Hellenic Committee for Paleontology and Stratigraphy of the Geological Society of Greece

Interinstitutional Program of Postgraduate Studies in Paleontology-Geobiology

Proceedings

of the Conference

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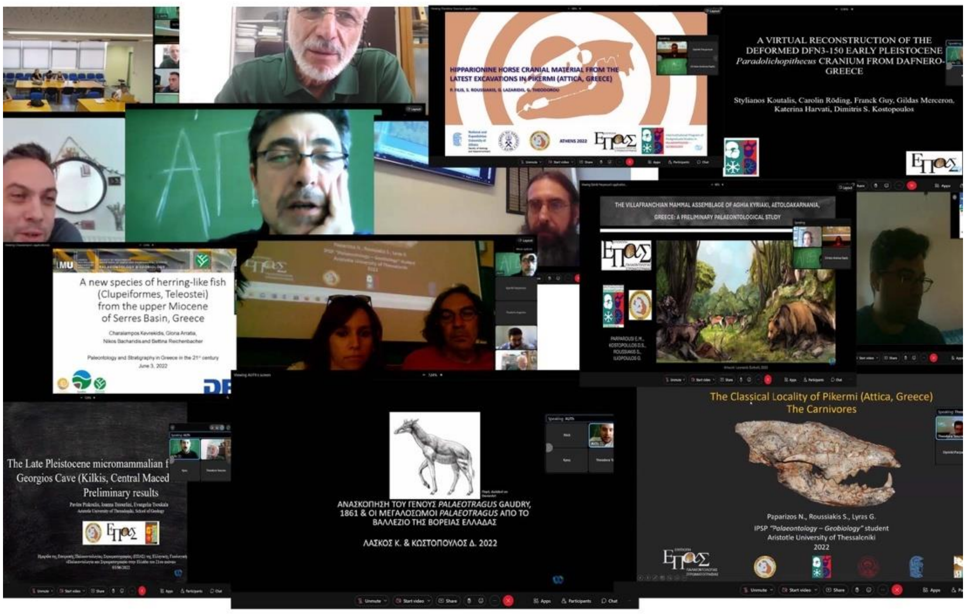
Επιστημονική Ημερίδα της Επιτροπής Παλαιοντολογίας-Στρωματογραφίας της Ελληνικής Γεωλογικής Εταιρείας

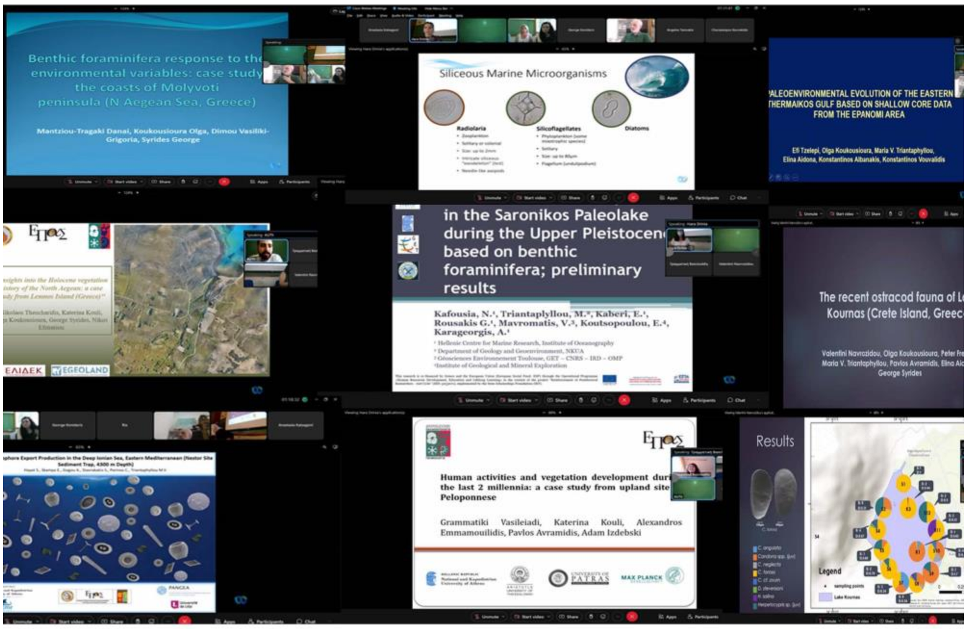
«Παλαιοντολογία και Στρωματογραφία στην Ελλάδα του 21ου αιώνα»

Με μεγάλο ενδιαφέρον και ανταπόκριση πραγματοποιήθηκε στις 3 Ιουνίου 2022, στο Τμήμα Γεωλογίας και Γεωπεριβάλλοντος, η υβριδική Επιστημονική Ημερίδα «Παλαιοντολογία και Στρωματογραφία στην Ελλάδα του 21ου αιώνα», που διοργάνωσε η Επιστημονική Επιτροπή Παλαιοντολογίας-Στρωματογραφίας (ΕΠΑΣ) υπό την αιγίδα της Ελληνικής Γεωλογικής Εταιρείας σε συνεργασία με το Διιδρυματικό Πρόγραμμα Μεταπτυχιακών Σπουδών «Παλαιοντολογία-Γεωβιολογία».

Μεγάλος αριθμός ερευνητών και μέλη της ακαδημαϊκής κοινότητας παρακολούθησε την Ημερίδα, διαδικτυακά μέσω της πλατφόρμας Webex, αλλά και δια ζώσης στα Τμήματα Γεωλογίας και Γεωπεριβάλλοντος του Εθνικού και Καποδιστριακού Πανεπιστημίου Αθηνών, Γεωλογίας του Αριστοτελείου Πανεπιστημίου Θεσσαλονίκης, Γεωλογίας του Πανεπιστημίου Πατρών και από το Ίδρυμα Τεχνολογίας και Έρευνας (ΙΤΕ)/Ινστιτούτο ΓεωΕνέργειας (ΙΓ).

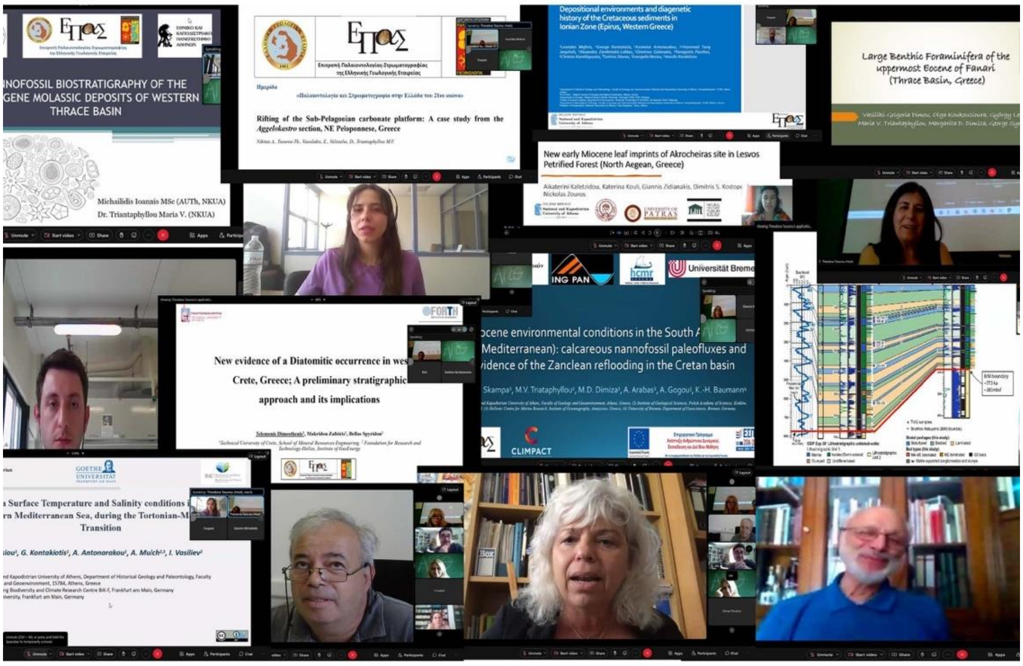


Η Ημερίδα αποτέλεσε ένα ακόμη βήμα στην προσπάθεια προβολής και προώθησης της ερευνητικής δραστηριότητας των νέων ερευνητών στο πεδίο της Παλαιοντολογίας και Στρωματογραφίας. Κατά τις εργασίες της Ημερίδας, 40 νέοι επιστήμονες και αναλυτικότερα 6 πρόσφατοι διδάκτορες/μεταδιδάκτορες, 5 κάτοχοι μεταπτυχιακού διπλώματος, 13 υποψήφιοι διδάκτορες και 16 μεταπτυχιακοί φοιτητές παρουσίασαν μια σειρά από πραγματικά ενδιαφέρουσες ομιλίες σχετικά με τρέχοντα και καινοτόμα ζητήματα Παλαιοντολογίας και Στρωματογραφίας, καθώς επίσης και την εφαρμογή τους στη σύγχρονη έρευνα των περιβαλλοντικών και γεωπεριβαλλοντικών επιστημών.



Χαιρετισμούς απηύθυναν η Αναπληρώτρια Πρόεδρος του Τμήματος Γεωλογίας & Γεωπεριβάλλοντος, του Πανεπιστημίου Αθηνών, Καθηγήτρια **κα Ασημίνα Αντωναράκου**, ο Πρόεδρος της Ελληνικής Γεωλογικής Εταιρείας, δόκτορας **κ. Αθανάσιος Γκανάς**, η Πρόεδρος της Επιτροπής Παλαιοντολογίας και Στρωματογραφίας, Καθηγήτρια **κα Μαρία Τριανταφύλλου** και ο Διευθυντής του Διατμηματικού Προγράμματος Μεταπτυχιακών Σπουδών «Παλαιοντολογία-Γεωβιολογία», Καθηγητής **κ. Δημήτριος Κωστόπουλος**.

Ευχαριστούμε θερμά τους ομιλητές, καθώς και όλους τους συμμετέχοντες για την παρουσία και συμβολή τους στην πραγματοποίηση της ημερίδας.



Βούληση και επίκεντρο των προσπάθειών μας αποτελεί, η συγκεκριμένη θεματική Ημερίδα να καθιερωθεί ως ετήσιος θεσμός στα πλαίσια των δραστηριοτήτων της Επιτροπής Παλαιοντολογίας-Στρωματογραφίας της Ελληνικής Γεωλογικής Εταιρείας.

Η Πρόεδρος της Επιτροπής Παλαιοντολογίας-Στρωματογραφίας
Καθηγ. Μαρία Τριανταφύλλου

Η Επιστημονική Επιτροπή: Καθηγ. Δ. Κωστόπουλος, Καθηγ. Α. Αντωναράκου, Καθηγ. Χ. Ντρίνια, Καθηγ. Ε. Κοσκερίδου

Γραμματεία: Αναπλ. Καθηγ. Μ. Δήμιζα

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Programme of the Conference

"Paleontology and Stratigraphy in Greece in the 21st century"

Hybrid meeting Friday 3 June 2022

Department of Geology and Geoenvironment, NKUA

9:00-9:30 *Welcome Speeches*

Prof. Assimina Antonarakou, Deputy Head of the Department of Geology and Geoenvironment, NKUA

Dr. Athanassios Ganas, President of the Geological Society of Greece

Prof. Maria Triantaphyllou, President of the Hellenic Committee for Paleontology and Stratigraphy

Prof. Dimitris Kostopoulos, Director of the IPSP Paleontology-Geobiology

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9:50-10:00 Benthic foraminifera response to the environmental variables: case study the coasts of the Molyvoti peninsula (N Aegean Sea, Greece)
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10:00-10:10 Paleoenviromental evolution of the eastern Thermaikos Gulf based on shallow core data from the Epanomi area (Greece)
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Investigating the effect of ocean acidification (natural and anthropogenic) on the size of *Emiliania huxleyi* from Late Holocene sediments of the North Aegean Sea (NE Mediterranean)

S. Apsemidou[1,2], E. Skampa[1], M.D. Dimiza[1], C. Parinos[3], A. Gogou[3], M.V. Triantaphyllou[1]

(1) Faculty of Geology and Geoenvironment, National and Kapodistrian University of Athens, Panepistimioupolis 15784 Zografou, Greece; apsemidou@geo.auth.gr

(2) School of Geology, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece

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The impact of ocean acidification on calcareous nannoplankton has been a topic of debate among researchers. This paper focuses to enrich the available data on coccolith size and calcification for the ubiquitous species *Emiliania huxleyi* and assess their connection to natural and anthropogenic environmental changes. The analysis is based on the high-resolution marine record M2 from Athos basin (Aegean Sea, Greece) (Fig. 1), with 80 samples being selected and processed in preparation for Scanning Electron Microscope (SEM) imaging. In total, about 4000 *E. huxleyi* coccoliths have been inspected under the SEM and their morphometric values have been calculated.

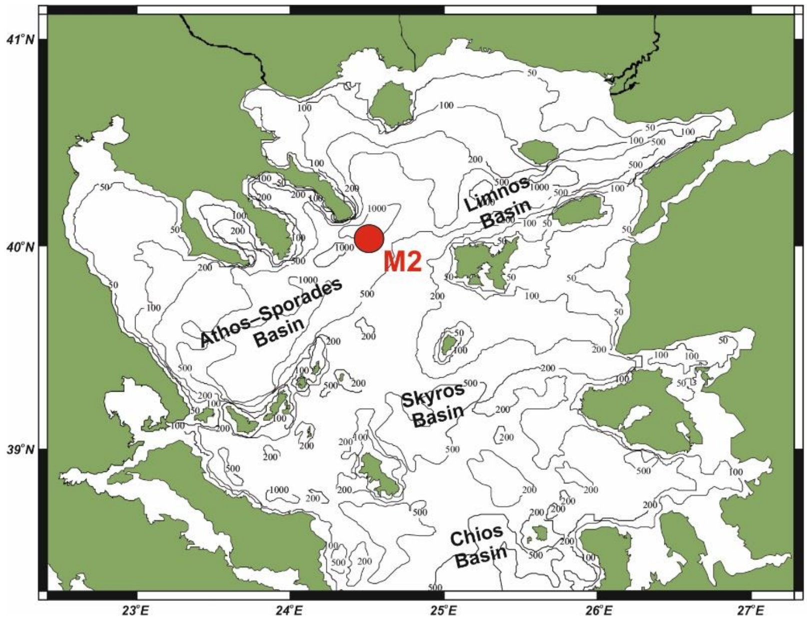

Figure 1. Location map of the study area in the North Aegean Sea (modified from Dimiza et al., 2020).

Compared with the age model and multiproxy analyses of previous studies in this same area (Gogou et al., 2016; Skampa et al., 2019; Dimiza et al., 2020), there are evidence mostly based on the Relative Tube Width (RTW; Young et al., 2014) for a tendency towards slightly increased calcified coccoliths within the Little Ice Age (c. 1200-1850 AD). Afterwards, during the Instrumental Period (c. 1850-present) values show a decreasing trend (Fig.2). In the latter period indices such as Sea Surface Temperature (SST) have been documented to also reach maximal values of the last 1500 years (Gogou et al., 2016). It is very likely that human activities, especially in the last century, have affected the marine equilibrium with higher atmospheric CO_2 absorption, environmental parameters changes and depletion of bioavailable carbonate ions. Although naturally induced environmental changes in the Northern Aegean could mask the clear effect of ocean acidification on *E. huxleyi*, our data may contribute to a potential tool for environmental monitoring in the context of tackling climate change.

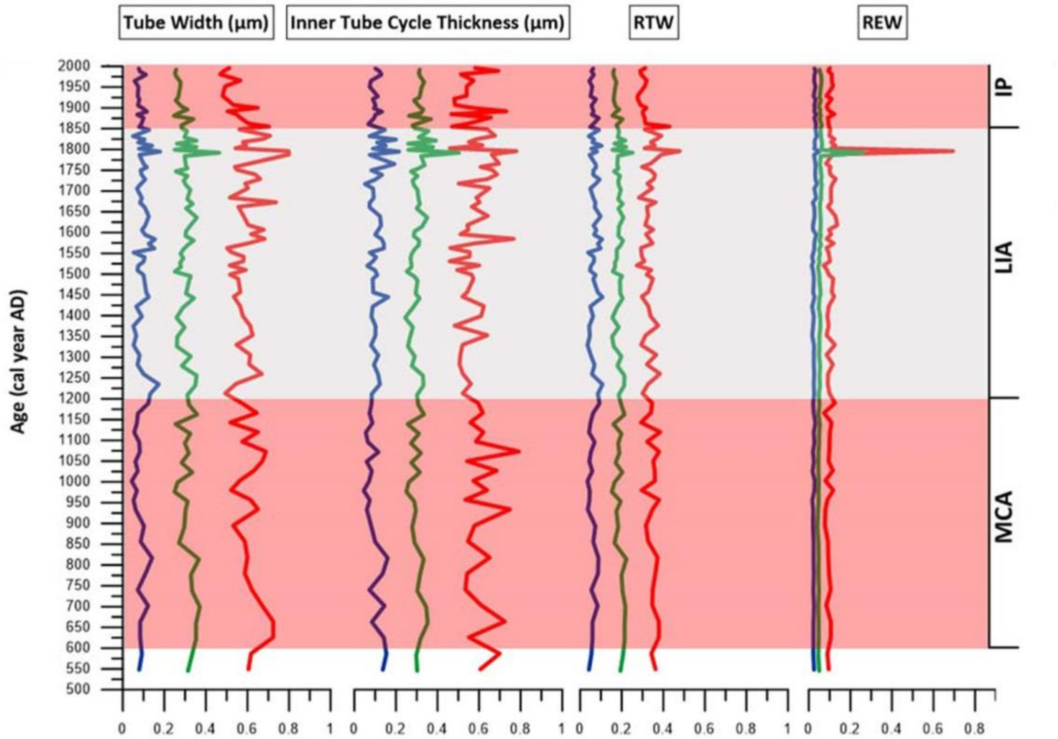

Figure 2. Morphometric parameters of *Emiliania huxleyi* coccolith from the M2 record, with minimum (blue), average (green) and maximum (red) values of Tube Width (TW), Inner Tuble Cycle Thickness at the long axis (INTL), Relative Tube Width (RTW) and Relative Element Width (REW).

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The Pindos paleo-biota (Greece) provide insights into the Cretaceous–Paleogene marine pelagic ichthyofaunas of the Tethys

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The effects of the Cretaceous–Paleogene (K–Pg) Extinction on marine vertebrates –teleosts in particular– and ecosystems are still incompletely understood. This is largely owed to the poor quality and scarcity of the global body-fossil record of the clade from the Maastrichtian–Paleocene interval (Argyriou and Davesne, 2021). The largest portion of the fossil record of Tethyan 'fishes' from the K–Pg corresponds to disarticulated material of limited systematic informativeness, coming from high-energy platform environments.

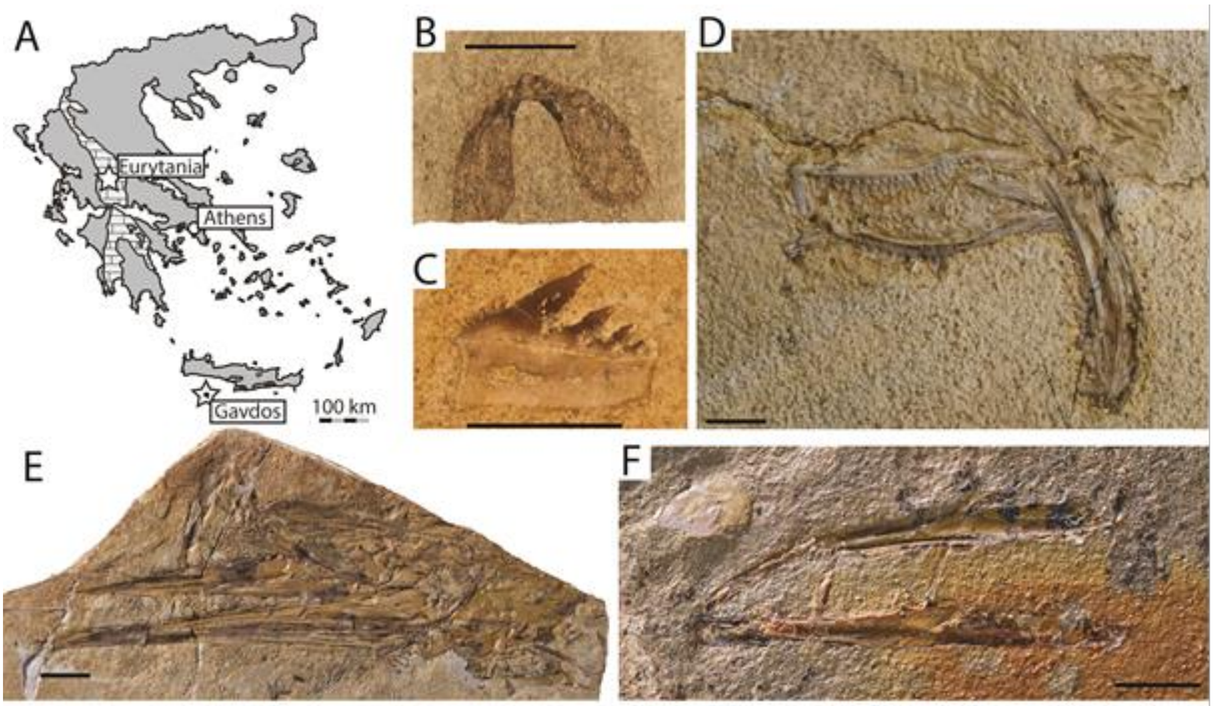

Figure 1. Examples of new fossil findings from the Maastrichtian–Paleogene deposits of the Pindos Unit in Greece. A. Map of Greece with the Pindos Unit and investigated localities plotted; B. Non-mineralized lower 'jaw' of †teudopsein coleoid (late Maastrichtian, Eurytania); C. tooth of the hexanchid shark †*Gladioserratus* sp. (mid–late Maastrichtian, Gavdos); D. palate and lower jaw of the newly recognized †enchodontid teleost †*Calypsoichthys pavlakiensis* (mid–late Maastrichtian, Gavdos); E. skull of the newly recognized †ichthyotringid teleost †*Ichthyotringa pindica* (late Maastrichtian, Eurytania); F. lower jaws of a possible stomiiform teleost (?Paleocene, Eurytania). Scale bars equal 10 mm.

Recent paleontological prospecting and excavations in the sedimentary successions of the Pindos Unit in continental and insular Greece yielded fossil fish assemblages from both sides of the extinction boundary. New semi-articulated fossils from the mid–late Maastrichtian of Gavdos Island and Eurytania in continental Greece help complete the picture of the extinction baseline of marine 'fishes' from the Tethys, especially with regards to those inhabiting deep/open-water paleoenvironments. When all Pindos sites are treated collectively, a minimum of three chondrichthyan (belonging to Hexanchiformes and Lamniformes) and 14 teleost (belonging to †Ichthyodectiformes; Elopomorpha; Aulopiformes; ?†Sardinioididae, and other indeterminate groups) morphotypes are shown to be present (Argyriou and Davesne, 2021; Argyriou et al., 2022). Based on geological data, the gross anatomy of fossils, as well as the lifestyle of modern representatives of higher taxa recognized as fossils, we conclude that Pindos ichthyofaunas, at least those of Maastrichtian age, sample animals inhabiting different niches in the water column, ranging from epipelagic to bathydemersal (Argyriou and Davesne, 2021; Argyriou et al., 2022). The newly available fossil sample allows for the recognition of two new aulopiform taxa. Additionally, it helps extend the stratigraphic range of several families into the Maastrichtian, implying a previously unrecorded Late Cretaceous higher-taxonomic continuum, instead of a staged decline, of offshore ichthyofaunas. Additional information on the status of Tethyan open-water marine ecosystems comes from the rich findings of non-mineralized 'beak' elements of cephalopods, including †ammonoids, coleoids of possible vampyropod affinities and †belemnoids, from the late Maastrichtian horizons of the Pindos Unit in Eurytania (Klug et al., 2020). Congruently with information from vertebrates, these elements reveal the presence of typical Mesozoic ecosystems, along with possibly complex food chains, at the very end of the Cretaceous in the deep waters of the Tethys (Klug et al., 2020). Scant ?Paleocene fossil 'fish' findings from the Pindos Unit come from a single site in Eurytania. These include a clupeid, a putative stomiiform, as well as indeterminate teleost remains, but represent one of the few records of earliest Cenozoic marine teleosts from the Tethys (Argyriou and Davesne, 2021). This presentation summarizes these new discoveries and their implications for understanding the K–Pg turnover in the Tethyan Realm and beyond.

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Athens, June 3, 2022 | Department of Geology and Geoenvironment, NKUA
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Sea Surface Temperature and Salinity conditions in the Eastern Mediterranean Sea, during the Tortonian-Messinian Transition

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The eastern Mediterranean is one of the best natural laboratories to study severe changes in the long-term hydrological cycle. At the Late Miocene the region was affected by significant changes preceding the Messinian Salinity Crisis (MSC; 5.97-5.33 Ma) (Ryan, 1973; Krijgsman et al., 1999). Restricted environmental conditions started well before the MSC being expressed by the fluctuations in water bodies salinity, variations of sea surface temperature and isotopic changes, during the Tortonian-Messinian Transition (e.g Cita, 1978). In the present study, we present an integrated study based on geochemical and biomarkers data from Potamida section (Crete Island, eastern Mediterranean) (Fig. 1).

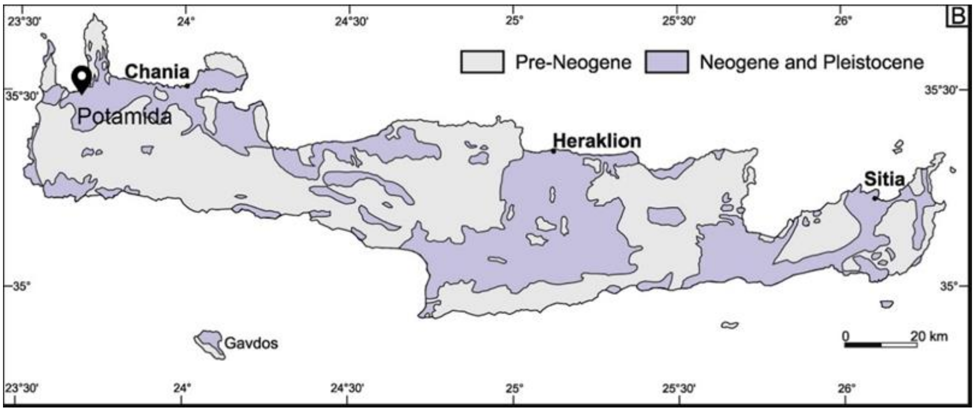

Figure 1. Geological sketch map of Crete island and location of the study section, Potamida section.

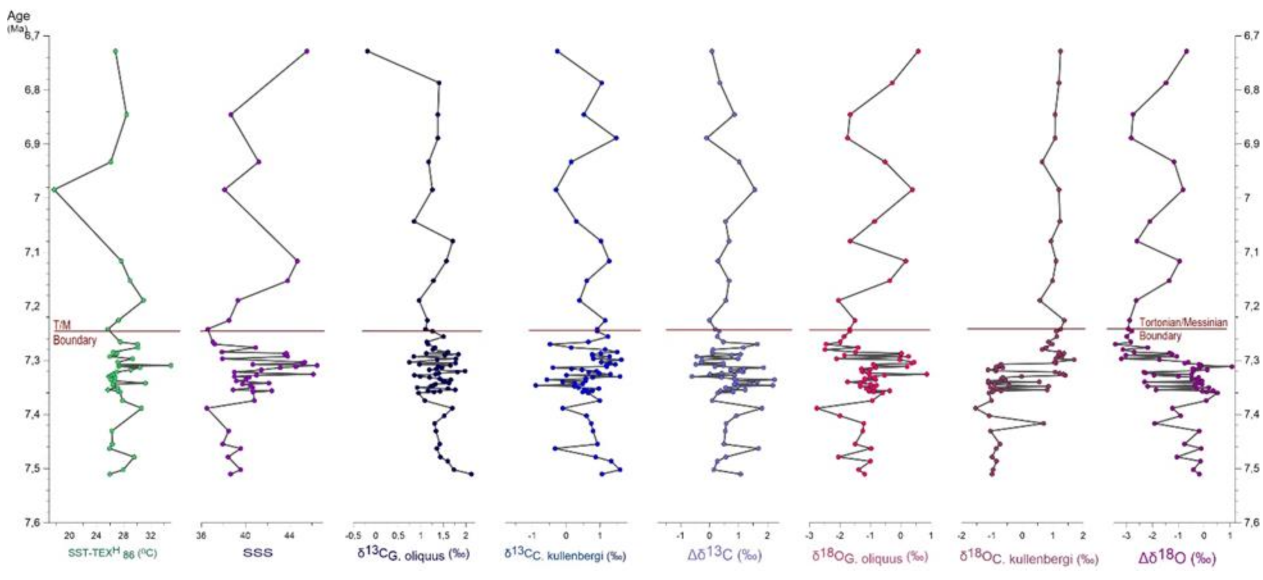

Figure 2. Potamida A) Sea surface temperature calculated based on TEX^H_{86} (SST-TEX^H_{86}); B) sea surface salinities (SSS) based on SST TEX^H_{86} and $\delta^{18}O_{G. Obliquus}$; C) $\delta^{13}C$ measured on *Globigerinoides obliquus* ($\delta^{13}C_{G. Obliquus}$) and on *Cibicides kullenbergi* ($\delta^{13}C_{C. Kullenbergi}$), $\Delta\delta^{13}C$; D) δ18O measured on *Globigerinoides obliquus* (δ18O*G. obliquus*) and on *Cibicides kullenbergi* ($\delta^{18}O_{C. Kullenbergi}$), $\Delta\delta^{18}O$.

Specifically, carbon ($\delta^{13}C$) and stable oxygen ($\delta^{18}O$) isotopes measured on both benthic and planktonic foraminifera (*Cibicides kullenbergi* and *Globigerinoides obliquus*). Firstly, the $\delta^{13}C$ results show a trend to lighter values as an excellent illustration of the Late Miocene Carbon Isotope Shift (LMCIS; 7.6-6.6 Ma) due to progressive restriction of the Mediterranean basin, with the exception of the 7.38-7.26 Ma time interval where significantly heavier $\delta^{13}C$ values are documented in both records. Such changes in carbon cycle seem to be most pronounced in the planktonic foraminiferal record (surface waters) through a 6-cycle development indicative of a cyclic productivity pattern during the latest Tortonian. Furthermore, the $\delta^{18}O$ data display a remarkable decoupling between the deep and surface water masses occurring at the latest Tortonian. The resulting difference between planktonic and benthic oxygen isotope signals ($\Delta\delta^{18}O$) further indicate an estimate of the degree of water column stratification during that time. The study records are completed by sea surface temperature (SST) estimates based on TEX_{86} biomarker based proxy (Brassell et al., 1986; Schouten et al., 2002).. The reconstructed SSTs indicate warm sea surface waters with average temperatures of 27^{o}C, during latest Tortonian. Afterwards, a significant steady cooling event is observed at the onset of Messinian, when the SSTs dropped to values as low as 20^{o}C. The salinity data resulted of the combined stable isotope and biomarker based SST data, showing an increasing trend on surface waters already before the Messinian, while at the Tortonian-Messinian Transition, the conditions in the surface waters changed towards cooler (~24^{o}C) and normal salinity conditions (Fig. 2).

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Paleoecological analysis and environmental interpretation of Pliocene sediments from Kefallonia Island (Ionian Sea, Greece) based on ostracod assemblages

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The aim of this study is to contribute to the palaeoenvironmental interpretation of the Pliocene sediments of the Katelios section by the thorough palaeoecological analysis of ostracod assemblages. The study area is located on the southeastern coast of Kefallonia Island (Ionian Sea, Greece). Katelios section is part of the Katelios sequence, which is located immediately below the Ionian thrust on Kefallonia Island. It is approximately 70 m thick and it consists of marls alternating with sandy layers and marly limestones. The biostratigraphical analysis with calcareous nannofossils (Triantaphyllou et al., 2010) assigned the Katelios section to the Late Zanclean, within the NN14-15 nannofossil biozone (4.12-3.839 Ma).

A total of 15 samples were prepared for the ostracod analysis. About 100g from each sample were disaggregated with H_2O_2 solution, washed over a 0.125 mm mesh sieve, and the residues were oven-dried at approximately 50 °C. When possible, at least 200 ostracod valves were hand-picked from each sample, identified and counted and a detailed quantitative and qualitative micropaleontological analysis was performed.

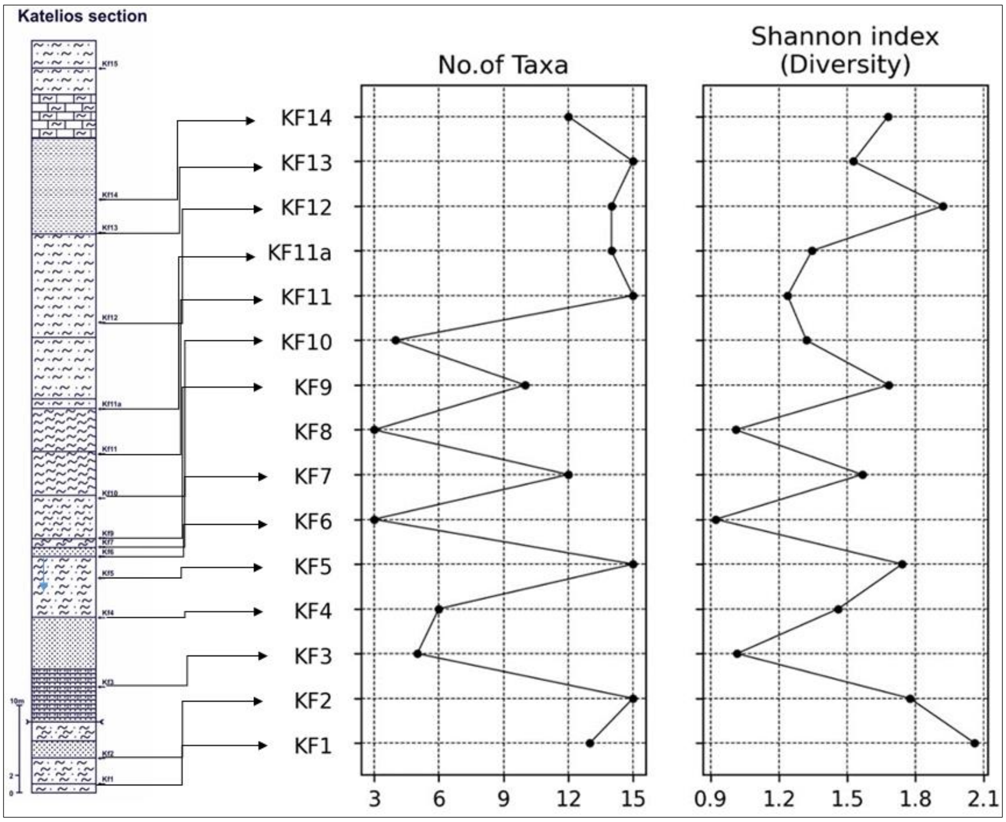

Figure 1. Distribution of ostracod assemblage indices along Katelios section.

36 ostracod species were identified, but most of them have a scarce presence in the samples. Ostracod assemblages are consisting mainly of *Aurila* species (43.75-91.37%), accompanied by species of *Xestoleberis*, *Callistocythere* (mainly *C. crispata*) and *Loxoconcha* (mainly *Loxoconcha* cf. *L. ovulata*), pointing to a shallow marine environment in the infralittoral zone. Towards the top of the section, assemblages are characterized by the increased presence of deeper marine taxa such as *Acanthocythereis hystrix*, *Buntonia sublatissima*, *Pterygocythereis jonesii*, *Ruggiera tetraptera*, *Henryhouwella asperrima*. Concerning ostracod assemblage

indices (Fig. 1), the number of taxa and Shannon diversity index present higher and more consistent values for the upper part of the section.

Species composition and the diversity indices of the ostracod assemblages indicate a deepening trend in the marine environment. This is in accordance with the preliminary results of Triantaphyllou et al. (2010) based on benthic foraminifera and dinoflagellate cysts.

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First occurrence of *Pliorhinus megarhinus* (Mammalia, Rhinocerotidae) in Greece

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Although Late Miocene Greek rhinoceroses are well diversified and known- by rich material as that from Pikermi, Axios Valley and Samos, they are poorly known from the Greek Pliocene, recorded as a whole in only 6 fossil sites. Two localities, Maramena in Serres basin and Nea Silata in Chalkidiki, dated at the Miocene-Pliocene boundary, provided a few specimens assigned to Rhinocerotidae indet. Stephanorhinus jeanvireti is reported from the Upper Pliocene localities of Milia, Angelochori and Saint George Priporos. Stephanorhinus sp. is recorded in the Upper Pliocene lower fossil layers of Sesklo and Rhinocerotidae indet. in the Lower Pliocene site of Apollakia in Rhodes Island (Giaourtsakis, 2022). Finally, Pliocene rhino material is also known from the here studied locality of Allatini, near Thessaloniki.

The Allatini fossiliferous clays belong to the Trilophos Formation, which is referred as of Lower Pliocene age and in particular to the Ruscinian in mammal biochronology. The site is located in East Thessaloniki and named after a private company that exploited clay pits (Syrides, 1990). The single rhino specimen from this site is labeled as "Rhinoceros" in the LGPUT collection and was previously ascribed as Rhinocerotidae indet. by Giaourtsakis (2022).

Order **Perissodactyla** Owen, 1848

Family **Rhinocerotidae** Gray, 1821

Subfamily **Rhinocerotinae** Gray, 1821

Tribe **Rhinocerotini** Gray, 1821

Subtribe **Rhinocerotina** Gray, 1821

Genus ***Pliorhinus***, Pandolfi et al., 2021

Type species: *Pliorhinus megarhinus (*de Christol, 1834)

Pliorhinus megarhinus (de Christol, 1834)

The specimen from Allatini is represented by a well-preserved right radius (Fig. 1, A), belonging to a sub-adult individual since the suture between the distal epiphysis and the diaphysis is not completely fused. The radius is morphologically and biometrically compared with published specimens from Eurasian Pliocene localities.

During Pliocene, rhinocerotids are documented by the genera of *Stephanorhinus* and *Pliorhinus,* with four species present in Europe; *P. megarhinus, P. miguelcrusafonti, S. jeanvrieti,* and *S. etruscus. P. megarhinus* is large size rhinoceros, which preserves a massive skull and wide thick nasal bones without nasal septum (Pandolfi et al., 2021). There is no record of this species in Greece yet. The species *P. miguelcrusafonti* is chronologically restricted, limited to a few Spanish French, and Georgian localities. This medium to small sized Pliocene species is larger than *S. etruscus* but smaller than the rest of the Pliocene species*. S. etruscus* and *S. jeanvireti* first found in MN16a throughout Europe. The first one is a slender, small sized rhino, more cursorial with head posture suggesting a primarily browsing diet, low crowned teeth, and shallow joints suggesting locomotion in open woodlands. It is one of the most abundant species in Europe, first appearing in the latest Pliocene and thriving until the Early-Middle Pleistocene transition. *S. jeanvireti* is a much larger sized, but still slender rhino, with browsing dominated diet.

The proportions of the distal epiphysis of the Allatini radius (Fig. 1, B) clearly distinguish it from the range of the smaller *S. etruscus* and *P. miguelcrusafonti.* The specimen of Allatini is close to the minimum values of *P. megarhinus* and within *S. jeanvireti* size range. Nevertheless, in proximal view the more marked concavity in the anterior border and in distal view, and the more convex posterior border of the articular surface for the scaphoid, are characters that discriminate it from *S. jeanvireti* and approach it to *P. megarhinus.*

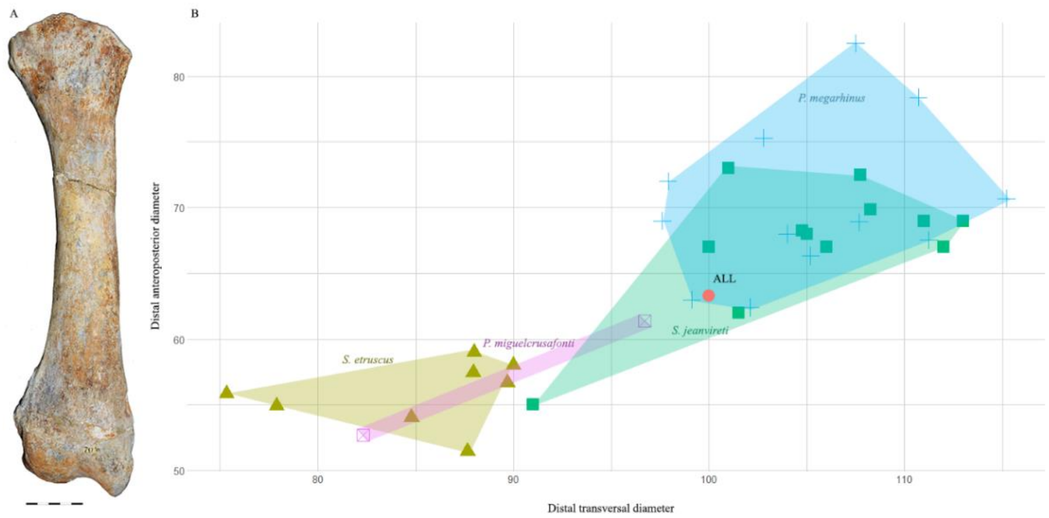

Figure 1. A. *P. megarhinus* from Allatini, in anterior view, scale bar 5 cm. B. Scatter plot of distal antero-posterior diameter and distal transversal diameter of the radius (in mm), data from published records of Eurasian rhinoceros bearing localities.

The biometrical and morphological comparison of the radius from Allatini, resulted its attribution to *Pliorhinus megarhinus,* which represents the first occurrence of this taxon in Greece. Nevertheless, the poorly known stratigraphy and chronology of the site restrict any further conclusion. In a broader view, the younger occurrence of *P. megarhinus* in Russia, allowed Fukuchi et al. (2009) to suggest that the taxon dispersed directly from Europe to Asia. This hypothesis, is however, challenged by Pandolfi et al. (2015) who advocates that *P. megarhinus* may have persisted longer in Asia, and therefore this species could have spread from Asia to Eastern Europe during the Late Miocene. The presence of *P. megarhinus* in the Early Pliocene of Greece, is rather in agreement with the later hypothesis. Nevertheless, further studies and material in needed for certain conclusions.

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Early Pleistocene nannofossil biostratigraphy in Rhodes Island, Aegean Sea

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In this study we present the biostratigraphy of calcareous nannofossils on the island of Rhodes, southeastern Aegean Sea, eastern Mediterranean during the Late Pliocene to Early Pleistocene, namely the analysis of 44 samples from three geological sections of the island: Agathi beach, Plimiri 5, Plimiri 6 (Fig. 1B). The identification of representative nannofossil index-species of Pliocene and Pleistocene time intervals, such as the specimens of various sizes that belong to genus *Gephyrocapsa* (<4μm, ≥4μm, >5.5μm) and the species *Calcidiscus macintyrei, Helicosphaera sellii, Pseudoemiliania lacunosa* etc. as well as the specimens that classify to genus *Discoaster* provide a detailed biostratigraphic and chronostratigraphic assignment of the investigated deposits.

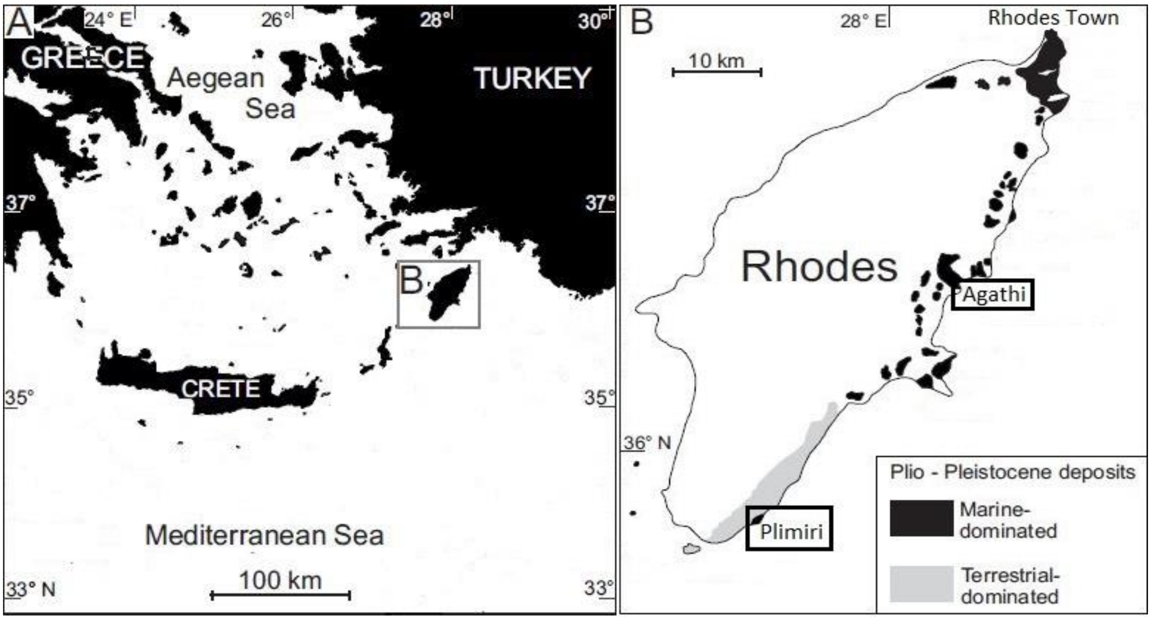

Figure 1. (A) Map for Rhodes Island (Greece) located between the southern Aegean and eastern Mediterranean Seas. (B) Plio-Pleistocene sediments on Rhodes Island, distinguished as marine and terrestrial dominated (modified from Meulenkamp et al. 1972; Hanken et al. 1996). The study areas are also shown in frames.

Here some preliminary biostratigraphic results are presented. The Agathi beach section is featured by the presence of *Gephyrocapsa* >4μm in percentages up to 25 gephyrocapsids in 100 placoliths, as well as the presence of *Calcidiscus macintyrei* (up to 72 individuals in 100 *Calcidiscus*) and *H. sellii* (up to 48 individuals in 100 *Helicosphaera*), thus assigned in the lower part of CNPL8 (NN19 of Martini (1971) biozone (Backman et al., 2012) in the Calabrian. (Fig. 2A). The Plimiri 6 section does not contain significant number of normal sized gephyrocapsids, hence, in conjunction with the high percentages of *Calcidiscus macintyrei* (up to 64 individuals in 100 *Calcidiscus)* we conclude that it belongs to CNPL7 (NN19 of Martini (1971)) biozone at the Gelasian/Calabrian boundary in the Early Pleistocene (Fig. 2B). The Plimiri 5 section samples are characterized by the presence of common *Discoaster tamalis* (up to 48%) and *Discoaster asymmetricus* (up to 30%), as well as the presence of *Discoaster pentaradiatus* (up to 70%), thus belonging to NN16 biozone of Martini (1971) correlated to CNPL4 biozone according to Backman et al. (2012). This points to Piacenzian age (Late Pliocene) (Fig. 2C).

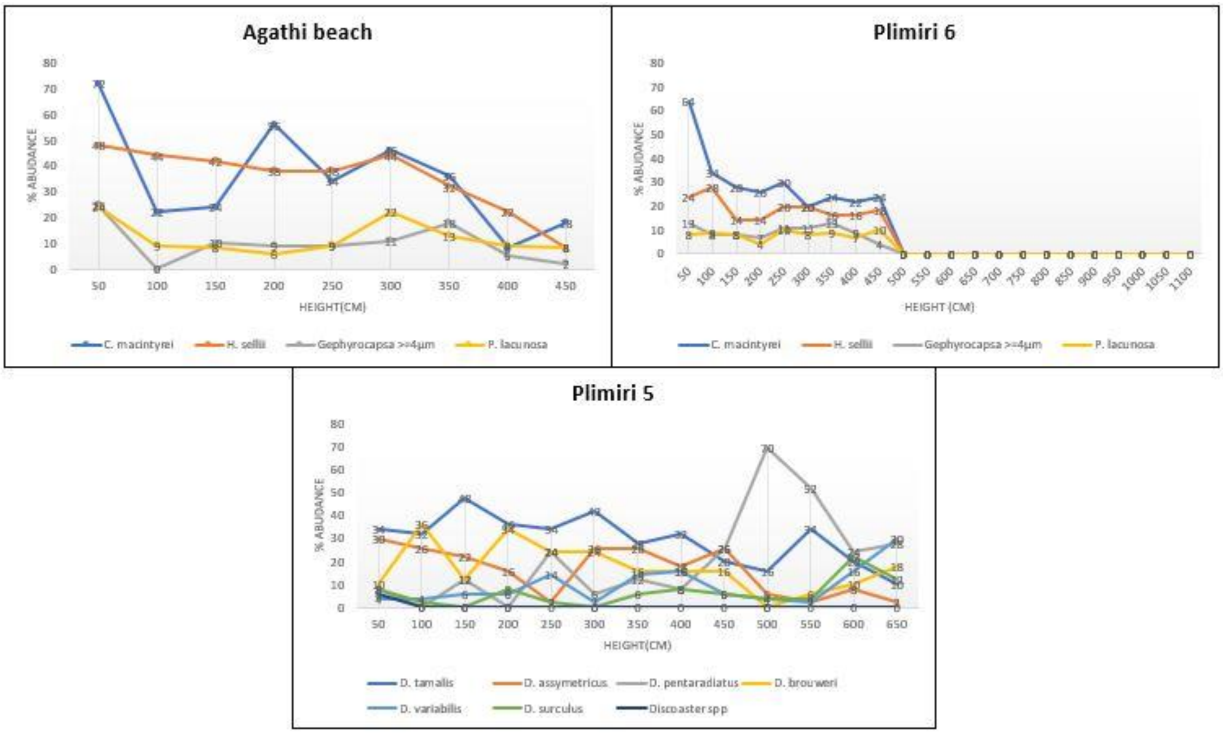

Figure 2. (A & B) Relative abudance of Pleistocene index-species at Agathi beach and Plimiri 6 sections. (C) Relative abundance of Pliocene index-species (Discoaster) at Plimiri 5 section.

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Large Benthic Foraminifera of the uppermost Eocene of Fanari (Thrace Basin, Greece)

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Paleogene sedimentary deposits are exposed in several localities along the extended Thrace Basin in the Greek territory. One of the best sites in terms of preservation, richness and type of sediment occurs 30 km southwest of Komotini city, in the coastline of Fanari village (Fig. 1). Two outcrops, which consist of shallow marine deposits accumulated during the latest stage of the Eocene, have been sampled. They comprise in general fossiliferous sandstones and siltstones that are rather continuous. Their displacement is related to a fault system. Stratigraphical sections (FAN A-lower part, FAN B-upper part) were studied to analyze and interpret the paleontological content and its variations.

In total 21 samples from the sandstone and siltstone were collected. The macro- and micro-faunal content was extracted after soaking in water and H_2O_2 (70%) and wet sieving. Subsequently, plethora of the recovered LBF specimens were submitted to the standard preparation techniques for their dichotomy. More than 1000 specimens have been elaborated (thin sections/bisected). The identifications (description and conducted measurements) are based on several studies (e.g., Schaub in Less, 1998; Özcan et al., 2022).

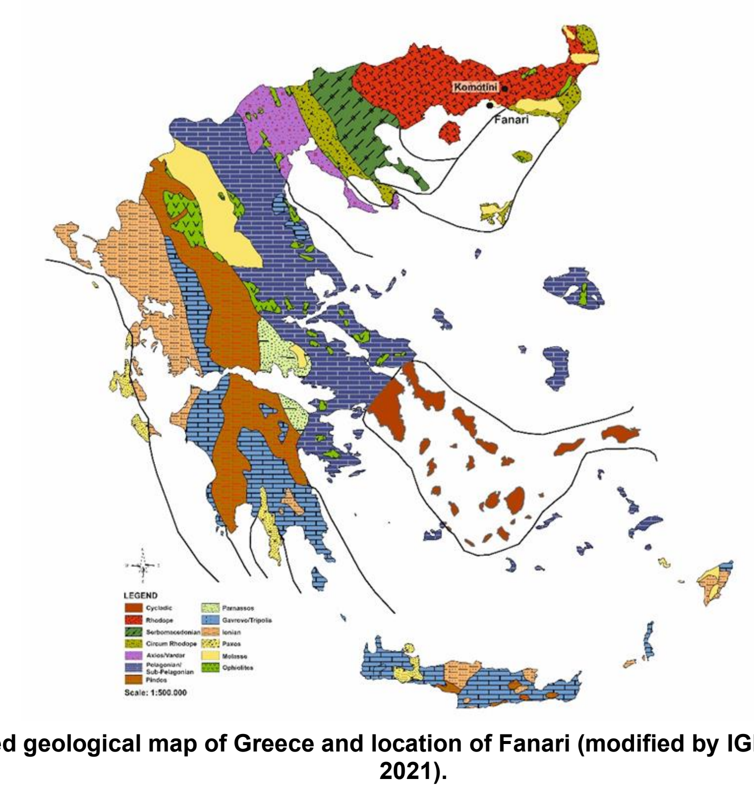

Figure 1. Generalized geological map of Greece and location of Fanari (modified by IGME, 1983 and Dimou et al., 2021).

According to the detailed systematic description twenty-four species and six subspecies belonging to twelve genera have been identified and most of them for the first time in the area. Moreover, almost all of them have been under biometrical analysis for the first time from Greece. The large benthic foraminifera comprise a rich and diverse assemblage of orthophragmines (*Discocyclina*, *Orbitoclypeus* and *Asterocyclina*), nummulitids (*Nummulites*, *Assilina*, *Operculina*, *Heterostegina* and *Spiroclypeus*), and other benthic taxa (e.g., *Silvestriella*, *Pellatispira*, *Fabiania, Sphaerogypsina,* etc.). In both sections macrofauna is also present. It is represented by both regular and irregular echinoids (whole tests, spicules and fragments), corals (individuals and fragments of colonies), bryozoans, bivalves and gastropods (whole tests, fragments and casts), serpulid bioconstructions, ostracods and fish bones. The sequence is characterized by the constant presence of *Nummulites fabianii*, although the most abundant species is *Pellatispira madaraszi* that occurs in the upper part of the sequence. Orthophragmines and *Spiroclypeus carpaticus* occur also in the upper part of the sequence.

The first occurrence of both *Heterostegina gracilis* and *Spiroclypeus carpaticus* is documented already from the lower layers of the sequence and occur through the top ones. This fact enabled us to place FAN A and FAN B sections within the stratigraphic framework, as the whole sequence is assigned to the SBZ 20 larger benthic foraminiferal zone of Serra-Kiel et al. (1998), indicating the upper part of the Priabonian. The foraminiferal assemblage also allowed us to make paleoenvironmental observations and reconstruct the evolution of Fanari area. Three main depositional marine shelf facies were distinguished that operated along the carbonate platform before its demise took place (Setawian, 1983).

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QECCORA: Quaternary environmental shifts in the Corinth Gulf (Greece)

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The sedimentary record of site M0078, located in the Gulf of Corinth, central Greece, was retrieved within the IODP Exp. 381. The Corinth Gulf is a semi-enclosed basin, sensitive to Quaternary climatic changes and sea level fluctuations and was repeatedly isolated and reconnected to the Mediterranean Sea (McNeil et al., 2019; Nixon et al., 2016). The area holds a long record of syn-rift sedimentation, with the earlier rifting phase being exposed onshore, while the younger phase deposits are found within the Gulf. Systematic palynological analysis was performed aiming to investigate the glacial-interglacial vegetation history, to constrain the refugial character of the Gulf, and to distinguish environmental changes from the alternations between marine, transitional, and isolated intervals and its impact on local ecosystems. The microscopic analysis of ~ 300 samples from the upper part of the M0078 sedimentary sequence recorded the occurrence of rich and diverse pollen, dinoflagellate cysts and NPPs assemblages.

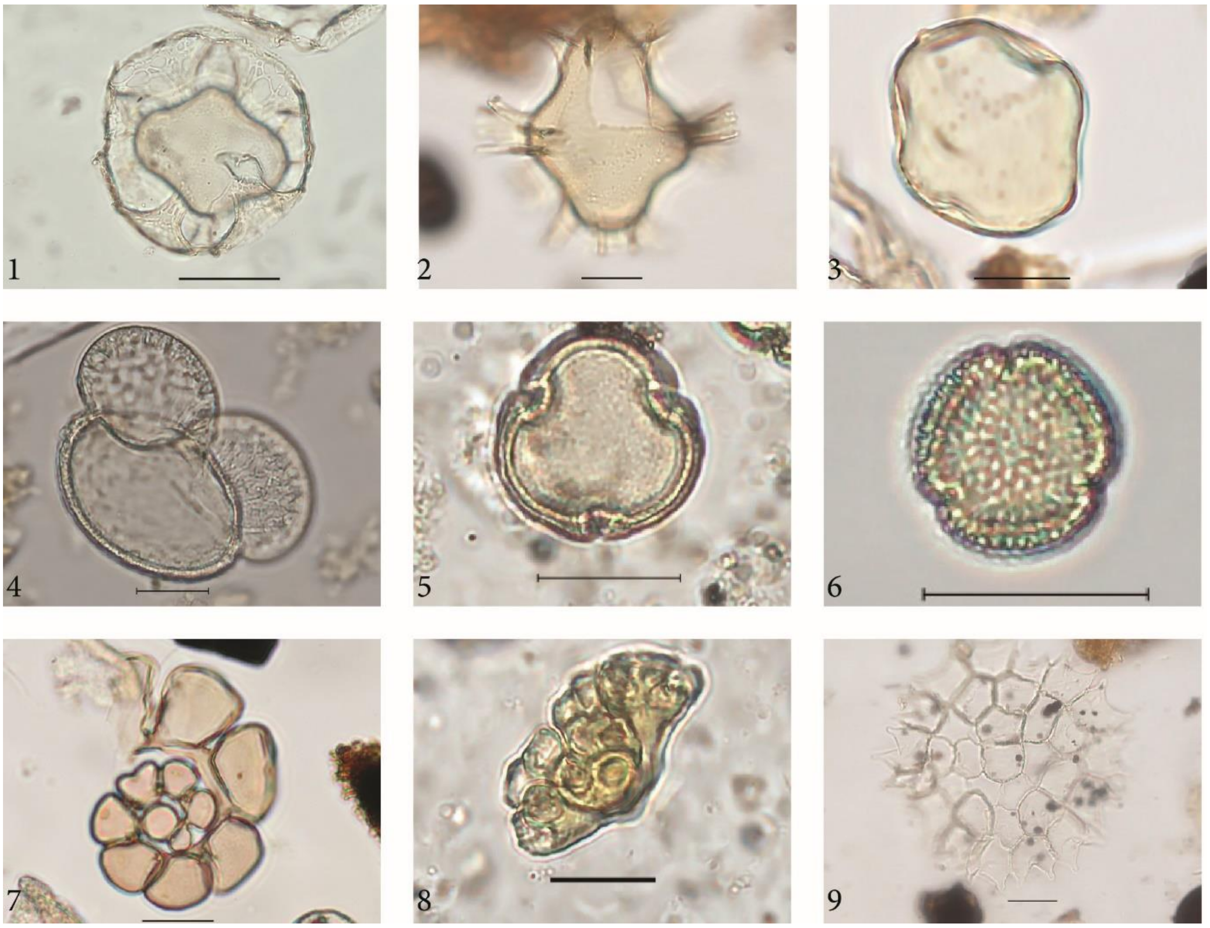

Plate 1. 1-2: *Spiniferites cruciformis*, 3: *Pyxidinopsis psilata*, 4: *Pinus*, 5: *Tilia*, 6, *Olea*, 7: Foraminifera linings, 8: *Botryoccocus*, 9: *Pediastrum boryanum*. Scale bar: 10μm

The dinoflagellate cysts are sorted into two major ecogroups presenting alternations between marine and isolated/brackish conditions in the Gulf in response to global sea-level changes and can be correlated to global Marine Isotope Stages (MIS). Dinocysts are an excellent proxy for paleoenvironmental reconstructions, as they thrive in a wide range of climatic conditions (Mudie et al., 2017). The alternations between marine and low salinity conditions recorded in the Corinth Gulf reveal changes in surface water salinity (SSS) and temperature (SST), in response to the Quaternary glacial – interglacial cycles. These seem to be in good agreement with global sea-level changes and trace orbital driven climate shifts as shown in the global Marine Isotope Record.

At this Mediterranean setting, the vegetation response during these glacial/interglacial cycles appears to be more complex in comparison with the aquatic ecosystem. The pollen assemblages exhibit unique shifts of the vegetation composition in response to climate variability millennial scale since the Middle Pleistocene. Interglacial (glacial) intervals show high (low) terrestrial pollen concentration suggesting an increase (decrease) in plant biomass and vegetation cover, which is typical in most southern European records. However, the glacial intervals retain surprisingly high percentages of both mesophilous and Mediterranean vegetation components, that has not been previously reported. Another interesting feature about the Gulf is the presence of several Neogene relict tree taxa which approve the refugial character of the Corinth Gulf area. The comparison of the vegetation succession of the Corinth Gulf record with to the reference ICDP site of Lake Ohrid, located 500km in the north (Sadori et al., 2016; Donders et al., 2021), highlight the similarities and differences of the vegetation succession along the Balkan Peninsula.

Acknowledgements

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Hipparionine horse cranial material from the latest excavations in Pikermi (Attica, Greece)

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Pikermi is one of the most important fossiliferous localities of Europe. Numerous excavations, conducted in the area from the middle of the 19th century until today, have unveiled a rich and diverse mammal fauna of Turolian age. Hipparionine horses (Tribe: Hipparionini) are among its most common representatives (Koufos, 2022). This group is composed of tridactyl horse species belonging to the genus *Hipparion* and various similar forms. They originate from the middle Miocene of North America and are considered to be among the descendants of the equid group known as Merrychippines (Alberdi, 1989) -which are recognized as the first grazing horses.

The present work concerns the study of craniodental material belonging to individuals of the tribe Hipparionini, from the PV1, PV3 and PV4 excavation sites in Pikermi, Attica. The aforementioned sites are part of the newest series of systematic excavation campaigns in the area, conducted by the National and Kapodistrian University of Athens since 2008, under the auspices of the Rafina-Pikermi Municipality (NKUA-SARG project no. 70/3/12977; Theodorou *et al.*, 2010, 2013).

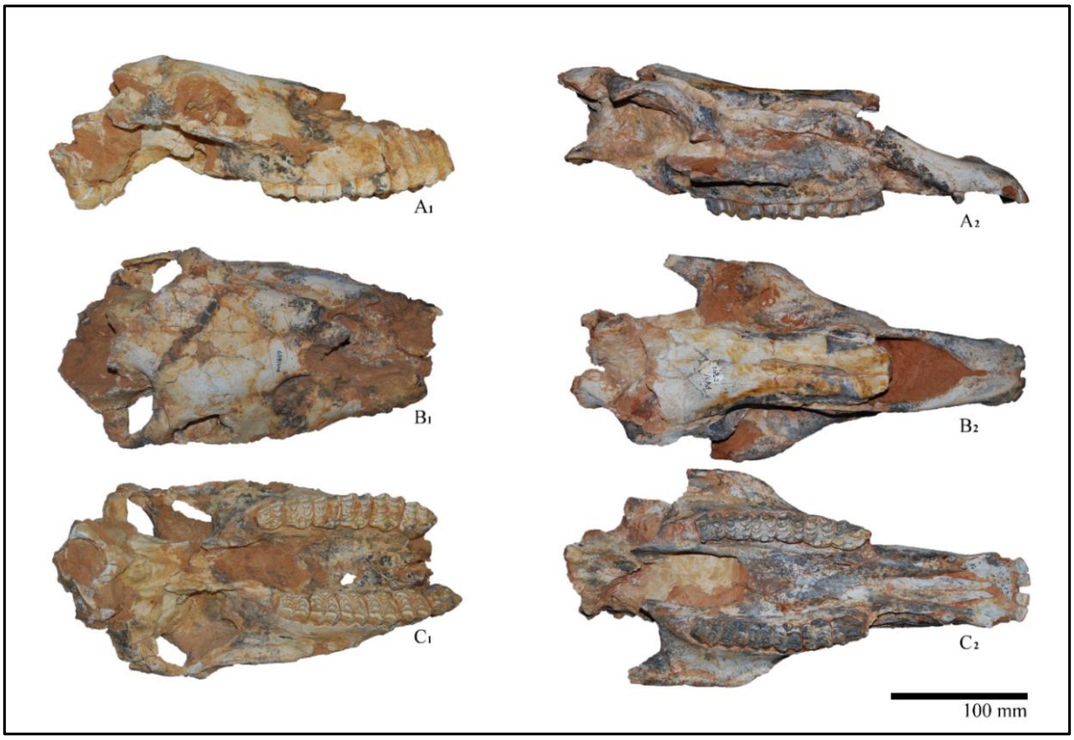

Figure 1. Skulls of *H. brachypus* (left) and *C. mediterraneum* (right) individuals from the studied material, in (A) right lateral aspect, (B) superior aspect, (C) inferior aspect. External viscerocranial morphology (especially on the preorbital area -outlined in red) is a major feature for identification on the generic and specific level.

Most of the remains studied can be ascribed to the typical Pikermian species *Cremohipparion mediterraneum* and *Hippotherium brachypus* (Fig. 1). The material, which is comprised of crania, mandibles and individual buccal teeth is described and compared with samples from homologous localities. Also provided, are remarks on inter-site and inter-locality relations, as well as comments on the paleoecology of the Pikermian biome. Finally, the re-emergence of the notion of an -as of yet- not fully identified additional hipparionine group (Bernor *et al.*, 1996), present in the locality (Fig. 2), is discussed

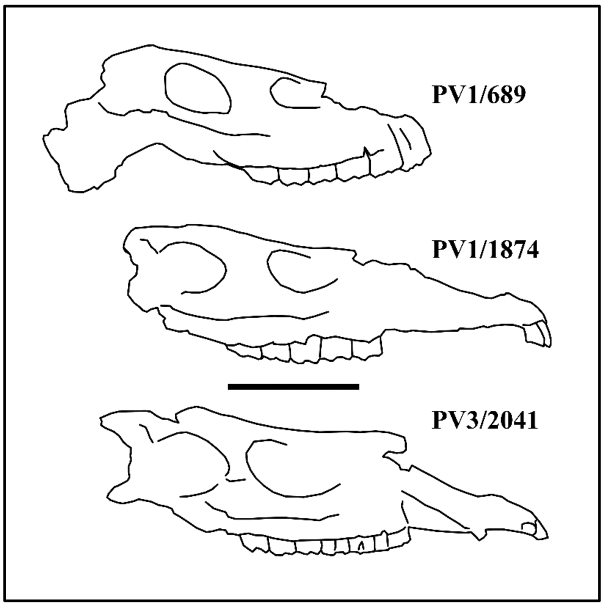

Figure 2. Skull outline of specimen PV1/1874 (from the latest excavations) in lateral aspect, compared to those of PV1/689 (*H. brachypus*) and PV3/2041 (*C. mediterraneum*). Specimen PV1/1874 possesses osteometric measurement values which place it close to *C. mediterraneum*, while the morphology and position of the preorbital fossa is more akin to that of *H. brachypus*. Scale bar is 100 mm.

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Preliminary assessment of the Upper Holocene environment and vegetation shifts in the Natura 2000 coastal lagoon of Prokopos (W. Greece)

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Through detailed palynological analysis, the aim of this study is to reconstruct the Upper Holocene vegetation and paleoenvironment of the costal lagoon Prokopos situated in the natural protected area Strofylia National Park, western Greece. The latter is nowadays characterized by wetlands, pine forest and shrub vegetation. For this study a, 115 cm long sediment core, retrieved from the deepest part of the lagoon was used. The core was systematically subsampled and 25 in total were selected for the palynological analysis. The samples were chemically treated successively with acids (HCl and HF) to remove the inorganic fraction and KOH solution to dissolve amorphous organic matter. The residues were mounted in glycerine and microscopically analysed under a X400 magnification.

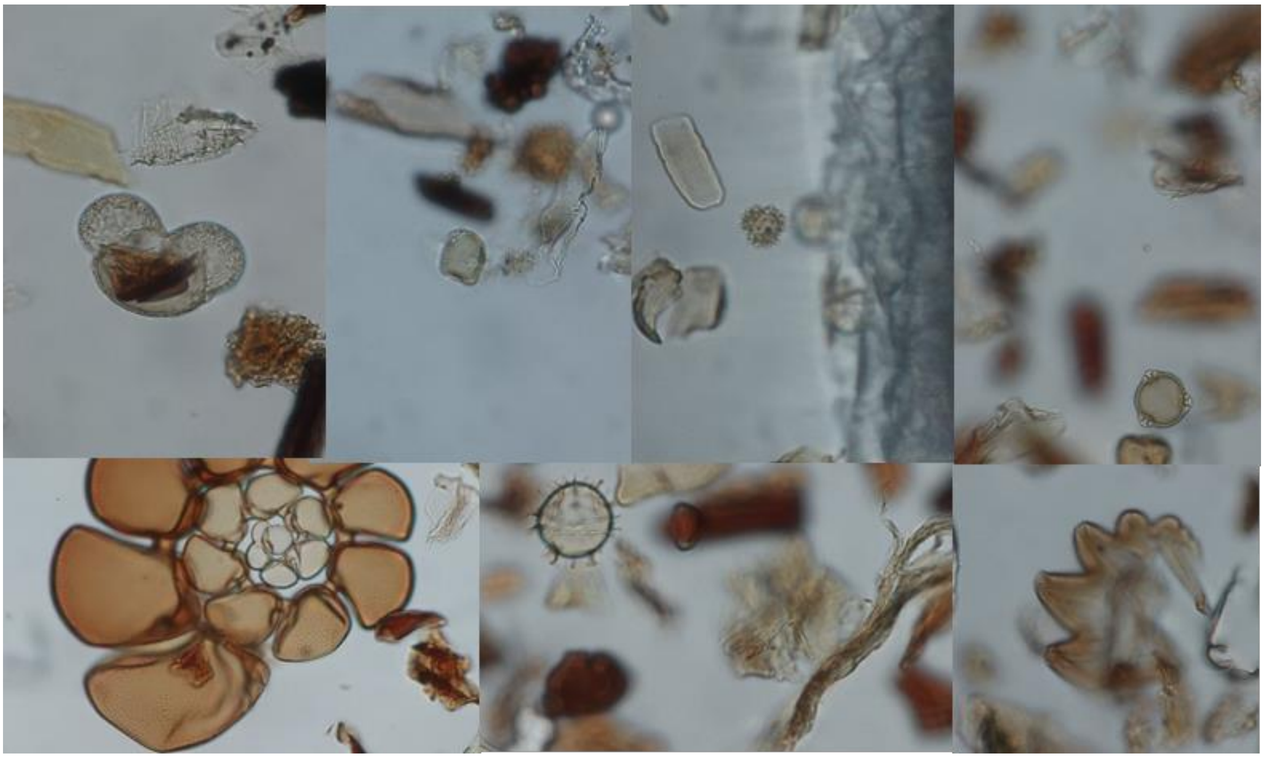

Figure 1. Top (left to right): pollen grains of *Pinus*, *Sparganium*, Asteraceae (Senecio-type) and *Sanguisorba minor*. Bottom (left to right) Non Pollen Palynomorphs: Foraminifera test linning, *Spiniferites* sp. (dinoflagellate cyst) and Mandibula.

The most common pollen that are observed during microscope analysis are *Pinus*, Asteraceae or *Sparganium* (Fig. 1), however a great diversity of pollen is detected. Other palynomorphs such as foraminifera test linings, dinoflagellate cysts and Non-Pollen Palynomorphs will consolidate the comprehension of the vegetation shifts through time (Fig. 1). Ensuing several centuries of overexploitation through intensive agriculture and urbanization (Katsaros et al., 2017) the palynological analysis is expected to disclose in the pollen record indicators of the extent and impacts of the human activity on the area. Considering the ecological significance of the region, this study is important as the results would reveal if the classification of the region as "protected area" in 2002 has indeed preserved the environment.

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Coccolithophore Export Production in the Deep Ionian Sea, Eastern Mediterranean (NESTOR Site Sediment Trap, 4300 m Depth)

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This study is the first attempt to understand the coccolith flux and its seasonal variability at one of the deepest part of Mediterranean located in SE Ionian Sea. The study area has complicated morphology comprised of valleys, steep slopes and deep basins (Stavrakakis et al., 2013). Sediments for the microscopic analysis were obtained from the deepest time-series sediment trap (4300 m) moored at NESTOR Site (Fig. 1) from March to October 2015 and the quantitative analysis was carried out using 1000x magnification under polarized light microscope. A total of 20 species of heterococcoliths were identified. The maximum coccolith flux was observed for the late September (1.07 x 10^9 coccoliths m^2 day^{-1}) and the minimum value was recorded for late June (1.25 x 10^8 coccoliths m^2 day^{-1}) (Fig. 2). The dominant species in all the samples is *Emiliania huxleyi* constituting 50 to 70 % of total coccolith count, while the second most abundant species is *Florisphaera profunda* constituting 8 to 25% of total coccolith count. *E. huxleyi* and *F. profunda* together with *Umbilicosphaera sibogae* (max. 8%), *Rhabdosphaera clavigera* (max. 4.8%), *Syracosphaera pulchra* (up to 5.6%), *Calciosolenia brasiliensis* (max. 3.2%), *Gladiolithus flabellatus* (max. 3.9%) and holococcoliths (max. 3%) account for 95 to 97 % of the total coccolith assemblage. The highest abundance of *E. huxleyi* was recorded in the interval of September 1-15 (7.17 x 10^8 coccoliths m^2 day^{-1}) and March 16-31 (6.80 x 10 ^{8} coccoliths m^2 day^{-1}). The highest abundance of *F. profunda* was recorded in October contributing 1.40 x 10^8 coccoliths m^2 day^{-1} in the first half of the month and 1.37 x 10^8 coccoliths m^2 day^{-1} during the second half. The occurrence of complete coccospheres was rare mostly due to the processing of the samples for coccolith analysis. Only few coccospheres of *S. pulchra, E. huxleyi, U. sibogae, R. clavigera* and *Algirosphaera robusta* were observed. The time periods of maximum and minimum flux for Nestor Site at relatively shallow depth (2000 m) as reported by Skampa et al. (2020) varies with the data from the present study. This difference is mostly attributed to the difference in the deployment depth, potential coccolith dissolution while sinking in the water column and the activity of bottom lateral currents. The summer maxima observed by Skampa et al. (2020) at 2000 m appeared in early fall in the present study. Similar time lag between shallow and deep water coccolithophore maxima has been observed in Creten Sea (Triantaphyllou et al., 2004). Moreover, Stavrakakis et al. (2013) observed an increase in total mass flux below 3200 m depth at NESTOR Site and attributed it to lateral advection, resuspension and/or the influence of Eastern Mediterranean Deep Waters (EMDW).

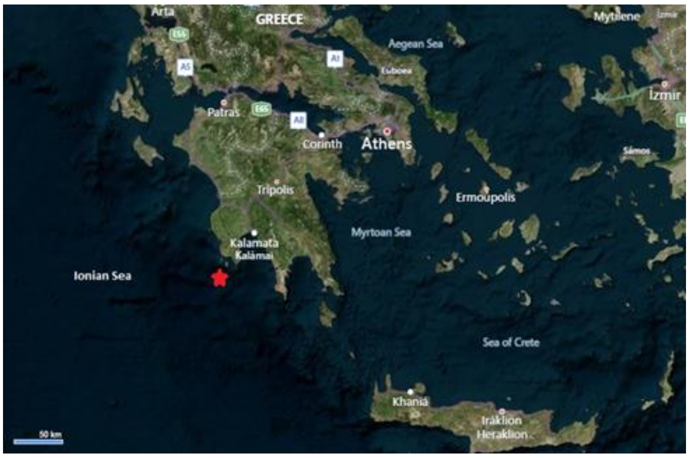

Figure 1. Map of study area showing the topography of sea floor. NESTOR Site is indicated by red star (modified from Google Map).

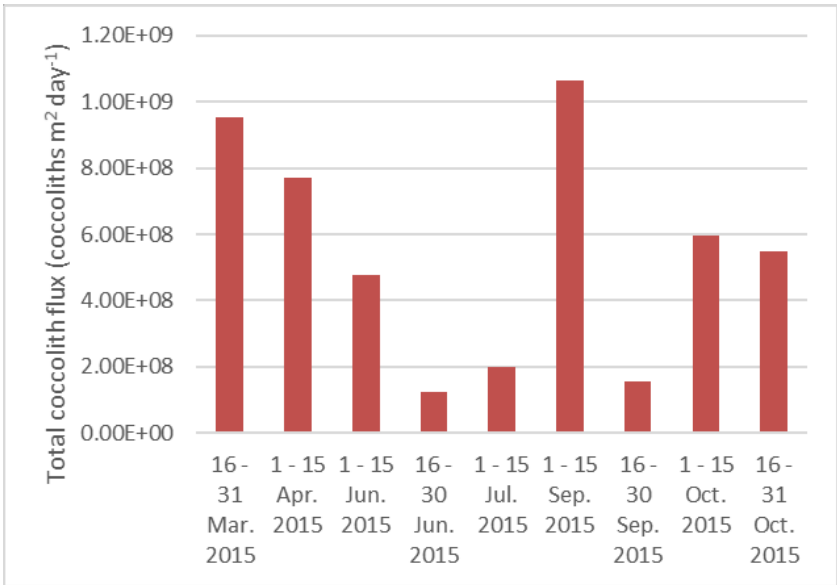

Figure 2. Total coccolith flux in the deep Ionian Sea.

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New early Miocene leaf imprints of Akrocheiras site in Lesvos Petrified Forest (North Aegean, Greece)

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The pyroclastic rocks of the Lesvos Petrified Forest in the North Aegean comprise one of the early Miocene's most imposing megaflora assemblage. The new outcrop of Akrocheiras, located in the Sigri- Antissa road, yielded numerous leaf compressions (Kafetzidou et al., 2022). The material studied here-in provides new palaeofloristic results of a significant fossiliferous site. The main objectives of the present study are (a) to describe the palaeoflora from a new locality at Akrocheiras area, (b) to assess data concerning the palaeovegetation and palaeoclimate, and (c) to compare the new flora to contemporaneous Greek and other eastern Mediterranean palaeofloras.

The identification of approximately 176 leaf imprints was based on their macro-morphological characteristics (Hickey, 1973; Dilcher, 1974; Ash et al., 1999 and Ellis et al., 2009). The statistical analysis used for the palaeoclimatic estimates was CLAMP (Climate Leaf Analysis Multivariate Program; Wolfe and Spicer, 1999) and for similarity indices Past software was applied.

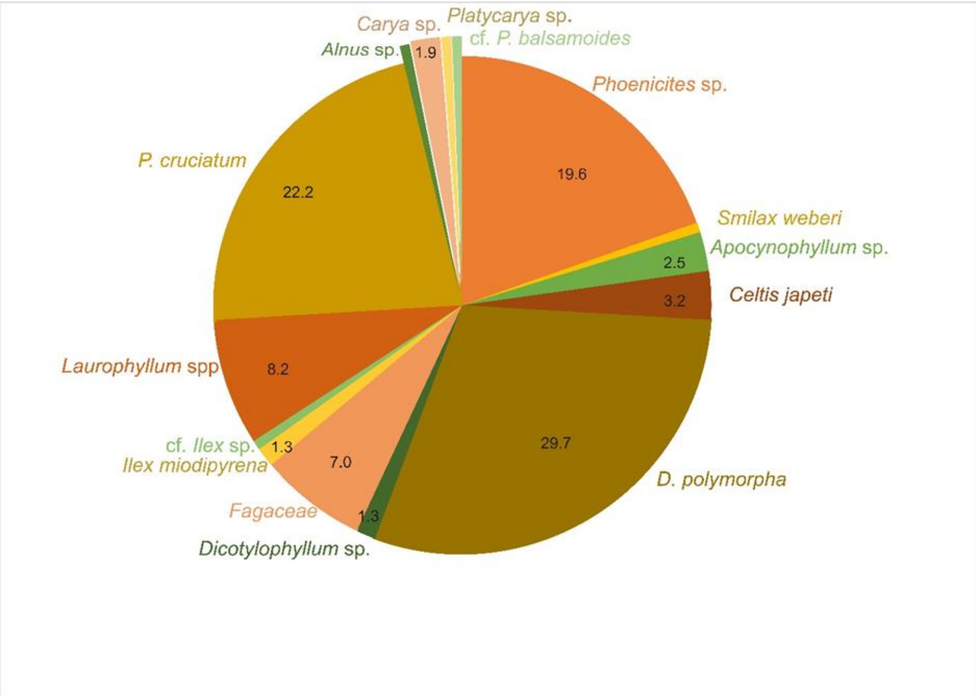

Figure 1. Vegetation composition in Akrocheiras site.

Based on their macroscopic features, a total of sixteen different taxa were identified (Fig. 1), most of them of palaeotropical origin. Dominant species are *Daphnogene polymorpha*, *Pungiphyllum cruciatum* and *Phoenicites* sp., represented by more than 50% of the specimens. Several taxa are new for the Neogene palaeobotanical record of Lesvos Island, such as *Smilax weberi*, *Celtis japeti*, *Apocynophyllum* sp., *Laurophyllum* sp. 1, cf. *Ilex* sp., *Ilex miodipyrena* and div. Juglandaceae, providing new floristic data for the area. According to the vegetation analysis, the plant assemblage of Akrocheiras site presents a mixed palaeonvironmental signal, assigned to lowland/ riparian and mesophytic forests on well drained soils. The palaeoclimatic analysis revealed a humid warm-temperate climate with seasonal alternations from wetter to drier conditions. The floristic characteristics are outlined, and the new studied material is compared to other early Miocene records, such as Euboea, Grevena, Lemnos (Myrina, Moudros), Bulgaria and Turkey (Denk et al., 2017; Ivanov et al., 2007; Kafetzidou et al., 2022; Velitzelos et al., 2004). The cluster analysis suggested floristic similarities of Akrocheiras with Bodovdol and the other Early Miocene localities of Greece, except for the sites of Euboea, while the latter and the record of Turkey present a strong differentiation from the floristic composition of Akrocheiras.

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Paleoenvironmental dynamics in the Saronikos Paleolake during the Upper Pleistocene based on benthic foraminifera; preliminary results

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Paleoenvironmental analyses based on foraminifera distribution has been carried out on 28 samples from Saronikos Paleolake. During the Upper Pleistocene, when the last glacial lowstand (sea level at -125 m) took place, semi-enclosed gulfs in Greece were isolated from the Aegean Sea. This isolation led to the formation of paleolakes that has been recorded with a carbonate sequence deposition (Richter et al., 1993; Karageorgis et al., 2013). In the present study, a sediment core (SARC-18) from the western part of Saronikos Gulf has been analysed.

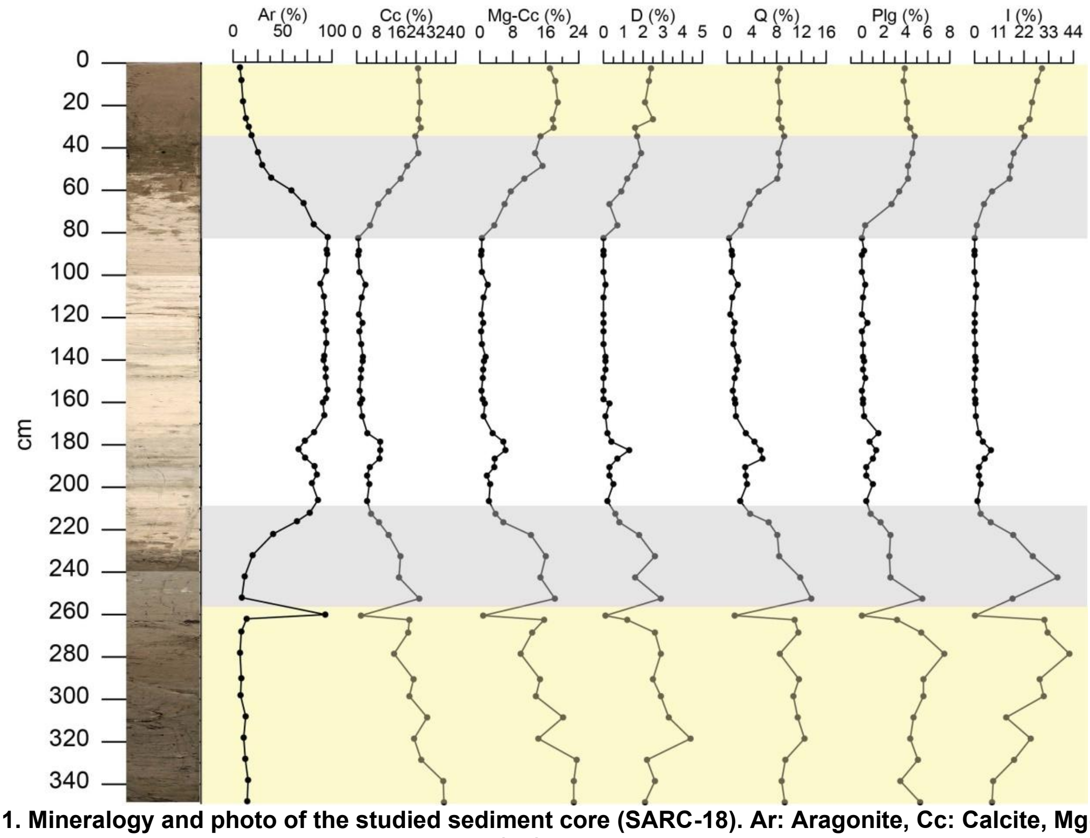

Figure 1. Mineralogy and photo of the studied sediment core (SARC-18). Ar: Aragonite, Cc: Calcite, Mg-Cc: Mg rich calcite D: Dolomite, Q: Quartz, Plg: Plagioclase, I: illite

The studied core has recorded a full succession of sediments from before (marine), during (lake) and after (marine) the isolation of the gulf. The older, typical marine sediments (240 to 210 cm) are followed by an about 130 cm thick carbonate sequence (210 to 80 cm) of mainly aragonite, and the section ends with marine sediments again (80 cm to top; Fig. 1). The foraminifera study of the older marine sediments, reflects the global climatic conditions of that period. The cold and deep water conditions are verified by species such as *Cassidulina laevigata, Hyalinea balthica, Bulimina aculeata* and *Bolivina* spp., while entering though the isolated part of the section, a totally different environment is revealed. The foraminifera assemblage consists mainly of the sporadic presence of *Elphidium crispum* and in a lesser degree of *Ammonia* spp.; these foraminifera along with the increased sand content of the sediments reflect a shallowing and strongly fluctuating salinity environment. While moving towards the upper part of the sediment core the foraminifera assemblages change and look quite similar to the lower part of the recovered sedimentary sequence.

The present study focuses mainly on the isolated part of the section, which is of the greatest interest. The environmental conditions, as revealed by the foraminifera assemblages, are also confirmed by distinct peaks in the vertical distributions of trace and major elements ratios such as Ti/Al, S/Al, Ba/Al, V/Al, Mo/Al, and Fe/Mn.

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Palaeobotanical study of the fossil flora from the Middle Pleistocene of Vigla Sychainon, Achaia

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The worldwide recognized palaeobotanical record of Greece has been in the interest of palaeobotanical research since the middle of the 19th century, with the study of various Cenozoic palaeofloras. In Peloponnese itself, some rich in plant macro-remains, fossiliferous localities of palaeobotanical importance have been discovered. One of the most important palaeobotanical studies in the wider area of NW Peloponnese, is that of Klaus Kleinhölter (1994, 1995), in areas located in the basins of Rio-Antirio, Patras, and Corinth. Kleinhölter recorded 31 plant taxa, and provided important information on six palaeofloras. The Pleistocene sediments of the Rio-Antirio Basin, have yielded several plant assemblages, which to the date, have not sufficiently been studied.

The present study concerns plant macro-remains from the middle Pleistocene sedimentary deposits of Vigla Sychainon, Rio-Antirio Basin (NW Peloponnese). The purpose of this study is to describe the fossilized material and provide any possible systematic affinities, regarding their classification. Due to their recent geological age, Middle Pleistocene 170 +/- 68 ky – MIS 6d (Tsoni, 2021), and the tremendous presence of oak fossils in the palaeoflora, the systematic affinities, were based mostly on their comparison with their modern analogs at the country level. A significant number (1.320) of plant macro-remains, mainly leaves, were examined macroscopically and stereoscopically, compared, and described as to their morphology. Using the fossil record, the vegetation of the broader study area during MIS 6d was reconstructed, and the knowledge of the palaeoenvironment at that time was enriched.

More specifically, plant macro-remains were attributed to one of the following morphotypes: *Quercus* aff. *robur*, *Quercus* aff. *kubinyii*, *Quercus* aff. *ithaburensis*, ?*Quercus* aff. *cerris*, ?*Quercus* aff. *infectoria*, ?*Quercus* aff. *aucheri*, ?*Quercus* aff. *frainetto,* ?*Quercus* aff. *sosnowskyi* and *Zelkova* aff. *abelicea*. Moreover, the presence of *Populus*, *Platanus*, *Acer*, and possibly Pinaceae, was also recorded. The palaeoflora of Vigla (Table 1, Figs 1-4) comprises mostly of leaf morphotypes, resembling modern Mediterranean taxa, and some forms, like *Quercus* aff. *kubinyii*, and ?*Quercus* aff. *sosnowskyi*, persisting from older geological periods.

Vigla palaeoassemblage flora list		
Taxa	Number of identified samples	Representation (%)
Quercus aff. *robur*	50	7
Quercus aff. *kubinyii*	67	9.3
Quercus aff. *ithaburensis*	8	1.1
?*Quercus* aff. *cerris*	7	1
?*Quercus* aff. *infectoria*	2	0.3
?*Quercus* aff. *frainetto*	3	0.4
?*Quercus* aff. *aucheri*	3	0.4
?*Quercus* aff. *sosnowskyi*	1	0.1
Quercus spp.	476	66.1
Zelkova aff. *abelicea*	75	10.4
Populus spp.	14	1.9
Acer spp.	8	1.1
Platanus spp.	3	0.4
?Pinaceae	3	0.4

Table 1. Vigla palaeoassemblage flora list.

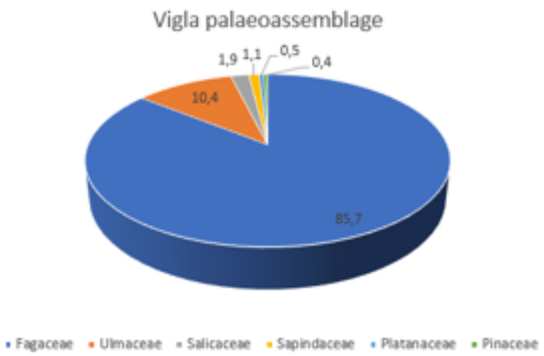
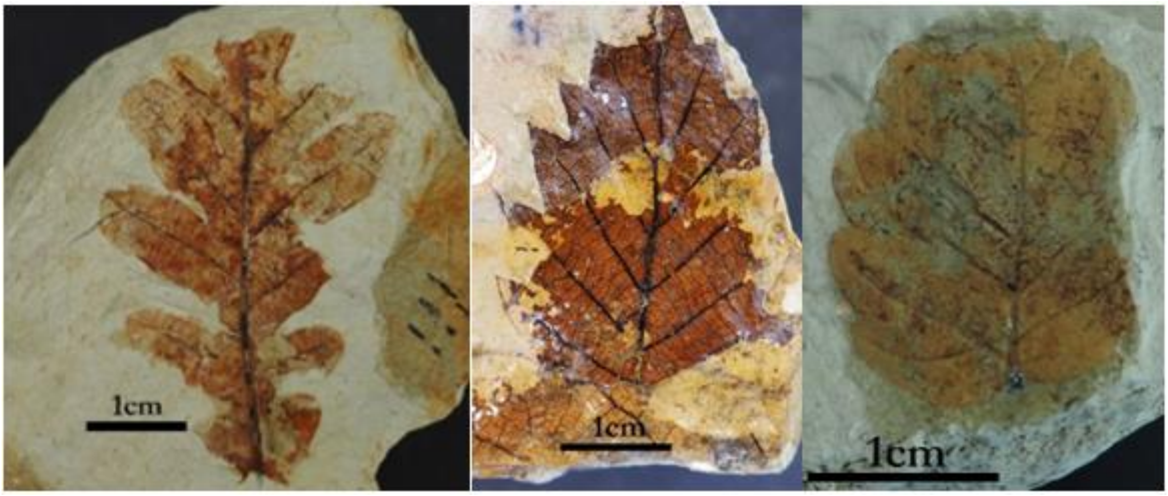


Figure 1. Family representation (%).

The fossil record indicates the presence of riparian elements (*Populus*, *Platanus*), nearby a lagoonal/lake body, and the presence of an active river channel, which played a vital role in the transportation and deposition of the leaf fossils. On the adjacent slopes and hills of the studied area, a mixed mesophytic forest, consisting mostly of deciduous elements (*Quercus*, *Zelkova*), seems to have thrived. The existence of sclerophyllous elements in the drier hinterland (evergreen *Quercus*, *Pinaceae*) is also possible. The palaeoflora of Vigla indicates temperate, warmer climate conditions, at NW Peloponnese during the glacial MID 6d, when extensive glaciers covered northern and central Europe.



Figures 2-4. Fossilized leaves from the palaeoflora of Vigla. From the left to the right: *Quercus* aff. *robur*, *Quercus* aff. *ithaburensis*, *Zelkova* aff. *abelicea*.

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A new species of herring-like fish (Clupeiformes, Teleostei) from the upper Miocene of Serres Basin, Greece

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Fishes of the order Clupeiformes, such as herrings, sardines and anchovies, are small to medium-sized fishes (<25 cm), that in their majority inhabit marine or brackish habitats, live in large schools and feed on plankton. Their fossil record spans from the Cretaceous to the Recent and comprises over 150 species. However, their evolutionary history remains obscure, owing to the bad preservation of several of the described fossils and the morphological similarities of many, not necessarily closely related, modern clupeiform taxa. Greece has a good fossil record of clupeiform fishes, most of them coming from the Miocene and Pliocene of the central and southern parts of the country (Argyriou, 2022).

Here we report on the findings from a new locality, "Aidonochori A" from the upper Miocene of the Serres Basin. Dozens of well-preserved skeletons of fossil clupeiforms were found in superimposed layers, about half a meter thick in total, of silty marls (Fig. 1). The specimens belong to a single species and are characterized by a small size (<150 mm), the presence of parietal-postpariatal striae, a smooth opercle, five branchiostegal rays, two elongate postcleithra, 40-42 vertebrae, eight or nine pelvic fin rays and the two last rays of the anal fin smaller than the rest. Among modern clupeiforms, the fossils seem to resemble, though they are not identical to, the Indo-Pacific genus *Hilsa*. They can however be classified as †*Pseudohilsa*, a fossil genus known from the Neogene of the Black and the Caspian Seas. They are identified as a new species within this genus, †*Pseudohilsa nikosi* Kevrekidis, Arratia, and Reichenbacher, 2021 (Kevrekidis et al., 2021). This is the first time that this genus is identified from the Mediterranean Basin and it is possibly another component of the "tropical" Miocene fauna of the Mediterranean.

Figure 1. A slab with †*Pseudohilsa* from the locality "Aidonochori A" from the upper Miocene of Serres Basin. ADS 006, Nikos Bacharidis collection.

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Contribution on the importance of thorough taphonomical and palaeoenvironmental studies of Upper Pleistocene microvertebrate assemblages

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Even though systematics is undoubtedly the basis of any palaeontological investigation, its use as the main objective of fossil microvertebrate studies has monopolized the interest of researchers in Greece for far too long. The study of terrestrial small vertebrates is, indeed, of great use within the context of systematics to uncover the palaeozoogeographical history and evolution of species. This is especially interesting and valuable when referring to Pleistocene representatives, an epoch of intense climate alterations and subsequent faunal turnovers, and relocations that formed the modern geographical distributions of most animal species.

The importance of microvertebrates (either mammalian, reptilian or both) in the studies of palaeoenvironments as well, is obvious. Their limited mobility (in comparison to that of larger animals) and their close dependence on specific types of habitats offer valuable information on a region's past climate conditions and vegetation. Additionally, microvertebrate fossils are commonly retrieved in great numbers, allowing safer interpretations and better statistical manipulation of the results, regarding their presence and diversity in an assemblage. However, the implications of the relationships between predator and preys of an original community may directly influence this same abundance and diversity of a fossilized microvertebrate assemblage. In other words, the studied microvertebrate material might be the result of animal (predator) influence (Andrews and Cook, 1990), and for the researcher to disregard such an important source of bias, might result in limited or even wrong interpretations. This is an issue that the present contribution aims to address by performing a thorough taphonomical investigation of microvertebrate assemblages, via the implementation of specific quantification methods to explore the palaeoecological and taphonomical history of the studied sites. The fossilized material came from three upper Pleistocene cave sites, all of which were inhabited by early humans: Panthera cave (Kythros islet, Inner Ionian Archipelago), Kalamakia cave and Melitzia cave (Mani Peninsula, Peloponnese).

The methodology used for the taphonomical analyses is based on the calculation of "classic" palaeontological indices (Number of Identified and Unidentified Specimens- NISP and NUSP, Minimum Number of Elements- MNE and Minimum Number of Individuals- MNI (Lyman and Lyman, 1994; Lyman, 2008)). Additionally, the identification and quantification of the effects of possible processes and/ or predators affecting the microvertebrate remains (e.g., relative amount of the different types of digestion, Relative abundances of skeletal elements (Ri) and their Average Relative Abundance (ARA)) were investigated based on the methodology described in previous works (Andrews and Cook, 1990; Fernández-Jalvo and Andrews, 2016).

Furthermore, the Taxonomic Habitat Index (THI) (Evans et al., 1981; Andrews and Cook, 1990) was used for palaeoenvironmental analyses performed for the same sites, based on the identified species' habitat preferences. The habitat preferences of the species present in the assemblage were scored as proportions of the different habitats these species (or their extant relatives) occupy at the present time. The habitats chosen for the present analysis are believed to be characteristic of the country's vegetation coverage throughout its current relief, as well as during the last few thousand years, and are categorized as follows: open forest areas, deciduous forests, evergreen forests, shrublands, grasslands, rocky areas and areas around water bodies. The scoring of ecological preferences for each habitat type and species was performed through the invaluable contribution of scientists that specialize in the fields of mammalogy and herpetology of Greece. Subsequently, the derived values of the different species were added and divided by the number of species per aggregate (stratigraphical units of each site). Finally, a cumulative index per habitat type and aggregate was produced, forming the "identity" of each aggregate's palaeoenvironment as a mosaic of the different habitats.

In this context, 74916 teeth and skeletal elements of amphibians, lizards, snakes, bats, insectivores, and rodents were examined stereo- microscopically. The above-mentioned methods revealed the existence of mixed habitats varying between the relative expansions mainly of shrublands, grasslands, deciduous forests and rocky areas with the occasional presence of local water bodies in the caves' wider areas. Concerning taphonomy, the most common agent of microvertebrate accumulation was predation since digestion was always present in every unit of every site in the present study. Different predators were identified in every site while, in some cases, predation by multiple predators is believed to have taken place simultaneously or successively. Additional alterations, related to post- depositional natural processes occurring in a cave or caused by its' residents (human or animal) were also identified. These processes seem to have significantly affected some of the results and interpretation efforts of the present study, either directly by altering the preservation state of the material or indirectly by producing inconclusive results.

The results from the present study clearly led to the conclusion that palaeocommunities were just as complex as modern communities regarding their palaeoenvironmental conditions and palaeoecological relationships. This complexity becomes even greater, when the researcher considers that fossilized assemblages also bear the "white noise" created by the thousands of years of taphonomical and diagenetical processes that affected them. Such an observation, of course, cannot come as a surprise to an environmental scientist or a geologist, but hopefully, the present contribution could be indicative of how a holistic approach of the topic might prove to be a useful tool for a realistic reconstruction of a site' s or species' history.

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A virtual reconstruction of the deformed DFN3-150 Early Pleistocene *Paradolichopithecus* cranium from Dafnero-3, Greece

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The tessellated presence of *Paradolichopithecus* species across Eurasia from Middle Pliocene and its abrupt disappearance from the record in the late Early Pleistocene, places the deformed LGPUT DFN3-150 *Paradolichopithecus* aff. *arvernensis* cranium from the Lower Pleistocene Dafnero-3 site, Greece in the front of paleontological interest, both in a taxonomical and evolutionary context (Kostopoulos et al., 2018).

It has been more than a hundred years since Wilhelm C. Röntgen introduced X-rays to the public, and almost thirty that Computed Tomography techniques have been utilized in the reconstruction of fossil crania. Here, exploiting two basic principles, namely bilateral symmetry and the smoothness of the cranial initial outer table (Harvati et al., 2019; Zollikofer et al., 2005), LGPUT DFN3-150 was submitted to a segmentation and virtual reconstruction procedure.

A segmentation routine applies directly on CT data, and allows one to separate the sediment matrix from the bone, as well as to divide the latter in different groups of interest, namely labels. Then, those labels that usually refer to distinct bone fragments can be manipulated independently, thus any examined structure can be restored by repositioning the fragments segmented. For LGPUT DNF3-150 cranium, twenty-five fragments were extracted from the initial fossil, but not all of them correspond to a clear breakage scheme. Most were segmented in preserved sutures, or in some cases, partially following sutures.

In order to eliminate post-burial deformation, and in parallel to study the results of different tactics on the reconstruction itself, four virtual models were created (Model1a, Model 1b, Model 2 and Model 2 warped). The first two deal with minimizing the effect that the deformation load applied on the right side of the cranium, by correcting the displacement of the right maxillary fragment. The third model constitutes a mirror reconstruction in which all left fragments were duplicated and bilaterally inversed. Then, following an approximate midsagittal relocation of the left frontal fragment and its mirrored counterpart, the rest of the left fragments followed the position acquired in the previously generated Model 1a. Finally, Model 2 warped represents an esthetically corrected version of Model 2, via superimposing an extant *Papio anubis* virtual specimen on Models' 2 surface.

When generated, further intraspecies comparative conclusions were based on the more "concrete" Model 2. In a conservative sense, when the more trapezoid occipital face contour obtained from Model 2 is considered, LGPUT DFN3-150 is placed closer than previously thought to UCBL-FSL 41336 *Paradolichopithecus arvernensis* specimen from Senéze, France, and the Romanian ISER VGr/ 345 of *Paradolichopithecus geticus*. On the same notion, the more circular shape of the foramen magnum observed in Model 2, resembles closely UCBL-FSL 41336 *Paradolichopithecus arvernensis* from Senéze, France and to a lesser extent ISER VGr/ 345 of *Paradolichopithecus geticus* from Romania and alters previous mention of an oval shaped foramen magnum (Kostopoulos et al., 2018). Still, some even lesser resemblance of this character places the reconstructed cranium close to PIN 3120-523 *Paradolichopithecus sushkini* specimen from Kuruksai, Tajikistan. A third originally reported differentiating *Paradolichopithecus* character, refers to the temporal lines structure that LGPUT DFN3-150 exhibits (Kostopoulos et al., 2018). The temporal lines of Model 2 do not converge towards each other at all, as opposed to the original fossil, that way placing it closer to PIN 3120-523 *Paradolichopithecus sushkini* specimen from Kuruksai, Tajikistan.

In terms of differences between the original fossil and Model 2, it is clear that the latter differentiates in the shape of the supraorbital torus, its resulted curved contour though is a matter of discussion, whether it is a valuable morphological trait, or rather an effect of the plastic deformation that couldn't be eliminated by the currently used techniques. This discussion should be further expanded on the wider intraspecies comparison, due to the misleading effect that some particular fragments, for which plastic load was not eliminated, may impose on shape reconstructions, that way sabotaging interpretations' validity.

Concluding, a thorough application of retrodeformation methods (Gunz et al., 2009) could be more useful in providing a definite reconstruction of LGPUT DFN3-150, since plastic deformation accounts for the majority of the post-burial damage of this fossil.

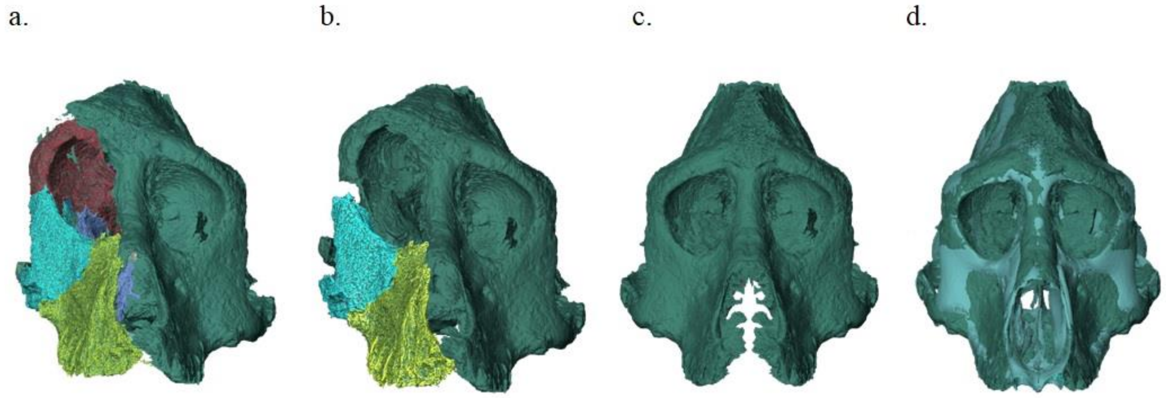

Figure 1. (a) Model 1a, (b) Model 1b, (c) Model 2 and (d) Model 2 warped in frontal views. Unscaled.

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A review of *Palaeotragus* Gaudry, 1861 (Mammalia: Giraffidae) and the large palaeotrages from the Vallesian of Northern Greece

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Although the genus *Palaeotragus* is the most common giraffid genus of the Late Miocene of Eurasia, its systematics remain rather obscure. In order to examine and properly classify the large-sized *Palaeotragus* specimens from Vallesian localities of Northern Greece we revisited the genus systematics, using various biometrical and morphological features (Laksos and Kostopoulos, 2022).

The herein examined *Palaeotragus* material came from four Vallesian localities of Northern Greece: Pentalophos (end MN 9), Ravin de La Pluie (MN 10) and Xirochori (MN 10) from Axios Valley as well as Nikiti-1 (end MN 10) from the Chalkidiki peninsula. The biometrical information interpreted through a series of scatter plots and combined in a Principal Components Analysis (PCA). Morphological and biometrical information were combined in a Principal Coordinates Analysis (PCoA; Fig. 1).

The aforementioned analyses provided 4 (possibly 5) different Late Miocene Eurasian *Palaeotragus* morphotypes: (1) the type species *Palaeotragus rouenii,* Gaudry 1861 characterized by molarized p3, small size and long, slender metapodials. *Palaeotragus pavlowae,* from Grebeniki, Ukraine demonstrates very fragmentary material, most of which could be attributed to *P. rouenii.* (2) *Palaeotragus microdon,* (Koken 1885) from China, resembling *P. rouenii* in size although having longer toothrow with relatively shorter premolar row, more advanced p3, shorter and more robust radius and metacarpal and shorter metatarsal than the type species. Finally, *P. microdon* females bear slender ossicones in contrast to those of *P. rouenii.* (3) *Palaeotragus berislavicus,* Korotkevitch 1957 (=? *Palaeotragus asiaticus*), characterized by fully molarized p3, intermediate size and metapodials as long but more robust than the type species. Suggestions about the Vallesian *P. berislavicus* morphology and proportions are relatively safe as they are based on material from a single locality, Berislav (Ukraine). The Turolian *P. asiaticus* is a more doubtful species, as its material comes from different localities of Kyrgyzstan, Kazakhstan and Uzbekistan and it cannot be excluded that this species concept is based on a mixture of contemporaneous small and large paleotragine populations. *P.* cf. *coelophrys* material from China (Bohlin 1926), also seems to fit *P. berislavicus- P. asiaticus* ensemble, although its postcranial material contains only an astragalus, hence any attempt to classify those remains would be unfounded (4) *Palaeotragus coelophrys* (Rodler and Weithofer, 1890) *(=P. expectans=P. borissiaki=P. hoffstetteri=P. quadricornis =? P. moldavicus*), characterized by the much larger size than the type species, the shorter and more robust metapodials and the more plesiomorphic condition of the p3. That synonymy among the several large *Palaeotragus* species was suggested by other scholars before us (Geraads, 1974, 1986; Iliopoulos, 2003) and our analysis did not detect any important difference among those taxa. *P. moldavicus* appears more distinct than the other large palaeotragines in PCoA and PCA, probably due to its larger postcranials as well as to having a more molarized p3. However, its material is so fragmentary that at the moment any attempt to validate that taxon would be premature.

As for the northern Greek fossils that were described here, the Pentalophos material contains several upper and lower toothrows and isolated teeth, a distal humerus and two proximal metatarsals. The size of toothrows and the robustness of the proximal part of the metatarsals fit those of *P. coelophrys*. The Ravin de la Pluie material is represented by an old individual's hornless skull and a mandible with the molar row, as well as two isolated upper molars. In the past it was ascribed to *P.* cf. *coelophrys* (Geraads, 1978). The dental dimensions fit pretty well to *P. coelophrys* group. Actually, the toothrow of that skull is one of the largest ever described. Due to the absence of any postcranial material from that locality we just reconfirm Geraads (1978) and ascribe it as *P.* cf. *coelophrys.* The Xirochori sample includes only two lower molars, and as a result it is referred as *Palaeotragus* sp. Finally, the Nikiti ensemble is represented by an ossicone-bearing skull and a plethora of postcranials. The skull bears a relatively large toothrow. However, the Nikiti-1 postcranial material is intermediate in size between large and small-sized palaeotragines, and its metapodials are almost as long as those of *P. rouenii* but more robust. In that feature the Nikiti-1 sample agrees with *P. berislavicus* and our analyses (PCoA and PCA) indicate a close relationship among those two populations (as well as to *P. asiaticus)*. Hence, the Nikiti-1 sample is classified as *Palaeotragus* aff. *berislavicus.* The existence of a taxon resembling *P. berislavicus* in Nikiti-1 might indicate an invasion of the Berislav taxon to the southern Balkans towards the end of the Vallesian. The *Palaeotragus* sp. from Kerassia (Iliopoulos 2003) might belong to the same lineage as the Berislav and Nikiti-1 taxa, as it is represented by a large sized mandible bearing a molarized, to some degree, p3, a feature rather uncommon in *P. coelophrys*. However, the material is inadequate for definite conclusions. *P. coelophrys* occurrences from the Vallesian of Greece are confirmed. Turolian reports of the species in continental Greece are rather dubious but the taxon has a strong presence in contemporaneous faunas south of Caucasus from where probably expanded in the Anatolian domain as well as southwards to Iran.

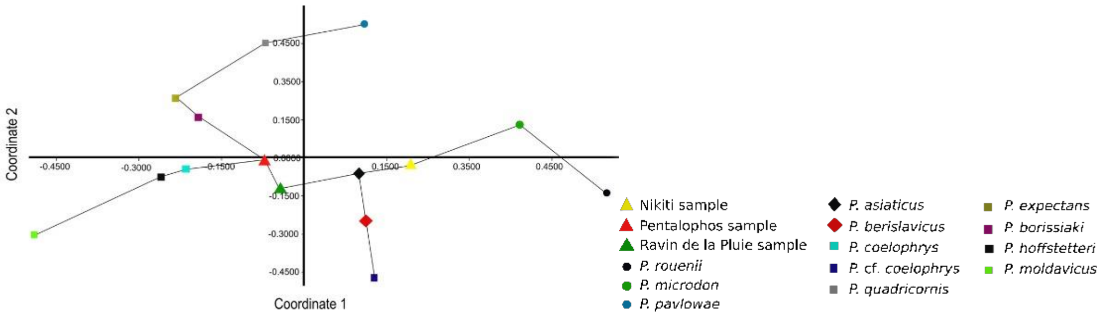

Figure 1: Principal Coordinates Analysis (plane of coordinates 1 and 2, representing 39,5% and 15,3% of initial data variance) comparing 27 biometrical variables and 4 selected features of premolar morphology of the Late Miocene Eurasian palaeotrages, as well as the Vallesian Greek *Palaeotragus* Gaudry, 1861 samples studied here.

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A Late Miocene Coralline Algae/Rhodolith Carbonate Formation record in Chania Region, Western Crete; stratigraphy and paleoenvironment

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The Neogene stratigraphic record of Crete is well-widespread all over the island. Neogene carbonate strata of West Crete comprise several bio- and lithofacies that represent various depositional environments. The present work is based on the study of an outcrop exposed along the eastern coast of Chania city. With a length of 1900 metres and a thickness of 45 metres, it can be subdivided into four distinct lithofacies (A to D). From the base to the top, the succession is composed by two sets of sands (a reddish and a yellowish one, parts A and B respectively), passing upwards into rhythmical marine, coralline-red-algal carbonate facies (C) that underlie neritic bioclastic limestones (D). It is the first time that such an occurrence of coralline algae is described from western Crete, therefore the present work is mainly concentrated in this facies (C) in particular. Rhodoliths are mainly nodular structures composed of the superimposed thalli of calcareous red algae. The dominant biological feature of coralline algae of the succession corresponds to an array of palaeo-environmental conditions; the structure and appearance of their development are interpreted to be related as to a transgressive–highstand cycle of relative sea-level change. These built ups are typical for the Mediterranean region, as a result of events predating the Messinian Salinity Crisis (MSC) onset, when the Mediterranean all dried up; rhodolith beds were widespread in Miocene platform carbonate and siliciclastic deposits in the Mediterranean and Paratethys (Halfar, 2005; Braga, 2017). Estimates based on paleoreconstructions and actualistic comparisons with the depth distribution of living rhodoliths comprising similar coralline algal assemblages, suggest a wide range of palaeodepths of growth ranging from 10–100 m (Brandano, 2005; Puga-Bernabéu, 2007).

Fifteen sedimentological sections were logged in high resolution along the outcrop, seven of them directly related to the red-algal facies (part C). Recorded data included the thickness of each bed and the depositional environments that deduced by combining lithologies, sedimentary structures and the (macro-) palaeontological content of the deposits, as well as the nature of interbedding surfaces (erosional, subaerial exposure, angular etc). Vertical facies successions and geometries at the outcrop scale were interpreted in terms of progradation, aggradation or backstepping of depositional environments reflecting the interplay between accommodation and sedimentary flux in time.

The basal part of the outcrop (part A) consists of non-cohesive red to brown sandstones, organized in thick beds, with frequent *Ostrea* shells, including an *Ostrea* biostrom at its upper part. It points to a restricted possibly of lagoonal character depositional environment. Part B consists of a not well cemented, yellowish silty sandstone, with rare bivalve shell fragments, which upwards passes into alternations with cohesive calcareous sandstones bearing coralline algae. It is a transitional facies to pure marine conditions, represented by part C. Seven cycles were identified in C, based on the different morphological types of the coralline algae. Each cycle consists of two layers grading into each other as prograding upwards. A first one, a rigid bindstone of patches of coralline algae that resemble as 'crusts' and a second one, a rhodolithic floatstone composed of various diameter of nodules (7cm-20cm). The fine- to silty sand bioclastic matrix contains bivalve shell-fragments, benthic foraminifera and echinoids (*Clypeaster* and a single individual of *Echinolampas*). Further up-section, (top, part D) the depositional environment changes to neritic nearshore. White to sub-white, massive, highly cemented and fractured bioclastic limestones are recorded with abundant coralline algae and other macrofauna such as diverse molluscs Echinoids, and bryozoans. The Part D unconformable overlies Part C. Parts A and B represent a Transgressive System Tract, passing normally to part C, which is considered as a Highstand System Tract (HST) (compare also Kroeger *et al*., 2005) while the limestones of part D appear strongly karstified at their base, an indicator of a sub aerial exposure pointing to a sudden sea-level drop before marine sedimentation was reactivated (SB).

The data suggest that the part C deposits represent a part of a carbonate ramp that was under the sea level base at depths ranging between 40 to 100 m. Rhodoliths prevailed layers are interpreted as a moderate-energy, of low sedimentation rates setting similar to the ones that develop at a fore-reef slope (middle Ramp), while the coralline bioconstructions represent rather a shallower (upper Ramp) environment in cyclic development due to sea-level changes within a HST.

The report describes a significant in size (both in length and thickness) Upper Miocene outcrop of coralline algae and rhodolith-beds from island of Crete. It highlights the presence of coralline algae as a major reef-like contributor while it introduces them as a new occurrence in the coralline algae/Rhodoliths palaeo-distribution global map.

Keywords: Red Algae, Rhodolith, Carbonate Facies, Sequence Stratigraphy, Transgressive System Track, Highstand System Track, Chania, Crete.

Figure 1. Gentle Dipping platform with development of coralline algae lithofacies cropping out on the Eastern outskirts of Chania Region, West Crete.

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Benthic foraminifera response to the environmental variables: case study the coasts of the Molyvoti peninsula (N Aegean Sea, Greece)

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Benthic foraminiferal assemblages have been analyzed to investigate their response to the environmental variables in the coastal area of Molyvoti peninsula (N. Aegean Sea). It is also an attempt to document the current biodiversity in this area. Molyvoti peninsula is located 25 km south of Komotini city at the coast of Thracian sea (N. Aegean Sea). North of the peninsula the natural closed Elos lagoon is situated, while at the west Chrysofora beach occurs (Fig. 1).

Figure 1. Map of the studied area. Location of the sampled stations at Elos Lagoon and Chrysofora beach (modified from Google Maps).

Sampling of the top 2 cm of bottom sediment was conducted in August 2014 in 7 stations using a Van Veen grab sampler. The samples were collected from 3 shallow stations in Elos lagoon and 4 stations in Chrysofora beach in order to compare the foraminiferal assemblages in two adjacent areas, where different environmental conditions prevail. In every station the environmental parameters (temperature, pH, salinity and density) were measured. The sampling and processing of the material had been done according to FOBIMO protocol (Schönfeld et al., 2012).Subsequently the foraminifera were counted and identified in species level, and relative abundances, diversity and other foraminiferal indices were calculated.

In total 15 species have been identified belonging to 9 genera. The faunal composition of the 2 different environments is highly diversified (Fig. 2). The closed lagoon environment is dominated by *Ammonia veneta* and *Haynesina germanica*, followed by *Aubignyna perlucida* and *Elphidium gunteri*. On the contrary, at the marine coastal environment the most representative species are *Ammonia beccari*, *Elphidium crispum* and the milliolids. The *A* ratio of the lagoonal samples is significantly lower than that of the marine ones, thus confirming the decreased salinity conditions (Koukousioura et al., 2012). The AEI index of the lagoon is higher, suggesting a more stressful environment. This is also indicated by the diversity Shannon-Wiener index, being higher in most marine than lagoon stations although it is relatively low in both cases. Additionally, the B/R ratio is higher in the marine stations confirming the coastal environment higher energy conditions.

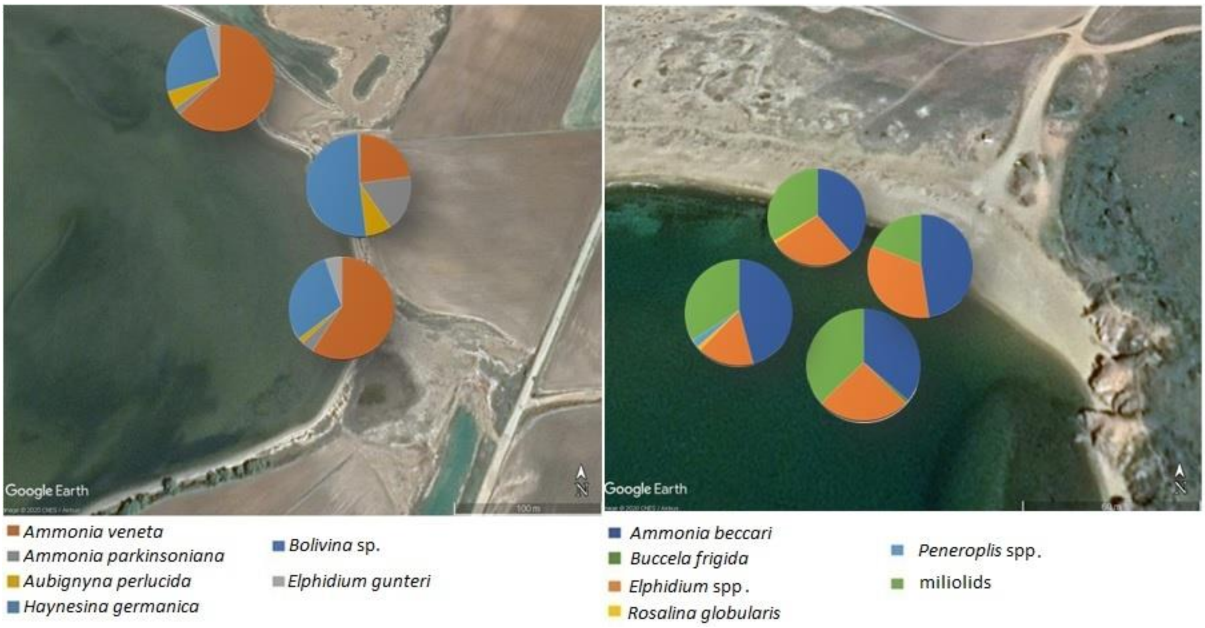

Figure 2.Species distribution and relative abundances in every station.

The assemblages of Molyvoti coastal area are similar to other assemblages described from the North Aegean Sea. Specifically, the Elos lagoon assemblage resembles the Lafrouda's closed lagoon microfauna (Koukousioura et al., 2012), whereas the Chrysofora beach resembles the shallow marine coastal Avdira's and Kitros' assemblages (Dimiza et al., 2016). In general all the assemblages share in common, the relatively lower diversity of the North Aegean, as opposed to those of the South Aegean (Dimiza et al., 2016). Finally, similar faunal compositions occur in Holocene sedimentary sequence paleoenvironments from the N. Aegean, such as the adjacent Ismarida lake (Koukousioura et al., 2020). The Elos lagoon microfauna is similar to the closed lagoon of Ismarida lake (3000-2000 cal yr BP), while the Chrysofora beach assemblage resembles to the marine coastal environment fauna that prevailed in the area from 5500 to 3500 cal yr BP.

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The biogenic content in the surface sediments from the deep South Aegean basins: Benthic foraminiferal assemblages

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Aim of this research is the study of the biogenic content of surface sediments from the deep South Aegean basins. In particular, the microfaunal content of 8 surface sediment samples was analyzed, which were collected during R/V Aegaeo MSFD cruise in 2019, at depths ranging from 335 to 2150 m. Samples were carefully wet-sieved on >63 μm and 125 μm sieves, dried and the sediment fraction >125 μm was examined for the included calcareous biogenic content. Samples presented rich assemblages consisted of pteropods, planktonic and benthic foraminifera, ostracods as well as otoliths.

This study focuses on benthic foraminifera which is the most diverse group in the samples. Benthic foraminiferal assemblages are composed of hyaline and agglutinated foraminifera. The agglutinated foraminifera are mainly represented by arborescent/tubular species which are presented here for the first time for the southern Aegean Sea, while the distribution of modern agglutinated foraminifera has been so far described from Saros Bay in the northern Aegean Sea (Frontalini et al., 2014, 2015). The most abundant taxa are *Saccorhiza, Bathysiphon, Rhizammina, Psammosiphonella* and *Glomospira* spp.

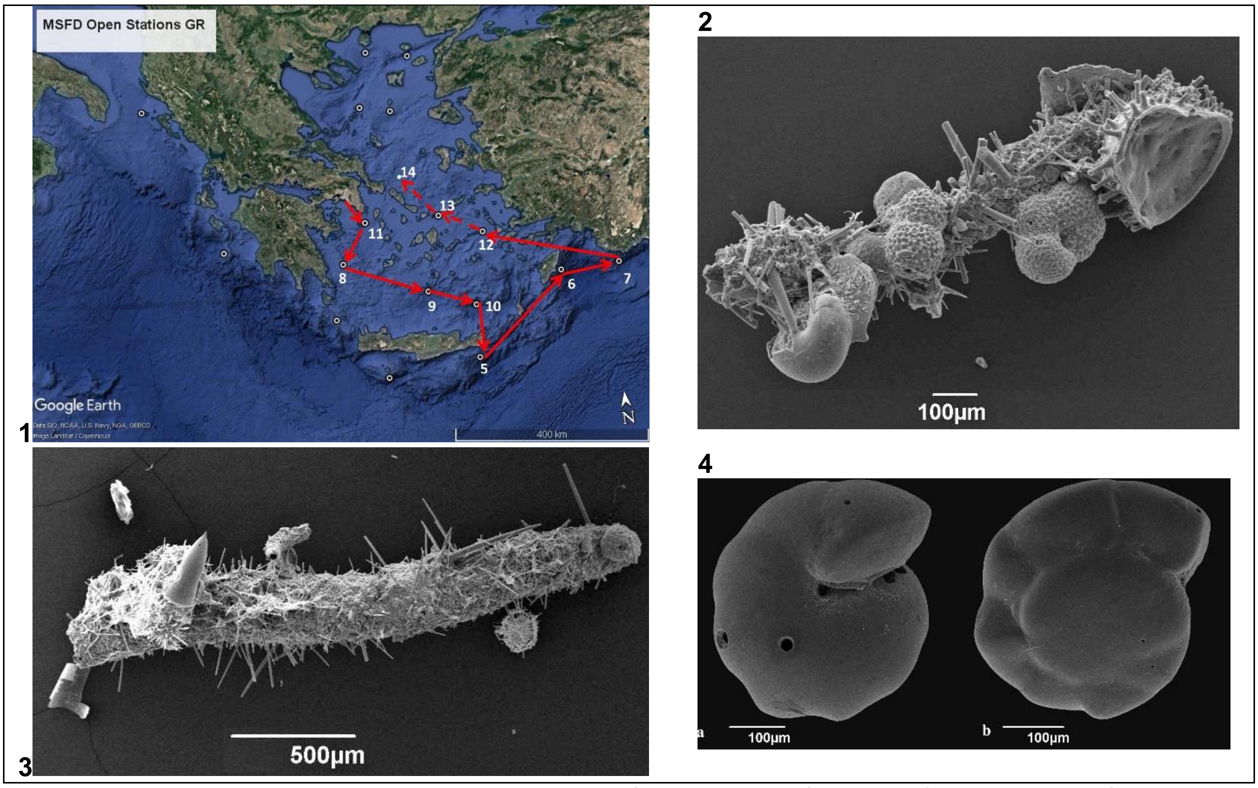

Figure 1. 1. Map presenting the sampling stations. 2.-3. *Saccorhiza* : 2. Specimen from sample 2MSFD-7 (1680m depth) and 3. Specimen from sample 2MSFD-6 (1470m depth). 4. The species *Gyroidina* cf. *umbonata* from sample 2MSFD-6 (1470m depth): a. Umbilical side and b. spiral side.

Overall, two distinct benthic foraminiferal assemblages were distinguished:

- The assemblage in the samples from the upper bathyal (200-600m) zone, which is composed of species of the hyaline taxa *Bolivina*, *Bulimina*, *Melonis*, *Cassidulina*, *Amphicoryna* and presents the lower abundance and diversity of the agglutinated species.

- The assemblage in the samples from the lower bathyal (1000-2000m) zone. The lower bathyal biofacies is characterized by the species *Gyroidina* cf. *umbonata, Gyroidina orbicularis, Melonis* sp., *Uvigerina* spp. *Gyroidina* spp. presents its highest relative abundances (up to 75% of the hyaline species) at the depths of 1670-2000m. Accordingly, the group of agglutinated foraminifera presents its highest values of diversity and abundance.

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Mollusc assemblages and paleoenvironmental implications during the Holocene in the Elefsis Bay (Saronikos Gulf, Greece)

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The Gulf of Elefsis is a geomorphological embayment located in the northernmost part of the Saronikos Gulf in central Greece. A 342 cm long marine core (S2P) was retrieved from the deepest part of the gulf and was used in various multiproxy researches (e.g., Petropoulos et al., 2013, Kyrikou et al., 2020; Kouli et al., 2021). The core's chronological framework spans from the Late Pleistocene – Early Holocene to present (Kyrikou et al., 2020; Kouli et al., 2021). This study focused on assessing the mollusc assemblages and their environmental footprint over time. The methods used included qualitative - quantitative - statistical analysis of the faunal specimens. A total of 10500 specimens were collected after standard sample preparation procedure (e.g., Carboni et al, 2009; Koukousioura et al., 2012), which resulted in 6661 individuals belonging to 45 mollusc genera and 47 species. Our data showed a clear grouping of certain species according to core depth, which was confirmed by molluscs concentrations (Figs 1, 2), diversity indices (Fig. 3), and Q-and-R mode Cluster Analysis (Fig. 4) Principal Component Analysis (Fig. 5).

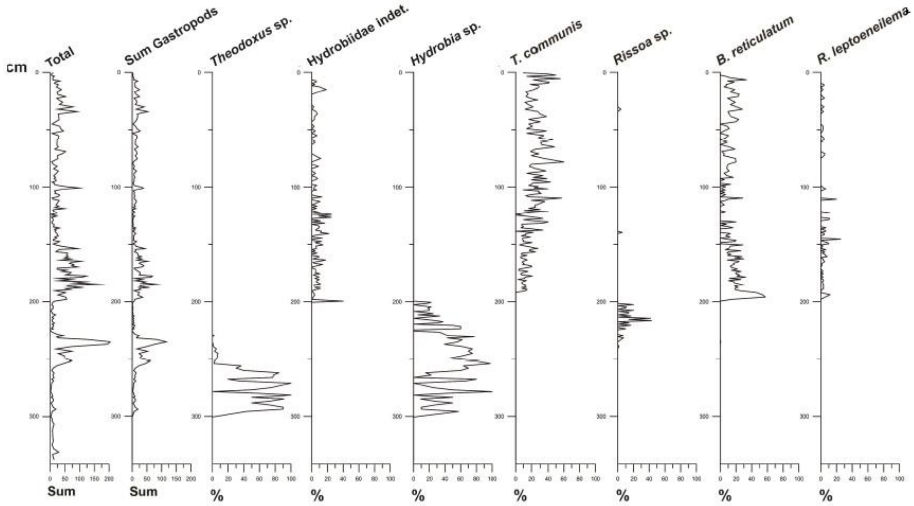

Figure 1. Sum of gastropods and selected species percentages.

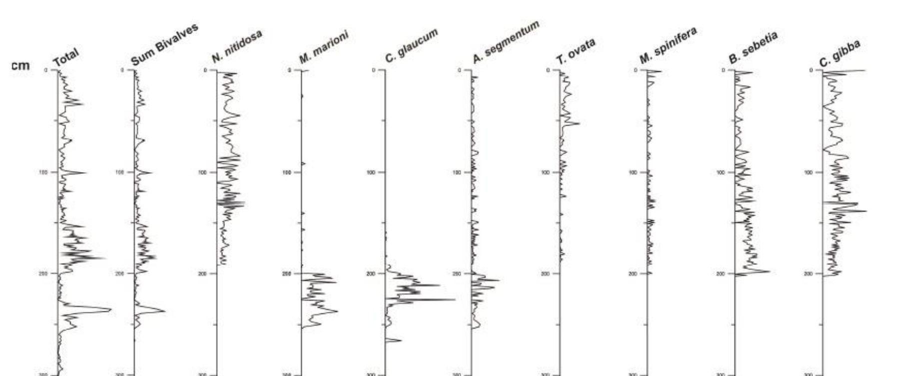

Figure 2. Sum of bivalves and selected species percentages.

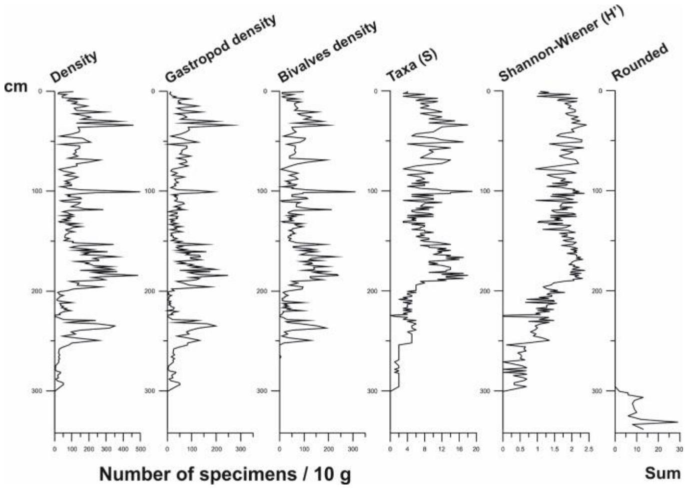

Figure 3. Total mollusc density, Shannon-Wiener (H') diversity index, number of taxa (S) and rounded specimens count.

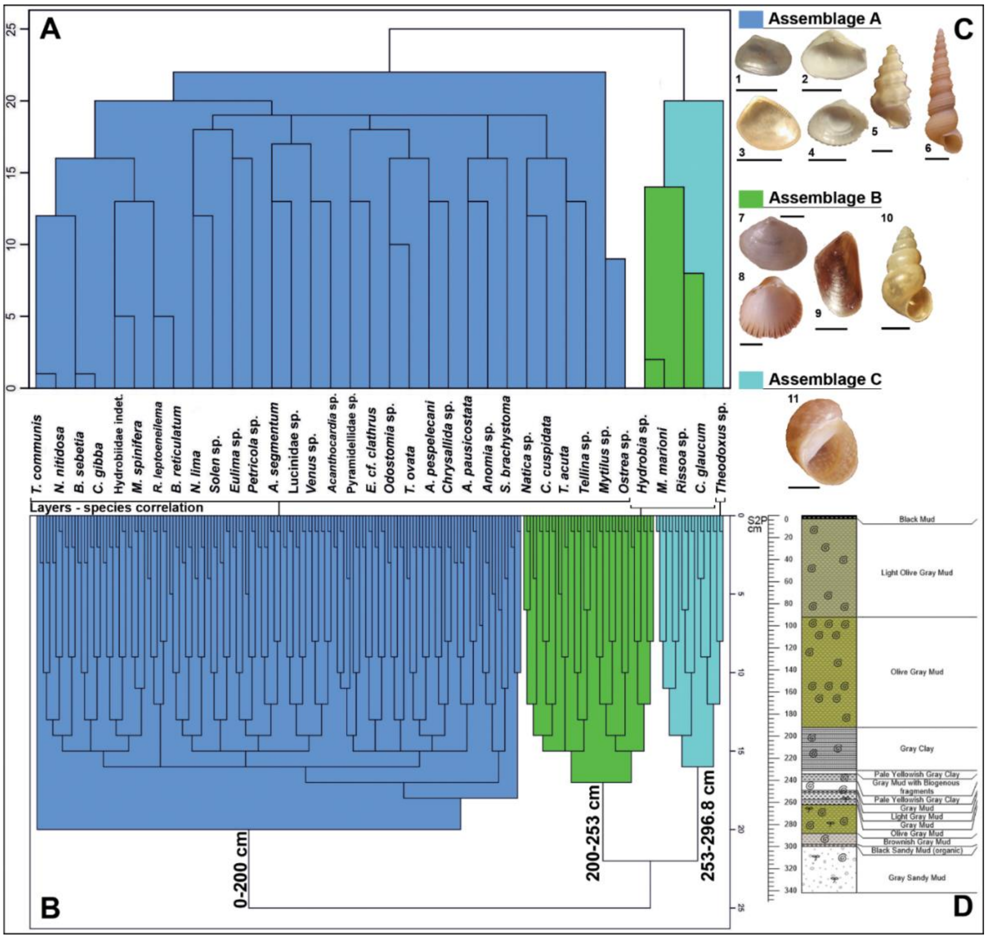

Figure 4. Cluster analysis results. A) R-mode grouping of species into 3 distinct assemblages. Species are correlated to layers depending on their abundance and presence in S2P core (Layers-species correlation); B) Q-mode grouping of S2P core layers; groups are colored blue, green and cyan to correspond to the R-mode assemblages; C) Assemblages A, B, C with selected most abundant species shown: Assemblage A (blue), *B. sebetia* (2 mm), *C. gibba* (1 cm), *N. nitidosa* (5 mm), *T. ovata* (1 cm), *B. reticulatum* (500 μm), *T. communis* (1 cm); Assemblage B (green), *A. segmentum* (1 cm), *C. glaucum* (1 cm), *M. marioni* (5 mm), *Hydrobia* sp. (1 mm); Assemblage C (cyan), *Theodoxus* sp. (5 mm); D) S2P core lithological data after Petropoulos et al. (2013).

Four faunal assemblages were distinguished from bottom to the top of the core: the oldest Assemblage D ("fossil", layers 342-300 cm) consists of rounded and possibly calcified specimens; Assemblage C (freshwater - oligohaline environment, 296.8-253 cm) includes freshwater-brackish living species such as *Theodoxus* sp. and *Hydrobia* sp. and low values of faunal indices (Taxa (S), Shannon-Wiener (H'), Density); Assemblage B (open lagoon, 253-200 cm) consists of the brackish living species *Cerastoderma glaucum*, *Mytilaster marioni*, *Hydrobia* sp. and intermediate values of faunal indices; Assemblage A (marine, 200-0 cm) comprises marine living species (mainly *Bornia sebetia*, *Corbula gibba*, *Myrtea spinifera*, *Nucula nitidosa*, *Timoclea ovata*, *Bittium reticulatum* and *Turritella communis*) and high values of faunal indices. The analysis concluded that in the Late-Pleistocene and Holocene Elefsis Bay evolved due to Saronikos area sea level rise (e.g., Kolaiti and Mourtzas, 2016), gradually changing the environmental conditions as follows: a dubious depositional system at first changed to a freshwater to oligohaline environment and then it turned into an open lagoon and later a marine environment. The resulted well constrained assemblages provided important ecological data to be considered as a set of environmental indicators. The methodology followed herein could be applied as a valuable alternative or supplementary tool for (paleo)environmental researches.

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Nannofossil biostratigraphy of the Paleogene molassic deposits of Western Thrace Basin

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The Thrace basin is one of the largest and most important basins in the North Aegean region. The eastern part of this basin extends to NW Turkey and has been extensively studied due to its high hydrocarbon potential. The western basin of Thrace is located in NE Greece and is the study area of the present work. It belongs to the Rhodope – North Aegean molassic basin and is characterized by Paleogene molassic deposits that are marginalized in the NW part by the metamorphic rocks of the Rhodope massif. Papanikolaou and Triantaphyllou (2010) identified two fault zones (FZ), the Ardas FZ and Soufli FZ, which divide the Western Thrace basin into three sub-basins (SB), the Petrota SB in the North, the Alexandroupolis SB in the South and the Orestias SB in between. The most complete sequence of the molassic formations is observed in the Alexandroupolis SB.

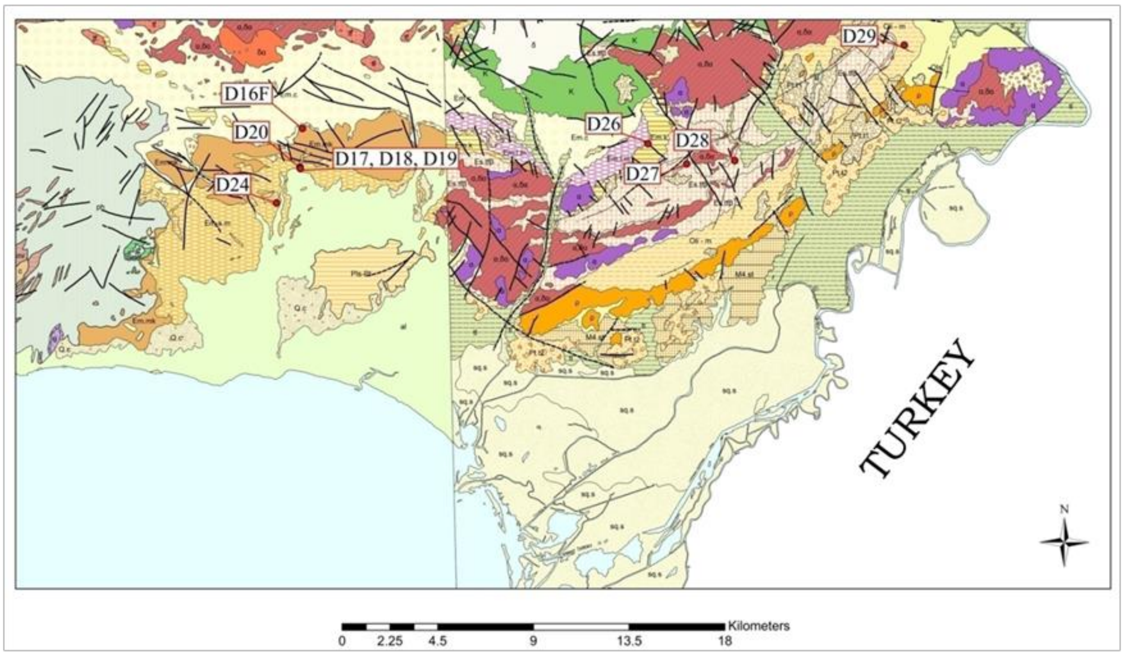

Figure 2. Geological map of the study area (Alexandroupolis SB) and the outcrop positions from which the 11 samples that contained calcareous nannofossils were collected.

As part of this research, sampling of the formations of the Alexandroupolis SB was carried out, during which, 44 samples were collected. From these samples, 51 smear slides were created and studied for their content in calcareous nannofossils, using a semi-quantitative analysis under polarizing light microscope. Out of the 44 samples, 11 contained nannofossils (Fig. 1). These were identified and the percentage of participation of each species in the samples was determined. The biostratigraphical characterization of the samples was possible with the presence of index species, such as *Isthmolithus recurvus*, *Sphenolithus predistentus*, *S. distentus*, *S. ciperoensis*, etc. (Fig. 2).

In this way, most of the samples studied were classified in a specific biozone based on the biozonations proposed by Martini (1971) and Agnini et al. (2014), thus defining the chronostratigraphical period of Late Eocene to Late Oligocene for the molassic sediments that comprise the Western Thrace basin.

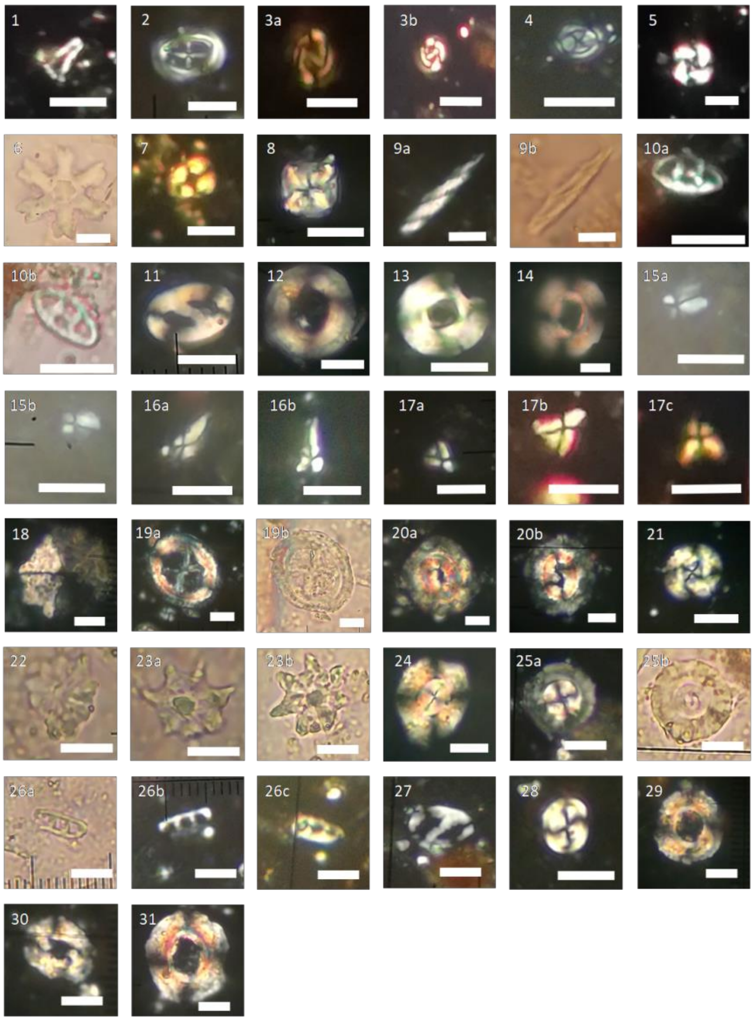

Figure 3. Micrographs of calcareous nannofossil species found in the studied assemblages. All scale bars on bottom right of each photograph represent length of 5 μm. 1: *Blackites clavus,* 2: *Campylosphaera dela,* 3: *Chiasmolithus nitidus,* 4: *Clausicoccus subdistichus,* 5, 21: *Cribrocentrum reticulatum,* 6: *Discoaster distinctus,* 7, 25: *Ericsonia formosa,* 8: *Micula staurophora,* 9: *Nannoconus funiculus,* 10: *Neococcolithes dubius,* 11, 27: *Pontosphaera obliquipons,* 12, 29: *Reticulofenestra dictyoda,* 13, 30: *Reticulofenestra hillae,* 14, 31: *Reticulofenestra umbilicus,* 15: *Sphenolithus furcatolithoides* "morphotype B", 16: *Sphenolithus radians,* 17: *Sphenolithus spiniger,* 18: *Braarudospha erainsecta,* 19: *Chiasmolithus oamaruensis,* 20: *Coccolithus eopelagicus,* 22: *Discoaster barbadiensis,* 23: *Discoaster saipanensis,* 24: *Dictyococcites bisectus,* 26: *Isthmolithus recurvus,* 28: *Pontosphaera ocellata.*

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Depositional environments and diagenetic history of the Cretaceous sediments in Ionian Zone (Epirus, Western Greece)

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The sedimentological, micropaleontological, petrophysical, and microfacies analyses of the Cretaceous carbonate succession in the Gardiki section of Epirus, provide new insights into the depositional and diagenetic processes of the Western Ionian Basin (External Ionian Zone) (Fig. 1).

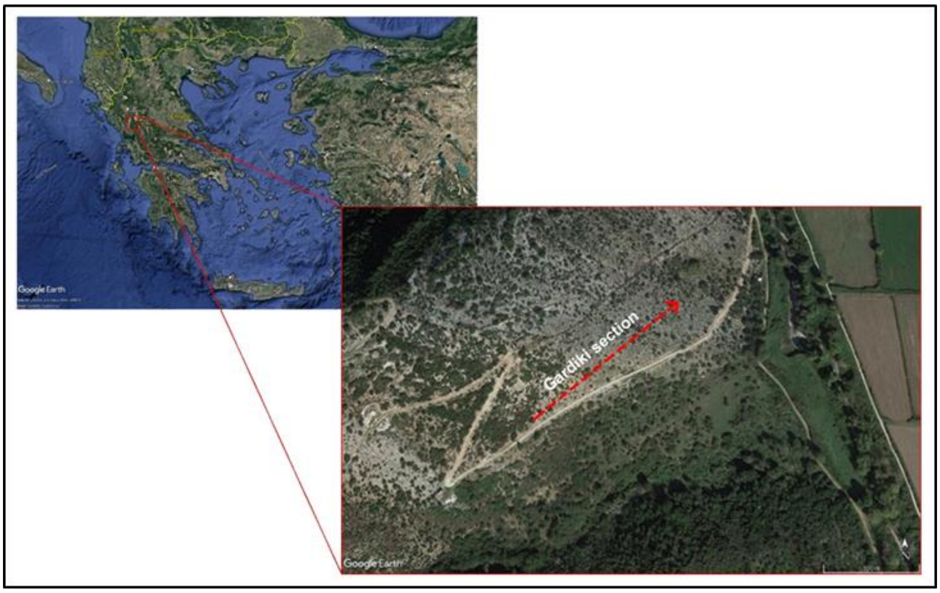

Figure 1. Google Earth map illustrating the studied area. Red dashed line shows the Gardiki section (lat: 39°20'22,09'' N, long: 20°33'5,63'' E)

Facies analyses allowed the description of the distinguished microfacies types, including the main textural and compositional characteristics and sedimentary features related to various depositional settings or facies zones (Karakitsios & Rigakis, 2007; Karakitsios et al., 2004; Kontakiotis et al., 2020). The Vigla limestone is characterized by two distinct microfacies: a) pelagic biomicrite mudstone to wackestone, with predominantly planktonic foraminifera, rare radiolarians, and calcite veins, which correspond to thin-bedded platy deposits; and b) pelagic biomicrite wackestone-packstone with planktonic foraminifera, radiolarians, and filaments (indicative to more uniform pelagic Vigla limestones) (Flügel, 2012). In terms of paleodepth deposition and energy conditions, the facies distribution shows a moderately deep environment with considerable internal differentiation. The post-rift sequence begins with the pelagic platy Vigla mudstone-wackestone limestones, which were deposited in a low-energy, deep basinal environment. The passage from thin-bedded platy limestones alternated with siliceous cherts to more uniform medium-bedded carbonates (unprivileged to siliceous deposits) of the Vigla limestone formation suggests slightly shallower depositional environments, such as those of the deep shelf.

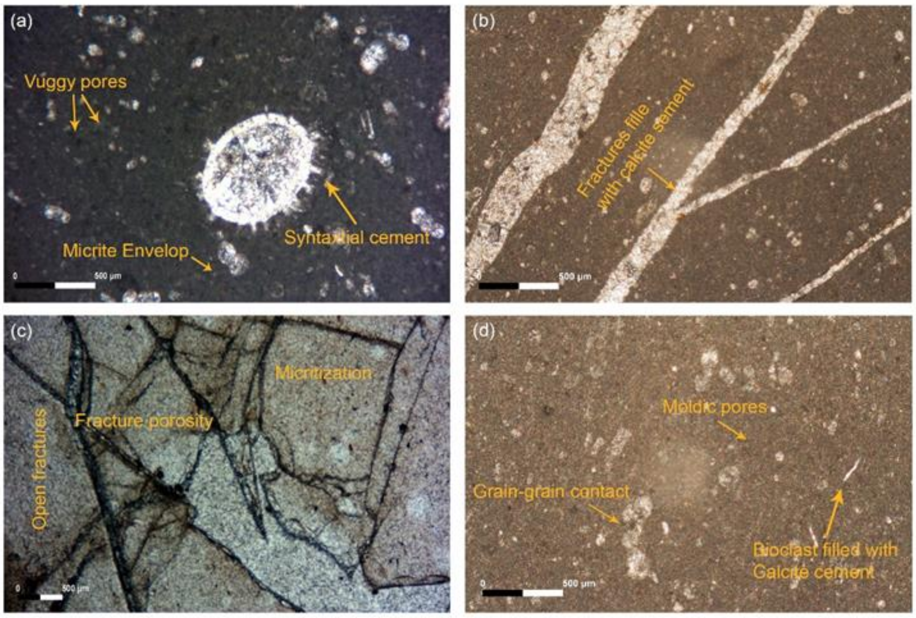

Figure 2. Petrographic analysis showing different diagenetic processes in carbonate samples collected from Ionian zone (Epirus, western Greece), a) high micritization, vuggy pores, and syntactical overgrowth cement, b) micritization, late stage of diagenesis-fractured filled with calcite cement, c) early stage of micrite envelop, late stage of open fracture, d) moldic pores, grain-grain contact (Physical compaction)

Samples	Diagenetic Processes	Marine	Meteoric	Burial	Effect on Porosity
B1-B7, B9, B14, B15, B17-B19, B23, B25-B39, B42, B44, B48-B53, B58-B63, B65, B69 – 81	Micritization				+ -
B3, B11, B78	Dolomitization				
B1, B3, B15, B17, B18, B19, B42, B44, B65, B69	Fracturing				
B1- B7, B9, B11, B14 - B19, B23, B25-B39, B42, B48-B53, B58-B63, B65, B69-81	Dissolution (Fabric Selective)				
B1- B7, B9, B11, B14, B15, B17-B19, B23, B25-B38, B42, B48-B53, B58-B63, B65, B69-81	Cementation 1. Syntaxtial cement 2. Equant Cement 3. Blocky Cement				
B1-B6, B9, B11, B14, B15, B17- B19, B23, B25- B39, B42, B48-B53, B58-B63, B65, B69-81,	Compaction 1. Physical 2. Chemical				
B3, B5 B17, B6, B11, B14, B15, B18, B19, B23, B25-B39, B42, B48-B52-B53, B58-B63, B65, B69-81,	Dissolution (Non-Fabric)				
B5, B6, B7, B9, B11, B17, B26, B28, B29, B32, B33, B35, B38, B39, B42, B50, B58, B60, B63, B65, B69, B73, B75	Neomorphism				
B1, B3, B4, B7, B9, B11, B15, B17, B23, B25, B27, B32, B34, B35, B42, B52, B60, B62, B65, B69, B76	Filled Fracture and Veins Filling				

Figure 3. Table showing the different diagenetic processes that take effect in this case study. Red boxes represent longer-dominant diagenetic events and green boxes represent minor events.

Furthermore, a petrographic study identified several distinct diagenetic features among the Cretaceous sediments (Fig. 2). In addition, for investigating the petrographic relationships, the Cretaceous reservoir deposits of the Ionian Zone may be categorized into marine, meteoric, and burial diagenetic settings. Micrite envelop, cementation, fracture, compaction, and dissolution are the dominant diagenetic parameters which are identified in the current field of study. This complicated diagenetic history of the carbonate rocks of Western

Greece has both positive and negative effects on porosity (Janjuhah et al., 2019) (Fig. 3). Even though radiolarians were uncommon compared to planktonic foraminifera in these deposits, the presence of filaments within the micritic matrix also denotes a relatively deep, low-energy environment.

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The recent ostracod fauna of Lake Kournas (Crete Island, Greece)

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Lake Kournas (35°21′, 0″N, 24°16′26″E) is situated at the southern part of Greece, at Crete Island (Chania Prefecture) at 19 m a.s.l (Fig. 1). It is the only natural lake of the island and the southernmost lake of Europe. It covers a surface area of ~0.6 km^2 and its maximum depth is 22.5 m. The lake is brackish (Moustaka et al., 2019; present study) and receives water from underground springs. The lake is monitored for its ecological quality status and is characterized by a continuous degradation due to anthropogenic activities in the surrounding area (Greek Biotope/Wetland Centre, personal communication), whereas the human impact is considered as the main factor of the ecosystem change in the area already since ~8000 years ago (Jouffroy-Bapicot et al., 2021).

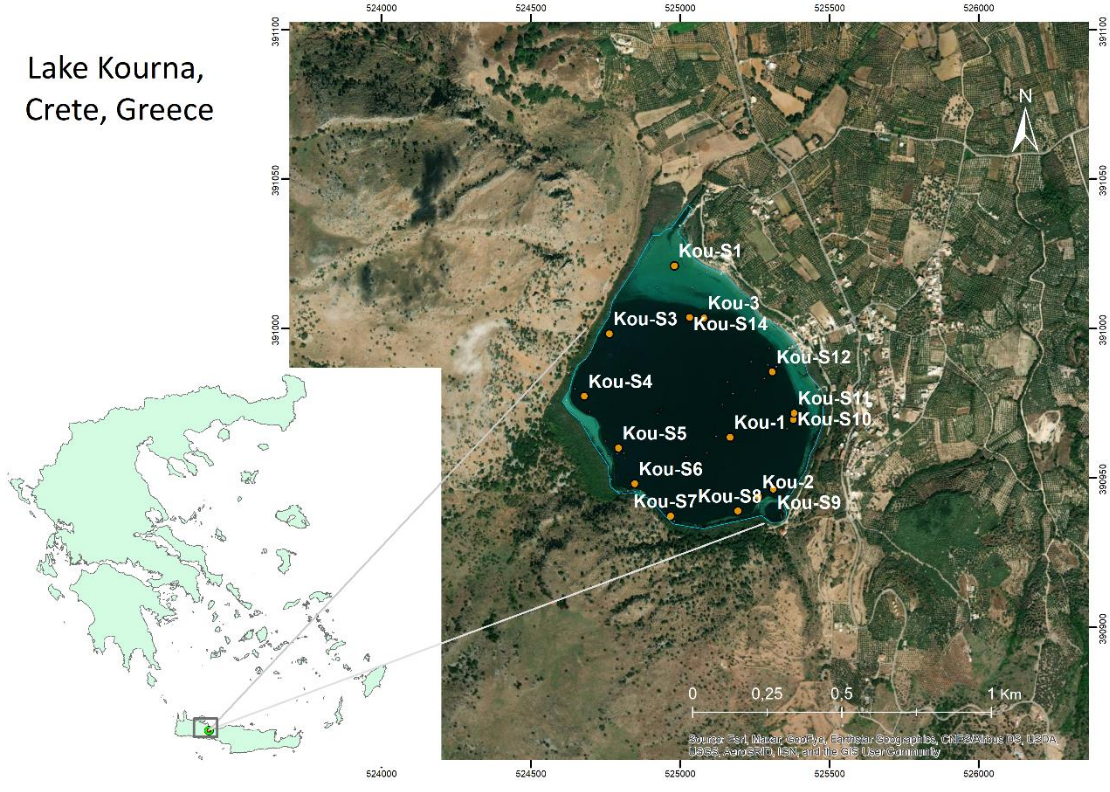

Figure 1. Map of Lake Kournas. The bullets indicate the sampled stations.

Recent ostracod assemblages were analyzed in order to investigate their composition and distribution in Lake Kournas (Crete Island, Greece), compared to a multi-parameter environmental dataset (temperature, salinity, pH, TDS, DO), geochemical, sedimentological analyses and magnetic susceptibility measurements. Sampling of the top 2 cm of the surface sediment was conducted in 3 stations in 2017 and in 12 stations during 2020, covering a big area of the lake bottom.

Ostracods are excellent bioindicators of the physicochemical conditions, with a remarkable response to variable salinities, water depth, temperature ranges, or pH (Ruiz, 2013). Along with foraminifers have been described as the most important microfossils for brackish waters systems (Frenzel and Boomer, 2005). Thus, the brackish character of Lake Kournas is supported both by salinity measurements and the majority of the ostracod species, which are typical for their brackish preference.

Based on grain size analysis the lake bottom sediments consist of silt to sandy silt and are characterized by relatively uniform distribution. Total organic carbon (TOC) concentrations present a mean value of 4.12%, while total nitrogen (TN) and phosphorus (TP) display low values. The geographical distribution of sediment nutrients shows a significant variation between the northern and southern part of the lake, with the higher values observed at the southeastern part.

In total, 3139 ostracod valves have been collected, most of them identified in species level, and assigned to 8 taxa. *C. torosa* was the most abundant species in the ostracod fauna, dominating or being the only species in most of the studied samples, followed by *Cyclocypris ovum* with lower abundances. The deepest station sample (Kou-1, depth 22.5 m) is dominated by >60% of juveniles *Candona* species. At the north part of the lake ostracod abundances and richness displayed the highest values, while the lowest were observed at the southeastern part. The documentation of the ostracod fauna of Lake Kournas provides information for the Cretan inland waters and becomes the starting point to evaluate the environmental conditions and the anthropogenic pressure in this vulnerable environment.

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Rifting of the Sub-Pelagonian carbonate platform: A case study from the *Aggelokastro* section, Argolida, Greece

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This study presents the preliminary results of selected samples from *Aggelokastro* section, NE Peloponnese, Greece. The section is comprised of a ~200 m thick carbonate sedimentary succession, followed by a ~10 m of thin bedded siliceous deposits, capped by ~50 m of clastic sediments of the "schist-sandstone-chert" formation and finally overthrusted by thick bedded carbonate deposits. The entire sedimentary sequence belongs to the Sub-Pelagonian type B Unit, member of the tectonostratigraphic terrane H3, equivalent to the non-metamorphic Pelagonian platform (Papanikolaou, 1990; Papanikolaou, 2021). For a preliminary study of the sequence, 12 thin sections were produced from selected samples around a clear lithological facies transition from thick bedded carbonates to Ammonitico Rosso facies and thin bedded siliceous deposits. The samples were studied under polarized microscope (Leica DMLSP) and were characterized according to the Standard Microfacies (SMF) and the respective Facies Zonation (FZ) scheme of Flugel and Munnecke (2010). The results show significant diversion between paleoenvironmental conditions and are divided into three main parts (see Fig. 1):

- Platform facies: thick bedded carbonate succession with densely packed peloidal packstones-grainstones with benthic foraminifera, gastropods and echinoids, (SMF 16, FZ8, restricted platform interior) (Fig. 1, sample Δ2).
- Ammonitico Rosso facies: carbonate succession, represented by mudstones-wackestones- with protoglobigerinids, benthic foraminifera, radiolaria, spicules and thin shelled bivalves (SMF 8, FZ2-deep shelf, evolving to SMF3, FZ1-deep sea) (Fig. 1, samples AM1, AM6).
- Deep sea facies: thin bedded siliceous deposits, represented by wackestones-packstones with spicules, thin shelled bivalves, radiolaria and protoglobigerinids (SMF1 and SMF3, FZ1-deep sea) (Fig. 1, sample TP2).

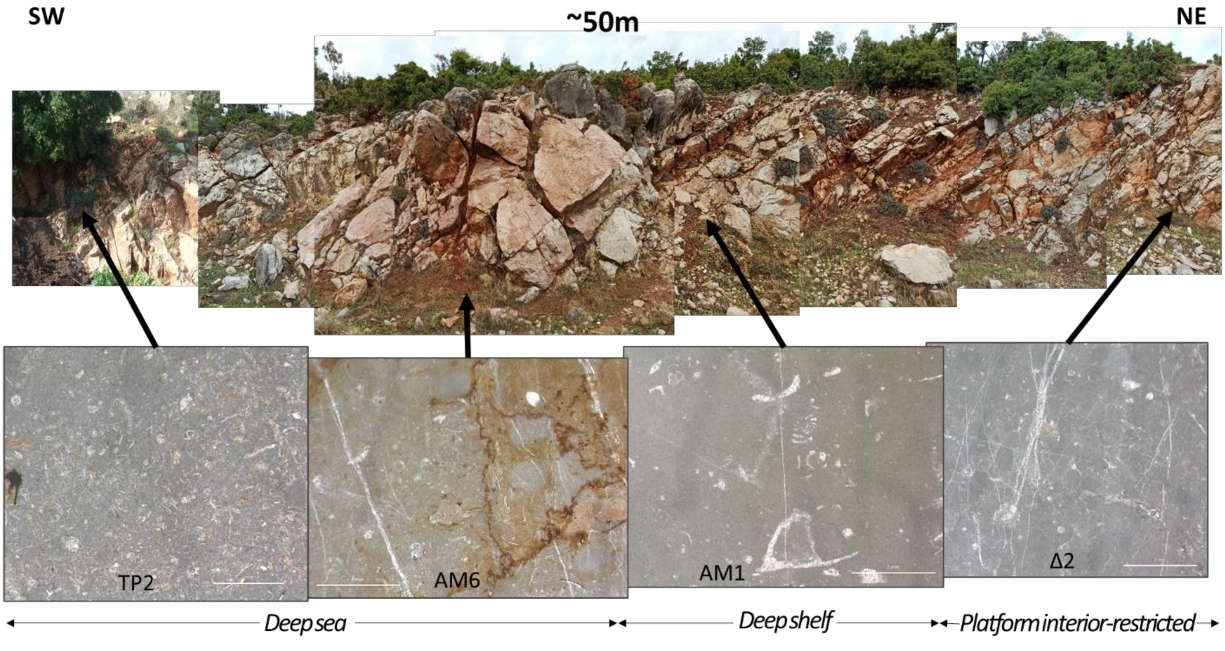

Figure 1. *Aggelokastro* section, carbonate part (point of view ~50 m) and microfacies images from 4 sampling positions (indicated by the black arrows). The defined Standard Microfacies show a clear deepening upward trend related to the rifting of the Sub-Pelagonian carbonate platform.

Additionally, smear slides from the "flysch-like" succession point to a deep marine clastic environment with rare or absent carbonate material. The defined Standard Microfacies show a clear deepening upward trend, marking the rifting of the carbonate platform. Regarding geological age considerations, the platform facies should be generally considered as Early-Middle Jurassic. The Ammonitico Rosso facies is tentatively attributed to Middle Jurassic, similarly to the dating of radiolarites above the carbonate platform in Beotia area (Danelian and Robertson, 1995). Lastly, the "flysch-like" clastic succession is generally considered of Late Jurassic-Early Cretaceous age, according to Papanikolaou (1990).

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Diatom and other siliceous phytoplankton fluxes in the N.E. Mediterranean

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In the present study, we examined the total vertical fluxes of siliceous phytoplankton groups (diatoms, radiolaria and silicoflagellates) at a north-eastern region of the Mediterranean Sea, in the Athos Basin of North Aegean (M2 site). Samples were collected along one year-period between October 2014 to November 2015 at ~15 day intervals, using a time-series sediment trap deployed at 500 m depth bss (below sea surface). Quantitative analysis of the samples occurred at 250x magnification for all groups, followed by qualitative analysis at 1250x magnification for diatoms.

Daily flux maxima were observed during late July 2015 for both diatoms and silicoflagellates (312.6 x 10^3 valves m^{-2} day^{-1}; Fig. 1, and 1309.8 x 10^3 silicoflagellates m^{-2} day^{-1}; Fig. 2), along with the second highest flux for radiolaria (13.4 x 10^3 radiolaria m^{-2} day^{-1}; Fig. 1). Moreover, both diatom and radiolaria fluxes exhibited a similar pattern, peaking during the 2015 winter-spring transition (February - March: 155.9 x 10^3 valves m^{-2} day^{-1}; 12.6 x 10^3 radiolaria m^{-2} day^{-1}) and at the end of autumn 2015 (late October – early November: 230.5 x 10^3 valves m^{-2} day^{-1} and 13.9 x 10^3 radiolaria m^{-2} day^{-1}), when lower sea surface temperatures were observed (February-March: ~14^{0}C; October-November: ~17^{0}C). In contrast to diatoms and radiolaria seasonal distributions in their fluxes, silicoflagellates exhibited their highest vertical flux rates during the summer period of 2015 (early June - early August), while maintaining lower average flux throughout the rest of the year. Increased precipitation rates (~30 mm/day) during June 2015 (Skampa *et al.*, 2020) indicates a potential driving force behind the flux maxima observed in all siliceous groups in July 2015, probably due to enhanced nutrient inputs through wet atmospheric deposition, despite the typical statification of the water column in the summer months.

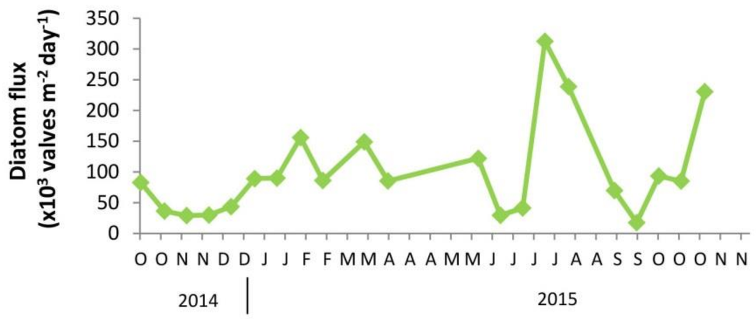

Figure 1. Average daily flux values for diatoms from the sediment trap at North Aegean (M2 site).

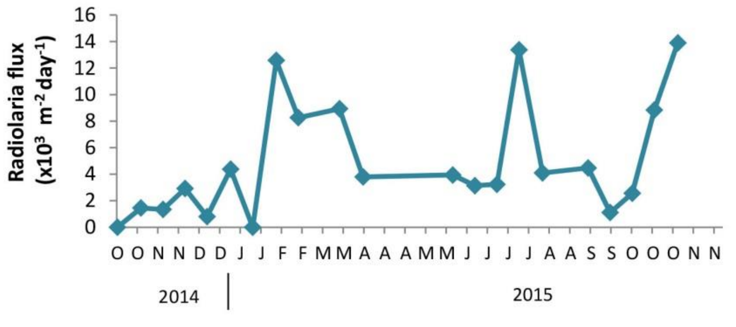

Figure 2. Average daily flux values for radiolaria from the sediment trap at North Aegean (M2 site).

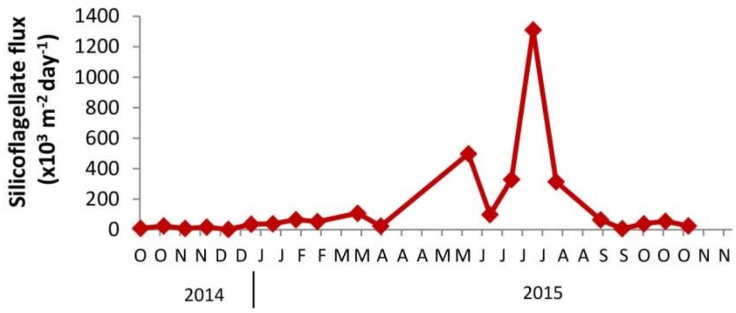

Figure 3. Average daily flux values for silicoflagellates from the sediment trap at North Aegean (M2 site).

Acknowledgments

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The classical locality of Pikermi (Attica, Greece): The carnivores

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The present work is part of my master's thesis on the taxonomy of carnivores from the classical locality of Pikermi. This project aims to show that studying and reviewing old museum collections under the light of the continuous stream of available information can often lead to new information (e.g., identification of previously unidentified material or its re-identification). Additionally, when completed, it will serve to enrich and increase the knowledge in the fossiliferous record of carnivores from Pikermi. This will be achieved by the increase of the sample size and intraspecific variation on some already well-studied species and with the contribution of additional information regarding the morphology of some previously less well-known species. Lastly, the combination of knowledge from the old collections with the new excavations conducted on Pikermi, almost yearly under the direction of Prof. Emeritus G. Theodorou, will hopefully bring to light even more information of its carnivores.

The classical locality of Pikermi is known worldwide for its rich Turolian mammalian fauna and is often simply referred to as the "Pikermian fauna". The fossiliferous sediments that lie within the red silts of the lower Pikermi Formation are located in the Mesogea Basin of Attika, Greece. The age of the classical fossiliferous site is estimated ~7.3 Ma (MN12, middle Turolian) according to recent magnetostratigraphic data by Böhme et al. (2017).

The material of the classical locality is the collective product of many excavations across the span of almost a century. The discovery of the fossiliferous locality was first recorded in 1836 by G. Finlay. In the years that followed, a chain of subsequent excavations led by various scientists such as A. Lindermayer (1843), J. Roth (1852), H. Mitzopoulos (1853), A. Gaudry (1855-1856, 1860), W. Dames (1882), L. v. Tausch and M. Neumayr (1885), Th. Skouphos and A. S. Woodward (1901) and O. Abel (1912) took place (Roussiakis et al., 2019 and references therein). Besides Greece, material from those excavations can be found in numerus natural history museum collections across Europe (e.g., Munich, Berlin, Paris, London, Vienna, etc.). These excavations yielded, amongst many other fossils, a rich and diverse carnivore fauna of at least eighteen species from six families (Hyaenidae, Felidae, Ailuridae, Mustelidae, Ursidae and Mephitidae) (Vlachos, 2022 and references therein).

The studied material is stored in the Palaeontological Museum of the National and Kapodistrian University of Athens. It consists of previously unpublished craniodental and postcranial elements. All specimens treated are documented, described and allocated in their appropriate species. Biometric measurements (e.g., length and width of the teeth) and indexes (e.g., robusticity of the teeth) are measured and presented in tables. Craniodental terminology generally follows the work of Werdelin (1988). Additionally, graphs are also plotted from the acquired metric data. These are either simple bivariate plots (e.g., of the length and width of a tooth) or log-ratio diagrams (Simpson, 1941). After each species description there is a section of discussion where brief historical information (e.g., taxonomical, nomenclature) is given. However, the main part of discussion, is dedicated to the comparison of the studied material (morphological and metrical) with other similar and recognized species, either from Pikermi or from similar localities. So far, representatives from the families of Hyaenidae, Felidae, Ursidae and Ailuridae have been recognized, with the main bulk of the material being occupied by hyaenids (Table 1).

During the progress of the thesis, two kinds of difficulties were encountered. The first is associated with the studied material. The absence of taphonomical data introduces a degree of doubt in the correlation between some of the specimens as exemplified in Figure 1. The second difficulty is associated with the comparative material. As a large portion of the classical collections from Pikermi are housed in various foreign institutions, I did not have the chance to personally study it. Thus, in order to substitute that, descriptions, measurements and photographs or illustrations already published were used.

Table 1. Identified carnivoran taxa at the present time.

Family	Species
Hyaenidae	*Plioviverrops orbignyi*
	Ictitherium viverrinum
	Lycyaena chaeretis
	Hyaenictis graeca
	Adcrocuta eximia
Felidae	*Paramachaerodus orientalis*
Ursidae	*Indarctos atticus*
Ailuridae	*Simocyon primigenius*

Figure 1. Mounted left frontal limb of an Ictitheriinae from the classical locality of Pikermi. Currently under study to verify whether it represents one or more individuals. Scale bar is 5 cm.

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The Villafranchian mammal assemblage of Aghia Kyriaki, Aetoloakarnania, Greece: a preliminary palaeontological study

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The fossiliferous karstic site of Aghia Kyriaki is located in the South-Western part of Central Greece, near the homonymous settlement. The locality lays on the Pindos Mountain range, and it is situated at an altitude of approximately 1300 m. The fossils were deposited in a karstic cavity and were exposed during the construction of a new road. All the remains were collected during palaeontological excavations that took place during 2017-2019 and are stored in the collections of the Laboratory of Palaeontology and Stratigraphy of the University of Patras (Greece). The material was studied in the context of a Master thesis (Parparousi, 2022). Despite the scanty preservation status of the material, the systematic palaeontological study allowed the identification of 13 different mammalian taxa. Among the most interesting remains we note a skull of the bear *Ursus etruscus* and several remains of the mid-sized bovid *Hemitragus*. The preliminary faunal list of the locality is provided on Table 1.

Table 1. Faunal list of the fossiliferous locality of Aghia Kyriaki (Aetoloakarnania, Greece).

Class **Mammalia**	Family **Mustelidae**
Mammalia indet.	**Mustelidae** indet.
Order **Chiroptera**	Order **Artiodactyla**
Chiroptera indet.	Family **Cervidae**
Order **Rodentia**	**Cervidae** indet. (mid-sized)
Family **Arvicolidae**	***Croizetoceros ramosus***
Arvicolidae indet.	Family **Bovidae**
Order **Carnivora**	**Bovidae** indet.
Family **Ursidae**	***Hemitragus*** sp.
Ursus etruscus	cf. ***Gazellospira torticornis***
Family **Canidae**	cf. ***Procamptoceras brivatense***
Canidae indet. (mid-sized)	
Canis (***Xenocyon***) sp.	

The site was biochronologically dated to 2.5-1.8 Ma, corresponding to the middle to early late Villafranchian (Fig. 1). Based on the faunal list of the locality, we can assume that the palaeoenvironment of Aghia Kyriaki was a mosaic of open areas, dense woodlands and rocky areas, close to a water body. The palaeoenvironmental interpretation is consistent with the predominant palaeoenvironments inferred for the middle and late Villafranchian of Greece.

Further systematic excavations on the site and stratigraphic studies are needed in order to clarify in more detail the chronological position of the locality and its fauna. This new remarkable locality could thus shed new light on the faunal assemblages and habitats of Greece during the Early Pleistocene.

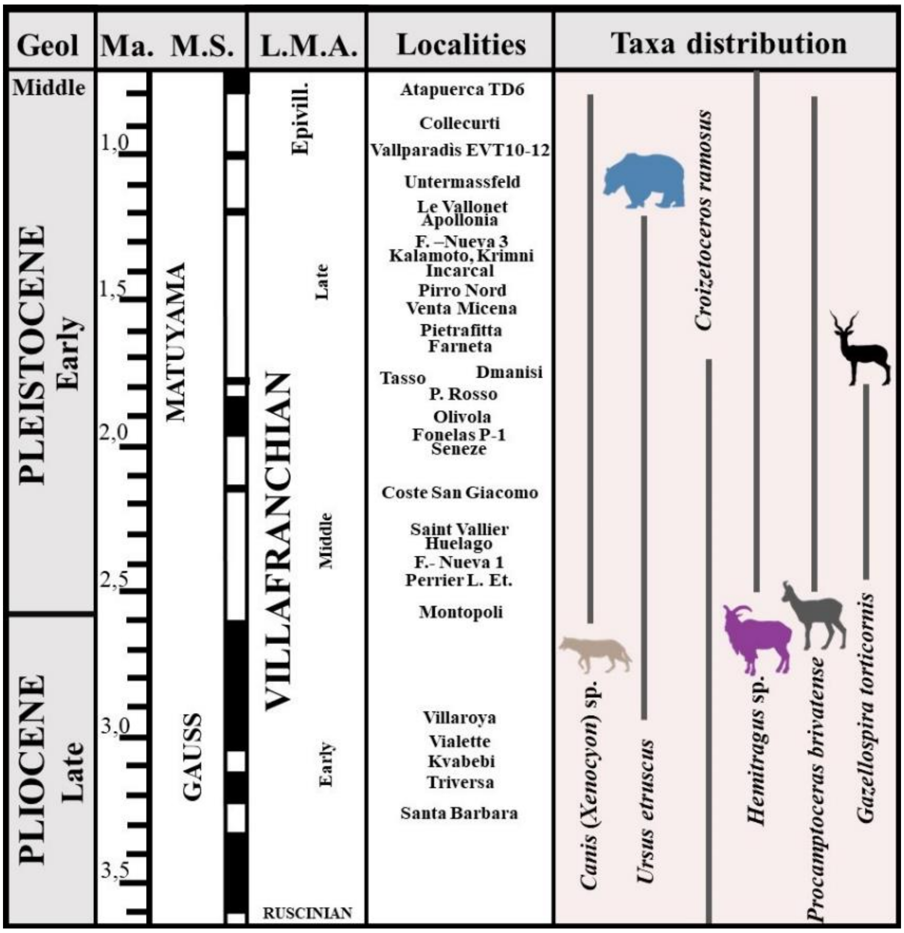

Figure 1. Biochronological table of the time range of different genera and species found in Aghia Kyriaki. Data from: Kostopoulos (1996), Crégut–Bonnoure (2007), Rook and Martinez–Navarro (2010), Madurell–Malapeira et al. (2021), and Bartolini–Lucenti and Spassov (2022).

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The Late Pleistocene micromammalian fauna from Agios Georgios Cave (Kilkis, Central Macedonia, Greece). Preliminary results

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Agios Georgios Cave (SGK) is a Late Pleistocene fossil site located on the southwestern part of Agios Georgios Hill, near the city of Kilkis. The locality was excavated in the early 1990s and the retrieved fossil remains resulted in the description of eight large mammal species: *Crocuta crocuta spelaea*, *Vulpes vulpes*, *Mustela putorious robusta*, *Bos primigenius*, *Megaloceros giganteus*, *Cervus elaphus*, *Equus hydruntinus* and *E. caballus* cf. *germanicus* (Tsoukala,1992; Bassiakos and Tsoukala, 1996; Makridis et al., 2013). SGK is characterised as a hyenid den (Tsoukala, 1992).

Alongside with the main excavation, fissure-filling sediments were also extracted from the main site B, an approx. 4 m deep and narrow natural hole, which were washed at superimposed sieves (3.0 mm mesh size for the top sieve and 0.8 mm for the bottom one). The examination of the remained material resulted in the preliminary identification of several micromammalian remains from Muridae, Cricetidae, Spalacidae, Sciuridae, Arvicolidae, Talpidae, Chiroptera and Leporidae and more specifically *Apodemus* sp., *Cricetulus migratorius*, *Mesocricetus newtoni*, *Microspalax* (*Mesoapalax*) *newtoni*, *Citellus citellus*, *Microtus arvalis* and *Lagurus lagurus* (Doukas et al., 1991; Tsoukala, 1992; Bassiakos and Tsoukala, 1996; Makridis et al., 2013).

Furthermore, the Electron Spin Resonance dating method was applied on dental elements of *C. crocuta spelaea* and *E. hydruntinus*, which resulted in an age of 12.500 ka and 29.349 ka for the former and 28.530 ka for the latter (Bassiakos and Tsoukala, 1996; Makridis et al., 2013). Tsoukala (1992) states that the age of the large mammal fauna is of Late Pleistocene and the age of the small mammal fauna corresponds to the lower part of the Late Pleistocene.

The aim of the current work is to present some (preliminary) taxonomic results that were obtained from the complete study of the micromammalian fauna from SGK.

The total number of the identified specimens (NISP) is 673. 159 belong to Chiroptera (Rhinolophidae, Vespertilionidae, Miniopteridae), 492 to Rodentia (Sciuridae, Muridae, Cricetidae, Spalacidae) and 22 to Lagomorpha (Ochotonidae, Leporidae). The examination of the fauna resulted in the identification of 16 species, which are *Rhinolophus ferrumequinum*, *R. mehelyi*, *R. mehelyi/blasii/euryale*, *Rhinolophus* sp., *Myotis myotis*, *M. blythii*, *M. myotis/blythii*, *M. bechsteinii*, *Myotis* sp., *Miniopterus schreibersii*, Chiroptera indet., *Spermophilus citellus*, *Apodemus sylvaticus/flavicollis*, *Cricetulus migratorius*, *Cricetus cricetus*, *Mesocricetus newtoni*, *Arvicola amphibius*, *Microtus arvalis/agrestis*, *Microtus* sp., *Spalax leucodon*, *Ochotona pusilla* and *Lepus europaeus*.

In order to proceed with the analysis of the obtained data at the species level, it is essential to examine whether the taxa identified from SGK are representative enough, in terms of sample size and species richness. The generated rarefaction curves (Fig. 1) demonstrate that when NISP is considered, it appears that further examination of material will not (significantly) increase the species number, as the identified taxa remained practically the same after approx. 300 specimens. On the contrary, when the minimum number of individuals (MNI) is taken into account, it is clear that the total taxa number is not stabilized, and therefore, the examination of additional material will (most possibly) increase species richness.

Moreover, the interrelationship between NISP and MNI was investigated with a log-log plot (Fig. 1). The correlation coefficient (r) is 0.8682, which suggests a relatively good correlation between the aforementioned. Although, when the rarefaction analysis is considered, the NISP appears to be a safer choice for further analysis of the SGK micromammalian fauna.

The SGK micromammalian fossil record is dominated by Rodentia (73.11%), which is followed by Chiroptera (23.63%) and Lagomorpha (3.27%). The most dominant family is Cricetidae (62.41%) and Vespertilionidae is second with a representation of 21.10%. Sciuridae is also well-represented with 9.06%. The percentages of the remaining families are trivial. In terms of species, *M. arvalis/agrestis* and *Microtus* sp. account for 48.89% of the fauna, *C. cricetus* for 9.51%, *M. myotis*, *M. blythii*, *M. myotis/blythii* for 19.91% and *S. citellus* for 9.06%. Thus, it is obvious that these taxa are the key elements of the fauna, with a combined representation of 87.37%. All species recorded in SGK have been previously documented from at least one locality from Greece, except from *C. cricetus*, which appears in the Greek fossil record for the first time (Vasileiadou and Sylvestrou, 2022).

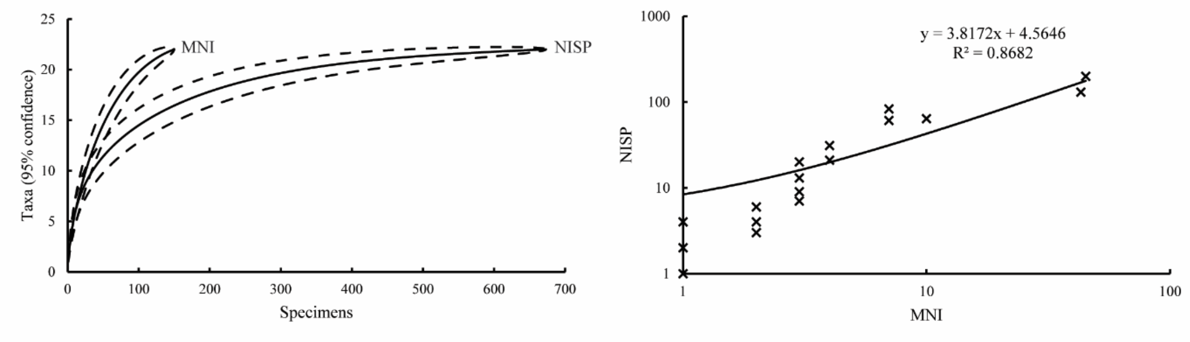

Figure 1. Rarefaction curves (left) with 95% confidence intervals for Agios Georgios Cave (SGK) based on the number of the identified specimens (NISP) and the minimum number of individuals (MNI) and the relationship between NISP and MNI (right) for SGK. Correlation coefficient (r) = 0.8682.

Based on the study of the large mammals and the preliminary study of the small mammals, Tsoukala (1992) described the palaeoenvironment of the area as an arborescent grassland, with a rather warm climate, relative to the rest of Europe. However, the micromammalian fauna composition from SGK is indicative of a slightly different palaeoenvironment with colder climatic conditions. Considering the aforementioned, the palaeoenvironment of the region around Agios Georgios Cave should have been a relatively arid steppe-like plain with sparsely-wooded patches, most possibly concentrated near a water body. The palaeoclimate of the region was colder than it is nowadays, but rather warm when compared to Northern Europe, that was severely affected by the Last Glacial Maximum.

In conclusion, the study of the Late Pleistocene micromammalian fauna from SGK indicated the presence of 16 species. One species – *C. cricetus* – is recorded for the first time in the Late Pleistocene fossil record of Greece. The palaeoenvironment of the region around the Agios Georgios Cave should have been a relatively arid steppe-like plain with sparsely-wooded patches, most probably concentrated near a permanent/temporary water body. The palaeoclimate of the region was colder than it is nowadays, but rather warm when compared to Northern Europe, that was severely affected by the Last Glacial Maximum.

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Early Pleistocene continental gastropods from the sedimentary basin of Sousaki Ag. Theodoroi, Greece

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Mollusks are a very old monophyletic invertebrate lineage, originating before the Cambrian (Barker, 2009). They are extremely diverse and globally distributed, inhabiting most environments, both aquatic and terrestrial, across a range of depths and altitudes, enabling them to act as proxies for (paleo)environmental and climate change studies (Fortunato, 2016). Furthermore, these taxa are important for palaeogeographical studies (e.g., fossil gastropods of inland waters (Neubauer et al., 2015)) in order to define biogeographical units in the European Neogene. Lacustrine fossils of freshwater gastropods are also useful tools for evolutionary paleontology (e.g., the fauna of the island of Kos (Willmann, 1985). Biodiversity in freshwater biomes provides invaluable ecosystem services sustaining human health, nutrition and fresh water supply (Neubauer et al., 2021). Part of this biodiversity are freshwater mollusks, which are threatened worldwide, due to the high environmental impact of human activities (e.g., global warming, extraction, invasive species (Bae and Park, 2020; Czaja et al., 2020; Neubauer et al., 2021). The Balkan peninsula, including Greece, hosts one of the world's freshwater biodiversity hotspots (Glöer et al., 2007; Strong et al., 2008). Continental gastropods comprise an important part of this local biodiversity (Strong et al., 2008), being present in the region since the Pleistocene, but many are today critically endangered (Neubauer et al., 2021; Neubauer and Georgopoulou, 2021).

This work involves the study of a Lower Pleistocene lacustrine malacofauna from the Sousaki sedimentary Basin, and contributes towards the better understanding of the poorly known relationship between modern and fossil species. By taking into consideration a series of works based on freshwater fossil gastropods (e.g., Fuchs, 1877; Willmann, 1981; Bukowski, 1896), the studied section revealed an interesting composition of continental malacofauna, which consists of extinct and extant species. The studied sediment samples were collected from a section, no longer accessible, during the tunneling construction works of the Athens-Corinth railway and lie unconformably above volcanic rocks. The area lies next to the Sousaki volcano, which is the westernmost end of the South Aegean volcanic arc, about 15 Km west of Corinth, in southern Greece. Studies of this locality record a complex history of volcanic activity during Pliocene and Quaternary, triggered both by extensional and subduction-related tectonics (Calvo et al., 2012; Francalanci et al., 2005; Pe-Piper and Piper, 2003; Piper and Perissoratis, 2003). Stratigraphic, tectonic and micro-paleontological analyses have been already carried out by Papadopoulou et al. (2019) and the age of the studied section is estimated to be early Pleistocene (Gelasian) (Papadopoulou et al., 2019). The similarities of the studied malacofauna with other Pleistocene ones, as well as the high rate (76%) of extinct taxa, seem to verify this age. The studied section consisting of alternations of marly and conglomeratic layers is located in the area of the youngest group of volcanic rocks, which comprises the substrate of the respective deposits. Four samples, almost 10 kg each, were collected from the base of the stratigraphic sequence, from a lacustrine, beige marl, rich in gastropod shells, deposited over the volcanic substrate (Papadopoulou et al., 2019). The processed material from the 500 μm sieve was thoroughly examined, while samples from the 63 μm, were split in quarters before they were examined. The gastropod shells were handpicked. For systematic analysis, by using Scanning Electron Microscope (SEM) photographs and taking into consideration the existing bibliography and databases, the recovered specimens were separated into morphospecies and they were identified, when possible, at species level.

As a result, 25 different species were determined, belonging to 11 families and 20 genera, namely Neritidae, Planorbidae, Lymnaeidae, Acroloxidae, Geomitridae, Hydrobiidae, Bithyniidae, Viviparidae, Melanopsidae, Thiaridae, and a species which probably belongs to Moitessieriidae. From these, 19 are extinct taxa, and six are extant; with one being endemic in Greece. Caenogastropoda prevail with 60%, against Heterobranchia 36% and Neritimorpha 4%, whereas the most diverse family is Hydrobiidae and second the Planorbidae. Representatives of the Superfamily Lymnaeoidea (i.e., Lymnaeidae, Planorbidae, Acroloxidae) appear in the study area as well, including extant species, such as *Gyraulus crista,* or widespread species in various Pliocene & Pleistocene basins like *Lymnaea megarensis.* In the family Hydrobiidae, we observed a so-called endemic species of the extinct genus *Graecamnicola*. Species of this genus have been known only from the Plio-Pleistocene sediments of the Atalanti Basin, and it has been recorded for the first time in the study area. The fossil species of the genus *Islamia* is reported in the Greek fossil record for the second time, while the first record was from the late early Pleistocene of Achaia (Esu and Girotti, 2015). Today, modern endemic species of this genus live in Greece (Glöer and Reuselaars, 2020). The statistical analysis (Hierarchal cluster analysis), groups the samples into two association clusters based on the gastropod species. According to the ecological preferences of the studied taxa, a lacustrine palaeoenvironment fed by a river could be inferred. The first cluster includes species that prefer the most stagnant aquatic environment rich in aquatic vegetation, such as several species of Lymnaeoidea. The second cluster lacks species that prefer mainly stagnant water and is dominated by species that prefer more stony substrates, especially by the genus *Theodoxus*, which could perhaps signal a change in the hydrological conditions of this environment. This palaeofauna eventually disappeared from the study area, due to the collapse of the ecosystem after the loss of this freshwater environment.

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The Lower Pleistocene locality of Karnezeika, (Peloponnese, Southern Greece): An overview

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The Karnezeika locality lies in the southern part of Argolis prefecture and corresponds to the Lower Pleistocene (Middle Villafranchian, MN17). It consists a small doline formed in the local limestone, as the substrate is characterized mainly by Upper Triassic / Lower Jurassic carbonate rocks of the Pantokrator Formation of the Pelagonian Unit. Most likely the site served as a natural trap which gradually was filled with sediments, rocks and skeletal material from the wider area transferred there by the actions of water and gravity, thus creating favorable conditions for their fossilization. A minor part of the skeletal material was studied in the context of an undergraduate dissertation and some preliminary results were provided in the form of an oral presentation during the 15th International Congress of the Geological Society of Greece (Kokotini et al. 2019). The large mammal fossil collection from the Karnezeika is the subject of an ongoing PhD study by the first author (PDS).

In total, 3358 identifiable specimens have been recorded. Apart from these cataloged and recorded specimens, there are also more than 7000 quite small fragments of all kinds of bone. The large number of fragmented material shows that most of them were transported rather violently to the final place of burial and the transportation seems to have been quite fast since the bones show no particular signs of weathering nor abrasion; no traces of carnivore activity were recorded either. The above, in combination with the presence of bones with various Fluvial Transport Index values, as well as the lack of articulated elements and any sign of bioclastic sorting shows that the place of burial was *peripheral* and the bones were transported from an area in close proximity and around the fossil trap.

The large mammal fauna that was recognized in the assemblage is vastly dominated by bovids (Sianis et al., 2022), a tendency which is quite unusual for post-Pliocene Greek localities where generally a large number of equid specimens occur instead. Apart from four bovid taxa and an equid, three different cervid species, the giraffe *Palaeotragus inexpectatus* Sampson and Radulesco, 1966, the common Villafranchian rhino species *Stephanorhinus etruscus* Falconer, 1868, seven carnivora taxa, as well as scarce remains of a large cercopithecid (Sianis et al., under review) were also recognized, rendering Karnezeika as a prime-bearing Villafranchian locality. A complete list of the large mammal fauna of the site is provided in Table 1.

Table 1. The fossil large mammal fauna of Karnezeika.

Artiodactyla
Bovidae
Gazella bouvrainae Kostopoulos & Athanassiou, 1997
Gallogoral meneghinii (Rütimeyer, 1878)
Gazellospira torticornis (Aymard, 1854)
Caprini gen. et sp. indet.

Cervidae
? *Eucladoceros* sp.
cf. *Metacervoceros rhenanus* Dubois, 1904
Croizetoceros ramosus (Croizet & Jobert, 1828)

Giraffidae
Palaeotragus inexpectatus (Samson & Radulesco, 1966)

Perissodactyla
Equidae
Equus sp.

Rhinocerotidae
Stephanorhinus etruscus Falconer, 1859

Carnivora
Mustelidae
Baranogale helbingi Kormos, 1934
Mustelidae indet.

Canidae
Vulpes alopecoides Del Campana, 1913

Ursidae
Ursus etruscus Cuvier, 1823

Felidae
Megantereon cultridens Cuvier, 1824
Felis sp.

Hyaenidae
Pachycrocuta brevirostris (Gervais, 1850)

Primates
Cercopithecidae
cf. *Paradolichopithecus* sp.

The bovid association *G. bouvrainae – G. meneghinii – G. torticornis*, combined with the three cervid species, is rather typical for the Middle Villafranchian faunas of Greece (2.6 – 1.8 Ma). The presence in the locality of the giant short-faced hyena, *P. brevirostris*, is very remarkable as it confirms the appearance of the species in South-Eastern Europe faunas before the beginning of the Late Villafranchian, likewise the Westernmost localities such as those in Spain (e.g. Fonelas P1, Almenara-Casablanca 1, (Madurell-Malapeira et al. 2014)). In addition, of great interest is as well the presence in the assemblage of plenty of *G. meneghinii* individuals, a taxon which constitutes a quite rare element in the Greek fossil record. Moreover, the assemblage contains several carnivore representatives of mixed-habitats. These facts, in combination with the striking absence of equids, which are represented only by a handful of specimens and the absence of typical open-landscape predators, such as *Homotherium latidens*, most likely shows that the palaeoenvironment of Karnezeika was not the typical more open-landscape of the Middle Villafranchian of Greece (see (Koufos and Kostopoulos 2016 and references therein), but instead was represented by rocky limestone terrains with hills and slopes.

Fossiliferous sites with Villafranchian assemblages are not uncommon in Peloponnese, but the material they have yielded is generally poor, thus the study of the Karnezeika assemblage provides important further information on the palaeofauna and the palaeoenvironment of Peloponnese and south Greece during the Middle Villafranchian.

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Early Pliocene environmental conditions in the South Aegean Sea (NE Mediterranean): calcareous nannofossil paleofluxes and evidence of the Zanclean reflooding in the Cretan basin

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The DSDP Leg 42A Site 378 located in the South Aegean Sea (Cretan basin; Fig. 1a) offers an exceptional opportunity to investigate in detail the Early Pliocene paleoenvironmental conditions through the study of calcareous nannofossil paleofluxes. In the DSDP sediment record (Fig. 1b,c) we focus on the "warm Pliocene" interval, following the Zanclean reflooding event of the Aegean Sea after the Messinian Salinity Crisis of the Mediterranean Sea. A detailed investigation on marine primary producers-calcareous nannofossils response to a high CO_2 world will reveal their paleoproductivity trends affected by 23-kyr monsoon variability and their re-colonization in the Cretan basin after the "post-Messinian flood".

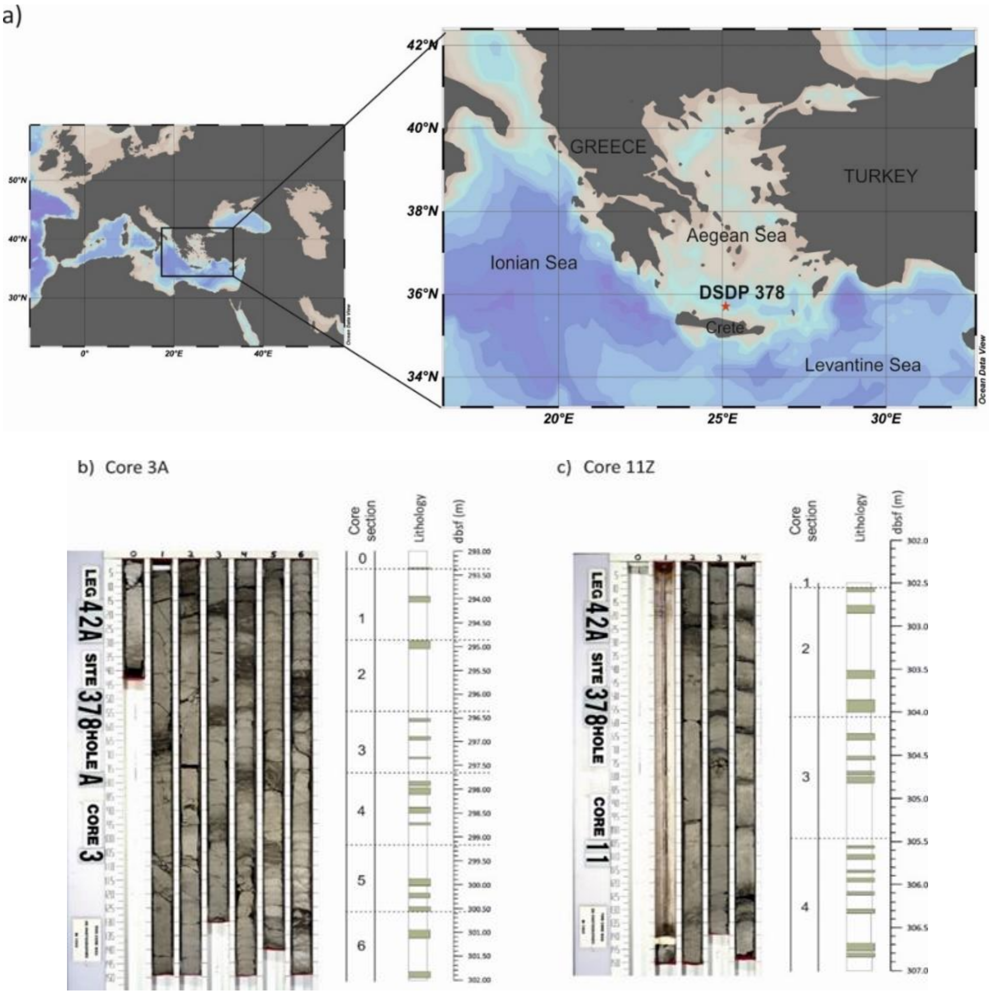

Figure 1. a) Map of the Cretan basin and DSDP Leg 42A Site 378 (Holes 378, 378A) drilling point, b) Core 3A, c) Core 11Z; Lithological description: white layers: marls, olive layers: sapropels, leg photos from Initial Reports DSDP Leg 42A, Site 378; Hsü et al., 1978).

Based on the produced age model, we present a composite dataset of the two Holes (Z and A) of Site 378 for the interval 3.8-5.09 Ma (Fig. 2). The calcareous nannofossil paleofluxes are in accordance with the $\delta^{13}C_{org}$ trend in the sapropel layers, suggesting that the sapropels presented in our study are not only formed by preservation factors but also reflect enhanced accumulation and increased primary productivity conditions. Reticulofenestra spp. prevailed in the calcareous nannofossil paleofluxes. The prevailing taxa of calcareous nannofossil assemblage support in general the occurrence of warm paleoclimatic conditions during the Early Pliocene. In addition, the two principal components that influence the calcareous nannofossil assemblage are the temperature and the stratification of the water column. The sapropelic layers of the present study, are characterised by intervals with increased temperature and low oxygen conditions as revealed by $\delta^{18}O$ and $\delta^{15}N$ isotopic analyses and by calcareous nannofossil species related to warmer and oligotrophic conditions. Moreover, a change in sapropel formation is depicted at 4.4Ma, with the low OC content sapropels do not capture the sapropel formation mechanism signal as intense as presented in the high OC sapropels of the same interval. Finally, the presence of PLG evaporites of the first stage of the MSC, suggests a fast evaporation and a possible isolation of the Cretan Basin. According to the present study and the produced age model, the oldest Zanclean sediment, dated at 5.09 Ma, is placed above the PLG gypsum (5.97–5.6 Ma), giving a first insight of the age of the deep-water marine paleoenvironment that was re-established in the Cretan Basin, thus the potential age of the Cretan Basin reflooding.

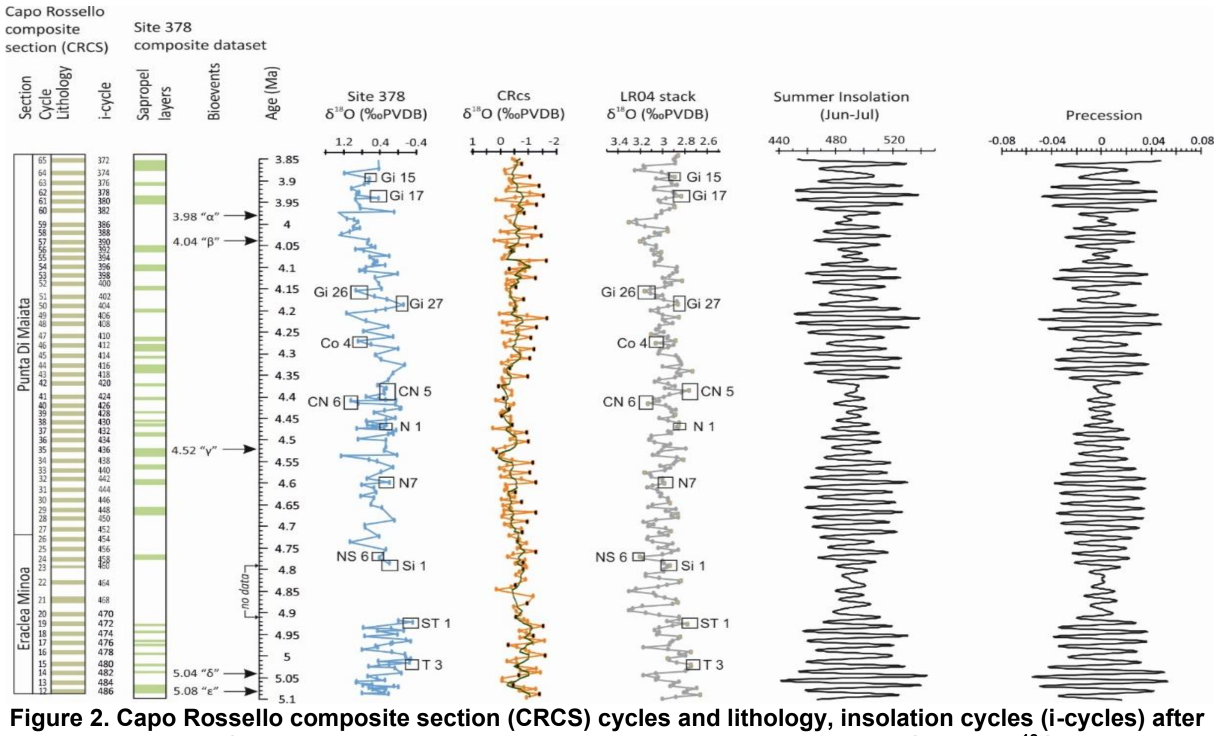

Figure 2. Capo Rossello composite section (CRCS) cycles and lithology, insolation cycles (i-cycles) after Lourens et al. (1996), Site 378 composite dataset age model and sapropel cycles, Site 378 $\delta^{18}O$, Mediterranean CRCS $\delta^{18}O$ stacked record (Wang et al., 2010), global marine $\delta^{18}O$ LR04 stack (Lisiecki and Raymo, 2005).

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Bovid remains from the new excavation sites of Pikermi (Attica, Greece)

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Among the most important and rich fossil-bearing localities of the European late Miocene, Pikermi maintains a prominent position. It is renowned for having a long excavation history -since the 19th century- and has revealed a great number of fossil vertebrates. Recent excavations (NKUA-SARG project no. 70/3/12977) since 2008, have taken place at the new fossiliferous sites PV1-4 ("PV" stands for "Pikermi Valley"), with bovid specimens (which account for the majority of the collected findings) serving to significantly enrich the locality's Bovidae sample.

The major radiation that bovids displayed from their mid Miocene emergence to these days, is directly reflected to their high representation in the living record, constituting 65% percent of all extant artiodactyl species. It is also apparent from the richness of the Greek fossil record, which diachronically presents at least 52 genera and 83 valid species (Kostopoulos, 2022). Almost one fifth of the aforementioned genera can be found in Pikermi alone. Specifically, 10 bovid species have been identified so far (Roussiakis et al., 2019), with some of them coming into view more often (e.g. *Gazella capricornis*) and others more rarely (e.g. *Oioceros rothii*).

The studied material comes from the new excavation sites and is comprised of craniodental specimens (skulls, horncores and maxillary teeth). The data extracted by the sample were compared with already described specimens, belonging to taxa typical to the locality, either measured by the presenting author (using specimens from the collections of the historical excavations of Pikermi, housed in the Museum of Paleontology and Geology NKUA and the collections from Pikermi, Samos and Maragheh, housed in the Museum of Natural History of Vienna) or retrieved from the relevant literature (e.g. Kostopoulos, 2009). The studied material was assigned to 8 different bovid species (Table 1) namely: *Tragoportax amalthea* (Fig. 1c), *Miotragocerus valenciennesi*, *Gazella capricornis* (Fig. 1b), *Oioceros rothii* (Fig. 1a), *Palaeoryx pallasi* (Fig. in the morphology of said species. Of note, also, is the relative rarity of the species *Palaeoryx pallasi* in the new sites, as well as the absence of the otherwise typical Pikermian species *Protoryx carolinae*, *Prostrepsicerus rotundicornis* and *Sporadotragus parvidens*. However, the latter genus is still represented in the sample by the completely new to the locality species *Sporadotragus* sp.

Table 1. List of the bovid species identified in the new excavation sites of the Pikermi locality.

SPECIES	TRIBE
Tragoportax amalthea (Roth & Wagner, 1854)	BOSELAPHINI Simpson, 1945
Miotragocerus valenciennesi (Gaudry, 1861)	BOSELAPHINI Simpson, 1945
Gazella capricornis (Wagner, 1848)	ANTILOPINI Gray, 1821
Oioceros rothii (Wagner, 1857)	OIOCERINI Pilgrim, 1934
Palaeoryx pallasi (Wagner, 1857)	CAPRINI Gray, 1821
***Sporadotragus* sp.**	CAPRINI Gray, 1821
Palaeoreas lindermayeri (Wagner, 1848)	Incertae Sedis
Protragelaphus skouzesi Dames, 1883	Incertae Sedis

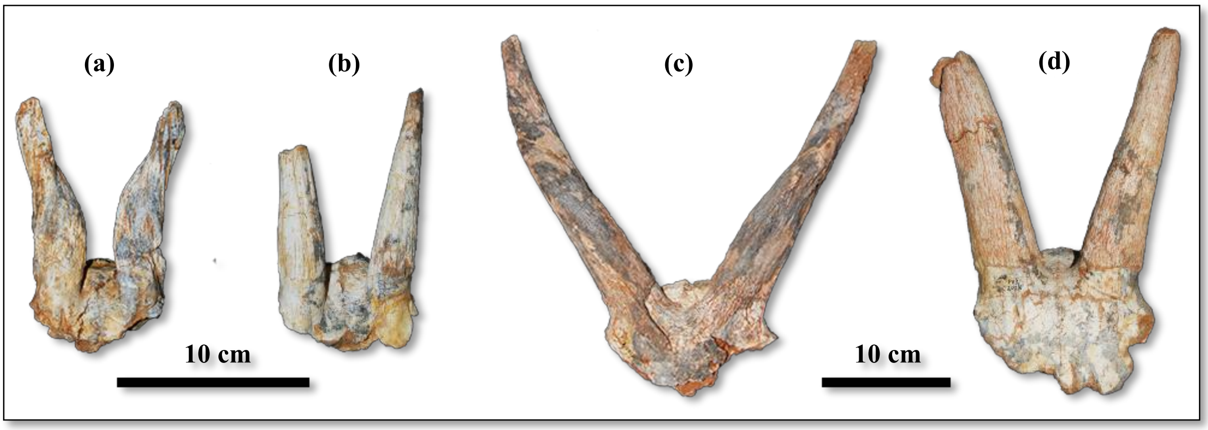

Figure 1. Frontlets of the smaller-sized bovids (a) *Oioceros rothii* and (b) *Gazella capricornis* and the larger-sized (c) *Tragoportax amalthea* and (d) *Palaeoryx pallasi*. They are included in the specimens identified in the new excavation sites.

Additionally, a preliminary paleoecological assessment was carried out for the bovid content between the two sites (PV1 and PV3). Once again, possible inter-site differences -this time in bovid diversity- between PV1 and PV3, that may be due to temporal variance, were observed. Additionally, further paleoecological evaluation was performed, by classifying the Minimum Number of Individuals (MNI), according to feeding habits (Solounias et al., 2010). The resulting near-absolute dominance of mixed-feeding bovid taxa, was found to be in agreement with the established idea of an environmental shift from woodland-type biomes towards open grassland-type ones during the Miocene (Fortelius et al., 2006).

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New evidence of Diatomitic occurrences in western Crete, Greece; A preliminary stratigraphic and geochemical approach and its implications

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The geological evolution and conditions that shaped the Neogene paleoenvironmental history of the Mediterranean Sea, have been investigated so far by numerous studies. The Upper Miocene particularly (late Tortonian and early Messinian) was generally characterized by the rapid building of extensive carbonate platforms and basins which included hemipelagic formations (marls/mudstones, sapropels), as well as shallow-marine deposits (evaporitic formations, coral reefs, bioclastic and red algae limestones). The Messinian Salinity Crisis (MSC) was a critical event that affected the general environment of the Mediterranean. A stepwise restriction of the whole basin had already begun prior to the MSC (Kontakiotis et al., 2022) and resulted in the development of marginal basins. In this context, Messinian upwelling resulting in diatomitic strata accumulation was reported from only three locations (two in Crete; Keupp and Bellas, 2000 and one in Gavdos Islands; Frydas, 2006) and six in total from the eastern Mediterranean (four in Greece, one in Cyprus and Turkey respectively; Pellegrino et al., 2018).

In the present study, a synthetic outcrop that includes new diatomitic occurrences in the marginal Neogene basin of Apokoronos area in northwestern Crete, is reported and studied both stratigraphically and geochemically. Our preliminary results point to an Upper Miocene (late Tortonian/early Messinian) pre evaporitic age of the deposits. The studied section is well-laterally extended and presents adequate thickness in relation to other diatomitic occurrences in Crete. It is subdivided into three profiles, the lower, middle and upper one, separated by not recorded parts due to high vegetation density and steepness. Each profile documents various levels with diatomites. Twenty-seven samples were taken in total. Several alternations were observed between fine sands/siltstones/mudstones and laminated diatomaceous beds from bottom to top. The basal part consists of grey/blueish bioturbated fine sand-to-siltstones moderately cemented, including *Pycnodonta* and other bivalve shells (slightly reworked). This part is followed by well-laminated white to slightly light grey diatomaceous deposits, while towards the top part silty mudstones underlie the diatomitic beds. The section closes at the top with thick, cemented sandy mudstone beds. It is evident that the major part of the sections' strata was deposited during a transgressive system tract (TST) [lower and middle profiles], which was developed following the Tortonian deepening in the early Messinian. Yet, at the top part (upper profile), shallowing of the water depth took place, pointing to a regressive system tract (RST) with minor interruptions. Upwelling seems to have been developed in distinct stratigraphic levels illustrating significant changes in the paleo-water-circulation and may well be correlated with the increased variability in climate of Phase 3 after Kontakiotis et al. (2022). Relevant evidence of upwelling during lower Messinian (Late Miocene) in Crete was also previously documented by stable isotope data on *Orbulina universa* by Brachert et al. (2015). Our geochemical results show strong variations in the TOC content. High values of TOC are recorded within the diatomaceous levels, ranging up to 3.33%. A clear negative trend of the values is recognized from the bottom (lower profile, minimum value of 2.2%) to the top of the synthetic section (0.27%). The results of this study, demonstrate that high to fair productivity diatomaceous facies prevail at the basal and middle part showing that a well-developed upwelling system was established prior to the MSC onset, which was undergoing major changes strongly affected by the climate variability.

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Insights into the Holocene vegetation history of the North Aegean: a case study from Lemnos Island (Greece)

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This study presents the results of the first palynological analysis of Holocene sedimentary deposits from Lemnos Island in the Northern Aegean Sea and aims to contribute to our knowledge on the island's vegetation history and paleoenvironmental conditions. The study was realized within the framework of an interdisciplinary scientific project that aims to investigate the early colonization of the Aegean islands. Lemnos Island bears a long record of human presence, beginning with the Ouriakos Late Paleolithic camp site (Efstratiou et al., 2014; Efstratiou, 2015).

Our study focuses on the SE part of Lemnos, where systematic coring was performed. For the palynological analysis a core retrieved from a transient wetland environment in Agia bay (Fig. 1) was used. The sequence of Agia, is characterized by alternations of silty and sandy, as well as peat deposits, as a result of a dynamic depositional environment. The total length of Agia core reached 15.50 m and 59 samples were carefully selected for laboratory processing according to the classical chemical protocol for palynological treatment (Faegri and Iversen, 1989).

Figure 1. Lemnos Island (source by Google Earth), photo of AGIA bay and the location of the drilling from recent (2022) data of unpublished internal reports of EGEOLAND Research Project.

The palynomorph assemblages (aquatic and terrestrial) and the microscopic charcoal concentration of the sequence, record the paleoenvironmental evolution of the wetland featuring changes in size, water depth and trophic status. Our data record the evolution of a small wetland with minor marine influence, to a marsh with submerged vegetation and finally a lagoon with sea water intrusions. Following these changes in the depositional environment, the pollen signal of Agia shifts from recording the local wetland vegetation at its lower part to providing a regional image of past zonal vegetation upwards.

The terrestrial pollen abundances reveal a mixed deciduous woodland complemented with Mediterranean species and rich grassland elements. The upper part of the sequence, dated c.a. 4500 BP, comprises evidence about human activities in the area, such as deforestation, cultivation, and pastoral practices, featured by the curves of Cerealia-type, Olea, and several anthropogenic pollen indicators (API). This interval correlates well to the chronology of the nearby Poliochni archaeological site, one of the most significant Bronze Age settlements of the island.

Even though the palynological record of the sequence is fragmented, it bears valuable insights about the paleoenvironmental evolution and the vegetation history of the area.

Acknowledgments

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Stratigraphic, Palaeontological and Palaeoecological study of Quaternary deposits from the Rio Graben (Corinth rift, Greece)

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The Corinth- Patras rift is a region of particular interest due to its rapid extension. It is characterized by complex stratigraphy, due to the constant change of depositional environments but mainly by complex tectonics that has affected sediments during the Quaternary. The Corinth- Patras rift contains three basins, the Corinth basin to the east, the Rio basin in the center and Patras to the west. The purpose of this study is the temporal and spatial tectonostratigraphic study and their correlation with similar environments in the Corinth and Patras basin.

The Rio basin was studied through detailed stratigraphic analysis of 23 sections around Charadros river. Micropalaeontological and statistical analysis were performed on 979 samples. Four diversity indices were calculated as well as the adult/ juvenile taphonomic index for ostracods. In addition, geochemical analysis and petrographic analysis of organic rich sediments were performed.

For the age determination, two independent dating methods were used. The age of the sediments was firstly estimated, taking into account the stratigraphic ranges and stratigraphic appearances of species (foraminifera, ostracoda and calcareous nannoplankton) and in addition absolute dating was done using Optically Stimulated Luminescence (OSL).

Combining data obtained from the analyses of the samples and the dating methods, a spatial and temporal palaeoenvironmental reconstruction during the late middle Pleistocene (MIS 7e-6a) was performed for the Rio basin. According to palaeontological and tectonic data, the slip rates of the faults were calculated. In addition, the elevation rate was calculated where it was possible, according to the relative altitude and the age of each sequence.

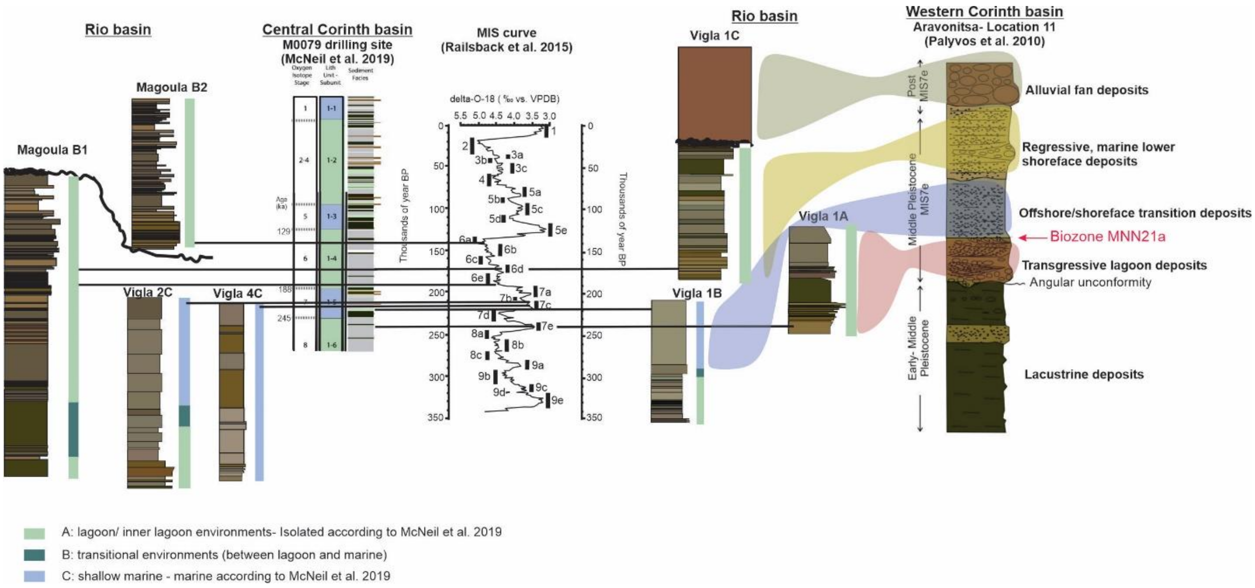

Figure 1. Schematic correlation between studied sequences, M0079 drilling site (McNeill et al., 2005), Aravonitsa-Location 11 (Palyvos et al., 2010) and MIS curve (Railsback et al., 2015).

According to the palaeoenvironmental analysis, the studied sequences present sea level fluctuations that are mainly due to eustatism. Three main palaeoenvironmental types comprises the study area (A: lagoon/ inner lagoon environments, B: transitional environments (between marine and lagoon), C: shallow marine environments). These alternations between shallow marine and lagoonal facies, are well correlated to alternations of marine and isolated assemblages that McNeil et al 2019 described at the Central Corinth basin (M0079 drilling site -IODP Expedition 381) (Fig. 1). Furthermore, Palyvos et al. (2010), described a sedimentary sequence from Aravonitsa formation (western Corinth basin) that possibly matches to a group of sequences in the study area (Fig. 1). Differences in lithology or sequences' thickness could be explained either by different tectonic rates or application of the same generation process (e.g. climatic cycles and tectonics) in these two different parts of the Corinth-Patras rift.

This study highlights the temporal palaeoenvironmental evolution of Rio basin during late middle Pleistocene, which was controlled by climatic- eustatic changes, whereas, the tectonic movements of faults. Detailed stratigraphic analysis, with micropalaeontolgy as the main tool, revealed alternations of lakes, lagoons and shallow marine deposits. These palaeoenvironmental changes, that characterise the study area, are caused from sea level fluctuations due to the Rio sill, which controls the connection between an isolated basin (Corinth basin) with Patras basin and the open sea. The comparison with other studies in the eastern and central part of the Corinth basin, showed that there is a coherence between the Rio and the Corinth basin. This coherence reveals that during the middle Pleistocene the palaeoenvironmental evolution of the two basins was controlled by the same factors and the palaeoenvironments were modified proportionally.

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Paleoenviromental evolution of the eastern Thermaikos Gulf based on shallow core data from the Epanomi area (Greece)

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The paleoenvironmental evolution of the Epanomi area (eastern Thermaikos Gulf, Greece) is achieved based on lithology determination, micropaleontological analysis (benthic foraminifera), magnetic susceptibility measurements and radiocarbon dating, of a 3m-long sediment core (EPN-P). Epanomi village is located at the eastern Thermaikos Gulf, 32 km SE from the town of Thessaloniki. The terrain at the Epanomi area is low and hilly. At the eastern part of Thermaikos Gulf depositional processes are mostly dominant. East Thermaikos Gulf consists of beach terraces with narrow coastal zones and local low depositional coasts. These depositional coasts extend as very low terrain capes which often host inland lagoons (Albanakis et al., 2005).

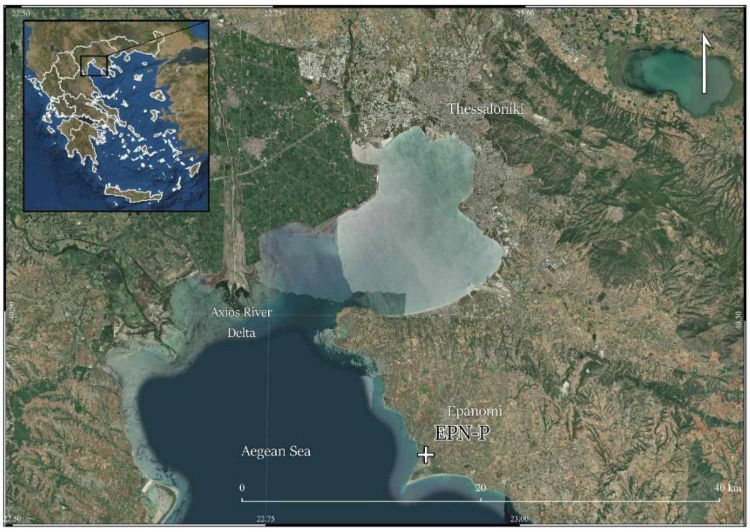

Figure. 1. Location map of the broader study area and the position of core EPN-P.

In total 33 samples from EPN-P core were selected for micropaleontological analysis. Additionally, the mud and sand fractions were measured. Subsequently, every sample has been individually processed under the stereo microscope. In the 33 samples analyzed from core EPN-P, a total of 14 foraminiferal species which belong to 8 genera were identified. The foraminiferal fauna consists mostly of hyaline-perforate species (8 taxa) and 6 porcelaneous ones. Among the hyaline foraminifera species, individuals exhibiting morphological abnormalities were observed. Gastropods, Bivalves, Ostracoda, Charophyta, seeds and gypsum crystals were also detected.

The quantitative analysis of foraminiferal fauna enabled separation of the EPN-P core into five sedimentary Units, representing distinct evolutionary stages of the area.

The high sand proportion and the low magnetic susceptibility values, the presence of gypsum crystals and few marine foraminiferal specimens, suggest that Unit 1 represents an environment with marine influence and possible desiccations due to increased evaporation (Kjerfve et al., 1996).

Unit 2 shows transient inputs from the land and sea and unstable hydrodynamic conditions due to the fluctuating sand and mud fractions. It represents a lagoonal environment with marine intrusions (miliolids and *Bolivina spathulata*) and constant freshwater contribution, considering the prevalence of *Ammonia veneta*, *Haynesina germanica* and charophytes. The increased presence of abnormal specimens certifies the fluctuating salinities in an unstable transitional lagoonal environment (Dimiza et al., 2012).

In Unit 3, the association of the euryhaline (*H. germanica, Haynesina* sp., *A. veneta*) with the marine species

(*B. spathulata,* miliolids) indicate an open lagoonal environment with a permanent connection to the sea and periodical fresh-water inputs. The assemblages of Unit 2 and Unit 3 are comparable to the adjacent Paliouras lagoon Unit C (7600–6900 cal yr BP) (Koukousioura et al., 2019).

Before ~6000 cal yr BP (Unit 4), the area shifts to a low energy closed lagoon, as suggested by the dominance of the oligohaline foraminiferal species, and the increase of magnetic susceptibility measurements. Similar environmental conditions were described in the upper part of Alykes Kitros and Lafrouda Thrace sequences (Koukousioura et al., 2012), as well as in Paliouras lagoon after 5500 cal yr BP (Koukousioura et al., 2019).

Unit 5 is characterized by only few foraminiferal specimens which, in association with the high magnetic susceptibility values and the lithological determination, suggests the closing of the lagoon and the dominance of the terrestrial deposits in the area after ~4500 yr BP.

Acknowledgements

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Micropaleontological study of sediments from Sychaina, Achaia, Greece and morphometric analysis of the ostracod *Cyprideis torosa* using geometric morphometrics

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Rio Basin is located on the west side of the Corinth Graben. Relatively, it is a less studied area when compared to the very well studied Corinth Graben to the east. The purpose of this work is to determine the palaeoenvironmental conditions of the studied sections and to unravel the Middle-Late Pleistocene palaeoenvironmental changes. Subsequently, a total of 112 sediment samples were collected from two sedimentary sequences (Sequence B and Sequence C) located at Sichaena, Achaia. Sequence B and Sequence C are actually a single sequence but due to the difficulty of sampling between them, this single sequence is divided into two parts. Sampling of the studied sequences revealed a microfaunal assemblage (Ostracoda and Foraminifera) with most of the microfossils identified at the species level. Stratigraphic columns were also plotted after detailed stratigraphic logging. Based on the results of other similar studies that have been conducted in deposits in the same area, a late Middle Pleistocene age for the studied sequences has been concluded.

The results of the micropalaeontological and statistical analyses imply four different units of a semi-closed lagoonal environment with a significant freshwater input, as well as with an increased marine water influence (Fig. 1). Sequence B is mainly composed of sandy samples, most of which are barren of microfossils. At the top of the section, the presence of low salinity indicator species reflects an oligohaline environment with freshwater input. In contrast to Sequence B, Sequence C, which is mainly composed of clays, is rich in micro- (Ostrakoda, Foraminifera) and macro-fauna (Bivalves, Gastropods, Scaphopoda). Micro-fauna implies the presence of a brackish lagoon at the base of the sequence. At the middle of the sequence stressful environmental conditions prevail. At the upper part of the sequence, the recorded species indicate a closed lagoonal environment, while the top of the section is mainly characterized by the presence of marine microfossils indicating the presence of a transitional lagoonal to shallow marine depositional environment.

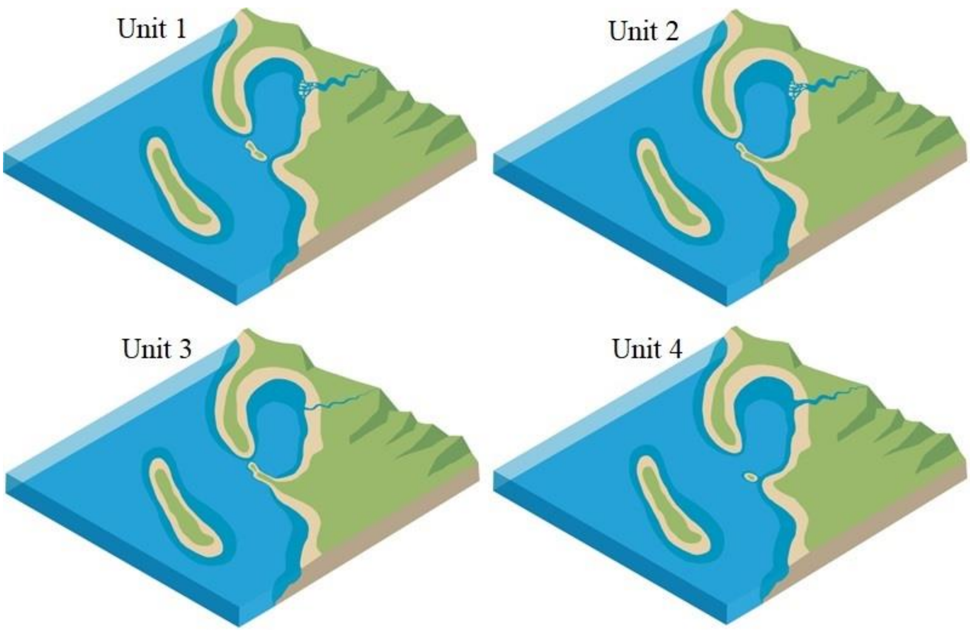

Figure 1. Palaeoenvironmental evolution of the study area. Four different units from Sequence C represent four different stages of a semi-closed lagoonal environment.

The most abundant species in Sequence C is the ostracod *Cyprideis torosa* which is a typical brackish taxon with high sensitivity to environmental changes. From the three different units of Sequence C (which are three different environments), 90 right valves of *C. torosa* adult females were selected in order to determine the differentiation of the species *C. torosa* through time. The results of the statistical analysis of these data using Geometric Morphometric methods, indicate an important differentiation in the length of the valves with differences located in the posterior and anterior part of the valves (Fig. 2). This fact confirms the significant influence of environmental changes to *C. torosa*. Data correlation (environmental data and data from Geometric Morphometric methods) revealed that the most important influencing factors that affect the differentiation of the species *C. torosa* are the distance from the sea and the increase in salinity or/and oxygen levels.

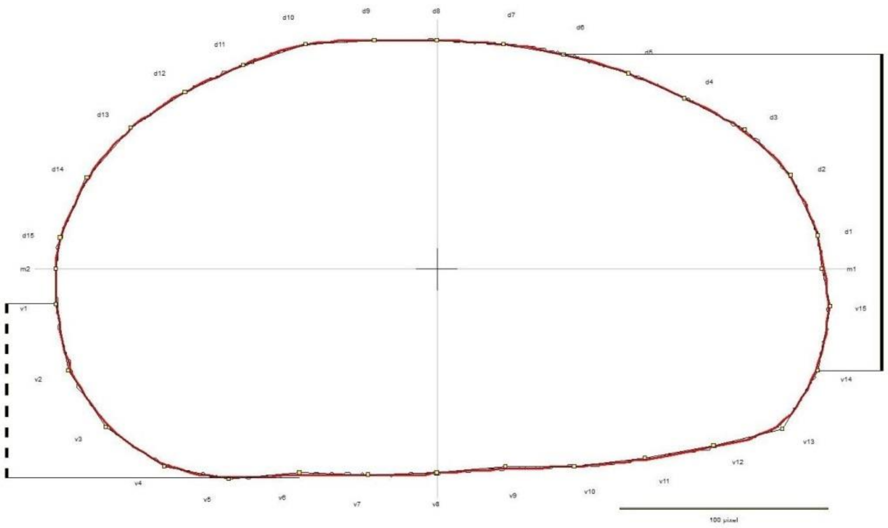

Figure 2. Differentiation in the length of the valves. Differences located in the posterior and anterior part of the valves. Results based on the Geometric Morphometric methods and Loadings plot diagrams of the PCA analysis of the PAST program (PAleontological STatistics, Version 4.08).

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Human activities and vegetation development during the last 2 millennia: a case study from upland site in Peloponnese

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The present study focuses on understanding the relationship between vegetation - human - climate of Greece, spanning the last 2,000 years. During the Late Holocene, Mediterranean mountain ecosystems had been continuously transformed by climatic changes and human exploitation (Mercuri and Sadori, 2014; Izdebski et al., 2016; Kouli, 2020). To evidence the vegetation response and decipher the human impact, a detailed palynological analysis was conducted.

A sediment core recovered from Rakita, an upland wetland of Achaea in the northwestern part of the Peloponnese (Western Greece) was studied at a mean 3 cm interval. The rich Rakita palynological record offers insights into vegetation and landscape evolution associated with changes in human land-use practices in mountainous areas, as well as, with climatic variability.

The domination of *Quercus robur*-type and *Carpinus/Ostrya*-type indicate the occurrence of mixed deciduous oak forests, while the presence of *Abies*, *Pinus,* and *Juniperus* suggest intervals of well-developed upland coniferous forest. The human activities in this mountainous landscape is evidenced by the presence of the cultivated taxa *Cerealia*-type, as well as *Juglans.* In addition, the occurrence of other indicators of anthropogenic activity such as Cichorieae (Florenzano et al., 2015) is associated with forest clearance and landscape opening as a result of pastoralism.

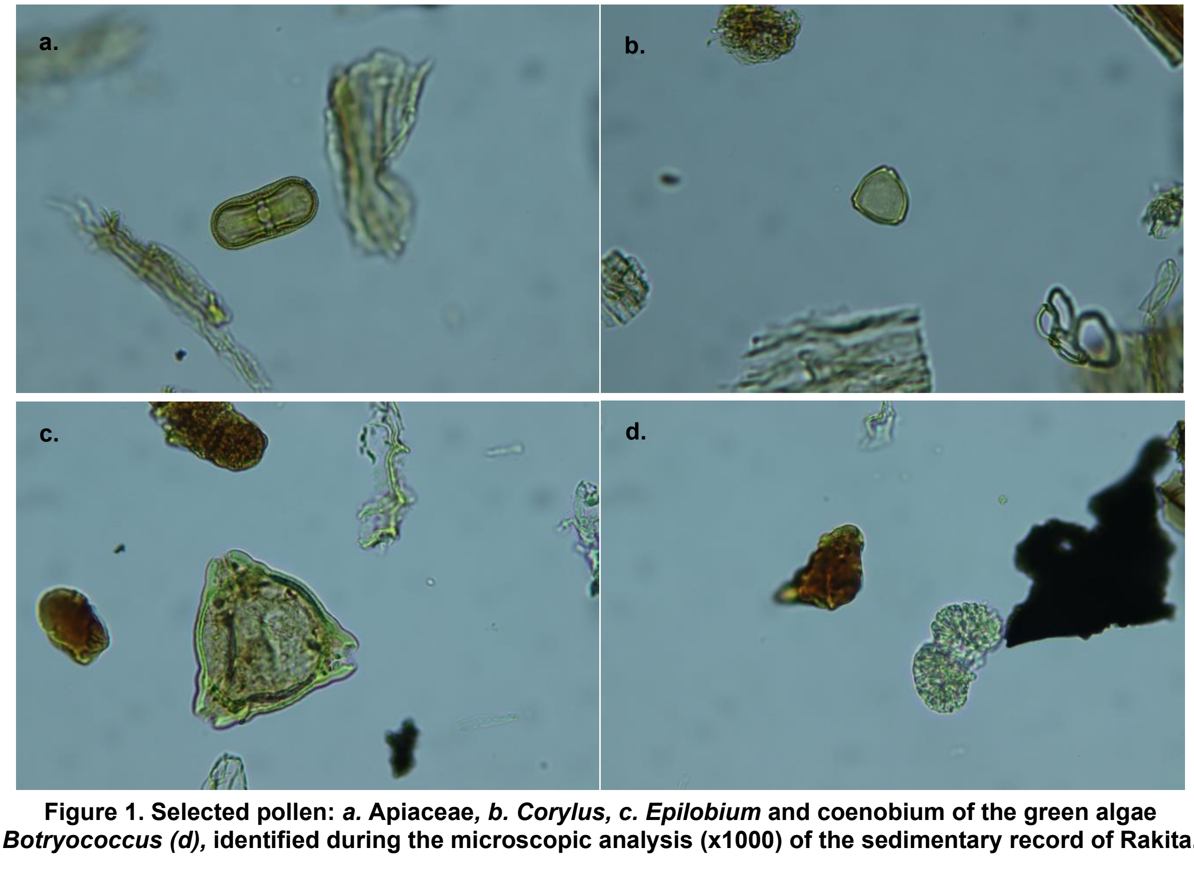

Figure 1. Selected pollen: *a.* Apiaceae*, b. Corylus, c. Epilobium* and coenobium of the green algae *Botryococcus (d),* identified during the microscopic analysis (x1000) of the sedimentary record of Rakita.

With the analysis of pollen and non-pollen palynomorphs (NPPs) (Fig. 1), the role of humans and their influence in the evolution of Holocene vegetation was investigated. These data ultimately contribute to the creation of a background for understanding both the vulnerability and resilience of the Medieval Communities in Greece.

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