

THE NEOGENE OF THE ISLAND OF EUBOEA (EVIA), A REVIEW¹

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ABSTRACT

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The Neogene sediments in the three major basins on the Island of Euboea (Evia) (the Aliveri-Kymi, the Palioura-Gides and the Limni-Istiea Basin) show roughly similar lithological successions, but differ in age. Fossil rodent associations show that sedimentation started in the Early Miocene (Early Aragonian) in the Aliveri-Kymi Basin, in the Late Miocene (Vallesian) in the Palioura-Gides Basin and in the Early Pliocene (Early Ruscinian) in the Limni-Istiea Basin.

The lignite occurrences in the Aliveri-Kymi Basin are shown to be of Early Aragonian (MN3) Age, while those in the Palioura-Gides and Limni-Istiea Basins are assigned a Vallesian (MN10) and Villanyian (MN16) Age, respectively.

It is concluded that lignite formation in the area depended primarily on the local circumstances of sedimentation and not on climate.

INTRODUCTION

All the Neogene deposits of the Island of Euboea, except for minor brackish intercalations in a section near Vlachia, are of continental origin. The successions found in the three major sedimentary basins (the Aliveri-Kymi Basin, the Palioura-Gides Basin and the Limni-Istiea Basin (Fig. 1) are lithologically roughly similar. In each of these basins the Neogene can be divided into a 'lower' unit of predominantly fine grained lacustrine sediments, which contain lignite deposits locally, and an 'upper' unit consisting of mainly coarse grained fluvial sediments (Figs. 3 and 5). The lithological similarity of the various basins has generally been attributed to their similar overall geological history; this interpretation has subsequently led to the time correlation of similar lithologies. The 'lower' unit has been considered by most workers to be of Early Miocene age, the 'upper' unit of Late Miocene age. These age determinations are based largely on the flora

(GAUDRY, 1860; DE SAPORTA, 1868; DEPRAT, 1904; GUERNET & SAUVAGE, 1969), but local occurrences of mollusc fauna (GORCEIX, 1878; GUERNET, 1971) and mammal fauna (MITZOPOULOS, 1947; DEPRAT, 1904; CORDELLA, 1878; WOODWARD, 1901) have also been considered. The occurrences of Neogene near Styra, near Almyropotamos, along the SW coast and near Vlachia are of minor geographical as well as stratigraphical importance. They consist almost exclusively of coarse grained red-bed deposits, except for the deposit near Almyropotamos (see MELENTIS, 1967, 1969), have not produced any mammal remains, and will not be considered below.

Our project started in 1975 and was primarily initiated by our interest in the, at the time unknown, Early Miocene fauna of smaller mammals of Greece. After the first results obtained in the areas of Katheni (Palioura-Gides Basin) and Limni (Limni-Istiea Basin) had shown that the age determinations suggested by previous workers needed revision, the investigations were also directed toward comparing the geological history of the three major basins. The results presented below suggest that sedimentation started as early as the Early Miocene in the Aliveri-Kymi Basin, possibly in the Late Miocene in the Palioura-Gides Basin, and as late as the Pliocene in the Limni-Istiea Basin.

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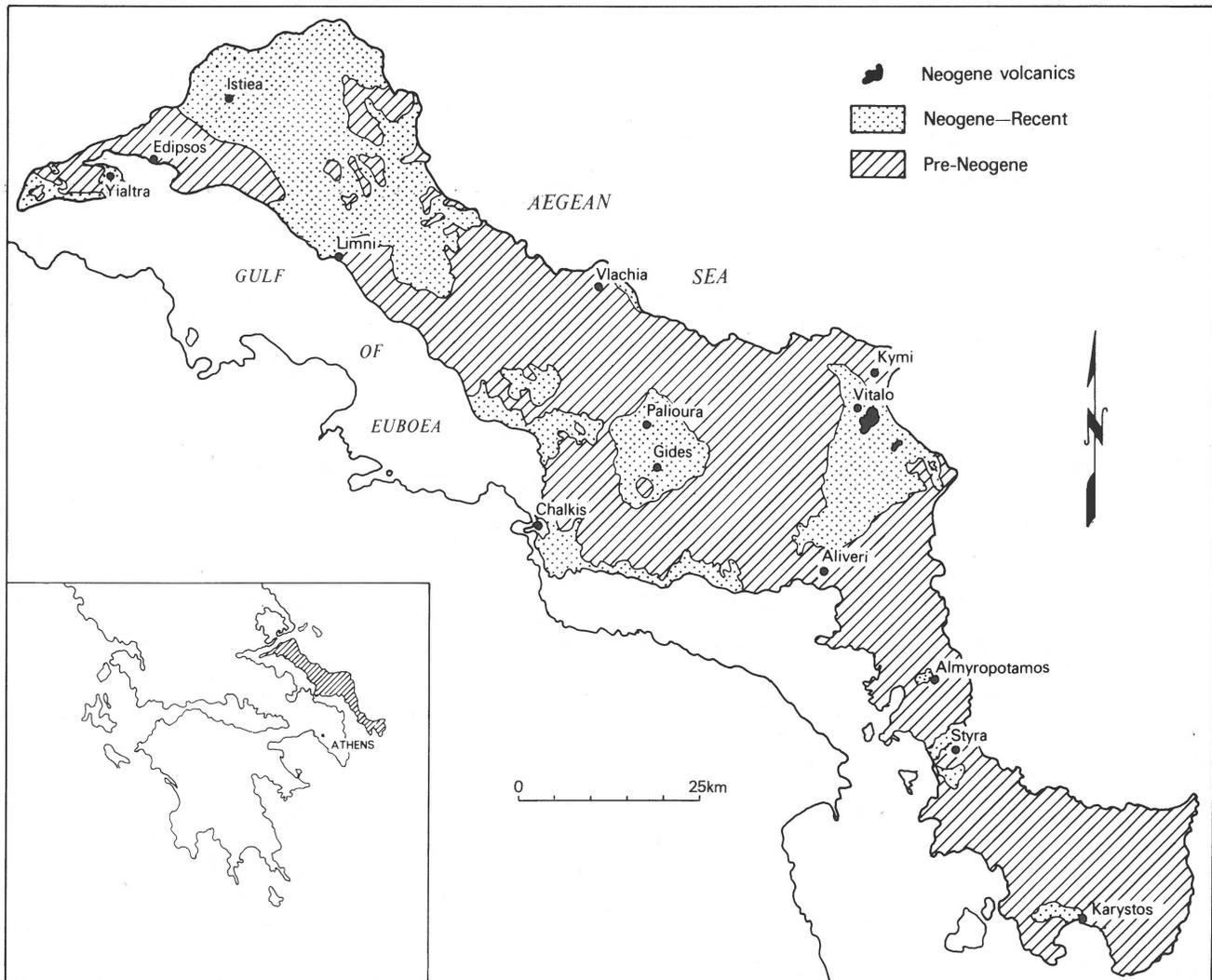


Fig.1
Geological map of the Island of Euboea showing the position of the three major Neogene sedimentary basins.

THE ALIVERI-KYMI BASIN

General

The Neogene sedimentary basin of Aliveri-Kymi (Fig. 1) extends roughly in a northerly direction from north of Aliveri to the fault-controlled north-east coast. The on-land part of the basin covers an area of roughly 200 km² between the mountains of Mavrovouni in the northwest and those of Octonia in the southeast. It is not known how far this basin extends northwards into the Aegean sea. The Neogene sediments can be divided into two units which in the southern part of the basin, near Aliveri, are separated by a distinct unconformity (Fig. 3). In the northern part of the basin, near Kymi, where the section is much thicker, these units pass gradually into one another.

The lower unit. The total thickness of the predominantly lacustrine sediments of the lower unit varies considerably, from some 40 m in the open cast mine of Aliveri to several hundred metres in the area of Kymi, but the general succession is similar throughout the area. From bottom to top one can distinguish a unit of alternating plastic clays, sandstones and conglomerates which in the SW part of the basin and in the NE part of the basin is overlain by lignites. The geographically quite limited lignite occurrences are (Fig. 3) overlain by well stratified marls and marly limestones which are locally slightly folded. The sediments of the lower unit are pierced by small volcanoes in the area south of Kymi. The age of these volcanic rocks has been determined at around 13 Ma by FYTIKAS ET AL. (1976).

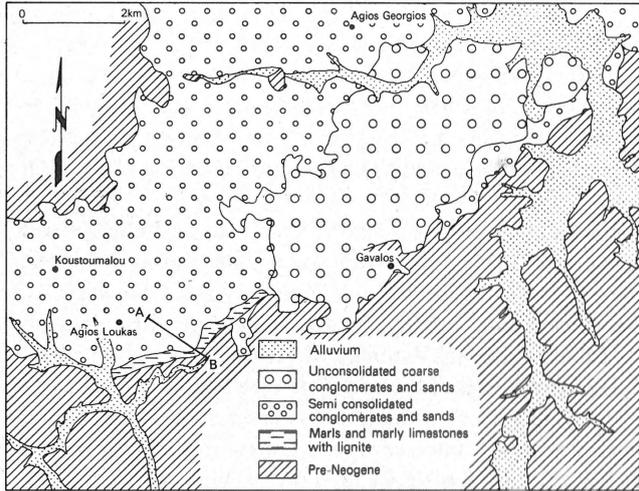


Fig. 2
Geological map of the southern part of the Aliveri-Kymi Basin. A-B indicates the position of the section through the Aliveri lignite mine (see Fig. 3).

The upper unit. The contact between the predominantly fluvial sediments of the upper unit and the lacustrine deposits of the lower unit is clearly unconformable in the area of the Aliveri lignite mine where the red-coloured sandy clays, sandstones, and conglomerates of the upper unit cover an erosional surface (Fig. 3). The components of the conglomerates suggest that the source area for these deposits has to be looked for in the metamorphic rocks of S Evia. The conglomerates which contain boulders as large as 5 m³ show a general trend to become coarser from bottom to top and from west to east.

The thickness of the upper unit ranges from about 50 metres in the open-cast mine of Aliveri to over two hundred metres in the area of Avlonori-Octonia.

The age of the Neogene deposits of Aliveri-Kymi

The lower unit has been studied intensively because of the economic interest of the lignite.

Paleontological age determination suggested for these deposits by previous workers are based primarily on the fossil flora. The lignite deposits near Aliveri and Kymi, which consist largely of *Sequoia* wood, have been considered to be of Aquitanian Age by DE SAPORTA (1868), GUERNET & SAUVAGE (1969). These authors have considered the whole sequence to be of Early Miocene age. DEPRAT (1904), however, placed the lacustrine marls which conformably overlie the lignites in the Sarmatian. FYTIKAS ET AL. (1976) dated the volcanic rocks which pierce the series south of Kymi at around age of 13 Ma, which determines a maximum age for the top of these deposits.

Two samples containing small mammals were taken from below the lignite beds during the summers of 1977 and 1978. One of these was collected from the clay bed directly underly-

ing the lignite in the open-cast mine of Aliveri (Fig. 3), the other comes from a clay-bed intercalated in the conglomerates which underlie the lignite of Kazarma-Vitalo near Kymi. The level from which the latter sample has been taken is situated some 6 m below the lignite in that particular section. The assemblages from Aliveri and Kazarma-Vitalo may thus be assumed to mark the age of the lignite deposit in the Aliveri-Kymi Basin. The association from Aliveri contains 21 rodent species (DE BRUIJN & VAN DER MEULEN, 1979; DE BRUIJN ET AL., 1980), numerous species of insectivores, two species of deer and one 'procyonid'. The rodent association, on which the age assignment will be primarily based, is quite varied, but does not fit the current zonal scheme (MEIN, 1975) easily. This poor fit is due to the fact that the Mammal Neogene zonation (MN-zonation) is based essentially on the succession of mammal faunas in SW Europe. Three sets of zones, one for N Africa, one for SW Europe and one for SE Europe, would provide a better basis for biostratigraphic correlation within the area now encompassed in MEIN'S (1975) scheme.

Early Miocene and younger small mammals of SE Europe and E Europe are poorly known. A number of species occurring in Aliveri are not known elsewhere and hence are of no biostratigraphical consequence.

Among the Aliveri rodents which are well known from western and/or Central Europe are some characteristic Cricetidae: *Megacricetodon primitivus*, *Democricetodon franco-nicus*, *Eumyarion* cf. *weinfurteri*, *Cricetodon* sp. and *Anomalomys minor*. All these cricetids are the oldest known representatives of the respective genera. *M. primitivus* and *D. franco-nicus* seem to appear as immigrants in W Europe in zone MN 4a. The oldest known occurrences of *Anomalomys minor* and *Eumyarion weinfurteri* are placed in zone MN 4b (Orechov, Czechoslovakia). The true *Cricetodon* from Aliveri is of particular interest because its dental morphology is similar to that of *C. meini* from Vieux Collonges (zone MN 4b), while its size is markedly smaller (size ranges do not overlap). This suggests that the fauna from Aliveri is older than that of Vieux Collonges. The abundance of a small-sized *Pseudotheridomys* in Aliveri, whose dental pattern seems

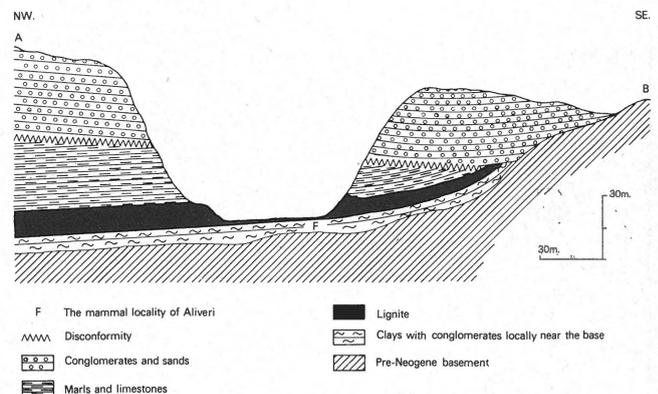


Fig. 3
Schematic section of the Aliveri open-pit mine. The position of the vertebrate locality is indicated with F.

only slightly more lophodont than in *P. parvulus* from Haslach (zone MN 2) but is more primitive than in the specimens of Bissingen (MN3) and Dolnice 3 (MN 4), supports this view. Moreover, the flying squirrel *Miopetaurista dehmi* is common to the assemblages from Aliveri and Wintershof West.

The mammalian fauna from Kazarma is documented by a limited number of specimens only. The sixteen rodent specimens collected represent eight species: *Aliveria luteyni*, *Miopetaurista dehmi*, *Blackia miocaenica*, *Anomalomys minor*, *Eumyarion* cf. *weinfurteri*, *Democricetodon francicus*, *Glis* sp. and *Paraglyrulus* sp.

All these species are also known from Aliveri, suggesting a similar composition and age for these two faunas. The only noticeable difference between the associations from Aliveri and Kazarma-Vitalo is the absence of *Pseudotheridomys*, the dominant taxon in Aliveri, in the association from Kazarma-Vitalo. This suggests distinctly different biotopes for the two faunas.

Both mammalian faunas are placed in zone MN 3, and are thus assigned an Early Aragonian Age. In the absence of biostratigraphic evidence the marls and marly limestones that conformably overlie the lignite deposits are tentatively considered to be not much younger than the beds that underlie the lignite.

The predominantly coarse-grained clastic deposits of the upper unit have generally been attributed to the Pliocene (DEPRAT, 1904; ARONIS, 1952) or the Pikermian (= Turolian) (GUERNET, 1971). These age determinations are based mainly on the occurrence of *Hipparion* faunas in similar rocks in other parts of the island (Almyropotamos, Palioura and Achladi).

The only vertebrate remains known to us from the conglomeratic series within the Alivery-Kymi Basin are two elephant tusks collected by Symeonidis and Dermitzakis in the Aliveri mine in 1977. Unfortunately this find does not permit even a rough estimate of the age.

The correlation of the conglomerate deposits which occur in different basins on the island is open to question because vertical tectonic movements are known to have occurred in the area during the Neogene and the Quaternary.

THE PALIOURA-GIDES BASIN

General

The Palioura-Gides Basin, situated at ± 17 km NE of Chalkis, (see Figs. 4 + 5) is at present surrounded on three sides by

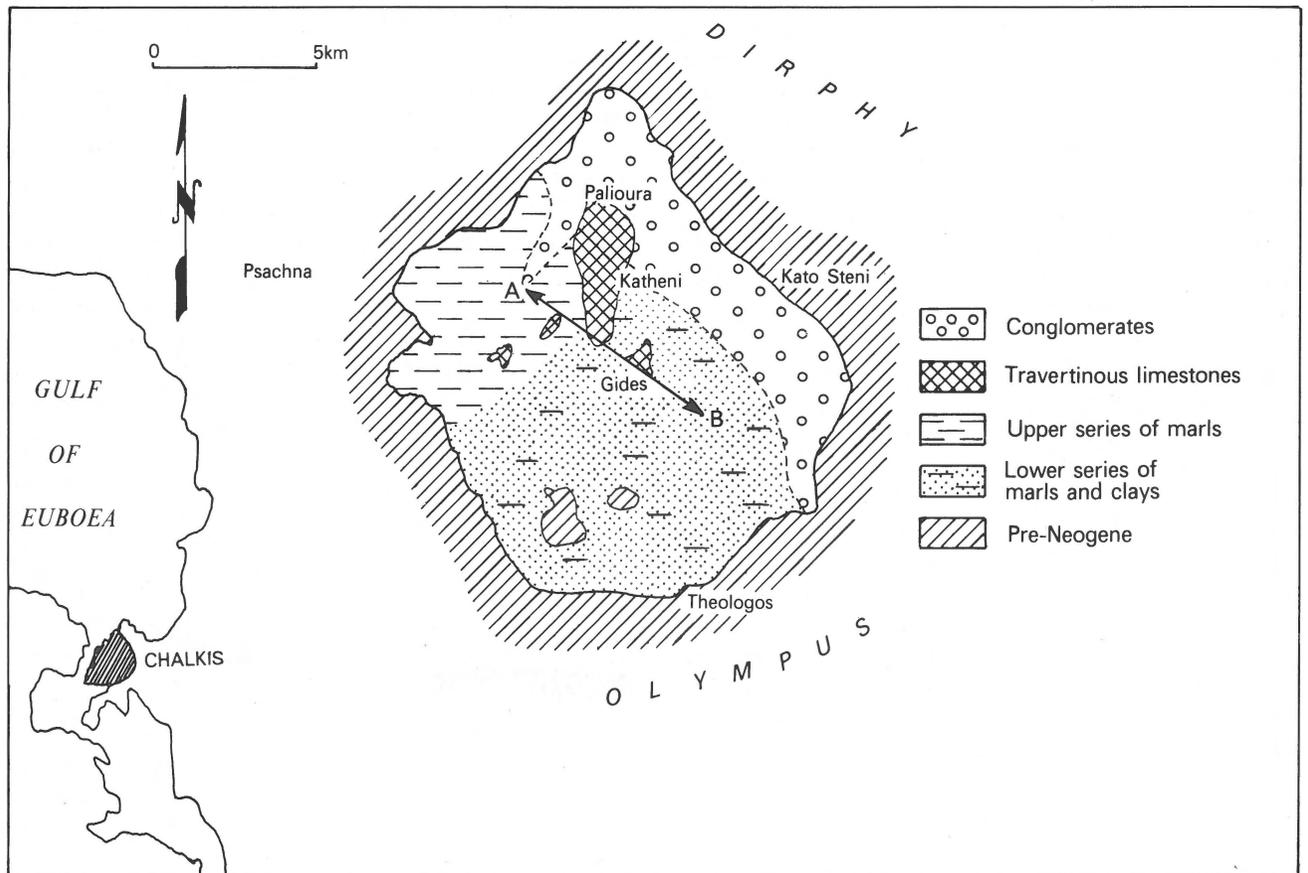


Fig. 4
Geological sketch-map of the Neogene basin of Palioura-Gides (after Guernet, 1971). A-B indicates the position of the section shown in Fig. 5.

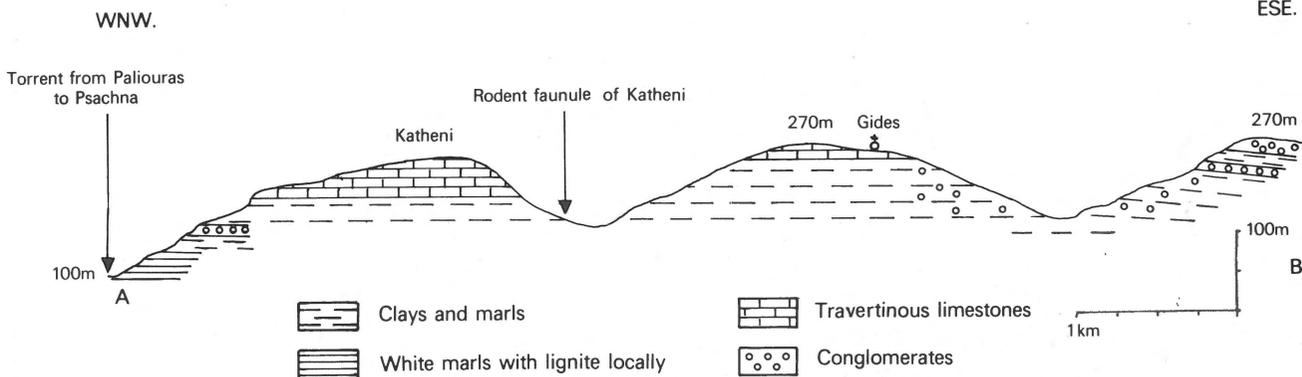


Fig. 5
Section through part of the Palioura-Gides Basin (emended after Guernet, 1971). For the position of this section see Fig. 4.

high hills consisting of Mesozoic rocks. Its western limit is formed by low hills of serpentine and by the alluvial plain of Psachna. The Neogene basin infill covering approximately 150 km² overlies the basement with a normal sedimentary contact in most places.

The Neogene sediments in the Palioura-Gides Basin can be divided into:

1. A 'lower' unit consisting of marls and limestones of lacustrine origin. This sequence, which contains minor lignite beds locally (Palioura), seems to reach a maximum thickness of about 100 m in the NW part of the basin.
2. An 'upper' unit consisting of sandstones and conglomerates of fluvial origin which disconformably overlies the lacustrine deposits wherever the contact is exposed. This clastic sequence covers the larger part of the basin and may attain a thickness of 150 m.

The Neogene succession in the Palioura-Gides Basin is thus quite similar to that of the Aliveri-Kymi Basin and it is not surprising that the similar lithologies have generally been given similar ages by previous workers.

The age of the Neogene deposits of Palioura-Gides

The age estimates given by previous workers for the Palioura-Gides basin sediments are in part based on microfossils (GUERNET & SAUVAGE, 1969) and in part on a fauna of fossil mammals collected by DEPRAT (1904) near the Chapel of Panagia de Heria (see also MITZOPOULOS, 1947; MELIDONIS, 1959). The association of spores and pollen from the lignite in the lower unit is considered by GUERNET & SAUVAGE (1969) to be of the same age as the one from the lignite beds in the Aliveri-Kymi basin: Aquitanian. The estimate given by the same authors for the upper unit is Burdigalian? Helvetian? The list of the mammal fauna collected from the conglomerate beds near the Chapel of Panagia de Heria is given as:

DEPRAT (1904)

Hipparion gracile
Sus erymanthius
Tragoceras amaltheus
Paleoceras pallasii
Hippopotamus sp.

MITZOPOULOS (1947)

Hipparion mediterraneum
Potamochoerus hyotherioides
Tragocera amaltheus
Palaeoryx pallasii

It is of biostratigraphic interest that MITZOPOULOS (1947) does not list *Hippopotamus*, because the first European hippos are the well-known occurrences of *Hexaprotodon* of Valdecebro, Venta del Moro and Messina which are all considered to be of Late Turolian Age. However, even without the questionable *Hexaprotodon* the association seems to indicate a Turolian (= Pikerimian) Age.

A small association of rodent remains collected from a road cutting at about one kilometre SE of Katheni (on the road from Katheni to Kato Steni just before the bridge over the torrent which comes down from near the village of Loutsas; see Fig. 5) contains only two species: *Byzantinia* cf. *nikosi* and *Myomimus dehmi* (see DE BRUIJN & VAN DER MEULEN, 1979). This association collected from a grey marl with fresh-water molluscs, which is estimated to be situated at about 30 m above the Palioura lignite from which GUERNET & SAUVAGE (1969) collected the micro-flora, suggests a (Late) Vallesian Age. Some very poor and inconclusive small-mammal associations collected from similar levels N of the village of Katheni contain fragmentary teeth of *Byzantinia* sp. and *Prolagus* sp., which supports the Vallesian Age of the marls above the lignite.

Unless the lower part of the section in the Palioura-Gides Basin is very condensed, it seems safe to say that sedimentation in this basin did not start before the Late Miocene.

THE LIMNI-ISTIEA BASIN

General

The Limni-Istiea Basin extends over an area of about 600 km² on N Euboea. The on-land part of this basin, which is bounded

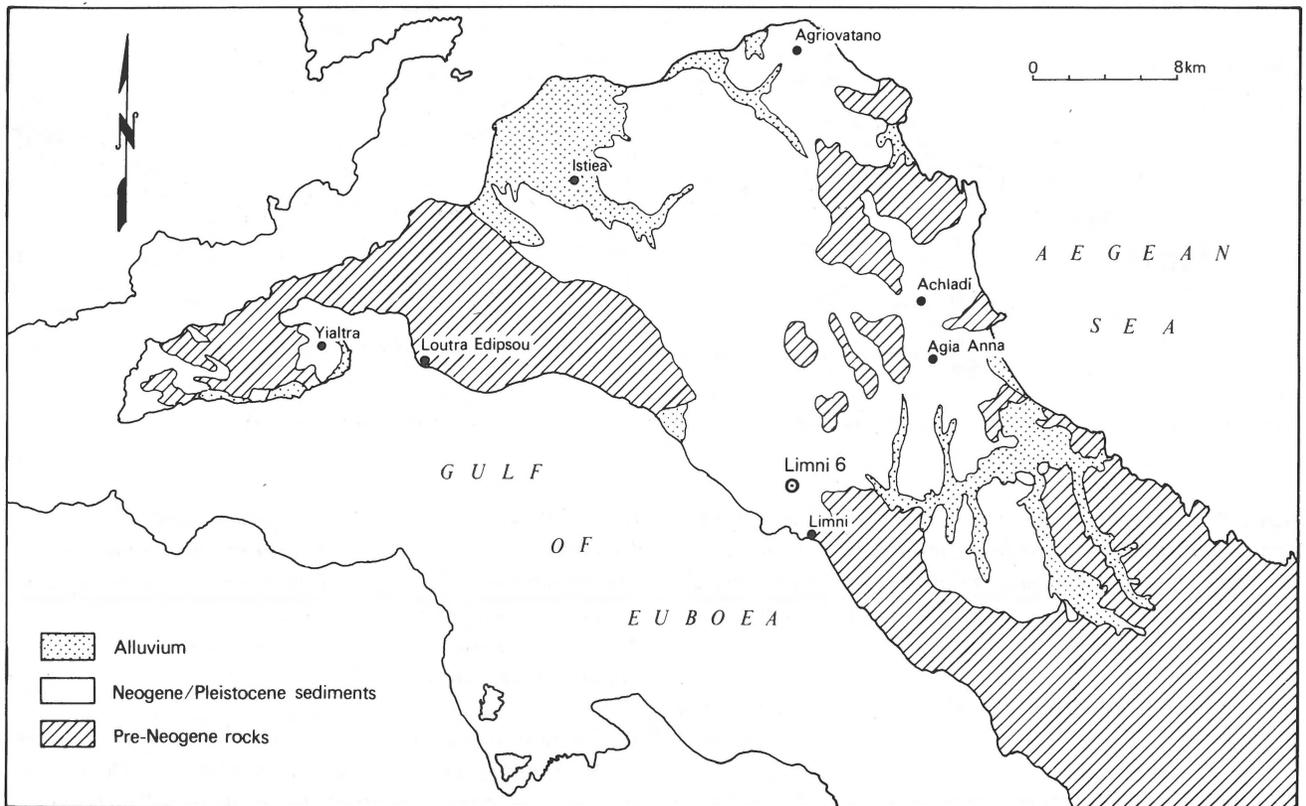


Fig. 6
Geological map of the northern part of the island of Euboea.

on the east and west by pre-Tertiary rocks, is probably only minor part of the original basin, because its southwestern, northern and eastern limits are determined by the faults bounding the island (Fig. 6). It is not known how far the basin extends north into the Aegean sea. Towards the southwest the lacustrine deposits of Atalanti on the mainland have been considered to belong to the same basin, but this seems now unlikely because those are much older (see SYMEONIDIS, 1975) than the oldest deposits known from the Limni-Istiea Basin proper.

The spatial and stratigraphical extensions of the different lithofacies within the basin are difficult to ascertain because exposures are limited, while lateral change of lithology and block faulting are common. Fig. 7 (after GUERNET, 1971) gives a schematic reconstruction of the situation (see also TELLER, 1880, GORCEIX, 1874; DEPRAT, 1904 and KATSIKATSOSETAL., 1980).

The section N of Limni shows conglomerates that overlie the pre-Tertiary basement (see Fig. 8). The contact between these units may be a normal sedimentary contact or a fault contact. Overlying the conglomerates near Limni is a section of marls and fresh water limestones (± 150 m thick), which contains poor lignites and which may be rich in fresh water molluscs. In other parts of the basin the lacustrine sediments are absent and there the section consists of sands and conglomerates only, while in yet other sections the lacustrine sediments are disconformably overlain by conglomerates.

Distinction between a lower and an upper series of conglomerates, as has been suggested by DEPRAT (1904) and others, may be possible locally, but can not be mapped throughout the basin.

The top of the section consists of the so-called marls and travertinous nodular limestones with *Brotia escheri* which are reported to have, at least locally, a disconformable contact with the underlying Neogene (DEPRAT, 1904).

The section of marls, fresh water limestones and poor lignites exposed near Yialtra is considered to belong to the Limni-Istiea Basin in spite of its present isolated occurrence (see Fig. 6).

The age of the deposits in the Limni-Istiea Basin

Age estimates for the various formations have been based on different groups of fossils such as mammals (CORDELLA, 1878; WOODWARD, 1901; MITZOPOULOS, 1947), molluscs (DEPRAT, 1904; GUERNET, 1971), pollen and spores (GUERNET & SAUVAGE, 1969; SAUVAGE ET AL. 1972). The conglomerates as well as the at least partly lateral equivalent lacustrine marls and limestones are generally attributed to the late Miocene and Pliocene, whereas the travertinous limestones that form plateaus on northern Euboea are considered to be of Plio-Pleistocene age. Judging by the fauna lists of various authors all the associations of larger mammals (all collected from the relatively

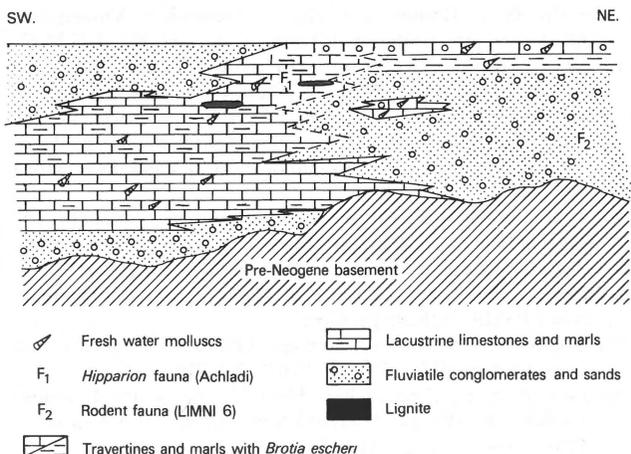


Fig. 7
Schematic section through the Neogene-Pleistocene deposits of N. Euboea (not to scale) reconstructing the relative position of the various lithologies (emended after Guernet, 1971).

coarse-grained fluviatile deposits) are similar and seem to indicate a Turolian Age.

CORDELLA (1878) mentioned finds of *Gazella* sp. and *Hipparion* sp. from near Limni, while WOODWARD (1901), listed *Hipparion* sp., *Gazella brevicornis*, *Ichthyerium* sp. and *Orycteropus* sp. from a locality near Prokopion. Unfortunately we have been unable to relocate these localities. MITZOPOULOS (1947) described a similar assemblage from near Achladi listing *Hipparion mediterraneum*, *Hipparion* cf. *brachypus*, *Tragoceras amaltheus*, *Potamochoeurus hyotherioides* and *Paleoryx* cf. *palasii*. The Achladi locality is situated relatively high in the local conglomerate succession.

Sampling from the relatively well-exposed section in the lacustrine facies NE of Limni during the summers of 1976 and 1977 has produced a number of rodent associations. Most of these are quite poor and do not allow an adequate biostratigraphic assignment. The one from Limni 6, (see Fig. 7) yielded a rich assemblage containing *Mimomys* cf. *polonicus*, *Mimomys* cf. *septimanus*, *Pliomys hungaricus*, *Orientalomys similis*, *Micromys praemurinus*, *Rhagapodemus frequens athenensis*, *Apodemus dominans*, *Eliomys* sp. and *Myomimus roachi* (see DE BRUIJN & VAN DER MEULEN, 1979). This assemblage collected from the upper part of the section of lacustrine deposits contains a number of characteristic arvicolids and murids indicative of an Early Villanyian Age and is considered to be younger than the assemblages of larger mammals mentioned above. Limni, 3 however, a locality in the lower part of the section yielded a few molars of *Apodemus* sp., *Occitanomys* cf. *brailloni* and *Promimomys* sp. indicating an Early Ruscinian (Early Pliocene) Age.

It is suggested that the low-energy and high-energy sediments are largely time-equivalent and do not show the superposition as in the Aliveri-Kymi and the Palioura-Gides Basins.

A sample from the section of lacustrine deposits near Yialtra has produced some poor *Mimomys* remains which, though inadequate, suggest an Early Pleistocene Age. This

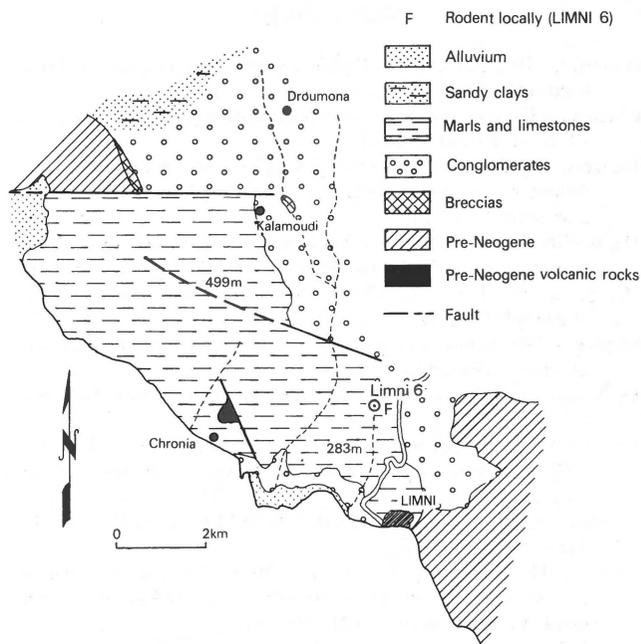


Fig. 8
Geological map of the area north of Limni (N. Euboea) showing the position of the vertebrate locality Limni 6.

age determination is supported by the presence of *Elephas meridionalis* (PSIARIANOS & THENIUS, 1953) and of a Plio-Pleistocene sporomorph association described by SAUVAGE ET AL. (1972) from the same deposit.

CONCLUSIONS

The Neogene-Pleistocene sediments in the basins of Aliveri-Kymi, Palioura-Gides and Limni-Istiea can be divided into a low-energy (lacustrine) part and a high-energy (fluviatile) part. In the Aliveri-Kymi Basin the fluviatile sediments overlie the lacustrine sediments, in the Palioura-Gides Basin the two lithologies are partly lateral equivalents and in the Limni-Istiea Basin the fluviatile sediments partly underlie, are partly lateral to, and partly overlie the lacustrine deposit.

The inadequate paleontological evidence available so far from the fluviatile deposits of these basins suggests that they are all of Turolian Age and that they may be related to one period of rejuvenation of the relief. Our collections of rodents from the lacustrine deposits of the three basins suggest that sedimentation started in the Aliveri-Kymi Basin in the Early Miocene (Early Aragonian), in the Palioura-Gides Basin in the Late Miocene (Vallesian) and in the Limni-Istiea Basin possibly in the Latest Miocene (Turolian).

The lignite occurrences of the three basins are successively dated as Early Aragonian (MN3), Vallesian (MN10) and Villanyian (MN16). Lignite formation in the area seems therefore to have been primarily determined by the local conditions of sedimentation within each basin and not by climatological factors.

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