22 PRELIMINARY RESULTS ON THE TAXONOMY AND PALEOENVIRONMENTAL ANALYSIS OF THE MOLLUSC FAUNA FROM MARATHOUSA 1, MARATHOUSA 2 AND KYPARISSIA 4 (MIDDLE PLEISTOCENE, MEGALOPOLIS BASIN, GREECE)

Georgia Boni[1*], George Syrides[1], George E. Konidaris[2], Athanassios Athanassiou[3], Vangelis Tourloukis[2,4], Olga Koukousioura[1], Eleni Panagopoulou[3], Panagiotis Karkanas[5], Katerina Harvati[2,6]

[1]*Laboratory of Geology and Palaeontology, School of Geology, Aristotle University of Thessaloniki, Thessaloniki, Greece*
[2]*Paleoanthropology, Institute for Archaeological Sciences and Senckenberg Centre for Human Evolution and Palaeoenvironment, Department of Geosciences, Eberhard Karls University of Tübingen, Tübingen, Germany*
[3]*Hellenic Ministry of Culture, Ephorate of Palaeoanthropology–Speleology, Athens, Greece*
[4]*Department of History and Archaeology, School of Philosophy, University of Ioannina, Ioannina, Greece*
[5]*M.H. Wiener Laboratory for Archaeological Science, American School of Classical Studies at Athens, Athens, Greece*
[6]*DFG Centre for Advanced Studies 'Words, Bones, Genes, Tools', Eberhard Karls University of Tübingen, Tübingen, Germany*
**georgiabonigb@gmail.com*

http://dx.doi.org/10.15496/publikation-97637

Keywords: Megalopolis; moluscs; paleoenvironment; Pleistocene

22.1 INTRODUCTION

The basin of Megalopolis, located in Arcadia (Peloponnesus, Greece), was formed during the Pliocene, and subsequently during the Pleistocene it was filled with fluvio-lacustrine sediments (van Vugt et al., 2000). Of particular importance is the Marathousa Member (Mb) of the Choremi Formation, which consists of sands, silts and clays mainly of lacustrine origin, alternating with the economically important lignite seams (Vinken, 1965). These alternations correspond to climatic fluctuations from warm and humid periods (lignites), to colder and drier ones (clastic sediments) (Okuda et al., 2002).

The basin has a long history of paleontological research, with the first systematic paleontological excavations conducted at the beginning of the 20th century. Since then, and especially during the last decades, extensive paleontological, paleoenvironmental, geological and chronological research has been conducted in the basin enriching our knowledge of the Pleistocene ecosystems of the basin and the wider region. Recently, targeted and systematic field investigations (2012–ongoing) in the basin have resulted in the discovery of several new sites and findspots, as well as in the re-investigation of previously discovered localities. Among them, Marathousa 1 (MAR-1), discovered in 2013, stands out for its wealth in paleontological and archaeological finds from well-stratified and secure paleoenvironmental contexts, and testifies homi-

G. Syrides: https://orcid.org/0000-0002-4738-5134
G. E. Konidaris: https://orcid.org/0000-0002-7041-233X
A. Athanassiou: https://orcid.org/0000-0002-9140-7011
V. Tourloukis: https://orcid.org/0000-0002-9527-2708
O. Koukousioura: https://orcid.org/0000-0001-8127-3331
E. Panagopoulou: https://orcid.org/0000-0002-4268-6157
P. Karkanas: https://orcid.org/0000-0002-7156-671X
K. Harvati: https://orcid.org/0000-0001-5998-4794

nin presence and butchering activities at the shores of the Middle Pleistocene lake during the Marine Isotope Stage 12, at ~450 ka (Panagopoulou et al., 2015; Harvati et al., 2018 and articles therein). In 2018, the nearby and almost contemporaneous site of Marathousa 2 (MAR-2) was discovered yielding fossil mammal remains, some of which preserve traces of hominin exploitation (Konidaris et al., 2019). Finally, field survey in the Kyparissia mine, including the re-investigation of the Kyparissia 4 (KYP-4) site, discovered in 2007 (Athanassiou, 2018; Athanassiou et al., 2018), enriched the vertebrate collection further and provided the opportunity for detailed paleoenvironmental reconstruction for the early part of the Middle Pleistocene (Athanassiou et al., this volume; Karkanas et al., this volume; Konidaris et al., this volume; Papadopoulou et al., this volume; van Kolfschoten et al., this volume).

Among the first faunal lists of moluscs from the Megalopolis Basin are those of Vinken (1965) and Hiltermann and Lüttig (1969); however, the first detailed study on moluscs was conducted by Schütt et al. (1985). Recently, preliminary analysis of the molusc fauna from MAR-1 was performed and provided the first taxonomic and paleoenvironmental results (Boni, 2019), while the systematic sampling carried out in 2019 and 2020 at MAR-1, MAR-2 and KYP-4 has substantially expanded the available molusc material (Boni, 2022). The present study presents the preliminary results of the taxonomy and paleoenvironmental analysis of these assemblages aiming to contribute to the reconstructions of the paleoenvironmental conditions in the Megalopolis Basin during the Middle Pleistocene. Additional molluscan material hand-collected during the excavations of 2013–2019 at MAR-1, as well as sediment samples collected from additional stratigraphic units (other than those presented herein) of the three sites, require further investigation and will be collectively analyzed in the future.

22.2 MATERIALS AND METHODS

The herein studied material includes 15 sediment samples, weighing approximately 3 kg each, and originating from three sites: MAR-1 (Areas A and B), MAR-2 (Areas A and B) and KYP-4. In MAR-1 the material comes from the stratigraphic layers UA2b, UA3a and UA3c from Area A, and layers UB2b UB3a/b, UB3c, UB4a/b, UB4c and UB5 from Area B (layers according to Karkanas et al., 2018).

Three samples were collected from MAR-2: sample 1 (Area A, layer with *Hippopotamus* fossils) and sample 2 (Area B, layer with *Hippopotamus* fossils), both corresponding to the same depositional event, and sample 3 (Area B, molusc shell-rich layer), located ~2 m bellow sample 2. From KYP-4, three samples are examined: UA2, UA5 and UA6. The analysis of the sediment samples from UA4, and UA7–UA9 is in progress.

The samples were air-dried, soaked in containers filled with ~10 L of water and ~50 mL of H_2O_2 (70%) and wet-sieved over a 0.5 mm mesh sieve. Very argillaceous and rich in organic material samples, needed re-sieving, which was not possible during the COVID-19 pandemic. However, those samples were dry-sieved in mesh sieves of 5 mm, 3.16 mm and 1.60 mm, and each fraction was examined separately; the larger fractions were handpicked with the aid of magnifying glasses and forceps, and the fine fractions were examined under a JENNA stereoscopic microscope with ×0.63, ×1.00, ×1.6, ×2.5 magnification and ×10 ocular lenses.

All recognizable molusc shells were collected and identified to the lowest possible taxonomic level, based on available literature. Afterwards, the shells per taxon were counted, and their relative frequencies were calculated. For shell numbers exceeding 100–200, their number was approximately estimated. The most representative and well-preserved larger shells were photographed using a

SONY 8-Mpixel Digital Still Camera, while the smaller shells were photographed under a ZEISS Stemi 305 trinocular stereoscopic microscope equipped with a MOTICAM S6 camera.

22.3 RESULTS

22.3.1. FAUNA

The total number of taxa identified in all studied sites is at least 28. This number is possibly larger as the bivalves of the family Sphaeriidae were not identified at species level (Fig. 1).

Class Gastropoda Cuvier, 1795

- *Bithynia candiota* Westerlund
- *Valvata cristata* Müller
- *Valvata* (*Cincinna*) *studeri* Boeters & Falkner
- *Galba truncatula* (Müller)
- *Stagnicola palustris* (Müller)
- *Lymnaea stagnalis* (Linnaeus)
- *Planorbis planorbis* (Linnaeus)
- *Anisus leucostoma* (Millet)
- *Anisus spirorbis* (Linnaeus)
- *Anisus vortex* (Linnaeus)
- *Anisus* sp.
- *Gyraulus albus* (Müller)
- *Gyraulus crista* (Linnaeus)
- *Gyraulus* cf. *acronicus* (Férrusac)
- *Segmentina nitida* (Müller)
- *Planorbarius corneus* (Linnaeus)
- *Ancylus* sp.
- *Bathyomphalus contortus* (Linnaeus)
- Planorbidae sp. 1
- Planorbidae sp. 2
- *Acroloxus lacustris* (Linnaeus)
- *Oxyloma elegans* (Risso)
- *Vertigo pygmaea* (Draparnaud)
- *Carychium tridentatum* (Risso)

Class Bivalvia Linnaeus, 1758

- *Unio* cf. *pictorum* (Linnaeus)
- *Sphaerium* aff. *corneum* (Linnaeus)
- *Pisidium amnicum* (Müller)
- *Euglesa* aff. *casertanum* (Poli)

22.3.2. MARATHOUSA-1

Area A: In UA2b the number of shells reached ~2,950 and that of gastropod operculii over ~3000. Sample UA3c was also relatively rich, with 1,200 shells, but with only 144 operculii. In contrast, UA3a is a rather shell-poor sample, with only 80 shells, but with 200 operculii.

The most abundant species are *Valvata cristata*, *Valvata studeri* and *Bithynia candiota*, which represent more than 80% of the total molluscan assemblage in each of the three samples. *Valvata cristata* is the most abundant reaching 53.1% in UA3c, 93.75% in UA3a, and 30.2% in UA2b; *Bithynia candiota* comprises 22.9% of the total shells in UA3c, 5% in UA3a, and 23.8% in UA2b, while *Valvata studeri* reaches 11.6% in UA3c, 1.25% in UA3a, and 28.8% in UA2b. In UA2b, large Unionidae fragments were also found.

Area B: The richest layer among the studied ones was UB2b (in stratigraphic correlation with UA2b) with more than 8,580 shells and ~1,300 operculii. Other shell-rich layers are UB3c, which preserves ~1,300 shells and ~500 operculii, and UB4c, being slightly less rich, with 870 shells and 65 operculii. UB3a/b and UB4a/b are somewhat poorer; UB3a/b comprises 260 shells and 200 operculii, and UB4a/b 416 shells and 400 operculii. The poorest layer of the site is UB5 with only 13 shells and 7 operculii.

The most abundant species in Area B are the same as in Area A: *Valvata studeri*, *Valvata cristata* and *Bithynia candiota*. *Valvata cristata* is the most common in UB2b, UB3a/b, UB3c, UB4a/b, and UB4c, and comprises 42–70% of the shells, while *V. studeri* presents lower values (21% in UB2b,

10.8% in UB3a/b, 11.6% in UB3c, 6.7% in UB4a/b, and 6.0% in UB4c).

In UB2b, 320 Sphaeriidae shells were found, with their total percentage reaching 3.7%, while in UB3a/b, UB3c, and UB4a/b, although the number of shells is lower, their percentage is more significant, (7.7%, 7.7%, and 6.7%, respectively).

22.3.3. MARATHOUSA-2

Area A: Sample 1 contained ~150 shells and ~100 operculii. The dominant species are *Valvata cristata* with 63 shells (44.1%), followed by *Valvata studeri* and *Bithynia candiota* with 37 (25.9%) and 32 (22.4%) shells, respectively. Besides the above,

Figure 1: Taxa of the studied samples. A: *Valvata cristata,* B: *Bithynia candiota*, C: *Valvata studeri*, D: *Planorbis plaborbis*, E: *Gyraulus albus*, F: *Planorbarius corneus*, G: *Gyraulus crista*, H: *Anisus spirorbis*, I: *Anisus leukostoma*, J: *Anisus vortex*, K: *Bathyomphalus contortus* , L: *Segmentina nitida*, M: Planorbidae sp., N: *Lymnaea stagnalis*, O: *Galba truncatula*, P: *Carychium tridentatum*, Q: *Vertigo pygmaea*, R: *Oxyloma elegans*, S: Unionidae sp., T: *Acroloxus lacustris*, U–X: Sphaeriidae spp. All the scale bars represent 1 mm, except those in E and S which represent 1 cm.

only a few Sphaeriidae valves, 5 lymnaeids and some gastropod fragments were collected.

Area B: Sample 2 contained less shells than sample 1, even though they represent the same depositional event, with only 10 *V. cristata*, 2 *B. candiota* and 30 operculii.

On the contrary, sample 3 is the most shell-rich and diversified, with ~2,550 shells and ~2,000 operculii, and 15 taxa included. The majority of the shells belong to *V. cristata*, which reaches 60.9 %, *B. candiota* and *V. studeri*, with 20.0% and 12.7%, respectively. 5 *Unio* cf. *pictorum* valves were collected, as well as some large Unionidae fragments, and 10 Lymnaeidae shells.

22.3.4. KYPARISSIA-4

The lowest studied layer, UA6 is the richest of those examined with ~6,070 shells and ~6,000 gastropod operculii. In UA5, ~760 shells and ~900 operculii were collected, and in UA2 only 2 shells and 5 operculii. In UA2, only 1 species was found (*Valvata cristata*), though the operculii indicate at least 1 more gastropod species. UA5 contains at least 12 taxa and UA6 at least 17.

In UA5, *V. studeri* is the most abundant species (39.0%), while the presence of *V. cristata* is also significant (28.8%), and *B. candiota* comprises 21.8% of the total shells. *Galba truncatula* is represented with higher values, reaching 24 shells, in addition to 28 Lymnaeidae broken shells, belonging to *G. truncatula*, *Lymnaea stagnalis* and *Stagnicola palustris*.

In UA6, *V. cristata comprises* 44.8% of the shells and *B. candiota* 26.4%, while only 79 shells of *V. studeri* were found (only 1.3%). *G. truncatula* is common in this layer, as 400 shells were found (6.6% of shells).

22.4 DISCUSSION

Approximately 25,200 molusc specimens were collected, though the true number of shells is expected to be larger. The identified taxa are at least 28, indicating quite diverse molusc faunas. However, mainly three species predominate the samples: *Valvata cristata*, *Valvata studeri* and *Bithynia candiota*, which account for ~70% or more in most studied layers, indicating that their optimal conditions, of rich vegetation and well-oxygenated waters (see Schütt et al., 1985; Okland, 1990), prevailed during the time of their occurrence. The diversity of the faunas and the abundance of the three dominant species is supported by the observations of Schütt et al. (1985), who also reported *Valvata cristata* as one of the most common taxa in shallow areas in Choremi. Similarly, *B. candiota* and *V. studeri* were very commonly found by Schütt et al. (1985).

The molusc assemblages are similar across the three sites, without many significant variations except shell richness and species diversity. The majority of the taxa are aquatic, while those characteristic of terrestrial habitats are few and statistically unimportant in most layers, with a small differentiation in KYP-4; in this site there is a slight increase of terrestrial species (*Oxyloma elegans, Vertigo pygmaea, Carychium tridentatum*; Fig. 1) and of *Galba truncatula*, which is characterized as semiterrestrial (Sparks, 1961; Welter-Schultes, 2012). Another important point is that unionids, which indicate the presence of a river or a stream in the area and which are documented at MAR-1 and MAR-2, are absent from KYP-4.

22.5 CONCLUSIONS

The Middle Pleistocene molusc fauna of the Megalopolis Basin presents an important taxonomic diversity, comprised predominantly by aquatic

species. The aquatic taxa indicate habitats with well-oxygenated waters and rich in aquatic plants, while the main components of the fauna are for the most part similar in MAR-1, MAR-2 and KYP-4. Despite the similarities, a slight difference is observed at KYP-4, which shows a somewhat increased presence of terrestrial/semi-terrestrial species. Aiming to obtain more comprehensive paleoenvironmental interpretations, future directions of the analysis will focus 1) on the detailed comparisons both within the sedimentary units of each site's sequence and among the sites, and 2) on the incorporation of the existing or in progress results from sedimentological analyses and other paleoenvironmental proxies (e.g., Karkanas et al., 2018; Bludau et al., 2021; Butiseacă et al., this volume; Papadopoulou et al., this volume). Finally, the inclusion of additional material from other sites/stratigraphic horizons of the basin will improve the resolution and expand the chronological range.

ACKNOWLEDGMENTS

Excavation at Marathousa 1 was conducted by a team from the Ephorate of Palaeoanthropology-Speleology and the University of Tübingen. Research in Marathousa 2 and Kyparissia 4 were conducted under a permit granted to the Ephorate of Palaeoanthropology-Speleology, Hellenic Ministry of Culture, and the American School of Classical Studies at Athens. The projects were supported by the ERC Consolidator Grant ERC-CoG-724703 ("CROSSROADS") and the ERC Starting Grant ERC-StG-283503 ("PaGE"), both awarded to K.H. G.E.K., V.T. and K.H. are also supported by the Deutsche Forschungsgemeinschaft (DFG Project no. 463225251, "MEGALOPOLIS"). K.H. is also supported by the ERC Advanced Grant ERC-AdG-101019659 ("FIRSTSTEPS"). The microscopic samples were photographed with the help of V. Dimou. We would like to thank the reviewers G. Iliopoulos and I. Sylvestrou for their valuable comments and suggestions.

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