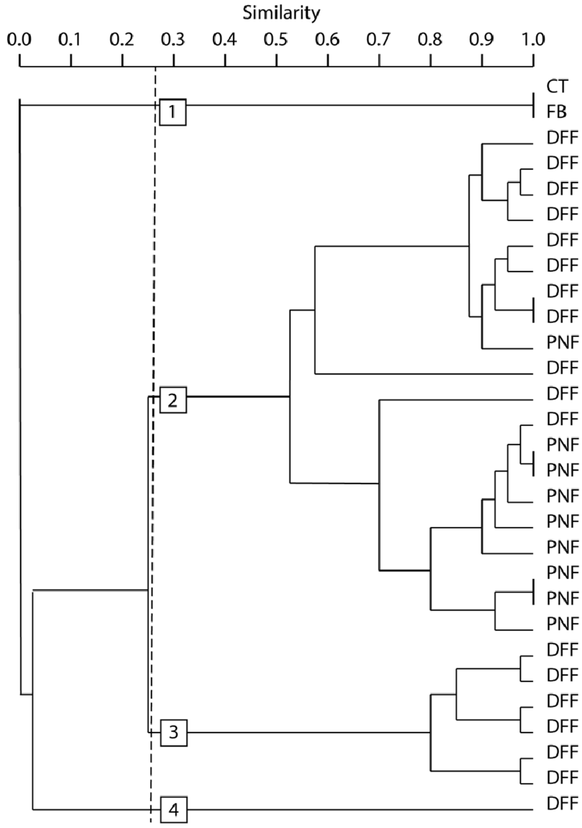

Fig. 2 - Dendrogram resulting from the cluster analysis in Q-mode (samples) using the UPGMA method and the Morisita similarity applied to the ostracods collected from the Dunarobba Fossil Forest area. The dotted line indicates the similarity level of the separation of the four clusters. Samples from: **FB:** Fosso Bianco section, **DFF:** Dunarobba Fossil Forest area, and **CT:** Cava Toppetti section; **PNF:** Ponte Naja Fm., modified from Spadi et al., submitted.

The cluster analysis performed in Q mode divides the samples bearing different ostracod assemblages into four clusters, suggesting that the lake hosted several different palaeobiotopes hosting diverse ostracod assemblages (Figs. 2 and 3).

Cluster 1 comprises all of the samples from the sedimentological facies association A at Fosso Bianco and Cava Toppetti I, characterised by the presence of five *Caspiocypris* species and *P. umbra*, which are typical of a rather deep lacustrine deposits (Spadi et al., 2018). All the recovered *Caspiocypris* of the Palaeolake Tiberino represent a species flock originated from the local speciation of one pioneer species, since they are more similar each other rather than to other known *Caspiocypris* species of similar age (i.e. the Gelasian *Caspiocypris* species flock from the San Demetrio Synthem, L'Aquila Basin - Spadi et al., 2016). The peculiar composition of the endemic ostracod association, characterized only by Candonidae and Limnocytheridae, together with the presence of endemic molluscs

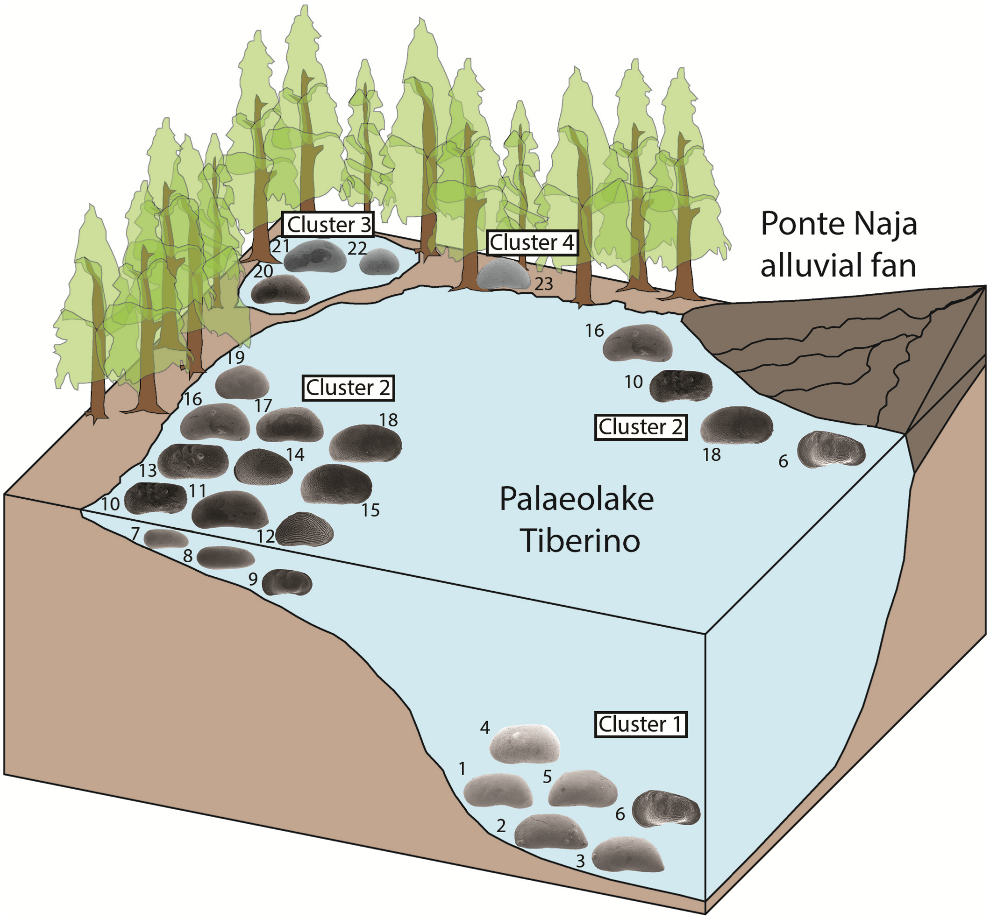

Fig. 3 - 3D reconstruction of the Palaeolake Tiberino palaeobiotopes in late Pliocene-Gelasian with occurrence of the related ostracod species. Legend: **Cluster 1:** 1 *Caspiocypris basilicii*, 2 *Caspiocypris perusia*, 3 *Caspiocypris posteroacuta*, 4 *Caspiocypris tiberina*, 5 *Caspiocypris tuderis*, 6 *Paralimnocythere umbra*. **Cluster 2:** 7 *Vestalenula cylindrica*; 8 *Darwinula stevensoni*, 9 *Paralimnocythere turgida* sp. nov.; 10 *Ilyocypris bradyi*, 11 *Candona angulata*, 12 *Zonocypris membranae quadricella*, 13 *Ilyocypris decipiens*, 14 *Cypris mandelstami*; 15 *Cyprideis crotonensis*, 16 *Candona neglecta*, 17 *Candona paludinica*, 18 *Cyprideis rectangularis*, 19 *Hemicypris lomastroi* sp. nov. **Cluster 3:** 20 *Candona improvisa*; 21 *Candonopsis kingsleii*; 22 *Cyclocypris ovum*. **Cluster 4:** 23 *Potamocypris fulva*, modified from Spadi et al., submitted.

(Ciangherotti et al., 1998), indicates that the Palaeolake Tiberino is a fossil “ancient lake” and that its rather deep lacustrine areas acted as an isolated environment in which endemic speciation was enhanced.

Cluster 2 includes some samples collected from the Dunarobba Fossil Forest as well as from the Cava Toppetti II section. The ostracod assemblage indicates a very shallow lacustrine environment with slow waterbody motions. These samples are also characterised by freshwater Prosobranchia-dominated associations (Ciangherotti et al., 1998). Shallow oxygenated waters rich in nutrients, typical of swampy lacustrine margins characterised by weak waves, is inferred for this well-diversified ostracod and mollusc assemblage. All the samples from Ponte Naja Fm. fall in this cluster, pointing to similar shallow coastal environments into which the alluvial fan prograded. Moreover, this finding confirms a similar age between the Dunarobba Fossil Forest deposits and the Ponte Naja Fm.

Cluster 3 is formed by the samples collected within and directly close to the fossil trunks from the Dunarobba Fossil Forest site. The ostracod assemblage is composed of several species that can withstand permanent/temporary very shallow environments and by *C.* (*C.*) *improvisa*, which is typical of temporary waters (Meisch, 2000). The same samples contain molluscs mainly related to terrestrial pulmonate gastropods (Ciangherotti et al., 1998). The assemblage indicates a transitional environment between the hydromorphic palaeosols (Cluster 4) and swampy lacustrine clays (Cluster 2), probably deposited in ephemeral ponds onshore of the lake margin, which, according to Ambrosetti et al. (1995b), was seldom occupied by small waterbodies.

Cluster 4 includes only one sample (Tr23-24-25M) from the Fossil Forest site containing the single ostracod species *P. fulva*. This species is typical of very shallow aquatic environments with standing waters and has been reported in channels with leaf litter (Meisch, 2000). In this sample the molluscs are represented only by terrestrial pulmonate gastropods (Ciangherotti et al., 1998). These sediments correspond to a hydromorphic palaeosol.

In the ostracod assemblages that populated the coastal area of the Palaeolake Tiberino, most of the species are well-known, although some of them are new records for the Italian Gelasian or have been collected in Italy for the first time. For example, the fossil species *C.* (*N.*) *paludinica* was previously recorded only from the Lower and Middle Paludinian Beds (Zanclean-Piacenzian) of Serbia; *Z. membranae quadricella* is a fossil species that is widely distributed in the Neogene and Quaternary of Turkey and the Paratethys (Mazzini, 2011 with references) but it was recovered in Italy only in the upper Tortonian deposits of the Cessaniti Basin (Calabria) (Ligios et al., 2012); *V. cylindrica* is known, mainly as fossil, from the Neogene and Quaternary of Europe and Turkey (Minati et al., 2008 with references) and, in Italy, only from the Piacenzian (Spadi et al., submitted). Finally, *C.* (*C.*) *improvisa* is a living species known from the fossil record only since the Calabrian, thus, the Dunarobba record represents its most ancient occurrence.

In a palaeobiogeographical perspective, the presence of *C. g. mandelstami*, *C.* (*N.*) *paludinica*, *Z. membranae quadricella* and, possibly, *H. lomastroi* in the coastal sediments of the Palaeolake Tiberino is remarkable. Indeed, their Pliocene-Gelasian distribution is limited to Balkans, Paludinian Beds (Serbia) (Krstić, 2006) and eastern Europe areas. It is possible to speculate that this ostracod group could have reached the Tiberino Basin by passive dispersal through aquatic birds *shuttling back and forth* between both sides of the Adriatic Sea.

In conclusion, the palaeontological and sedimentological information provided by the literature and the present study indicate that during Piacenzian–Gelasian the Tiberino Basin hosted a huge (minimum surface of 500 km^2) and rather deep (at least 50 m) lake, the Palaeolake Tiberino (Basilici, 1997). The presence in the deep lacustrine environment of a low diversity ostracod association made only of Candoninae and Leptocytheridae, together with the presence of a *Caspiocypris* species flock lead to consider the Palaeolake Tiberino as a palaeo-ancient lake (Medici & Gliozzi, 2008; Spadi et al., 2018). The ostracods assemblages from the Paleolake Tiberino were collected in different lacustrine environments from rather deep lake bottoms (Fosso Bianco Fm, facies A) to several diverse shallow coastal areas (Fosso Bianco Fm., facies C and Ponte Naja Fm.) including swampy lacustrine margins occupied by a “Taxodiaceae” forest, and humid areas surrounding the lake (ephemeral ponds and hydrosols).

REFERENCES

Abbazzi L., Albianelli A., Ambrosetti P., Argenti P., Basilici G., Bertini A., Gentili S., Masini F., Napoleone G., Pontini, M. R. (1997) - Paleontological and sedimentological record in Pliocene distal alluvial fan deposits at Cava Toppetti (Todi, central Italy). Bollettino della Società Paleontologica Italiana, 36 (1-2), 5-22.

Ambrosetti P., Basilici G., Capasso Barbato L., Carboni M. G., Di Stefano G., Esu D., Gliozzi E., Petronio C., Sardella R., Squazzini, E. (1995a) - Il Pleistocene inferiore del ramo sud occidentale del Bacino Tiberino: aspetti litostratigrafici e biostratigrafici. Il Quaternario, 8(1), 19-36.

Ambrosetti P., Basilici G., Ciangherotti A. D., Codipietro G., Corona E., Esu D., Girotti O., Lo Monaco A., Meneghini M., Paganelli A., Romagnoli, M. (1995b) - La foresta fossile di Dunarobba (Terni, Umbria, Italia centrale): contesto litostratigrafico, sedimentologico, palinologico, dendrocronologico e paleomalacologico. Il Quaternario, 8(2), 465-508.

Basilici G. (1995) - Sedimentologia della parte distale di una conoide alluvionale del Pliocene superiore (Bacino Tiberino, Umbria). Il Quaternario, 8(1), 37-52.

Basilici G. (1997) - Sedimentary facies in an extensional and deep-lacustrine depositional system: the Pliocene Tiberino Basin, Central Italy. Sedimentary Geology, 109(1-2), 73-94.

Bellucci L., Bona F., Corrado P., Magri D., Mazzini I., Parenti F., Scardia G., Sardella, R. (2014) - Evidence of late Gelasian dispersal of African fauna at Coste San Giacomo (Anagni Basin, central Italy): Early Pleistocene environments and the background of early human occupation in Europe. Quaternary Science Reviews, 96, 72-85.

Ciangherotti A. D., Esu D., Girotti, O. (1998) - Review of the history of the Late Neogene-Early Quaternary non-marine molluscs of Italy. Mededelingen Nederlands Instituut voor Toegepaste Geowetenschapen, 60, 491-498.

Girotti O., Capasso Barbato L., Esu D., Gliozzi E., Kotsakis A., Martinetto E., Petronio C., Sardella R., Squazzini, E. (2003) - The Section of Torre Picchio (Terni, Umbria, Central Italy): A Villafranchian Site Rich in Mammals, Molluscs, Ostracods and Plants. Rivista Italiana di Paleontologia e Stratigrafia, 109(1), 77-98.

Krstić N. (2006) - Pliocene ostracodes of the Paludinian Beds in the Pannonian Plain, Serbian part. Herald of the Natural History Museum, 1- 409, Belgrade.

Ligios S., Anadón P., Castorina F., D’Amico C., Esu D., Gliozzi E., Gramigna P., Mola M., Monegato, G. (2012) - Ostracoda and Mollusca biodiversity and hydrochemical features of Late Miocene brackish basins of Italy. Geobios, 45, 351-367.

Martinetto E., Bertini A., Basilici G., Baldanza A., Bizzarri R., Cherin M., Gentili, S. & Pontini M. R. (2014) - The plant record of the Dunarobba and Pietrafitta sites in the Plio-Pleistocene palaeoenvironmental context of Central Italy. Alpine and Mediterranean Quaternary, 27(1), 29-72.

Mazzini I. (2011) - The genus *Zonocypris* Müller, 1898 (Crustacea, Ostracoda, Cyprididae) from continental Miocene deposits of central Anatolia (Turkey): palaeoecological and palaeobiogeographical implications. Johannea Geologie und Paläontologie, 11, 124-125.

Medici M. C., Gliozzi E. (2008) - Preliminary data on the freshwater ostracods from the Middle-Late Pliocene Tiberino “palaeo-ancient lake” (Umbria, Central Italy). Atti del Museo Civico di storia naturale

di Trieste, 53, 49-66.
Meisch C. (2000) - Freshwater ostracoda of Western and Central Europe. Spektrum Akademischer Verlag, 1-522, Heidelberg, Berlin.
Minati K., Cabral M.C., Pipík R., Danielopol D.L., Linhart J., Neubauer, W. (2008) - Morphological variability among European populations of *Vestalenula cylindrica* (Straub) (Crustacea, Ostracoda). Palaeogeography, Palaeoclimatology, Palaeoecology, 264, 296-305.
Napoleone G., Albianelli A., Azzaroli A., Bertini A., Magi M., Mazzini, M. (2003) - Calibration of the upper Valdarno basin to the Plio-Pleistocene for correlating the Apennine continental sequences. Il Quaternario, 16(1bis), 131-166.
Pontini M. R., Bertini A. (2000) - Late Pliocene vegetation and climate in Central Italy: high-resolution pollen analysis from the Fosso Bianco succession (Tiberino Basin). Geobios, 33(5), 519-526.
Spadi M., Gliozzi E., Cosentino D., Nocentini M. (2016) - Late Piacenzian-Gelasian freshwater ostracods (Crustacea) from the L'Aquila Basin (central Apennines, Italy). Journal of Systematic Palaeontology, 14(7), 617-642.
Spadi M., Gliozzi E., Medici M. C. (2018) - A Plio-Pleistocene *Caspiocypris* species flock (Candoninae, Ostracoda) from the Palaeolake Tiberino (Umbria, central Italy). Journal of Systematic Palaeontology, 16(5), 417-434.
Spadi M., Gliozzi E., Medici M. C. (submitted) - Early Pleistocene (Gelasian) non-marine ostracods from the Dunarobba Fossil Forest (Tiberino Basin, Umbria, central Italy). Paper in Palaeontology.

Ms. received: May 6, 2018
Final text received: May 18, 2018